2. THE PANEL PROCESS

This section of the report:

- briefly summarises the matter before the Panel;
- records the appointment, functions and terms of reference of the Panel in relation to ongoing environment assessment processes; and
- summarises the Panel hearing process undertaken.

The following more detailed matters are considered in Appendices A to D which include:

- records of submissions referred to and considered by the Panel;
- the Panel's Terms of Reference;
- consideration of Panel directions made to guide its public hearing process; and
- records of public hearings and appearances before the Panel.

2.1 THE ENVIRONMENT EFFECTS STATEMENT

2.1.1 THE PROJECT & PROPONENT

The project considered in this report consists of proposals to deepen shipping channels in Port Phillip Bay by dredging, enabling ongoing access by deeper draught vessels to existing wharfage and related facilities in the Port of Melbourne.

At the project outset, the former Victorian Channels Authority was the proponent. Following the establishment of the Port of Melbourne Corporation (PoMC), responsibility for the project passed to the latter body. As the means of delivering the project were refined, an alliance contract was proposed under which PoMC would deliver works jointly with a dredge undertaking, Boskalis Australia Pty Ltd (Boskalis). At all times relevant to the Panel process, the project proponent was either PoMC on its own account or as a component of the alliance with Boskalis. All references in this report to the 'proponent' should be taken to refer to PoMC, inclusive of appropriate action from the Alliance and or Boskalis, unless the text specifically indicates otherwise. All references to the 'Alliance' refer specifically to PoMC and Boskalis in their alliance capacity, again unless the text specifically indicates otherwise.

2.1.2 THE ENVIRONMENT EFFECTS STATEMENT PROCESS

An Environment Effects Statement (EES) was prepared for the project under the *Environment Effects Act 197*8. This was publicly exhibited for a period of 6 weeks between 5 July 2004 and 16 August 2004.

The project is also a controlled action for the purposes of the *Environment Protection & Biodiversity Conservation Act 1999* (Cwth). The Victorian EES has been accredited by the Commonwealth as the means of assessment for the purposes of *the Environment Protection & Biodiversity Conservation Act 1999*.

2.1.3 SUBMISSIONS

845 submissions were made during the exhibition period and were referred to the Panel for consideration. An additional 61 late submissions were made between 17 August and close of business on 20 September 2004. The Minister for Planning directed that these late submissions be referred to the Panel. However, in doing so the Minister also directed that the Panel in the interests of expedition should not consider submissions received on or after 21 September 2004 (the commencement date of the Panel's full hearings). Further to the Minister's directions, a number of submissions received between 21 September 2004 and 9 February 2005 are not considered in this report. It follows that the Panel has considered a total of 906 submissions. A full record of submissions considered by the Panel is set out in the Appendices.

2.2 THE PANEL

2.2.1 APPOINTMENT

The Minister for Planning appointed the Panel on 5 August 2004 pursuant to Section 9 of the *Environment Effects Act 1978.* It was appointed to hold a public inquiry in respect of the EES prepared for the project and submissions received.

The Panel consisted of:

- Chairperson: Mr Rynd Smith;
- Member: Dr Bronwyn Ridgway;
- Member: Dr David Smith; and
- Member: Mr Nick Wimbush.

Matters germane to the appointment of the Panel including declarations of interests are included in the Appendices.

The Panel was assisted by many, but particular thanks are due to:

- Mr Michael Crossman (Panel Research Officer);
- Ms Diana Michetti (Panel Coordinator); and
- Mr Adrian Williams (Panel Business Manager).

2.2.2 TERMS OF REFERENCE

The Panel was appointed with Terms of Reference made by the Minister for Planning on 11 August 2004. The key tasks provided for in the Terms of Reference can be summarised as follows.

- Inquire into the potential environmental effects - including physical, biological, social and economic aspects - of the Port of Melbourne Corporation's proposal to deepen the main commercial channels that provide access to the Port of Melbourne for vessels with a draught of up to 14m, at any state of tide.
- Consider the exhibited Environment Effects Statement (EES), all submissions received in response to the exhibition of the EES, and other relevant information provided to or obtained by the Panel.

- Advise on:
  - whether potential adverse environmental impacts of the project are capable of being effectively managed to achieve acceptable environmental outcomes, in the context of relevant legislation and policy;
  - the implications of the project for matters controlled under the Environment Protection and Biodiversity Conservation Act 1999;
  - matters of project design and operational methods that need to be prescribed to ensure acceptable environmental outcomes, while having regard to the cost-effectiveness of design and operational options; and
  - an appropriate framework for managing the environmental performance of the project, including for environmental monitoring, controls and project governance.
- To conduct a public hearing and make such other inquiries as are necessary for the Panel to inform itself in relation to the project and its environmental effects.

The following matters are *not* within the Panel's Terms of Reference:

- Alternatives to the Port Phillip Bay Channel Deepening;
- Land-side port development or upgrading of transport infrastructure which may be indirectly associated with improving access to the Port achieved by the proposed channel deepening;
- The relocation of infrastructure services crossing the lower Yarra; and
- The financing of the Port Phillip Bay Channel Deepening Proposal.

A full copy of the Terms of Reference can be found in the Appendices.

The Panel has also paid close regard to the assessment guidelines for the project as issued by the then Department of Infrastructure in October 2002[1].

2.2.3 THE PANEL REPORT IN THE ASSESSMENT PROCESS

Following submission and consideration of this report, the Victorian Minister for Planning will make a formal assessment of the effects of this project under the *Environment Effects Act 1978,* referred to below as the Minister's Assessment.

The Minister's assessment in turn supports two further decision-making processes:

- consideration by the Victorian Minister for the Environment and Conservation pursuant to Section 37 of the Victorian Coastal Management Act 1995 (although the intention to use this legislation as the primary approvals power is a matter considered further by the Panel below); and

1 "Assessment Guidelines for the Port Phillip Bay Channel Deepening Environment Effects Statement", Department of Infrastructure, October 2002.

- consideration by the Commonwealth Minister for the Environment pursuant to the following Sections of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999:
  - Sections 16 and 17B (wetlands of international importance);
  - Sections 18 and 18A (listed threatened species and communities);
  - Sections 20 and 20A (listed migratory species); and
  - Sections 26 and 27A (protection of the environment from actions involving Commonwealth land).

2.3 THE HEARING PROCESS

2.3.1 DIRECTIONS

A Directions Hearing was held on 31 August 2004 in Hearing Room 2 at Planning Panels Victoria, 11/80 Collins Street, Melbourne 3000.

A number of directions were made that bore largely on the conduct of public hearings. These directions were augmented at various stages during the later public hearings.

Having been made for procedural as opposed to substantive purposes and having in broad terms been complied with, most directions do not require to be discussed in this report: their function has been discharged. Issues in relation to directions that gave rise to contention or required consideration in detail are summarised in the Appendices.

2.3.2 PUBLIC HEARINGS

Full public hearings were held at Hearing Room 2, Planning Panels Victoria, 11/80 Collins Street, Melbourne 3000. These commenced on 21 September and concluded on 17 December 2004. The Panel sat for 45 days.

All submitters whose submissions were referred to the Panel were provided with an opportunity to be heard. Those who requested to be heard were heard, with the exception of a limited number of parties who did not attend the hearing at their appointed time and provided no explanation to the Panel.

The panel has considered all written and oral submissions and all material by way of evidence or background information presented to it in connection with this matter with great care.

The Panel has inspected the areas proposed for channel deepening and spoil dumping using a vessel equipped with multi-beam sonar. It has also visited Newport Power Station.

3. THE POLICY CONTEXT

This section of the report:

- records the legislative and policy framework that the Panel has considered as applying to the project and its deliberations; and
- sets out a summary response to the policy environment.

Detailed analyses and responses to the identified policies are found in the Appendices.

3.1 THE POLICY FRAMEWORK

The policy framework considered by the Panel is set out below. All references are Victorian unless separately annotated:

- Primary Environment Assessment & Protection Legislation & Policy
  - Environment Protection & Biodiversity Conservation Act 1999 (Cwth)
  - Environment Effects Act 1978
  - Environment Protection Act 1970
  - Planning & Environment Act 1987
- Relevant Generic Policy
  - National Strategy For Ecologically Sustainable Development 1992 (Cwth)
  - Inter-Governmental Agreement On The Environment 1992 (Intergovernmental)
  - Growing Victoria Together
  - Melbourne 2030
  - Linking Victoria
- Ports & Freight Legislation And Policy
  - Port Services Act 1995
  - Channel Deepening Facilitation Bill
  - Victorian Ports Strategic Framework 2004
  - Melbourne Port@L 2002
  - Victoria: Leading The Way 2004
  - Shaping A Prosperous Future, Prospects Issues And Choices, 2003
  - The Next Wave Of Port Reform In Victoria 2001
  - Linking Melbourne - Metropolitan Transport Plan 2004
  - Future Directions 2001
- Marine & Water Environment Legislation And Policy
  - Quarantine Act 1908 (Cwth)
  - National Ocean Disposal Guidelines For Dredged Material 2002 (NODG) (Cwth)
  - Australia's Ocean Policy 1998 (Cwth)

  - Australian & New Zealand Water Quality Guidelines For Fresh And Marine Waters 2000 (Intergovernmental)
  - Coastal Management Act 1995
  - Marine Act 1988
  - Pollution Of Waters By Oil & Noxious Substances Act 1986
  - State Environment Protection Policy (Waters Of Victoria) 1988
  - State Environment Protection Policy (Waters Of Victoria): Schedule F6 Waters Of Port Phillip Bay 1997
  - State Environment Protection Policy (Waters Of Victoria): Schedule F7 Waters Of The Yarra Catchment 1999
  - State Environment Protection Policy (Groundwaters Of Victoria) 1998
  - Waste Management Policy (Ships' Ballast Water) 2003
  - Industrial Waste Management Policy (Waste Acid Sulphate Soils) 1999
  - Best Practice Environmental Management Guidelines For Dredging 2001 (BPEMGD)
- Resource Conservation & Management Legislation & Policy
  - EPBC Act (Cwth)
  - Fisheries Act 1995
  - National Parks Act 1975
  - Crown Land (Reserves) Act 1978
  - Flora & Fauna Guarantee Act 1988
  - Wildlife Act 1975
  - Water Act 1989
  - Water Industry Act
  - Catchment And Land Protection Act
  - Land Act
  - Victoria's Biodiversity Strategy 1997
  - Victoria's Native Vegetation Management: A Framework For Action 2002
- Cultural Resource Legislation & Policy
  - EPBC Act (Cwth)
  - Native Title Act 1993 (Cwth)
  - Aboriginal & Torres Strait Islander Heritage Protection Act 1984 (Cwth)
  - Historic Shipwrecks Act 1976 (Cwth)
  - Archaeological & Aboriginal Relics Preservation Act 1972
  - Heritage Act 1995
- Noise Policy
  - SEPP (Control Of Noise From Commerce, Industry And Trade) 1992 (N-1)
  - Interim Guidelines For Control Of Noise From Industry In Country Victoria Publication 1989 (N-3)
  - EPA Noise Control Guidelines (Construction)
- Air Policy
  - SEPP (Ambient Air Quality) 1999
  - SEPP (Air Quality Management) 2001
  - Industrial Waste Management Policy National Pollutant Inventory

  - Victoria’s Greenhouse Strategy 2002
- Tourism And Recreation Policy
  - A Medium To Long Term Strategy For Tourism – Green Paper 2003 (Cwth)
  - Victoria’s Tourism Industry Strategic Plan 2002-2006
  - Melbourne Surrounds Regional Tourism Development Plan 2004 – 2007
  - Victoria's Food And Wine Tourism Plan 2004 – 2007
  - Victoria's Adventure Tourism Action Plan 2002-2004
  - Victoria’s Nature Based Tourism Directions And Opportunities For Victoria 2000 - 2003
- State Planning Policy Framework (SPPF)
- Local Planning Policy Framework (LPPF)
- Other Legislation & Policy
  - Occupational Health And Safety Act
  - Essential Services Act
  - Electricity Industry Act
  - Mineral And Resources Development Act
  - Gas Safety Act
  - Pipelines Act
  - Health Act
  - Seafood Safety Act
  - Victorian Shellfish Quality Assurance Program (VSQAP)
- Other Relevant Documents
  - Dredging Strategy For The Port Waters Of Geelong And Melbourne- Environmental Management Plan 2000
  - Victorian Emergency Management Manual
  - Melbourne Port Emergency Management Plan 2004 (Not Sighted)
  - Port Phillip Region Marine Pollution Contingency Plan 1999 (Last Update, June 2003)

A more detailed policy discussion is included in the Appendices.

3.2 SUMMARY RESPONSE

Detailed Panel responses to key legislative and policy drivers are found in the Appendices. They are also called up in the discussion of issues in the following chapters where necessary.

The project is clearly supported by Government policy, subject to the proviso that it can be delivered in a manner that leads to acceptable environmental effects.

However, as an overall response to the materials reviewed, the Panel must record the following key directions:

- A key concept emerging from many directions under relevant policy and legislation is that of best practice. It appears to be a widespread expectation of government that a project such as that before the Panel should demonstrate application of best practice techniques. However, as will become clear below, the Panel does not consider that the project as advanced represents best practice.

- Bodies of relevant legislation set out environmental principles that should apply to the project. These include:
  - The **principle of integration** (under which environmental decisions should integrate economic, social and environmental considerations), including the following position:

    > *measures adopted should be cost-effective and in proportion to the significance of the environmental problems being addressed* [;][2]

    However, in general terms, the Panel finds that the proponent has not well integrated and balanced its advocated position in a 'triple bottom line' or related sense. It follows that the Panel finds that the project often does not represent an optimised position in economic, social and environmental terms. Considerable further work is required to achieve optimisation.
  - The **precautionary principle** (under which scientific uncertainty should not be used as a justification for postponing measures or action necessary to prevent environmental degradation in the face of possible serious or irreversible environmental damage).

    The Panel finds that a lack of assessment and scientific uncertainty as to the outcomes of key proposed measures in the project (particularly those relating to the disposal of contaminated sediments and the generation of turbidity) do pose the risk of possible serious or irreversible environmental damage. In terms of risk assessment, methodological flaws in the risk processes employed are such that the proponent cannot identify with rigour and clarity the significance and relative weights of the risks posed. The risk assessment accompanying the project requires complete re-evaluation.
  - The **principle of inter-generational equity** (under which the needs of future generations for environmental values and services should be considered in decision making alongside present needs).

    The Panel finds that where there is any significant potential for uncontrolled risks of significant environmental harm of an ongoing nature, and again it highlights sediment chemistry related risks, the project has not sufficiently responded to inter-generational equity requirements. The proponent must be clear that its measures will not generate ongoing environmental liabilities to be borne and/or remedied at great cost by future generations.
  - The **principle of conservation of biological diversity and ecological integrity** (under which decision making should seek to conserve these values).

    The Panel finds that the effects of the project on biological diversity and ecological integrity are largely contingent on the degree to which matters of sediment chemistry and turbidity impacts are properly controlled. In circumstances where it finds these have not been adequately controlled, the Panel cannot find that biological and ecological risks have been properly identified and assessed.

[2] All elaborations of principles are as stated in the Victorian Environment Protection Act, although other legislation and policy adopt very similar positions.

- the principle of improved valuation, pricing and incentive mechanisms (under which environmental decision making should support the development of appropriate mechanisms of market valuation and cost apportionment of environmental values and effects), including the following positions:

  (1) [e]*nvironmental factors should be included in the valuation of assets and services* [;]

  (2) [p]*ersons who generate pollution and waste should bear the cost of containment, avoidance and abatement* [the “polluter pays” principle] [;]

  (3) [u]*sers of goods and services should pay prices based on the full life cycle costs of providing the goods and services, including costs relating to the use of natural resources and the ultimate disposal of wastes* [; and]

  (4) [e]*stablished environmental goals should be pursued in the most cost effective way by establishing incentive structures, including market mechanisms, which enable persons best placed to maximise benefits or minimise costs to develop solutions and responses to environmental problems* [;]

  Economic analysis of the project undertaken to date has not fully examined the application of polluter pays/user pays principles. Nor are these principles fully integrated into the project’s statements of net present value or economic benefit.

- The principle of the wastes hierarchy which operates as follows:

  [w]*astes should be managed in accordance with the following order of preference—*

  (a) avoidance;

  (b) re-use;

  (c) re-cycling;

  (d) recovery of energy;

  (e) treatment;

  (f) containment; [and]

  (g) disposal.

  The Panel is clear that the project has not applied the waste hierarchy to the generation of dredged materials. The Panel is clear that opportunities to avoid the generation of material in both capital and maintenance terms have not been fully taken: the channel designs still require to be optimised. Only the most cursory evaluation of re-use, re-cycling and treatment options has taken place, despite a twenty year history of such methods being deployed in the industry in Europe. The effect is that the project seeks to avoid re-use, re-cycling and treatment options in favour of straight disposal options. Energy recovery is not a relevant component of the hierarchy for this project. Containment proposals for chemically contaminated materials advanced in the project appear inadequate to task.

- The principle of integrated environmental management (under which the most balanced environmental outcome must be sought in matters that impact on more than one environmental segment or value).

  Again, as with the principle of integration, the lack of optimised and balanced solutions suggests that the project does not comply with this principle.

- The **principle of accountability**, which has a particular bearing on decision making and public inquiry processes and provides:

  (1) [t]*he aspirations of the people of Victoria for environmental quality should drive environmental improvement* [;].

  (2) [m]embers of the public should therefore be given—

  (a) access to reliable and relevant information in appropriate forms to facilitate a good understanding of environmental issues;

  (b) opportunities to participate in policy and program development.

  Here the Panel considers that the people of Victoria have real aspirations for environmental improvement. It is not unreasonable that the Port be asked to manage channel deepening and dredge programs to reduce environmental impacts, in line with established international best practice.

  The Panel also notes that information provided by the proponent pursuant to assessment and decision making processes has not always been of adequate quality and reliability. The non-availability of relevant material (such as the Stage 2 sediment chemistry evaluations) has also reduced rather than expanded opportunities for participation.

That being said, the Panel does not consider that this indicates against the principle of the project. It ought to be possible, having regard to relevant policy and best practice, to configure the project in a way that meets best practice and meets thresholds of compliance. However, these are matters that the Panel strongly believes require further consideration by the Minister, Government and the proponent before an assessment of environmental effects is made.

4. THE EES PROCESS

This section addresses matters of EES process that are relevant to the Minister for Planning's decision. Submissions referred to the Panel raised the following concerns:

- the EES was poorly written and presented in that it lacked basic document tools such as an index or page referenced table of contents, was too long, was repetitive or otherwise contrived to impede effective use and comprehension;
- the EES was incomplete and/or that the incompleteness was of such a nature that the EES was somehow 'invalid' in law;
- that specific material sought to be relied upon by the proponent was not exhibited; and
- that other material sought to be relied upon by the proponent was not called in evidence and that only limited weight should be ascribed to it.

4.1 AN EFFECTIVE EES?

Discussion

Issues of the effectiveness of the EES as a set of documents were raised by both written and verbal submissions before the Panel.

Submitters were concerned that the EES was long, but that length did not equate to sound and well argued responses to the many individual issues raised by it. Rather, the length appeared to result from a less than adequate marshalling and organisation of data in the EES. At worst, it was construed by some as a deliberate mechanism to obscure relevant data without omission, by surrounding it with large volumes of additional but not necessarily directly relevant data. Others saw the volume of the documentation as an attempt by the scale of material reproduced to reduce the capacity for and likelihood of any third party reader 'making it' to the end of the documents and hence gaining a sound understanding of the issues.

This position was compounded in the eyes of some by the absence from the EES documents of some basic tools, normally found in documents of more than a few pages in length. Of most concern to parties were:

- the lack of a proper study-wide table of contents for the EES volumes;
- the lack (in respect of material that made regular and deep references to scientific literature), of any systematic, study-wide bibliography and method of citation; and
- the lack of any sort of subject index to guide readers through the many locations within the voluminous document set at which references to an individual issue or subject might be found.

A number of submitters expressed concerns about the structure of the EES documents, suggesting that they tended to pass and re-pass over relevant subject matter, as opposed to resolving issues and impacts in one location. This approach reinforced the difficulties of many readers with the documents, making the text reiterative in nature.

Panel Response

As a starting point in its consideration of EES process and of the effectiveness of the EES as a document, the Panel notes that the documentation is of unprecedented and formidable scale. Perhaps the size of the exhibited EES documentation can be best conveyed through the size of a Table of Contents which was eventually supplied to the Panel pursuant to its directions, part way through the hearing process. The Table of Contents alone is 80 pages long. The exhibited EES documentation comprises over 6000 pages of detailed technical material. Since the closure of the exhibition period, this material has been augmented by further material that the Panel estimates as amounting to some 3000 further pages of data, comprising submissions, expert evidence and responses to Panel questions by the proponent alone. No account in this estimate is made of documentation associated with third parties.

The volume of documentation in an EES need not itself be a concern, providing that the material is necessary and relevant to the environmental assessment of the project. However, volume becomes a concern in circumstances where there begins to be an imbalance or lack of clear relationship between the significance of an issue demanding complexity and rigour in analysis and the volume of the relevant component of the document. The Panel cannot help but observe that the EES in some cases does provide large volumes of analysis for relatively simple and less weighty issues, whereas highly significant issues obtain proportionally little more analysis.

A case in point here arises from a comparison of the treatment of visual impact issues in the Key Features and Initial Risk Assessment components of EES Volume 1 with sediment chemistry issues. Whilst not intending to in any way denigrate the significance of visual impact issues, the Panel must observe that in this project, most visual impact considerations in the terrestrial environment are readily comprehensible and, in comparison with the foundation stone nature of other issues, of relatively little weight. Marine visual considerations are clearly of greater weight, but do not appear to be of great technical complexity. In total, visual analysis in the two relevant components of EES Volume 1 received 24 pages of text. On balance, the Panel would suggest that this entailed an over-thorough and detailed analysis of this particular subject.

Sediment chemistry on the other hand is clearly a major and foundation stone issue, of significant analytical complexity, having a bearing on the feasibility and configuration of the project as a whole. An analysis of rigour in proportion to the significance of the subject matter could have been expected to be orders of magnitude larger than the visual impact analysis. However, the two relevant components of Volume 1 contain only 32 pages of text. As the Panel will observe more fully later in this chapter, the Volume 1 analysis of sediment chemistry also excluded reference to significant and relevant bodies of work amounting to many hundreds of pages in extent.

Many similar observations could emerge from other and equivalent case studies, with which the Panel does not propose to bore the reader. Suffice it to say that in terms of the overall construction and prioritisation of content in this EES, the Panel has formed a general and qualitative response that the document was not well balanced. A reader could not reasonably judge from the volume and level of analysis that the proponent or its independent expert advisors saw any one issue as being, on balance, of greater or lesser significance to the outcome than any other. In many ways, the reader of the EES could be excused for taking the material as being two dimensional, lacking any significant sense of the relative scale of issues.

Volume is a considerable concern in circumstances where a document lacks the normal tools by which volumes of material can be effectively searched, martialled and digested. In this regard, the Panel notes that the EES contained only the most rudimentary table of contents for the primary volume (Volume 1). This consisted of a list of the main chapter headings, with no page numbers whatsoever. When one has regard to the fact that each individual chapter is paginated and is also divided into a three tiered hierarchy of sections and subsections, addressing themes, and issues within themes, the lack of any master table of these makes Volume 1 very difficult to navigate.

Further, it must be noted that the EES also lacks a topic or subject index, (such as are typically found in contemporary policy documents such as Melbourne 2030), providing an alternative window into the masses of material placed before the public.

This situation is compounded when one turns to the supplementary volumes (Volumes 2 – 4). These contain a plethora of references to which there is no one single table of contents, reference table, or index. Nomenclature, structure and pagination methods vary substantially across this documentation. There is no single synthesis of the locations at which common theme data may be found. The situation is deeply compounded by the failure to deploy a clear citation system and bibliography for those aspects of the EES that rely on scientific literature. There is no simple way for the Panel to reference any quotations it takes from the seven volumes of the EES document for inclusion in their report.

The Panel finds this approach to have been unsatisfactory.

- It is inefficient for the proponent, which will have incurred significant avoidable legal and consultancy costs due to unnecessary the time spent in navigating the document set.
- It is inefficient for decision-makers and government for the same reasons in respect of public service, administrative, Panel and assessment costs. To this extent, the Panel found it necessary to direct the proponent to produce a document reference and navigation tool, for its own and parties use during the hearings. However, the Panel takes the view that this is a step that a Panel should not have to take (and in the experience of its Members no Panel has previously had to take).
- It is inappropriate for the public, who faced the challenge of resourcing their own use of the documentation, without the detailed technical assistance available within a government department or an EES consultancy team. Members of the public engaging in the exhibition stage of the EES in good faith had to navigate the document set, without the benefit of the Panel's directed document reference and navigation tool, which only became available during the hearing stage.
- The lack of basic tools such as a table of contents, subject index or bibliography is neither good nor indeed normal practice in generic document management or in the documentation of environment assessment.
- The failures to have a comprehensive EES-wide table of contents or to list page numbers in the limited Volume 1 table of contents are as a matter of principle unacceptable in a public document used for environment assessment.

On balance, the Panel takes the view that the EES document slipped below the threshold of what is both normal and acceptable in the practice of environment assessment in Victoria. However, that being said, the Panel is conscious that there are no rules or requirements and little guidance as to the form of EES documentation. Further, the Panel sees its primary role as to consider the content of the documents – the issues raised, as opposed to their form. For this reason it does not make any recommendation about matters of form – an approach which relates to that taken on questions of precursor legal 'validity' in section 6.2 below. However, it does find it necessary to make its view clear that the format and presentation of this EES was highly unsatisfactory. Considerable sympathies are extended to all who have sought and struggled in good faith to elicit issues and evaluation from such a poorly structured and un-transparent body of work.

4.2 A COMPLETE EES?

Discussion

The issue of EES completeness and validity was one that largely played out in the Panel's consideration of preliminary submissions at its first directions hearing. The Panel responded to it in Special Directions A, issued on 2 September 2004. For completeness in this report, the Panel has further examined the issues raised and its approach taken in those directions and considered whether they remain applicable.

The Blue Wedge Coalition (BWC) applied for an adjournment in order for the Panel to consult the Minister for Planning on its Terms of Reference. This request related to concerns that exclusions from the scope of the Panel's inquiry in the Terms of Reference had the effect of preventing the Panel from fully addressing the approved EES Assessment Guidelines and relevant requirements of Commonwealth and State legislation. Particular reference was made to the precautionary principle and, in relation to the Environment Protection and Biodiversity Conservation Act 1999, to the need to consider 'indirect impacts' pursuant to the decision of the Federal Court in the 'Nathan Dam' case – <u>Minister for Environment & Heritage</u> v <u>Queensland Conservation Council and WWF Australia</u> [2004] FCAFC 190.

The BWC application also sought to delay the hearing process to enable the proponent to address identified aspects of the EES. It was contended that there was insufficient or incomplete data in that the precautionary principle had not been met and/or the need to consider indirect impacts emerging from the Nathan Dam case could not be met. This request was supported by an 11 page summary review of suggested data or assessment deficiencies in the exhibited EES.

Both aspects of the application for an adjournment were supported by detailed written submissions (BWC Prelim 1 and BWC Prelim 2) that have been placed on the public record as part of the Panel's documentation.

Parties broadly representing dive industry, community and environmental interests supported the application for an adjournment. Whilst those speaking in support referred to different illustrative material, they concurred in supporting the underlying grounds on which an adjournment was sought by BWC.

The application was opposed by the proponent Port of Melbourne Corporation (PoMC) and by other parties. Grounds for opposing the adjournment in summary were as follows:

- An adjournment should not be granted by the Panel for it to seek changes to exclusions in its Terms of Reference, as Terms of Reference are not within the Panel's power to change. They are made by the Minister. If there are matters of concern about the current drafting of the Terms of Reference, including legal matters, these are matters for the Minister and her Department.
- The application for an adjournment is in any case a renewal of an old application that has been considered by other means and not granted. BWC (alongside other organisations) requested an extension to the EES exhibition period that would have amounted in effect to a delay in the commencement of the full hearing. This was considered by the Minister for Planning who resolved not to grant the application and circumstances appeared not to have materially changed since that decision was made.
- Further, the identification by BWC and other parties of issues in respect of which additional information or assessment was required amounted to questions of merit that should most properly be dealt with in a full hearing. The proponent had completed and exhibited an EES, which the Panel must now examine as its substantive task.

The adjournment sought was not granted. However, in refusing to grant the adjournment, the Panel's reasoning made clear that the issues raised were potentially ones of merit and substance to be considered as part of the full hearing process. It is this sense that these issues need to return for consideration here and in the remainder of this report.

Panel Response

In its issued directions, the Panel indicated that it considered the request made by BWC raised the following issues:

- *What is the nature of the relationship between an EES Panel and its Terms of Reference? and*
- *Whether BWC's concerns as to EES content are or should be dealt with as questions of process, or are rather questions of merit that require to be heard in a full hearing?*

The Panel and its Terms of Reference

The Panel's issued directions made clear:

> [t]*he Panel is not the author of its Terms of Reference. These are made by the Minister for Planning and, as their name suggests, form what amount to terms of the Panel's appointment. The Minister for Planning has a wide discretion as to whether and on what terms to appoint a Panel inquiry under the Environment Effects Act 1978. If the Minister appoints a Panel on certain terms, the Panel's obligation is to honour those terms. The Panel has no head of power to vary or amend its Terms of Reference. Further, the Panel cannot make declarations as to the validity of its Terms of Reference.*
>
> *The Panel has taken steps to ensure that the Minister (through her Department) is advised of the issues raised in the BWC submission. It will be for the Minister to determine what action (if any) requires to be taken.*

It should be noted in the latter regard that the Panel's Terms of Reference were not changed and remained the same on its final day of operation and discharge of duty through the submission of this report as they were when first issued.

The questions raised in submissions amount to questions of powers in relation to both the Minister and the Panel. In this regard, the Panel considers that its position as stated in its directions was correct.

- An EES Panel takes its head of power from the exercise of the Minister for Planning's discretion under section 9 of the Environment Effects Act 1978. It is not an equivalent to the Victorian Civil and Administrative Tribunal or to a Panel appointed under the Planning and Environment Act 1987, in that it does not have a specific head of statutory power for its actions that arises independently of the Minister's power. Its only power is that which flows from the Minister and her exercise of discretion under section 9 to 'hold an inquiry'. The situation of this Panel is therefore distinguished from that of previous EES Panels where questions of the power of the Minister to set Terms of Reference in a matter subject to an EES have arisen. In such cases (for example the Hazelwood EES) there has been a conflict of provisions between a Panel's Terms of Reference provided under the Environment Effects Act 1978 and the wider statutory powers of the same Panel appointed concurrently under the Planning & Environment Act 1987. However, that is not the case here, where the Panel is appointed under only one head of power.
- Further, an EES Panel is not a body that is in principle empowered to make a declaration of law.
- As the Panel is not appointed under the Environment Protection and Biodiversity Conservation Act 1999 but rather is part of a process accredited under that Act, it cannot avail itself of any of the direct powers of an inquiry directly appointed under that Act. It follows that no direct conflicts of provisions on powers arise between the Environment Effects Act 1978 and the Environment Protection and Biodiversity Conservation Act 1999.
- To the extent that questions as to the lawfulness of the Minister's actions in setting Terms of Reference arise in relation to the role of the EES as an accredited process under the Environment Protection and Biodiversity Conservation Act 1999 and questions of law within the Commonwealth jurisdiction, the Panel is not a body that can either declare the law or 'correct' Terms of Reference, even should a conflict of provisions between Terms of Reference and Commonwealth law appear to arise.
- To the extent therefore that the Minister seeks to appoint an EES Panel subject to terms and the Panel is not concurrently appointed under any other Victorian or Commonwealth legislation, it appears correct that the Panel should find itself bound by those terms.

Concerns as to lack of EES Content

One argument emerging from BWC submissions was that the exhibited EES contains insufficient material and analysis to be capable of being considered as a 'valid' document. A related argument was that the EES contains insufficient material to address the Assessment Guidelines or to enable relevant statutory obligations to be met. Following these arguments, BWC suggested that these substantive issues might be resolved as preliminary questions of process. If the EES itself is demonstrably inadequate to task, it might then be suggested that it somehow 'invalid' and hence that a public inquiry process should not commence until work has been done to make the EES 'valid'. In response to this position, the Panel in making directions found as follows.

> *That being said, this and previous Panels observe that there does not as a matter of law appear to be a clear definition of what must be comprised within an EES for the purposes of 'validity'. Past practice suggests that Panels and government assessing authorities have provided 'issues based processes'. Instead of focussing on the*

> *question of whether an EES is formally 'valid' or complete before a hearing commences, they have simply sought the necessary information to enable an assessment to be made, a process that typically continues until the conclusion of the Panel component of the EES process. If at the conclusion of a full hearing, the Panel is not satisfied that sufficient information is present or alternatively considers that requirements of the Assessment Guidelines or relevant legislation have not been met, it can find and recommend accordingly.*
>
> *The Panel sees no reason why this generally accepted process and approach should not be applied in this case. It appears wrong to artificially characterise the current concerns about 'knowledge gaps' as procedural in nature. By characterising these arguments as procedural, the Panel would be drawn to make an early and prejudicial judgement of what are clearly merits issues, without having heard anything more than summary submissions from BWC and extemporary responses from others. These matters are serious. They require to be tested in a full hearing, with the benefit of properly considered submissions and evidence from all parties.*

Having considered this position in full, the Panel remains of the view that there is not as a matter of law any primary requirement as to 'validity' of an EES that requires to be met before the commencement of a public hearing.

In reaching this position, the Panel notes that there has now been a full public hearing process in which the substantive concerns alleged to be the source of 'invalidity' were considered and have been addressed as required in this report below.

Some credit must also be given to the proponent in such circumstances: it had prepared an EES, which it believed to be worthy of public test. It had requested the process of public test and assessment to begin. The Department of Sustainability and Environment had authorised the commencement of that process. The proponent had the opportunity to withdraw from the Panel process before commencement if it wished to, but it made its judgement to remain. Whilst Panels must ensure procedural fairness, it is not their role to assert procedural barriers against their primary task to engage with the merits, unless there are good, sound and clear reasons to do so.

Finally, it was an article of government policy that the EES process, including the Panel's own hearing and reporting processes, should be expedited. Government is entitled to articulate policy, including policy as to process, and for this policy to be broadly complied with. In this regard, the Panel took all steps that were reasonably consistent with procedural fairness to parties and conformity with the rules of natural justice, to provide an expedited hearing and reporting process.

Whilst it was a valid article of government policy to provide an expedited EES *process*, it was no part of government policy that the substantive environmental assessment of the project should be anything other than of the normal rigorous standard. The Panel has applied this standard.

4.3 FAILURE OF EXHIBITION

Discussion

In written submissions and in the early stages of the Panel hearing, a number of submitters raised concerns that that EPA and Commonwealth guidelines on the characterisation and management of sediments for marine disposal had not apparently been met. Questions were raised within the Panel process about the data sources for proponent submissions and evidence on these topics. These concerns and questions led to the disclosure by the proponent on 7 October 2004 that a significant body of work on sediment chemistry analysis had not been made available at EES exhibition locations (although it had apparently been made available on at least some CD Rom copies of the EES made available to parties.)

The body of work concerned consisted of "Stage 2: Additional Environmental Survey Work", Dr Adam Cohen, Sinclair Knight Merz, (14 April 2004). This was a major report, providing detailed argument and analysis around a secondary round of sediment sampling and analysis, seeking to move the project towards compliance with the relevant EPA and Commonwealth Guidelines. The report was clearly known to the proponent, having been available in draft since late 2003 and in final form since April 2004. However, it became clear that despite this knowledge, subsequently drafted material including the main Volume 1 of the EES failed to refer to, cite or acknowledge this work in any but the most passing terms.

Further, as will become clear in later sections of this report, this report later became a key reference point for parties and the Panel in seeking to establish the validity and integrity of the sediment chemistry analysis undertaken for the EES as a whole.

Panel Response

The Panel would note from the outset that the failure by the proponent to exhibit "Stage 2: Additional Environmental Survey Work", Dr Adam Cohen, Sinclair Knight Merz (14 April 2004), is a serious failure in procedural terms.

In turning its mind to the consequences of not exhibiting a document, the Panel has considered the following questions.

- Is the document a substantial document, necessary to the proponent's and its consultants' formulation of views of the environmental effects of the project?
- When was the document available to the proponent and was it possible for it to have been exhibited?
- Could third parties have reasonably expected to rely on the document in forming their view on the EES (and to this extent, might the non-availability of the document have conditioned the decision of parties to submit or not to submit, or influenced the content of their submission)?

In relation to the second of these questions, the document on its face was available to the proponent in a final form in April 2004, considerably before the commencement of the public exhibition period. Its table of revisions suggests that its existence and potential to contain substantial and relevant information to be included in the EES would have been known to the proponent some 6-7 months before the finalisation of the exhibition version of the EES. It would in the circumstances appear reasonable that the document could have been exhibited.

In these circumstances, it is also germane to note that the Panel has not been provided with a clear explanation from the proponent as to why the document was not exhibited, the closest comment being that from Senior Counsel to the extent that it had been 'forgotten'. The Panel must remark that this is an explanation that it finds hard to credit, given the scale and significance of the body of work. However, even assuming it to be correct, the Panel considers that to forget to exhibit a significant document is a quality control error of startling scope that simply should not be made in an undertaking as significant as an EES.

It is also necessary to note the complete exclusion of reference to the document and the almost complete exclusion of reference to the involvement of Dr Adam Cohen from the exhibited EES Volume 1. A rigorous manual and electronic search of Volume 1 discloses no citation of a document entitled "Stage 2: Additional Environmental Survey Work" from any source. Searches for permutations of that title render an equivalent blank. Dr Adam Cohen is referred to only once, in Appendix D, as an unspecified 'technical specialist' within the Sinclair Knight Merz component of the team.

The Panel would be more prepared to accept the position that the document had simply been forgotten, were it not for the fact that Volume 1, the primary exhibited document that most interested third parties could be expected to read, had excluded all reference to it. This circumstance is such that it is not possible to exclude the possibility that a conscious decision was taken to exclude the document.

In short, the Panel will never know whether the document was deliberately or accidentally excluded from the exhibition process. However, whichever of these occurred, it was clearly possible for the document to have been exhibited and some remediating action is clearly necessary in circumstances where it was not exhibited.

In relation to the third question, as to whether third parties could have reasonably expected to rely on the document in forming their view on the EES, the Panel is clear that they could. Once the document was made available, some, and notably Dr Simon Roberts of Monash University, did rely extensively upon it. It is therefore possible to accept the view that the non-availability of the document combined with the lack of any reference to it in Volume 1 might have conditioned the decision of potential parties to submit or not to submit, or in turn have influenced the content of their submission.

For parties already within the process, the Panel notes that the document did become available at a sufficient time before the conclusion of evidence from Dr Adam Cohen, to enable both the Panel and parties to have perused it and factored it in to their questions and cross-examination. Once the significance of the document became apparent, the Panel made provision in its directions for Dr Cohen to return, with questions and cross-examination on the document reserved to a later date. In this way the Panel was clear that it and interested parties had sufficient opportunity to consider the document and then to raise necessary questions on it. It flows that in relation to the hearing processes under the direct control of the Panel, no breach of the rules of natural justice or procedural fairness has occurred.

However, the Panel can make no such statement in respect of the exhibition process, which took place under the control of others. It has no means of reassuring itself that there are not persons outside the Panel process who, had the Cohen material been available as it should have been, would have decided to make a submission and to be heard. Whilst the existence of such a party is notional at this stage, this does not undo the seriousness of the underlying procedural defect that has been generated by the non-exhibition of this material.

At this point, the question might validly be asked, 'if this matter of procedure is so serious, why did the Panel not then adjourn the hearing, and direct the undertaking of the relevant steps to enable it to be cured?' The answer to this question is complex and will emerge fully in the remainder of this report below. However, at this stage, it is important to record that the Panel deliberated long and hard over this very question. Its resolution not to adjourn the hearing was based on its then emerging and now concrete view that the sediment chemistry work was substantively as well as procedurally flawed.

It follows that, if the Panel had adjourned when the Cohen material was discovered and made provision for further exhibition and submissions, and had this led to a delay and the potential introduction of many new parties, would the content of this report have been affected in any way? In the Panel's view, the answer to this question must be no. The Panel has very substantive concerns about the adequacy of the sampling strategy employed, the non-representative nature of the sample suite, the lack of quality control of the analytical chemistry procedures, and their combined effect as a body of work on the consequences for project design and the choice of project technology. The Panel finds that a truly representative sample suite is required and that the samples should be analysed suing well managed quality control procedures for the integrity and soundness of the EES process. It should be subject to further exhibition and review.

The Panel recommends as follows:

The failure to exhibit the document "Stage 2: Additional Environmental Survey Work", was a significant procedural defect. The most expeditious remedy for potential parties procedurally disadvantaged by the non-exhibition of documentation will be to participate in the exhibition and public review of a successor document. The Panel recommends the replacement of the sediment sampling strategy and characterisation in the EES, and re-exhibition to enable public comment on this change and its consequences.

4.4 INDIGENOUS COMMUNITY CONSULTATION

Discussion

Another matter of procedural concern was raised by the proponent's Aboriginal Heritage consultant Mr David Rhodes. Mr Rhodes had informed the Aboriginal communities of the impending exhibition of the documentation and undertaken that copies of the EES would be provided. The EES study manager however did not inform Mr Rhodes of the exact exhibition date, nor did it directly inform the Aboriginal groups who were expecting to receive copies. It was not until towards the end of the exhibition period that Mr Rhodes learnt of this and promptly arranged for the documentation to be provided. This however did not occur until the last week of the exhibition period.

Various submitters drew the Panel's attention to unhappiness in some Aboriginal communities in respect to their opportunity for involvement, although the Panel notes that there were few submissions from these parties and none requested to be heard.

Panel Response

The Panel is concerned at the apparent failure of the proponent to honour consultative commitments made to Indigenous communities. It particularly notes that the provision of a major set of EES documentation to communities, with only a few days in which to read them before the closure of the exhibition period is not acceptable.

Strictly in law, the Panel considers that the EES was exhibited and that indigenous communities with concerns could have availed themselves of the public exhibition process, as opposed to the proffered but unfulfilled parallel process. That being said, had time permitted, it would have designed a mechanism that enabled this issue to be addressed in the processes under its own control. The Panel is conscious that traditional formal hearings are not looked upon as being culturally appropriate by some Indigenous communities.

The Panel does consider that ongoing efforts should be made to construct and retain sound relationships between indigenous communities and the proponent. These issues are explored further in the Chapter Human Effects below.

4.5 LACK OF EVIDENCE

Discussion

A final process issue raised by a number of parties was the lack of formal 'evidence' to support some critical positions advanced before the Panel by the proponent.

Concerns were raised that the EES documentation itself having said little about aspects of the specific choice of dredging technology or dredged material disposal and management techniques, had in turn not fully evaluated the environmental impacts of these.

In appearing before the Panel, the proponent then sought to address these concerns, but did so by making submissions, as opposed to the calling of formal evidence. Examples of this approach lay in:

- The introduction of detailed dredge technology and dredged material management information by way of submissions from the dredge undertaker Boskalis Australia Pty Ltd.
- The making of detailed statements by way of assessment and clearly of a scientific or technical authorship, as 'annexures' to legal submissions, as opposed to by way of evidence.

The use of both techniques was a cause of considerable concern to third parties who perceived that they lost rights of advance access to documents and to cross-examination that would have been available had the material been introduced as evidence.

Panel Response

It is correct that considerable volumes of material of a technical and expert nature were not included in the EES or admitted as evidence before the Panel, but were advanced by way of submissions.

The first major instance of this relates to the dredge undertaker Boskalis Australia Pty Ltd, introduced by way of submissions. Boskalis occupy what the Panel would characterise as 'grey territory' in the procedure of evidence before Panels.

Boskalis clearly had much to add to the analysis of the EES in terms of the detailed use of technology to achieve project objectives and also in key aspects of project design. Whilst the EES had identified the likely range of dredge technology to be used, it described these in the loosest of terms, for example (from EES Volume 1 at page 9):

> *The bulk of the work proposed to be undertaken in the approach channels [...] would probably be done with a large Trailer Suction Hopper Dredge ('Trailer'). In places where the bed material is too hard to dredge directly with a Trailer, a Cutter Suction Dredge ('Cutter') would probably be used. … This harder material could also be loosened with a hydrohammer. … To trim slopes in the Yarra River it is most likely that the contractor would use a Backhoe Dredge ('Backhoe'). To assist with levelling the sea bed during and after dredging, a sweep barge may be employed[3].*

[3] Panel emphasis.

The proponent made clear that the dredge technology analysis in the EES was generic. The EES team did not contain ongoing access to an independent expert on dredge technology. From this standpoint, the proponent could not field an independent witness capable of standing before the Panel and justifying the selection of a particular dredge technology portfolio, or discussing its specific environmental effects.

Nevertheless, as the Panel will make clear in its analysis below, the selection and performance of dredge technology can be critical to an assessment of environmental effects. Until a precise technology portfolio is known, it cannot be stated conclusively that dredge methods are ‘fit for purpose’ or are ‘best practice’ methods. For example it will not be known that particular turbidity effects are likely to result from dredging in particular locations. To provide another example, it will not be known whether sediments will be recovered in largely solid or fluidised form. It will follow that detailed prescriptions for their disposal and management cannot be made, a fact that underpins the failure of the EES to adequately come to terms with or assess the proposed containment of contaminated material from the Yarra, as will be seen below. In short, at the generic and inexpert level of technological discussion available in the EES team and documentation, an environmental assessment of the choice of dredge technology are difficult to articulate.

Boskalis was clearly in a position to (and did) fill in most of these blanks and lead the Panel and parties towards a detailed appreciation of the actual effects of the technology to be deployed. As a major dredge contractor, they are clearly experts in their field. However, by the time they came before the Panel, they were no longer independent. They formed part of the proponent, as a party to a concluded alliance contract. It was therefore not proper for their personnel to be called as expert witnesses, or for the Panel to accord their material the weight due to the evidence of an independent expert.

That being said, by seeking to introduce their material by way of submissions alone, the proponent was also seeking a considerable procedural advantage. Neither the Panel nor third parties had advance sight of the Boskalis material or were able to appreciate its potential significance in answering questions about actual environmental effects, until the point of its delivery. It was clearly material on which the proponent sought to place detailed technical reliance, over and above that actually published in the EES. It was for this reason that the Panel directed that the Boskalis material had to be open to a fuller questioning than is normally appropriate for submissions. It also directed that the material had to be documented and lodged on the Panel document table.

The Panel considers that these procedural steps went some considerable way towards curing the otherwise legitimate concerns of third parties that they had no means of obtaining prior knowledge of or questioning significant technical material on which the proponent sought to rely. On reflection, the Panel considers that it would have been desirable that the proponent had engaged separately and called a person of sufficient independent expert standing to give evidence on the choice of dredge technology. Alternatively, it would have been appropriate for Boskalis to have been so called, had they not been formally engaged by the time of the Panel hearing and effectively formed part of the proponent. However, in procedural fairness, the Panel considers that no great harm was done. It urges that proponents before Panels should recognise that where they seek to rely on the technical and expert submissions from an internal or non-independent body to make their case, this material should be treated as though it were evidence. It should be documented and circulated in advance and it should be cross-examinable.

Turning to the question of the introduction of expert analysis as ‘annexures’ to legal submissions, the Panel would remark that this is a dubious and borderline practice. It tends to damage and belittle the weight and effectiveness of legal submissions, as the authorship of the document is clearly not in the advocate before the Panel or their instructor. Nor does the document contain genuine submissions on points of law (which are entitled to be treated with expert weight when advanced by Counsel) or on merits. The submission has ceased to perform its clear function. However, the material has not been formally heard as evidence and has not been cross-examined. It cannot be accorded the weight of an expert witness statement. Such 'annexures' are the worst of both worlds: neither submissions nor evidence, they sit at the procedural margins of a Panel hearing and serve only a limited useful function.

Concern must be expressed about the potential for their use as a means of enabling experts to express views without being subject to appropriate questioning and test. This Panel has been very guarded indeed in its references to these 'annexures' and has always been mindful that a proposition sought to be established within them may not necessarily have appeared so solid if it had been subject to advance disclosure and questioning. This is an issue that finally reduces the weight that can be ascribed to these documents.

The Panel has a concern about their use to set out technical rebuttal in relation to the position of particular third party submitters or witnesses. The clear instance here relates to the material of Captain Hart, where the proponent sought to introduce the expert opinion of the Harbour Master and the Port Phillip Sea Pilots in rebuttal. These persons were not submitters and had not been called to give evidence. Their employment to give 'evidence in absentia' by way of annexure reduced Captain Hart's reasonable opportunity to know the expert case against him or to rebut it by putting issues directly to those experts raising concerns.

Whilst not making a formal recommendation, as a point of principle the Panel considers that where an EES proponent seeks to rely on internal or non-independent but clearly expert advice before a Panel, this advice should be documented in advance, circulated between the parties and (subject to the Chair's discretion) cross examined.

The practice of introducing the evidence of experts in absentia by way of annexures in legal submissions that go beyond the role of an advocate is procedurally doubtful. It should not be encouraged before future EES Panels.

4.6 SUMMARY

Drawing this material together, the Panel's findings in summary are as follows.

The exhibited EES document set was poorly drafted, over lengthy and reiterative. It did not present a coherent statement and balance of issues bearing on the project.

Key documents tools such as a complete table of contents with page references, a bibliography or a subject index were missing.

There is no legal test of the 'validity' as such of an EES. Matters raised by parties as procedural questions of preliminary validity in fact amounted to substantive concerns about the EES that are examined further below.

The Panel finds that the failure of the proponent to exhibit the document "Stage 2: Additional Environmental Survey Work" by Dr Adam Cohen of Sinclair Knight Merz dated 14 April 2004, was a significant procedural defect that requires to be remedied. However, that remedy will most expeditiously be provided through the medium of the Panel's substantive recommendations in relation to sediment chemistry.

Concerns arise as to the processes used to engage Indigenous communities with the exhibited EES material.

Aspects of the proponent's approach to the bringing of technical and expert material before the Panel were procedurally unsatisfactory and lead to a reduction in the weight that can be accorded to that material.

5. PROJECT DEFINITION

This chapter addresses the definitions of the project as set before the Panel by the proponent and issues raised in submissions related to those definitions. It considers:

- the need to achieve an understanding of project scale;
- the project description advanced before the Panel and changes to this;
- the key issue of design at The Heads as a component of project description; and
- the inclusion or otherwise of 'interface' works at berths;

It concludes by setting out a summary of the Panel's current understanding of the project requirements as they move forward to impact assessment.

5.1 PROJECT SCALE

Discussion

The nature and enormous scale of this project appear to be difficult for people to comprehend. The proponent and many parties before the Panel appeared to experience considerable difficulty in expressing the scale and significance of the project within clearly defined and justified boundaries as to action and effect.

In starting, it must be noted that the EES documentation does not contain a consolidated or complete description of the works or actions that are proposed by the proponent. As a result, members of the public, relevant industry sectors, government agencies and the Panel have had to put considerable effort into sourcing and summarising fundamental project information. This includes the existing and proposed depths and widths and hence the degree of deepening or widening of the channels. They and we have found it necessary to try to 'pin down' the fundamental physical components of the project.

Without well defined boundaries, much of the EES and documentation presented to the Panel has been focussed on defining and assessing the impacts associated purely with the channel enlargement and the dumping of spoil. Little evidence was provided in relation to other proposed works such as berth protection and upgrades, the protection of other services, ongoing maintenance and the ongoing use of the channels.

The Panel has been attempting to understand the scale, effects and costs of the project in a situation where there is a basic lack of clarity as to what is within the project and what is not. These circumstances, the Panel must state at the outset, do not augur well for effective, efficient, or value for money project implementation, to say nothing of the chances for robust environmental impact assessment.

However, in summary terms from many sources, the proponent's preferred project concept can be described as follows:

- Deepening, widening and realignment of channels and berths in the declared waters of the Port of Melbourne and the construction associated with these works.

- Reinforcement and/or reconstruction of berths/docks in the Port of Melbourne.
- Protection works to other infrastructure and services (noting at this point that the Panel's Terms of Reference precluded assessment of some works for services in the lower Yarra and that these have been the subject of a separate referral to the Commonwealth under the *Environment Protection and Biodiversity Conservation Act 1999*).
- Disposal of spoil in a new Dredged Material Ground (or 'DMG') in the south of the bay.
- The additional use of and extension to the existing Port of Melbourne DMG.
- Maintenance dredging in the South Channel up to the year 2030.
- Ongoing use of the channels for larger vessels to the year 2030.

Such statements are, however, somewhat bald and do not place the project within a scale of other human undertakings. In reading this report it is necessary to understand that by all measures, the project before this Panel is a 'mega-project' and of a significant scale in terms of global infrastructure.

To provide some sense of this scale it is necessary to have some simple comparators. For example, the amount of material to be dredged in the capital phase of the project is more than the equivalent of digging a 2 metre deep by 15 metre wide trench from Melbourne to Sydney. This dredged material will then be transported and dumped at two spoil grounds. If instead it were placed on the City of Melbourne's Hoddle Grid (the central city area), it would cover it to a depth of approximately 23 metres, the equivalent of a typical eight-storey building.

Turning to maintenance dredging, the project proposes works extending a human generation in duration that would lead to an additional 30% more dredging and spoil placement than that recorded above.

The greatest challenge the proponent has is to demonstrate that it is possible to construct an acceptable deep water 'gateway' between Bass Strait and the waters of Port Phillip Bay in an environmentally sound and safe manner. The gateway needs to be constructed in the unique conditions of The Heads. These conditions include a narrow opening already serving as a major shipping channel, a severe wave, tide, current and meteorological climate and a rocky bottom all within an area containing very delicate, beautiful, special and in parts statutorily protected sea bed and ecosystems. This is a major challenge in global marine engineering terms.

However, without this gateway the project is not viable. The project is justified in the documentation in terms of enabling ongoing access by shipping to the Port of Melbourne, without undue delays due to depth constraints. In simple terms, if the gateway cannot be enlarged by means combining environmental prudence with economic and technical feasibility, sufficient to enable the safe transit into the bay of shipping of appropriate scale, there will be no need for the remaining deepening works to be undertaken. Deep draught vessels will not have safe and regular passage into Port Phillip.

The project includes the necessity to remove very significant volumes of mainly sedimentary material from the bed of the Yarra. This is an area that has functioned for 150 years as a port, commercial waterway and (at least in the early years) as primary drain and disposal mechanism for a major city. This material must be treated as being potentially contaminated. Questions of characterisation and material management during removal are highly significant. Disposal option design and performance for considerable volumes of potentially contaminated material are also critical considerations.

Turbidity will be generated by works in the Yarra and in the remainder of the bay. Turbid plumes have the potential to be extensive and of long duration, affecting large areas of the bay. The prudent selection and scheduling of dredge technology to minimise turbidity is a key consideration, as is the prudent siting and management of disposal options. Understanding of the effects of turbidity and light loss on the ecology of the bay and its capacity to discharge nitrogen must be obtained and deployed. The bay is a complex ecological system and there is considerable scientific uncertainty about these issues.

It must therefore be understood at the outset that the project is more than ordinarily large and that it embodies scale, volumes of material and complexities that are not typically found in Victorian marine infrastructure projects. This is an understanding that does not require an immediate Panel Response in terms of findings or recommendations, but should be carried forward by the reader as an aid to understanding in the later chapters of this report.

5.2 PROJECT DESCRIPTION

Discussion

Having provided a sense of its own understanding of the scale and complexity of the project, the Panel turns to consider the means by which the proponent has identified and communicated these issues to others.

A major problem the Panel faced from the outset was the lack of a firm and detailed description of the proposal and hence what has actually been assessed in the EES. Little firm information was provided and what was given was variable.

This sections of this report provides various summaries of project descriptions as they have been produced by:

- The proponent describing the action to the public in the EES.
- The proponent describing the action to the Commonwealth government and the public in the EPBC Act documentation.
- The Victorian government in the Assessment Guidelines providing advice to the proponent in respect to the EES.

These are all discussed below and provide ample illustration of the degree to which the project has lacked a firm and detailed description.

Even the most informative document in the EES gives only the following description:

> [T]*o deepen the channel in Port Phillip Bay (the bay) to the Port of Melbourne (POM) to a depth sufficient to accommodate ships of 14 metre draught in all tidal conditions. The project includes:*
>
> - *dredging of shipping channels in the south and north of the bay and the Yarra River and at the PoM*
> - *removal of rock in, and adjacent to, the Great Ship channel and near Port Phillip Heads (the Heads)*
> - *placement of dredged material at underwater dredged material grounds (DMGs) in the Bay*
> - *maintenance dredging required in the South Channel until 2030 above that required if the Project did not proceed*

- *use of the shipping channels by larger ships until 2030* [4]

In the EPBC Act referral the proponent gives minimal information about the project. Little more is stated than that the action is:

> *To deepen the shipping channels at Port Phillip Heads, in Port Phillip Bay and the Yarra River and its approaching channels.*

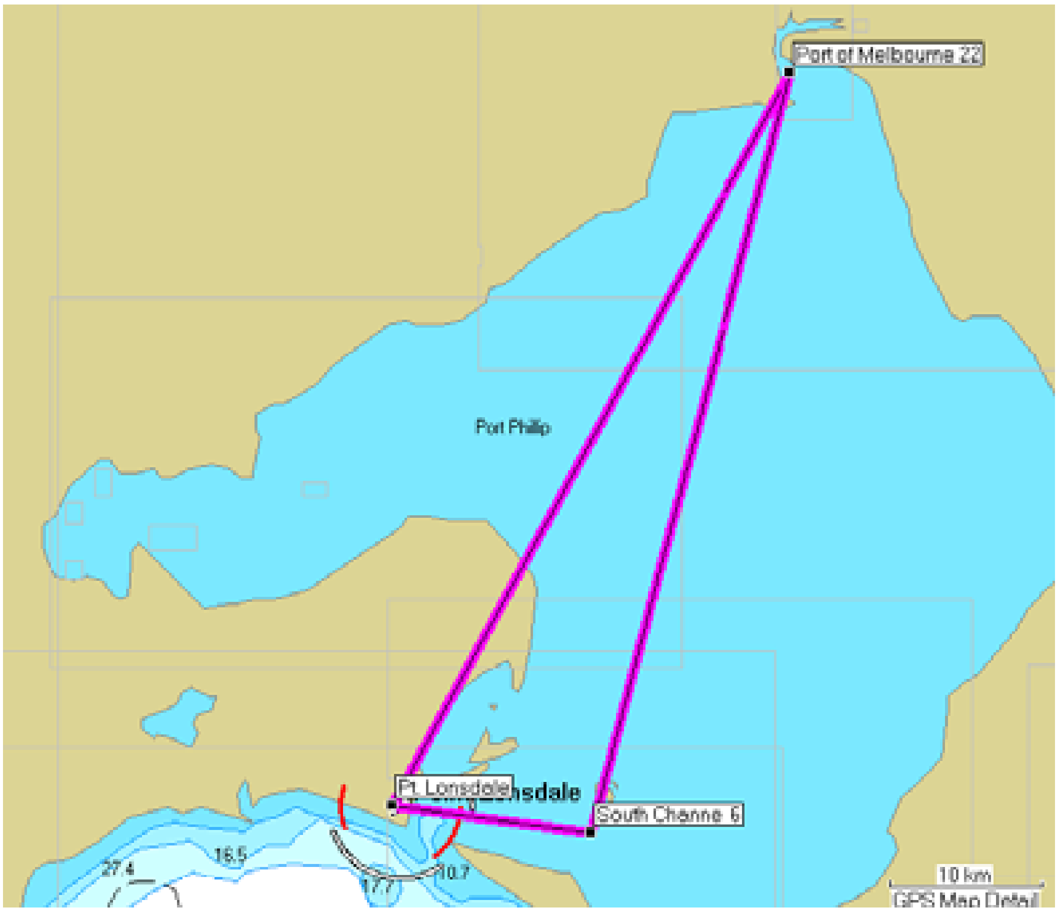
And that the expected deepening of the channels will be only:

> *in the order of 1.5 metres to 2 metres* [5]

The following actions are not mentioned:

- placement of spoil (including the placement of potentially contaminated material) within Port Phillip Bay,
- maintenance dredging,
- works at berths/docks, and
- ongoing use of the shipping lanes by larger vessels.

Figure 1: EPBC Act Referral Area Coordinates



EPBC Referral 2002/576 Referred Location of Project Area

[4] EES Summary ppS1-1
[5] Referral Form at p3

In respect to the referred project area the coordinates of three points are specified in the referral, one of which is on land, one to the west of Hovell Pile and one to the south of the Yarra mouth. The referral is not clear whether these are the sites of the action or whether they define the triangle within which the action is proposed. In either case, the area of proposed activity extends considerably beyond the referred area (see below) and includes:

- the Heads, including widening beyond the width of the Great Ship Channel taking the project closer to the Port Phillip Heads Marine National Park,
- the Yarra River,
- South Channel east; and
- the proposed south east DMG.

It should be noted that the Panel was not provided with any 'Preliminary Information' pursuant to Section 86 of the EPBC Act that may have provided additional clarification about the definition of the proposed works.

The Panel notes that the Commonwealth in its notice under section 75 of the EPBC Act defining the project as a controlled action, defines it in the following terms:

> [T]*o deepen the shipping channels at Port Phillip Heads, in Port Phillip Bay, and the Yarra River and its approaching channels…*

It appears clear that the Commonwealth have obtained a better understanding of the geographical scope of the project than that provided by the original referral. However, the clarity of the Commonwealth's understanding is not the only issue, with clarity of public understanding arising from documentation also being significant.

Turning to Victorian processes, the Government in the Assessment Guidelines for the project describes the proposed works in the following terms:

> *The aim of VCA's proposal is: to modify channels within the existing alignment that lead to the Port of Melbourne, to accommodate vessels with a draught of up to 14m at any state of the tide. …..The proposal includes dredging works at locations on the existing channel alignment (including berth pockets in the port itself), as well as the management of dredged material.*
>
> *The proposed dredging activities are located in three main areas (refer to the Appendix):*
>
> - *The entrance to Port Phillip Bay at Port Phillip Heads – Great Ship Channel*
> - *Southern Port Phillip Bay and the Great Sands region – South Channel*
> - *Hobsons Bay, Port of Melbourne and Yarra River – approach channels including the berth pockets.* [6]

The Assessment Guidelines go on to say that proposal involves the following works:

> - *Removal of rock in the Great Ship Channel*
> - *Capital dredging of the South Channel*
> - *Capital dredging of the approach channels to the Port of Melbourne*
> - *Capital dredging of berth pockets in the Port of Melbourne*
> - *Placing and managing the dredged material (mainly sand, silt, clay and rock).* [7]

[6] Assessment Guidelines, Section 2.6, p4

[7] As above.

and that:

> *The proposal that is subject to this EES process does not include land-side development of port infrastructure, which may be indirectly associated with improving access to the Port due to proposed channel deepening. Such land-side development implications and possible works are subject to other planning and approval procedures and may emerge over a number of years.* [8]

The Assessment Guidelines appear to be silent in respect to works related to maintenance dredging and use of the channels to the year 2030. Further, whilst excluding the land-side works associated with the project they also did not recognise the necessary works to berths/docks at the land-water interface. These have not been assessed within the EES despite the great potential for environmental impact associated with these works.

The Assessment Guidelines are also silent in respect to the now proposed works in the Eastern and Western Ship Channels in the Heads (as opposed to the Great Ship Channel). These are now proposed to be permanently deepened to 14 m for approximately half their widths (80m and 40m). These works were described during the Panel process as the provision of 'construction channels'.

To provide another and more detailed example than those above, the EES documentation refers many times to the deepening of the project being required for container shipping. Documentation describing the project draws very little attention to the fact that larger tankers and bulk vessels will also use the channels and the port. In fact, much of the EES analysis appears to have been based on the position that the volume of oil imported will decrease and that there will be no increase (or even a decrease) in number of tankers. That being said, evidence led for the proponent included the following:

> *The original analysis … forecasts, crude oil imports were expected to plateau and subsequently decline. The historical record since the production of these forecasts shows an increase in import volumes. Our industry consultation, and new analysis undertaken as part of trade forecast revision, have led us to the conclusion that this increase is likely to continue.* [9]

The proponent currently estimates that the volume of oil imported will increase by 87 % over the project but this issue received little attention in the EES. It is nevertheless a significant issue of project definition as will be seen when the Panel comes to consider aspects of channel design and operational safety.

In particular, if the likely volume of tanker traffic has not been conservatively assumed or is not known, it will be difficult to consider and assess within the project potentially significant issues of adverse environmental impact such as shipping incidents and spills.

Panel Response

The Panel is conscious that all projects change and evolve. What is originally described as a project at its inception is seldom exactly the same as what is finally assessed or approved. This is a necessary function of the need to respond to the results of environmental analysis and to improve project performance to address issues. However, such latitude for definitional revision and change does not include a charter for imprecise or shifting description, such that relevant elements of government and third party stakeholders remain in substantial doubt as

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[8] Assessment Guidelines, p5.

[9] From Meyrick (Economics Expert Witness Statement at Annex A)

to what the project might be, what key actions and effects might arise within in and whether these have been properly identified and assessed. It is a foundation stone of environmental impact assessment practice that one must undertake the assessment phase with a clearly understood, understandable and reasonable project definition. If the nature of the project then changes in response to one or more impact assessment outputs, this should then be documented. Pre-dating research and analysis must then be revisited with rigour, to ensure that relevant issues have not been accidentally 'lost' on the journey.

The Panel recognises that this is a very difficult task in a project as large as this one. However, it takes the strong view that there is a corresponding need for greater rigour in project management and clarity of project definition and its application in process so that issues are not 'lost'. The Panel cannot convince itself that the project team in this case has applied the necessary rigour.

Large bodies of assessment work have been carried out, but there has been no explanation or demonstration of the techniques used to ensure that all are working to the same definition. Similarly, where definitions have changed, there is no clear indication as to how the change was communicated to all relevant members of the assessment team or how they then responded to advice of that change. Further, in areas where the boundary of the project was not well defined, there is no evidence that this situation was discussed with relevant consultants and clear determinations made as to the necessity and extent to which potential boundary effects might be studied.

The Panel finds that the project definition in the area of The Heads is inconsistent between the design and the assessment in the EES. Similarly, the project definition does not address well or clearly issues raised by dredging in the water/land interface.

The Panel finds that the project descriptions examined do not capture the proposed scope of works nor are they accurate in the description of the type of vessels that will utilise the deepened channels. They do not convey an appropriate sense of project scale to the reader.

From this position, it appears that a number of environmental impacts bearing on the changed understandings of the project have not been properly or rigorously assessed. These issues are discussed further in the sections immediately below.

5.3 DESIGN AT THE HEADS

Discussion

Clear understanding of the design criteria proposed at The Heads is critical to the success or failure of a project of this nature. As has been outlined above, The Heads form the gateway to the bay. If they cannot be deepened in a manner that enables largely unrestrained access by deep draught ships to the deeper channels within the bay, many of the project benefits are under threat.

Bearing this issue in mind, the Panel became concerned by the range of approaches to project definition in The Heads and the lack of definitional clarity or shared understanding about this aspect of the work. The proponent, whilst apparently persuading itself that these issues had been addressed, demonstrated in the content of its own documents and submissions that there was still considerable movement and lack of clarity. This in turn inhibited its capacity to explain its proposals for The Heads to others, as is made clear below.

The EES Summary Brochure states that the purpose of the project is:

> *...the Removal of rock at the entrance to the Bay (so that the channel accommodates ships of 14 metre draught in all tidal conditions[10]):*
>
> - *in and adjacent to, the Great Ship Channel,*
> - *in the area between the Great Ship Channel and the South Channel over the Nepean Bank [11]*

In his expert witness statement for the proponent, Mr Peter Burton, the channel designer described the design basis of the project in the area of The Heads as:

> *Ships at the nominated draft are to operate inward and outward, taking into account expected vessel induced motion and wave induced motion, with a minimum allowance for tide of 1.5 m on Rip Bank, and wave conditions that will facilitate a transit over the Rip and Nepean Banks for 95% of the time.[12] [13]*
>
> *The design criteria include a requirement for the design ship to be able to pass through the heads for 95% of the time when there is at least 1.5 m of tide. The analysis for the Great Ship Channel has therefore been undertaken for a minimum water depth of 18.5m. [14]*

A first key concept here is the issue of transit availability with a minimum allowance for tide of 1.5m on Rip Bank. The Panel's questions to Mr Burton elicited the response that this was a value of +1.5m over zero tide. The term 'minimum' clearly expresses the view that where less than such a value is present, the transit of a 14 metre draught vessel could not be automatically assumed as supported by the design concept. It should be noted that this constraint is intended to operate in terms of inward and outward movements (notwithstanding that later discussions and references tended to place greater emphasis on inward movements).

A second key concept here is the issue of transit availability for 95% of the time. This was explored with Mr Burton, who made clear his view that this measure was an expression that for 95% of the time, the metocean conditions in The Heads would be such that transit would be possible, assuming any tide conditions to have been met. However, it was estimated that for 5% of the time, metocean conditions would be of a severe or extreme nature, such that transit would not be prudent, even if tidal conditions were met. He emphasised that this was a reasonable response to the balance between the need, expense and effect of removing material from the Heads, as against the benefit of providing 100% accessibility.

The distinction between these positions caused considerable confusion amongst submitters. Key industry bodies in transport and logistics commenced with the view that the proposed channel would accommodate ships of 14 metre draught in all tidal conditions. They appeared unaware of the qualifications provided in the Burton material for the proponent. They were concerned to ensure that the project would be delivered in a manner that minimised operational constraints, particularly the potential for ships being constrained to meet windows of acceptable transit of The Heads.

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[10] Panel emphasis

[11] EES Summary Brochure at p7

[12] Maunsell, Channel Design Report section 2.2 p11

[13] Panel emphasis

[14] Maunsell, Channel Deepening Design Final Report p54

As a result of confusion in the documentation and information being presented at the Panel hearing the Panel sought clarification in respect to the project definition. The proponent issued a clarification statement on 1 November 2004. The Panel then distributed this to all submitters who had requested to be heard. As issued, it said:

> *The current proposal by the Port of Melbourne Corporation is to deepen the shipping channels to provide access for 14 m draught vessels to the Port of Melbourne:*
>
> - *At all stages of the tide within Port Phillip Bay and the Yarra River: and*
> - *With a 95% probability of transiting The Entrance to Port Phillip Bay (ie over Rip bank and Nepean Bank) when the rise of tide is 1.5 m*[15]

The document went on to say that:

> *Should a 14m draught capacity at the Entrance be required at all conditions of tide, this would require a much deeper channel to be dredged. It may also require additional channel widening in the area of The Entrance.*

It should be noted that as originally drafted, this was a longer and more complex document than that which was issued. The Panel was conscious that it had requested its production in an attempt to reduce avoidable confusion as to the project definition. The draft as produced appeared in the Panel's view potentially to exacerbate confusion. For these reasons, the Panel suggested that the draft be simplified. The proponent without demur accepted this suggestion and the final document was issued. Later, in response to concerns raised by some parties that the simplified explanation was proposing operational constraints, the proponent maintained that there would be no such constraints.

Following the release of the clarification statement, the proponent released a variety of other descriptions of the design basis either to the Panel or outside the Panel process. However, none were provided to the Panel as expert evidence as opposed to in submissions. All therefore have some caveat as to reliability and weight.

For example, the Part E proponent submission to the Panel states (at page 6):

> *Specifically Port Phillip Heads was designed to cater for 14 metre draught vessels with a 95% probability of transiting Port Phillip Heads when there is 1.5 m of tide (under benign conditions 14 m draught vessels should be able to transit with less tide than this).*

It is therefore of concern that the proponent also goes on to state (on the same page) that:

> *Since the initial criterion was set a final depth of 17m has been determined without reference to 95% probability. This means that the probability once determined is likely to be less or more than 95%.*

and that:

> *The extra 1.5 metres* [of tide] *was included because to allow for a complete static design that incorporated an 'all waves' allowance would have required a much deeper channel.*[16]

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[15] Panel emphasis.

[16] Panel emphasis.

Key points to note here are as follows:

- The implications of the apparent change in the design criteria of the '+1.5 metres of tide' as a minimum value were not explained to the Panel.
- The view is provided that 'under benign conditions', the +1.5 metre value may not be required to be met. However, no evidence was provided as to what 'benign conditions' might amount to in terms of more rigorous descriptions of either classes of metocean conditions or percentages of time.
- Doubt is cast on the reliability of the concept of a 95% probability by the proponent's own submission. The proposed channel depth in the Heads is suggested as not having been set with express reference to this as a criterion, which may have to be varied.
- It is nevertheless maintained that to depart significantly from the designer's basic criteria to deliver a non-tidal and/or non conditional limited channel at the Heads, would require a 'much deeper channel' than that which has currently been assessed.

A 'further clarification' of this matter was issued in a document 3 December 2004, which sought to demonstrate that:

> *It is intended that vessels of 14m draught will commonly have access through Port Phillip Heads at all stages of the tide, except where severe metocean conditions are such as to restrict safe navigation.*[17]

By the end of the hearing process and having experienced some further difficulty around this issue, the proponent was actively attempting to dissociate itself from the suggestion that the situation at The Heads might apply as any form of practical operational constraint:

> *Unfortunately, the issue of the Project description at Port Phillip Heads became a source of much unnecessary confusion during the panel hearing. The reality is that the Project description in this area has never changed…*[18]

Verbal submissions for the proponent also sought to instruct the Panel that we would be misdirecting ourselves were we to find other than this position. However, the proponent in its written closing submission then stated the following:

> *In practice, as currently occurs, PoMC expects that vessel masters of deep draught vessels will plan their arrival* [and by implication departure] *to avoid transiting at zero tide, when currents are strong, by two hours or so. This does not currently and will not in the future adversely affect the vessels' passage. Even in severe metocean conditions, vessels up to 14m draught should be able to transit the Entrance 95% of the time with a 1.5 m tide.*

Turning back to the channel designer, Mr Burton, one should note that his 95% value was expressly adopted to exclude the 5% of severe or extreme metocean conditions. To suggest that the 95% value would then apply within what had been defined as severe metocean conditions suggests that the proponent's legal team either did not understand the issue, or that their instructions had in turn been confused.

The proponent's final response to these issues states:

> *New port rules* [governing transit of the Heads] *will be developed once the project is approved. The development of these rules will require a substantial amount of*

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[17] As summarised in Part H Submission at Para 6.14, p21

[18] Part H Submission at Para 6.12, p21

> *work and the outputs of the work may include possible restrictions on a number of permutations of vessel type, day/night conditions, vessel length as well as vessel draught. These restrictions are expected to be minor.*[19]

Modelling to assist in the development of such rules is a work in progress.

Panel Response

The Panel's response to these issues is to re-emphasise its view of the critical nature of The Heads as the gateway to bay for the success of this project for the following reasons.

The economic and community benefits of the project are contingent upon an understanding that it will facilitate relatively unrestricted access to deep draught ships. Such an understanding must sensibly recognise that there will be periods when metocean conditions are too severe to prudently transit the Heads. However, if the value of the project is to be maintained in effective terms, the Panel considers that it is utterly essential that the sum of any relevant constraints not be overly large. If the project were to be implemented at great cost, only to find that 14 metre draught vessels must still routinely wait substantial and in turn costly periods of time for access to the channels or to the Bass Strait, this would not in the Panel's view be an acceptable outcome.

It is therefore important for government, industry and the community to be provided with a reasonably sound and sure explanation as to the design criteria that the proponent proposes to adopt in this location. This should provide assurance that the broader economic and community benefits assessments made not only within the EES, but by a wide range of stakeholders, can sensibly be relied upon to draw one to the conclusion that the project represents a 'wise investment'.

It is also of critical importance in environmental terms that the physical implications of such issues are well understood. If detailed calculations of operational protocols lead to the view that the Great Ship Channel at The Heads channel requires to be deepened by a further 1 or 2 metres, or that it needs to be widened further over and above the maximum values assessed in the EES, these changes could have profound consequences for assessments undertaken elsewhere in the EES.

For example, the hydrodynamic, sediment transport, turbidity, tide and sea level modelling of post project conditions in simple terms all flow back to a key data input: the cross-sectional area of the smallest section of the Heads, through which waters are exchanged between Port Phillip and Bass Strait. Should this cross sectional area need to increase significantly, all assessments as to hydrodynamic, sediment transport, turbidity, tide and sea level effects would have to be revisited. Consequential assessments, for example in relation to the effects of sea level change on engineering structures or critical coastal habitats or species would also need to be revisited.

Other relevant considerations also relate to the volume of material to be removed from The Heads (which might rise), the ecological significance of the additional material to be removed, the safety of channel works and operations (which might change) and the techniques for managing duration and turbidity impact of the works (which might change).

These issues bear on project cost, perhaps significantly. We appear to face a circumstance in which it will be very difficult for the proponent to guarantee that there is no potential for the

[19] Part H Submission at Para 6.15, p22

cost of works in this area to significantly change. In such circumstances, the Panel considers that the proponent's definition of the project design criteria for The Heads require to be resolved to a high level before the project, and its consequent assessment, can proceed. It needs to be able to provide reasonable assurances as to the issues outlined above.

Turning to what has been provided, the Panel notes the widespread confusion of submitters, including key industry stakeholders on this matter. It notes with reference to the discussion above that the proponent appears confused as to the nature, effect and deliverability of its own design criteria. The Panel itself will admit to having been considerably confused as to these issues. However, having devoted many hours of detailed analysis to them, it can only conclude that the source of the confusion rests in the contradictions emerging from the face of the proponent's own submissions and evidence.

The existence of confusion on a matter of such importance is in the Panel's mind simply unacceptable. There is little value to be obtained from determining precisely why or how the confusion occurred but it is now utterly essential that the project definition in The Heads and other areas be clarified.

The Panel finds that the design criteria that were used to determine the depth of the channels in the vicinity of The Heads are not consistent with the stated project definition. The Panel is concerned that it may now be proposed to operate the channels in a manner that is not consistent with the design, or alternatively that the design might need to change, with all that implies. It is not appropriate to proceed via approval to construction whilst these critical issues and their environmental impacts remain unresolved.

At this juncture, it is sufficient for the Panel to state the following:

- Confusion remains regarding a clear project definition at The Heads.
- It is apparent that different consultants (for example Mr Burton in channel design, Mr Meyrick in his economic assessment and Mr Edmunds in his safety and risk assessment) appear to have proceeded with their studies on the basis of variants of the definitions as identified above.
- The design of a major shipping channel in a unique and challenging environment such as Port Phillip Heads requires the establishment of a rigorously applied project definition. The Panel is not confident at this point that this has occurred.

For these reasons, the Panel recommends as follows:

Before the assessment of environmental effects, the proponent should be required to complete its evaluation of design and operational criteria for the Great Ship Channel in the Heads. An independent channel design expert should validate these.

It will be necessary to:

- outline the percentage of metocean conditions and tide conditions for which the design criteria intend the Great Ship Channel to be capable of transit by 14 metre draught vessels;
- determine that these provisions are either broadly in accordance with the project definition providing for '*...the removal of rock at the entrance to the Bay (so that the channel accommodates ships of 14 metre draught in all tidal conditions*', or if this cannot be met, to explain the new specification that can be met and the precise reasons for the change; and
- state clearly whether this new specification requires a deepening or widening of the channel, significantly in addition to that assessed in the EES.

Should the proposed works significantly depart from the original design definition or require a deepening or widening of the channel, in addition to that assessed in the EES, all directly and indirectly impacted aspects of social, economic and environmental effects should be rigorously re-assessed.

Whilst the Panel has focused its attention on The Heads as a critical gateway to the bay, it believes these issues of project definition and achievement of project design objectives should be reviewed for all channel areas in the bay.

5.4 INTERFACE WORKS

Discussion

Interface works are works that the Panel has referred to above, whereby dredging at quays, wharf-sides or river banks is undertaken in tandem with works such as the construction of new sheet pile walls and sediment traps. The objective of such works is to make a structurally sound boundary between dredged dock basins or channels and land-side operations. Interface works also relate to works undertaken in close proximity to existing features beside the channels in the bay, such as channel markers, or in relation to pre-existing infrastructure where dredging must pass in close proximity.

Whilst some engineering appraisal of existing channel-side structures has taken place, little detailed information has been provided about the large range of interface works associated with the project. It is apparent that little impact assessment has been undertaken of these works.

Works are predicted to be undertaken on channel navigation features such as Fawkner Beacon and significant activities related to wharfs and berths including: 32 South Wharf; East and West Swanson Dock approaches and berths; Gellibrand Pier; Appleton Dock; Webb Dock; Yarraville 6; the north end of Holden Dock and Newport Park. These works include removal of wharf structures, upgrading sheet pile walls, reconstruction of armour rock walls, piling, construction of capping beams, demolition of derelict wharfs and installation of gross pollutant traps.

To provide a detailed example, during its site visits, the Panel noted that existing Swanson Dock berths have wharfage mounted on extended concrete piles. Dock basin waters and sediments on the basin batter extend beneath the wharf surface. It is likely that removal of such material might be required preparatory to reinforcement or replacement of the wharf. It is further tenable to suggest that one economic means of addressing such removal in the context of a dredge campaign would be for it to be removed to a barge by a backhoe. Whilst such a method could be expedient, it is still necessary to know whether it will occur for both project management and environmental impact assessment purposes. Channel batters adjacent to long-standing wharfage may be contaminated by virtue of cargo spillage over many years and propeller wash depositing fine sediments there. It is therefore necessary for assessment to have occurred and a detailed management strategy to be in place if material from such a location is to be treated as dredge material and disposed of accordingly.

Works are also predicted in association with protection of the ethane pipeline, Westgate Bridge abutments, navigation aids, and the construction of a deep draught anchorage (the location for which is not specified).

Panel Response

The Panel finds that the interface works associated with the project have not been clearly defined nor assessed as part of the environmental impact assessment.

Dredged materials removed from adjacent to and under wharves should be managed as per general materials being dredged with appropriate sampling and characterisation of contamination, if present. This characterisation should in turn inform a disposal and management strategy that embodies best practice as recommended elsewhere in this report for contaminated material.

In relation to other interface works, the following appear to raise the potential for significant orders of environmental risk and to warrant more detailed assessment:

- options for the surface protection of the ethane pipeline; and
- options for the protection of the Westgate Bridge from ship impact

The Panel believes that technical solutions to these issues will be found. However, if options are not canvassed at the environmental impact assessment stage, it is not known whether an eventually selected option represents the best balance of environmental risk minimisation against cost. Nor can the impact of the project overall be effectively assessed.

For these reasons, the Panel recommends as follows.

Interface works (works to approaches and berths, anchorages, navigation aids, pipeline protection etc) associated with the project must be clearly specified. Options for work delivery must be properly evaluated and the environmental impacts associated with the works must be properly assessed.

5.5 SUMMARY

Drawing its understanding of the proposed works together into a reasonable summary has been a difficult task for the Panel. However, the scale of the project notwithstanding, the Panel considers that such a task ought not to have been too difficult.

The EES does not make a clear and consolidated statement about the actual depths of material that are proposed to be moved and disposed of. In particular, no consolidated information has been provided about the current overdredge depths. Information has not been provided in a consistent frame of reference making analysis difficult. For example, some information is provided as water depths and some is provided as relative depths (eg 1.5m CD). The coordinate systems used to locate places jump between latitude and longitude and eastings and northings, sometimes in AMG 55, sometimes in MGA and sometimes not stated.

After three months of questioning and reviewing additional documentation the Panel has developed its own summary tables to inform its understanding of the proposed works. These are still not complete (in that some apparently necessary data is still not to hand) but are provided below.

Conflicting information has been provided about the proposed deepening of the eastern and western channels at the Heads. This has not been resolved.

The Panel notes that there also appear to be operational/design constraints (ie tidal assistance required) in the Yarra and vicinity of Hovell Pile that are not generally acknowledged in the EES documentation and remain unresolved.

The Panel has not been provided with sufficient information to determine whether the selection of the final water depths in The Heads (CD and overdredge) is sound.

For all of the above reasons, the Panel recommends as follows:

The proponent must prepare a consolidated list for all primary dredge locations of the following data:

- current actual and declared depths;
- proposed actual and declared depths; and
- the actual proposed depth of dredging.

All operational and design constraints should be consolidated into a single document. These include the requirement for tidal assistance in the Yarra, over the Melbourne Water sewer, in the vicinity of Hovell Pile and for passage through the Heads. The full economic, safety and other environmental impacts associated with these constraints should then be returned to relevant consultants for environmental assessment.

All references specifying locations or using coordinates should be in a consistent format in all future documentation produced by the proponent.

The Panel's concern is that if such action is not taken, the confusion that was only too apparent during the Panel Hearing will persist to the implementation stage. Such confusion should not be allowed to stand in the way of effective environmental impact assessment or the responsible selection of options for the delivery of project works. It must be eliminated and existing works of assessment re-evaluated before the project can proceed.

Table 1: Panel Works Summary - Rip Channels

Location	Current m	Proposed m	Difference m (not including overdredging)	Overdredge Depth m
Great Ship Channel Nepean Bank	14.0	17.0	3	18.0
Great Ship Channel Rip Bank	14.0	17.0	3	18.0
Western channel embayment (addition to Great Ship Channel)	11.4	17.0	5.6	Not provided
Western Construction Channel (widening by 50m)	11.4	14.0	2.6	Not provided
(V1 table 5.1) conflicting depth	11.4	17.0	5.6	Not provided
Eastern Construction Channel (widening by 80m)	11.9	14.0	2.1	Not provided
(V1 table 5.1) conflicting depth	11.9	17.0	5.1	Not provided
Western Channel (outside construction channel)	11.4	11.4	0	0
Eastern Channel (outside construction channel)	11.9	11.9	0	0
Outer Western Channel	10.3	10.3	0	0
Outer Eastern Channel	10.0	10.0	0	0

Table 2: Panel Works Summary – South Channel

Location	Current m	Proposed m	Difference m (not including overdredging)	Overdredge Depth m
South channel west	13.1	15.5	2.4	17.5
South channel east	13.1	15.5	2.4	16.5
Hovell Pile vicinity	13.1	16.0	2.4	17.0

Table 3: Panel Works Summary – Port of Melbourne Channel

Location	Current m	Proposed m	Difference m (not including overdredging)	Overdredge Depth m
Port of Melbourne channel	13.1	15.5	2.4	16.5
Over ethane pipeline	13.1	15.5	2.4	16.3

Table 4: Panel Works Summary – Yarra and Williamstown channel

Location	Current m	Proposed m	Difference m (not including overdredging)	Overdredge Depth m
Williamstown channel	13.1	15.5	2.4	16.3
Yarra beacons 21/22 to 33/34	13.1	15.5	2.4	16.6
Yarra near West Gate Bridge	13.1	15.2	2.1	16.3
Beacon 46 to Swanson Dock	13.1	14.6	1.5	16.7
Silt traps (33329)	13.1	17.8	4.7	to 17.8

Table 5: Panel Works Summary – Berths

Location	Current m	Proposed m	Difference m (not including overdredging)	Overdredge Depth m
Swanson Dock berths and basin	13.1	14.6	1.5	15.9
Gellibrand Pier	10.6 to 12.1	14.6	4.0 max	15.6
Appleton Dock	10.7 to 11.4	14.6	3.9 max	15.9
Holden Dock	13.1	14.6	1.5	15.1
Webb Dock berths 4 & 5	12.5	14.6	2.1	15.9

6. PROJECT APPROACH

This section addresses the following issues emerging from the proponent's approach to the project that are relevant to the Minister for Planning's decision:

- The base case, under which the proponent sought to base its environmental assessment on a platform of technologies that are not best practice.
- The performance based approach, under which the proponent has in general preferred to identify performance objectives to be met, as opposed to identifying or prescribing particular means by which performance must be achieved.
- Adaptive management, under which a monitoring framework is developed to assess ongoing project and environmental performance and, where necessary to review and change project objectives to refine performance during delivery.
- The relationship between the project as proposed and 'best practice' approaches to project design and delivery.
- The means by which the project deals with alternatives.
- The means by which the project identifies and responds to risk.

6.1 BASE CASE APPROACH

Discussion

The Port of Melbourne developed a Base Case dredging scenario which was explained in Chapter 27 of the EES. It is worth quoting one of the relevant sections here:

> *The base-case represented a dredging scenario in which a dredging contractor is allowed to undertake dredging using standard dredging equipment and techniques in accordance with standard operating and regulatory controls. However, the scenario assumed that there are no inhibiting environmental controls required to protect the particular environmental, economic and social assets of the Bay. The base-case therefore represented neither an extreme (nor absurd) or understated dredge scenario.*

The scenario was provided to specialist consultants to enable them to undertake impact assessment in their particular areas. The equipment used was that as described in Chapter 5 of the EES with the primary dredging work being carried out by a trailing suction hopper dredge.

The base-case assumed a 50 week program in the north of the Bay and a 35 week program in the south of the Bay.

Panel Response

The EES did not demonstrate any attempt to identify best practice equipment or technologies to undertake the work and there appears to have been very little expert dredging advice engaged to inform the design and EES teams.

In this respect the EPA[20] also notes that:

> *…the capacity of the Panel to consider the range of options available for undertaking the dredging, appears to have been constrained by a number of decisions made early in the project in defining the base case. These include in-situ disposal of all spoil and use of a trailer suction hopper dredge (TSHD) and/or cutter suction dredge (CSD) as the preferred methods.*

The base case scenario predicted unacceptable impacts and the EES went on to propose solutions and alternative scenarios to solve the problems. It also introduced new pieces of equipment - the hydro hammer, TSHD ripper head and stone fisher.

Another key change to dredging equipment during the Panel hearings was the commitment of the Proponent to using dredgers with 'green valves' to minimise air entrainment. The Panel was told that the use of the green valve reduces turbidity at the dredge site (not disposal). The Panel endorses the use of the green valve but notes its concern that no evidence was provided about its efficiency despite the apparently successful operation of the valve on vessels over a reasonable time period. The Panel is also concerned that:

- no assessment of the green valve was undertaken by the EES consultants,
- the valve is apparently less effective in shallow water
- its suggested use has not been broadly been tested by public submission.

The use of the base-case scenario in the EES that was exhibited followed by the introduction of new material into the hearing process was a source of great vexation to the Panel. It transpired that the dredge plumes modelled in the EES from base case dredging were also inaccurate due to the source terms used. New modelled plumes (Annexure D of Dr David Provis' Expert Witness Statement) based on an altered dredging scenario in some cases covered a much larger area, even though new dredging technology was being applied.

Specialist consultants, who had prepared all their material based on the base-case, were then required in the middle of the hearings to respond to a more likely or the "real" proposed dredging scenario with obvious difficulties.

The use of a base-case to inform the work of specialist consultants that appears to have never been a likely, let alone best practice scenario appears to the Panel to be a waste of time and resources at best. The Panel recommends:

That a review of available dredging technology and practice be carried out to enable the development of a best practice dredging program followed by environmental impact assessment and management measures.

6.2 PERFORMANCE BASED APPROACH AND ADAPTIVE MANAGEMENT APPROACH

Discussion

The Port of Melbourne Corporation proposes using a performance based management approach for the project which includes a adaptive management approach for the southern part of the Bay.

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[20] EPA Submission 153, Page 17

The performance based approach is explained in Section 1.3 of the Environmental Management Plan Version A. The proponent argues that if the performance standards are met, the economic, social and environmental assets of the Bay will be protected. The performance based approach sets:

- Management Objectives (targets for protection of particular assets)
- Threshold Levels (maximum allowable level of impact on an asset)
- Performance Criteria (threshold level with an added margin of safety to ensure the threshold level is not crossed for a particular asset)

As part of the performance based approach the Port of Melbourne Corporation has adopted two major strategies to managing the potential environmental impacts of the Channel Deepening Project. These are outlined in Section 1.4 of the Environmental Management Plan Version A and in essence are:

- An adaptive management approach in the more dynamic south of the Bay
- A prescription or regulatory based approach in the north of the Bay

The adaptive management approach suggested for the south of the Bay is to be based on a light driven primary production model which is used in real time to predict primary production loss based on turbidity plume modelling.

The prescriptive approach was originally proposed for the north of the Bay at the time of the early turbidity plume modelling results which had indicated the hydrodynamics of the northern bay would not give rise to significant dredge plume. However, the Annexure D work of Dr David Provis has now shown that this may not be the case.

Panel Response

The Panel has grave concerns with the general approach adopted for managing the environmental impacts of the Channel Deepening Project. These concerns relate to:

- The use of a performance based system in the absence of any real attempt to minimise environmental impact by appropriate use of dredging technology
- The integrity of the identified performance criteria thresholds
- The use of adaptive management in a project context in the south of the Bay

To put it very simply, the Panel is concerned that the environmental management proposals start at the wrong end of the dredging process. The preferred approach in the Panel's mind would be to use best dredging technology to minimise impact, particularly turbidity, (with appropriate economic consideration) and then use management controls and monitoring to "fine tune" and further minimise impact and protect the Bay.

The approach that has been taken is to say that the Bay can take a particular level of impact, and monitoring and predictions can be made around dredging as to when that impact will occur and thus the dredging modified to prevent unacceptable impact.

The major problem with this second approach is that the science surrounding the Bay, whilst much improved through this project, is at a level where the prediction of level of impact tolerance is extremely poor. Thus the confidence the Panel has in the proponent being able to predict, measure and respond to environmental impacts is very low.

There are many specific examples including marine ecology where the science behind the development of threshold levels is not apparent, and is questioned by respected peers, and this leads the Panel to conclude that the potential impacts on the Bay have not been adequately assessed.

The Panel is not discounting the use of a performance based system per se. Rather it is suggesting that it should be a component of the environmental management framework for the Project which is applied in addition to best practise dredging technology (e.g. that which minimises turbidity) and reduces the potential environmental impacts at the source.

The Panel also has concerns regarding the use of adaptive management in the context of a major project such as this. Whilst the Panel supports the concept of adaptive management itself, it believes the use of adaptive management, which is an approach to managing natural *systems* to implementing a *project* is fundamentally invalid.

There are a number of definitions of adaptive management. An example is given below:

> *Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Its most effective form – "active adaptive management" – employs management programs that are designed to be experimentally compare selected policies or practices by evaluating alternative hypotheses about the system being managed*[21]

In the context of the dredging project, the adaptive management approach appears to be proposed as an approach that deals with high levels of scientific uncertainty in a very dynamic environment. This is not the Panel's understanding of adaptive management.

A useful list of key factors and approaches to adaptive management is provided in Chapter 4.3.1 of the US NEPA Task Force Report to the Council on Environmental Quality[22]. It includes:

- *The ability to establish clear monitoring objectives*
- *Agreement on the impact thresholds being monitored*
- *The existence of a baseline or the ability to develop a baseline for the resources being monitored*
- *The ability to see the effects within an appropriate timeframe after the action is taken*
- *The technical capabilities of the procedures and equipment used to identify and measure changes in the affected resources and the ability to analyse the changes; and*
- *The resources needed to perform the monitoring and respond to the results.*

The Panel has serious concerns for the Project and Port Phillip around a number of these points, related to the level of knowledge of ecological systems in Port Phillip and the ability of the Port of Melbourne Corporation (or anyone at this stage) to develop sound threshold performance criteria.

Of most concern is the temporal issue of "being able to see effects within an appropriate timeframe after the action is taken". In the Project case this would mean having a timeframe within which an action (dredging) is taken, an impact occurs (decline of seagrass or fish species) and remedial action (stopping or relocating dredging) is applied.

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[21] British Columbia Ministry of Forests, www.for.gov.bc.ca/hfp/amhome/Amdefs.htm

[22] NEPA Task Force Report to the Council on Environmental Quality, Modern NEPA Implementation.

For many of the impacts predicted this will not be possible for dredging in Port Phillip. The effects may be long term and slow to appear perhaps, weeks, months or years after dredging has occurred in a particular location. They may also be impacts that occur further up the food chain and thus are not easily observed or connected to the project.

The PoMC has developed a predictive approach to modelling primary production to improve this situation for the base of the food chain. However, this is untested and its reliability will not be fully known until well after the dredge campaign has finished and all long term effects have been compared to model predictions.

The light driven primary production modelling will not assist in managing other areas of the project such as impacts on predator and prey species that depend on visibility for feeding.

The Panel is not suggesting that applying learning from the dredging operation to improve environmental outcomes should not be done, of course it should. But this is a normal component of fine tuning operational environmental management, not a fundamental management procedure in itself.

A more appropriate consideration of adaptive management in this context would be the deployment of a small scale experimental dredge program based on best practice and minimising predicted impacts. The effects of this deployment might then inform a capital dredging program which is modified to improve environmental outcomes even further.

In summary the Panel believes the general approach to the Project introduces a high level of risk to both the Bay's assets and potentially the Project itself from a financial and feasibility perspective. The Panel recommends:

In reconfiguring the Channel Deepening Project to accord with best practise environmental management, consideration must be given to the following issues.

- Impact minimisation by selection of dredge technology and spoil disposal methods.
- Additional baseline studies of the Port Phillip environment to enable further proving of ecological threshold limits.
- Development of active environmental management responses to protect key assets.
- Proving of all concepts to ensure they will meet project and environmental protection objectives in a practical manner.
- However, before commencing to address this recommendation, attention should be focussed on the primary need to respond more fully to the waste hierarchy; a matter addressed further below.

6.3 ALTERNATIVES

Discussion

The Terms of Reference for the Panel inquiry precluded the Panel considering alternatives to the deepening of channels within Port Phillip such as alternative port developments in Victoria or land bridging transport projects.

Nevertheless, many of the submitters raised this as an issue and considered that the proposal to deepen the channels in Port Phillip could not be appropriately considered without discussion around other options, not necessarily in Port Phillip.

Whilst outside the Terms of Reference for the Panel, some of the Port of Melbourne Corporation's (PoMC) specialists did raise the issue, notably the transport economics consultants Meyrick and Associates. In addition the EES main volume also devoted some time to consideration of alternatives outside Port Phillip[23].

Alternatives within Port Phillip however were considered and these cover the following issues and areas:

- Alternative channel alignments via the Symonds or West Channel
- Alternative channel depths (i.e staged deepening 13m/14m)
- One –Way and Two Way considerations
- Alternative spoil disposal methods and locations (different spoil grounds, dumping of spoil outside The Heads, environmental island and beach renourishment)

The Symonds and West Channel alternatives were discarded on the grounds that more dredging would be required and therefore the costs would be greater[24]. The potential for hydrodynamic changes and environmental impact from sediment movement[25] was also considered to be greater than pursuing an option within the existing South Channel.

A staged depth alternative was also considered whereby the channels would be dredged to a declared depth of 13m in the short term and 14m in the medium term. This staged approach was discounted on the grounds of the cost benefit analysis favouring a "one off" project and the environmental consequences of undertaking two major capital dredging campaigns approximately ten years apart rather than one as is currently proposed.[26]

A summary of the "one way" or "two way" in channels is provided in Section 4.4.2 of Volume 1 of the EES. There are areas within the channel system (such as the Yarra River) where only one way traffic is possible. In other areas a combination of one way and two way transit is proposed, depending on the specific channel design parameters.

The channel design process is discussed in detail elsewhere in this Panel report.

The no-deepening case was also examined but discarded on economic grounds[27], concluding that the economic loss (or rather lack of realisation of benefit) would be significant over the Project life.

The Project will generate approximately 40 million cubic metres of spoil from capital and maintenance dredging between commencement and 2030. The alternatives for use or disposal of this material are summarised in the PoMC Part A submission in Section 4.6. Some of the key alternatives are discussed in more detail below.

The PoMC preferred position as presented in the EES is the deposition of this material in an extension of the northern DMG and the development of a new DMG north east of Hovell Pile off Mt Martha. The use of existing spoil grounds in the south at Symonds Channel and Capel Sounds was discounted for environmental reasons. The dredged material in the north of the

[23] Section 4.2, EES Volume 1

[24] Section 3.25, Part A Submission, Port of Melbourne Corporation

[25] Section 3.25, Part A Submission, Port of Melbourne Corporation

[26] Section 4.4.3, EES Volume 1

[27] Section 4.5, EES Volume 1

Bay and the Yarra River has particular issues of sediment contamination and these are discussed elsewhere in this Panel report.

The creation of an "environmental island" in the Bay was also considered as an option and was supported or opposed by a significant number of submitters. The island location and proposed use varied considerably and ranged from a nature reserve to a highly developed "city in the Bay".

The PoMC discounted this option on the basis of cost and hydrodynamic issues associated with stabilising an island.[28]

The use of clean sand and spoil for beach renourishment was also considered as an option and this was strongly supported in a submission from the Association of Bayside Municipalities (ABM).

The PoMC have not recommended the use of material for beach renourishment at this time due to cost issues and possible technical issues related to particle size of the material but have indicated they will investigate this option further[29].

Following initial studies of alternatives only the preferred option as presented in the EES was subjected to the full range of specialist investigations.

Panel Response

Subject to the discussion in the channel design chapter of this Panel report, the Panel accepts that the general channel alignment of the south channel is preferred to the utilisation of the Symonds Channel or West Channel.

The Panel has some concerns regarding the impact of the South East DMG. This area was chosen on economic grounds as it is close to the end of the South Channel rather than some of the options pursued further to the north west. Dr Greg Jenkins in his Expert Witness Statement[30] has some concerns related to this area due to its proximity to the Mt Martha aquaculture zone and its importance for recreational snapper fishing and snapper migration.

The Panel also has concerns regarding the potential for turbidity affecting beaches in the area as the proposed DMG is relatively close to the Port Phillip coast. The Panel is not recommending strongly that the DMG be moved to one of the north west sites. These areas are recognised in other specialist studies as being high biomass areas (e.g. microphytobenthos, fish, avian fauna) during the period when dredging is proposed and they are also close to the proposed Pinnace Channel aquaculture zone.

The Panel, however, does consider that the specific issues raised by Dr Jenkins need further investigation to determine whether there are opportunities to mitigate these potential impacts.

The alternative of dumping spoil material (from the South Channel at least) offshore in Bass Strait has also not been considered in the EES. Given the potential severity of impact from turbidity from spoil dumping in the Bay, this would seem to be an obvious alternative to be considered. The Panel is not in a position to conclude that it is a better alternative, but simply that is should be investigated in detail and the social, economic and ecological consequences

[28] Section 4.7(b), Part A Submission, Port of Melbourne Corporation

[29] Section 4.7(a), Part A Submission, Port of Melbourne Corporation

[30] Section 4.2(d), Expert Witness Statement, Dr Greg Jenkins, PIRVIC

compared with in-bay options. The Panel considers that prior to project approval the proponent should undertake a detailed investigation of the social, economic and environmental implications of spoil dumping in Bass Strait with the objective of ameliorating impacts within Port Phillip. The detail of this finding is addressed further in Chapter 11 below.

The Panel notes the consideration of, and submissions on, the environmental island concept. The Panel is of the view that an island is currently not supported or encouraged by Government policy. Given that "an island in the bay" as a concept has been around for at least 40 years to the Panel's knowledge without coming to fruition, this appears to be a long held position.

In practical terms the Panel believes the island concept is to a large extent independent of the dredging proposal. The lead time for developing the island concept in terms of design, hydrodynamic modelling and planning and environmental approval would be many years and not sit comfortably with the timeframes placed on the channel deepening project by the PoMC.

If spoil is dumped into a DMG for later "harvesting" to create an island, then again, this can be done independently of the channel deepening project itself. The Panel does not wish to debate the merits of an island in principle as that would be extending its brief untowardly.

The use of dredge spoil for beach renourishment is a different matter. Beach renourishment has been undertaken in Port Phillip since the 1970s both to provide a recreational resource and as a coastline protection measure. Beach renourishment was originally undertaken by the Port of Melbourne Authority but now falls under the umbrella of the Department of Sustainability and Environment (DSE).

DSE has undertaken studies over the past few years to prioritise beach renourishment needs around Port Phillip and has preliminary designs for some beaches. The Panel considers that further investigation of beach renourishment should be strongly pursued via the Channel Deepening Project. The Panel is not in a position to conclude at this time that beach renourishment via the Project is technically, economically, environmentally or socially feasible or appropriate but it should be further investigated.

The Victorian community pays for beach renourishment which in many areas will be required in the future. It would seem to be prudent to take advantage of cost savings (if any) that may be achieved by using dredge spoil. The Panel considers that opportunities for incorporating beach renourishment needs into the Project should be actively pursued to maximise economic, environmental and social benefits from the channel deepening. Again, this matter is pursued further in Chapter 11.

6.4 RISK

Many submitters before the Panel raised deep questions in relation to the manner of the proponent's consideration of risk issues and application of a risk management framework as the central tool for identifying impacts, determining impact controls and assessing their acceptability in the project.

Sound project management demands a well-structured approach to the identification, assessment and management of risk. This is recognised in the EES Assessment Guidelines which required that an …*environmental risk management approach based on assessing potential* *hazards to environmental assets, values and uses, and the likelihood of their occurrence to guide effective risk management measures*[31] be used to guide the EES process.

The Proponent uses both qualitative and quantitative risk assessment approaches in the EES. Qualitative risk assessment compares activities to see whether one carries a higher risk than another without the need to calculate absolute risk. Quantitative risk assessment calculates and evaluates risk based on event data.

Both approaches require the same basic steps of:

- establishing the context;
- identifying hazards (or risk events);
- risk analysis;
- risk evaluation;
- developing and implementing risk treatment;
- developing and implementing communication and reporting systems; and
- monitoring, auditing and reviewing the system overall.

The project's environmental impact assessment process and the EES document itself are structured around a basic qualitative risk management framework. This framework seeks to focus the efforts of the EES consultants on areas of higher risk and to integrate their findings into an environmental management framework aimed at controlling those outcomes that were initially identified as unacceptable.

In addition to this qualitative framework that is (at least theoretically) applied throughout the EES, quantitative risk techniques have been deployed in the field of shipping incident modelling, with the application of the data generated to marine ecological analysis (although with apparently wider uses also having been made of it.)

This section of the Panel report is divided into two main parts.

- The first examines the qualitative risk assessment basis underpinning the Proponent's approach to environmental impact assessment.
- The second part examines the specific areas where the Proponent has used quantitative risk assessment techniques.

These two parts are followed by consideration of two special cases to which submissions ran in some detail:

- safety; and
- oil and chemical spill risk.

6.4.1 THE EES RISK MANAGEMENT FRAMEWORK: QUALITATIVE RISK

Discussion

The qualitative risk management framework developed by the proponent is probably the single most critical tool or process for managing information and supporting decisions in its EES process. The proponent has acknowledged from the outset that the project bears on

[31] Assessment Guidelines at pg 13.

significant areas of possible risk, in circumstances of considerable scientific uncertainty. In these circumstances it has sought to identify and make transparent the risk areas that it responds to, and to use assessments of these as the primary driver in determining whether an action should be taken, and if so under what terms as to design, control and performance.

There was little criticism of this basic stance. Submitters acknowledged that it is necessary for a project of this scale to be aware of the risks inherent in its delivery and to use this awareness to manage and minimise them. However, submitters were concerned that the validity of the outcomes of the proponent's qualitative risk assessment process rest primarily on the integrity of the risk management framework and the rigour applied to managing the data it produces throughout the EES process. Should this not be the case in the complex and integrated nature of the Port Phillip Bay environment the errors will propagate into the judgements made about project design, implementation and environmental management taken across more than one field. There is also a deep underlying concern that the risk framework methodology should have appropriately considered issues of the relative weighting risk between disciplines, together with the potential for compound or cumulative risks. These are issues that in the Panel's mind require very careful exploration.

Panel Response

The Panel commences its response to these issues by considering the following related questions:

- Was the method deployed in the proponent's risk framework sound?
- Can the outcomes from the risk framework inherently be relied upon?
- Is the risk framework a sound basis for the making of project design, implementation or ongoing environmental management decisions?

In order to commence the addressing of these questions, it is necessary to return to the methods deployed by the proponent in the generation of the risk framework.

A tiered assessment approach was adopted in the EES based on the assessment of risk in accordance with Australian Standard AS/NZS 4360 *Risk Management*. It describes the risk assessment undertaken as comprising the following steps:

- Vulnerability assessment.
- Initial risk assessment.
- Residual risk assessment[32].

In terms of AS 4360, the Panel understands these to be normal steps. A vulnerability assessment examines in principle instances of potential asset vulnerability arising from the interventions proposed by the project. Assets in this context are environmental values or conditions that are sought to be protected for whatever reason. The vulnerability assessment targets assets for initial risk assessment, which in turn brings a more detailed knowledge about assets and effects to bear. Areas of 'unacceptable impact' can then be defined as requiring project change or management to address. The project consultants are then asked to consider means of project change or management, and a residual risk assessment is carried out to determine whether their proposed responses will have the effect of reducing unacceptable impacts to acceptable impacts. It should be made clear to the reader that the method by which 'unacceptable impacts' are defined and responded to for the purposes of such a process are absolutely critical to its value and integrity.

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[32] From EES Volume 1, 7-6.

The Panel heard evidence that:

- Risk assessment expertise was engaged very early in the EES process to train the proponent's lead consultant and others in the application of AS 4360 type risk assessment techniques. However, this risk assessment expertise was not retained throughout the EES process.
- Relevant personnel in the proponent's consultant team then managed the risk assessment process, with Mr John Arup taking the lead in this field.
- Mr Arup does not list participation in risk assessments as an area of experience or expertise on his CV.
- No documentation in relation to the structure, purpose, approach, objectives etc of the risk assessment process was made available to the Panel.
- No report or other documentation summarising the outcomes of the risk assessment process was made available to the Panel.

To this extent, the method was not transparent. Critical questions of method and integrity of process had to be drawn piece by piece from the proponent. Whilst the Panel and parties asked many questions, the detailed examination necessary for certainty would have had to continue over many further weeks. The Panel does consider that it has enough information to hand from which to evaluate the basic nature of the exercises that occurred; sufficient also to suggest that they lead to some profound concerns.

Risk assessment is a methodical, pedantic, rigorous process, which requires the development of detailed and accurate information management systems and record keeping. The EES itself contained little of the 'working' documentation that would be expected from a risk assessment for a project of this scale. This would not be a concern if the information that is provided, and the conclusions drawn, demonstrated a consistent and comprehensive approach to the task. However, submissions suggested and the Panel found that this was not the case. These focussed on the following areas:

- Concerns as to the definition and application of likelihood and consequence criteria.
- Concerns as to the consistency of application of the risk analysis method.
- Concerns as to the lack of real risk controls in the risk management framework, as opposed to assertions as to the appropriateness of outcomes.

The Panel considers these issues with reference to two case studies – Newport Power Station and the proposed bunded DMG structure. However, it is fair to note that they bear on a much wider range of issues that the Panel cannot document in detail without this report extending to many further hundreds of pages or its writing extending unacceptably in duration. Aspects of these are represented in a bulleted summary list below.

Likelihood and consequence criteria and their application

The Panel considers that the proponent used the AS 4360 risk matrix in a manner that fails to address the purpose and intention of such risk analysis. This failure, which first occurred at the initial risk assessment stage, then propagated without identification or correction throughout the whole EES document. To this extent, it has invalidated the final risk conclusions, EMP and management recommendations that are based upon it.

The key concern is that those managing risk assessment in the project decided not to 'normalise' or 'moderate' the likelihood and consequence criteria and bring them back to a common base, as would normally be done in a risk assessment of this type. To explain why this is important, an example will assist.

If one examines a notional development scenario that is subject to risk, one might identify that there are three key risk areas, such as:

- risk to listed protected species or communities;
- risk of economic loss; and
- risk of adverse human health impacts.

One should then consider, having regard to both likelihood and consequence, the relative significance (scale or weight) of each risk area.

It should not be taken as given that an extreme risk under one risk area will equate in weight to an extreme risk in another. Subject to validation, it may be possible that a risk assessed by an individual consultant as moderate in relation to say the economic loss equates to an extreme risk under say the adverse health impacts. This would mean that in relative terms, impacts in the economic loss risk are being judged as more weighty (or bigger) than impacts in the adverse health impacts.

In short, it is necessary to conduct an exercise to determine the relative weight of each head of risk and to relate these weights, before one decides what risk management strategies to adopt and what the residual risk of the 'whole project' might be. If one does not take this critical step, one is left with a sequence of individual 'flat form' risk assessments, but no understanding of overall project risk. In prioritising management action to mitigate or control extreme or high risks against all measures, one might in fact be devoting resources to low weight extreme risks, whilst ignoring high weight moderate risks, simply because the methodology was applied in a manner which disallowed or failed to their potential weightiness. Further, if one has not undertaken a holistic and weighted risk assessment, one will have ignored or underplayed the potential for cumulative risk development between risk areas.

Having taken the material provided in submissions and evidence by the proponent carefully into account, the Panel considers that the proponent has fallen into this error. It appears that it has produced a 'flat form' risk assessment, which therefore can tell us nothing about (for example) the relative weightiness of the visual risk flowing from the stationing of a dredger in the Heads, as against the risk of changing the nitrogen balance of the Bay.

The proponent notes in the EES that:

> *Upon commencement of the risk assessment stage of the EES, the specialists were asked to derive a set of likelihood and consequence criteria that would be applied to assess the risks of the Project to particular assets. The reason for developing their criteria prior to the commencement of the risk assessment was to ensure that the criteria were independent of the risk assessment and were not unduly and subjectively influenced to achieve a specific outcome.* [33]

This is fine as far as it goes. However, until the Panel requested that it be done during the hearing process, these criteria were not collated into a single table so that a comparison between them could be easily made. The previous absence of such a table alone strongly indicates that the risk assessment cannot have been undertaken as an integrated group process and that the resultant assessment is therefore 'flat form'.

Further indication of this error flows from the fact that each consultant effectively established their own separate 5x5 risk matrix and ranked risks within their own matrix to determine whether they were extreme, high etc. (And it should be noted that this approach also

[33] EES Volume 1, *29-2*

appeared to hinder opportunities to identify risks arising from interactions between disciplines.) The proponent then appeared to set the level of the 'as low as reasonably practicable' risk (known as ALARP) at *extreme* and *high* risks within each study apparently irrespective of large apparent differences in relative weight between risks in individual disciplines. They then used the risk rankings in a comparative fashion to determine which risks were acceptable and which ones were not, embedding the invalid 'flat form' assumption of equal weighting as between risk areas. For example:

> *The initial risk assessment identified a total of 37 extreme risks and 92 high risks. A further 54 moderate risks and 59 low risks were not carried through to the residual risk assessment.* [34]

This suggests very clearly that all extreme risks, high risks, moderate and low risks were treated as having the same or similar broad weight as all other similarly characterised risks.

Given that this approach has been taken, the Panel must remark most strongly that it is not methodologically valid to select the extreme and high risks from each study to drive the risk framework and to reduce or cease further consideration of the other risks. The likelihoods and consequences have not been normalised. Direct comparisons cannot be made between the disciplines. The analysis runs the severe risk of accidentally but grossly under or overweighting relative risks or of ignoring cumulative risk interactions.

The following statements bring attention to some of the concerns that this caused to the EES consultant team:

> *Following the residual risk assessment, many of the items assessed still have risks that are assessed as high or extreme. Whilst elevated risks remain, this does not necessarily mean that the risk should imply that the Project should not proceed.*
>
> *Generally the risk remained high for most assets since the likelihood used to determine the risk rating was already low and could not be reduced further by the mitigation measure.* [35]

The Panel interprets these statements as the unconscious struggle of the lead consultant, seeking to somehow grapple with the fact that some risks identified for management did not 'feel' as though they ought seriously be the subject of detailed management, whilst others still felt under-managed. They represent value judgements within which some loose comprehension of relative weighting might begin to find expression. However, in this regard they are not transparent, incomplete and unreliable. They cannot stand in the stead of a thorough, holistic and documented analysis of relative risk weights, leading to more soundly based management recommendations and residual risk conclusions.

In the absence of such an approach, the Panel has considered whether it is sound to rely upon the proponent's risk framework as a means of prioritising actions in terms of project design, delivery and environmental management. On balance, the Panel has concluded that the 'flat form' error in the risk analysis is of such a basic and widely propagated nature that it questions the validity of decisions taken as an output from the application of the framework. Without considerable further analysis, it is simply not possible to tell whether any given risk is being appropriately managed as to weight; whether 'light' risks are being over managed, whilst significant and weighty risks remain untreated. This is not an acceptable position from which to commence the detailed implementation of a project of the significance and potential uncertainty as to outcome of that before the Panel.

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[34] EES Volume 1 46-20

[35] EES Volume 1 46-20

The approach to the risk assessment work undertaken in the EES is flawed. The risk assessment methodology was applied in a 'flat form' manner. It did not allow for the comprehensive identification, comparison and reduction of risks to an acceptable level across all disciplines. It did not allow for the identification of risks arising from the interaction of one disciplinary area with others. Even if such risks were identified, there was no way to rank them on a risk table and weight them against each other. It follows that decision makers cannot rely on the risk framework in the EES to support the proposition that all significant or weighty risks have been appropriately identified and managed.

Consistency and data linkages

These foundation stone methodological concerns aside, the Panel also has considerable concerns in more detail about lack of consistency and data linkages in the risk assessment process used in the EES.

The first study presented in Chapter 28, Part C Volume 1 of the EES (the Initial Risk Assessment) was *'Hydrodynamics Sediment Transport and Water Quality Modelling.'* This chapter contains a standard preamble about risk assessment in the introduction to the vulnerability assessment and goes on to say that the study identifies the threats and details the assessment methods used to evaluate the impacts and undertake the risk analysis.[36] The Expert Witness Statement of Dr David Provis relating to this study also states that the scope of work included:

> *… completion of a risk assessment in accordance with the risk management framework developed for the Project EES;* [37]

Fully expecting a summary of the risk assessment undertaken by this consultant, the reader has every right to feel perplexed to read later in Chapter 28 under the heading 'Initial Risk Assessment' that *'… a risk assessment was not undertaken specifically for this study'*.[38]

Later in Part C, the summary of another study undertaken by the same consultant *'Coastal Engineering'* presents a table of likelihood and consequence criteria, along with the findings from its initial risk assessment. If the consultant's original report is reviewed it can be seen that no likelihood and consequence criteria are established and risk assessment is not mentioned. When cross-examined, the consultant said that he did not undertake a risk assessment for any of the work that he was involved with.

Similarly, avian and terrestrial ecological impacts were not subject to the theoretically standard risk methodology. Mr Brett Lane, the consultant in that case, considered that the application of the likelihood and consequence components in AS 4360 risk method might underplay a proper and conservative assessment of potential risks for key habitats and species.

> *This was a different approach than that taken by other specialist studies. The consequence component of the risk assessment was therefore the focus of the assessment.* [39]

The Panel happens to consider that he was correct to articulate these concerns, but notes that the response to it in overall project management terms was strange. Credibly, Mr Lane's concern should have been brought to bear to deliver a coherent and systemic revision of the

[36] EES Volume 1 28-1

[37] Expert Witness Statement of Dr David Provis at Pg 2

[38] EES Volume 1 28-19

[39] EES Volume 1 38-3 Birds and Terrestrial Ecology

risk framework. Alternatively, Mr Lane could have been instructed to carry out his assessment on the same basis as others. However, neither outcome eventuated, with the project managers accepting instead circumstances in which Mr Lane's analysis would be conceptually and methodologically different from that carried out by others, but would still be compiled into the greater whole.

A number of other consultants in their expert evidence for the proponent expressed the view that they found the risk framework conceptually difficult, or poorly adapted to their field of expertise and modes of analysis, but nevertheless soldiered on.

These examples illustrate the Panel's real concerns about the integrity and source of risk data in the EES, given that it is sometimes not derived from the original consultant's reports or any other transparent source. They are suggestive of a risk analysis that has been 'welded on' to at least some parts of the EES ex post facto, as distinct from one that has been solidly integrated into all stages of project design, management and delivery.

They also demonstrate that the risk assessment has not been undertaken systematically across all studies. The risk assessment has omitted at least one of the 'foundation stone' set of studies - '*Hydrodynamics Sediment Transport and Water Quality Modelling*' as well as that for '*Coastal Engineering* ' from its process. This is despite the very obvious potential consequences identified by these studies such as changes in water levels, waves, currents etc., all of which have some relative probability of occurring or not (and indeed are probably more predictable than some of the assessed 'environmental' and 'social' consequences of aspects of the project).

It must also be noted that the EES Part C summary of the initial risk assessment also does not include a social or community risk assessment and no significant risk assessment of social matters has been undertaken for the project.

Risks have not been assessed in any integrated or complete manner. At least some of the hazards have been assessed in isolation and not across the whole system.

Lack of real risk controls

Submitters and then the Panel also became very concerned about the tendency within the risk management framework and the EMP to state the achievement of criteria (as opposed to the identification, assessment and application of practical methods or technologies – controls) as being sufficient to reduce an identified risk.

The proponent saw this as being a valid component of a performance-based approach. In its view it was sometimes sufficient to identify for strategic purposes that certain criteria would be met. It was implied that it was not for the Panel or an approvals body to inquire into the means by which this might take place. It was also implied that it should be sufficient for the Panel or approver to accept that the criterion would be met. However, such an approach can hide circumstances in which the articulation of a performance criterion cannot be supported by a known control. This in turn leads the Panel to the troubling conclusion that significant numbers of the proposed performance criteria might not have any proven or even possible control or controls to ensure they are met in a manner not entailing excessive cost or further risk. This raises the twin spectre of a project in which critical environmental risks that require to be controlled to a specified performance turn out not to be sufficiently controlled, or alternatively that sufficient control can be delivered, but only at a dollar cost significantly over and above that currently allowed for.

Many events that were initially ranked as *extreme* and *high* risk were reduced to acceptable levels in the residual risk assessment on the basis that the proponent would meet some specified performance criteria rather than through the identification of the controls that would allow this performance to be achieved. This approach, without the specification of additional controls, is not valid in risk management methodology and compounds the earlier problems identified. It also means that the EES documentation presents an unduly positive message to the reader that there are few outstanding concerns to be resolved.

For example, the EES Economic Assessment dismisses the economic risk of oil spills in the following terms:

> *However, compliance with the performance criteria clearly state that there will be no oil or chemical spills as a result of channel deepening. Therefore this risk is no longer considered to pose a threat.*[40]

In the Panel's mind, this comes close to the adoption of performance criteria as articles of faith, rather than as rational project and risk management tools. Unless a clearly identified suite of controls exist to ensure that the criteria can and will be met, they should not be used on their own account to justify a lower residual risk, as they may prove impossible to meet.

Where risk controls are mentioned in the EES there also appears to be little understanding of the importance of using of 'proactive' controls as opposed to 'reactive' controls. In practice this amounts to not being certain as to whether one best prevents the 'accident' or cleans up the resultant 'mess'. There often is a lack of evidence or supporting detail to demonstrate that the desired performance criteria can be met if the control is applied.

There is also no way of telling by reviewing the risk management tables whether actual controls have been identified or not, particularly where procedures have been cited as the control mechanism.

There are many, many examples of this in the EES. Two of the most significant are examined in more detail here:

- turbidity and the clogging of intakes for Newport power station, and
- the containment of contaminated material in the bunds.

Newport Power Station

In *Table C1 Risk Assessment Summary* the *Clogging of Industrial Intakes of the Newport Power Station*[41] is given an initial risk ranking of *Extreme.* It then lists *Operational Control Procedure CDP446.4155.1A Newport Power Intake* as the control mechanism to reduce the residual risk to *Low*. It is intended to do this by requiring that that the range of quality of water taken into the power station does not vary from the natural range.

However, the detail of the cited procedure has not yet been developed. The Panel has been provided with no evidence that there are any controls that will in fact be able to meet the water quality requirements of the power station. As the Panel discusses further below in its consideration of beneficial use effects, existing engineering opinion on balance supports the view that there is no currently demonstrated means of meeting the proposed requirements of the procedure. This example can also be used to further emphasise the consistency concerns discussed earlier in this report.

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[40] EES Volume 4, A3 at p 38.

[41] From the EES EMP

Later in the EMP (but without cross reference to Table C1 or vice versa) it is also stated that:

> *There is a concern that suspended sediments from dredging could be drawn into the cooling water intake of the Newport Power Station. ….. The Alliance will place silt screens around the intake to prevent material being drawn into the plant (Check against Newport submission).*
>
> *The monitoring program will undertake measurements of water quality inside and outside the silt screen at the commencement of works in the vicinity of the intake to demonstrate that the silt screens are working effectively (M41).*
>
> *Methods for protecting the cooling water intake and associated monitoring are still being investigated.*

Not only is the silt screen not mentioned in *Table C1*, the procedure that is mentioned has not been written and the Panel heard subsequent evidence from both the power station and the proponent that silt screens have no hope of being a technically feasible means of improving water quality during dredging for the purposes of the power station. It should be noted that in reaching this position, the power station called a technical expert witness with direct experience of the deployment of silt screening in dredging programmes, a circumstance that significantly enhances the credibility of their position. The Panel must note its understanding that the proponent did not have detailed dredging expertise or advice available to it during material components of its risk assessment processes. It is therefore difficult to perceive how suggested controls reliant on the performance of specific dredge techniques could be accurately assessed for the purposes of determining residual risk. Such assessments at the end of the day appear to be based on little more than informed guesswork and to be little more weighty than informed lay opinion.

For these reasons, the Panel is clear that the reduction in residual risk ranking claimed by the proponent for problem facing Newport Power Station is not valid and the Panel's concerns about the proponent's ability to manage and cross reference risk data are heightened.

The Panel notes in this regard that Newport Power Station is one of the few instances in which Counsel put the proponent's evidence to detailed technical review by appropriately qualified experts and subjected it to formal cross-examination. It was examined with rigour and by no means withstood the test, demonstrating that a wide range of considerations as to determining the real residual risk were unresolved. Counsel for the power station remained with all relevant components of the Panel hearing, including the Panel's examination of governance and environmental management considerations.

In such circumstances, the Panel can only prudently return to the initial risk ranking of Extreme and consider that this has not been adjusted in any way. The Panel is also left with a deep concern that the exposure of other aspects of the risk management framework to a similar rigour of examination would demonstrate equivalent flaws.

Placement of contaminated material within a bunded area

Another example is that of the proposed construction of a bunded area for the management of contaminated sediments.

Table 45.1 in the EES EMP contains a performance criteria under mobilisation of contaminants that says:

> *No contaminated material to be placed outside the bunded areas of the DMG.*

This performance criterion is repeated in the updated EMP Version A considered by the Panel, where Chapter 4, Table 4.4 *Regional Procedures for the Northern Bay* also states that a silt screen will be placed around the bunded site.

The use of a silt screen as a control at this location is not mentioned in the EES nor contained in any other evidence presented at the Panel Hearing. It is also not mentioned in EMP Version A *Table C1 Risk Assessment Summary* which only refers to *CDP OP 446.465.1A Mobilisation of Contaminants:* a procedure that makes no mention of silt curtains or screens. It appears to have been an approach that was identified late in the piece, most likely pursuant to advice from the dredging alliance partner, Boskalis: but this is only surmise on the Panel's part. However, the more critical possibility is that this proposed control has not been subject to full consideration by relevant EES consultants and certainly a transparent residual risk assessment was not made in the EES.

This example raises more concerns about the proponent's ability to manage and cross reference data in respect of the following outstanding questions:

- is a silt screen needed as a control or not?
- was the residual risk ranking done with this control in place or not?
- who was involved in the residual risk ranking process?
- what factors did they take into account?
- do they have sufficient expertise to determine the likely beneficial effect of the proposed control?

Again, the Panel must note the lack of specific dredging technology expertise in the primary EES team understood as having carried out risk analyses, with Boskalis' expertise becoming available only a late date, after many fundamental aspects of risk assessment had been completed.

Whilst such questions remain unanswered across a significant range of the material embodied in the EES risk analysis, the Panel does not consider it safe to assume that the reduced levels of residual risk can and will be delivered. From here it is only a very short step to the conclusion that assessments of environmental impact based on such residual risk analysis are likely to be systematically unreliable.

Other qualitative risk concerns

The preceding discussion has highlighted a number of methodological problems with the risk assessment. Some of these stem from the approach of the proponent to risk. The Panel sought answers to the links between the EES, the project as a whole and the approach taken by the proponent and found that:

- No overall risk and safety management strategy or framework was provided to the EES team by the proponent that could have provided a 'risk/safety management' context to the EES.
- The proponent either does not 'subscribe' corporately to AS 4360 as a risk management tool, or if it does this was not communicated to the EES team.
- No analysis was undertaken by the proponent or the project team of the suitability of AS4360 for the task undertaken and whether any 'gaps' may remain following its implementation.
- No safety or Port emergency service personnel appear to have been involved in the risk assessment.

The Panel has over-riding concerns as to method, explored above with reference to examples of the risk management approaches to issues emerging from Newport Power Station and the proposed bunded DMG. The list below gives guidance as to the overall scope of the Panel's concerns.

- The description of the project used in the assessment did not cover all works (eg the Yarra berths) and work activities (eg the proposed drag rock ripper head), was too generic and did not include alternative best practice methods. It therefore appears that material inputs to risk scenarios have not been properly considered or have been 'forgotten', because there was no detailed checklist of risk sources and potential control techniques.
- There appear to have been insufficient personnel involved in the process with relevant expertise in the proposed dredging, berth works and operational activities.
- The proponent could not tell the Panel whether or not the initial risk assessment had been undertaken with or without existing control measures in place. Therefore, the underlying level of risk may not have been determined for what appear to be lower risk events.
- The initial risk ranking undertaken by EES consultants was largely undertaken in isolation from the other EES consultants. They do not arrive at an interdisciplinary or holistic assessment.
- The hazard prompt list was not in sufficient detail and different lists appear in different places in the EES.[42]
- The hazard register is not comprehensive and does not list assumptions that were made in the risk assessment process.
- Some threats do not appear to have been taken through the whole process, for instance, the hydro hammer and stone fishing units were not part of the Evers Consult base case.
- The threats analysed did not include human health, social and economic threats.
- Multiple scenarios from a single event were not considered. Also, the Panel was informed by Mr Arup for the proponent that it was not valid to consider them, demonstrating a poor understanding of the application of risk assessment techniques.
- There is a lack of assessment of possibly remote but nevertheless conceivable adverse outcomes/ worst case scenarios; eg failure of the hydro hammer to be productive, bund failure, inability to achieve minimum acceptable turbidity levels in the Yarra, ripper dredging of unexploded ordinance from previous deepening programs, sinking/grounding of a dredge within the Heads, etc.
- The risk assessment does not appear to have been conducted as a facilitated group process.
- The time apparently devoted to risk assessment workshops was significantly less than that required to produce a comprehensive robust outcome.
- There was an inconsistent application of risk assessment techniques across consultants.

[42] eg see EES Volume 1 45-3-2

Conclusions on qualitative risk

It is germane for the reader to ask: where does all of this lead?

Drawing its analysis together, the Panel considers that it was entirely relevant and appropriate for the EES Assessment Guidelines to specify the use of a risk framework in the EES as a reasonable mechanism to manage the levels of scientific uncertainty and system complexity inherent in the project. Sadly however, the risk management methodology adopted by the proponent has been implemented in a manner that embodies critical methodological flaws of a foundation stone nature. It is not possible to soundly conclude that the risk framework has appropriately and systematically identified risks and prioritised these for action through either project design or environmental management.

It flows that this Panel has no underlying confidence in the conclusions emerging from the risk framework as applied to date. This in turn serves to place significant question marks over the validity of all conclusions derived from it.

So: what should be done in the Panel's view?

The Panel considers that before the project is formally assessed as to environmental impact, it will be necessary to take the project through a detailed risk assessment process, in which relevant expertise (including dredging expertise) meets together and is used to systematically:

- validate and confirm the key risk areas to which the project is subject;
- weight these in relation to one another;
- re-determine the threshold of 'acceptability' (which may vary as between different risk areas dependent upon weight);
- identify impacts which require further assessment or management to reach the identified threshold.
- determine clearly identified, verifiable or validated controls to the task of achieving reductions to the threshold: - regard should be had to the need for these to represent best practice;
- re-assess residual risk; and
- transparently document the procedure, to ensure that there can be no repeat of circumstances in which nature and relevance of key aspects remain unclear.

For reasons as set out above, the Panel recommends as follows:

The existing EES risk assessment embodies flaws that have propagated throughout the EES, which makes reliance upon its outcomes for environmental assessment and decision-making purposes most unsound.

The risk assessment should be repeated in a whole of project-team process, which meets the following criteria.

- It should remain under the supervision of relevant expert risk advisers throughout.
- It should preferably be based upon a common methodology for and shared understanding of risk assessment as between all participants. If it does not take this step, a clear explanation should be provided, with consideration give to methodological consequences.
- If a standard methodology is to be applied, the assessment should use a normalised set of likelihood and consequence criteria across all studies to weight each risk area, before impact acceptability thresholds are set.

- It should include a comprehensive group workshop process that allows risks arising from the interactions between disciplines to be identified and assessed.
- Dredging experts should participate in the process.
- The proponent should also undertake a comprehensive review of the risk rankings, to ensure that no risks have had their ranking reduced, without the identification of at least one, and preferably more workable controls.
- The outcomes of the process must be rigorously tracked and fully documented, to support decision making in reliance upon them.

The Panel is certain that this repeat risk assessment will identify subject matters that require additional environmental impact assessment and to that extent this recommendation should be seen as being of a foundation stone nature.

6.4.2 SHIP INCIDENT RISK: QUANTITATIVE RISK

Discussion

This section of the report examines the quantitative risk assessment work undertaken in relation to the dredging works and operation of the deepened channels until 2030. This work (known as the Port of Melbourne Shipping Incident Model or POMSIM) was prepared by the proponent's Marine Ecology Expert Witness, Dr Edmunds.

The EES Assessment Guidelines required the identification of:

> *Potential changes in the risks to the Bay's environment and users from larger ships and changes to shipping movement patterns (e.g. due to increased wake, changed risk of collisions and spills, and risk of translocation of exotic pests).* [43]

Pursuant to this requirement, quantitative risk assessment of shipping incident related risk was undertaken.

The nature and method of this work was a source of concern to a number of submitters who sought to advance views to the extent that:

- the body of work undertaken for the proponent was not soundly based;
- it did not provide a clear basis for conclusions that shipping incident risks during the channel construction stage had been satisfactorily controlled; and
- it did not provide a clear basis for conclusions that shipping incident risks during the long term operation of the deepened channels had been satisfactorily controlled.

Submissions were presented to the extent that:

- The proponent's Marine Ecology consultant undertook the principle body of quantitative risk assessment work for the project. This body of work is primarily presented in Volumes 11 (Impact Analysis methods) and 17 (Oil Spill Impact and Risk Assessment). There is also some discussion of it in the Marine Ecology Expert Witness Statement.
- The Marine Ecology consultant used the DNV POMSIM model for the Port of Melbourne without technical assistance or advice from DNV.
- That the consultant was not trained in the use of the model nor had prior experience in the use of the model.

[43] Assessment Guidelines Section 2.7

- The model used is based on pre 1976 UK shipping incident data, reduced by a factor of 10 to account for Australian shipping volumes.
- The actual shipping incident data used to verify the model was provided by the PoMC and covered only a few years. This data did not include a range of relevant incidents in particular any of the recorded groundings at the Heads.
- The consultant recognised that the model gave only a preliminary indication of risks and recommended that the validity of the model be assessed. No evidence was presented that this body of work has been undertaken.
- The risk assessment has not been peer reviewed.

These issues were viewed as being critical by submitters, who were concerned that for the purposes of determining a wide range of risks of environmental, social and economic impacts of the project, it was important that any quantified understanding of shipping risk be sound.

Panel Response

The critical issues raised in submissions are as follows in the minds of the Panel.

- Was it germane to weighting the results of the analysis that it may have been carried out for marine ecological purposes, but appeared to find a wider than intended application?
- Was the analysis carried out or reviewed by an appropriately qualified expert?
- Was the quantitative analysis methodologically sound?

In relation to the first of these points, the Panel finds that the quantitative analysis generated by the Marine Ecology consultant was relied on by others outside his field, despite the proponent submissions to the contrary:

> *POMC states that the shipping incident model was used by Dr Edmunds for the specific purpose of his ecological assessment……POMC did not, and does not rely on Dr Edmunds model for any other purpose.* [44]

Despite this submission, analysis by the Panel of many other bodies of work in the EES demonstrates a widespread team reliance on the shipping incident work carried out by the Marine Ecology expert. This is evidenced in some of the statements in the table below.

This fact gives the Panel cause for concern. Without wishing to denigrate the very substantial efforts to which Dr Edmunds, the Marine Ecology expert went to determine the potential effect of shipping incident risk on his own field, he was not by any measure a formal shipping risk practitioner. A shipping model (the DNV model) was being used, but in a manner that required substantial adjustments to key values within it to fit these to the conditions in the heads. This notwithstanding, the authors/normal custodians of the model do not appear to have been involved or consulted as to the appropriateness of the use to which their tool was being put. Nor was the decision taken to subject any of this work to relevant peer review. The Panel cannot avoid the conclusion that to place a marine ecologist in charge of the primary shipping incident modelling for a project of this scale and significance, using an adapted model without the supervision of its custodians or of a peer reviewer, was not wise. This considered it tends to reduce the weight that should be ascribed to the outputs of the model.

[44] POMC Submission Part E page7

In the Panel's mind, the extracts in Table 6 below also demonstrate that there are broader causes for concern about this work, vis:

- a general lack of understanding/shared understanding of quantitative risk work amongst the proponent team;
- the confusion that existed about the results or the significance of results to and for other consultants fields;
- there is poor separation of risk assessment arising from the construction phase of the project and the operational phase of the project; and
- that inaccuracies that have propagated throughout the body of work as a result of this confusion.

Of significant concern, it should be noted that there is confusion amongst the consultant team and in the documentation about the likelihood of specific incidents, which (with reference to one key example) can range from almost certain for a vessel collision in the Rip:

> *Vessel collision is almost certain in Rip (~50%) without management measures* [45]

to minimal:

> *The assessment concluded that the risk presented by the Project was no greater than if the Project did not proceed.*[46]

Table 6: Quantitative Risk Assessment: References from EES Sources

Author	Quotation
Edmunds (Primary source for quantitative risk)	*There is an increased risk of shipping accident, particularly collision, during channel deepening operations. This is because dredge vessels and equipment would be required to work for long and continuous periods of time in existing and operational shipping channels during deepening operations. (V3A2-4 oil spill and risk assessment page 7)* *The modelling indicted that the capital dredging will result in a substantially increased likelihood of collision impact at the Rip and Hovell Pile (where the channels are narrower). This translated into a substantially increased likelihood of an oil spill (approximately doubling the likelihood of an incident). (V3A2-4 oil spill and risk assessment page 13)* *A probabilistic model of shipping incidences in Port Phillip Bay indicated the presence of a dredger increased the likelihood of a shipping incident if only rudimentary shipping and navigation controls were in place. In particular, the probability increased from 1:10 000 to 1:10 per year for the Rip (assuming no controls in place).* *Detailed probability modelling of effectiveness of collision reduction measures (to ensure risk no greater than 10 x existing likelihood of an oil spill from a collision). (V3A2-9 EMP page 12)*
Edmunds	*Of greater concern is an increased collision risk associated with dredging equipment present for long periods in the shipping channels for the duration of the dredging. I classified the risk of this threat for the base case (worst case) as extreme – possible in likelihood but with major to catastrophic consequences. (EWS page 24)*
EES Volume 1	*In assessing the risks posed by oil and chemical spills, the Project EES focuses on the likelihood of an incident, particularly given that there is little scope for mitigating the consequences, should an incident occur, and that the consequences could be*

[45] see Mustoe reference in Table 6 below.

[46] EES Volume 1 50-12

Author	Quotation
	major to catastrophic. This assessment was done as part of the Marine Ecology specialist study, which built on work done previously on oil spill risks in Victoria (Det Norske Veritas 2000 ; (Australian Marine Ecology, 2004)). *The assessment included modelling probabilities of a wide range of incidence types that may lead to oil spills. This modelling highlighted the fact that the number of shipping movements is a primary factor of oil spill risk. Two different types of issues were identified with very different likelihoods and management considerations: the risk posed by ordinary shipping entering, transiting and docking in the channel; and the risk posed by the dredging vessels being present within navigation channels. (V1 pC-6)*
EES Volume 1	*An oil and chemical spill due to collision with the dredge poses a 'moderate' risk, as do oil spills due to collisions during normal shipping operations. Given the relatively short period of time activity will be carried out at the Rip, the likelihood of a collision involving the dredge leading to an oil spill is considered 'rare'. (V1, 31-10)*
EES Volume 1	*There is, however, a substantial increase in the likelihood of vessel collision causing an oil (or chemical) spill during dredging. The Heads is particularly vulnerable, as dredge vessels would be operating here for long periods of time and may have limited ability to manoeuvre in this area. (V1 35-20)*
EES Volume 1	*For the initial impact assessment, the potential for ingestion of oils at the oil/water interface has been considered as likely, the consequence major and the resulting risk rating extreme. This risk will be limited to the duration of dredging activities. As the Marine Ecology Study (Chapter 35) found, there is no greater risk of ship collisions from the Project than would exist should the Project not proceed. (V1 37-9 Marine Mammals and Penguins)*
EES Volume 1	*The Marine Ecology study has assessed the risk of a collision leading to an oil and chemical spill. The risk of a spill occurring was increased due to the risk of a collision between the dredger and a vessel using the channel. The simple presence of the dredger in the channel provided a possible obstruction that could be struck under emergency situations (e.g. loss of power, loss of steerage). This risk was further exacerbated where the channel sections narrowed. The greatest risk was found to be in the Heads, along South Channel, in the northern half of the Port of Melbourne Channel, and along the Yarra River between Williamstown and the Maribyrnong River.* *Due to the high tidal currents, the greatest effects would be likely to be in the Heads and South Channel where the risk was rated as extreme. (V1 44-3)*
EES Volume 1	*The accidental release of oil or chemicals into the marine environment due to an incident involving the dredger — most likely a collision between the dredger and a commercial vessel operating in the channel — may result in a significant environmental impact. The initial risk assessment by the Sediment Chemistry and Water Quality Specialist Study rated the risk as moderate for the south of the Bay, high for the north of the Bay and extreme for the Yarra River. Other specialists also assessed this risk as being high (see Section 46.2.4) and, as a result, the draft EMP requires that there be no oil or chemical spills arising from dredging. This would be handled by the imposition by the Harbour Master of strict best practice management procedures on the dredging. Such procedures would then reduce the risk of an oil or chemical spill to low. (V1 46-5)*
EES Volume 1	*The identified risk of concern was the potential impact of oil spills, both directly on coastal aboriginal heritage sites and also as a result of any clean up required. This was particularly an issue in coastal areas where investigations had not yet been carried out to determine the presence of artefacts. The assessment concluded that the risk presented by the Project was no greater than if the Project did not proceed. (V1 p50-12)*
Longmore	*The Marine Ecology specialists recommended that dredging operations are carried out such that there is no greater than 10 times existing risk of collisions or grounding (which may cause oil spills). Furthermore the dredging operations should be carried*

Author	Quotation
	out such that there is no greater than 5 times the existing risk of collision or grounding (which may cause chemical spills). (V3B6-p51)
Mustoe	*Vessel collision is almost certain in Rip (~50%) without management measures (Edmunds et al, 2003) but not every collision likely to result in spill. Likelihood of spill as a precaution considered 2. Likely10% (V 3B8 – Table 8.2 page 46)*
Cohen	*Given the relatively short period of time activity will be carried out in the Rip, the likelihood of a collision involving the dredge then leading to an oil spill in the Rip is considered rare. (sed chem. V3B4 page 34)* *There is a greater likelihood of an oil spill in the Rip from normal shipping operations over the lifetime of the project, but on past performance the likelihood is still unlikely, rather than likely. (sed chem. V3B4 -Page 34*
Lane	*Oil spill data based on information spreadsheet from Project management consultants dated 3rd May 2003 (Terr Ec and Birds V3B-p10)*
Meyrick	*There is likely to be minimal risk of [sic] safety during the construction phase of this project as a result of changed traffic conditions in the channel. (Meyrick PWC V4A1 – unnumbered Table page 62)* *The introduction of a comprehensive dredging management strategy by PoMC , which will mandate active coordination by dredging operations and the management of vessel movements is proposed in the EMP. This is expected to minimise the potential for collisions between ships and a dredger. The revised likelihood of a channel blockage is then reduced by a factor of 10 to 0.1% per annum. (Meyrick and PWC page 38)* *In order to ensure that the most appropriate management approach is achieved, the relevant standard determined by specialists in this area was applied to the threats identified in Section 3.4. An exception has been made in the case of managing the reduced threat of collision between a dredging vessel and a commercial shipping vessel. In this case the Economic study identifies a suitable management approach. (Meyrick V4A3 page 32)* *The current annual threshold for vessel collision rate in Port Phillip Bay is zero - a rate which is expected to be maintained. (Meyrick V4A3 page 34)*[47]

Table 7: Ship Incident Data: Groundings: Source – Captain Frank Hart[48]

	Ships involved	Date (& time)	Incident type	Pilot on board	Comment
1	Global Spirit	23/09/03 2100 hr.	Grounding	yes	Vessel rounding Hovell pile, pilot advised that he nodded off.
2	Sapphire	18/01/03	Grounding ?		Webb Dock. Incident listed – public report not yet released.
3	Mirande	28/06/01	Grounding	yes	Steering gear failure, grounded in south channel. Inquiry found first and third mates had inadequate knowledge of bridge equipment specifically emergency steering gear.

[47] The last statement in this table demonstrates confusion on the part of the author. It presents what is presumed to be a target vessel collision rate of zero, as an actual vessel collision rate of zero.

[48] The Panel does not specifically endorse this data, having no independent control as to its accuracy. However, it was not challenged by the proponent. All data including commentaries are sourced from the submission of Captain Frank Hart.

	Ships involved	Date (& time)	Incident type	Pilot on board	Comment
4	Eburna	16/03/97 1215 hr.	Grounding	yes	Shell tanker. Investigation found vessel hit bottom passing out of Port Phillip Heads holing fore peak tank.
5	Matru Kripa 1	0/09/94 2050 hr	Grounding	yes	When entering through Port Phillip Heads vessel entry aborted, whilst returning to sea, vessel grounded putting hole in fore peak tank.
6	Berlin Express	02/05/93	Grounding	yes	Vessel inward bound grounded in south channel as a result of ship taking a rapid sheer to starboard. At time vessel in automatic pilot.
7	Novikov Priboy	07/06/92	Grounding	yes	Vessel grounded off Gellibrand shoal.
8	Ampol TVA	11/09/91	Grounding	yes	Vessel grounded off the Hovell light.
9	George Tobin	15/08/91	Founded	yes	Pilot launch founded on reef off Point Lonsdale.
10	Premier	30/04/91	Grounding	yes	Vessel grounded in South Channel.
11	Golden Gate Sun	30/08/84	Grounding	yes	Oil tanker failed to turn off leads entering through Heads and vessel grounded on Shortland Bluff. Pilot claimed he had been taking anti-histamine medication for a cold, causing him to fall asleep.
12	Africa	1969	Grounding	yes	Bulk carrier grounded while negotiating Point Richards Channel.
13	Nagaosan Maru:	02/10/64	Grounding	yes	Grounded near Queenscliffe.
14	Millers Canopus	30/08/64	Grounding	yes	Oil tanker grounded in Hobsons Bay.
15	Kissavos	20/08/64	Grounding	yes	Oil tanker grounded in Hobsons Bay.
16	Beltana	16/09/63	Grounding	no	Grounded Point Nepean Reef in strong ebb tide.
17	Karoon	08/09/63	Grounding	no	Grounded Point Nepean Reef in strong ebb tide.
18	Wangara	18/11/61	Grounding	no	Freighter grounded near Point Lonsdale, outward bound, forced to the west giving sea room to inward bound vessel
19	River Glenelg	21/07/60	Grounding ?		Bulk carrier grounded Hobsons Bay.
20	Pattawilya	26/07/59	Grounding	yes	Freighter grounded Hobsons Bay.
21	Patricia	26/01/57	Grounding	yes	Oil tanker grounded Hobsons Bay.
22	Iron Master	03/10/57	Grounding ?		Grounded in South Channel.
23	Tasmania Star	09/05/56	Grounding	yes	Freighter grounded Point Richards Channel.
24	Orsova	24/05/56	Grounding	yes	Passenger vessel grounded in South Channel.
25	River Burnett	17/07/55	Grounding	no	Bulk carrier grounded on Corsair Rock.
26	Orcades	07/05/52	Grounding	yes	Grounded South Channel.
27	Time	22/08/49	Grounding	no	Freighter grounded Corsair Rock, unable to be refloated and remained on rock for 10 years until it disappeared in a storm.

Table 8: Ship Incident Data: Collisions: Source – Captain Frank Hart[49]

	Ships involved	Date (& time)	Incident type	Pilot on board	Comment
1	Tamesis	02/12/02	collision with wharf	yes	Collided with wharf whilst berthing, primary cause squall of wind.
2	Cape York	05/08/02 2048 hr.	collision with wharf	yes	Departed B Berth, Appleton Dock without tugs. Engine failure. Vessel blown across river and struck 32 South Wharf.
3	Santa Lucia	31/10/01 0245 hr	collision with wharf	yes	Vessel departing F Appleton Dock struck 29 south wharf.
4	Bunga Orkid Dua	23/05/01 2336 hr	collision with marina pier	yes	After departure vessel proceeding down river struck pier 35 marina structure.
5	Western Tiger	April 1997	collision with wharf	yes	Collided with Lascelles wharf Geelong during berthing operations.
6	Columbus Victoria Sampet Hope	17/11/96 2232 hr.	collision	no	Both vessels at anchor off Williamstown. "Columbus Victoria" dragged anchor in strong winds and collided with "Sampet Hope".
7	Searoad Mersey AM Vella	31/01/94 2151hr	collision	no `	"Searoad Mersey" using ARPA set course to pass dredge "AM Vella" working in South Channel. Struck No. 15 beacon and proceeded on to collide with dredge.
8	Pacprince HMAS Castlemaine	09/08/93	collision ?		Collision at North Wharf.
9	Reliance Trader Anangel Apollo	12/09/90	Collision with ship at berth.	yes	"Relliance Trader" berthing at Corio Quay North No.1 collided with "Anangel Apollo" berthed at Corio Quay North No. 3, Geelong.
10	Ace Chem Tolema	18/04/89	collision	yes	Collision in River Yarra.
11	Yue Man Charles H McKay	20/06/84	collision	yes	In collision off Gellibrand, Williamstown, hopper barge "Charles H. McKay" sank.
12	Nieuw Holland Tug Melbourne	09/08/72	collision	yes	Passenger ship "Nieuw Holland" collided with tug "Melbourne" when picking up headline and tug "Melbourne" sank as a result.
13	Wyuna Bass Trader	15/06/72	collision	yes on Wyuna no on Bass Trader	Pilot vessel "Wyuna" collided with cargo ship "Bass Trader" at Port Phillip Heads in fog.

[49] Again, the Panel does not specifically endorse this data, having no independent control as to its accuracy. However, it was not challenged by the proponent. All data including commentaries are sourced from the submission of Captain Frank Hart.

The Panel finds it inappropriate that the Economics consultant appears to have identified the management measures that are to be taken to reduce the risk of a collision between a dredger and commercial shipping vessel (see Meyrick as cited in the table above). This is a matter that requires appropriate expert attention. Without such attention it appears to reinforce the Panel's concerns expressed above in relation to the qualitative risk assessment, to the extent that performance measures are being applied as articles of faith, without reference to the existence or otherwise of genuine, practical, implementable controls.

Finally, in relation to methodological concerns, the vessel incident statistics provided by the proponent to verify the risk assessment results covered only a five-year period. This was a period that did not include any grounding or collision incidents in the heads. Submitter Captain Hart presented a set of grounding and collision data, which he had personally collated. He made no claims that his data was fully accurate, but tellingly, the Panel notes that the proponent, whilst seeking to undermine the credibility of Captain Hart on a number of grounds, did not challenge his shipping incident data set. The Panel collates this data in a table above.

The Hart data set out in the table suggests that there have been at least 13 collisions and 27 groundings in Port Phillip in the last 20 years. Of the collisions, seven are shown as involving vessels under way and 6 between a vessel under way and either the wharf or a ship at the wharf. Two collisions involving dredge equipment, one of which resulted in the sinking of a hopper barge. These incidents are not reflected in the modelling and no credible explanation has been provided as to why this is not the case. On balance again the Panel takes the view that this reduces the credibility of the model outputs.

As a result of the above analysis, the Panel finds that:

- The risk work of Dr Edmunds is methodologically flawed and that the level of risk associated with the project has been not been properly estimated, providing a false sense of security throughout the EES document set.
- There is likely to be an increased risk of environmental impact arising from shipping incidents as a result of the project construction phase, but the level of the increased risk has not been adequately assessed.
- The use of POMSIM in its current form (and probably in any form) was inappropriate to calculate changes in shipping risks during the construction and operation of the deepened channels. In particular it does not adequately account for the changed shipping conditions in The Heads and other channels, nor for the complex and dangerous currents in the Rip. A number of assumptions are also made that raise grave doubts about the credibility of the outcomes.
- The appropriateness of the modified shipping incident data set that was relied upon in the running of the POMSIM model needs to be assessed. The proponent's incident data then relied upon to verify the outcomes were apparently not an appropriate data set.
- Dr Edmunds did not have the appropriate expertise or access to data to undertake the risk assessment without some level of input from DNV or independent peer reviewers.
- Contrary to its submissions, the proponent and its consultant team have relied extensively on the risk analysis by Dr Edmunds as a foundation to the decisions and findings in a number of the studies.

In its current form, the outcomes of the quantitative risk assessment work expressed in POMSIM cannot be relied upon. This body of work needs to be peer reviewed by a person or organisation with appropriate expertise and with access to the appropriate risk tools and a full range of data inputs. Such a review should determine the degree to which model adjustments or a complete remodelling are required to produce valid and sound outputs. The outcomes of this assessment should be presented separately for the construction and operational phases of the project.

Following the outcome of this re-evaluation and review, other studies that rely upon the findings of the quantitative risk assessment also need to be reassessed accordingly.

6.4.3 SAFETY

Discussion

Although safety is not usually a key focus of an EES of this nature, it also cannot be isolated from broader environmental, social and economic project outcomes. For example, collisions, oil spills, chemical spills, noise and odour etc all have potential safety and environmental/social/economic impacts and cannot be assessed in isolation.

The proponent did not provide any data in the EES or to the Panel in respect to safety related incidents or the number of lives lost (ship's crews and pilots) as a result of shipping operations. This data should have been readily available as it can underpin key design and operational criteria for new infrastructure. A typical example is the identification of need for and design of a new highway alignment, where the roads authority will always refer to empirical safety data as a means of determining in principle need for a realignment, and then in driving the choice of alignment and detailed design. It will be important that any new alignment maintains or preferably reduces hazards in comparison with the existing alignment.

The proponent did not introduce a safety expert for the project to the Panel nor did they present any work from a safety professional in support of the EES.

Panel Response

The Panel finds that EES does not contain a basic safety assessment and very little safety-related information. This is not considered to be good practice noting that other environmental impact assessment documents for dredging and/or major projects have included the following types of assessments, albeit at a preliminary level:

- Establishment /recognition of safety standards for the project as a whole.
- Dangerous goods analysis.
- Transport risk assessment.
- Safety related analysis of working conditions and hours.
- Navigation aids.
- H_2S risk assessment in relation to dredging of muds.
- Safety risks associated with larger vessels using waters shared with recreational craft.
- Preliminary assessment that the project will meet workplace safety standards.

As noted previously, the Panel also considers that the qualitative and quantitative risk assessment work would have greatly benefited from the input of a safety professional.

The above factors, once investigated, could have outcomes that have a significant impact on the findings of the EES.

For these reasons, the Panel recommends as follows:

Before the commencement of works, a basic safety assessment should be undertaken to inform the findings of the other EES studies.

6.4.4 OIL & CHEMICAL SPILL RISK

Discussion

Oil and chemical spills deserve special consideration because they are repeatedly identified as a major threat throughout the EES. They are identified by several submitters as a key potential source of ecological and bay natural process risk. Critical considerations for some were the degree to which the project might affect oil spill risk, both during the construction and operational phases. It should be noted that as well as discussing the issue as a component of risk analysis in principle the Panel will also return to the subject in relation to channel design processes.

The proponent did not dispute the basic significance of such events for the bay and its ecology or bay and foreshore heritage assets. However, it did and does seek to rely almost entirely upon the use of outside resources in the event of a spill. These include the Victorian Marine Pollution Contingency Plan and the Melbourne Port Emergency Management Plan. However, these plans were not put to the panel and despite aspects of them being sourced after the conclusion of hearings it is difficult to make informed comments about their adequacy to materially control risk during the construction or operational phases of the project. It is not known if the plans contain specific scenarios for oil spills in the Rip. It is also not known whether the volume and placement of emergency response equipment is appropriate given the increased likelihood of an incident during dredging.

The management of refuelling and oils spills is also examined here as a 'safety case' study example of the means by which the proponent has understood, assessed, managed and tracked a significant threat.

Many of the EES studies identified oil and chemical spills, particularly those arising from refuelling operations as a risk to the environment. This is recognised in a number of places in the Main Report of the EES which sets the following performance criteria in the Chapter 45 EMP (p45-22):

> *No oil or chemical spills from dredging operations (E26)*
>
> *No refuelling spills outside the port area designated for dredging operations (E27).*

The EES goes on to make the following comment in respect to the second of these criteria:

> *While recognising the likelihood of refuelling spills, this threshold minimises the impact of refuelling spills on the marine environment.* [50]

[50] EES Volume 1 at Pg 45-22

Whilst the intention is good, it the proponent appears not to have appreciated that it will need a detailed and practical control to ensure that these criteria are met and that further, there should be no in principle acceptance of the appropriateness of spills within the operational area.

Panel Response

Given proponent responses in relation to questions put to it in respect to this matter the Panel expresses concern about the adequacy of the Plans in respect to the project risks. In particular, it is not known if the plans contain specific scenarios for oil spills in the Rip. It is also not known whether the volume and placement of emergency response equipment is appropriate given the increased likelihood of an incident during dredging.

The proponent stated during the panel hearing that they did not intend to undertake any new oil spill contingency modelling. However, neither did they make clear the degree to which existing contingency modelling provided a sound and well-adapted basis for the management of project (as opposed to existing) risks.

As will become more clear in relation to the Panel's consideration of ecological asset conservation issues below, the threat of an oil or indeed chemical spill is potentially extreme, with up to catastrophic outcomes for the bay. Depending on the location of a spill, impacts could be exacerbated due to proximity to high value assets (vis Ramsar sites, Marine National Parks/Reserves or heritage places) or due simply to the long water exchange time between the northern bay and Bass Strait.

One key issue is that the proponent does not appear to have formed a ready view on the current oil spill risk and contingency in the bay, and whether this is acceptable. It may well be so, but current performance should not be accepted without critical review.

The Panel clearly accepts that risks during the construction phase will be higher than normal, but they should be subject to a clearly identified suite of controls to ensure that this rise is capped to the minimum reasonably achievable value. In relation to operational risks, the Panel takes the view that these should be capable of being demonstrated as equal to or lower than current operational risks, assuming these to be acceptable.

Having considered these issues in respect of oil spills, the Panel notes that similar issues can in principle arise in relation to chemical cargo spillage.

Turning to consider oil and chemical spills as a safety case study, the Panel:

- does not find it acceptable to set a target of anything less than a zero level of refuelling spills at any location within the Bay;
- notes that the port area designated for dredging will be a very large part of the Bay;
- notes that the stating of a threshold in itself does not in itself minimise the risk of the impact of refuelling spills on the marine environment.

The EES Main Report goes on to outline a number of potential control methods in relation to refuelling spills, many of which are 'reactive controls' (after the event) such as emergency response plans and incident management. Some preventative 'proactive controls' are mentioned including:

- …. all such operations will be undertaken at a dedicated dock within the port area.51 undertaking all refuelling in port with appropriate response equipment available for rapid deployment should an accident occur.[52]
- the Harbour Master has already identified that, should dredging proceed, a specific berth would be allocated for use by the dredger for the period of the dredging operations. All refuelling operations would be conducted at this berth. [53]

However, once mentioned, these do not appear to be carried through, or accounted for, in any of the EMP documentation. This reinforces the Panel's previously mentioned view that the proponent has demonstrated poor information management and record keeping processes. Measures capable of being implemented are known and documented, but are not being followed through because the programme has not provided the proponent with sufficient time for rigour in risk management.

For these reasons, the Panel recommends as follows:

Before the commencement of works, the proponent should undertake consultations and studies to ensure that current oil spill risks and contingencies are adequate, and conform to industry practices.

Oil spill contingency modelling should be undertaken for a suite of scenarios that consider the outcomes of the quantitative shipping risk assessment. This modelling should then inform the project emergency response plan. Where necessary, additional oil spill response equipment should be provided by the proponent and located in areas where it may be necessary to protect sensitive environmental resources. If this is to be managed by others, the response plan must provide for communication mechanisms between the proponent and the plan manager, during the dredging.

The panel recommends that chemical spill contingency modelling commensurate with the level of risk also be undertaken.

Readers should note that the Panel undertakes additional consideration of emergency response planning issues in Chapter 17 below.

6.5 SUMMARY

Drawing all of this material in relation to the project approach together, the Panel must observe that it has fundamental concerns.

It considers that the combined effect of philosophical and methodological choices made at very early stages in the project has been to disable the proponent from carrying out an effective environmental impact identification process. This position derives from:

- Concerns that the performance based and adaptive management approaches adopted throughout the EES have not always resulted in the identification of certain means whereby it can be determined that actions will result in reasonably bounded environmental effects.

[51] EES Volume 1 at Pg 44-4.

[52] EES Volume 1 at Pg 45-23.

[53] EES Volume 1 at Pg 46-5.

- Concerns that the starting point of the project was not 'best practice', with all that is implied, in terms of not complying with Victorian legislative and policy imperatives and not demonstrating that environmental effects have been controlled to the extent reasonably possible.
- Concerns that the risk approach taken to respond to scientific uncertainty was methodologically flawed. The risk analysis is an uncertain body of work on which no reliable conclusion can be drawn.

The Panel considers that the balance of these considerations leave the EES on foundations that, in comparison with normal Victorian EES practice, are insufficiently sound to proceed to the immediate environmental assessment of the project as a whole.

The Panel considers that the balance of these considerations strongly suggest that the proponent requires to take time to examine the approaches which underpin the development of this project. Attempts to rapidly resolve substantive issues addressed in following chapters without re-examining the basic approach to the project and setting them on a sound footing are (in the Panel's view) likely to compound the difficulties that the project has experienced to date. Furthermore, they would represent the imprudent devotion of further public resources to 'solutions', before the nature of the problem has been systematically identified and responded to. This will be critical to the success of the project overall.

This chapter has identified foundation stone issues. The proponent now needs the space and time in which to consider and positively address these, before proceeding to detailed resolution. If this does not occur, the Panel takes the view that the project will be proceeding on an unsound foundation and subject to an assessment of environmental effects so qualified as make it nugatory for many purposes.

In final conclusion, the Panel recommends:

Before the recommencement of detailed evaluations pursuant to later recommendations, a process requires to be set in train whereby the proponent devotes a reasonable period of time to setting the project and its environmental assessment onto a sound methodological and policy footing.

7. PROJECT DESIGN

This section addresses the following issues that are relevant to the Minister for Planning's decision:

- A geographical framework bearing on project design is outlined, leading to an examination of specific design issues that emerge in different locations.
- Relevant design standards and methods are outlined. The compliance of the project with relevant standards and methods is considered.

7.1 GEOGRAPHY & DURATION

This section gives a general description of the proposal to deepen the commercial shipping channels in the Port of Melbourne and describes particular geographical aspects.

Channel modifications are proposed in the:

- Rip, at the entrance of the Bay, along sections of the Great Ship Channel, Western Ship Channel and Eastern Ship Channel,
- South Channel,
- Approach channels to the Port of Melbourne, and
- the Yarra River generally downstream of Appleton Dock.

The Project also includes dredging works at berth pockets in the Port of Melbourne, as well as the management and placement of dredged material. These works are referred to as the 'capital works'.

Following the deepening, the 'maintenance works' necessary to support ongoing use of the channels at their new declared depths form a second component of the project.

The third component of the project comprises use of the deepened channels up to 2030.

7.1.1 CAPITAL WORKS IN THE RIP

Discussion

The entrance of Port Phillip Bay is known as 'the Rip' or 'the Heads', and is located between Point Lonsdale to the west and Point Nepean to the east. The entrance is 3.5km wide but the reefs projecting from these points reduce the navigable width to about 1 kilometre. Extending to about 800m outside the Heads, there is a shallow rocky flat known as the Rip Bank. Towards the inside of The Heads is another bank named Nepean Bank. In past years both these banks of rock have been blasted within the Great Ship Channel to their current depth of 14m chart datum. Between these two banks is the Entrance Deep, a horseshoe shaped canyon like feature about 200 m wide and up to 90 metres deep. The canyon walls provide significant marine habitat and they, as well as other features in the area, are of considerable visual interest to divers and of ecological significance.

The narrow tidal entrance between Bass Strait and Port Phillip Bay combined with the inequality of depths between the banks and the Entrance Deep cause the world-renowned difficult sea conditions that give 'the Rip' its name.

Materials to be removed during dredging works in the Rip largely consist of limestone in a layered structure. It is proposed that a trailing suction hopper dredger (TSHD) with a specially adapted ripper head would be used in this section of the Bay. A barge mounted hydro-hammer device is proposed to loosen more consolidated material that cannot immediately be dredged using the TSHD rock ripper head.

If any rocks remain after dredging that are too large to be broken down by the TSHD, and cannot be ripped into smaller particles due to a lack of 'bottom contact', then a stone fishing barge is proposed to used. This technique is similar to trawling.

Great Ship Channel

The Great Ship Channel is the deepest of the channels located in the Rip. The proposed works for the Great Ship Channel involve full-width deepening of the existing one-way channel. It is also proposed to widen the channel out on the western side at the northern end to the full width of the Western and Outer Western Channels.

East and West Channels: Construction Channels

It is also proposed to deepen 40m of the Western Ship Channel and 80 m of the Eastern Ship Channel immediately adjacent to the Great Ship Channel for the purposes of construction safety.

Disposal

It is proposed that material dredged from the Rip will be disposed of in a new south-east DMG located north-east of Hovell Pile in the southern part of the Bay. This rocky material will be covered by sand dredged from the South Channel.

7.1.2 CAPITAL WORKS IN THE SOUTH OF THE BAY

Discussion

Works referred to in this report as in the south of the Bay refer to works in South Channel and associated disposal works in a South East Dredged Material Ground (SEDMG).

South Channel

The South Channel is located in the southern area of the bay inside the Heads. The proposed channel deepening works in this Channel roughly extend from The Heads to an area beyond Hovell Pile. The South Channel dredging can be divided into two separate sections that possess different geological characteristics.

The 'South Channel East' section largely consists of sand and sandy clays, with some rock outcrops. Sands and sandy clays can be dredged using standard drag head assisted by water jets to dislodge and dilute the sandy material. The ripper drag head may be used to dredge any rock outcrops that are detected.

The 'South Channel West' section is made up of sand waves rather than a continuous volume of sand. It is proposed that most of the material in the South Channel will be dredged using the TSHD and sweep.

Disposal

It is proposed that material dredged from the South Channel and the Great Ship Channel will be disposed of in a new south-east DMG located north-east of Hovell Pile in the southern part of the Bay.

7.1.3 CAPITAL WORKS IN THE NORTH OF THE BAY

Discussion

Works referred to in this report as in the north of the Bay refer to works in the Port of Melbourne Channel, the Williamstown Channel, the Yarra River, Dock basins and berths.

Port Melbourne Channel

The proposed works for the Port Melbourne Channel would involve deepening the full-width of the one-way deepdraughtchannel from near kilometre mark Kp 20.5 south of Fawkner Beacon up to Beacon 12.

For dredging works in the Port Melbourne Channel, a trailing suction hopper dredger would be used. When necessary, the dredger's drag head can be adapted to remove any stiff clay.

Stiff clay dredged from this Channel would be used to construct bunds for a laterally contained disposal area (see below).

Williamstown Channel and Yarra

The proponent describes works in the Williamstown Channel and the Yarra in two broad segments.

The proposed works for the Williamstown Channel and lower Yarra involve deepening the full width of the existing one-day deep draught channel from Beacon 12 up to Beacon 36 just south of West Gate Bridge. They include access works to Webb Dock and Gellibrand Pier.

The remaining Yarra works consist of all dredging proposed north of the West Gate Bridge. These works involve deepening the full width of the existing one-way deep draught channel from Beacon 36 up to Beacon 52 at the entrance to Swanson Dock, and Holden and Appleton Docks.

In the Williamstown Channel and Yarra it is proposed that the TSHD will first dredge the contaminated mud layer, and then the underlying clay layer using adapted drag heads.

Berths

Near the berths, services and other sensitive areas a backhoe dredger would be used to dredge as accurately as possible to avoid exceeding clearance lines and to avoid damaging the structures. This is referred to as 'fine tolerance dredging'.

Disposal

It is proposed that disposal in the north of the bay would occur at the existing Port of Melbourne Dredged Material Ground (PoMDMG), plus an extension to it.

A bunded area is proposed on the existing PoMDMG, as containment for contaminated materials. As the DMG slopes in a southern direction, bunds are required at three sides of the proposed facility. Around the bunds, a 100 metre wide buffer zone is proposed to assist in preventing material spreading beyond the DMG.

It is proposed that the bund would be 25 metres wide at the top and have slopes of 1:40. The actual bund would be built from dredged clay lumps. The size of the bunded area would be approximately 1650 x 1500 metres. The top of the bunds would be at –15.4m, and when filled with dredged material to –15.6m, approximately 3 million cubic metres of dredged material could be stored.

7.1.4 MINOR CAPITAL WORKS

Discussion

The EES also proposes a number of minor capital works as part of the proposed project. These would include:

- Swanson Dock Berths: works to deepen existing area of berth pocket to accommodate design vessel.
- Swanson Dock Swing Basin: works to modify the existing swing basin to accommodate the design vessel.
- Gellibrand Pier: works to deepen and extend the existing berth pocket and adjacent area to accommodate the design vessel for the liquid bulk facility.
- Appleton Dock: works to deepen the existing berth pocket and approaches to accommodate the design vessel.
- Holden Dock: works to deepen the berth pocket to accommodate the design vessel and to minimise the impact of the surge effect associated with the transit of deeper draught vessels.
- Webb Dock: works to deepen the berth pocket at Berths 4 and 5 to accommodate the design vessel.

7.1.5 MAINTENANCE WORKS

Discussion

The project also comprises maintenance dredging required in addition to that if the project did not proceed, for a period until 2030. This includes an allowance for the placing of maintenance dredged materials in the DMGs described above.

7.1.6 OPERATIONS

Discussion

The project also comprises channel operations for a period until 2030.

7.2 DESIGN & OPERATION

Having set out a geographical frame of reference for the project and its key works components, the Panel now proceeds to consider approaches to the design of channels. It is necessary to consider design in terms of its physical implications for works: what is to be removed from where and where is it to be put? It is also necessary to consider design in an operational sense: how deep and wide must the channels be to safely accommodate the proposed design vessels?

Having identified that this is a task for the Panel, it should be remarked that it is not one that the EES sought to accomplish in any great detail. In line with the performance-based philosophy of the EES, the consultant team preparing the exhibited body of work did not seek to make committing statements about channel design and operation. They took the view that these were matters for the proponent and the dredging alliance. They need not be specified in advance, as long as the environmental effects of works were considered and appropriate performance criteria established. For this reason, much of the body of work relating to the engineering channel design did not form part of the exhibited EES documentation.

However, as will already be apparent from the preceding chapters of this report, the Panel does not consider that it is possible to properly identify, consider and assess a range of relevant environmental effects, until one can broadly predict how the channels will perform during construction and in operation. In order to be able to make such predictions, it is often necessary to go beyond generic performance requirements to understand design. For example, if one does not know the width of a channel or the radius of a channel curve, it is not possible to predict how a ship of particular dimensions might pass through it, assuming certain metocean conditions. If one cannot predict this, it is not possible to assess whether the ship will be subject to an acceptable level of statistical risk in passing through the channel. If one cannot assess this, it is not possible to assess whether key ecosystem assets will or will not be subject to acceptable levels of risk from oil or chemical spillage. It is in such a fashion that the chain between the assessment of environmental effects and the physical details of design are often established.

It is fair to say that this is a position that did become increasingly clear to the proponent as the EES process developed. The practical concerns of submitters such as Newport Power Station on the operational effects of their facility, OMC on dynamic under-keel clearance or Captain Hart on marine safety begged proven design as opposed to objective based responses. So it was that whilst the EES was relatively quiet on the detail of channel design, information on channel design was made available by the proponent during the panel process.

This section examines that data from the following perspectives.

- Approaches to the design of channels: was the channel design process appropriate?
- DMG design: was the approach taken to the design and management of sediment disposal appropriate?
- Channel operations: has the chosen channel design approach been selected with a view to controlling operational risks and optimising benefits?

7.2.1 CHANNEL DESIGN

Discussion

Despite the fact that the work relating to the engineering channel design did not form part of the exhibited EES documentation a number of submissions raising significant issues were received in relation to this aspect of the project. The proponent chose to present the designer of the channel, Mr Peter Burton, and other engineering design-related members of the project team (Messrs Newcomb, Day and Boyd) to the Panel as expert witnesses. The Panel and parties were not provided with express design statements or briefs, although excerpts have emerged in various disclosed reports and witness statements.

There are no minimum standards in Australia covering basic port and channel design, choice of design vessels, turning basins, definition of acceptable levels of maritime risk, etc. There is also no Australia-wide marine equivalent of the Civil Aviation Safety Authority (CASA) to govern the maritime equivalent of runway design, pilot training, use of simulators, etc.

Various groups around the world have developed guidelines for the safe design of shipping channels. The major sources of practice are:

- the Permanent International Association of Navigation Congresses (PIANC) in conjunction with the International Association of Ports and Harbours (IAPH),
- the United States Army Corps of Engineers (USACE), and
- the Canadian Coast Guard.

Documentation from these sources do not have legislative or policy force. All provide a guide only. Further, all tend to take a desktop driven conservatism which, in the absence of detailed design attunement to local conditions, tending to lead to the over-design of a waterway in the first instance, leading to more dredging than may be necessary. In short, the design process proceeds in two broad steps. An initial design emerges from the application of the relevant guidance publications. Detailed refinements are then made to respond to local conditions and subject to evaluation and testing by a variety of means.

The proponent chose to use the PIANC guidelines for the concept design and found that:

- there was less channel width available in both The Heads and Yarra River than was suggested by PIANC as adequate;
- there may not be sufficient room for post Panamax vessels to pass a tanker in the South Channel;
- some existing bends have lower radii than recommended; and
- currents across the channel of greater than 1.5 knots could not be avoided by realignment in the Heads.

The proponent then followed the PIANC recommendation of a second design stage to detail or optimise the channel profile. PIANC note that this second stage may utilise physical, mathematical and/or simulation models along with marine risk analyses, marine impact assessments berthing studies[54].

The proponent chose to use the real time simulation package *SimFlex* to undertake the detailed design. This package is a commercial product marketed by their consultant used for the project. It then proceeded to carry out a range of simulated ship runs through the design

[54] PIANC Guidelines p5

channels using Port Phillip Sea Pilots to command the design vessels. These in turn provided data about the performance of the vessels in the channels against a range of metocean conditions applied in the model. This was then used to refine and in the proponent's view validate the channel designs.

The concept design was undertaken for two 14 m design vessels - a tanker and a container ship. The other dimensions of each ship were chosen based on a review of current and anticipated vessel sizes for this draught (see table below).

Table 9: Design Vessel Dimensions

	Length (m)	Beam (m)	Draught (m)	Speed (knots) (AMOG)
Tanker	280	52	14 arrival 13 depart	12
Container ship	320	40	14	16

For the simulation phase of the design the characteristics of four real vessels of approximately these dimensions were chosen to provide real behavioural characteristics that could be input to the simulator.

The simulation study was then used to assess and refine the concept design. This lead to changes including some narrowing of the widths of the channels in The Heads and Yarra – essentially better configuring the channel design to the existing physical conditions (see table below).

It is fair to say that there was considerable disquiet amongst third party submitters as to whether these exercises had been in any way adequate. Concerns arose most particularly from Captain Frank Hart and from O'Brien Maritime Consultants (OMC).

Table 10: Design Channel Widths[55]

Location	Design outcome based on PIANC (Concept design)	Proposed width following simulation (Detailed design)	Comments
Great Ship Channel	260 m	245 m	
South Channel	Not stated in this reference.	350 m and 400m	May not be sufficient for a post Panamax vessel passing a tanker
Yarra River	175 m	150 m	Some bends have lower radius than recommended

55 Summarised from Peter Burton, Expert Witness Statement, p 5

Captain Hart is a retired former Harbour Master of Westernport. He appears to have limited direct interests beyond a family relationship with a Port Phillip Sea Pilot and a clear desire to ensure that the design processes used are appropriate and lead to channels that are safe in operation.

OMC are a Melbourne based company in the business of providing dynamic under keel clearance systems for ports and harbours. They hold a proprietary interest in a system marketed as DUKC ®. The essence of this system is it applies real time and modelled metocean and vessel position and control data to optimise the passage of vessels along channels. Amongst other benefits claimed for such systems is a capacity to admit larger ships to channels for longer tidal windows than would normally be permitted under the typically conservative fixed under keel clearance rules that currently operate. The system can also apparently be used for channel design optimisation in the same manner as the proponent's consultants sought to use their competitor *SimFlex* model. It is fair to observe that in this capacity, OMC had tendered for aspects of the Port Phillip Channel Deepening design contract. Whilst they had prepared detailed modelling and data-sets to the point of pre-implementation testing of a DUKC ® system for Port Phillip, they did not proceed to membership of the project design team. OMC had a clear view that in the rejection of their product, the proponent had forgone an opportunity to best optimise the channel design. They also sought to some extent to protect the public reputation of their product from public comments proceeding from the proponent, which they construed as adverse to their interests.

The proponent worked hard during the Panel hearings to demonstrate its view that both Captain Hart's and the OMC submissions were born more of mischief or misunderstanding, than from an open desire to 'do right' by the project. Considerable weight in submissions was laid on Captain Hart's lack of direct expertise as a sea pilot or channel designer and lack of expertise in directly commanding vessels passing through Port Phillip Heads. Considerable weight was also laid on the fact that OMC's position was entangled in a web of commercial interest, such that the Panel should not weight their material.

That being said, both these parties and other submitters raised a range of issues that are in the Panel's view germane to the environmental impact assessment of the project and require to be assessed. These are as follows:

- Was the design modelling and ship simulation work carried out in a manner that was methodologically sound?
- Is the design depth of the channels sufficient to accommodate safe use, or is it possible that additional dredging over and above that considered by the EES might be required?
- On what basis was the under keel clearance regime for the designed channels chosen?
- On what basis had the proprietary DUKC ® system been rejected from consideration for use in the project and could it render relevant benefits in terms of environmental impact reduction or performance enhancement?
- Has channel operational safety been sufficiently considered in the design process?
- Are the design team sufficiently experienced or have they been subject to sufficient expert peer review?

Other submitters raised concerns about design in relation to the adequacy of channel batter slopes in the Yarra to support adjacent structures. This was a particular concern for the operators of Newport Power Station. Matters such as the selection of a location for a deep draught vessel anchorage were raised, as were issues around the safeguarding of heritage places/structures (although these latter issues are considered in the Panel's examination of heritage). These issues are considered below.

Panel Response

Status and 'bona fides' of submitters

The Panel would remark as an initial comment on process that it notes the proponent's concerns as to the status and bona fides of both Captain Hart and OMC. Some response to these issues and elaboration of the Panel's methods in relation to material introduced by these parties is necessary.

In relation to Captain Hart, the Panel notes that whilst he sought to introduce himself as an expert witness, he was not in the strict sense a person of the independent standing that would normally be expected of an expert witness. As a *submitter*, he had a partisan view that might (by some) be expected to colour his response to technical issues. As a former Harbour Master, whilst he has some directly relevant expertise, he cannot be expected to be expert across the full range of channel design and construction related disciplines. Issues also arise in respect of the time now separating him from active practice in his field.

To this extent, the proponent was clear that the Panel should not admit him as an 'expert' in the sense of fully weighting his material. However, they took clear and full advantage of the proffered availability for advance notice and cross examination of his material, so in many senses, they benefited rather than suffered from the status that he sought.

Having considered Captain Hart's material, the Panel considers on balance that whilst not wholly expert, he did raise a significant range of relevant and soundly based considerations. It also notes that whilst seeking to disallow his expert status, the proponent did not always challenge let alone disprove the factual basis for significant bodies of his material.

Turning to OMC, there is no concern as to evidence, as all material was put before the Panel by way of submissions. That being said, the Panel is clear that there were issues sought to be put before it relating to concerns about issues such as commercial competition and commercial reputation that have no place in principle in an environmental impact assessment process. The Panel cautions against attempts to use its very limited jurisdiction as a means for testing what may amount in real terms to questions of contractual or tortious liability. It would note that it has made findings exclusively on the basis of underpinning an assessment of environmental effects.

However, having made these observations, it should be noted that both parties did raise significant questions that require in principle to be tested. The Panel's route forward has been to treat them as questions and not to rely particularly on the opinions or even the factual basis of matters advanced by theses parties. It has preferred to rest its analysis on the proponent's material and on relevant published guidance sources such as PIANC. Having taken this somewhat precautionary approach, it must nevertheless observe that the concerns of these parties do appear to have sufficient basis to warrant further investigation before the project proceeds to implementation.

Approaches to Modelling

The proponent's modelling for design purposes used the *SimFlex* model under the guidance of Lawson and Treloar.

It should be noted that the proponent was reluctant to release its full background document set in relation to channel design, asserting commercial confidence as a basis for limited or non-release of material. To this extent, the Panel cannot be fully convinced that it has sighted all relevant background references. However, at the end of the day, the Panel can only rely on the material that the proponent is willing to disclose, and this it has done.

The Panel is not aware of whether this consultant's relationship with *SimFlex* predates the channel project but does note that an understanding of this relationship may be relevant to others assessing the use of DUKC® (for which one should also see later comments in respect of the submissions of OMC). There is a potential issue of commercial conflict of interest, which arises when the provider of one proprietary modelling system is the adviser of a proponent against the interests of another potential provider. Again, this aspect of this issue suggests the need for resolution through the exposure of this debate to and independent expert peer reviewer, bound by agreement as to commercial confidentiality to the extent necessary, but hence able to review all approaches used with complete access to all materials.

The panel notes with considerable concern that there was no mention in the simulation methodology of the following sequence of ‘good practice’ verification and validation procedures that:

- The sea pilots used to ‘drive’ the simulator for the purposes of modelling were first provided with a monitored training and acclimatisation program to ensure that their expertise in commanding virtual vessels in the model was equivalent to their expertise in piloting real vessels. As part of this program it would be necessary to expose the sea pilots to training in the commanding of vessels up to the design maximum vessel for the new channels, it being noted that existing pilots may have limited to no experience with such vessels
- The fidelity of the simulator performance was checked by first running the model using the existing waterway conditions and current vessel(s), or by calibration with reference to comparisons between simulator and actual real time vessel tracking data. (Essentially such a calibration exercise ensures that the model does reasonably reproduce current physical and risk conditions.)
- The new waterway configuration was then modelled and checked using current vessels.
- The design vessels were then added.
- That structured interviews or questionnaires with pilots before and after the simulations were used to identify possible flaws in the mathematical model.

On this basis, the Panel considers that it is fair to conclude that the sequence of validation steps outlined above was not fully followed. For example, it is not clear whether the sea pilots used in the simulation exercises ‘trained on the job’ during the simulation study, or whether prior training and testing were put into place. It is not clear that the simulator was ever effectively calibrated with existing channel configurations or existing shipping. Nor is it clear that the new channel configurations were checked with existing vessels. The disclosed data appears to suggest that the proponent proceeded at an early stage to simulation events that modelled the design vessels in the design channel.

Without the above procedures in place there is good reason for the concerns of *submitter*s that there is no baseline upon which to measure the effect of the changes. Also, in other design processes it is common to use actual tracking data to verify models. In this case comparing actual tracking data against that produced by the simulator could have also checked the fidelity of the model. The proponent did not provide any evidence that they track vessels through their channels despite the ease with which this could be done with modern technology.

The Panel notes the concerns of OMC that there were a large number of unsuccessful runs of the simulator during the two phases of the ship simulation study. A review of the data from the simulation runs shows that in principle this was the case. OMC questioned whether it was possible to validate the design, particularly at The Heads, using these studies when the design acceptance criteria had not been defined in advance. An example of such criteria would be: for a particular geometry and design ship, how many total runs need to be done and how many/what percentage of them should be successful before the design is determined to be acceptable?

The Panel has reviewed the two Lawson and Treloar ship simulation studies and notes that it was not possible to determine from these reports what the acceptance criteria may have been. The Panel also observes that there are potentially other related reports that have not been drawn to its attention and that these may contain this information. In its absence however the Panel must note its unresolved concern about this issue.

OMC's concern reinforces the Panel's earlier expressed concern about the overall methodological approach used for this body of work.

Table 11: Ship Simulation Studies[56]

Report	Run description	Number
Report 1	Total runs	103
	Familiarisation	8
	Successful runs (no groundings or adverse incidents)	57
Report 2	Total runs	83
	Familiarisation	2
	Successful runs (no groundings or adverse incidents)	69

What does all of this mean in practice?

In short, it appears to the Panel to mean that it is not yet possible to rely on modelling conducted for the proponent to demonstrate that the channel has been optimised in design terms. This generates larger than necessary room for uncertainty around the volumes of material that may have to be dredged (with consequent environmental impacts) or the safety of the proposed channel design (with consequent shipping incident risks and environmental impacts). The Panel considers that it is imperative that best practice techniques are deployed to assure the government and people of Victoria that the proposed channel design will not lead to unlooked for and higher orders of risk and environmental impact than those suggested by the EES. However, at present, the data and analysis sufficient to generate that assurance are not present.

The Panel considers that it would be beneficial if independent expert peer review of the basis for and benefit of selecting the *SimFlex* model in preference to other commercial packages was provided. This would best be undertaken by persons without a commercial interest in the competitor packages, but with a sufficient understanding of their key technical characteristics. The Panel considers it necessary to recommend as follows:

[56] Lawson & Treloar, Port Phillip Channel Deepening Ship Simulation Report J2184/R2065, J2184/R2071.

The simulation study should be peer-reviewed by an independent simulation expert. Attention should be paid to:

- the prior training and assessment of pilots on simulator use with both existing and design vessels and conditions; and
- model validation against existing channel and vessel conditions.

In relation to the above, a vessel tracking system could be established for vessels transiting the channels and the data collected could be used by the proponent and used to verify simulation model accuracy.

Design Depth & Under Keel Clearance

Design depth is a highly relevant consideration, particularly at The Heads, where a change to channel geometry involving the removal of significantly more material than predicted has the capacity to change the entire structure of hydrodynamic modelling assumptions on which the bulk of impact assessment has been conducted.

The Panel examines this issue in some detail in its consideration of risk and so seeks not to reiterate that consideration here. Nevertheless, readers seeking a more complete picture of the Panel's response to this issue are referred to the Risk section.

In summary, in relation to The Heads, the Panel finds that if the current design is based on no tidal assistance then once additional validation is undertaken, the project may be found not to deliver the required outcomes. There could be reduced economic benefits and increased risks of adverse environmental impacts. To ensure that these will not flow, it will be necessary to ensure that the specified design depth will enable transit of the design vessels across the Rip Bank at most tidal and other metocean conditions. As the Panel has observed elsewhere in this report, it is simply not acceptable that this project be implemented, only to find its benefits significantly eroded due to shipping delay contingent on the normal range of tidal and metocean conditions at the Rip. It is equivalently unacceptable that it proceed without further environmental assessment, should significant volumes of further dredged material require to be removed from the Rip in order to facilitate an economically acceptable access regime.

Here, the Panel intends to concentrate solely on the degree to which ship simulation modelling has been carried out to an extent that would support passage of the design vessel across Rip Bank. Lawson and Treloar set out the basis for their work as follows:

> *The ship simulation was to be used to check only the design depth in the Port of Melbourne and around Hovell Pile. The depth requirements through the Port Phillip Heads was to be checked by other methods.*[57]

Current fields were extracted for five conditions, four of them related to the heads:[58]

- Typical flood currents with tidal water levels at least 1.5 m chart datum
- Peak flood tide current when tidal water level is 2.4 m chart datum
- Maximum ebb when water level at least 1.5 m chart datum
- Maximum flood when water level is at least 1.5 m chart datum

[57] Lawson & Treloar, Port Phillip Channel Deepening Ship Simulation, Report J2184/R2065, p1

[58] Lawson & Treloar, Port Phillip Channel Deepening Ship Simulation, Report J2184/R2071, pp6-7

On this basis, the Panel considers it appropriate to find that:

- All simulations were carried out based on 1.5 metres of tidal assistance at Rip Bank and there have been no simulations of transits with less tidal assistance at Rip Bank
- The channel simulation cannot and has not demonstrated safe passage for conditions with less tide in the Rip.

Turning to under keel clearance, no logically reasoned argument was presented to the Panel in respect to the various under keel clearances along length of the channels, nor for the amount of overdredging at different locations. If 1.5 m of tidal assistance is required at The Heads for instance then it may be logical to assume that some tidal assistance and less dredging would be acceptable in the western South Channel. If a reduced depth is acceptable over the Western Trunk Sewer then it would seem to be logical to assume that the channel could also be shallower in the vicinity of the sewer. This issue has a strong bearing on the generation of volumes of dredge spoil, which the Panel discusses at more length below. It also links to consideration of turbidity, as there is an in-principle environmentally beneficial objective to be served by reducing the take of dredged material: that of reducing turbid plume extent and duration at the dredge and DMG sites.

No adequate assessment was provided of the potential for ongoing re-suspension of materials/scour as a function of under keel clearance and overdredge depth nor of where re-suspended materials would be deposited. Again, this is a consideration that bears strongly on questions as to the nature of turbidity as an adverse impact to be controlled.

The proponent should prepare a document that defines and provides reasons for the proposed underkeel clearances and overdredging along the channels.

Dynamic Under-Keel Clearance and DUKC ®

Readers of this section should note with caution the possible distinction between the general concept of Dynamic Under-Keel Clearance and the proprietary concept of DUKC ®, which is undisputedly held by OMC. OMC submitted to the Panel that the two concepts were not distinct. To the degree that they have developed Dynamic Under-Keel Clearance as a proprietary system, they claim the entire territory as their domain. The proponent disagreed, asserting that there is a separate and general concept of Dynamic Under-Keel Clearance, which does not necessarily imply the usage of OMC systems or expertise. The Panel will not purport to rule on this fine point of the law of intellectual property.

The Panel notes that studies previously undertaken by the Victorian Channels Authority when it was independent of the Port had identified DUKC as a key component of a preferred option for deepening the approach channels to the Port:

> *Clearly implementing a DUKC is the preferred option, providing a higher level of benefits for a very low capital outlay…in the light of its manifest benefits, it is appropriate to compare the net benefits of the other development options against the DUKC options as a Modified Base Case rather than against the 'do nothing' Base Case'*[59]

The Booz Allen study found that an alternative to channel deepening (but not berth deepening) was the implementation of a dynamic under keel clearance system (DUKC) and that this system would allow vessels with drafts of up to 12.5m to enter/exit the port (with tidal assistance). That is, it would allow an additional 0.4 m of draught with no channel dredging.

[59] Booz Allen at Pg 4

OMC take the view that such references are to their system, whereas the proponent takes the view that they are generic. To the extent that it is necessary to do so, the Panel finds that the facts appear more supportive of the OMC position, inasmuch as at the relevant time, it had been contracted by the former VCA to undertake studies preparatory to the possible introduction of DUKC ® to the Port Phillip channels. It therefore appears reasonable to assume that references to DUKC in studies undertaken for the VCA at this time did at least import reference to DUKC ® even if they did not intend to refer to that product exclusively.

The Panel does not consider that it is its proper role to determinatively recommend that DUKC® should be adopted for use within the project. Such a recommendation would not be a proper one, germane to environmental impact assessment. It is a rather a matter of balanced commercial and technical judgement. However, it is appropriate for the Panel to consider whether the proponent appears to have transparently examined a range of apparently feasible and beneficial methods to optimise channel design and thereby to maximise economic benefits relative to project costs or prescribing design methods ensuring acceptable environmental outcomes. In this regard, the Panel must remark that it has seen more signs of a stubborn and intractable commercial dispute than it has of an open and transparent evaluation of costs and benefits vis a vis environmental effects.

Some of the proponent's rebuttal of OMC positions appears sound. To the extent that wave monitoring data has suggested the possible existence of wave spikes in the Rip that might confound DUKC ® systems, it is clearly necessary the a transparent appraisal of possible deployment is undertaken in the light of this data, to ensure that ships indicated by the system as having sufficient under keel clearance, are not in fact placed onto the bed of the channel. However, whether one uses a dynamic or a static under keel clearance system, it is necessary to determine that the risk of such placement is satisfactorily controlled. If the wave spikes exist, studies are required to validate the static under keel clearance proposed in the Rip, which may in turn run to the chosen channel design, dredge volumes and bay aperture cross-section. Alternatively, it needs to be demonstrated that the proposed channel design is of such conservatism that it will not be necessary to understand any features of the scale of the encountered spikes as these would just not be material to the under keel clearance of vessels transiting The Rip under any permitted conditions. However, the proponent has not demonstrated that its current design is that conservative design.

A certain amount of the proponent's rebuttal of OMC positions appears to be assertion that highlights confusing logic. For example, the proponent disparages the application of DUKC ® at the port of Taranaki in New Zealand. It highlights in its closing submission that whilst the DUKC ® system may result in larger tidal windows than under fixed rules, it may also result in smaller windows or even prohibition of transit in severe metocean conditions. Under the proponent's logic:

> *The objectives of the project would not be met if similar restrictions applied to the port of Melbourne and Port Phillip Heads as a design outcome. Moreover, the metocean conditions at Port Taranaki are not considered to be as unpredictable as Port Phillip Heads.*[60]

When this position is scrutinised, it stands for the proposition that where a DUKC ® system might limit access to the Rip on the basis of detailed predictions suggesting the absence of sufficient under keel clearance for safe transit, static rules would still allow the transit to go ahead, with concomitantly raised levels of environmental and personnel risk. Further, the logic suggests that such situations could emerge with sufficient regularity as to adversely

[60] Part H Submissions, Para 6-29 at p25.

impact on the economic performance of the Port. If this submission is to be taken as sound, then it suggests that questions of under keel clearance in the Rip, vessel transit safety and environmental impacts further to shipping incidents require to be scrutinised with much greater rigour and clarity than they have been to date.

The Panel does not accept the argument put forward by the proponent that the DUKC ® should not be used because it is based on algorithms that are proprietary and undisclosed. Proprietary or 'black box' solutions are common in engineering, particularly where computer programs are involved. There are a number of ways that performance can be validated by a purchaser without access to the algorithms. The Panel heard for instance that the hydrodynamic model used in the EES is proprietary. It has been used and the results accepted by the Port without the proponent (or indeed the modeller) knowing the algorithms.

It is fair to note that whilst the proponent went to some pains to describe the transition arrangements, the reasons for the change of priorities in respect to DUKC® following the merger of the VCA and the MPC was not adequately explained to the Panel.

The Panel finds that Mr Burton, the channel designer was not asked to consider, and did not consider either dynamic under keel clearance or DUKC® in the design process for the channel.

The Panel is of the opinion that the proponent has had a significant period of time where it could have collated data to contribute usefully to the validation of the DUKC® system and yet no evidence has been provided to the panel that an attempt has been made to collate this data. Limited exercises have been offered, including the suggestion in closing submissions that OMC might have been offered a ‘possible role’ as a peer reviewer for the development of the prospective harbour rules following channel deepening. However, no systematic attempt appears to have been made to evaluate the contribution that generic or proprietary DUKC® might make to the project in terms of managing the requirement for the removal of bed material and hence potentially reducing the environmental impact of the project.

The Panel takes the view that this dispute requires to be deconstructed. It appears relevant to note that Melbourne has access to apparently world lead research and implementation experience in dynamic under keel clearance systems. It appears that such systems still offer an unexplored potential to minimise dredged material. It further appears that arguments presented to the extent that DUKC® should not be used stand also for the proposition that the existing channel design at The Heads is uncertain. This is yet a further indicator that additional dredging may be required and that the EES may have insufficiently stated and assessed environmental impacts contingent upon this. An independent peer evaluation of the potential for the use of dynamic under keel clearance systems in optimising channel design should be undertaken and, depending on its conclusions, appropriate reconsideration of channel design at The Heads should take place.

For these reasons, the Panel recommends as follows:

Computerised UKC systems (including DUKC®) should be transparently investigated as potential management responses to:

- optimise the use of the current port facilities and services, including channel depth; and
- minimise future maintenance and capital dredging works

Safe navigation

Capt Hart in his evidence in relation to the width of the channel in The Heads notes that the Eastern and Western Ship channels currently provide vessels transiting the Great Ship Channel with an in-built factor of safety. However, in his contention this will be reduced for the proposed channel design in The Heads in at least two ways:

- Deeper draught vessels are longer on average and this additional length adds to the effective width of the vessel when it is pushed sideways by the wind or cross currents (an effect known as crabbing).
- Whereas currently much of the Eastern and Western Shipping channels are of an equivalent depth to the Great Ship Channel and can be infringed by a crabbing vessel with no ill effects, they are not being deepened to the same depth as the GSC. A future design maximum vessel when crabbing would therefore have a more slender margin between it and the effective outer safe transit boundary than do current vessels.

Table 12: Shipping Channel Widths and Depths in The Heads

Location	Width (m)	Declared depth (m)	Proposed declared depth (m)
Great Ship Channel	245	14	17
Western Ship Channel	95	11.4	14 * & 11.4
Eastern Ship Channel	140 northern end 200 southern end	11.9	14* & 11.9

* partial deepening parallel to Great Ship Channel

Capt Hart put to the panel that both the quantitative risk analysis and the design have not allowed for the reduced safety factor and that the EES consultants have therefore not assessed the potential impacts of the increased risk of an incident. He notes that there have been ship wrecks in The Heads in the past when ships have strayed from the channel and is concerned that the in-built factor of safety will be reduced unacceptably if the Great Ship Channel is deepened to a greater degree than the adjoining channels.

The Panel was not presented evidence in respect to how often vessels (or parts of vessels) stray from the Great Ship Channel during transit. However, it appears clear that vessels do depart the channel from time to time as evidenced by the history of groundings and wrecks that have occurred in The Heads.

A relationship will exist between the number of incidents (vessel groundings say) and number of near misses (vessels straying from channels). If this data does exist or was collected it would be useful input to the risk analysis.

The Panel considers that in the absence of data demonstrating that there is no significant concern with vessels straying from the existing Great Ship Channel and infringing the existing Eastern or Western Channels as their means of making a safe transit, it is necessary to conservatively assume that such incidents can and do occur with reasonable frequency. Therefore it would be reasonable for the designer to expect, and allow for vessels to depart the defined channels from time to time. This suggests the provision of a more conservative depth allowance in the Eastern and Western channels than has currently been proposed, although noting the potential that such a change has for increased environmental impacts and the need for re-assessment. Alternatively or additionally, actual ship tracking data (from GPS records of actual transits) could be used to settle this issue from a statistical perspective.

The Panel recommends as follows:

For the purpose of validating channel design safety at The Heads, the proponent should define the nature of a 'near miss' and an 'incident', in respect to vessels leaving the channels, grounding etc. Vessel tracking data should be collected. The data should inform a review of shipping incident risk as an input into channel design.

Construction Channels

The EES foreshadows the creation of permanent 'construction channels' to the east and west of the Great Ship Channel. These are intended to reduce the risk of an incident during the construction period by enabling existing maximum draught vessels to avoid dredging equipment in the Great Ship Channel. No evidence was presented in respect to initial (without construction channel) risk or the residual (with construction channel) risk.

> *The presence of the dredger in the Heads was seen to pose an elevated risk due to the constriction of the channels at this point and the severe oceanographic conditions that are found there (e.g. strong currents, larger waves, Bass Strait swells). The response to this has been to consider the inclusion of a construction channel in the project design. This would widen the channel and allow a greater clearance between the dredger and any commercial vessels transiting the region. The alternative may be to impose controls on the interaction between the dredger and operational shipping vessels specific to the Heads to ensure that the risk of an incident is minimised.*[61]

The Panel requested detailed information about the proposed operation of these channels from the proponent which was not forthcoming. The Panel recommends as follows:

The proponent should provide the 'before' and 'after' risk information in relation to the deepening and use of the construction channels and evidence that the design of these channels is optimised. The proponent should also provide information about the operation of these channels during the construction period, so that the associated environmental impacts can be assessed.

Batters

The Panel notes that batter design work is still incomplete, particularly in the Yarra, where structures owned or operated by other stakeholders may be affected. In particular the concerns of Newport Power Station in respect to the stability of its structures has been brought to the Panel's attention.

Another area of concern held by the Panel is that it has not seen data to suggest that possible vessel suction or other dynamic effects from the design vessels have been considered in relation to the stability of batter slopes, or related sediment re-suspension.

[61] EES Volume 1 at Pg 44-3

The Panel recommends that:

A design review should be undertaken by the proponent in relation to areas in the Yarra, where there is a possibility that infrastructure owned by other stakeholders may be affected. Any areas of disagreement should be subject to a defined mechanism of external dispute resolution.

Channel batter stability in sensitive locations should be reviewed in the light of the dynamic effects of the proposed design vessels.

Hobsons Bay Anchorage

No information was provided in the EES documentation about the forecast anchorage requirements and potential impacts of deeper draught vessels accessing the anchorage and anchoring in the Bay. For example, there is the potential that deep draught vessels transiting between the Port of Melbourne channel and the anchorage may impact on the ethane pipeline or enter waters above the Port of Melbourne DMG, re-suspending contaminated sediments that have been placed there.

The Panel recommends that:

The anchorage requirements for deeper draught vessels should be determined in a study that seeks to document and control the environmental impacts and risks of transiting to the anchorage and anchoring.

7.2.2 PORT OF MELBOURNE DMG BUND DESIGN

Discussion

One key design issue that gave rise to widespread concern in verbal submissions was the proposal that the key design response to contaminated sediment disposal would be the construction of a bunded but uncapped area for semi-fluidised material containment in the Port of Melbourne DMG.

This was effectively a 'new issue' raised via the hearing process. The exhibited EES had proceeded on the basis that contaminated material would be capped. The uncapped and bunded solution emerged only following the confirmation of Boskalis as the alliance dredge partner.

Submitters design concerns here related to the absence of a formal design. The bund concept was not well documented. Nor were references made to practice in other locations suggestive that such an approach was sound or supportable.

Whilst no formal design specification or drawings of the bund was placed before the Panel various presentations by the proponent' s experts, the Alliance contractor Boskalis and the proponent submissions shed more light on its current thinking. The Panel understands that the bund will be:

- 5 metres high, 25m wide at top and have slopes of 1:40.
- Settlement of 1.5m will be allowed in the bund wall (ie a wall will be constructed to 6.5m with an expectation of its eventual settlement to 5m) in an unspecified time.
- It would be made from stiff Fishermens Bend silt and possibly from the Williamstown Channel.

- It would be constructed of dredged clay lumps (although no piece of equipment that has been presented appears to be able to deliver this outcome).
- There is only just enough clay required to build the bund. [62]
- The bunded area is 1650x1500 metres.
- The settled top of bund would be at -15.4 m
- The bunded area would have a storage capacity of 3 million m3.
- The bund would contain contaminated materials in a fluidised or semi-fluidised condition, incapable of capping. It has a planned freeboard of 20cm after settlement allowances.
- The bund will not be compacted and therefore will be of an unknown permeability. Settlement would also appear unpredictable.
- Part of the contaminated material may enter voids in the bund.
- There would be a 100m wide buffer zone between the edge of the bund and the edge of the spoil ground

Panel Response

This section of the report discusses the engineering aspects of the proposed bund. Material relating to the appropriate disposal of the contaminated spoil, and in particular the feasibility of capping, can be found elsewhere in this report, from which it must be noted that the Panel does not accept the in-principle suitability of a bunded-uncapped DMG as a management method for acutely toxic material. The comments below are therefore restricted to the engineering design feasibility of the proposal.

The BPEMG defines a bund as '*a wall constructed to retain spoil*''[63] .

There appear to be several engineering reasons why the proponent is now suggesting that a bund be used at the PMDMG location. Firstly, the EES Channel and Dredged Material Ground Stability Report indicated that the material previously placed at the Port of Melbourne DMG has migrated beyond the southern boundary raising general concerns about the stability of the ground.

> *The hydrographic contours of the southern batter of the northern spoil ground appear to indicate that the toe of the spoil ground batter extending beyond the spoil ground boundary.* [64]

Secondly, the proposed dredge technology for the Yarra is such that sediments are likely to be delivered in a semi fluidised or fluidised state, capable of flow if not contained. Thirdly, experience in the Geelong dredging campaign indicates that such materials can and do flow and can be significantly relocated from the point of disposal. The bund is therefore proposed as an engineered barrier to contain the spoil. Fourthly, the material proposed to be bunded is acknowledged to require confinement by virtue of its (at minimum) moderately contaminated status.

That being said, the Panel considers that experience from the Geelong dredge campaign suggests that there is some merit in seeking to contain the flow of any semi-fluidised material, whether contaminated or not. This position is adopted on the basis that sounder predictions of

[62] See Part E Submissions at Pg 10.

[63] BPEMGD Pg 99

[64] GHD Channel Deepening EES V2 -5 Pg 20

environmental effects will be made if materials can be disposed of to a known, selected, surveyed and monitored location, than if they flow freely across the bay floor. It is therefore of concern that the proponent feels it appropriate to dispose of a significant portion of the northern spoil outside the bunded area on the gently sloping seabed to the south of the proposed bund. Contamination aside, this spoil has similar engineering characteristics to the material that is proposed to be bunded and may relocate itself to unlooked for places.

No significant analysis has been provided about the constructability, feasibility or stability of a bund in this location in the EES documentation. GHD state that a bund would require further investigation as the placement of dredge material at the DMG has the potential to destabilise any material already within the DMG. *(EES V1 p)30-9* All this in an area where they note that:

> *…the very low strength materials encountered below the seabed in this area will make the design and construction of such bunds very difficult.* [65]

The Panel has serious reservations about ability of a true bund to be constructed, with sufficiently low permeability material being placed and consolidated to give a reasonable assurance of design performance. This view is reinforced by the apparent inability of the proponent to provide the Panel with any examples of structures built elsewhere in the world for similar purposes despite requests. Whilst there are many overseas examples of bunds being constructed to contain sediments, most of these appear to rise above the water level, enabling surface compaction. Alternatively, sediments are routinely contained in natural depressions and pits borrowed from the sea bed.

The Panel has great reservations about the effectiveness of the bund as proposed to contain a semi fluidised material. These concerns are founded on the view that:

- The compacted condition and permeability of the eventual bund is not certain.
- The settlement rate and effect is not certain.
- The planned freeboard is very low.
- The ground conditions on which the bund is to be constructed is not known.
- The bund will be containing a considerable mass of semi fluidised material on a slope.
- The prospects of the bund remaining intact and forming an adequate containment appear insufficiently established to warrant its implementation without further study.

Given the likely status of that material, the level of assurance as to performance required of this structure ought be high. At present it is negligible.

For these reasons, the Panel recommends as follows:

The concept of a bund as proposed before the Panel is insufficiently resolved to enable any assessment of its fitness to task or engineering feasibility in situ. Later in its recommendations, the Panel calls for a re-appraisal of sediment characterisation and disposal, which may suggest different spoil disposal options. If the bund concept is pursued, then a detailed structural design should be prepared before implementation.

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[65] GHD Channel Deepening EES V2 -5 Pg 20

7.2.3 CHANNEL OPERATIONS

Discussion

Although not widely raised in submissions, one issue not considered in any depth by the proponent was the issue of possible changes to channel operations. This is raised for discussion, as, in seeking to optimise the balance of economic against environmental efficiency, it is sometimes valuable to consider whether the current operation of a piece of infrastructure can be improved.

The operational concern most widely expressed in submissions related to vessel speed and the potential relationship between this and damage due to ship generated waves. Concerns were raised about the impact of waves generated by larger vessels on coastal infrastructure and coastal erosion. The main areas potentially affected are the Royal Yacht Club of Victoria at Williamstown and the beaches at the southern end of the Mornington Peninsula.

The related issues of speed, vessel squat, vessel suction and the implications of this for channel design depth, erosion and re-suspension also require to be considered. Third parties were also concerned that vessels were not meeting declared channel speed limits.

The Panel considers the following issues below.

- Ship generated waves
- Vessel suction
- Modes of channel operation inclusive of vessel speed

Ship Generated Waves

Ship generated waves were the focus of specific submissions from leisure boating interests, they require some individual response.

The EES Main Report states:

> *It is known that the major factor controlling the height of vessel-generated waves is the speed of ships through the water (e.g. Croad and Morris, 2003; McDonald, 2003). The draught of a ship, however, does not affect the size of the waves that the ship generates.*[66]

This statement appears to misrepresent the actual situation. In fact the height of ship generated waves does appear to be controlled by draught (along with other factors), as noted by one of the proponent's consultants:

> *Ship generated waves are predicted to increase by approximately 10% for the deeper vessels operating in the channels.*[67]

That being said, the Panel accepts that vessel speed is likely to be the single most significant contributory factor to vessel wave generation. However, no evidence was presented by the Port that vessel speeds (refer to Table 5) are monitored within the declared port area, or that any action is taken in relation to vessels exceeding limits.

[66] EES Volume 1 at Pg 28-11

[67] AMOG Technical Report 1 page iii

Table 13: Vessel speed limits in Port Phillip Bay[68]

Location	Speed
South Channel to two nautical miles north of Hovell Pile	18 knots
Bay generally	None specified
Two nautical miles south of Fawkner Beacon to Port Melbourne Channel Beacon 9	18 knots
Port Melbourne Channel Beacon 9 to Westgate Bridge	8 knots
Westgate Bridge to Appleton Dock	6 knots
Upstream of Appleton Dock	4 knots

The Panel heard evidence that vessel speed is the principal factor affecting vessel-induced waves and hence impacts on recreational vessels and shoreline erosion. The Panel also heard evidence that vessels have been observed exceeding speed limits in areas where they are defined. This is alleged to have caused adverse impacts already (eg on moored vessels at Williamstown). If such effects persist and are exacerbated, they have the potential continue to cause problems unless managed.

Consultants for the Royal Yacht Club of Victoria calculated, and the proponent did not dispute, that an increase of speed from 8knots to 10 knots would result in a doubling of wave height. Therefore, it appears possible that even slight breaches of speed limit can cause very large additional wave impacts. [69] The potential contribution of speed to wave height problems was agreed by the proponent in their submission which states:

> *Dr Provis' discussions with RYCV suggest that the surge rather than the wave heights cause them problems and also suggests that the largest waves are caused by vessels other than commercial cargo vessels, possibly exceeding the speed limit.*[70]

Whilst this submission suggests that vessels somehow outside the control of the proponent or the Port Phillip Sea Pilots might be the cause of existing (or indeed future) problems, it is also clear that causation had not been determined in a detailed sense.

In the Panel hearing, the proponent indicated that the Harbour Master gives precedence to allowing higher speeds to allow the maintenance of steerage over the strict application speed restrictions. However, it remains of concern that vessel speed (more than size) is a significant contributor to vessel generated wave height and that this does not appear to be monitored in the Port. It is not clear that the optimum balance of declared channel speed limits as against environmental performance has been reached.

The Panel considers that channel speed limits should be set and operate after the manner of highway speed limits. Whilst there may be a rational basis to set different speed limits for different classes and sizes of vessels, the channel should be designed and regulated for all vessels that use it. It should not be sufficient to defer action in respect of vessel generated waves just because such waves are alleged to come from vessels other than commercial cargo vessels.

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[68] Source IP2 Operational Management 8.2

[69] Submission No 092 RYCV at Pg 15

[70] Proponent Part B Submission at Pg 9

Nor does this appear to detract from the proposition that action be taken to validate existing speed limits and to protect third party structures and vessels from vessel generated waves. Should validation suggest that speed limits require to be routinely increased with consequent significant increases in regular wave exposure, wave protection actions at the proponent's expense would clearly be justified.

For this reason, the Panel recommends as follows.

The current impacts of ship generated waves on coastal infrastructure and moored leisure craft should be studied. This study should then form the basis of an assessment of the impacts of ship generated waves from larger vessels. Should speed limits that exacerbate the current ship generated wave climate be adopted, protection measures for third party structures and vessels should be designed and implemented.

Vessel Suction

Vessel suction forces are most affected by increases in vessel beam and reductions in under keel clearance, but not significantly affected by vessel length. This issue was studied outside the EES process by AMOG who found:

> *As the vessel beam increases from 32.2m (pre deepening vessel) to 43 m (post deepening vessel) the peak suction force nearly doubles. At a vessel beam of 50 m the peak suction force has increased by a factor of 2.45 .*[71]

AMOG went on to find that for the deepened South Channel for instance that vessels passing each other at 16 knots the suction effects would extend out to a vessel separation distance of approximately 200m. Whilst there is room for vessels to maintain this distance in the South Channel the safety of the channel will be reduced and additional operational oversight will be required.

> *The separation of a vessel berthed at Holden Dock is approximately 80 to 90 m. In order to maintain the same suction forces as currently exist the vessel speed in the deepened channel would need to reduce from approximately 10 knots to approximately 6.5 knots.*[72] -

This study was focussed only on commercial vessel interactions. It raises a number of questions in relation to impacts on:

- recreational and other non commercial vessels; and
- the seabed (scour and resuspension).

Further, the Panel has seen no evidence that the findings of this study have been taken into account in the EES process. It therefore follows that further opportunities for the economic and environmental optimisation of the dredge program have not been pursued.

The Panel recommends:

The effects of vessel suction should be studied. This study should focus particularly upon impacts on recreational and non-commercial vessels, seabed scour and re-suspension. Such studies could have implications for optimisation of dredge depths and control over operational turbidity in the Yarra, which could have significant environmental and economic consequences, currently unassessed.

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[71] AMOG Technical Note 1 page 10

[72] AMOG Technical Note 1 page iii

Modes of Operation

The Panel finds that there is no proposal to fundamentally alter the current one and two way operations over the life of the project. The proposed working pattern of the channels is summarised in the table below.

Table 14: Channel Operations

Location	Proposed Operational Characteristics
Great Ship Channel	One way, minor widening to the east plus additional area to the west over Rip Bank
Eastern and West Channels in The Heads	Permanent widening for construction purposes
South Channel	One way at the eastern end for deep draught vessels, two way otherwise. Extension to the north of Hovell Pile into existing fairway and widening at Hovell Pile, 0.2m tidal assistance at Hovell pile, design vessels required to maintain 200m separation due to suction effects.
Port Melbourne Channel	One way, extension to the south of Fawkner Beacon, realignment of channel near Fawkner Beacon
Williamstown Channel	One way
Yarra River	One way, widening near Swanson Dock, 8 knot speed limit, 0.3m tidal assistance, 6.5 knot speed limit near Holden Dock

It should be noted that there may be some additional operational constraints over those currently in place such as:

- limiting of some two way operations in the South Channel as vessels approach design size; or
- reduced speed limits in the Yarra to maintain wave impacts at current levels.

The proponent acknowledges that:

> [a]*n outcome of the design process has been that in limited 'extreme' sea conditions (waves, tidal levels and currents) the design vessel (the larger vessel) will not be able to use the Great Ship Channel because insufficient underkeel clearance and width of channel existing in the current design.* [73]

The impact of such effects is likely to be minor, but they do not appear to have been included in the economic forecasts.

Finally, only the South Channel and the unchannelised sections of the Bay operate in two way mode. Congestion points will continue to exist in the greater port area at points such as the Rip entrance and the Yarra and these points will have a limiting capacity that will also limit the size of the Port. No evidence was presented to the Panel in respect to this limitation and whether in fact the future capacity of the Port is independently constrained by this, or other capacity related factors.

[73] Main Volume EES p4-9

Panel Response

As such, options to optimise channel design for operation in economic and environmental terms appear not to be fully explored.

For these reasons, the Panel recommends as follows:

An assessment should be undertaken of design limiting operational factors (such as one way channels) that may determine the growth limits for the port, and how these interact with the need for channel deepening.

It should be clearly demonstrated that set channel speed limits represent an optimised balance between vessel squat, channel depth, dredge requirements and the maintenance of safe vessel operations in the channel. Pursuant to such an evaluation, additional options to reduce the volume of dredged materials and consequential environmental impacts may exist.

Discussions between the proponent and Port Phillip Sea Pilots should develop a clear protocol for the monitoring and enforcement of any declared channel speed limits.

8. VOLUME & NATURE OF SPOIL

As the Panel has already emphasised in its consideration of project definition and scale above, this is a mega project on a world scale. The proponent proposes to undertake a capital dredge program in Port Phillip Bay (channel deepening) involving the dredging of around 32 million cubic metres of material followed by a regular maintenance dredging program through to the year 2030 for an additional 11 million cubic metres of material. It is proposed to dispose of all spoil materials to two spoil grounds in the Bay.

The Panel requested the proponent to provide examples of projects elsewhere in the world that are of a similar scale and/or nature. The largest project cited before the Panel by the proponent was to dredge 11.5 million cubic metres or material, less than a quarter of the size of the project in hand.[74]

It is in this context that it is necessary to understand and consider issues bearing on dredge volumes and the geological composition of the material to be dredged.

The chemical composition of that material is also highly relevant and conceptually falls to be considered in this chapter of the report. However, it is also a matter of considerable technical complexity and importance and the Panel has determined that, on balance, it requires a chapter of its own, which follows as Chapter 10. For this reason, this chapter examines:

- Whole of project dredge material volumes;
- Maintenance dredge material volumes; and
- Geological characterisation.

8.1 WHOLE OF PROJECT DREDGE VOLUMES

Discussion

The EES states that the total volume of spoil to be removed will be 43 million cubic metres broken down into 32 million cubic metres of capital dredging and 11 million cubic metres of maintenance dredging. The EES studies were undertaken on dredge volumes provided by Evers Consult in the base case dredge scenario. During the course of the hearings other figures were given. These are compared in separate tables for capital and maintenance dredging below.

[74] POMC Submission Part E at Pg 6

Table 15: Capital Dredge Volumes

Location All volumes in m3	Base case Insitu (Evers)	Base case Bulked (Evers)	POMC Submission Part A Page 12	Documented in EES & IP2 (bulked)
Great Ship Channel	500,000 (implied)	500,000	500,000	500,000
South Channel	16,240,762	19,001,692	21,100,00	21,100,000
Northern channels & Yarra	13,233,900	15,483,663	11,100,000	10,500,000
Total	29,974,662	34,985,355	32,700,000	32,100,000

Table 16: Maintenance Dredge Volumes

Location All volumes in m3	EES Table 5.6 Summary Brochure p10	POMC Part A page 12 * not known if bulked or insitu	Annual figures Appendix A bulked
Great Ship Channel	0	0	
South Channel	6,670,000	7,700,000	278,000
Northern Channels	4,420,000	3,000,000	184,000
Total	11,090,000	10,700,000	462,000

Whilst the gross dredge volume has not changed significantly from the base case there is a large difference in the dredge volume proposed in the Yarra. The Panel requested an explanation in respect to the changes in these volumes but did not receive a satisfactory response from the proponent.

Despite ongoing requests from the Panel and submitters, the stratification of sediments in the Yarra were not quantified. That is, the proponent did not inform the Panel or the community of the important difference between the volume of potentially contaminated silt and that of the cleaner bed materials.

The Panel also requested the dredging history of the Bay and Yarra from the proponent and was provided with the volumes dredged from the north for the period 1887 to 1982. No recent information, (apart from the 2002 maintenance campaign cited in the EES), was made available and no information about dredging in the south was made available at all. Using the data history provided to calculate long term averages it can be found that the capital dredge program is over 25 times the annual average dredged volume and nearly 30 times the annual average disposed of into the bay. It should be noted that some material has historically been disposed of to land.

The EPA, in its submission notes that one of the most effective ways to minimise the impact of the proposal would be to minimise the dredging undertaken. It goes on to suggest that the Panel satisfy itself that the extent of dredging has been minimised. [75]

Panel Response

Flowing from the data on dredge volumes in tandem with its consideration of design issues, the Panel agrees with the EPA and notes that the PoMC has not provided evidence to show that the dredging has been minimised. Nor has there been any meaningful attempt to optimise channel design and material removal so as to provide the most effective balance of capital and maintenance dredging. The Panel particularly notes the lack of information relating to the nominated overdredge depths. In such circumstances, it is not possible to make any concrete finding to the extent that the volumes of material to be removed actually need to be removed and hence represent a prudent response to project requirements.

Further, as was made clear in the Panel's consideration of design issues above, until a number of the issues identified there are resolved, the dredge volume generated by the project cannot be established with reasonable certainty.

The Panel finds that the scale of the proposed dredging (at more than 30 times the annual average dredging) precludes reference to previous dredging campaigns as a yardstick for assessing the impacts of the proposed dredging. No reasonable comparisons of scale or impact can be drawn. That being said, the Panel considers that there would be virtue in compiling the disparate historical records referred to in the Panel Hearing to produce a combined dredging environmental history of the bay. A single and well documented reference for the volumes of materials that have been dredged, how and where they were disposed of, and any observed effects of both dredging and disposal would be valuable.

For these reasons, the Panel recommends as follows:

Having refined the project design issues referred to above, and as a response to the waste hierarchy, the proponent should undertake a study to ensure that the works minimise the dredging required to achieve the project objective.

8.2 MAINTENANCE DREDGE VOLUMES

Discussion

There is no systematic assessment of the magnitude and environmental effects of maintenance dredging in the EES. Present indications of the total volumes to 2030 predict a decrease in maintenance dredging over annual figures (see above table); however, this is a conclusion that the Panel questions, having regard to the current assessment in relation to issues of sediment transport.

The EES states that:

> *There should be no increase in the need for maintenance dredging as a result of changes in erosion/accretion …[76])*

[75] EPA Submission 153 at Pg 8

[76] EES Volume 1 at Pg 28-19

then goes on to say that there will be:

> *…dredging 20 per cent more material from the south channel during the periodic major maintenance dredging …*[77]

and also:

> *It is expected that there will be some additional maintenance dredging required in South Channel West and South Channel East as a result of the Project. … It is estimated that the maintenance volumes in these areas will increase by 20 per cent after the proposed capital dredging.*[78]*)*

No mention is made of maintenance dredging in the north at all.

Panel Response

The Panel can make no findings in respect to the maintenance dredging until the proponent has reassessed the volumes properly and then undertaken an assessment of the environmental impacts. This issue also affects the design of the proposed disposal sites.

The Panel is also concerned that the economic assessment does not appear to fully cost the maintenance works:

> *A specialist report by GHD suggests that deepening of the channel may require a greater level of maintenance to be carried out in the future….. However, the GHD report anticipates that the cost of maintenance will remain at current levels which are approximately $3 m per annum despite the increased work….*[hence] *our assumption of zero additional costs.* [79]

The Panel notes that:

- There appears to be errors in the calculation of the maintenance dredge volumes and/or their relationship to annual average dredge volumes.
- That if there is a 20 per cent increase in the maintenance dredge volumes then there is likely to be increased maintenance dredge costs and that it does not appear that this has been allowed for in the economic assessment.

That the EES consultants could not and have not analysed the medium to long term impacts of the maintenance dredging campaign.

It flows from this that the Panel finds that the EES itself provides no basis for an assessment of environmental effects due to dredging. It makes no recommendation at this juncture, but carries this issue forward to its specific consideration of maintenance below.

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[77] EES Summary Brochure at Pg 8

[78] EES Volume 1 Appendix A at Pg 2-7

[79] EES Meyrick at Pg 34

8.3 GEOLOGICAL COMPOSITION

Discussion

Geological concerns considered by the Panel related to the degree to which the proponent had characterised bed materials to be removed. Such characterisation must be sufficient to enable reasonable assessments of the application of dredge technology required for efficient removal. It must also be sufficient to enable the identification of the degree to which materials might form and persist in turbid plumes and the areas over which sediment settlement might take place.

A description of the general geological nature of the materials before dredging and of the dredge management grounds can be found in the table below.

The principal implications of the geological studies relate to how the material will be to dredge and the impacts that could arise as a result of dredging and placement. Clays can be 'gluey' and difficult to dredge, sands may be cemented into rock like lumps or layers. Rocks can range from weak and easy to break to very hard requiring significant energy and effort to remove.

The geology of the sediments affects a number of environmental impacts, in particular the turbidity. The turbidity generated as a result of dredging and dredge spoil placement is a function mainly of:

- the type of sediment being dredged (eg clay, sand, rock);
- the method of dredging and placement;
- the hydrodynamics of the dredge area and placement area; and
- the existing water quality environment.

Finer materials and higher energy environments tend to lead to higher and longer lasting levels of turbidity. The proponent has noted the presence in past dredging campaigns of a very fine material in the south, which tends to create a persistent plume, referred to in evidence as ‘rock flour’. The proponent has not analysed this material despite the fact that it would be relatively easy to do so. Finer materials tend to have a shallower angle of repose in a DMG and/or to be more easily fluidised or re-suspended, leading to unlooked for changes in location and persisting turbidity.

Coarser materials such as sands tend to fall out more quickly. They have more limited turbidity implications, They can more easily be mounded for storage at a DMG with a steeper angle of repose. They are less amenable to flow or re-suspension.

The Port of Melbourne DMG is an existing 936 ha spoil ground to the south west of Fawkner Beacon. It is proposed to extend the southern boundary to create another 270 ha of spoil grounds to take uncontaminated materials.

The seabed slopes gently down away from the southern boundary of the spoil ground and there are no natural depressions or valleys. The water depth varies from 10m deep at the northern end to 20m deep at the southern. The spoil ground is about 4 km long north south and varies from 1.6 km to 2.7 km east west.

Table 17: Overview of Geology: Dredged Areas & DMGs

Location	Geology
Rip	Hard dune rock and rock fragments with low to medium rock strength, calcareous dune sands in various stages of cementation
South channel west	Dune sand shoals, cemented to fine sand, some shell, silty sand,
South channel east	As above plus silty clay, clay, some rocky outcrops
Port Phillip Basin (Bay generally)	Sands, central muds and channels infilled with soft sediments
Port of Melbourne channel	Coode Island Silt (silty clay), Fishermens Bend Silt (stiff clay)
Yarra	Geology dominated by Yarra delta, Quaternary deposits are youngest, Port Melbourne Sand, Coode Island Silt, Jolimont Clay, Newer Volcanics Basalt, Fishermens Bend Silt, Moray Street Gravels Artificial fill, soft and stiff clays, some cemented bands, some basalt near Westgate Foreign objects Coode Island Silt is classified as acid sulphate soil Silt traps contain boulders of unknown origin
PMDMG	More than 4.5m depth of spoil silty clay materials with high plasticity, deposition at very flat slopes of 2 to 5 degrees
PMDMG extension	Soft, high plasticity silty clay (
SEDMG	Fine stiff clay and silt

The proposed south east DMG lies 3 km from Martha Cliff and 2 km from the Mt Martha aquaculture zone. It is about 3.7 km long north south and varies from 1.6 km to 2.5 km east west and will cover 770 ha. The water depth is approximately 20 m across the ground. This is where the materials from the Rip and south channel are proposed to be deposited.

Two geological boreholes were drilled in the proposed SEDMG for the EES.

Panel Response

In general terms, the Panel takes the view that the proponent has sufficiently characterised the geological composition of the materials to be removed from the channels. Whilst it would always be possible to move to higher levels of definition at the study stage, such a movement will be a trade-off between the additional costs of definition, as against the environmental management benefits to be obtained thereby. On the balance of benefits, the Panel considers that additional broad scale geological study is not warranted – with the next substantive step being to move to the consideration of appropriate dredge technology below.

The Panel clearly reserves its position in relation to issues of contaminated sediments and sediment chemistry from this position.

It also reserves its position in relation to one phenomenon referred to in evidence that was never satisfactorily resolved and has potential to significantly affect environmental outcomes. Here the Panel refers to the occurrence of fine materials described as ‘rock flour’ in the South

Channel. Should such fine material be encountered regularly, it would have the potential to affect the assumptions made in existing turbidity modelling. Given that its presence is known, it should prove possible to determine sampling locations from the records of maintenance dredge campaigns. It would then be a relatively simple task to understand the implications of this material for generation.

For this reason, the Panel recommends as follows:

The proponent should sample and characterise the fine 'rock flour' known to exist in the south of the bay. Parameters for study should include all the necessary data for input into revised turbidity modelling. Estimates of the distribution/extent of this material should be made.

8.4 SUMMARY

In relation to capital works, there is significant scope for channel design changes related to optimisation to drive changes to reduce the dredged material volumes. It will be necessary for dredged material volumes to be recalculated and the effects of their disposal re-assessed, pursuant to the carrying out of the design optimisation recommended above.

The Panel does not consider that maintenance dredge volumes have been studied to the extent necessary to make any assessment of the environmental effects of the maintenance campaigns required for the channels.

In general terms, the Panel considers that the EES has referred to sound characterisation of geology. However, it retains concerns that material described as 'rock flour' in the south of the bay has not been characterised. This retains the capacity to influence turbidity and should be further studied.

9. SEDIMENT CHEMISTRY & TOXICITY

The purpose of this chapter is to examine what the Panel has identified to be a key and critical issue raised by the EES and submissions: the characterisation and management of sediments produced by the project, which are moderately contaminated or acutely toxic. Conceptually it forms part of Chapter 9 above, considering the volume and nature of spoil. However, the critical nature of the sediment chemistry subject matter justifies a distinct chapter.

In commencing this record, the Panel must open by stating that the analysis of sediment chemistry issues presented in the EES was in very poor condition, subject to methodological flaws that prevent the making of a sound assessment of environmental effects. It is also true to note that the body of sediment chemistry work is complex, requiring a high level of engagement and understanding in terms of sampling theory, analytical chemistry, statistical and biological/ecological analysis. The Panel resolved these complexities by promoting the use of non-traditional hearing methods, primarily involving the use of technical and scientific dialogue between the Panel, the proponent's expert witnesses and other appropriately qualified and experienced people.

This aims to place on record the outcomes of the dialogue process undertaken by the Panel in very much the pattern that this eventuated, enabling complex considerations to be fully explored and understood, in broadly the order and sequence that events took place and were examined by the Panel. This chapter examines:

- the background to best practice management of dredging in relation to sediment management;
- key policy requirements for the characterisation of sediments in this project; and
- a step by step review of the applicable guidelines and methods.

This latter follows the steps taken by the proponent and/or considered by the Panel as necessary to be taken, articulated in the following terms:

- a review of the use and contamination history of the dredging site;
- sampling strategy;
- the proponent's first sediment studies;
- the proponent's second sediment studies;
- test results;
- approaches to laboratory quality control; and
- ecotoxicology issues.

9.1 SEDIMENT MANAGEMENT BACKGROUND

Discussion

A number of submissions raised concerns that the proponent was seeking to dredge material that was potentially contaminated and dispose of it to the Bay environment in ways that were not made fully clear or justified in the EES. Views were expressed that the environmental effects of the proposed dredging and disposal of such sediments had not been properly identified.

When managing sediments generated by dredging, it is necessary to consider the degree to which either natural conditions or historic patterns of use or development of waterways or surrounding land may have endowed it with chemical characteristics that could have adverse environmental effects. Worldwide experience of dredge programs indicates that dredged material may be in one of three broad states. It may be 'clean' or chemically benign; it may have measurable levels of contaminants but be demonstrated not to give rise to adverse environmental effects if managed using normal and prudent procedures; or it may be acutely toxic or highly contaminated, requiring special consideration and management. International practice has evolved towards the view that clean material may prudently be disposed of in the marine environment. Manageable materials may also be, provided that appropriate means of management are demonstrated. In general terms, acutely toxic or highly contaminated are managed on land, in response to the high risks that can be posed by their mobilisation or ecological accessibility in the marine environment.

The main volume of the EES, in Part B Key Features, contains Chapter 14 Sediment Chemistry and Water Quality. In this, the introduction states;

> *A Sediment Chemistry and Water Quality Report for the Project, prepared by Longmore et al. (2004), is included in Volume 3b of this Environment Effects Statement (EES). This chapter outlines the key findings of this report in relation to existing sediment chemistry, water quality and nutrient cycling features of the Bay.*
>
> […]
>
> *This section describes the sediment chemistry of the Bay channels and Dredged Material Ground (DMGs), in relation to toxicants, nutrients, oxygen and toxic algal cysts.*[80]

The conclusions include:

> *Key issues with respect to the proposed dredging program are discussed below. These will need to be addressed as part of the risk assessment and subsequent environmental management:*
>
> *Port of Melbourne and Port of Melbourne (PM) DMG*
>
> - *The potential for the release of turbid plumes is significant.*
> - *The major likely impacts of nutrient release include enhanced plant growth and ammonia toxicity to fauna.*
> - *Some contaminants in these sediments are elevated and exceed ANZECC and BPEM Guidelines. Consequently there is a risk that some of these contaminants will have adverse impacts arising from the dredging activities.*

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[80] EES Volume 1, Pgs 14-1 and 14-3.

- *Toxic algal cysts occur in the Yarra River, Hobsons Bay and in and around the Proponent DMG. Therefore, the potential exists for remobilisation.*
- *There is a potential for dredging and dredged material disposal to negatively impact nutrient cycling processes that maintain the health of the Bay by inhibiting denitrification in the Bay's sediments.*

South Channel and Southern DMGs

- *While the sediments of South Channel are sandy, there is potential for the generation of turbidity during dredging and placement in DMGs. The characteristics of the plumes generated by dredging these sediments are less well known and have therefore been included in the EES studies. Even so, contaminant concentrations are typically low and it is considered that there is a low risk of remobilisation of contaminants.81*

This draws attention to the presence of elevated levels of contaminants and nutrients in the Yarra area and potential problems with the generation of turbidity in the South Channel area.

Matters raised as key issues in Part B are reiterated and formalised in Part C Initial Risk Assessment of the main volume of the EES. The risk based procedure employed throughout the EES process resulted in statements of what the proponent considers to be Residual Risk. In relation to sediment chemistry, this was then rolled forward into Part D Environmental Management and Residual Risk Assessment of the main volume.

In Section 46 Residual Risk Assessment a subsection 46.2.2 Water Quality includes sections on Turbidity and on Chemical Contamination. The introduction to this section includes a statement of the principles adopted:

> *The residual risk assessment in this EES assesses the environmental risk of the Project assuming that the works are undertaken in accordance and in compliance with the draft Environmental Management Plan (EMP). It is not an assessment of the likelihood of whether the dredging operator would meet the performance criteria, or the consequences if these are not met. Rather, the implicit assumption is that the operator would meet the threshold limits and the performance criteria that are listed in the draft EMP.*

A consequence of the implicit assumption in the assessment process that "threshold limits and the performance criteria will be met" is that the consequences of them not being met are not considered. The following residual risk assessment relating to chemical contamination must be read with the assumption kept in mind:

> *The Geology, Geotechnical and Hydrogeology Specialist Study found the material in South Channel and Port Melbourne Channel to be uncontaminated according to the EPA's Best Practice Environmental Guidelines for Dredging, and the material in Williamstown Channel and the Yarra River to be moderately contaminated.*
>
> *Despite their classification as uncontaminated, the sediments in South Channel may still retain trace levels of contaminants and could possibly result in bioaccumulation of said contaminants. The risk of resuspension of contaminants and bioaccumulation was, therefore, rated high on the initial risk assessment by the Sediment Chemistry and Water Quality Specialist Study. Even so, this was primarily due to the likelihood being rated as almost certain. The consequence of an impact was rated as insignificant. Given the draft EMP measures and the proposed monitoring aimed at directly controlling contamination levels and water quality, the residual risk was then assessed as being low.*

[81] EES Volume 1 Pg 14-5.

> *The potential for contaminants to be released into the water column in the northern channels and at the Port of Melbourne DMG was found to be of a greater risk, with the initial risk being assessed as extreme and the consequence rated as moderate. The EMP identified the need to ensure contaminant levels were well controlled and, as such, included the requirement that such levels comply with the ANZECC and SEPP (Waters of Victoria) guidelines. The resulting residual risk was then reduced to low.*
>
> *The transport of such sediments from the channels to the DMGs also has the potential to raise contamination levels at the DMGs. Given the classification of the South Channel sediments, the draft EMP only addressed this issue for the Port of Melbourne DMG. The requirement is that any contaminated materials must be contained within a bunded area within the Port of Melbourne DMG. This should reduce the areal footprint over which contaminants are spread. Inclusion of this requirement in the draft EMP saw the initial risk rating of high then drop to low.*[82]

A reasonable reader of the EES Main Report could stand to be reassured from the words in the document that the project would raise no significant risk arising from the dredging of the sediment from the north or south of the Bay.

A reasonable reader could also be considerably misled as to the nature of work undertaken to enable the proponent to reach this position. The work clearly references the Port Phillip Bay Environmental Study (PPBES) and reports published by the CSIRO in 1999. (The Panel found the PPBES reports valuable throughout its deliberations.) However, it does not refer fully to the extensive work undertaken by the proponent's expert team as part of the EES studies. Most particularly, whilst the EES cites the work of PIRVic and Longmore, it makes no reference to detailed work undertaken under instructions to Sinclair Knight Merz, which included a body of work by Dr Adam Cohen.

Panel Response

The Panel has already outlined above its generic concerns as to the risk management approach taken in the EES. It has considered the approach under which environmental performance criteria were assumed as being capable of being met, including in circumstances where there was insufficient data or proven means of control to suggest that that would be the case. Sediment chemistry provides a clear and troubling example of the major difficulties that can emerge from the adoption of such an approach.

In most cases no information is given on the methods by which the threshold limits and the performance criteria will be met. Typically this obligation is simply transferred to the contractor carrying out the work. The proponent then assumes the contractors will meet this obligation and are free to employ any methods they choose to do this. The idea that it may not be technically possible to meet threshold limits and performance criteria at reasonable cost is not openly considered.

For reasons which will become clear as the reader moves through material below, the Panel regards the residual risk assessment cited above as being far removed from the true residual risk relating to the sediment chemistry.

The Panel accepts that sediments from the South Channel are likely to be uncontaminated having regard to relevant best practice guidance that is considered further below. The south of Port Phillip Bay does not have a pollution history of concern.

[82] EES Volume 1, p 46.4

However, the assertion in the EES that sediment from the Williamstown Channel and the Yarra River is moderately contaminated is highly questionable. The studies undertaken to reach this conclusion (Sinclair Knight Merz and the work of Dr Adam Cohen) are not referred to in EES Volume 1. The conclusion appears to emerge as if by magic, a fact that the Panel considers to give rise to significant procedural issues that it has already documented above. Further, as will become clearer below, the methodology employed in the studies to characterise the sediments was seriously deficient and did not comply with the minimum requirements set out in best practice guidelines.

At this stage in consideration of the residual risk it is the Panel's view that there is no formal foundation for classifying sediment in the Yarra as moderately contaminated and there is a strong case for considering it as acutely toxic and highly contaminated.

9.2 SEDIMENTS CHARACTERISATION: POLICY & BEST PRACTICE

Discussion

Best practice in the characterisation and management of potentially contaminated materials is a key concept. Major dredging programs in the state of Victoria are subject in principle to the Best Practice Environmental Management Guidelines for Dredging, EPA 2001 (the BPEMGD). These set out guidelines for characterising the sediment material to be moved and steps for selecting appropriate methods and site locations for disposal of the spoil based on these characteristics. Best practice approaches to sediment chemistry issues are central to these guidelines.

The proponent conducts by far the greatest amount of significant scale dredging in Victoria. In this context, it is reasonable to commence by assuming that in elaborating the BPEMGD, EPA sought them to apply to the activities of the proponent.

The guidelines refer to best practice in their title and assert that the philosophy they embody is that best practice as it is found at the time of the relevant decision should be followed. It is not the intention of these guidelines (or indeed of the concept of 'best practice') that dredge practice in Victoria be arbitrarily set for the foreseeable future at a level applying in 2001. The underlying philosophy of BPEM guidelines is to provide a forward-looking approach rather than simply reflect what is presently the norm.

The National Ocean Disposal Guidelines (NODG) are a second set of best practice guidelines for dredging, published by the Commonwealth of Australia in 2002. In many ways these are similar in principle to the 2001 EPA guidelines. Their primary function is as a pathway to implementing the London Convention for disposal of material at sea, to which Australia is a signatory. Whilst the London Convention does not apply to State waters (within which the project is sought to be implemented), it does embody international best practice in the characterisation and impact control of potentially contaminated materials that are proposed to be disposed of in the marine environment. It also a represents a step forward in evolutionary terms from the 2001 EPA guidelines.

The proponent's submissions proceeded on the basis that neither document has the force of law and that both form sources of guidance, which may if necessary be set aside. There was clear resistance by various proponent consultants who appeared before the Panel to the proposition that there may be a need to systematically comply with relevant guidance in the

NODG. It was argued to the Panel that in some instances the proponent was not obliged to meet even the less stringent requirements set out in the BPEMGD. A clear example of this was the argument by the proponents that the number of sediment samples collected and analysed could be less than the minimum required in the BPEMGD (to say nothing of the NODG) guidelines. The Panel was told that at a meeting of the EES Technical Reference Group (TRG), approval to take fewer samples was sought and provided by the EPA. It was suggested that such ‘approval’ should over-ride the application of the relevant guidelines. However, investigation by the Panel revealed that no such approval was ever provided under TRG auspices. EPA had advised that an informal approach to obtain such agreement had been made, but this had merely been consultative officer level contact. No formal statement of obligation had been made.

In their submissions to the Panel, and in response to questions, the EPA confirmed that the concept of best practice in the EPA guidelines includes the adoption of current best practice in the general sense of what is appropriate at the time, inclusive of progress since the elaboration of their own guidance.

Many third parties approached their submissions on the basis that the proponent would and should wish to comply with the spirit of the EPA guidelines and to adopt forward movement in best practice, including references to the NODG. In their view, such an approach was especially desirable because of the magnitude of the proposal. In terms of the volume of material to be dredged, the project is massive on a world scale. Dredging and disposal sites include marine and estuarine areas that are environmentally sensitive and highly visible areas, considered as precious environmental assets by the people of Victoria. Balancing this was the recognition by the proponent and shipping interests that the Port of Melbourne is a major commercial asset for the state and that the dredging campaign would need to be carried out at a reasonable cost and without major disruption to the activities of the port.

Clear direction in this regard is provided by the Department of Sustainability and Environment’s Assessment Guidelines for the project. The applicable sections state:

> *The project will need to comply with the mandatory process for Victorian dredging proposals specified in the Best Practice Environmental Management Guidelines for Dredging (BPEMGD) published by EPA in November 2001. The VCA will require consent from the Minister for Environment and Conservation, under the Coastal Management Act 1995, before dredging works can commence. The EES must adequately address all requirements set out in the BPEMGD in order for the dredging and coastal works to be assessed. This includes the preparation of an EMP that covers all proposed dredging and dredged material management activities.*
>
> *Where adverse environmental effects are unavoidable, the proposed safeguards – for example silt control equipment and practices – should be described in reasonable detail and should indicate to what extent these safeguards will minimise anticipated effects.*
>
> *If long-term adverse environmental effects from the project are considered unavoidable despite implementation of proposed environmental management (e.g. short-term ecosystem damage or loss of conservation values), intended remediation and compensation measures will need to be indicated.*
>
> *The project will also need to comply with the National Ocean Disposal Guidelines for Dredged Material (Commonwealth, 2002). The EES should highlight any requirements that are over and above the BPEMGD and state process, and describe how these national disposal requirements will be adhered to.*

Panel Response

The Panel takes the view that, in line with the Assessment Guidelines, the proponent is required to comply with the Best Practice Environmental Management Guidelines for Dredging (BPEMGD) published by EPA, 2001 and the National Ocean Disposal Guidelines for Dredged Material (NODG) Commonwealth, 2002.

To comply with both of these guidelines it is obvious to the Panel that it would be necessary for the proponent to compare all the relevant conditions and to assemble a body of practice that follows the more stringent requirement. The Assessment Guidelines require that this be done and that the EES should highlight any requirement in the NODG that are over and above the BPEMGD and state process, and describe how the national disposal requirements will be adhered to. As the Panel makes clear in its policy analysis (see Appendix F), this is very directive language, not supportive of the proponent's view that the guidelines may be easily departed from.

The Panel finds that there is no evidence in the EES, in relevant background studies, in the proponent's evidence or in submissions to the Panel during public hearings that this comparison was ever done in any systematic way.

The Panel finds there was a prevalent attitude of aiming to minimise the scope, scale (and presumably expense) of the sediment chemistry study. However, the implications of this attitude went significantly further than the prudent control of study costs. It has eliminated any confidence that the Panel might reasonably have had in the broader outcomes of the study and its capability to guide the management of dredged material.

The Panel notes that the Assessment Guidelines state that proposed safeguards should be described in reasonable detail, and that any long-term intended remediation and compensation measures will need to be indicated. The guidelines give an example of silt control equipment and practices. From this example, the Panel concludes that the proponent is required to describe in reasonable detail the technical methods they propose will be suitable to ensure the various threshold limits and the performance criteria will be met in all of the proposed dredging works, but most particularly in respect of sediment chemistry. However, the EES fails to provide this information and consistently argues against providing it. The basis of the argument is that under the process of adaptive management, adjustments to operations will be made as required at the time. However, the Panel finds that once one is handling and disposing of contaminated materials, one's margin of error and adaption may turn out to be very small, or, as will transpire from the more detailed evaluation carried out below, non-existent. In such circumstances, adaptive management will not resolve the dilemma that sediments are likely to be recovered in a condition that is not appropriate for uncapped marine disposal, without the interposition of lengthy and potentially extraordinarily costly delay to facilitate technological and design re-appraisal.

The Panel finds that the EES fails to comply with the directions of the Assessment Guidelines in respect of sediment characterisation and management guidance. This failure gives rise to the possibility that dredging equipment and crew may be brought to Port Phillip Bay from other regions of the globe and remain here at a high daily cost, when (as is most likely) it is subsequently found that the technology and disposal method are inappropriate.

In relation to other policy sources, the Panel also remarks that the Environment Protection Act and relevant SEPP (Waters of Victoria and Schedules F6 and F7 to that policy) clearly expect the application of best practice. They require the consideration of best practice as defined in EPA guidance, but also recognise continuous improvement and the need to have regard to relevant newer sources such as the NODG. A plethora of broader legislative and policy provisions considered in the Appendices demonstrate that Victoria has a strong, whole of government commitment to best practice in this field. It is simply untenable to propose a solution that seeks to depart from it, without a very sound understanding as to the basis for such a departure.

9.3 APPLYING THE GUIDELINES

Discussion

Having reached the position that best practice as evidenced in the combination of the BPEMGD and NODG guidelines is relevant and should be applied, the Panel finds it necessary to move through the combined processes in a stepwise fashion, considering the degree to which relevant requirements have or have not been met.

The guidelines have a combined size of two hundred and seventy pages and in this report only the most relevant material is discussed. Each guideline follows the same stages of assessment. These are discussed below, referring to only a single requirement where the two are in agreement as to what is required and to the highest level requirement where the frontier of best practice appears to rest with one, or the other. The Panel's response emerges after discussion of each requirement.

9.3.2 HISTORICAL REVIEW

Out of the large number of inorganic elements and compounds and the vast number of organic compounds, a selection of those to be measured must be made to suit the conditions. The selection must include those potentially toxic materials listed in tables in the guidelines. This is well summarised in the BPEMGD

> *The contamination status of the site to be dredged must be established prior to dredging. The history of uses that may contribute to contamination of sediments in the area must be documented and previous analyses of contamination or dredging at the site summarised.*
>
> *Typically, the concentration of a range of organic and heavy metal contaminants on the site to be dredged must be measured before dredging commences. The choice of contaminants to be measured will be based on the site history and the volume of material to be dredged. Proponents must ensure that the suite of contaminants analysed and the intensity of sampling adequately characterise the area to be dredged.*[83]

In the EES, some previous analyses are tabulated but are not critically reviewed.

The site history is not discussed in the EES and Dr Adam Cohen (expert witness for the proponent) confirmed that the selection of contaminants to be measured had not systematically taken site history and most critically adjacent site history into account.

The proponent in part took the view that such historical evaluations were not always necessary, if one proceeded to whole of sediment toxicity testing. If a sediment body can be extracted and managed based on knowledge of its toxic effect, it may not be necessary to know what substances or what combination of substances are the source of any toxicity.

[83] BPEMGD Pg 15

Panel Response

Because a comprehensive site history assessment was not undertaken, the approach taken in the EES means that sediments in the Yarra may contain significant concentrations of some toxicants that have not been reported simply because they were not looked for. This is despite the fact that historic industrial and port precincts adjacent to the Yarra and long used berths and dock basins are well documented as potential sources of contaminants.

Prudently, it would be necessary to use a historical evaluation to target a range of materials that are documented or could be expected to be present, based on the land and port use history of the Yarra precinct.

The absence of such a study gives added importance to the whole-of-sediment toxicity testing that was carried out in the proponent's Stage 2: Additional Environmental Survey Work. Results of such toxicity testing give a direct indication of potential problems from disturbance and disposal of the sediment, independently of the exact nature of the toxicants present. It has the advantage of revealing toxicity due to materials that may have been programmed for individual testing, had the potential for their presence been identified in a historical survey (although clearly not revealing what those materials individually might be). It also has the advantage of revealing toxicity that may be the result of synergistic interaction of a number of toxicants that individually may not have the same toxic effect.

However, it must be remarked that if one decides to move directly to a whole of sediment test as a means of characterising and determining the management strategies for recovered sediments, without also using the vehicle of a historically directed study, one has to abide by the emerging result. If for example, a whole of sediment test indicates that the amalgamated sediments for a large sediment zone are all acutely toxic, they must all be treated as so, unless one returns to a more targeted approach and then undertakes analysis to determine whether this result emerges from the detectable presence of discrete hot spots, which can be removed for separate management.

The Panel recommends as follows.

It is essential to carry out historical research to disclose locations of potential contamination in the Yarra sediments, to guide the selection of contaminants to be investigated, sampling design and the location of potential 'hotspots'.

9.3.3 SAMPLING STRATEGY

Discussion

Accurate sampling that applies relevant statistical method and materials handling protocols is utterly critical to the integrity of any sediment chemistry analysis.

As the aim of the exercise is to accurately characterise the sediment to be dredged, especially the concentration and distribution of contaminants and nutrients, the quality of the final results can be no better than the quality of the sampling program. Samples collected should be representative of vertical and horizontal variation in the properties of materials to be dredged, using the correct methods and precautions to avoid contamination. Without due care, analytical data will be rendered invalid.

The NODG requires a Sampling and Analysis Plan before any material is sampled. This sets out the study objectives and the proposed sampling, analysis and quality assurance/quality control procedures. Sampling strategy and analytical quality assurance/quality were not clearly explained in the EES documentation.

These issues were explored at length via the medium of dialogue between the proponent's expert witness Dr Adam Cohen, third party submitter Dr Simon Roberts and the Panel.

Panel Response

In the exceptionally large scale dredging program being considered here, in an area with complex history and high probability of the occurrence of contamination hot spots, the prudent approach would be to use both judgmental sampling and statistical sampling to ensure the objectives of the exercise are fully met.

For a project of greater than 500,000 cubic metres of spoil the dredge area should be divided into 'zones' based on chemical characteristics. A sampling program should then be planned for each sampling site or location in the zone from which a sample is to be taken.

The number of sampling locations in each zone should depend on the spoil volume expected from that zone. The minimum numbers of sampling locations according to spoil volume are listed in Table 1 of the NODG at page 31 and Table 7 of the BPEMGD at page 59. Perusal of these tables shows clearly that the NODG has the higher requirement. Consequently, in the absence of a very clearly articulated reason, soundly based in the established methods and protocols of sampling, the number of sampling sites should comply with the NODG.

An abbreviated table from the NODG is included here as an indication of sample numbers required for a statistically based analysis. It is important to establish clearly that the NODG sample number guidance is not a simple 'bureaucratic requirement'. It has been consciously articulated to take account of the need for sound sampling and statistical method. Failing to meet relevant guidelines is not simply therefore a cause for regret. In principle it is capable of invalidating the basis on which the body of work then reaches conclusions about sediment characterisation for the affected zone. Where the guidelines are not met, it is critically important that the methodological basis for this has been fully thought through and documented.

Table 18: Abbreviated NODG Zone Sampling Requirements

Volume to be Dredged (cubic metres)		Minimum Number of Sampling Locations
0	10,000	6
10,000	17,000	7
50,000	58,000	13
100,000	141,000	19
305,000	346,000	24
468,000	509,000	28

The minimum number of samples indicated is six. This is the smallest number that might be expected to yield meaningful results from statistical manipulation. Where a sediment unit contains larger volumes of material, larger numbers are required – necessitating knowledge of likely sediment volumes in each unit as a precursor to deciding the sample number. In the Yarra, more then the minimum number of samples is desirable, as the dredge area is geographically complex, the sediments are variable and the contamination is likely to have a complex distribution.

Sediment samples must be taken so that they are as representative as possible of the sediment that will be removed by the proposed dredging. Dr Adam Cohen was put to detailed technical questioning on his basis for the sampling strategy used in the project. Answers were provided to the effect that it was (at one point) a random sample strategy and (at another point) a grid assigned stratified sample strategy. His answers were most unclear and variable. Sadly, the Panel was left with the distinct impression that Dr Cohen did not have a sound theoretical/technical understanding of the distinction between different sampling strategies and the basis for choice between them.

Extra judgmental samples are also needed if the aim of the study overall includes location of hotspots of contamination. Such samples should not be confused with the samples taken for the purposes of statistical analysis. They support a separate and targeted evaluation, supported by qualitative and historically based judgement and reasoning as to where hot spots might be.

The sediments in the Yarra are known to consist in general of a layer of unconsolidated, recently deposited silt overlying an older base of stiff clay. The material of most concern is the silt, as this is most likely to be contaminated by materials carried to the estuary from the catchment area or discharged as a result of nearby historical industrial activity.

It is most important that the physical distribution of the silt and variations in the degree of contamination of the material in different locations are well characterised.

The older clay is mainly firm Coode Island Silt and is less likely to be contaminated as it was laid down before settlement and has been undisturbed. The presence of porous layers such as the Moray Street Gravel need to be identified as they provide a pathway for intrusion of contaminated ground water into this clay layer.

It is essential that the depth of the silt layer be measured and mapped using a physical survey. This would allow calculation of the volume of this material and provides the basis for planning a coring program to ensure that the samples collected are a good representation of the material to be dredged. It will also enable the first step to be taken in determining the likely volume of material in which significant levels of contamination or acute toxicity may be found, as distinct from the lower, more consolidated, older sediments that can be expected to be in a less contaminated condition. Knowledge of the boundary and relative volumes of these materials will then inform the commencement of a more valid materials management strategy.

To ensure that sampling of the silt is representative of the volume of material, it would be appropriate to take more samples where the silt layer is deepest. In the Yarra this is likely to be towards the edges of the channel as ship movements tend to disperse loose sediment towards the banks. In many locations, silt also accumulates under the wharfs that are supported on piles driven into the river bed.

The Panel notes that there is no evidence that a survey of the silt layer in the whole Yarra area has been undertaken. The Panel could not find his information in the EES documents, including the technical appendices. It has to record that Dr Cohen's answers to questions on this point were very confused.

On several occasions during the public hearings the Panel asked for plans showing the depth distribution of the silt across a range of sections of the channel, and for calculations of the volume of silt in different zones of the port. Appropriate results were promised but never produced. Various estimates of the amount of silt were produced at different times but the source of these figures was not indicated.

The bore logs from the cores collected in the sampling program that was carried out and reported in the EES indicate the depth of the silt layer at those locations. However, these are not sufficient in number to permit production of a map of appropriate detail.

The Panel does not accept that mapping the silt layer need be a long or expensive process. For example, appropriate silt maps could be produced with relative ease using a density probe (measuring radiation attenuation) that permits rapid measurement of many sediment density profiles.

For all of the reasons set out above the Panel recommends as follows:

The volume and location of recent (post settlement) silts should be mapped as an essential early part of additional sediment studies.

The proponent should design a new sampling strategy for the Yarra zones. The historical use analysis and the silt distribution map recommended above should be used, together with the results of a critical review of previous studies. This is required to ensure that the results obtained are representative of the material to be dredged, in both area and depth. NODG provides clear guidance on this process, which should be followed.

The number of samples should be sufficient to yield statistically valid results that as a minimum meet NODG requirements. The sampling strategy should be documented and externally approved before additional survey works commence.

9.3.4 SEDIMENT CHEMISTRY REPORTS: STAGE 1

Discussion

The Panel now proceeds to an analysis of the phases of sediment chemistry analysis presented before it. There were two main phases of survey and analytical work. This section concentrates on the first of these.

The EES documents contain a report of collection and analysis of a set of 70 cores. This work is described in EES Vol 2 Geology, Geotechnical and Hydrogeological Specialist Study, Section 3 – Sediment Chemistry author Dr Adam Cohen, reviewed by Dr Peter Morrison and approved by Jason Fong. The date of the final report for this work is August 2003. The work was undertaken in accordance with the Parson Brinkerhoff scope of work. This is referred to by the Panel as Sediment Chemistry – Stage 1.

The objectives of this sediment chemistry investigation were as follows:

- *To undertake sediment sampling across the proposed areas to be dredged and within the vicinity of the proposed spoil ground(s);*
- *To characterise the sediments and recommend appropriate disposal options, following dredging;*
- *To provide discussion on the nature and extent of potential impacts and provision of recommendations to mitigate against such impacts on the surrounding environment*

- *To provide recommendations with respect to further sampling and testing, if required, to meet the requirements of the EPA Guidelines for Dredging (EPA, 2001).*

Selection of sample locations described in Part 1 of the report states:

> *A total of 70 boreholes were drilled as part of the EES project for the purpose of collecting factual sediment chemistry and geotechnical information.*
>
> *Borehole sites were selected by Parsons Brinkerhoff in conjunction with the PoMC. A summary of the geotechnical borehole drilling locations, as-drilled depths and sea floor reduced levels is presented on PoMC drawings (32392, 32463 and 32466) in Appendix A*

There is no discussion of the rationale for the choice of location of these sample sites. In fact, they were selected as part of the engineering geotechnical investigations, rather than for their suitability in terms of representing the sediment to be dredged for the purposes of chemical characterisation.

The report continues to record the zonation of the project for the purposes of sampling and the numbers of samples taken.

> *The following areas were sampled within the Yarra River, Williamstown Channel, Port Melbourne Channel and South Channel:*

- *Yarra River - Bolte Bridge to Westgate Bridge;* [23]
- *Yarra River - Westgate Bridge to Westgate Terminal;* [3]
- *Yarra River - Westgate Terminal to Webb Dock West ;* [4]
- *Williamstown Channel – Webb Dock West to Junction;* [4]
- *Port Melbourne Channel South – Junction to Fawkner Beacon;* [9]
- *Port Melbourne Channel South Extension – Fawkner Beacon to South of Ethane Line;* [4]
- *South Channel – Popes Eye to Hovell Pile;* [6]
- *Proposed spoil ground locations within Symonds Channel, South Channel, Capel Sound, Mornington and Port Melbourne Channel.* [17]

This shows that the proponent has divided the Yarra area into six distinct zones. For ease of use, the Panel has inserted in square brackets the number of bore locations in each zone.

The bore locations are shown on plans in Appendix B of the Stage 1 Report.

Panel Response

Without data on the volume of sediment to be dredged from each zone it is not possible to see whether the number of borehole locations in all zones meets the minimum requirement of the NODG guidelines. However, even without sound sediment volume data, it is clear from the number of samples taken that for some zones the minimum requirements were not met. The minimum number required is 6 when the volume to be dredged from a unit is less than 10,000 cubic metres. The Panel understands that the minimum volume to be dredged from any one zone could be more than 500,000 cubic metres, requiring a minimum number of sample sites of 28. The stated dredge volumes varied throughout the hearings and were never fully identified on a conservative basis, giving to issues that have been discussed elsewhere in this report.

The plans also show that samples in the Yarra are mainly taken in the main channel and under-represent the areas of likely contaminated silt accumulation towards the edges of the channel. This further lessens the degree to which the study represents the sediment characteristics.

There is a further issue with the depths within each core from which sub-samples were taken for analysis and with the number of parameters that were then measured in the sub-samples.

The samples were analysed and the results are reported in Tables 2.2 to 2.6 of the EES chapter. The report states:

> *Surface samples (0–0.3m) and subsurface samples (0.3–0.6m) were analysed. Only a limited suite of analyses (sediment characteristics) were completed in the virgin materials at depth (i.e. >0.6m) and this was used to characterise changes in the sub-surface profile.*

Adding the number of cores analysed the Panel notes that total appears to be 62 which is less than the 70 cores collected. Of these, chemical analyses were carried out only on samples 0–0.3m and 0.3–0.6m and not on deeper samples. Evidence is not presented to support the assertion that the material below 0.6m is uncontaminated.

The EES summary of Key Issues and Implications for Dredging states:

> *On the basis of the scope of work undertaken as part of the sediment chemistry investigation, the following key issues and implications for dredging have been highlighted. These recommendations are based on the assumption that the scope of work undertaken was sufficient to satisfy the EPA Guidelines for Dredging (EPA, 2001). If further sampling and investigation works are required as part of a Stage 2 investigation, these recommendations may require revision.*

Recommendations are listed that provide the basis for the proposed further work

> *The following recommendations provided are also based on the suite of analyses undertaken If additional analytes are tested, then the contamination status of the sediments may change.*

The EES chapter contains a number of significant recommendations for further work on characterisation of sediments but makes no reference to the fact that the further work was completed before the EES was issued for public comment. Critically, it makes no use of the findings of the additional work. To this extent, readers of the EES can be forgiven for having adopted an understanding of sediment chemistry issues that was not correct.

The Panel's first conclusion is that the sampling campaign described at this stage and presented in the published EES is highly inadequate to provide a basis for assessing sediment characteristics in the Yarra area.

The Panel's second conclusion is that the limited sampling program could not lead to a reliable assessment of sediment characteristics in the Yarra. Consequently it would provide an unsound basis for discussion on the nature and extent of potential impacts and provision of recommendations to mitigate against such impacts.

The Panel's third conclusion is that that the work described in this chapter, and hence that included in the exhibited EES, should be considered as a pilot program. It did not seek systematically to survey for sediment contamination in a methodologically sound manner. It should not have been presented as assessing the sediment characteristics in any formal way. It did not and could not comply with the combined requirements of the BPEMGD and NODG guidelines as described above.

9.3.5 THE SEDIMENT CHEMISTRY REPORTS: STAGE 2 (THE COHEN REPORT)

Discussion

Dr Adam Cohen of SKM provided expert evidence for the proponent on matters of sediment chemistry before the Panel hearing. Mr Andrew Longmore of PIR Vic provided evidence on the biological/ecological consequences of this material.

Once the proponent's evidence on sediment chemistry issues was disclosed to the public in preparation for the hearing, it became apparent that the exhibited EES Volume 1 did not consolidate and tell the entire story in relation to the proponent's investigations. In response to a request put to Dr Cohen by the Panel during the public hearing, a very substantial volume containing the additional work was produced for the Panel. This document is referred to here as the Stage 2 Report.

Examination of the volume showed that the material it contained was highly significant and altered substantially the Panel's perception of the character of the Yarra sediments.

The Stage 2 volume did not form part of the exhibited EES documentation.

Retrospective examination of the seven exhibited volumes of the EES document revealed the extent of reference to the material in the un-exhibited volume.

It was not referred to in logical order, beside the earlier sediment chemistry work: EES Vol 2 Geology, Geotechnical and Hydrogeological Specialist Study, Section 3 – Sediment Chemistry, also written by Dr Cohen. Instead, it was called up in the Geology, Geotechnical and Hydrogeological Studies – Risk assessment report, written by Mr Raisbeck (page 1).

> *This Risk assessment report summarises the risks to a number of asset classes from the geology, geotechnical & hydrogeology issues addressed in the Key Features Summary Report prepared during Phase 2 of the Port Phillip Bay Channel Deepening Project - Environmental Effects Statement (EES). Further field and laboratory investigations were carried out in the Yarra Delta area during Phase 3 and these have been reviewed for this final Risk Assessment report. Issues relating to sediment contamination in Management Units 1 to 5 were further investigated in field and laboratory studies by SKM (ref.3) and the final risk assessment presented by Primary Industries Research Victoria (PIRVic) (ref.4) Other specialist groups have used factual information from the Key Features Summary Report and Phase 3 investigations as inputs into their own specialist risk assessments.*

The Raisbeck reference continued (page 3) as follows:

> *SKM undertook additional environmental surveys as part of the Phase 3 investigations, titled "Stage 2 Additional Environmental Survey Work, 2004. These surveys were undertaken following preparation of the Key Features Report and were used to gather additional information on classifying sediments across each of the Management Units. The Stage 2 Additional Environmental Survey Report was provided to Primary Industries Research Victoria (PIRVic), for completion of their Risk Assessment Report, titled "Volume 2—Risk Report Sediment Chemistry and Water Quality Specialist Study, 2004".*

- *Sediments to 3m depth in Management Unit 1 were classified as uncontaminated. Whereas, moderately contaminated sediments were reported to 0.6m depth in Management Units 2, 3 and 5 and to 0.8m depth in Management Unit 4.*
- *The whole sediment toxicity tests undertaken on moderately contaminated surface sediments were found to affect the survival of the juvenile life stage of the benthic amphipod, M. plumosa. (Stage 2 Report p 40) A sea disposal strategy will be*

required that considers capping and/ or isolation (i.e. bunding) of the moderately contaminated surface material with uncontaminated material at the spoil ground;

- *Hotspots (elevated nickel, mercury, arsenic, zinc, OC pesticides and TBT above maximum screening levels) were detected in various areas throughout the Management Units. These samples were associated with either Recent Deposits or Fishermens Bend Silts. The dredging contractor will be required to manage these 'hotspots'. Some guidance is provided in Environment Australia (2002), regarding the management of hotspots;*
- *Port Melbourne Dredged Material Grounds extension contained sediments with naturally elevated concentrations of nickel;*
- *Surface sediments at Mornington, Hovell Pile, Capel Sound and Symonds Channel were considered uncontaminated. It is recommended that if deemed suitable as dredge material disposal locations, only uncontaminated material should be disposed of at these locations; and*
- *Elevated lead concentrations were reported in mussels collected from the Yarra River and Hobsons Bay, compared to mussels collected from control sites in South Channel. Further sampling of mussels in the designated areas will be required before and after dredging, if ProponentC wish to investigate the potential effects post-dredging.*

However, there was little evidence that material in this reference was given weight in the *PIRVic report.*

In the introduction to Stage 2 work, Dr Cohen states its objectives to be:

- To re-characterise the contamination status of sediments in units 3, 4 and 5 by additional testing of retained samples (the Yarra River units).
- To re-characterise the contamination status of sediments in unit 2 based on additional investigation works.
- To identify the geometric mean of organochlorine pesticides and PCBs concentrations in units 2 to 5 and re-characterise the contamination status of these sediments based on additional investigation works.
- To characterise the contamination status of sediments at the proposed spoil ground locations.
- To determine the toxicity and bioavailability of contaminants in sediments from units 2,3 and 5.
- To conclude whether metals are being significantly bioaccumulated in Blue Mussels in the vicinity of the Yarra River compared to a non impacted area of the Bay.[84]

Sampling

Very substantial concerns about the methodological adequacy of sampling were raised by Dr Simon Roberts. A detailed dialogue process allowed these to be explored in some depth at the Panel hearing.

The proponent's position was that the samples in Stage 2 were taken to augment Stage 1 data, to satisfy the requirements of the EPA Guidelines for Dredging. The area to be dredged was divided into management units replacing the Management zones of the Part 1 study. The number of samples taken is summarised in the table below.

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[84] SKM (2004) Stage 2 Additional Environmental Survey Work Page 5

Table 19: Stage 2 Sediment Chemistry: Summary of Samples

Management Unit	1	2	3,4 & 5	Spoil grounds
Number of samples	23	10	30	12

The Stage 2 volume states in section 3.1 on page 8:

> *Diver cores were collected from locations chosen to be representative of the entire channel (mid-channel, Batters, toe lines and silt traps).*

It further states in attachment 3 on page 12:

> *A stratified systematic sampling approach was proposed and justified. As mentioned in the body of the text, the sample design used stratified systematic sampling, not stratified random sampling. The EPA Guidelines for Dredging (EPA, 2001) suggest that an alternate design may be used to stratified random sampling, when circumstances favour an alternate design. The various management units were divided into parts (strata) and a systematic sampling approach was adopted, where sampling was undertaken at regular intervals in space and time (ANZECC/ARMCANZ, 2000). When properly planned and executed systematic sampling can be as unbiased as random sampling (ANZECC/ARMCANZ, 2000). As mentioned in the communications to the TRG, care was take to ensure that bias was not incorporated into the sampling scheme, ie the samples locations were chosen to be equi-spaced along the channels and staggered across the channels to ensure that the full volume of material from each Management Unit was properly classified. In the case of random sampling, there is the potential for this not to occur. No focussed/targeted sampling was used to avoid bias (in compliance (page 58).*

In dialogue with the third party Dr Simon Roberts and in response to Panel questions, Dr Cohen insisted that a random stratified sampling approach was adopted and computer generated random numbers used to select the locations on a grid. This is different from the approach claimed in the reference above. However, this position was reached after considerable probing, again suggestive that Dr Cohen did not understand the underlying methodological approaches in relation to sampling.

Some Stage 2 sites were seen to be exactly the same as some Stage 1 sites. The Panel was advised that these provided new cores that were to be used to complete the suite of analyses.

Bottom sediments were sampled using diver held cores.

> *Cores were collected at each location using 1 m polycarbonate cores.*
>
> *….sampling was undertaken at depth intervals of 0-0.3m, 0.3-0.6m and 0.9-1.2m.*[85]

However, not all material from all strata proceeded to analysis and the basis for selection was not made clear.

Taking Stage 1 and Stage 2 in aggregate, it is necessary to examine whether they have together moved the sampling and analysis closer to compliance with both the BPEMGD and the NODG Guidelines. The number of sample sites in both Stages of the work is tabulated below.

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[85] SKM (2004) Stage 2 Additional Environmental Survey Work Page 8

Table 20: Aggregate Sampling Summary: Stage 1 and Stage 2

Management Unit	Drill Cores Stage 1	Diver cores Stage 2	Total
1	23	13	36
2	9	5	14
3	7	7	14
4	14	13	27
5	9	9	18

Sediment samples were sent to outside laboratories for analysis. The eight remaining cores from Stage 1 were analysed at this time.

All the results are summarised in Tables 4.4 to 4.9 in Appendix B of the Stage 2 report.

Panel Response

The Panel can only reiterate its astonishment that a full volume describing the results of the additional work on the characteristics of the Yarra sediment existed more than six months before the EES was released, but that this was not exhibited with the EES, referred to or summarised in EES Volume 1. References in other volumes of the EES were also unclear. The work does not appear to have been taken into account in the work of others, most particularly in relation to that or Mr Longmore, Dr Edmunds and Dr Mustoe.

The express purpose of the Stage 2 work was to enable a move to compliance with the EPA BPEMGD. However, no reference was made to the relevance of NODG provisions pursuant to the requirements of the Assessment Guidelines. Nor was the Stage 2 work configured to respond to the NODG in any way. Issues around sample strategy and its relationship with the respective guidelines remained undiscussed. The volume of material to be dredged was not stated as a relevant component of this methodological consideration. The NODG sets out more stringent guidance for sample numbers which the Panel has already indicated should have been met or exceeded.

The Panel examined a plan showing the location of all sample sites but remain unenlightened about the actual sampling strategy used, an situation that it considers to arise from the incomplete understanding of sampling theory by the proponent's expert.

Most significantly, the sampling strategy for the second sediment survey was limited by the fact that a plan of the distribution of the silt layer had still not been produced. This meant that it was not possible to plan the sampling to weight the number of samples to represent the amount of sediment. That is, there could not be more samples taken where the silt was thickest or a mathematical procedure applied to give adjusted weighting to some samples. The result, at best is that when a mean concentration is calculated for any contaminant the result is simply the average analytical result and is not the average concentration of the contaminant in the zone and strata of material to be dredged. In Port Phillip Bay a variety of environmental objectives need to be met and any error of sampling method or judgement in this regard may have major adverse consequences. This applies equally to the effects of contaminants and the effects of nutrients.

It was put to the Panel that the additive programmes of Stages 1 and 2 did provide a combined data set sufficient for valid conclusions to be drawn. The Panel notes the NODG guidelines still require a minimum of 28 samples where the volume to be dredged is greater than 509,000 cubic metres. On this basis only Yarra sediment management Unit 1 would have the possibility of meeting the minimum requirement of combined sample numbers.

As discussed above, there are conditions that must be considered in relation to determining whether the number of sample sites is adequate. The guidelines suggest that where there is good quality data available then the number of samples may be reduced. Where contamination has a complex distribution, more samples may be desirable. In this case there is not good quality data for all the contaminants, particularly the organic compounds, and the upper parts of the Yarra estuary do have a complex distribution of contaminants. This suggests that there is no basis for reducing the number of samples from that stated by the NODG, and an in principle basis for consideration of an increase.

The guidelines require that for large projects the dredge area could be broken into a number of sites (zones), each with about half a million cubic meters to be dredged. For larger zones the NODG suggests that number of samples should be calculated using power analysis and provides directions to the methodology. Each of the zones designated in the report is likely to have more than one million cubic meters to be dredged and the number of samples required should be calculated and not simply accepted as ‘more than 28’.

A further issue emerging from the combined work is that some of the Stage 2 sample sites coincide with Stage 1 sites. This is a rational action as the cores taken in Stage 2 were analysed to add data for the organic contaminants (OC, PCB and TBT) to the data for metals and hydrocarbons collected at Stage 1. However, it can have the effect of reducing the number of sample sites as the coincident sites can still in practice be a single location for the purposes of a complete suite of analyses. The Panel has not undertaken the comparative work needed to elucidate how many sites overlapped, as this information is not set out clearly in the reports. However, this is a significant matter as it tends to reduce rather than increase the number of sample locations.

The picture is further complicated by the fact that not all samples were analysed for all analytes at all depths. The implication in the guidelines that sample location means locations where the samples are collected and analysed for the full suite of contaminants of interest at all appropriate depths. If some preliminary and rational calculation of sediment volumes had been carried out, such that it was possible to be clear that sediments divided between older and undisturbed materials and newer material more likely to contain contaminants, there would have been a clearer basis for these stratification decisions. However, as it is they appear only to weaken then integrity of the analysis.

On the basis of its consideration of the Stage 2 and its aggregation with Stage 1 data, it appears to the Panel that the sampling plan falls short of meeting the requirements of the Assessment Guidelines.

A strategy for disposal of the dredge spoil in a way that ensures acceptable environmental outcomes can only be developed when the sediment to be dredged is properly characterised. This is the reason for the existence of dredge and ocean disposal guidelines. It is also the reason that assessment methods are being improved globally and that dredge technology is being advanced to allow dredging with reduced interaction between disturbed sediment and the water.

The project being considered is large by any standard and consequently has great need for preparation and implementation that minimises environmental effects. It cannot proceed on the basis of such preparation and implementation being complete whilst fundamental issues in the adequacy of sampling remain to be responded to.

A sampling regime in compliance with relevant guidance in the BPEMGD and the NODG design process should be prepared and subjected to independent peer review.

9.3.6 SEDIMENT CHEMISTRY RESULTS

Discussion

The results in the Cohen Stage 2 report cover many pages. It would take excessive space in a Panel report to analyse them in any detail. This must not be taken as in any way underplaying their significance in detailed terms, or as suggesting that matters of detail were not considered. Both Dr Simon Roberts and the Panel examined the material in considerable depth.

It considers:

- the results thresholds set by the applicable guidelines;
- chemical and statistical methodological considerations; and
- whole of sediment toxicity testing.

Applicable Guidelines

As a starting point, it is necessary to understand the primary directive content of relevant guidance documents and some key operational concepts.

- The documents refer to 'screening levels'. These are levels at which a substance must be found in a sediment to trigger a particular action or process in further consideration.
- The NODG refers to a decision tree, in which a staged action process in response to a range of relevant tests and levels is set out.
- The BPEMGD also contains relevant statements in relation to the handling of Yarra sediments, based on local historical knowledge.

The screening levels and maximum levels for contaminants set out in the NODG Guidelines are reproduced below (BPEMGD uses the same levels).

A summary of stages 1 to 6 in the sediment screening process required in the NODG is also provided below. Some of the less general requirements are omitted. This is intended to assist the reader follow the later discussion. It is not intended as a working document.

Figure 2: NODG Table 5 Extract

TABLE 5. ACTION LIST (SCREENING AND MAXIMUM LEVELS).

For substances not listed, consult the Determining Authority regarding requirements (mg/kg dry weight except where noted).

Analytical Parameter	Screening Level (Effects Range-Low)	Maximum Level (Effects Range-Median)*
METALS & METALLOIDS#		
Antimony	2	25
Arsenic	20##	70
Cadmium	1.5	10
Chromium	80	370
Copper	65	270
Lead	50	220
Mercury	0.15	1
Nickel	21	52
Silver	1.0	3.7
Zinc	200	410
ORGANICS***(µg/kg=ppb)		
Total PCBs	23	-
Pesticides		
DDD	2	20
DDE	2.2	27
Total DDT	1.6	46
Dieldrin@	0.02	8
Chlordane@	0.5	6
Lindane@	0.32	1.0
Endrin@	0.02	8
Polynuclear Aromatic Hydrocarbons (PAHs)(µg/kg)		
Acenapthene	16	500
Acenapthalene	44	640
Anthracene	85	1100
Fluorene	19	540
Napthalene	160	2100
Phenanthrene	240	1500
Low Molecular Weight PAHs	552	3160
Benzo [a] anthracene	261	1600
Benzo [a] pyrene	430	1600
Dibenz[a,h] anthracene	63	260
Fluoranthene	600	5,100
Chrysene	384	2800
2-methylnapthalene	70	670
Pyrene	665	2600
High Molecular Weight PAHs	1700	9600
Total PAH	4 000	45,000
Tributyltin (as Sn)####	5 µg Sn/kg	70µg Sn/kg
RADIONUCLIDES**	35 Bq/g	35 Bq/g

*Source:Long et al 1995, as modified by Batley, 1997, except where noted, rounded to 2 significant figures

** maximum specified by Australian legislation (Bq/g is becquerels per gram)

*** Normalised to 1% total organic carbon. If the sediment organic carbon content is markedly different from 1%, the TBT value measured should be adjusted accordingly. Normalisation is only appropriate over the TOC range 0.2-10% (equates to multiplication factors of 5 times-0.1 times, respectively. Outside this range, use the end value which applies (eg for less than 0.2% TOC, use 5 times the TBT value measured).

For other metals, compare to background levels at disposal site

Sediments in eastern Australia commonly have high natural levels of As

Batley, 1997, pers. comm

@ Screening level is below Practical Quantitation Limit (**Table 3**). If detected, these substances are present at above Screening Level and must be assessed accordingly.

The statistical analysis relating to the Steps 1 to 6 set out below aims to determine whether or not the level of any contaminant exceeds the Guideline values (see the extracted NODG Table 5 above). In accordance with general practice in Australia, as set out in NSW EPA's widely used Sampling Design Guidelines (1995), the upper 95% confidence limit of the mean (95% UCL) is used to determine compliance. If the 95% UCL for a contaminant does not exceed the Guideline value, this means that there is a 95% probability that the mean concentration of the contaminant in the dredge spoil will not exceed the Guideline value.

For the dredge area, or for a distinct site or zone within the area, the mean and standard deviation are calculated, and the upper 95% confidence limit of the mean determined. A Guideline value is exceeded if the upper 95% confidence limit of the mean exceeds the specified value. Where the data are normally distributed, the arithmetic mean is employed. If the data are log-normally distributed, the geometric mean is appropriate. Values less than the Practical Quantitation Limit (PQL) are entered as half the PQL.

EPA NSW (1995) sets out the procedures in detail and includes worked examples.

The NODG procedures for carrying out the comparison of study results with the guidelines, and NODG procedures for dealing with "Hot Spots" must also be understood. The NODG clearly intends that materials found to be acutely toxic are not suitable for unconfined ocean disposal. Turning to consider what the guidelines mean by confined and unconfined disposal, they refer to confined disposal in the following terms:

Disposal of material in a location where transport away from the disposal site is minimised; and contaminated material is covered with a layer of dredged material that is of acceptable quality for unconfined ocean disposal and of an appropriate thickness such that burrowing organisms would be unable to reach the contaminated material[86].

The London Convention specifically excludes diluting pollution as a means to dispose of contaminated material. There will always be a fine line to be drawn between what constitutes 'dilution' (ie the wilful intermixing of sediments to reduce relevant material concentrations) and what constitutes a practical response to recovery (ie the minimum body of material that can practically be identified and separately managed). Where it is feasible to separately handle and properly dispose of a pollution 'hot spot' (that is a contaminated layer or area exceeding the Guidelines set out above), it is clearly best practice that this should be done. However, in some circumstances it may not be feasible to closely locate and remove the contaminated material, in which case it would be permissible to dispose of it with uncontaminated material if, when combined, the two materials met the guidelines set out above.

For comparison, the general requirements of the Victorian EPA BPEMG are also set out below. The BPEMGD EPA refers to disposal of spoil from the Yarra in the light of some knowledge of the history of its uses and dredging processes. It states a preference for disposal to land. It should also be noted that in calling up the ANZECC 1998 Ocean Disposal Guidelines, the BPEMGD is not seeking to supplant or exclude the NODG: very much the reverse. The NODG is a successor document to the ANZECC reference. In best practice terms, it would therefore be untenable to continue to refer to the detail of the ANZECC reference, when that has been relevantly supplanted by the NODG.

[86] From NODG Appendix 2: Glossary at Pg 100.

Figure 3: NODG Summary Steps for Assessment of Sediment Quality[87]

` NODG Summary

Step 1. Compare contaminant concentrations to the relevant Screening Level in Table 5, using the upper 95% confidence limit of the mean (95%UCL) as set out in Section 3.10.5. For organics, first normalize to TOC content. If the 95%UCL values for all substances are below the Screening Level, it is unlikely that sediment contaminants will have adverse effects on organisms living in or on that sediment. The sediment is considered to be *non-toxic* and there are no chemical obstacles to ocean disposal.

Note that for the organochlorines dieldrin, chlordane, lindane and endrin, the Screening Levels are below the Practical Quantitation Limit. If detected, these substances are therefore present at above the Screening Level and must be assessed accordingly.

Step 2. If the 95%UCL value for any contaminant lies above the Screening Level in Table 5, compare that value to the current background concentrations for the disposal site. Background concentrations are the ambient levels in sediment in the vicinity of the disposal site, but unaffected by disposal at the site.

They will be different to the natural levels if there is any level of contamination in the area. Ambient background concentrations can be determined either by (a) sampling of a new site prior to disposal; or (b) sampling of sediment at reference areas in the vicinity of the disposal site, but beyond the dispersion pattern of dumped sediment.

For naturally occurring elements, such as heavy metals, normalising to a reference element enables a better determination of background level to be made.

If above background levels, the sediment is *potentially toxic*. Proceed to Step 3.

Step 3. Carry out elutriate testing and compare data to the relevant ANZECC/ARMCANZ 2000 marine water quality guidelines

If all contaminants are below the relevant guidelines after initial dilution, effects on water column organisms would not be expected during disposal, however, effects on benthic organisms after disposal must still be evaluated.

Proceed to Step 4. If any contaminant is above the relevant guideline after initial dilution, effects on water column organisms could occur during disposal. The proponent would need to investigate disposal controls (Figure 2 and Section 4.2.3). If these prove effective in reducing water column contamination to acceptable levels, proceed to Step 4. If not, the material is unacceptable for ocean disposal, as it would have significant impacts on water column organisms and water quality.

Step 4. If the 95%UCL value for any contaminant lies above the Screening Level in Table 5, *and* above the background level as determined in Step 2, investigate factors controlling bioavailability (Section 3.10.4). Most tests presently relate to metals, although pore water analysis is relevant to all contaminants. If these studies indicate that the bioavailability of the relevant contaminants is acceptably low, the spoil is classified as *non-toxic* and is acceptable for ocean disposal. If the bioavailability is above acceptable limits (criteria set out in Section 3.10.4) the sediment is *potentially toxic*. Proceed to Step 5 (except for TBT19).

If mean TBT levels are above 95%UCL Guideline Maximum values (Table 5), are bioavailable, and no appropriate toxicity tests are available, the sediment must be considered to be *toxic* and is unacceptable for ocean disposal.

[87] Source: NODG at Pgs 58-60.

NODG Step 5. This step involves acute toxicity testing as set out in Section 3.8. If the sediment is not found to be acutely toxic, proceed to Step 6.

If.the sediment is acutely *toxic*, it is unacceptable for unconfined ocean disposal.

The values for TBT in Table 5 are based on chronic effects, so there is no point to doing standard toxicity testing on these samples (Section 3.8). If TBT-appropriate toxicity tests are not available the sediment must be considered contaminated

NODG Step 6. This step involves sub-acute and/or chronic toxicity testing, as set out in Section 3.8. If the sediment is not found to be toxic, it is acceptable for ocean disposal. If the sediment is *toxic*, it is unacceptable for unconfined ocean disposal.

For *toxic* sediments (Steps 4, 5 or 6), should the proponent still wish to consider ocean disposal, they would need to investigate management options (treatment, control measures, confined disposal etc) to determine if impacts can be successfully mitigated (Figure 2 and Section 4.3

If impacts cannot be mitigated, the material is unacceptable for ocean disposal.

Note:

Whilst the NODG sets out its analytic requirements in the form of a decision tree, there is no requirement that the strict order of the tree always be adhered to. If for example one decided to undertake a Step 5 acute toxicity test and a sediment body is found to be acutely toxic, the entire body can then be managed in that class. It will not be necessary to return to the previous steps in the decision tree.

Figure 4: BPEMGD Summary Steps for Assessment of Sediment Quality

BPEMGD

In the urban lower reaches of the Yarra River, dredge spoil has periodically been discharged to the fast-flowing central section of the river. This practice results in these sediments being dredged again sometime later from shipping channels in the port area and should be avoided. Where feasible, sediments from the urban lower reaches of the Yarra should be disposed to land.

The contamination status of the site to be dredged must be established prior to dredging. The history of uses that may contribute to contamination of sediments in the area must be documented and previous analyses of contamination or dredging at the site summarised.

Typically, the concentration of a range of organic and heavy metal contaminants on the site to be dredged must be measured before dredging commences. The choice of contaminants to be measured will be based on the site history and the volume of material to be dredged. Proponents must ensure that the suite of contaminants analysed and the intensity of sampling adequately characterise the area to be dredged.

The sediment quality guidelines for aquatic disposal are based on measured toxic effects and are based primarily on the interim ANZECC ocean disposal guidelines (ANZECC 1998). Levels of contamination in sediment should be compared with both the low and high screening levels specified in the interim ANZECC ocean disposal guidelines and the background levels in the area (table 12). A low screening level is the concentration of a contaminant where toxic effects occur rarely (10 per cent of studies), while at the maximum screening level, toxic effects are common (occur in 50 per cent of studies). Note that guidelines for sea disposal are based on measured toxicity of contaminants to aquatic organisms.

The interim ANZECC ocean disposal guidelines classify sediments into one of three categories. Where the geometric means of all contaminants are below the low screening level sediments are considered clean and suitable for disposal at sea.

Where contaminant levels exceed the low screening level (or twice the background level for those sediments with high background values) but are below the maximum screening level, sediment is considered moderately contaminated. Its suitability for disposal at sea then needs to be established by further testing. If analyses indicate trace metals exceeding the low screening level, further metal analyses should be conducted using dilute acid extraction

Once suitable sediment toxicity tests are developed for local species, toxicity tests are likely to be required for all sediments classified as moderately or highly contaminated. There are no tests yet approved for this purpose in Australia, but tests are currently being developed. Until suitable tests are developed the acceptability of mildly contaminated spoil for unconfined sea disposal will be determined based on the practicality and likely cost of the alternatives, and the likelihood of significant toxicity based on the number of contaminants and the extent to which the low screening level is exceeded by each.

Panel Response

Having set out the basic provisions of the guidelines, it is then necessary to understand what was done in response to these by the proponent. This encompasses an analysis of relevant field and laboratory procedures, as provided for in the guidelines and as implemented.

Study of the sediments to be dredged requires the establishment of a carefully planned sampling program, collection of the samples, then well a well-managed analysis regime with a high level of laboratory quality control. Environmental sample analyses generally work near the limit of material detection using even the most modern methods. It is essential to pay close attention to relevant protocols to avoid sample damage in the field and in transport to the laboratory. Sound storage and timing protocols must be adhered to for the same reasons. Analysis itself demands a high level of skill from the laboratory staff and good understanding of the requirements of the program manager.

Submissions and particularly that of Dr Roberts were concerned that relevant protocols had not been adhered to. For this reason, the Panel has examined the laboratory quality control regime in place, starting with the basic requirements set out in the NODG.

A sound starting point is for the laboratory to demonstrate that it achieves accurate results consistently for the type of samples being analysed. This is done by analysing Standard Reference Materials (SRMs). These are commercially available sediments that have been rigorously analysed using a range of different methods so that the certified composition is well established. The NODG requires that an SRM be analysed with every batch of samples. The results for the SRM should then be examined and if they differ from the certified value by more than a margin agreed with the client, this should be reported.

The reproduction of results of repeat analyses of any sediment sample is measured in the agreement among replicate analyses of the same sediment. The NODG requirement is that in each batch of samples at least one be analysed in duplicate. The agreement of any duplicate (or indeed triplicate or other multiple) analyses should be reported systematically. This gives the project manager a clear idea of the precision of the analyses for each batch.

There is no evidence in the documentation that these fundamental requirements were met in the program before the Panel. Consequently, the accuracy and precision of the analytical results is open to question as it is not referenced to accepted norms and standard controls against analytical error have been removed.

On cross-examination, the manager of the sediment chemistry program indicated that he was unaware of the role of SRMs and went as far as stating a view that they were inappropriate for use in this type of work.

The Panel has examined the level of quality control in the sediment chemistry program relating to precision. A parameter examined was the level of organic carbon (TOC) in each sediment. This is of critical importance. When any organic compound is measured in sediments, the concentration is adjusted in proportion to the total organic carbon in the same sample. They are all adjusted to what they would be if the TOC was present at 1% by dry weight.

Examination of the results for triplicate analyses of sediment samples used to assess the precision on the determination of TOC (Table 4.3, p 56 of the Stage 2 Report) revealed that the precision was grossly inadequate. If this level of precision is to be taken as representative of the performance of the method, then the TOC concentrations reported for all organic contaminants are uncertain. They may be substantially in error.

Dr Roberts drew attention to the fact that some samples were analyses for unstable components after expiry of the recommended storage time limit in the guidelines.

It appears to the Panel that there have been sufficient analysis method and quality control shortfalls to cast considerable doubt on the suite of analyses undertaken to date.

The Panel recommends as follows:

A new analytical chemistry strategy must be devised, based on sound statistical and quality control principles. This should incorporate rigorous management oversight extending to matters of detail. It should ensure performance that meets NODG requirements as a minimum. An external peer review process should be devised to provide necessary additional assurance.

A new program of sampling and analysis incorporating the strategies from the two previous recommendations above should be implemented, to respond to the serious deficiencies in the sampling, handling and analysis of samples reported in the Stage 1 and Stage 2 reports. The Panel considers that this program can only incorporate data from the Stage 1 and Stage 2 reports with the utmost care and attention to methodological and quality control considerations.

Examining the interaction between the NODG and the BPEMGD, the Panel notes that the NODG contain the stricter requirement in that they require comparison of the 95% UCL of the geometric mean of the concentration of each contaminant with the screening levels in the Guidelines. The BPEMGD do not contain this requirement. The screening levels are identical in both documents. Further, the BPEMGD do not contain detailed procedures for toxicity testing and defer to a predecessor to the NODG document. In best practice terms, the NODG is clearly the later and more clearly defined source which the Panel, pursuant to the direction provided by the Assessment Guidelines, considers should apply.

The Stage 2 Report page 10 states:

> *3.3.5 Guidelines for Disposal*
>
> *The following assessment against the sediment quality guidelines was undertaken:*
>
> *In accordance with the National Ocean Disposal Guidelines (Environment Australia,2002), where the concentrations were reported above the minimum screening level, the 95% Upper Confidence Limit (UCL) of the mean was also used to investigate whether sediments were toxic. The 95% UCL was compared to the derived background concentrations, determined for analytes that were reported at naturally elevated concentrations.*

The methodological issues outlined above are such that the Panel does not consider that this work has achieved the necessary results. The analysis cannot from a statistical perspective soundly derive the 95% UCL of the mean. Any 95%UCL value will be higher than the mean for the same data set. The Panel cannot estimate how much higher and consequently cannot assume that no results will rise above the Maximum screening levels in the NODG and requiring the sediments to be classified as highly contaminated on chemical rather than toxicity considerations.

The Panel recommends;

The new program recommended above should ensure that the sampling and analysis is conducted in a manner that permits implementation of the NODG requirement to compare 95% upper confidence limits (UCL) of mean concentrations of contaminants in the sediment with the appropriate screening levels.

9.3.7 SEDIMENT TOXICITY RESULTS

Discussion

The Stage 2 Report describes toxicity tests carried out generally in accordance with steps set out in the dredge spoil assessment framework for ocean disposal in the NODG Figure 1 at page 21.

Dilute acid-extractable metals

Dilute acid-extractable metals (AEM) analyses were carried out on nine sediment samples.

Two samples (BH 47 0.9-1.2m and DC 32 1m) contained lead above the lower screening level, and these were only slightly above.

The results of analyses of the corresponding whole sediments gave results for lead below the lower screening level.

Elutriate Tests

Two composite samples were prepared from sediments from each of three management Zones 2, 3 and 5. This gave a total of six samples for toxicity testing.

Sediment and seawater were mixed and the seawater was then separated. This seawater was analysed for some metals and for ammonia. Results are summarised in Table 4.3 of the Stage 2 Report at page 58. The concentrations of the metals extracted into the elutriates were compared with guideline values in the BPEMGD. For each element tested the number of samples, out of six, that exceeded the guideline values is listed in the table below:

Table 21: Elutriate Tests: BPEMGD Guideline Value Excellences

Analyte	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn	Ammonia
Number exceeding criteria	6	0	6	6	6	2	0	3	1
Total number of test samples was 6 Organochlorine pesticide values were all less than the limit of detection of the method used.									

All of the sediment composites tested contained a number of contaminants that were extracted to a significant degree when the sediment was mixed with seawater.

The elutriate water described above was also examined for toxicity using two organisms

- Diatom Nitzschia closterium
- Sea urchin larvae Heliocidaris tuberculata

These organisms were placed in elutriate water that had been diluted serially from 100, 50, 25, 12.5 and 6.25 percent with clean seawater.

The results showed that none of the elutriates inhibited growth of the diatom. In some cases growth was increased, probably due to increased nutrients.

The sediment elutriates did not induce toxicity related effects upon sea urchin larval development.

Whole of sediment

The six composite sediment samples from zones 2, 3 and 5 were also used for whole of sediment toxicity testing. Whole sediment was mixed with clean seawater then allowed to settle. Larvae of the amphipod *Melita plumulosa* were placed in the water above the sediment. For each sediment there were four (5 for the control) replicate tests each with 20 organisms and survival after 10 days was observed.

The mean percentage amphipod survival (and standard deviation) for each composite sediment after ten days exposure is tabulated:

Table 22: Whole of Sediment Test: Mean percentage Amphipod Survival

Site	MU2S1	MU2S2	MU3S1	MU3S2	MU5S1	MU5S2	Control
Survival %	55 ± 7	24 ± 25	45 ± 9	49 ± 6	43 ± 6	39 ± 3	99 ± 2

The toxicities of the sediments from the three Management Zones appear to be similar.

Average survival rate for each composite sediment was in the range 24 to 55%.

The report states:

> *Juvenile amphipod survivorship in the control sediment treatment group was 99%, whereas in the test sediments the percentage survival ranged from 24% to 55%.*
>
> *The sediment samples tested were found to affect the survival of the juvenile life stage of the benthic amphipod, M plumosa. It was evident that the sediment contained a wide range of contaminants, which may exert undesirable toxicological effects upon benthic infauna at the proposed spoil ground location.*
>
> *Studies undertaken by CSIRO with M. plumulosa have indicated that sediment is the greatest uptake pathway for inorganic contaminants, when compared to the uptake from overlying water and pore water.*

The report contains no discussion of the significance of the survival rates of the organisms exposed to the sediment as against the survival rate in the control samples.

The Significance of the Testing

Results of elutriate testing show that contaminant metals are extracted from sediments into seawater to concentrations above thresholds for concern.

Organism tests with the elutriate indicated no adverse outcomes for diatom or sea urchin larvae.

Toxicity testing using whole sediment and juvenile amphipods (sand hoppers) showed the sediment to be acutely toxic. These results were not prominently featured in the EES summary documents.

The Stage 2 Report appears to find that the additional sediment sampling and analysis does not change the assessment stated in the EES. No tightening of the disposal strategy is proposed.

Sediments from management Unit 1 are classified as uncontaminated. Sediments from Management Units 2, 3, 4 and 5 are all still described as moderately contaminated despite being found to be acutely toxic.

Hotspots are identified in Management Units, 3, 4 and 5. These contain elevated levels of some contaminants. The recommended procedure for dealing with these contaminated sediments (Stage 2 Report, p 40) is;

> *The dredging contractor will be required to manage these 'hotspots'*

The identification of acute toxicity in composite sediments from Management Units 2, 3 and 5 has not resulted in any change in the classification assigned to these sediments. The NODG (p 41) appears to require that these sediments be designated as highly contaminated and considered toxic.

The Stage 2 Report continues with the recommendation of the EES report that these sediments are suitable for disposal to the present northern spoil site in Port Phillip Bay, provided that the material is isolated by capping.

According to Boskalis capping is not feasible. This arises because the spoil from these units will be fluidised as a result of the chosen dredging method, using a trailing suction hopper dredger with non-overflow. Confinement of the spoil by underwater bunding is the current proposed solution to disposal of the "moderately contaminated" spoil.

That being said, the NODG refers to toxic material as unsuitable for unconfined ocean dumping. It states that management options should be examined and these include confinement and capping.

Panel Response

The exhibited EES does not consider NODG compliance. It refers mainly to requirements in the BPEMGD and in particular to the view that the sediments from the Yarra are "moderately contaminated material" on the basis that this may somehow entitle the proponent to undertake uncapped marine disposal. However, the Panel understands that the claim that sediments in the Yarra can be described as "moderately contaminated" in terms of the BPEMGD has not been shown.

In fact, having regard to the whole of sediment testing, (which in comparison with other test procedures appears to have been appropriately conducted), the Panel considers that the only clear finding that can be made in relation to materials from management units 2, 3 and 5 is that they are acutely toxic. According to the NODG, this leads to a definition of all of the sediment from these units as being highly contaminated. The guidelines require that one should then proceed to consider management of the material using confined ocean disposal, methods, which are demonstrated to satisfactorily mitigate the toxicity.

These results support the view that any proposal for marine disposal of the sediment must be based on a procedure giving long-term security. The Panel must strongly emphasise its view that the poorly documented proposal for containment using an uncompacted bund deposited on unstable spoil in shallow water and with the toxic sediment exposed to the overlying seawater does not meet this long-term security requirement.

The Panel's main concerns in this regard are that the NODG calls for such materials to be dealt with by way of a confined disposal mechanism, demonstrated to effectively mitigate impacts, to the satisfaction of the approval authority. In circumstances where a whole of sediment test led to amphipod death, a proposal for uncapped bunding must demonstrate that it is nevertheless able to control/prevent such effects. The Panel cannot see how there would be any practical means whereby the material could remain uncapped and resolve the concern generated by the failure of the whole of sediment test. To add further emphasis to this position, it should again be noted that the bunded disposal proposal is not a form of confined ocean disposal for the purposes of the NODG. It does not have a layer of clean fill above it, sufficient to prevent bioturbation by benthic organisms.

Continuing on this theme, the Panel considers that placement of a large volume of sediment classified as highly contaminated, in open contact with the waters of Port Phillip Bay poses an unacceptable environmental risk. There could be food chain contact between benthic organisms contaminated by contact with the toxic sediment and predators in the overlying water.

The risk is increased by the waters of the disposal site being shallow, so that there is a possibility of some sediment being moved out of the bunded area by wave action. Dr Provis for the proponent suggested that this would not be an issue, as the fetch of bay waves was insufficient to produce routine wave motion at –15m. However, the Panel notes that some level of wave motion at this depth may still occur. Secondly and far more critically, it notes that the proposed disposal location is not proposed to be in an exclusion zone for shipping. The passage of shipping over an uncapped repository poses unconsidered and uncontrolled issues of re-suspension. Finally, the PPBES did note but leave unexplained some significant current spikes at depth in the bay. Dr Provis considered it was sufficient to explain these with reference to logger malfunctions, ship or fauna movements. Dr Graham Harris (formerly of CSIRO) took the strong view that it was scientifically necessary to exclude the impact of such spikes far more conclusively, where the risk posed was the remobilisation of toxic sediments.

The Panel has concerns that the under water bund described in outline would in all likelihood be or become unstable and not retain its integrity over many years. In such circumstances, fluidised toxic material would spread to the Bay. Toxicity from metals does not decrease with time. Organic compounds are also long lived. Reference to global practice suggests that whilst bunds have been used for confinement purposes, they have tended to be constructed above the water and to be consolidated to reduce permeability. Neither step is proposed here. Alternatively, containment has been effected using natural depressions, or in pits dredged in the sea bed. These methods have the virtue of being less exposed to marine morphological/transport processes. Even if the bund was capable of being capped, the Panel would retain concerns about the medium to long term integrity of an exposed but unconsolidated containment structure.

It follows in the Panel's mind that any marine confinement needs to be complete and not simply confinement round the edges, and the effective duration of confinement needs to be very much longer than the thirty year time span envisaged in the project concept. However, to achieve such requirements, it will be necessary to reconsider the choice of dredging technology in the Yarra, with the objective of delivering the materials to the DMG in an un-fluidised condition capable of capping with clean fill. If this cannot be achieved, consideration will require to be given to some form of de-watering treatment for the fluidised materials, possibly in turn leading to land based disposal. These options might also require consideration in the context of better characterisation, such that the volumes of acutely toxic materials can be better understood, and the Panel would hope, considerably reduced.

The Panel recommends as follows:

The results of whole of sediment toxicity testing to date show the Yarra sediment to be acutely toxic, leading to an NODG classification of 'highly contaminated'. This eliminates the option of open marine disposal for most of this sediment and necessitates development of more expensive and complex management solutions. For this reason, it is important that the Yarra sediments should be examined in more detail, to determine the distribution of toxic material and contamination hotspots. A more comprehensive, flexible and targeted sampling strategy should inform the development of a wider choice of disposal methods.

Using better information, the disposal strategy should be re-examined with a view to considering separate disposal methods for highly contaminated, moderately contaminated and uncontaminated materials. Different approaches to work scheduling and disposal scheduling should also be considered.

It is most important that any new disposal strategy is considered in an integrated fashion to ensure that it delivers an appropriate waste hierarchy solution and meets other environmental requirements, especially the need to control turbidity.

9.4 PROJECT IMPLICATIONS

Panel Response

The Panel now turns to consider the implications of these findings and recommendations for the delivery of the project overall. The range of approaches that will require to be considered cannot be specified too closely until the results of new analysis are to hand. However, it will be necessary to consider the following.

- What bodies of existing Yarra sediments require to be disposed of to land?
- What sediment volumes are under consideration for this means of disposal?
- What does this imply in terms of de-watering, holding, land transport, disposal locations and processing for disposal?
- Will there be any significant effects that also require impact assessment, such as the designation of truck routes for the movement of large volumes of materials or the selection, designation, acquisition and management of new land disposal sites?
- What bodies of existing Yarra sediments require to be disposed of in the marine environment?

- Do they require to be confined, inclusive of capping?
- By what means will they be dredged?
- Will the dredging techniques enable storage of the sediments such that they can be capped (if required) or such that re-suspension or flow will be minimised (if they are not capped)?

It can be seen that the interaction between these factors has the potential to be significant cost drivers and the project and may well impel the consideration of other strategic project configuration options. For example:

- Is it strictly necessary to dredge the entirety of the Yarra at all? There are sound environmental and cost arguments for avoiding or minimising a Yarra dredge. One cost benefit response to Yarra sediments could be to excise components of the river from the deepening program, accepting that the Port facilities may develop into upstream (shallow draught) and downstream (deep draught) segments. This might imply a shift of land use in current port functions (as for example some inherently deeper draught containerised shipping facilities are currently upstream, whereas some shallow draught functions such as car shipping are downstream).
- Alternatively, could the project be subdivided into immediate and medium term components? Is it strictly necessary to dredge the entirety of the Yarra immediately?
- Could (for example) Webb Dock be nominated as an immediate location for developing deep draught facilities, with the deeper channel extended up-stream later, subject to a more detailed analysis of port requirements against costs?
- Similarly, even if immediate deep draught access to Swanson Dock was to be provided, would this also be required to continue upstream to Appleton Dock?

This does not pretend to be a holistic consideration of the available options. However, suffice it to say that the balance of cost and benefit in handling Yarra sediments may suggest some further, cost reducing but yet still operationally attractive and viable options that have not been considered in the EES. Such a strategic re-evaluation would clearly appear to be the most soundly and rationally based response to the issues at hand.

Similarly, the Panel notes that decisions about the balance of land based versus DMG disposal may require a similar strategic re-appraisal of dredge technology, disposal sites and options. For example:

- A possible strategy is that adopted in Antwerp and described in Chapter 11of this report – low turbidity, low dilution dredging using a cutter-type dredge that minimises mixing of sediment and water. Contaminated material being disposed of in a deep hole dredged in an area of clean sediment in the sea floor. The material would be suitable for capping and should be capped with clean spoil.
- The Port of Melbourne DMG may not necessarily be the appropriate for a pit as it needs to be located on clean sediment. This has not been examined in the EES.

9.5 SUMMARY

The Panel has concerns as to the body of sediment chemistry work relating to all stages from sampling through analysis to interpretation. The Panel sets its findings out in sequence below.

- The design of the sediment sampling strategy was poor and poorly communicated. The Panel cannot assess the sampling strategy as it is not clear what it was. It considers that the proponent was unclear as to what its sampling strategy was and did not understand the consequences of designing a significant body of work, based on an unresolved approach.

- A preliminary body of work of measuring the depth and mapping the distribution of the potentially contaminated silt layer in the Yarra was not done.
- The volume of material to be dredged in the silt and clay layers was not clear and the Panel was given figures that changed frequently during the hearing.
- As a result of both the above consideration and the more fundamental issue that the proponent appeared not actively to seek compliance, the number of sediment sample sites required to meet the minimum requirements of the NODG was not correctly assessed.
- It appears that the number of sites sampled is too few to permit assessment of sediment quality according to the NODG.
- The sample sites appear to under-represent the silt material towards the edges of the channel where it is likely that much of the silt would be located and where contamination from local activities would be greatest.
- Many of the sample cores collected were not analysed for all contaminants at depths below 0.6m, which is less than the proposed dredge depth.
- The range of contaminants measured was arbitrary and there was no study of the history of the catchment to assess what other contaminants may be present.
- The quality control of the analytical process was inadequate.
- The concentration of organic contaminants in sediments is required to be normalised to a total organic carbon content (TOC) of 1%. This requires that the TOC in every sample needs to be accurately known. The quality control results show that the reproducibility of the TOC values is inadequate for the task.
- The geometric mean concentration for each contaminant and not the higher 95% upper confidence limit of this mean was compared with the screening levels in the guidelines.

It is therefore not shown that the sediment recovered from the Yarra (or any part of it) will clearly be ‘moderately contaminated’. It is not shown that it will not be ‘toxic’ within the meaning contained in the NODG.

Furthermore, having regard to the results of whole of sediment testing, (in which the Panel has greater confidence), it is suggested that the sediment to be recovered is likely to be acutely toxic; certainly if treated as a whole, into which sediment from both hot spot and less contaminated locations are sought to be combined.

Should this approach of combining sediments continue, it would suggest that very considerable volumes of sediment would require the application of a much more rigorous treatment and disposal strategy than that currently proposed. However, it must be noted that such combination is typically not supported in the ocean disposal literature and is certainly not best practice.

In best practice terms, the Panel considers that the proponent should seek to identify hotspots, to segregate them, and enable these to be managed to the appropriate level of precaution suggested by the guidelines.

This combination of findings suggests that it will be necessary to re-evaluate the sediment chemistry work from the first principles of sampling strategy, to ensure that errors in the work undertaken to date are not unwittingly propagated forward into new work. The new work should be capable of enabling hotspot identification.

Whilst it is only speculation at this stage, the Panel considers that it is conceivable that the new work might enable disposal of moderately contaminated materials in a DMG subject to appropriate management (and consideration of turbidity issues), with a lesser amount of toxic highly contaminated material required to be managed on land.

The balance between the amounts of these two materials will be a critical driver of the choice of dredging and disposal options. It will also bear strongly on project costs, which cannot be considered as being in any way secure until this work has been done.

10. DISPOSAL & DREDGE EQUIPMENT

Intuitively, one tends to commence considering these issues by examining the actual dredge technology and then to move to consideration of the means of dredged material disposal. However, in the Panel's view, such an approach places the cart before the horse. The production of volumes of dredged material, disposal and management of it is a major outcome of dredging works. The degree to which dredging conforms to best practice and/or is environmentally appropriate will depend primarily on the approach taken to spoil disposal and management. For this reason, there is considerable virtue in the practice of commencing with an examination of spoil disposal, defining some broad measures of a desired outcome and then turning to the portfolio of dredge equipment available, to measure the degree to which it assists in delivering the desired outcome.

Following this logic, this section addresses the following issues that are relevant to the Minister for Planning's decision:

- The means of dredged material disposal management are considered and the proposed method is outlined.
- Alternative dredging equipment is considered and the proposed suite is outlined.

Where relevant, comparisons are made with global practice examples to assist in determining the degree to which the project utilises best practice.

In examining dredging technology, it is also relevant to consider some 'special cases' that emerge from this project, involving responses to conditions and issues that are not typically found in major dredge projects and can provide some justification for special action.

10.1 SPOIL DISPOSAL

This section commences with an examination of a key policy direction emerging from SEPP and BPEMGD guidance: the proposal that in any give dredge project, one seeks to minimise the need to generate spoil for disposal. When avoidance is optimised and one still has material to manage, one examines beneficial uses of the dredged material. When beneficial use is optimised and one still has material to manage, disposal options can then enter the frame.

For these reasons, this section examines the following issues:

- Approaches to minimising dredge volume.
- The potential to use dredged material as a resource.
- Disposal as a waste.
- Proposed disposal arrangements.

10.1.1 MINIMISING THE DREDGE VOLUME

Discussion

A number of submitters were concerned that the project before the Panel did not as a matter of principle appear to seek to minimise the volume of material to be dredged. These concerns were both environmental and economic. In environmental terms, the scope for reducing adverse impacts by reducing the volume of material to be handled was highlighted. In economic terms, reduced handling had the potential to translate into reduced project costs. If reduced handling opportunities were insufficiently identified, there would be potential for the project cost to be reduced against a retained project benefit: in short, it was suggested that the project had not been optimised.

Panel Response

Little effort has been demonstrated in the EES that the proponent has sought to minimise dredging in the Bay, whilst still meeting the project aim of allowing deeper draught vessels into the Bay.

The minimisation of dredging is not stated as an objective of the PoMC. It is not stated in the:

- environmental policy for the port;
- as an objective of the project; or
- as an objective of the EMP.

Further, there is no evidence of a holistic, formalised channel alignment evaluation process, whereby options to change channel alignments to reduce capital dredge volumes or nor of a review optimising the balance of overdredging and maintenance. Apart from a reference to a decision to drop the13 m assumption because it would *duplicate environmental impacts*[88], there does not appear to have been an evaluation of how to best distribute the expected volume of dredging over the project time frame.

The proponent could for instance have developed a series of planning scenarios to meet a staged introduction of the project. This would also allow time for the port to schedule future developments such as the expansion of Webb Dock into the project framework.

The proponent could also have included dynamic underkeel clearance models or similar into these scenarios with the aim of minimising dredging requirements.

On an even simpler level; the channels are located broadly where they have been for many years. This does not necessarily mean that they are in the optimum location for dredge volume minimisation. The decision to marginally realign a section of the Port of Melbourne Channel to avoid the need to relocate expensive infrastructure (the Ethane Pipeline) and thereby also avoiding some dredging is an example of the approach to project strategy that appears to be missing elsewhere in the project.

[88] EES Volume 1 at Pg S5-13

Panel finds that the proponent has not

- systematically sought to minimise dredging associated with the project;
- systematically reviewed channel alignments to minimise dredging requirements;
- undertaken a significant assessment of the staged introduction of the project; or
- included options such as DUKC as part of the environmental assessment

The proponent has not demonstrated that the dredging proposed is the minimum required to achieve the project objective. They should do so before the environmental impact of the project is assessed.

10.1.2 DREDGED MATERIALS AS A RESOURCE

Discussion

Flowing from concerns about minimisation, even should it be demonstrated that minimisation had been achieved, a number of submitters and particularly the EPA were concerned that insufficient attention had been paid to the potential for the beneficial re-use of dredged materials. Options referred to in submissions included:

- municipalities raising the potential for clean fill to be used in major beach renourishment works around the bay; and
- yachting and development interests raising the potential for the creation of one or more artificial islands in the bay, for development, to act as a recreational boating destination and safe harbour or to provide additional wetland/shorebird habitat.

Panel Response

Rather than just being dumped as a costly and environmentally impacting waste, some dredged material can be used as a resource for a variety of purposes or 'beneficial uses'. Beneficial use projects can provide benefits to the community which go far beyond the original purpose of the dredging. The US Army Corps of Engineers, NODG, and the EPA BPEMGD all list a range of beneficial uses that dredged material can be used for depending on their nature including:

- beach renourishment;
- shore and land protection works;
- land reclamation;
- land improvement;
- wetland restoration;
- development of wildlife habitat;
- construction materials and industrial use;
- topsoil; and
- capping and lining materials for landfill.

It is acknowledged, and accepted by mature dredging organisations throughout the world, that the use of dredge material as a resource may involve an intermediate stage of drying at a 'rehandling' facility. Depending on the contamination status of the materials it may also have to be treated prior to reuse. It must also be recognised that some contaminated materials may require to be permanently isolated or 'confined', away from the aquatic environment.

The Panel finds that the evaluation of dredged materials as a resource is consistent with the spirit of the London Convention, the NODG and BPEMGD. With reference to overseas projects it does represent 'best practice'. A more than merely cursory evaluation of the potential for it would be in the interests of the Victorian community.

The Main Volume of the EES makes a number of very limited claims about having assessed the use of spoil material as a resource. However, the Panel is clear that this assessment was not done in detail. Nor were outcomes from it apparently considered on equal terms with the currently proposed and clearly strongly preferred full disposal option. The various options cited such as beach renourishment, environmental habitats, use by industry, extending Webb Dock, garden soil and land based placement are only documented most sparsely in the background EES consultant reports. The Panel cannot avoid the conclusion that these were treated as 'shadow options', to be cycled through swiftly in the EES process, merely as a means of demonstrating some level of attention to obvious policy and best practice drivers, without ever properly scoping potentially practicable alternative use options.

Also, despite a detailed submission of the EPA to the effect that this issue required further attention, requests from other submitters and questions from the Panel, little further information was forthcoming.

One exception to this position was the work carried out in relation to an environmental island. Hydrodynamic and coastal process evaluations were undertaken, which led to a conclusion that an island in one location was not a preferred DMG solution. However, the Panel takes the view that this evaluation was largely oriented towards the resolution of a political issue: namely that artificial island solutions have not received widespread community support and so were seen as a liability to be dispensed with, as opposed to as an option for fuller assessment. If the latter approach had been taken, the Panel argues that a range of siting options might have been considered. It notes the geomorphological and coastal process evidence of Mr Gerry Byrne for the proponent to the extent that the use of dredged material to generate economically useful and/or environmentally valuable land at some point in the bay was likely to be technically feasible, but had been ruled out.

The Panel considers that this issue of an 'artificial island' has become an artificial contrast of extremes, when this need not be the case. It notes the dreams of some for a mid bay 'harbour suburb' island. It notes the very strong views of others to the extent that such a proposal would be strongly opposed. It has some sympathy for a proponent unwittingly caught between these positions. However, by failing to examine land reclamation as an option, the Port has given away options that form a realistic and cost reductive means of dredged material management in many projects elsewhere. For example, expansion of the Port of Brisbane has used dredged material to impound an area of sea, which will provide for the future land requirements of the Port, together with a forward dredged material depository for many future years. The cost of dredging can then be offset against the development value created, whilst otherwise absent land based treatment options can be facilitated on the newly created land. However, no option of this nature (for example adjacent to Webb Dock) was considered in the EES.

The Panel notes that the proponent's witness Mr Byrne was of the opinion that clean sand dredged from the south could be readily used for beach renourishment.

Having found that only the most cursory and limited attempts to consider re-use have been made by the proponent, the Panel finds that the EES approach to dredged material re-use is not a best practice approach. It is not in compliance with the broad thrust of international, national and State policy.

It recommends as follows.

Following action to minimise the production of dredged materials, those required to be produced must be properly evaluated for use as a resource. Such evaluation should determine whether there is a practicable alternative to the proposed aquatic discharge, which would have less adverse impact on the aquatic ecosystem and might offer a greater balance of public benefit as against the cost of works. The aim of this evaluation should also be to develop implementation strategies and programs for using the spoil materials for particular projects.

10.1.3 DISPOSAL AS A WASTE

Discussion

Noting the issues discussed above, the EPA and other submitters remained concerned that, even if dredged material had been minimised and re-use options pursued or validly exhausted, the EES did not include a full evaluation of disposal options.

The proponent did evaluate a range of in bay DMG options. However, for reasons not fully apparent to the Panel, out of bay (ie Bass Strait) DMG options were not considered. Further, given the discussion of sediment chemistry issues above, land disposal was not evaluated.

DMG studies were also of a simple nature, confined to the mounding of materials in locations examined in relation to hydrodynamic, sediment transport and turbidity considerations, partially examined in relation to ecological considerations, but unexamined in terms of the condition of materials to be disposed of, flows and the like.

Of great concern to submitters such as Dr Simon Roberts was the fact that a detailed performance evaluation of the Port of Melbourne DMG proposed to receive what appeared to be acutely toxic materials had not taken place. Detailed evaluation of containment and confinement techniques for contaminated materials had also not taken place.

Panel Response

If the spoil is to be considered as a waste material then the available disposal options depends on a number of factors, the most important of which is whether or not the material is contaminated.

The main choices when disposing of spoil as a waste are:

- where the material can be placed (the acceptable location of the spoil ground), and
- acceptable placement techniques and controls

This section of the report examines the proponent's choice of disposal ground locations and whether or not material should be confined/contained. Additional discussion in relation to placement techniques and controls can also be found in the section 'Dredging Equipment' below.

Disposal location

There are three broad categories of spoil ground location available to the project: disposal to the ocean, disposal to confined waters (the Bay) and disposal to land. In principle, disposal to confined waters combines the largest assembly of potentially adverse impacts against the smallest range of benefits of the three methods.

It must be noted at the outset that the proponent did not undertake the assessment of two of the three categories of spoil ground location - land and ocean (see below).

Table 23: Disposal Options Assessed by Proponent for Spoil as a Waste

Spoil type Location of spoil ground	Contaminated spoil	Clean spoil
To land	Not assessed	Not assessed
To bay waters	Partly assessed	Assessed
To ocean (Bass Strait)	Not assessed	Not assessed

Land based disposal

Schedule F6 of SEPP (Waters of Victoria) specifies the beneficial uses of Port Phillip Bay that are to be protected. There is no specific exemption from the requirement to protect these beneficial uses within the dredge material grounds (DMGs).

Clause 13 requires that dredge spoil be disposed to land effectively wherever practicable and environmentally beneficial, and yet land based alternatives for the disposal of material (contaminated and clean) receive only cursory attention in the EES.

The proponent acknowledged the lack of detail in respect to land disposal and stated that they had disregarded the option early in the process because of *cost, timing and practical reasons* [89].

In October the proponent promised that they would go back and prepare for the Panel and the EPA cost estimates for this option. However, this information was never provided.

The Panel's perusal of international sources such as PIANC, the websites of other Port authorities and dredging undertakers have highlighted that a range of specialised land based materials reclamation and treatment facilities are being developed to address the issues raised by this project.

A case meriting further study in relation to Melbourne emerges from the development by the Port of Rotterdam, Nederlands, of 'De Slufter', a land based treatment farm for dredge sediments. The De Slufter facility has been operational for 19 years. It extends over 250 ha, including lagoons, settlement areas, dewatering and treatment facilities for a range of sediments. Whilst its initial purpose was to serve the Port (from which it can take capital and maintenance dredge materials), it also now provides a management facility for sediments generated by other land and water uses. Sediments deposited at De Slufter are assessed for the optimum mix of storage, processing and re-use options.

[89] POMC submission Annexure E1 page 8

Figure 5: Port of Rotterdam: De Slufter[90]

The EES could provide an opportunity to consider the development of such a facility for Port Phillip, to handle contaminated capital and maintenance dredge spoils, together with contaminated sediments generated by others, on a commercial basis. The vision that in the 19th Century led to the development of the Werribee Treatment Works as a then best practice solution for Melbourne's sewerage treatment could be deployed to deliver a treatment facility for Port, dredge and related sediment management, maximising the treatment and beneficial re-use of materials. However, to date, this opportunity has not been explored.

The failure of the EES to significantly evaluate land disposal options is a breach of policy. Options for disposal to land, particularly for contaminated spoil from the north, should be fully evaluated and assessed, with reference to the international literature, including the practice of land based treatment and re-use of materials including contaminated sediments at De Slufter, Port of Rotterdam, Nederlands.

Bass Strait Disposal

Logic dictates that all of the Bay turbidity and related impacts associated with the disposal of spoil at the SEDMG could be eliminated if the material was disposed to Bass Strait. It is even likely that the distance to travel to an ocean spoil ground could be less than that to the SEDMG and the overall cost to the project reduced. However, no engineering or environmental assessment was produced to enable an evaluation of this important alternative to be made.

The Proponent stated that they dismissed the Bass Strait alternative prior to assessment because …*of the risks associated with the dredge moving through the Heads and into Bass Strait in difficult sea conditions.*[91]

No evidence was provided to substantiate the claim. The statement is also illogical when it is considered that some of the material is actually being dredged directly in some of the most difficult of those 'difficult sea conditions', in the heads. Further, there appears to be no reason in principle why the movement of a loaded or empty dredger though the heads should be any more risky than the transit of existing commercial vessels. If simple dredge transit is

90 Picture credit: Port of Rotterdam:
http://www.portofrotterdam.com/maritime/NL/Overig/Baggerspecie/Slufter/Index.asp

91 EES Volume 1 Pg S5-13

genuinely unacceptably risky, then the transit of a range of other vessel types through The Heads requires to be re-evaluated.

A more plausible explanation was provided to the Panel by the proponent, to the extent that the proponent did not wish to seek direct Commonwealth approvals under sea dumping legislation and involving the NODG. A Bass Strait DMG option would have triggered such a process.

The Panel considers that to fail to evaluate a Bass Strait DMG option on the basis of the 'fear' of a Commonwealth process would be to enable artificial considerations to obtain an unduly high weighting in environmental impact assessment terms. Whilst such disposal is clearly subject to a separate, proper and rigorous assessment regime, it would appear unsound to accept potentially higher order bay impacts, simply due to the fact that Bass Strait DMG options had remained untested.

The proponent should undertake a full environmental, economic and risk assessment of the disposal of the spoil from the south of the bay to Bass Strait. The assessment must be able to be compared on the same basis to the work already done for disposal within the Bay. The disposal option with the best balance of benefit against environmental impact should be selected.

Alternative DMGs within the Bay

The proponent reviewed a number of existing and new spoil ground locations within the southern part of the Bay.

These included:

- An environmental island
- Symonds DMG and extension
- Capel Sound DMG and extension
- Other SE DMGs

Whilst the panel notes that some of these alternatives appear to have been assessed to some degree, the level of assessment of the SEDMG is not sufficient to justify the choice of this location in preference to others. For example, Dr Provis the hydrodynamics experts notes that whilst he examined the alternative of an environmental island and had also indicated against the Symonds and Capel Sound extensions on hydrodynamic grounds, he: *.... has not considered the alternative DMG locations in the south east apart from the preferred option of the PoMC* [92]. The implications of this admission are that there may be other 'in bay' locations that offer a better balance of hydrodynamic and sediment transport characteristics than the chosen new DMG.

When the foundation stone nature of his work is considered this implies that the other consultants can also have not fully considered the alternative DMGs.

In summary the key problems associated with the choice of SEDMG include:

- Insufficient seabed samples were taken to comply with the BPEMGD.
- No marine ecology samples were taken within the area.
- No video of the seabed was taken within the area.

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[92] Provis EWS page 22

- The location is outside the area referred in the EPBC referral co-ordinates.
- A comparative location outside the heads was not considered.
- The aquaculture consultant recommended against it and preferred another location.
- There are many non specific references to the spoil grounds in the consultant reports making it difficult if not impossible to tell which one they are talking about when they make comments or recommendations. Most of these reports do not have maps that the reader can use to confirm locations.

The Panel's over-arching position is that ocean disposal DMG options be assessed in the Bass Strait and considered on a balance of benefit with the generic concept of a bay option. If a Bass Strait option is genuinely not acceptable then the Panel recommends as follows.

A detailed rationale for the choice of the location for the southern DMG should be undertaken. This should include a full assessment of the environmental impacts of the proposed SEDMG against other alternatives. The assessment should include an analysis of the long-term effects on declared marine aquaculture zones and recreational fishing.

In the northern part of the bay, dredged material has historically gone to a number of sites with much of the material from the Yarra, including contaminated material, being dumped in an unconfined, un-contained manner at the Port of Melbourne spoil grounds (PMDMG). No evidence was provided evidence of the total volumes disposed to the PMDMG, nor that the dumped spoil has been fully retained there (as opposed to dispersing more widely across the bay floor). This is of particular concern given the finding that:

> *the toe of the spoil ground batter extends beyond the spoil ground boundary.* [93]

The Panel finds that the proponent has not fully demonstrated that the placement of dredge spoil at the PMDMG has not been deleterious to the environment in the past and that therefore the practice should be allowed to continue.

The proponent has not demonstrated that the unconfined material to the south of the bund will remain within the extended PMDMG.

Placement of additional spoil at the PMDMG should not be considered until it is demonstrated that any material to be placed will remain within the proposed boundaries.

Containment and confinement

A discussion of whether or not the contaminated material should be contained or confined is elsewhere. This part of the report seeks to define the terms as they are used by the Panel in this report. The NODG provides a definition of confined disposal, which the panel's definition is consistent with. The BPEMGD do not contain a similar definition.

The terms are not defined by the proponent in the EES documentation, nor have they been used by the proponent in a consistent manner.

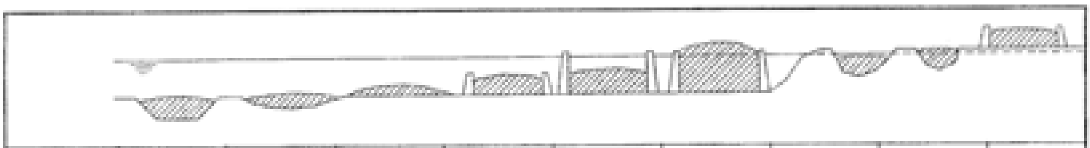
[93] GHD: Existing Conditions, Pg 20

The Panel defines these terms in the following manner:

- **Confinement:** is taken as defined in the NODG to mean the separation of contaminated spoil material from the aquatic environment by an impermeable barrier such that burrowing organisms are unable to reach it. Capping is a method of confinement.
- **Containment:** is taken to mean 'held in place laterally' by a wall or other structure that prevents the spoil materials from flowing beyond the desired spoil ground area.

The definitions are not universal and the dredging literature often uses them in different ways, even reversing them. They are however consistent with PIANC which has produced a diagram showing the various ways in which containment (Types 1 to 5) and confinement (Types 6 to 9) can be achieved.

Figure 6: PIANC Extract: Discussion of Disposal Modes



	type 1	type 2	type 3	type 4	Type 5	type 6	type 7	type 8	type 9
site characteristic	created depression in seabed	natural depression in seabed	mound on seabed	subaqueous berms	Artificial atoll	artificial island /peninsula	inland lake, river or other open water	inland lake or other open water	upland site
type of disposal	**Aquatic Disposal**	**Aquatic Disposal**	**Aquatic Disposal**	**Aquatic Disposal**	berm construction: **aquatic disposal;** infill: Confined Disposal	berm construction: **aquatic disposal;** infill: Confined Disposal	**Aquatic Disposal**	**Aquatic Disposal**	Land Disposal
type of containment	Lateral containment			lateral containment	Confined disposal	confined disposal	confined disposal	confined disposal	confined disposal
with capping	Contained Aquatic Disposal	Contained Aquatic Disposal	Level Bottom Capping	Contained Aquatic Disposal					
site potential						Beneficial Use		Beneficial Use	Beneficial Use
remarks							disposal types 1 to 5 exist within type 7		

Figure 1.1 - Definition of types of disposal

Management of Aquatic Disposal of Dredged Material [1] (PIANC, 1998 page 6)

Proposed Disposal Arrangements

The proponent proposes to dispose of the:

- Contaminated spoil from the north to the existing Port of Melbourne DMG (PMDMG) near Fawkner Beacon
- Clean spoil from the north to a southerly extension of the PMDMG
- All spoil from the south a new spoil ground (SEDMG) near Mt Martha

as outlined in the table below.

All clean spoil is proposed to be disposed of to form a mound on the seabed, neither contained nor confined.

Table 24: Proposed Spoil Ground Locations and Placement

Spoil source	Spoil ground	Notes
Port Melbourne channel	PMDMG existing	Uncontained, used to construct bund wall
Contaminated Yarra spoil	PMDMG existing	Placed within the bund*, uncapped (unconfined)
Uncontaminated Yarra spoil	PMDMG extension	Uncontained
South channel	SEDMG new	Uncontained
Rip	SEDMG new	Rock to be covered by sand from the South Channel

* note that there is additional discussion on the bund suitability elsewhere in this report

The PoMC has proposed that the contaminated spoil material be 'contained' by a bund within the existing PMDMG. However, this is at best a hybrid of the PIANC Type 4 disposal as the bund wall is not structurally guaranteed as to height, stability or permeability. It is proposed that clean spoil materials will form the containment at the southerly 'downhill' end and the upwardly sloping spoil ground itself provide containment to the north. The proponent has stated that the bunded material is to be extracted in a manner that fluidises it such that it cannot be capped. It follows that the spoil is not separated from the sea (types 5 to 9) and so the material is not 'confined', it is only semi (or laterally) 'contained'.

As described elsewhere and for other reasons, the proposed disposal arrangements for the contaminated spoil are unacceptable. This is particularly so, considering that they are not suitable for habitation by burrowing benthic organisms, and yet such creatures can not be prevented from living there, creating a link in the food chain that should not be made and once made, cannot be controlled.

The fact that the materials in the bund cannot be capped is largely the result of the chain of decisions that proponent has made throughout the project, including the decision to proceed to contracting particular vessels with particular equipment offers, before in principle environmental assessment has taken place. A review of world literature suggests that there are solutions available that will readily meet the BPEMGD and NODG requirements and allow the materials to be capped. There is therefore no need in principle for an environmental compromise. The Panel cannot recommend such a compromise until it is clear that alternative methods have been considered and assessed and are still found wanting.

The panel provides an example dredging which is now undertaken at the Port of Antwerp (PIANC Volume 2, Case Study Underwater Disposal of Dredged Material in the Port of Antwerp).

In summary in Antwerp the Port:

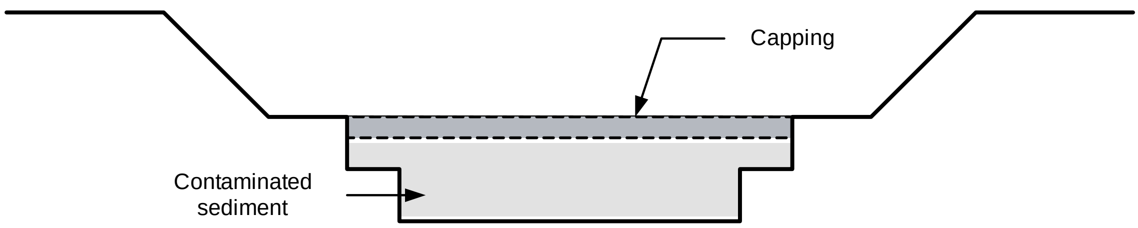
- Dig a pit in a clean seabed area.
- The material removed is used as a resource elsewhere such as for reclamation.
- A special sweep dredger, which minimises the volume of water in the sediment, dredges the moderately contaminated material in a relatively 'solid' state.
- The moderately contaminated dredge material is placed directly into the hole via an underwater diffuser in such a manner that it is dense enough to cap.
- Capping is undertaken.
- Capping stability and erosion calculations are done to ensure that it will remain capped.

The following basic procedures are also enforced:

- Rehandling of the material (with the risk of further fluidisation) is avoided.
- Rotating devices are not allowed, to reduce turbidity creation.
- The silt has to enter the dredge pump as much as possible at in situ density.
- Accurate vertical and horizontal positioning during dredging has to be possible.

The typical profile of the pits used in Antwerp can be seen in the diagram below.

Figure 7: PIANC Extract: Capped Pit Disposal in Antwerp



Similar capped pit disposal techniques have been used in other locations, including Hong Kong, where they have been referred to as contaminated mud pits.

The Panel recommends as follows:

An international literature review should be undertaken prior to the selection of a method for any marine disposal of contaminated materials. Any selected method should be demonstrated as providing full confinement pursuant to the requirements of the NODG, to the satisfaction of the approving authority.

10.2 DREDGING EQUIPMENT

Discussion

Submitters before the Panel were concerned that the EES dredging base case was not a ‘best practice’ package of technologies. As such, it appeared that it would always have produced results that were contrary to policy and environmentally unacceptable. It was put to the Panel that by commencing with such a base case, and moving upwards only in response to identified environmental concerns, the proponent had sought to perpetuate what amounted to an 'improved worst case' as opposed to a best practice case. As such, large volumes of evaluation had been undertaken to perpetuate the use of non-best practice technology, when a simpler, more straightforward and more acceptable approach would have been to adopt best practice, reducing the range of adverse impacts that required active mitigation.

Submitters before the Panel also had strong concerns that the EES contained a very limited and caveated examination of the dredge material that 'might' be used to implement the project. For this reason, it was suggested that individual consultants had not had access to specific advice about dredge techniques and their effects in examining the degree to which in principle environmental impacts can be controlled. This significantly reduced the credibility with which subject specific environmental impact assessment in fields such as nutrient or marine ecology could be undertaken.

In turn, submitters were concerned that the first detailed information about dredge technology and performance arose from Boskalis and were not considered within the EES process.

Panel Response

The Panel in broad terms agrees with submissions that the dredge technology EES base case was not a 'best practice' offer and so was not of principle adapted to the policy requirement to minimise impacts through the application of best practice.

The Panel does not devote significant space in this section to a description and assessment of the base case. The findings and recommendations made by the Panel in the earlier sections of this Chapter and elsewhere in this report suggest that a mitigated or improved version of the base case cannot deliver necessary the levels of environmental performance necessary for the project. On this basis, there is little purpose in undertaking an evaluation of the foundation from which such an offer was constructed. Appendix G of this report contains a summary statement of the base case for reference purposes.

Even further, the findings and recommendations made by the Panel in the earlier sections of this Chapter and elsewhere in this report make a detailed assessment of dredging equipment options using a mitigated or improved version of the base premature. Decisions made in respect to the fate of the dredged material determine the dredging equipment that can be used and vice versa. The impact of this dependency was noted by the EPA in their submission to the Panel:

> *The capacity of the Panel to consider the range of options available for undertaking the dredging, appears to have been constrained by a number of decisions made early in the project in defining the base case.*[94]

In particular, the choice of trailing suction hopper dredgers to undertake the dredging of most of the contaminated materials means that these materials will be fluidised when they are placed rather than solid or semi solid. It is the fluidised nature of the spoil that then dictates that the material will be difficult, if not impossible, to cap. The simple choice of a more suitable dredge and placement method would solve this problem.

The EES, based on the 'base case' has assessed a particular 'equipment package', albeit with a few minor variations, that will:

- loosen material on seabed prior to later removal (in The Heads and parts of the Yarra)
- extract /remove rock and sediments from seabed,

94 EPA Submission 153 at Pg 17

- transport it to another location, sometimes by another vessel
- rework the surface - eg sweep beam, sucking (impacts not modelled)
- deposit the material as spoil in the waters of Port Phillip Bay

The EES does not effectively examine other equipment, work methods or project scheduling that may offer:

- Reduced dredging requirements.
- Alternate uses of the spoil as a resource.
- Alternate spoil locations.
- Alternate spoil placement methods.
- 'Clean up' of sediments.
- Confined disposal techniques that will meet BPEMDG and NODG requirements.

The formation of Alliance has further entrenched the proponent's position in respect to their equipment package and, unless it has other technologies at its disposal of which the Panel was not made aware, has almost totally removed flexibility to move to more environmentally suitable best practice alternatives.

The EES and panel presentation documents contained almost no information about Best Management Practices (BMP) that could have been applied to the project, some examples of which can be found in the table below.

Table 25: Examples of Best Management Practice

Best practice type	Device, operational practice, design option
Device	Silt curtains, at source and/or spoil grounds to protect sensitive assets from turbidity in low current environments,
	Gunderbooms
	Recirculation systems to dragheads
	Pneuma pumps to create high solids concentration
	Cutting heads that dissect clay to produce clay blocks
	Equipment that 'bags' spoil that can be used to construct retaining/bund walls
	Environmental dredging buckets
	The use of submerged pumps on the suction heads
	Silt pumping
	Mechanical screening/sand silt separation
	Sand separation plants and engineered water treatment facilities
	Low fish kill water intakes
	Alternate capping technologies such as screens
	Sweep dredges (Antwerp solution)

Best practice type	Device, operational practice, design option
Operational practices	Lowering of hopper fill level in rough seas Accurately pinpointing contaminated sediments using specialist sensing technology Precision dredging techniques Field testing of equipment to ensure that performance meets standards Use of 'Silent Inspector' systems to monitor dredging activity Deposition of overflow upstream/upcurrent of dredging Maintaining station during spoil placement Preventing overflow while transiting between dredge site and DMG Dredge operator training to minimize multiple 'biting' Minimisation of double handling Minimisation of bank undercutting Optimised dredge cycle times
Design	Capped sediment pits to contain and confine contaminated spoil channel design location to minimize dredging Minimising channel wall slumping Design of self scouring channels

The Panel draws attention to the extensive array of dredging equipment outlined in the PIANC documentation. This and other world sources should be reviewed for this project if spoil disposal and particularly contaminated spoil disposal to the waters of Port Phillip Bay does ultimately become the preferred option.

The same principles also apply to the control of turbidity. The Panel has found elsewhere in this report that the dredging technology advanced, although proposing to use a ‘green valve’ does not necessarily control turbidity to the extent possible. Given the current absence of an effective assessment of the environmental effects of turbidity on key environmental and bay system assets, it will also be necessary to return to the portfolio of possible equipment to determine whether equipment offering the best balance of benefit and impact to minimise turbidity has been adopted.

For the above reasons, the Panel recommends as follows.

The proponent should seek expert and independent assistance to review available dredge equipment, work methods and project scheduling approaches, in particular:

- Dredges capable of producing spoil with high solids content, that lower turbidity at source and that would enable capping.
- Cutting heads that dissect clay to produce clay blocks.
- The construction of a sediment 'pits' to contain and confine contaminated sediments.
- Equipment that 'bags' spoil that can be used to construct retaining walls.
- Mechanical sand-silt separation equipment such as the 'mechanical treatment of harbour sediments' plant in Hamburg.
- Sand separation plants and engineered water basins such as De Slufter, Rotterdam, Nederlands.
- Alternate capping methodologies such as sediment screens.[95]

[95] Examples drawn from PIANC.

10.3 WORKS IN THE RIP

Discussion

On a more specific issue, Mr Keith Burren, an engineer, PIANC member and former Port authority board member, had specific concerns about the capacity of the chosen dredge technology to remain 'on station' in the Rip. He identified the Rip as the 'gateway' to the project and the capacity to maintain plant there in a productive role as a 'mission critical risk' to the project. Unless the Rip can be dredged, the remainder of the project is at risk.

He noted that the:

> *…*[c]*ontracted design studies are now being focussed upon a single technical option based upon a trailing suction hopper dredger to remove the bulk of material and supplemented by an underwater hammering device to pre-treat harder bedrock where required. Technical feasibility, environmental impacts and estimated costs of this option have yet to be established.*
>
> *The EES however does not elaborate upon the factors which led to elimination of other options listed as viable until very recently. In the absence of such elaboration and any other parallel lines of investigation, the outlined method appears to place all eggs in one basket and is at best provisional at this time.* [96]

He went on to state that earlier phases of the project had reviewed a range of other technologies, most of which had been dismissed and that finally the largest self propelled cutter suction dredge was proposed. However, this evidence was not presented to the Panel by the PoMC.

> *…Options dismissed included elevated platforms and the use of explosives in the Great Ship Channel for understandable reasons. However a notable omission from the rejected options is any mention or discussion of a previously favoured option, ie. the feasibility of a large self-propelled cutter dredger. In the absence of any acknowledgment, detailed examination and discussion of this alternative option in the EES, it is difficult to accept that a base-case dredging scenario for the Heads (The Rip) has been properly validated.* [97]

Mr Burren presented to the Panel where he maintained his view that the:

> [s]*ea state and tidal conditions present a serious challenge to both trailer and cutter dredgers and concurrent shipping operations can also present problems for the operation of both hydro hammering devices and cutter dredgers.* [98]

The validity of the proposed approaches is in turn critical to the maintenance of ecological, terrain, visual and tourism values (dive sites) in the spectacular Heads Canyon region. The EES proposed the following actions.

> *There are a number of potential methods available to the Dredging Alliance to facilitate compliance with the performance criteria. These include:*
>
> - *dredging at specific times of the tide*
> - *dredging away from the Canyon*

[96] Burren Submission at Pg 2.

[97] As above.

[98] As above.

- *ensuring that the equipment for rock breaking in the Heads is capable of producing material of a size that is suitable for using the dredger proposed for material removal*
- *removing all mobile material as soon as feasibly possible after rock breaking*
- *dragheads not to side-cast materials outside the perimeter of the area to be dredged*
- *stone fishing not to be undertaken in areas less than 20 metres from the perimeter of the area to be dredged.99*

It was therefore disappointing to see almost no enhancement of this information in the relevant operational procedures contained within the EMP. There is little indication of how the interaction of swirling currents and tides are to be managed to protect the canyon walls from rock fall especially as there is no detail in the EES about this matter.

Panel Response

Findings in relation to dredging in The Heads are required in response to the submissions of Mr Burren. The Panel agrees in principle with Mr Burren that a major strategic issue of project risk is raised by the dredging of the Heads.

The use of mechanical dredging in the Rip has not been validated by previous campaigns, for which the Panel understands explosives were used.

The proponent proposes to use a specially adapted rock cutting drag head for a trailer suction hopper dredge. This is 'new technology'. Whilst it has been tested on land in a quarry in Portland, (on what is understood to be similar geology), it has not been tested over terrain with significant variations in micro relief, or in the sea conditions likely to be experienced in the Heads. Particularly, it has not been tested on the variable and historically blasted bathometry of the sea floor in locations such as Rip Bank. The Panel considers that there are un-excluded but likely risks that the head may become 'stuck' in sea floor relief, resulting in the tethering of the dredge vessel or the need to cast off the drag head. Individual incidents could pose an unassessed risk to shipping transiting the Heads. Even if this is not the case, delays, loss of or damage to the drag head could depress dredging productivity, increase project duration, create demands for unassessed changes to ecological dredge windows and increase project costs.

Where the adapted drag head cannot be used, the proponent proposes to use a hydro-hammer, mounted on a barge, dynamically positioned in The Heads dredging area. This method was chosen to avoid the use of a fixed platform that would stand as an obstruction to shipping whilst works were under way. However, its use in such waters, exposed to acknowledged difficult metocean conditions is equivalently unproven. Mr Burren likened its prospects of success to the undertaking of key-hole surgery on a patient mounted on a continuously moving operating table. This would clearly be a slower method than the adapted drag head. Reductions in the anticipated dredge productivity caused by using this method could cause delay and increased costs. Furthermore, this method may prove to be less productive than is currently assumed, compounding delay and increased costs. The effects of noise from this method on marine species (acknowledged as likely to be significant) have yet to be assessed.

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[99] EES Volume 1 at Pg 45-15

Loosened rock is proposed to be recovered to the surface using a stone fisher barge, not dissimilar in operation to a trawler. Whilst such vessels have been demonstrated in practice in the North Sea, the Panel understand the bed to have been of a sandy nature, with occasional rock scatters. Again, the Panel doubts the efficacy of a stone fisher on variable, rocky sea floor conditions, such as those found on Rip Bank.

With reference to international literature, the Panel has not found examples of similar methods that might give insight as to the prospects for success in the Heads. This is not surprising: the Heads constitute what is likely to be a uniquely challenging dredge environment in metocean terms. However, this serves only to emphasise that a preliminary in situ testing program should be undertaken to ensure that The Heads can be dredged using the proposed technology, before the project goes much further. If the proposed technology is not validated, other options (such as for example the use of explosives, the diver handling of loosened rock, the acceptance of loosened rock remaining in situ or falling to the base of The Heads Canyon) would have to be considered. Consideration would have to be in the context of the acceptability or otherwise of their environmental effects and economic costs.

The Panel also considers that, the situation of The Heads being unique, the only feasible means of undertaking an assessment of the environmental effects of dredge technology there will be to conduct a physical trial. Any such trial should be closely monitored to ensure that the environmental effects of its continuance and of a full scale dredge campaign using the same technology are properly documented and assessed. Full scale dredging at The Heads should not proceed until the results of this trial are known.

For strategic reasons, the Panel would also indicate that the success of such a trial also holds the key to the remainder of the project. If a trial is conducted but, despite the best endeavours of relevant dredge experts and environmental consultants, fails to deliver an acceptable level of dredge productivity at an acceptable environmental impact and economic cost, there will be little point in proceeding with the remainder of the project. Deep channels leading to an un-deepened Great Ship Channel have no practical value for the Port or for the people of Victoria. Further evaluations would have to be undertaken to demonstrate that The Heads can be deepened. The project should not proceed until it has clearly been demonstrated that this is the case.

In summary, a number of significant concerns emerge about the ability to successfully deliver this aspect of the project in the unpredictable and dangerous waters of the Rip:

- The proponent has no experience of mechanical dredging in the Rip as it was previously blasted.
- All proposed mechanical configurations appear untested in any waters in the world.
- It will therefore be necessary to include a trial dredge stage before this aspect of the project can be assessed or committed to.
- The only foreseeable alternative if all mechanical dredging fails is to use explosives.
- The environment is very sensitive and protection of the canyon walls is critical.

Given the physical and project risks potentially emerging from dredging the Rip, the Panel recommends that:

An early trial dredge campaign should be undertaken in, or near, the Heads, to validate and assess the proposed new technology for use there. The wider project should not proceed until this work has been done. This should be subject to independent review as to method and outcome. It should include:

- A determination of the environmental characteristics of the proposed technology in the field, so that they can be assessed by EES consultants.
- Further work being undertaken to determine the specific tidal and current conditions that will best protect the canyon walls from rock fall.
- The works can be undertaken in the proposed tidal and potential sea condition windows and that this can be safely achieved in the vicinity of commercial and recreational vessels transiting the rip.
- A quantitative risk assessment by a suitably qualified organisation be undertaken of the works with the view to ensuring acceptable risk criteria are met.
- That all of the above work inform the economic analysis of the project

10.4 EQUIPMENT INVOLVED IN OTHER WORKS

Discussion

Significant aspects of the works in the Yarra have not been the subject of a resolved technical description. It is therefore difficult to determine what effects might flow.

Panel Response

No information has been provided about the techniques and equipment proposed to be used to undertake works in the Yarra such as sheet piling, rock armouring etc., or the effects of such work.

The Panel recommends that a complete description of interface works on berths and infrastructure be developed so that the environmental impacts associated with the works can be adequately assessed.

10.5 SUMMARY

The Panel finds that the dredging technology and disposal base case and the current technology and disposal portfolio (which represents a mitigated base case) do not represent best practice solutions. There are therefore in breach of policy as a matter of principle and should not be approved.

Dredge spoil volumes have not been minimised. The project appears likely to involve the unnecessary movement of spoil. Hence there is the potential for reduction of adverse environmental effects due to spoil movement.

Options for dredge spoil re-use have not been effectively canvassed and assessed. It has not been demonstrated that practical and economical re-use options cannot be pursued. Further evaluations of options such as beach renourishment and materials recovery/recycling in purpose constructed facilities such as De Slufter in the Port of Rotterdam have not been undertaken. It should be noted that the latter facility may also offer opportunities for contaminated materials handling and for the processing of materials generated by other uses than the Port.

Assuming that after dredge minimisation and re-use mechanisms have been thoroughly considered, there will still be material requiring to be disposed of, a thorough examination of disposal options has yet to occur.

Critically in respect of contaminated materials, land based disposal options have not been assessed. Sea based 'confinement options pursuant to the NODG have also not been assessed. The proposed bunded storage mechanism has not been validated and reference to international literature suggests that such an approach is not best practice. It appears unlikely to effectively contain and manage the material sought to be placed within it.

There does not appear to have been an effective strategic evaluation of DMG options and locations. Ocean disposal options in Bass Strait have been dismissed for reasons that are unclear and lack a logical basis.

This pattern of evaluation leaves a strongly bay-based disposal portfolio, in circumstances where it is not demonstrated that this provides the best balance of project benefit and environmental performance.

Returning to contamination and the bunded disposal solution, this has been necessitated because of the choice of dredge technology that will leave contaminated Yarra sediments in a fluidised or semi fluidised condition such that they cannot be capped. This indicates that dredge technology choices should not have been made and confirmed, without a careful comparative evaluation of the costs and benefits of each. The proponent should be clear that, if the Yarra is to be dredged, it should be dredged using equipment that will leave contaminated sediments in the best condition for the chosen means of management. This should be the case whether disposal be on land, at sea in a contained facility, or in a mixture of both.

Finally, the Panel must observe that the dredging technology proposed for The Heads is new technology, addressing what appear to be globally unique circumstances for a dredging campaign. If The Heads cannot be dredged to relevant depths, there is little value in proceeding with the balance of the project. The Panel considers on balance that the only means of proving an appropriate technology for use in The Heads and assessing its environmental effects will be the use of a monitored trial dredge campaign.

The Panel considers that this most unsatisfactory balance of issues has emerged, largely because of the lack of independent expert dredging advice as part of the EES consultant team. The Panel considers that such advice should be obtained forthwith to assist the Port in the next stages of the project. However, it notes that such advice should be independent, in that it should not have a strong financial interest in the promotion of dredge technology that may not represent the most appropriate or best practice solution to the environmental circumstances of Port Phillip Bay.

11. HYDRODYNAMICS

This chapter of the report considers hydrodynamics: the degree to which the project can change the volumes and patterns of water movement into out of and within Port Phillip. Contingent upon this analysis is the background to a considerable range of concerns raised by submitters, including concerns about flooding/inundation, changes to tides, changes to sediment transport and changes to coastal habitat.

This chapter accomplishes the following tasks:

- it explores the background to hydrodynamic issues;
- it examines the approach to the hydrodynamic modelling carried out;
- it then cycles through the results of the modelling; and
- considers input from a peer review carried out for the Department of Sustainability and Environment.

11.1 HYDRODYNAMICS BACKGROUND

Discussion

The proposed dredging has the potential to change water movements between Bass Strait and Port Phillip Bay as well as water movements.

Deepening the shipping channel through The Heads will allow more water into and out of the Bay with each tide. The increased water movements will increase the water levels at high tide and decrease them at low tide. The effect of dredging on tide levels throughout the Bay is a major focus of concern as significant changes in high and low tide levels would affect coastal processes. The increased water movement will change currents in the Bay especially at The Heads and the Great Sands at the south of the bay. Changes to water residence times, sediment movement, salinity and temperature and wave action are all changes that will continue permanently, after the capital dredging has ended.

Predicting the magnitude of these changes and their environmental effects was one of the major tasks of the EES process.

Issues around hydrodynamic change were widely raised in submissions. Many individual submitters from the eastern side of Port Phillip Bay and the Mornington Peninsula were strongly concerned about flooding and beach erosion, leading to direct impacts on dwellings and other third party property. Others were concerned about the effect of changes on coastal and intertidal habitats and the species reliant upon them. Others still were concerned about sediment transport processes and the degree to which wider erosion and deposition processes in the Bay were understood and/or might be influenced.

The method used by the proponent was to rely on predictions from a commercially available mathematical model. No physical modelling was undertaken. The accuracy of the predictions is dependent on:

- the intrinsic reliability of the model;

- the accuracy of the data used in the model; and
- the relevance of adjustments made during calibration of the model.

The reliability of the predictions can be assessed by comparing the computer output with real outcomes based on environmental measurements and on previous experience: the calibration process.

It should be noted that the body of hydrodynamic work undertaken for the project was recognised from the outset as requiring to be conducted with rigour and integrity. For this reason, the Department of Sustainability and Environment appointed Dr Kerry Black, an eminent hydrodynamic modeller to provide an ongoing independent peer review of the work. Dr Black advised through the EES preparation process and was made available to the Panel to present his conclusions and respond to questions.

The initial model calibration was found to be unsatisfactory by Dr Black. The model was recalibrated before the EES was finalised with collaboration among Lawson and Treloar, Dr Black and DSE after which Dr Black reported that he considered the revised modelling to be of a sufficiently high standard to be used for the assessment of effects, with some limitations.

Some of the resulting key conclusions in the EES Report directly relating to hydrodynamics[100] were that:

- the changes in tidal range caused by the Project will be imperceptible;
- changes in currents will be small;
- there will be some small changes in the wave climate at The Heads;
- any observable changes in coastal processes are considered unlikely; and
- there will be no significant changes in the erosion and accretion processes in the Bay.

These conclusions were summarised in the main volume of the EES Report[101]:

> *The modelling work undertaken as part of this specialist study has shown that in general the changes in hydrological and sedimentation processes will be very small or imperceptible, and the resulting risks are therefore considered only 'moderate'.*

In terms of tidal range, conservative maximum changes of + 8mm and – 9 mm were assessed. The general view was provided that these fell within the range of changes due to individual meteorological events and would also be absorbed into sea level rise due to anthropogenic global warming within a relative short timescale (years).

Dr Black, the peer reviewer, had some reservations about the wisdom of these conclusions and stated[102]:

> *The effects on the environment may prove to be subtle, and so only a bold consultant would dismiss any chance of impacts, as L&T have done, by stating that there will be no significant change to tidal range, currents or wave climate.*

His position can best be summarised as considering that whilst issues of tidal range were acceptably addressed, other issues required some further and more detailed consideration.

[100] Main Report Section 28.4 , pp28-19

[101] EES Volume 1 at 28.4

[102] Black Final Report at p15

Panel Response

The Panel notes the considerable value provided to the EES process and to the consideration of hydrodynamics by having an expert peer reviewer, independent of the proponent and at arms length from the project. The Panel notes that if other foundation subjects in this EES, including sediment chemistry and risk analysis, had this type of exposure to a robust technical debate process, it may well have been presenting a very different report today.

The panel accepts that in general the predictions that changes in high and low tide levels in the Bay are likely to be smaller than +/- 9 mm appears to be credible. When water subject to tidal influence flows from Bass Strait through The Heads (an aperture of broadly known cross section) and into Port Phillip Bay it is possible to estimate reasonable volumes and rates of inward and outward flow for each tide. This estimate can be revised for the increase in aperture after dredging. They indicate in broad terms whether the analysis of tidal flow and range is in broad terms likely to be correct, or in broad terms likely to be incorrect and by what order of magnitude. It is fair to say that the Panel considers the proponent to have broadly conservatively assessed these changes within the correct range, a view that is reinforced by the findings of Dr Black.

The report does not include any calculated predictions of the change in volume of flow that may occur. It moves straight to predictions of change of tide heights. Some uncertainty about the magnitude of changes to hydrodynamic processes arises because the changes in bathymetry input to the model were not explicitly described. The lack of calculated confidence intervals or other statistical analysis of the model predictions reinforces this uncertainty. The Lawson and Treloar results were expressed with the implication of certainty: an approach that departs from the strict science of modelling and tends to assert outcomes as matters of faith.

The modelling of long time processes was based on taking the outputs for short times and summing the results. Where predictions depend on summation of multiple model runs the Panel finds that limited accuracy in the underlying ‘small’ model can limit the reliability of major outcomes. This is particularly significant for the behaviour of turbidity plumes, where the results require summing of many cycles of the model. This is described in the section on turbidity below. It also applies to the field of sediment transport, where apparently insignificant changes over individual tide cycles taken over hundreds to thousands of tide cycles, can compound into major changes over the years to decades timescales that are sometimes necessary to be deployed in coastal process analyses.

A further important outcome of the expert view that any changes would be small or imperceptible is that experts carrying out other studies took this at face value and did not assess outcomes that might occur if the changes were small but significant. This becomes important on coastal flats where a small change in tide heights translates into a substantial change in area inundated or exposed. This is significant for land ecology discussed later. It also has significance in the field of sediment transport.

11.2 THE MODEL

Discussion

As previously noted, no physical model was constructed or used. All predictions of hydrodynamic changes and of sediment plume behaviour are the result of mathematical hydrodynamic modelling. The model used was a commercially available mathematical model developed by Delft Hydraulics of the Netherlands (the Delft Model). Different modules of the Delft model were used for different purposes[103]:

- Flow: computes the currents and sea level variations in two dimensions, giving vertically averaged currents. (This is also capable of three dimensions where currents are computed at different levels in the water. Some three-dimensional computations were carried out after the EES was released.)
- Waves: computes the generation of waves by wind, taking into account changes in water depth, currents, bottom friction and wave breaking.
- On-Line: computes sediment transport. It calculates the dispersion and settling of material placed into suspension by dredging, or indeed the movement of existing bed loads.
- Morphology: uses the previous three modules to compute changes in the seabed caused by sediment transport.

Panel Response

The Panel has no concerns about the chosen model as a tool. However, as in all mathematical modelling exercises, the key to the reliability of outputs lies in the integrity of data input and calibration processes.

The model used and its first calibration are described in a report that was not included in the EES. The peer reviewer Dr Black made substantial criticism of that model and it was revised and recalibrated over some months. The second report of model calibration is included in the EES.[104]

The Panel was informed that the proponent was unaware of the flaws in their calibration of the commercial model until the peer reviewer advised them of these. Whilst the Panel commends the proponent for taking the necessary steps to adjust and recalibrate the model, the need to do so reduces the confidence of the Panel in the degree to which predictions from the modelling can be relied on. This applies especially to the more complex issues of turbidity plumes and sediment transport which are derived from the base model and where errors can be magnified by the need to sum the outputs of many computer model runs. It flags that a note of caution in accepting the results is warranted.

The accuracy of the predictions remains dependent on the quality of the input bathymetric data, wind force, direction and duration, tidal levels in Bass Strait and the choice of parameters used to adjust the model.

The EES states that bathymetric data from the Port of Melbourne was entered into the model but no details were provided. The objective of the modelling is to predict changes in hydrodynamics resulting from changes in the bathymetry. The lack of information presented in the EES placed an immediate limit on any ability of the Panel to estimate the level of confidence that can be placed in the results produced by the model.

Descriptions of the proposed dredging in The Heads varied throughout the hearings and even at a late stage there was uncertainty. The studies described in the EES were undertaken many months before the hearings started, increasing the level of uncertainty.

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[103] Dr David Provis, Expert Witness Statement, p4

[104] Lawson and Treloar, Report Rm2074/J5372, EES Volume 3, Biological and Physical Workstream

This model was used to predict the behaviour of plumes of water made turbid by dredging activities. This major matter is considered in a later part of the this Panel report.

The model is used to predict sediment movement in the Great Sands area at the south of the Bay. It is also used as a basis for predictions on the likely stability of clean spoil deposited on the south east DMG and the likely stability of contaminated spoil from the Yarra deposited on the northern DMG. Again, the results of these exercises are considered further below.

11.3 RESULTS

Discussion

This section summaries the key results of the modelling, taking into account interactions between the proponent and the peer reviewer Dr Kerry Black. It examines:

- changes to the volume of water passing through The Heads;
- changes to tide levels;
- sea level change
- greenhouse gases; and
- the proponent's conclusions.

Volume Changes

Changes in the volume of water passing through The Heads before and after dredging receive little discussion in the EES and its technical appendices. Knowledge of the change in volume would provide a conceptual basis for considering the magnitude of other less simply visualised changes such as currents, tide heights and sediment transport.

The major account of Dr David Provis from Lawson and Treloar states[105]:

> *I calculated the volume of water moving through Port Phillip Heads and predicted the change after the dredging. The volume varies from one tide to another due to the normal changes in tidal range, however, on a typical tidal cycle, approximately 1.3 cubic kilometres of water passes through Port Phillip Heads. With the changes due to the Project included in the modelling, there is an increase of approximately 2% in this volume.*

Tide Level Changes

A major concern of submitters was with changes in tide heights and possible effects on beaches and coastal structures. Changes in tide heights have a potential impact on feeding grounds of shore birds, and inundation of coastal property.

Dr Provis considers changes in tide heights in some detail in his technical reports. The largest predicted change, at Williamstown on a spring tide, is a high tide increased by 8 mm and a low tide decreased by 9 mm, giving an increased tidal range of 17 mm. A summary that refers to the changes is provided by Dr Provis[106]:

> *I computed the change in tide levels for a typical month for existing conditions and with the dredged channels. At Williamstown, which is representative of tide levels north of the Sands,*

[105] Dr David Provis, Expert Witness Statement, p14

[106] Dr David Provis, Expert Witness Statement, p8

> *and where tide levels were found to have the largest change as a consequence of the Project, I calculated that the tide levels after dredging will be up to about 9 millimetres lower at low tide on some occasions and at high tide the levels will be higher by up to about 8 millimetres.*

And further down on that same page:

> *The largest difference in the values shown in the table is 8 millimetres indicating that the proposed dredging would have a very small impact on tidal levels. The differences are 2 millimetres or less at Queenscliff and increase slightly into Port Phillip Bay, through Hovell Pile and up to Williamstown, which shows the largest differences.*

Sea Level Change

Future sea levels will change due to natural processes, with a predicted rise resulting from anthropogenic global warming. The dredging will change tide heights but is not expected to cause a change in mean sea level. This is summarised in Dr Provis' expert evidence[107]:

> *My work has shown that the Project will not result in any change in sea level which would have an adverse effect on the coastline. There is no change in mean sea-level due to the Project and hence no overall change in shoreline position. The highest sea-levels change by a very small amount (3 millimetres) and given the duration of the peak of a high tide, a matter of a few minutes, and the lack of any identifiable change in the distribution of sea level, I am confident that there will be no impact on coastal infrastructure or coastal processes due to the Project.*

The significant statement here is the confident prediction that there will be no impact on coastal infrastructure or coastal processes due to the Project.

Greenhouse Gases

Changes to the Bay due to increased flushing have not been calculated by the consultants and so the extent of any related effect is difficult to determine. An increase of only 1% in the amount of exchange water at every tidal cycle will compound into a significant change in the flushing of the Bay.

In assessing the magnitude of the project on greenhouse gas balance, there has been no mention of and change due to changed gas exchange across the air sea interface. The main gas involved is carbon dioxide. Exchange rates will be affected to some degree by changes in the degree of carbon dioxide saturation of the Bay. This is influenced by salinity and temperature and by primary production and attendant changes in pH.

Because of the commitment of the State to reduction of greenhouse gas emissions, the change resulting from hydrodynamic changes should be addressed.

At present the only reference to greenhouse gases is in relation to emissions from the engines of ships entering the Bay. It is claimed that the project will be beneficial in reducing greenhouse gas emissions but the assessment is incomplete because the effect of changes in air-sea gas exchange has not been considered.

Over a period of years, at least up to the year 2030, this may be a significant change.

[107] Dr David Provis, Expert Witness Statement, p10

The Panel recommends that:

An estimate be made of the likely changes to greenhouse gas exchange across the air-sea boundary as a result of increased water exchange between Bass Strait and Port Phillip Bay.

Proponent's Conclusions

The hydrodynamic studies led by Dr Provis are reported in two Lawson & Treloar reports contained within the EES[108]. The full suite of investigations that were required by the Assessment Guidelines were not completed for inclusion in the EES and an augmented expert witness statement by Dr Provis was presented to the Panel on the 6th day of public hearings. This document contained substantial amounts of new material, including some 3-dimensional modelling that had not been included in the EES. Annexure D to Dr Provis' expert witness statement deals with substantial flaws in the EES in the assessment of the turbidity caused by the dredging and is considered in a later section of the Panel report below. Annexure C provides new model predictions of qualitative short-term deposition or erosion in Lonsdale Bight and the Sands area.

The view of the proponent on the impact of dredging in the Bay on matters relating to hydrodynamics (as listed in the Assessment Guidelines) is summarised in the Conclusions in the Main Report Part C - Residual Risk Assessment Section 28.4 of the EES:

> *The Hydrodynamic, Sediment Transport and Water Quality Modelling Study assessment of the Project found that:*
>
> - *Astronomical tide levels may be up to 8 millimetres higher at high water and up to 9 millimetres lower at low water, but will be within 7 millimetres of existing levels for at least 98 per cent of the time.*
> - *There will be no perceptible change in the frequency distribution of sea levels: that is, no variation in the frequency with which a given piece of coast will be inundated.*
> - *There will be no change in the impacts of sea-level rises due to climate change, or storm surges or both combined.*
> - *The change in tidal currents across the Great Sands will be less than 1.6 per cent, except in areas immediately adjacent to the areas to be dredged in the Heads and South Channel.*
> - *The change in tidal currents north of the Great Sands will be very small in areas away from the DMG, with the percentage change difficult to quantify*
> - *Wave heights will be within 1 per cent of existing conditions for most locations most of the time, and less than 1.5 per cent for all but a few specific combinations of site and wave direction.*
> - *There may be small changes in wave power, and hence potentially sand transport, along the St Kilda — Middle Park coast and at Point Gellibrand and Williamstown, although the changes would reduce existing losses of beach at Middle Park and Point Gellibrand is predominantly rocky coast with little sand. The effect at Williamstown didn't account for the effect of coastal works in areas that would prevent losses.*
> - *Despite the effects identified in the modelling, all changes in wave power are within natural variation.*

[108] EES Volume 3B-1 & Volume 3B-2

- *Increased vessel sizes will not result in increased coastal erosion due to wake and wash effects.*
- *The changes in salinity and current profiles in the Yarra River will be minimal and not ecologically significant.*

Panel Response

The Panel finds that the discussion of hydrodynamics is dominated by consideration of the model. There is little explanation of the meaning of the results from it and the confidence that can be placed in them. The interdependence of the predictions is not examined in detail.

The Panel finds the results of the hydrodynamic study are not clearly presented in the technical reports. The Assessment Guidelines set out a list of matters to be investigated and the results reported in the EES are summarised under headings corresponding to the contents of the list.

The Assessment Guidelines for the EES are quite directive in this field. They required that specific matters be examined which are quoted, in part, below[109]:

- *Potential changes to:*
  -tidal levels, ranges and durations;
  -slack water, turbulence, currents and water flow in and around the Rip;
  -seawater movement within the Bay;
  -the movement and volume of seawater flowing into and out of the Bay, and seawater residence times in the Bay
  -the extent of land inundated by tides (i.e. boundaries of wetted areas or intertidal zones)
- *Potential changes to currents, wave patterns and refraction in the vicinity of deepened channels, as well as in the vicinity of 'spoil grounds'.*
- *Potential impacts on seabed and coastal erosion, and sediment movement in Port Phillip Bay and around Port Phillip Heads, including for Swan Island, Swan Bay, Mud Islands, the Bay's beaches, dunes and cliffs, and other foreshore environments.*

The Assessment Guidelines also required the study of turbidity and sediment movement in the bay. However, these topics are both studied in detail in another section of this Panel Report.

Tide Levels, Ranges and Duration

The results set out computed changes in tide levels for a typical month. At Williamstown, where tide levels were found to have the largest change, tide levels up to 8 millimetres higher at high water and up to 9 millimetres lower at low water are predicted. Tide level will be increased or lowered for short periods around the time of high and low tide. Changes will be less for other locations. The average sea level at all locations will be unchanged.

The Panel is in agreement with this prediction, although, having regard to the likely accuracy and reliability of model conclusions, it would prefer not to express this range as having too certain a value. A maximum increase in tidal range of about 20mm appears to be the likely result of the proposed dredging.

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[109] Assessment Guidelines p14

Slack Water, Turbulence, Currents and Water Flow in and Around the Rip

The Panel notes that there will be increased volume of flow through the Rip. The increase in cross sectional area to carry this additional flow means that the overall increase in current speed is not likely to occur. The magnitude of any localised change in current speed is not apparent, nor is the effect on ships traversing The Heads.

Seawater Movement within the Bay

The EES reports only that current speeds would be changed by less than 1.6% in the Great Sands region, excluding the shipping channels. Change in the shipping channels is not described.

Changes in wind-driven currents are simply described as 'small' changes when they appear to be much larger than 1.6%. The position of an eddy about 10km from Ricketts Point will be moved. The changes are stated in the EES to be insignificant compared with the complexity of the wind-driven circulation in the Bay.

Impacts of the project on currents and the effects of the increased currents could be much larger than the EES suggests. It appears likely that an increase of up to 20 million cubic meters of water flow with each tide will have a significant effect in the southern part of the Bay, especially the channels and sand bars of the Great Sands.

The Movement and Volume of Seawater Flowing into and out of the Bay

This is an important matter. No quantitative descriptions of present flows and predicted changes in the flows are presented in the EES. The Panel finds that examination of the changed volumes of seawater flowing into and out of the Bay is inadequately treated.

Dr Provis identified that the project will make in the order of a 2% increase to the volume of water exchanged, which is currently estimated to be 1.3 cubic kilometres of water. The Panel notes that 2% of 1.3 cubic kilometres corresponds to an extra 26 million cubic metres of water (Dr Black refers to a volume of 20 million cubic metres). This is said to pass through The Heads on a typical tidal cycle. The wording leaves some ambiguity as to whether this volume represents the volume on each of the ebb and flow stages of the tidal cycle or the sum of the ebb and flow. The difference amounts to a potential factor of two change in a most important finding of the hydrodynamic study.

This additional water flow will continue permanently after the dredging is completed. Taken over a period of many years it will have a substantial influence on the Bay. This will be significant whether this additional volume of water moves through The Heads and across the Sands two or four times each day. It will change the flushing time of the water in the Bay and little by little it will change the sediment distribution in the Sands.

Seawater Residence Times in the Bay

No calculations are presented for the effect of increased water flow on residence times in the Bay.

The Panel regards this as a major omission. Residence time of water in the Bay impacts on the fundamental properties of the Bay water. It influences salinity and temperature and flushing of nutrients and pollutants from the Bay. In relation to greenhouse gas considerations, it can influence the state and capacity of the Bay as a net carbon store or emitter. It has ecological effects including influence on the introduction and distribution of animal larvae into the Bay from Bass Strait.

The Panel finds that changes in seawater residence times in the Bay are not discussed in the reports on hydrodynamics.

Extent of Land Inundated by Tides (boundaries of wetted areas or intertidal zones)

No report is made on application of hydrodynamic modelling to predict the location and extent of land where increased inundation or drying would occur. This study would require detailed topographical data at the water margin, without which predictions of the extent of inundation cannot be effectively made.

This is a major omission on a matter that impacts on terrestrial ecology, especially the activities of shore-feeding birds that are of national and international significance. Prediction of changes to the extent of land inundated by tides is central to the Panel's ability to carry out its obligations under the EPBC Act. The changes are described in the EES as insignificant, but this conclusion appears to have been reached without the real changes being localised or quantified to any extent.

The Panel finds that extent of land inundated by tides or exposed to more drying is not well treated.

Changes in the Yarra River

The Panel has reviewed the hydrodynamic modelling in the Yarra River estuary. This modelling was restricted to an assessment of the effects of dredging on the stratified salinity regime. The study does not include assessment of water movements that could be used in predicting the behaviour of turbidity produced by dredging or the residence time of plumes generated by dredging.

Basic parameters such as the tidal excursion, tidal prism and residence times of the seawater layer were not investigated. This is mentioned in the section of this report on turbidity.

The Panel is concerned that a detailed evaluation of the hydrodynamics of waters adjacent to the cooling water inlet and outlet sites of Newport Power Station was not undertaken.

The Panel accepts the prediction that the salinity regime in the stratified Yarra estuary will be unchanged to any significant degree.

11.4 PEER REVIEW

Discussion

The peer review was carried out by Dr Kerry Black. Dr Black reports that the revised model described in the Calibration Report of the specialist studies and included in the EES is adequate for the impact assessment applications with some specific exceptions. The exceptions relate to the fact that the model is in two dimensions whereas the Bay experiences three-dimensional circulation. Thus the movement of muds and nutrients or pollutants cannot be accurately predicted.

The following is a selection of the most significant comments that Dr Black included in his review. Dr Black is critical of much of the report but in relation to one major finding he does agree with the report.

> ***The information provided in the hydrodynamics, sediment transport and water quality report is brief and presents only simplified interpretations of the model outputs, making application to assessment of impacts difficult.*** *Given the central role of this report and the very large amount of modeling that was undertaken, more results could be presented. Specifically, it would be beneficial to have more information on sediment transport, plumes and current changes. More detail is warranted around the Great Sands and ebb-delta, with diagrams at expanded spatial scales over regions predicted to be impacted.* [110]

> ***The information provided in the hydrodynamics, sediment transport and water quality report is too selective in relation to risks.*** *For example, the EES notes that current speeds are changed by less than 1.6% in the Great Sands region, excluding the shipping channels. However, the change in the shipping channels is not presented, while the changes to wind-driven currents are simply described as small changes when they appear to be much larger than 1.6%. The change outside the Heads also appears to be significant.* ***As such, the impacts of the project on currents and the components of the system that are influenced by currents could be much larger than the L&T report is suggesting.*** [111]

> ***Confidence limits need to be placed on the modeling of velocity changes due to the channel deepening****. For confirmation of the consultant's predictions of altered tidal currents, Primary Industries Research (Vic.) were asked by POMC to provide predictions from their modeling undertaken with the 3DD Hydrodynamic Model. When compared to the primary modeling, the predicted magnitudes of the current differences are similar, but changes to currents are predicted in the primary model at unexpected and unlikely locations, e.g. well away from the Bay in Bass Strait. The implications are that while the consultant's model may be "calibrated", when the differences between model runs are compared, unlikely results occur. One of the primary risks will be inaccurate predictions of sediment transport, which is highly sensitive to the differences in currents.*[112]

> ***The potential to change water levels in the bay is small (<10 mm).*** *The altered levels are not expected to have a significant effect on the bay, including low lying areas and intertidal zones. Lower frequency natural changes to levels (e.g. storm surge, greenhouse etc.) are not altered by the planned project because they are not sensitive to changes in entrance cross-sectional area or channel deepening. This has been previously demonstrated by the reviewer's own modeling of Port Phillip Bay.* [113]

> ***No information is provided in relation to changed requirements for extra maintenance dredging with the deeper channels.*** *The consultants conclude that maintenance dredging rates will not be changed, but my experience is that dredging would increase* ***because the shipping channel is larger in volume and deeper. The extent of the increase cannot be determined without sophisticated sediment modeling.*** *However, plans need to be put in place to mitigate this risk.*[114]

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[110] Dr Kerry Black, Independent Peer Review of Physical Environmental Reports – Water Movements and Coastal Processes, p11

[111] Dr Kerry Black, Independent Peer Review of Physical Environmental Reports – Water Movements and Coastal Processes, p11

[112] Dr Kerry Black, Independent Peer Review of Physical Environmental Reports – Water Movements and Coastal Processes, p11

[113] Dr Kerry Black, Independent Peer Review of Physical Environmental Reports – Water Movements and Coastal Processes, p13

[114] Dr Kerry Black, Independent Peer Review of Physical Environmental Reports – Water Movements and Coastal Processes, p14

> *Changes to sea levels will cause up to nearly 20 million cubic metres of water to flow in and out of the bay each tidal cycle. This can be calculated knowing that the tide level will be about 10 mm higher (worst case) and that the Bay surface area is about $2x10^9m^2$. Key risks relate to extra flushing and higher salinity in the Bay. Although extra flushing would normally be beneficial in a Bay, the potential adverse effects of this large volume are not described.*[115]

Panel Response

The Panel places considerable reliance on the written comments of Dr Black. Dr Black is experienced in computer modelling and has conducted studies of Port Phillip Bay. It should be noted that the Panel had no access to the models to carry out any checks of the results reported in the EES and so the access provided to Dr Black provides the one clear independent control as to data and methodological quality. The Panel questioned Dr Black during the public hearings. The proponents were able to respond to the views of Dr Black in questioning and through a written submission.[116]

The proponent did not dispute the views of Dr Black in any substantial way.

Taking Dr Black's responses in sequence, they can be summarised as follows.

- The reports are brief and could be made more useful to other experts who depended on this material.
- The information and discussion is selective.
- Confidence limits are not assessed and applied to the results.
- The reviewer agrees with the major finding on tidal changes.
- Extra maintenance dredging is likely to be required.
- Changes in water flow in and out of the Bay will be up to 20 million cubic metres each tidal cycle.
- The effects of extra flushing of the Bay are not described but may be adverse.

The Panel accepts the comments in the review by Dr Black.

11.5 SUMMARY

The Panel concludes that the predictions of tide level changes in the Bay as a result of dredging are likely to be of the correct order with changes in tidal range in the order of 20 mm, for short periods. This places the project into an impact context such that it can be accepted with reasonable confidence that major and unlooked for tidal range changes will not occur.

This finding is contingent upon the position that the current design of the project at The Heads does not significantly change. Should it prove necessary to remove significantly more material from The Heads than has been discussed in this report (and considerations of operational safety and design are such that such changes cannot yet be prudently excluded), then there would be potential to further change the aperture controlling the movement of water into and out of the Bay. In such circumstances, the modelling discussed in this chapter would have to be revisited.

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[115] Dr Kerry Black, Independent Peer Review of Physical Environmental Reports – Water Movements and Coastal Processes, p14

[116] Submission on behalf of Proponent Port of Melbourne Corporation. Part B – Engineering and Physical Processes.

Beyond this position, the likely precision of the current predictions cannot be assessed as the report fails to include any calculation of confidence limits on the model results. A statement of confidence limits, which entitle a significantly more certain view to be taken as to weight, would have assisted the Panel. It could still assist decision makers.

It follows that the key conclusions in relation to hydrodynamics summarised in the EES may have presented an unsubstantiated impression that changes would be negligibly small or could be safely disregarded. Consequently, where other expert consultants have relied on these conclusions without understanding the confidence with which such predictions were made, their work may have limited reliability.

The Panel supports the conclusions of hydrodynamic modelling as to changes in tide level. However, it notes that the confidence limits of the results were not presented and considers that they should be before the project is assessed. Lack of confidence limits means that the Panel cannot assess the order of magnitude of short or long term changes.

12. TURBIDITY & SEDIMENTATION

This chapter considers turbidity: the production of particulate matter by dredging that becomes suspended in the water column, reducing or eliminating the capacity of water to transmit light. It considers the generation of turbidity by dredging processes. It also considers the ways in which turbid water plumes develop in the Bay, due to the combination of dredge campaign location and duration and hydrodynamic processes. In turn, it forms a key input into the Panel's consideration of Bay nitrogen processes and marine and terrestrial ecological considerations.

The chapter considers:

- the relationship between dredging and turbidity;
- the environmental impacts of turbidity; and
- the modelling of turbidity plumes (which took place in various stages).

The chapter then moves on to consider:

- sedimentation from dredge plumes; and
- sediment movement on the bay floor.

12.1 TURBIDITY BACKGROUND

Discussion

Metropolitan Melbourne is a bay city. It possesses a highly significant asset, in that the waters of its Bay are generally clear. This is largely a result of the Bay being in a healthy state with only moderate levels of dissolved nutrients and moderate algal growth. Water clarity is important in relation to human activities and in maintaining the health of the Bay and its varied fauna and flora. That such a condition persists is a credit to the planning and environmental management processes that have accommodated millions of people within the Bay catchment in the past 150 years. However, for a number of reasons set out below, it is also critical that this condition is sustained for future generations.

As a Bay city with a pleasant climate, Melbourne has a coastal lifestyle. Clear water is visually attractive to visitors to the coast and especially so to those who enter the water for recreation. Clear water is pleasant for swimmers and essential to divers who need it to see the underwater environment and for safety reasons. Historic activities such as the discharge of untreated effluents or scallop dredging led to less than satisfactory water quality and clarity in the past. Several decades of policy effort and public expenditure have improved the Bay to its present quality. Improved clarity of the waters is one of the reasons that a range of water sports are increasing in popularity.

Good visibility is needed by predatory animals including diving birds and penguins seeking to catch fish. Seagrass and seaweeds need a minimum level of light for survival and growth and they in turn are nursery areas for important recreational and commercial fish species.

In the Bay, the low level of dissolved nitrogen limits algal growth and an increase in algal growth would cause an increase in turbidity. The level of dissolved nitrogen is kept down by the process of denitrification that occurs at the surface of the bottom sediments.

Denitrification is mediated by microphytobenthos, small organisms that live in the surface layer of the sediment and require light. This leads to a situation where an increase in turbidity could reduce light at the sediment surface thereby reducing the efficiency of denitrification. This could start a cycle where interference with denitrification allowed an increase in dissolved nitrogen levels resulting in an increase in algal growth. his would increase turbidity and the cycle could intensify. The outcome could be eutrophication and an irreversible change in the state of the bay (or parts of it) to one of high nutrient levels and high turbidity. Such a state would clearly interfere with and depress enjoyment of the beneficial uses of the Bay described above.

A major environmental effect of dredging is the generation of turbid plumes in the water. This arises by a number of mechanisms and needs to be controlled to ensure that turbidity plumes generated by dredging do not cause unacceptable environmental consequences. An investigation of turbidity and its consequences was a major part of the present EES process.

12.2 ENVIRONMENTAL IMPACTS OF TURBIDITY

Discussion

In turbid water, the suspended particles both block light and scatter light by reflection. The result is that turbidity reduces light transmission through the water column and causes a reduction of light intensity with increasing depth.

It is for this reason that the American Public Health Association define turbidity as an:

> *…expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample.*

There is reduction of light intensity with increasing depth in clear seawater. Light of long wavelengths (red light) penetrates deeper than light of shorter wavelengths (blue light) and the relationship between turbidity and transmission is not a simple one. Consideration of light in the environmental quality context is simplified by the fact that the visible light that people see is also in the wavelength range of light that is essential to plants for photosynthesis.

Suspended sediment in seawater eventually settles through the water column back to the seafloor. The rate of settlement is faster for particles of larger diameter and very slow for the finest particles. Settling rates vary from metres per hour for fine sand to metres per day for fine particles. In the sea, water can be turbulent as a result of currents, wind and wave action. This has most effect on fine particles and vertical water movements may interfere with their settling. Settling of the coarser particles is less affected and they typically settle quickly, irrespective of all but the most extreme conditions.

In the water column turbidity effects can include a reduction of the rate of photosynthesis in phytoplankton and interference with visual feeding by predatory animals (including seabirds).

The suspension and later settlement of sediment results in a transfer of material from the dredged channel, or from the disposal site, to the sea bed in adjacent areas. One result in the affected areas can be covering of organisms living on the seafloor – benthic organisms.

The mass of material falling on the benthic organisms, the rate at which it accumulates and the particle size of the depositing material depend on a range of factors. The effects on the organisms also vary.

For plants an important effect is blocking of light and reduction of the rate of photosynthesis. For animals blocking of gills interferes with oxygen uptake, and blocking of filter feeding apparatus or reproductive apertures interferes with feeding and breeding.

This is a brief summary of some important and widespread environmental effects of turbidity. The effects are dealt with in sections describing the ecology of important species including fish, penguins, shore birds, seagrass, seaweeds and the microphytobenthos (MPB) that are important agents in the nitrogen cycle in the Bay. It is important to understand the capacity of turbidity to exert significant and adverse environmental effects.

12.3 DREDGING AND TURBIDITY

Discussion

During dredging, sediment is detached from the bottom by the dredge equipment and in principle it is transferred to a dredge hopper or barge for disposal. The amount of detached sediment that is released into the seawater depends on many factors; principally the type of equipment being used, its mode of operation and the physical nature of the sediment.

Sediment that is loosened from the bottom but not gathered immediately into the spoil collecting system is subject to rapid and vigorous dispersal by the action of dredging itself (e.g. the passage of a drag head) and the propellers of the dredge vessel. This is apparent in a plume of turbid water in the wake of an operating dredger.

Where sediment is gathered into the spoil collecting system by a method that entrains water, entrained water can be retained within the hopper. This water is allowed to overflow via a valve back to the sea. Overflow water contains finer sediments in suspension and is a source of turbidity.

When dredge spoil is discharged at the spoil ground there is further mixing of sediment and seawater. This can occur as the material is released from the dredge hopper, as it falls through the water to the bottom and by the impact of the rapidly sinking sediment on the seafloor. There is the possibility that existing unconsolidated sediment on the seafloor at the disposal site can be resuspended by the impact of the deposited material. The suspended material introduced by these mechanisms at the spoil ground can also be subject to rapid and vigorous dispersal by the action of the propellers of a dredge vessel. Impacts vary depending on the chosen methods of dredged material placement.

A further source of suspended sediment in seawater is the sediment lost by the dredger as it travels from the dredge site to the spoil ground. This may be a distance of many kilometres and cause a long trail of turbid water.

The behaviour of turbid plumes generated by dredging can be predicted by mathematical modeling. These combine information about the suspended material with predictions of water movements and sinking rates for the particles. They can produce outputs showing changes in plume density and extent over time for a proposed dredging program.

Mathematical modelling to predict the behaviour of turbid plumes is an essential component of the study of the environmental effects of the dredging.

In relation to issues raised in submissions, submitters were concerned that turbidity modelling by the proponent had not adequately represented the likely extent, duration and intensity of plumes. As a consequence it would not be possible to use the results to assess ecological impacts of the dredging.

12.4 MODELLING TURBIDITY PLUMES: STAGE 1

12.4.1 INTRODUCTION

Discussion

The modelling of turbidity in the Bay provides the physical basis for managing the effects of dredging during the proposed project.

The management principle the proponent proposes to employ in the south of the Bay is based on adaptive management. This has been chosen over alternatives and in the form advanced before the Panel does not embody best practice. The management process is to set threshold limits and performance criteria for environmental outcomes and manage the dredging program to keep within the threshold limits. A full explanation of this is given elsewhere.

Threshold limits and performance criteria for a vast array of situations are listed in the draft EMP. Implementation of many of these requires forward predictions of environmental effects (including light budgets at seagrass beds) for up to a year, using output from the turbidity model predicting turbidity plume behaviour over the immediate weeks ahead. These predictions are to be used as the basis for modifying the dredge program on a day-to-day basis with the objective of staying within threshold limits and ultimately meeting the performance criteria.

12.4.2 THE MODEL

Discussion

The model used has been described in part in the Hydrodynamics chapter, but it is so central to the management of the entire environmental outcomes of the proposed dredging program the basic outline is repeated here.

The hydrodynamic model used is a commercially available mathematical model developed by Delft Hydraulics of the Netherlands. Modules of the Delft Model were used for different purposes[117]:

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[117] Dr David Provis, Expert Witness Statement, p4

- **Flow:** computes the currents and sea level variations in two dimensions giving vertically averaged currents. (This is also capable of three dimensions where currents are computed at different levels in the water. Some three dimensional computations were carried out after the EES was released.)
- **Waves:** computes the generation of waves by wind taking into account changes in water depth, currents, bottom friction and wave breaking.
- **On-Line Sediment Transport**: computes the dispersion and settling of material placed into suspension by dredging.
- **Morphology:** uses the previous three modules to compute changes in the seabed caused by sediment transport.

The model conditions outlined in this section are taken from pages 36-38 of the technical report prepared by Dr Provis[118]:

> *The Delft3D FLOW model with the added "on-line sediment" module was used for the turbidity modelling. Two models were used based on the two-dimensional hydrodynamic model for the whole bay and the north of the bay. The sediment component of the FLOW model was included in the model set-up to simulate the settling and dispersion of sediment plumes in the water.*
>
> *The coarse sediment (sand) and the fine sediment (mud/silt/clay) have different settling characteristics and transport mechanisms, therefore the two are modelled as separate fractions.*

Input

In the initial turbidity model runs described in the EES documents, input parameters included only two classes of particles, designated as 'sand' and 'mud'. The sand was assigned a diameter and the smaller cohesive particles (mud) were assigned a settling rate. To allow for the influence of turbulence in the water on particle sinking both were assigned critical shear stresses for deposition and erosion:

The input parameters for the turbidity modelling were adopted as[119]:

- Median sediment diameter (sand) 0.05 mm (50 μm)
- Settling velocity (mud) 0.002 m/s
- Density of sediment (sand and mud) 2650 kg/ m^3
- Critical shear stress for deposition (mud) 0.1 Nm^2
- Critical shear stress for erosion (mud) 0.5 Nm^2

The proponent described this in the following terms[120]:

> *The modelling thus considered two fractions (*sand and mud*). Since the settling/re-suspension formulation for cohesive and non-cohesive sediments is different, they cannot be combined in a single run in the model. By treating the sediment as only two fractions, the results concentrate on the sedimentation for the sand and the turbidity for the fines.*
>
> *For impact assessment, the results from the two fractions are combined outside the model computation. The coarser sands, greater than 62 μm, were not included in the*

[118] Lawson & Treloar – V 3B -1 pp36-38

[119] Lawson & Treloar – V 3B -1 p38

[120] Lawson & Treloar – V 3B -1 p38

computations because the results of SKM (2003) indicate that these sediments will settle out within 5 to 10 minutes and hence be contained within the channel.

Consideration of these chosen particle sizes indicates that the sand at 50 µm is not much smaller than the 62 µm of the coarser sand (above) that was rejected because it would settle out within 5 to 10 minutes. The 50 µm particles may be expected to settle out in about twice this time giving it a residence time of about half an hour.

The mud settling velocity reported in the documents was 0.002 m sec $^{-1}$, which is the same as 7.2 metres per hour. If there were no turbulence to keep the particles in suspension they would reach the bottom of a 14 m deep channel in two hours.

This settling velocity of 0.002 m sec $^{-1}$ was later reported in expert evidence by Dr Provis on 4th October 2004 as an error[121].

The velocity was corrected to 0.0005 m sec $^{-1}$. This is a change by a factor of four. Using the revised settling velocity (equivalent to 1.8 metres per hour) the mud particles would reach the bottom of a 14 m deep channel in eight hours.

The section headed Comparison with earlier reports simply states[122]:

Some errors have been identified in the Calibration report, Chapter 9 which dealt with the turbidity modelling.

Page 38, table of values;

Settling velocity (mud) should read 0.0005 m s $^{-1}$

No explanation of the implications of this are given and the Panel is left not knowing whether the value for settling velocity actually used in the model was 0.002 m sec $^{-1}$ or 0.0005 m sec $^{-1}$

This is a matter of significance as all the results for turbidity modelling reported in the EES are based on whichever value was used. The results were used by other experts in their various studies. The proponent continued to describe the output in the following terms[123]:

The outputs from the modelling consisted of cumulative sedimentation, that is, the amount of material deposited on the sea bed, in kg/m^2, and suspended sediment concentration in the water column in kg/ m^{3}or g/L . Data were output both as two dimensional "fields" over the whole model-domain and as time series of values at a number of locations selected in consultation with biologists and ecologists. While the simulations are for limited time-periods, the time series can be combined in a variety of ways to simulate various dredging-scenarios. Linear superposition can be used to extrapolate deposition on the bed. The time history of suspended sediment concentrations can be added successively to extrapolate beyond the simulation time period .

Simulations for the entire proposed dredging-period were not undertaken because of the large computational effort required and the unknown scheduling of dredging in different areas. The modelling includes the effect of tidal movements and typical wind conditions.

Dr Black the peer reviewer had concerns as to the adequacy with which the first part of the hydrodynamic model had been calibrated. He also made strong criticisms of the turbidity modelling in the EES saying:[124]

[121] Dr David Provis, Expert Witness Statement, Annexure D, p8

[122] Dr David Provis, Expert Witness Statement, Annexure D, p4

[123] Lawson & Treloar – V 3B -1 p38

The Bay (particularly the Inner Bay) experiences 3-dimensional circulation (e.g. the top and bottom of the water column may flow in different directions), but the bulk of the modelling is only 2-dimensional or poorly resolved 3d .The reviewer's own published modelling of the Bay and the later work by CSIRO shows that 3d circulation occurs and has a strong effect on dispersal. In support of this, Fig. 4.8 in the Calibration Report shows differences between the 2d and 3d modelling. Thus, the movement of material (muds, nutrients or pollutants etc) cannot be accurately predicted with a 2-dimensional model, particularly in the Inner Bay. The implication is that material would be expected to spread more widely than that predicted by a 2d model.

The plume model simplifies the plume by using only two grain sizes, when there is a complete spectrum of sizes in the plume sediments from the proposed dredging. This simplification should lead to errors in the time for settlement and concentrations in the plume. The implications are that impacts to seagrass beds and other impacts due to turbidity could be over or under-estimated.

It is likely that the very fine sediment will remain in the water column longer than predicted by the model. The calibration of the sediment plume model against measured concentration decay rates appears to be good, but the presentation lacks clarity in relation to this assumption. The key implication and uncertainty relates to potential for higher concentrations of muds during dredging than predicted. The consultants would be advised to provide further information in relation to this risk.

The reviewer has been informed that the sediment transport modelling work will be undertaken by the proponent's specialist following the EES' exhibition and presented at the Panel Inquiry. As the sediment model calibration has not been completed, a review is not achievable.

One issue raised with Dr Provis as a possible model input was the degree to which re-suspension of materials or scour along the channels due to dredge and/or shipping movements might contribute to turbidity, during and after the works. Dr Provis confirmed that this was not considered as an input term at any stage in the modelling.

Panel Response

The Panel has previously recorded that it has some limited confidence in the degree to which predictions from the modelling can be relied on in relation to the most basic application but enough to accept the predicted tide height changes. The Panel has less confidence in the more complex issue of predicting turbidity plumes where errors are magnified by the need to add successively the outputs of many computer model runs.

The step from modelling water movement to modelling turbidity plume behaviour requires additional input. This includes information on the suspended sediment in the water at the starting time of the model run, the source data. It also requires information on parameters influencing the rate of sediment removal. These can be complex, including sinking rates and shear stress for sinking and re-suspension. Critical shear stress is the value below which a particle may be deposited (or may settle) or the value above which it may be eroded (or re-suspended). There is a further complication, that small particles may settle then be resuspended if the current or wave action is strong enough.

The Panel has carefully considered the position of the peer reviewer Dr Black in relation to the modelling reported in the EES, a position that it endorses. It had independently come to the view that the input conditions used in the EES were inappropriate. Examination of the model prediction for the turbidity plume over the Port of Melbourne Channel showed that it was a

[124] Black, Peer Review

very narrow elliptical shape that defied credibility. It supported the view that the two particle sizes chosen for the model were unrepresentative of the likely conditions of dredging. The absence of 3D modelling was also a concern. It appeared that the model was producing results that were conditioned by its input terms but were not representative of real environmental conditions.

The Panel does not propose to discuss results from this model in any more detail as they were withdrawn and superseded by results in a second report, generated using more appropriate particle sinking rates.[125] This second report was presented during the public hearing and is considered in following sections of this chapter.

Development of the turbidity model by the consultants followed the same path as development of the original hydrodynamic model used to predict tide level changes. In both cases, the first calibration of the commercial model was reported to be unacceptable by the peer reviewer and a second report describing revised calibration was prepared. Having major failures in calibrating two components of the hydrodynamic model limits the confidence of the Panel in the capability of the proponent in this field.

Finding after the hearings were concluded did the Panel realise that the most important parameter for the only fine particle considered in the turbidity model was being corrected by a factor of four. This did not add to the Panel's confidence in the whole modelling process. There had been numerous opportunities during the public hearings for the proponents to draw this matter to the attention of the Panel and explain the significance of the error.

This is a major concern because:

- other experts applied modelling results as fundamental environmental conditions in their assessment of the effects of turbidity on ecosystem components including seagrass, seaweeds, fisheries and penguin survival; and
- modelling is proposed to play a central role in making real time decisions on modifying dredging plans to ensure the program stays within threshold limits to ensure performance criteria are met.

The Panel is greatly concerned at the fact that two stages of the hydrodynamic modelling for the project were highly likely to give incorrect predictions of the effect of the project in relation to:

- prediction of changes in water movement, and
- behaviour of turbid plumes.

If modelling work is to provide the key to real time adaptive management of a dredge program, it must be carried out with the combination of accuracy and expedition and the community must be able to rely upon it. This is a theme to which the Panel returns.

Much of this analysis is carried forward to later sections of this chapter. However, in relation to scour and re-suspension, the Panel considers that this should be considered as an input term. It recommends as follows.

The proponent should quantitatively assess the potential for re-suspension of materials/scour along the channels and determine the environmental impacts that this will cause.

[125] Dr David Provis, Expert Witness Statement, Annexure D

12.4.3 RESULTS

Discussion

Because the original predictions of turbidity plume behaviour were withdrawn, only two sets of results are discussed here. These were generated using the two particle size calibration and were displayed in the Summary Brochure as Figures S7.3 and S7.4 and in the main volume of the EES as Figures 28.10 and 28.9

Model results show predicted extent of turbid plumes South of the Bay and North of the Bay. They show suspended sediment plumes with contours of maximum sediment concentration (mg/L) after 6 days of dredging in the Port of Melbourne Channel and after 5 days of dredging in the South Channel. They originate as Figure 7.8 and 7.6 in the Lawson & Treloar Report of June 2004[126]. The outer limits of the plume are bounded by the concentration value of 25 or 20 mg/L suspended material.

Inspection of the North of the Bay (S7.3) map shows that after six days the plume was closely retained over the channel. This appears to be an unlikely outcome.

Panel Response

On considering the input terms used the results are explicable. All the sand falls out almost immediately. The mud, with a settling speed of about 2 metres per hour, does not stay in the water column for more than about eight hours. This means that the scale of a turbid plume would approach its maximum extent after about one day. What is represented as the development of the plume over six days may possibly be similar to the state of development of the plume over only one day.

Where the sediment contains smaller particles they would remain in suspension for longer, achieve a wider dispersion and show a greater cumulative effect during dredge campaigns of more than one day. Practical observation of dredge plumes indicates this effect is most likely to occur. However, small particles were not considered in this model. The criticality of this is emphasised when one considers the physics of light attenuation in a turbid water column. Levels of turbidity as low as 2mg/L can significantly reduce the light available to the benthos in waters only a few metres deep. Small particle sizes at low concentrations can be the critical controlling factors for natural systems requiring access to light.

The choice of scale for the suspended sediment contours (20 – 200 mg/L) indicates that the initial modelling was based on an absence of understanding of the particles likely to be suspended, or of the environmental conditions that are appropriate for the health of the Bay. Primary producers on the seafloor (seagrass, seaweeds and the microphytobenthos) require a level of light above a threshold intensity for photosynthesis. The entire range of suspended sediment concentrations shown in this model would result in darkness below depths of a few metres. They do not encompass the threshold conditions between ecosystem viability and non-viability. The practical effect of this observation is discussed later in this section.

The Peer Reviewer suggested that the modelling of sediment plumes using more realistic sediment particle sizes and producing results in a more useful output form should be undertaken. The results were reported in Dr Provis' Annexure D, produced once the Panel hearings were underway.

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[126] Lawson & Treloar, Hydrodynamics, Sediment Transport and Water Quality Modelling, Report Rm2054/J5372

For the reasons set out above, the Panel recommends as follows:

No reliance can be placed on turbidity modelling in the exhibited EES to support environmental assessment or decision-making.

12.5 MODELLING TURBIDITY PLUMES: STAGE 2

12.5.1 CHANGES TO THE MODEL

Discussion

In Annexure D to Dr Provis' expert witness statement produced during the hearings the Panel was presented with a less optimistic but more realistic view of the requirements for the source term used in the model. The description of source terms in Annexure D is reproduced here as a statement of the many factors that influence the description of the suspended sediment at the start of the hydrodynamic modelling of the plume behaviour.

> *Source Term*[127]
>
> *The suspended sediment is introduced into the model by having flow into the model with a specified volume flow rate (cubic metres per second) containing a given concentration (kilograms per cubic metre) of the sediment in question. This flow is directed into a given grid cell and this cell can change as the model time progresses to simulate the movement of the dredge. A number of different materials with different properties can be introduced so that for turbidity, a number of "fractions", each with different properties, can be defined. This feature is used to provide a range of settling velocities for the different components which make up the total suspended material.*
>
> *The parameters which are required to simulate turbidity from dredging are therefore:*
>
> - *The timing and location of the dredge, how long it is dredging before the hopper is full and overflow begins, the total time of dredging, sailing time to the disposal site, time taken for disposal and sailing time back to the dredging location.*
> - *The total mass of material released by the dredge and the variation of this during the different activities of the cycle.*
> - *The composition of the discharged material, the proportion of various particle sizes and the properties of each of these, commonly termed "fractions" of the total discharge. (The impact of these properties is discussed below under "fate of the material").*
>
> *A major issue in the modelling is determining the amount of material to be introduced into the model, the so called "source strength". Dredge operators are able to provide estimates of the amount of material passing through the overflow under various operating scenarios. However there are other sources of material in suspension, in particular the scouring action of the vessel propellers on the sea bed and stirring up of the material from the overflow. The action of the propellers will depend on the power being applied, the distance from the propellers to the sea bed and the nature of the sea bed material. Estimates can be made, but ultimately there is significant uncertainty in these numbers. Another consideration is that when material is introduced to a grid cell in the modelling process, it is immediately distributed evenly through out the whole grid-cell. This occurs because the model maintains a single value for the concentration of each fraction in each grid cell. The effect of this process is to increase the initial spread*

[127] Dr David Provis, Expert Witness Statement, Annexure D, p2

> *of the material and reduce the initial concentration. In reality, the material placed into suspension by the dredge forms a plume with a width slightly wider than the beam of the dredge and tending to meander as the wash from the propellers is directed from side to side to keep the vessel on course. The initial conditions in the model might be considered as representing the conditions some distance behind the dredge where the material has spread laterally. The actual distance and degree of lateral spread will depend on the current strength and the detailed dredging conditions at the time.*

Annexure D also states that there must be input to the model that allows calculation of the rate of removal of the sediment. As is suggested above, defining this accurately is essential if reliable predictions of sediment plume behaviour are to be produced:

> *Fate of the Material*[128]
>
> *Once the material from the source(s) is in suspension and being advected and dispersed, some mechanism is required to remove the material from the model, to "allow it to settle". This is a complex sequence of processes in nature and these are simplified in the model. Each sediment fraction in the source term is assigned a settling velocity, a density and two critical shear-stresses, one for deposition and one for erosion or resuspension. At each time step, for each grid cell, the model computes the shear stress at the sea bed. Shear stress is a function of the water velocity and the bottom friction. If the shear stress is less than the critical value for deposition, material is allowed to "fall" out of suspension at a rate which is a function of the concentration and the settling velocity for each fraction for that cell. If the shear stress is above this value, no deposition takes place. If the shear stress is above the critical velocity for erosion for a given fraction, and there is material available on the sea bed, then some of the material on the bed is resuspended and placed back into the water column. In general, the critical value for erosion is well above the level for deposition so that material will accumulate on the sea bed. In this way, the material in suspension in the model is gradually removed and deposited on the sea bed, especially in areas with low current speeds. This reduces the sediment concentration. The concentration is also reduced by dispersion.*

It is clear that there can only be confidence in the model predictions if the wide range of parameters required are identified and known with confidence.

The origins of four source terms used by Dr Provis in the second round of modelling are examined below. These are:

- Particle settling velocities and critical shear stresses
- Eddy diffusivity
- Wind data
- Dredger operations

Particle Settling Velocities and Critical Shear Stress

The choice of particles used in the revised modelling described in Annexure D are the four below:[129]

[128] Dr David Provis, Expert Witness Statement, Annexure D, p3

[129] Dr David Provis, Expert Witness Statement, Annexure D, p4

Table 26: Annexure D Sediment Fractions with Settlement Velocities

Fraction	Percentage of Mass	Settling Velocity mm/s	Settling Velocity m/s	Settling Velocity m/hr
1	35	4.0	0.004	14.4
2	50	0.5	0.0005	1.8
3	10	0.1	0.0001	0.36
4	5	0.01	0.00001	0.036

The settling velocity of the mud particles entered in the first round of modelling (Stage 1) corresponds with the velocity of the new Fraction 2 (about 2 metres/hour). The settling velocity of the finest particles used in the new model, Fraction 4, at 0.036 metres per hour is 50 times slower than the mud particles entered in the first model sinking at 1.8 metres per hour.

Critical shear stress for deposition and erosion were assigned to each particle fraction.

There is no discussion of why the percentage of finest material was set at 5%. It would have been helpful if this figure had been related to the actual percentage of material this fine has been observed in sediments from all the areas that are included in the dredge proposal.

Eddy Diffusivity

Eddy diffusivity is the tendency of a suspended particle to diffuse in a water column. A value (known as a diffusivity factor or coefficient of eddy diffusivity) can be calculated from observations in the field, derived from previous published research or assumed. It can then be applied to a model.

A parameter for eddy diffusivity was entered into the model:

> *The only input parameter in this section is the coefficient of eddy diffusivity for the horizontal dispersion of the suspended material. A value of 10 metres squared per second has been used. This is the default value recommended for Delft 3D and there is no means of verifying the validity without very detailed calibration.*[130]

In short, the value was left at the default value set by the model supplier, with no questioning as to whether this might be relevant here. This amounts to derogating from the capacity to even assume a value. An assumed value at least rests on the judgement of the locally based expert as to relevant conditions.

The peer reviewer Dr Black is an experienced modeller. He expressed great surprise at the magnitude of the eddy diffusion value used in the model. Dr Provis offered no explanation for the magnitude beyond saying it was the value recommended in the operating manual for the

[130] Dr David Provis, Expert Witness Statement, Annexure D, p5

model program. Dr Black however stated that typical observed values are orders of magnitude lower.

Wind Data

Dr Provis described the selection of wind data for the purposes of the re-modelling in Annexure D.

> *The winds were selected to provide a range of conditions. The winds from September 1994 (figure 8) included a sustained period of strong winds from the north west to south west, the winds in July 1994 (figure 9) were more normal with strong north to north-westerly winds with lighter east and north-easterly winds. The February 1995 period (figure 10) included a sea-breeze system with south and south westerly winds with diurnal cycles.*[131]

Dredger Operation

The dredge cycle times and associated numbers applied in Annexure D are based on data supplied by the Alliance for "The Queen of the Netherlands", with some minor adjustments in times to fit into the modelling.[132]

Results from a number of runs are presented in order to provide some indication of the impact of various changes to the dredging method.

The chosen conditions include some time of simple dredge operation, some time with non-overflow and some time with the green valve operation. The time of the dredge program is not made obvious in Appendix D. By examining Table 4 containing complex details of the scenarios used in modelling and then examining Table 5 stating the number of cycles used in simulations, the Panel was able to come to a conclusion that the maps probably represent nearly two weeks dredging. This is supported by graphs showing results of sediment concentration extracted from the data at fixed points in the south of the Bay against time. The time scale is seen as extending from 14/09/1994 to 26/09/1994 which is about 12 days. In the North of the Bay the winds are from February 1995. The 1994/5 times were used because wind data was available from the Port Phillip Bay Environmental Study work.

The new results are presented as maps in Figures 1 to 7 showing contours of percentage time a given level of suspended solids is exceeded. The levels are 2, 5, 10 and 20 mg/L.

Time series suspended sediment concentrations for three set places are presented in Figures 11 and 12.

The modelled duration is for about two weeks, when the proponent proposes campaigns of considerably longer duration.

Panel Response

In relation to the chosen four fractions and their settlement velocities, the Panel observes that, in terms of settlement velocity, the second fraction is approximately equivalent to the smallest (mud) fraction in the EES modelling. It settles at a rate of 1.8 m/hr. However the model introduces two new smaller fractions. The smallest fourth fraction has a settlement rate that is 50 time slower than the minimum settlement rate considered in the original EES modelling.

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[131] Dr David Provis, Expert Witness Statement, Annexure D, p5

[132] Dr David Provis, Expert Witness Statement, Table 4, Annexure D

If the original sinking velocity of 7.2 metres per hour were to be accepted then the difference between the Stage 1 and Stage 2 sinking rates would be 200 times.

This indicates the order of magnitude of the error made in choosing particles for the Stage 1 modelling that was reported in the EES. These were provided to all the other consultants as the basis for their assessments. It was prominent in the widely circulated summary document of the EES and in the main volume of the of the EES.

In relation to eddy diffusivity, the Panel finds a strong likelihood of potential for major error still being present in the model, based on Dr Black's critique. This raises uncertainty about the calibration of the model. If this parameter is in error but the model still gives credible output then it is possible that a second parameter is in error in a compensating direction.

The Panel has no way of assessing the true position but regards it as essential that substantial effort be made to verify the calibration of the model. This should be done before any reliance is placed on the model predictions.

In relation to wind conditions, the Panel notes that these were selected from a short time period during the Port Phillip Bay Environmental Study, from which a prior data set was available. This was done for convenience. The period chosen does not contain the full range of conditions that will be encountered over a two year dredging campaign. The capability of the model to predict outcomes of extreme or infrequent events has not been assessed. In this aspect the modelling is therefore not conservative.

The Panel notes that no attempt was made to model a credible dredge campaign of a duration typical of those set out in the Boskalis Channel Deepening Dredging Program. At the outset of the Panel hearing process, the Panel released an issues paper to accompany its directions. This indicated that the Panel perceived a strong need for what it called a 'proof of concept' approach to dredge impact modelling. In relation to turbidity a number of discussions between the Panel and the proponent made very clear that a credible assemblage of model outputs to examine the likely order of effects of turbidity plumes from a simulated dredge campaign was sought.

The proponent's initial response was that it would be possible to produce within the anticipated timescales of the Panel enquiry the output of a 'proof of concept' turbidity model. Its clarified position was that to cover a long dredging period such modelling would consist of a summed sequence of two week models similar to those summarised in Annexure D. It was asserted that this could be produced it time to be presented at the Panel's foreshadowed workshop on environmental management, near the end of the hearing.

The Panel had some concerns, on the basis that such modelling could potentially apply compounded errors and use repeated, unrepresentative and seasonally dissociated wind data. However, it considered that on balance the exercise in scoping the indicative turbidity effects of a whole of dredging campaign was still a worthwhile input into its consideration of environmental management. It also saw this exercise as a valid test for the concept of adaptive management. If modelling is to play any role in an adaptive management framework, it must be capable of swift response, when recalculating plume behaviour when conditions unexpectedly change, and timely analysis output to assist the needed real time decision-making.

The proof of concept was not produced which gave the Panel some concern whether the proponent possesses the capacity to use such modelling in a real time adaptive management framework. Returning to the results that were presented in Annexure D, the Panel notes that the model output has not been verified by field measurements. At the time of the end of the hearing it appeared that the model remains a potentially valuable tool but its accuracy and reliability has not been demonstrated to a level that makes it acceptable. The central role played by the model in the prediction of the effects of dredging on the Bay ecosystems imposes the need for high standard of reliability before acceptance. Particularly, it has not been demonstrated that it is effective in the time scales required for real time adaptive management.

12.5.2 MODEL OUTPUT AND APPLICATION

Panel Response

The Panel would like to look beyond the problems of calibration and verification and the continuing problem of what is to be used as the input term for sediment plume predictions and examine the positive aspect of applications of the modelling.

Annexure D modelling shows that the usefulness of the model is enhanced when the form of the output is directed towards the needs of its users. The adoption of maps showing sediment plume extent with contours of percentage of time that a given level of suspended solids is exceeded is a potentially useful style of presentation. The concentration of suspended solids present is entering the useful range relevant to assessment of impacts on light availability by extending down to 2mg/l. The plotting of sediment concentration against time for spot locations is important in predicting when threshold limits are being approached and modifications are required to the dredging program.

Contribution by Dr Roberts

The results that were presented as maps and plots of suspended sediment versus time at fixed locations were taken by Dr Roberts of Monash University and subjected to quantitative analysis to interpret their content in an environmental context.

Dr Roberts of Monash University made valuable submissions on a number of topics. He took results in Annexure D and used them in a demonstration of their powerful potential for application to specific environmental issues.

Dr Roberts used the data to prepare graphs of the area of the Bay covered by the plume against percentage of time for a model two week dredging campaign. From this he calculated the area of seafloor of the Bay impacted at suspended sediment concentrations of 2 and 5 mg/L in the water column. Dr Roberts went on to calculate the effect of these sediment concentrations on light attenuation at different depths in the water column.

Because light levels at the seafloor decrease with increasing depth, and light is important to primary producers including microphytobenthos, Dr Roberts compared the area of the 2 mg/L plume with the map of Bay bathymetry and with the map of microphytobenthos biomass. As light intensity is a product of turbidity and water depth, the consideration of bathymetry and turbidity allows assessment of what area of the seabed may be affected by light reduction. Taken with the model output of percentage of time any level of turbidity is predicted to occur it is possible to make quantitative assessment of the effects of dredging. Dr Roberts has demonstrated the value of this approach in protecting important seagrass and seaweed communities and the more generally distributed microphytobenthos.

Panel Response

The Panel observes that Dr Roberts' practical developments based on the Annexure D modelling is indicative of the fact that the proponent is perhaps moving towards the development of a scientifically relevant tool.

The panel notes that the EES and the proponent team of specialists produced no quantitative assessment of the physical area predicted to be affected by dredge plumes and no quantitative assessment of their environmental effects. The discussion of the turbid plumes was focused mainly on the model rather than on their predicted effects.

The Panel in validating its own judgements on the implications from modelling, placed considerable weight and reliance on the analysis undertaken by Dr Roberts. It thanks Dr Roberts for giving generously of his expertise and time over the long period of the hearings to assist in this regard.

Conclusion

The Panel notes that there are limits in the reliability of the calibration of the hydraulic model as used in predicting water movements. These limitations are magnified when modelling turbidity plumes over long times as a result of the need to combine the outputs of many computer model runs. Complexity in the input and removal terms further increases the uncertainty that the model output will represent real plume behaviour when dredging is undertaken. The diffusivity error identified by Dr Black is a fundamental matter that requires further consideration before the model outputs can be considered useful: as highlighted above.

Flowing from these errors, the Panel cannot presently place confidence in the predictions from the model. Further, as with previous modelling, there has been no discussion of confidence limits in the reports: an omission that requires to be rectified. Because of their late emergence, the model results presented in Annexure D have not been set in a holistic environmental context by suitably qualified experts from the EES team.

The Panel notes that the model has potential to provide useful predictions of turbidity resulting from dredging and is deserving of the time and resources necessary for further development. The Panel recommends:

The Annexure D turbidity modelling prepared for the proponent provides a valuable step towards viable turbidity modelling for use in environmental impact assessment of dredging. However, before it can be fully used in assessment, the following must be undertaken:

- the model must be calibrated with further reference to real Bay data. Specifically, the selection of the eddy diffusivity factor must be justified or amended. Runs with appropriate representative meteorological data must be undertaken, with some attempt made to control against foreseeable extreme events.
- a methodologically sound means of assembling a 'proof of concept' model of a whole of dredge campaign under a range of meteorological conditions should be pursued.
- If the model is still intended for use as a real time adaptive management tool, trial runs of expedited responses to real time environmental effects and change processes must be undertaken.

Boskalis Involvement in Modelling

A new approach to providing model input terms was raised in the closing days of the hearing and the Panel finds it difficult to effectively evaluate the prospects for success of this new information. This essentially involves taking turbidity measurements from the dredge with equipment supplied by Boskalis to input to the hydrodynamic model.

Whilst the Panel did not receive details of how this arrangement might work in practice, it has some concerns that an extensive period of collaboration and testing between the Alliance partners would be required to implement it effectively, and any such system must be open to scrutiny from regulators.

The Panel recommends as follows:

Whilst there is virtue in interactive real time modelling of turbidity plumes from data gathered in the field, this must be done using mechanisms that provides real access to monitoring and compliance tools to the relevant regulatory authorities and does not delegate them exclusively to the dredge undertaker.

12.6 SEDIMENTATION OF DREDGED MATERIAL

The model that is used to predict the behaviour of turbid plumes also produces predictions of the rate of sedimentation from the plume. This second function of the model is examined here.

The model starts with an input of suspended sediment material. It calculates the rate of removal of the suspended sediment and reports turbidity as the difference between the starting amount and the amount lost by sedimentation. The model has the capability to report the removal term and this gives the rate of sedimentation. One set of input data gives both the turbidity and the sedimentation.

The Provis Calibration Report describes the operation of the Delft3D FLOW model used to predict turbidity:

> *The outputs from the modelling consisted of cumulative sedimentation, that is, the amount of material deposited on the sea bed, in kg m-2, and suspended sediment concentration in the water column in kg $^{-3}$ or g L^{-1}. Data were output both as two-dimensional "fields" over the whole model-domain and as time series of values at a number of locations selected in consultation with biologists and ecologists. While the simulations are for limited time-periods, the time series can be combined in a variety of ways to simulate various dredging-scenarios. Linear superposition can be used to extrapolate deposition on the bed. The time history of suspended sediment concentrations can be added successively to extrapolate beyond the simulation time period.* [133]

Effects of Sedimentation

The effect of the plume on benthic organisms is the combined effect of the light loss caused by the suspended material and the various effects of the deposited silt. In order to be able to predict the effect of dredging on benthic organisms it is essential to have the information on both terms.

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133 Lawson & Treloar, Hydrodynamics, Sediment Transport and Water Quality Modelling, Report Rm2054/J5372, p38

In the north of the Bay sedimentation of potentially toxic sediment from the Yarra would occur and it is necessary to have predictions of the areas over which this will prevail and the amount of material settling. Contaminants are present at higher concentrations in the finer particles and these will be the particles most widely distributed.

Results for Sedimentation

The chapters by Dr Provis on the hydrodynamic model contain some results for predictions of the extent of suspended sediment plumes. Results for sediment deposition are not given in those chapters but are contained in the report by Dr Edmunds and others on Marine Ecology.

Dr Edmunds made a substantial scientifically based assessment of the potential effects of dredging on the ecology of Port Phillip Bay. The effect of the physical changes is described in the volume Physical Pressures and Effects Analysis in the Ecology Specialist Studies. Dr Edmunds considered 20 simulated dredging scenarios made up of 5 dredging cases starting in 4 seasons. He made a detailed analysis of the results using the Delft Model. The program is described as follows:[134]

> *Hydrodynamic models of the northern and southern regions of Port Phillip Bay were developed for this project by Lawson and Treloar Pty Ltd (Lawson and Treloar, 2003). These models were used to predict the sediment plume conditions and plume movement from tidal and wind conditions. Inputs to the plume simulation models included initial sediment loadings arising from the dredging, provided by Evers Consult, and the cycling and movement patterns of the dredger. The cycles only considered placement of dredged material at the new spoil ground in the southeast and the existing/expanded area at the North Melbourne Spoil Ground. Because of considerable computation time required, the simulations were run for only a subset of the time required for the dredging in any given sector. The dredging simulations were run under a set of average tidal and wind conditions.*
>
> *The simulation models provided estimates of sediment water concentration in the water column (mg L^{-1}) and settlement of sediment onto the substratum (kg m^{-2}), for coarse and fine particle fractions. The ratios of these fractions and settling velocities were based on laboratory tests and comparisons with data from maintenance dredging (Dr David Provis, Lawson and Treloar, pers. comm.).*
>
> *The plume simulation models provided outputs as two-dimensional plots of bottom sedimentation and maximum suspended sediment concentration recorded during the simulation. The maxima were the highest hourly value at each model grid point. The models also provided time-series data (every half-hour) for each parameter at 109 a priori selected positions in Port Phillip Bay. These plume data extraction points were selected as places of particular biological interest, as well as important management zones such as marine protected areas and aquaculture zones.*
>
> *The time series for the full dredging sequence was constructed by concatenating multiple time sequences from the hydrodynamic modelling output. A subset of the hydrographic modelling output was selected for concatenation. In most cases, the subset consisted of four or five days plus one hour of time. The additional hour was used such that the dredging cycles and conditions at a particular location occurred during various hours of the day over the campaign period. The time sequences used for this project are given in……. The plume conditions were not modelled for dredging in the Yarra River. The sequence for dredging the Port of Melbourne Channel was used as s conservative substitute – the plume arising from Port of Melbourne being likely to be transported to a wider range of places than the plume arising from dredging in the Yarra River.*
>
> *The data for cumulative sediment settlement was concatenated by addition to the sediment previously settled. An exception was for the fine suspended sediment concentration at Popes Eye, Nicholsons Knoll, West of Beacon 2 and East of Beacon 2. This sediment fraction was deemed likely to be accumulated in the water column, based on maintenance dredging*

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[134] Australian Marine Ecology, Physical Pressures and Effects Analysis, V3A2, pp9-10

operations (Dr David Provis, Lawson and Treloar, pers. comm.). For the simulations, the concentration was accumulated over the first four days, after which the fall-out rate was assumed to be in equilibrium with the accumulation rate (Dr David Provis, Lawson and Treloar, pers. comm.). To do this, a linear regression was fitted to running 12 hour averages of concentration for the first four days. The time sequence of the residual values from the regression was then added to the fourth day end value of the regression, for all times thereon.

This will sound familiar as the sedimentation model is simply a different output set from the same model discussed at length above in relation to turbidity plumes.

Results are presented as contour maps of maximum suspended sediment concentration (mg /L) after various numbers of days dredging (Figs 2.5 to 2.10) and as corresponding maps of sedimentation (kg/m ^{2}) in (Figs 2.20 to 2.24)[135]. Time series for sediment concentration (mg/L) data are extracted for 109 selected points of biological interest or in important management zones. This is important in relation to light attenuation and the effect on light budgets, described elsewhere in this report. The total sedimentation rates at different cumulative percentiles (5 %, 10 %, 25 %, 50 %, 75 %, 90 %, 95 % and 100 %) were determined for northern and southern points, and converted to units of mm/day. These graphs [136] therefore indicate the total amount of time that sediment concentration and settlement exceeds particular values for each scenario.

This is valuable and imaginative application of modelled conditions to predict the physical effects of dredging in different conditions. It is used in estimating the likely effects on marine communities including seagrass. It is particularly important in relation to predictions of the effect of dredging on light budgets. This is discussed in other sections of this report.

The Panel finds that the applications of modelling demonstrated by Dr Edmunds has the potential to be a valuable aid in managing future dredge programs. This work should be continued and extended, but most importantly should be based on sound underlying predictions of sedimentation and turbidity.

Taken with the input by Dr Roberts that extracted important relevant information from the suspended sediment output from the same model, this work shows the possibilities for quantitative assessment of the environmental effects of dredging and the real possibility of objective management to achieve environmentally acceptable outcomes.

At the time of writing this report there is an impediment to implementing the scientific application of the model. This it the poor state of calibration and the lack of verification of the accuracy and reliability of the model out puts.

All of this work reported by Dr Edmunds is based on use of the particle size and settling rate data provided early in the EES process and later shown to be inappropriate. Consequently the results described in the chapter by Edmunds and his colleagues are not representative of what is likely to occur. These do not give a true picture for the extent of areas of significant turbidity and sedimentation, and when used for predicting environmental effects may lead to inappropriate management outcomes.

In response to comments from the peer reviewer and the Panel new modelling was undertaken using more realistic input data. This is described earlier in this section. New results were presented during the hearing (Annexure D from Dr Provis). These contained maps of suspended sediment distribution plotted as contours of percentage time a given level of suspended solids is exceeded. This is a useful presentation, especially as results are given down to a level of 2 mg/L (shown by Dr Roberts to be approaching an important threshold level).

Because of the unreliability of the results the Panel is not going to make a detailed report on predicted rates and patterns of sedimentation. Given more time it would have been possible to make some

[135] Australian Marine Ecology, Physical Pressures and Effects Analysis, V3A2, pp20-25

[136] Australian Marine Ecology, Physical Pressures and Effects Analysis, V3A2, pp67-74

interesting comparative but non-quantitative comparisons in the effects of the various conditions considered.

Typical of the results presented in the EES is that showing the model prediction of the area expected to be affected by settling sediment from dredging in the Port Melbourne Channel. The predictions for a six day dredge program are shown in Fig 2.24 of the Edmunds report[137]. This depiction of sedimentation is similar in appearance to the predictions of the extent of the suspended sediment plume in the same place after the same time. Again, visual inspection shows a small spread of material and the result it is not credible.

The Panel notes that there was no field-testing done to verify the computer predictions of sedimentation from the dredge plume. It is clear that had any field verification been done the inappropriate nature of the computer simulations could have been detected and remedied at an early stage. The Panel has recommended field verification above in relation to turbidity plumes, which should also extend to sedimentation.

The Panel recommends:

Real-time monitoring and medium term predictions of plume behaviour are only suitable for confirming progress and making small modifications to the dredging programme to ensure threshold limits are complied with. Computer modelling and plume predictions are not sufficiently reliable to permit them to be used to control major changes in a dredge program. This is a powerful driver for the adoption of a ‘best practice’ approach.

12.7 SEDIMENT MOVEMENT

The Assessment Guidelines[138] required that there be some investigation of changes in sediment movement in the Bay that could occur as a result of the dredging:

> *The EES should include a detailed analysis of potential changes to water and sediment movement and related coastal processes - in both the short and long-term - that may result from the proposed dredging and management of dredged material. This includes alterations to the channel depth profiles in The Rip and other channels, as well as from the passage of larger ships through the Bay (e.g. increased shipping wake).*
>
> *Appropriate modelling will be needed to assess the possible impacts, and the analysis should be sufficiently detailed to inform a sound assessment of risks to*
>
> - *Accelerated coastal erosion or accretion, including areas such as Mud Islands, Swan Island and Lonsdale Bight.*
> - *Altered seabed sediment movement patterns and physical processes, with associated ecological implications as well as implications for on-going maintenance dredging.*
> - *Potential impacts on seabed and coastal erosion, and sediment movement in Port Phillip Bay and around Port Phillip Heads, including for Swan Island, Swan Bay, Mud Islands, the Bay’s beaches, dunes and cliffs, and other foreshore environments.*
> - *Potential impacts on sediment movement in the Hobsons Bay area and the Yarra River estuary, as well as for the salt-water wedge in the Yarra estuary.*

137 Australian Marine Ecology, Physical Pressures and Effects Analysis, V3A2, p53

138 Assessment Guidelines, p14

The EES made only a partial response to these Guidelines relating to sediment movement. In the Lawson & Treloar the Scope of Work includes[139]:

- *sediment transport modelling with currents only for the south of the Bay;*
- *sediment transport modelling including currents and waves for Lonsdale Bight and the Great Sands;*

Initial Risk Assessment 28.4 on p28-9 of Vol 1 of the EES states:

> *The modelling work undertaken as part of this specialist study has shown that in general the changes in hydrological and sedimentation processes will be very small or imperceptible, and the resulting risks are therefore considered only 'moderate'. The key conclusions are that:*
>
> *Changes in currents will be small and confined to areas subject to dredging where the effect is largely the result of the change in available cross-section for the passage of water.*
>
> *There will be some small changes in the wave climate at the Heads, especially in Lonsdale Bight, resulting in some local changes in sediment transport, but any observable changes in coastal processes are considered unlikely.*
>
> *It is unlikely that there will be any significant change in wave climate as a result of vessel movement.*
>
> *No significant changes in the erosion and accretion processes in the Bay, the impact of which will be discussed in other chapters in this EES such as terrestrial ecology, and coastal engineering.*
>
> *There should be no increase in the need for maintenance dredging as a result of changes in erosion/accretion, with the possible exception of the potential for increased erosion and migration towards the channel, of any material placed at the Symonds DMG or environmental island, although neither of these alternative material grounds are preferred.*

The Residual Risk reported on (p48-5) of Vol 1 of the EES states:

> *The Hydrodynamic, Sediment Transport and Water Quality Modelling Study assessment of the Project found that:*
>
> *The change in tidal currents across the Great Sands will be less than 1.6 per cent, except in areas immediately adjacent to the areas to be dredged in the Heads and South Channel.*
>
> *The change in tidal currents north of the Great Sands will be very small in areas away from the DMG, with the percentage change difficult to quantify*
>
> *Wave heights will be within 1 per cent of existing conditions for most locations most of the time, and less than 1.5 per cent for all but a few specific combinations of site and wave direction.*
>
> *There may be small changes in wave power, and hence potentially sand transport, along the St Kilda — Middle Park coast and at Point Gellibrand and Williamstown, although the changes would reduce existing losses of beach at Middle Park and Point Gellibrand is predominantly rocky coast with little sand. The effect at Williamstown didn't account for the effect of coastal works in areas that would prevent losses.*
>
> *Despite the effects identified in the modelling, all changes in wave power are within natural variation.*

[139] Lawson & Treloar, Hydrodynamics, Sediment Transport and Water Quality Modelling, Report Rm2054/J5372, p2

Increased vessel sizes will not result in increased coastal erosion due to wake and wash effects.

The residual risk assessment appears to have dismissed matters listed in the Assessment Guidelines as having no residual risk. The peer reviewer, Dr Black is not so dismissive of the potential for sediment movement and comments:[140]

> *The consultant's reports do not show whether the channels in the Great Sands region or the shape of the ebb-tidal delta will be significantly changed by infilling of the existing channels through the Sands or erosion of new channels. The latter could change the wave refraction patterns and lead to open coast or southern bay beach adjustments (erosion or accretion). Thus, the key risks relate to beach erosion and realignment of the channels through the Sands leading to secondary impacts. The likely magnitudes of these impacts are difficult to determine as the report does not predict the likely change to the channels.*
>
> *Only one diagram showing altered sedimentation patterns is presented in the modeling report (their Figure 5.2). This diagram indicates that there will be large changes to the banks and channels throughout most of the Sands region. There appears to be systematic increases in sedimentation to the north of the shipping channel, major changes off Queenscliff, and against the coast at headlands on the south side of the Bay. While the sediment model is uncalibrated, this prediction is the only information available for all the secondary consultants who are determining risks and implications. Thus, this diagram plays a pivotal role in determining the risks to the Great Sands and surrounding beaches. Taking the predictions as presented, the Great Sands and surrounding beaches may be impacted significantly.*
>
> *Surprisingly, the diagram of sedimentation predictions does not include the regions where currents are forecast to be most different, i.e. at the eastern end of the Shipping Channel (e.g. their Figure 2.16) and the ebb-tidal delta outside the entrance to the Bay. Such omissions make it difficult to fully assess the impacts on sedimentation. Given those omissions and my own experience, the claims that impacts will be negligible are presently unsubstantiated.*
>
> *The sediment transport modeling work is to be undertaken by the proponent's specialist following the EES' exhibition and presented at the Panel Inquiry. However, the lack of sediment model calibration and the inclusion of sediment model predictions in the EES and appendices ultimately left some substantial questions unanswered.*
>
> *The information provided in the hydrodynamics, sediment transport and water quality report is too selective in relation to risks. For example, the EES notes that current speeds are changed by less than 1.6% in the Great Sands region, excluding the shipping channels. However, the change in the shipping channels is not presented, while the changes to wind-driven currents are simply described as small changes when they appear to be much larger than 1.6%. The change outside the Heads also appears to be significant. As such, the impacts of the project on currents and the components of the system that are influenced by currents could be much larger than the L&T report is suggesting.*
>
> *Confidence limits need to be placed on the modeling of velocity changes due to the channel deepening. For confirmation of the consultant's predictions of altered tidal currents, Primary Industries Research (Vic.) were asked by POMC to provide predictions from their modeling undertaken with the 3DD Hydrodynamic Model (Fig. 1). They were engaged to assess likely impacts on the dispersal of larvae and recruitment of King George Whiting (Fig. 1). When compared to the primary modeling, the predicted magnitudes of the current differences are similar, but changes to currents are predicted in the primary model at unexpected and unlikely locations, e.g. well away from the Bay in*

[140] Dr Kerry Black, Independent Peer Review, p11

Bass Strait. The implications are that while the consultant's model may be "calibrated", when the differences between model runs are compared, unlikely results occur. One of the primary risks will be inaccurate predictions of sediment transport, which is highly sensitive to the differences in currents.

As shown in Figure 1, there are significant changes to currents in the Great Sands and on the ebb-tidal delta outside the Heads. The regions affected are broad and well beyond the locations that are proposed to be dredged. The current changes extend up the channels to the north of the shipping channel and well out into Bass Strait.

These responses cover the two main influences on sediment transport. These are currents and wave action. In the Sands area changes will be mainly the result currents altered by the increased tidal flow after the dredging.

In relation to Lonsdale Bight the report states:[141]

The model results discussed above indicate that there will be little or no change to the currents in the heads and Lonsdale Bight. Thus any significant change to sediment transport will arise from the change in wave conditions, particularly along the beach in Lonsdale Bight. Taking into account the frequency of occurrence of the various cases, the modelling results indicate that there will be an overall decrease in potential sediment-transport at location 17b and no change at Wyuna. Since Point 17b is backed by a sea wall, it is likely that the change in transport will not be identified since potential longshore transport is likely to exceed the sand supply in this location.

(Note: location 17b is in Lonsdale Bight)

During the public hearing the Panel received an expert witness statement from Dr Provis. This contained material not in the EES documentation, including Annexure C containing additional details of the modelling on sediment movement in the south of the Bay. The results state:[142]

The results are presented as the changes in sediment thickness of the bed over a period of one year (Figure C4 in Annexure C). The actual volumes of sediment are not reported since these depend on the initial sediment thickness, sediment size distribution, sediment density, availability of sand and any other sources or sinks in the system. Since these parameters were largely unknown, the results for the actual sediment transport may not be meaningful. However, the potential erosion and deposition (changes in sediment thickness) patterns resulting from the action of the waves, tides, currents and changes in bathymetry were used to assess the qualitative impact of the project.

The aim of this was to estimate changes in sediment movement due to changes in bottom topography resulting from the dredging. It did not estimate actual volumes of sediment deposition or erosion. The results indicate the qualitative impact of the project.

The Panel recognises the difficulty in predicting possible changes in sediment movement in an active area affected by many variable influences. This complexity is described in the report:[143]

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[141] Lawson & Treloar, Hydrodynamics, Sediment Transport and Water Quality Modelling, Report Rm2054/J5372, p27

[142] Dr David Provis, Expert Witness Statement, Annexure C, p4

[143] Lawson & Treloar, Hydrodynamics, Sediment Transport and Water Quality Modelling, Report Rm2054/J5372, p27

> *When the sand reaches Point Lonsdale, it is moved by the combined action of the tidal currents and waves. The tidal currents, on the flood tide, will transport the sand to the north and east across the centre of Lonsdale Bight. On the ebb tide, the sand is transported offshore and may be lost to this part of the coast. In the surf zone close to the beach, wave action will transport sand along the coast into the bight. This is a narrow band of high activity and, where the angle of approach of the waves to the coast is steep, the sand will be moved rapidly alongshore. There are thus two pathways for sand from Point Lonsdale to Shortland Bluff, one is along the beach and the other is across the bight primarily under the action of tidal currents.*

The Panel notes that the changes would vary progressively from year to year and could be altered to a major degree by individual storm events. Consequently, the model does not have the ability to predict changes over the time to 2030 and beyond.

The Panel finds that the hydrodynamic model in its present state of calibration is unable to provide quantitative predictions of changes to sediment movements over the time scale required. It is unable to predict what part of any changes in sediment movement would be due to dredging. It is possible that the processes being studied are too complex and variable for them to be amenable to numerical modelling.

If this is the case then it is not valid for the proponents to draw the conclusion that there will be no significant changes in the erosion and accretion processes in the Bay.

The Panel recommends as follows:

As was stated by peer reviewer Dr Black, it appears that the sediment modelling has not excluded the potential for large changes to banks and channels throughout most of the Sands region, increases in sedimentation to the north of the shipping channel, major changes off Queenscliff and against the coast at headlands on the south side of the bay. As a precaution to limit such effects, changes at The Heads should be minimised.

The Panel notes the recurring comments on the lack of confidence limits on any of the findings presented in the EES and associated documents. In relation to sediment movements resulting from the dredging process, especially in the long term, the Panel cannot with confidence advise the Minister of the magnitude of likely changes simply because the y have not been presented with information that itself has an indication of degree of reliability.

Maintenance Dredging

The Panel notes that no increase in maintenance dredging is predicted. This seems unlikely especially as there will be a large new dredged area to the north of Hovell Pile. It is unlikely that this extensive, previously undredged area will not require maintenance dredging within the life of the project. This has environmental and cost consequences.

This is supported by the peer reviewer Dr Black who states:

> *No information is provided in relation to changed requirements for extra maintenance dredging with the deeper channels. The consultants conclude that maintenance dredging rates will not be changed, but my experience is that dredging would increase because the shipping channel is larger in volume and deeper. The extent of the increase cannot be determined without sophisticated sediment modeling. However, plans need to be put in place to mitigate this risk.*

12.8 SUMMARY

As a result of the demonstration of what might be achieved using the turbidity model results, the Panel finds that plume modelling has real potential for predicting the environmental effects of dredging but it also finds that these effects have not yet been demonstrated.

To achieve the objective of predicting the environmental effects of the proposed dredging the Panel finds that the model must be developed and calibrated further. This is required to demonstrate that the model is accurate and reliable and to determine the statistical confidence that can be placed on the outcomes.

The Panel also finds that it will be necessary to carry out this work using a team that includes specialists with the necessary skills in modelling, ecology and statistics. The management of this project to date appears to have relied on individual experts working independently. This has not been productive in terms of meeting the requirements of the Assessment Guidelines or in producing robust outcomes.

The Panel finds that if the modelling development documented in Annexure D can be calibrated and implemented successfully, the proponent will be able to predict some of the environmental effects of dredging in at an appropriately quantitative level. If this can be demonstrated as being achievable in timescales appropriate to real time monitoring, then it may yet prove possible to be used for monitoring the effects of dredging.

It may also be possible to use the model results as a basis for making any necessary minor adjustments to the dredge program based on plume monitoring during the implementation of the dredging.

However, to move to a position of being able to use the model in managing the dredge program the proponent must demonstrate that the model can be run in real time to predict plume behaviour for the following few weeks. It must also demonstrate that it can calculate in real time the predicted effects on light budget and consequently any changes needed to remain within threshold limits and thus achieve the performance criteria. This demonstration did not occur during the Panel process.

The Panel recommends that before approval is granted for the dredging:

The proponent should demonstrate a tested and reliable procedure for monitoring turbidity plumes and predicting their development over times corresponding to their persistence.

Time should be allowed for the establishment of an audit team trained and equipped to carry out the proposed audit process as set out under the EP Act.

In Annexure D, prominence is given to the reduction in turbidity achieved by using modifications to the main dredging methods. These are the general use of a green valve to reduce air entrainment in the spoil stream during discharge and occasionally using non-overflow of turbid water from the hopper during dredging.

The Panel notes that the proposed “improvements” to dredging practice to reduce turbidity will have some effect but declaration of their proposed use has obscured the fact that alternative dredge methods that are intrinsically low-turbidity have not been investigated and not proposed to be used. This is a matter that has been addressed in more detail above. However, it is necessary to reiterate that the portfolio of dredging equipment currently on offer is not best practice equipment. It may yet prove better and more economical to use different equipment that could accomplish the dredge program with fewer delays, triggered by the need to meet turbidity performance requirements.

The Panel recommends that an independent investigation of low turbidity dredge equipment be undertaken and methods producing intrinsically lower levels of turbidity be used.

The prediction made using the source term containing finer sediment material showed that the turbid plumes would persist longer and cover wider areas than the predictions reported in the EES. The model output was not verified by any physical measurements in the Bay.

There is no evidence that the model calibration is able to provide detailed predictions at the confidence level that would be necessary for it to be used as the fundamental management tool for adjusting the basic (base-case) dredging program.

There are two matters that illustrate the level of detail and the accuracy required for the predictive model of turbidity to be reliable enough for use in project management.

- The threshold limits necessary to meet long term performance criteria for protection of seagrass beds are based on light climate. (This is described elsewhere in this report). The light climate relates to the total light reaching the seagrass on the seafloor with some regard to seasonal variations. The model is to be used to predict the light reduction over the seagrass beds as the dredging proceeds and it indicate when the threshold limits are being approached. The dredging would then be stopped or modified to keep the environmental effects within the defined acceptable limits. This needs the highest level of accuracy and reliability in the model predictions. Verification of the model calibration has not been carried out and the Panel finds that it has not been demonstrated that it will meet required performance levels.
- Dr Roberts explained that turbidity causes decreased light intensity with increasing depth. The light intensity eventually falls to a level where photosynthesis is no longer possible. With a water depth of about 10 to 15 metres light reduction was caused by a turbidity corresponding to a suspended sediment concentration of about one milligram per litre could have significant impacts. For seagrass and other primary producers on the seafloor, including seaweeds and the microphytobenthos involved in nitrogen cycling, this means that it is essential to be able to predict turbidity levels at the 1 mg/l level and below.

Annexure D provides plume predictions at the 2 mg/l level of turbidity. Dr Roberts made quantitative studies of the data to show that in a two week dredging program the plumes at this level of turbidity will extend over about half of the southern part of Port Phillip Bay for a substantial period of time. This observation shows that much more modelling at lower levels of turbidity and a higher level of reliability is required to indicate the degree of environmental influence the dredging will have.

The Panel finds that the predictions of the extent, duration and intensity of turbidity are inadequate to allow estimates of the environmental effects. The Panel also finds that the reliability of the model for forecasting plume behaviour during dredging is not demonstrated and the proposed adaptive management is incapable of implementation with the present state of development of the model.

Dr Simon Roberts of Monash University made a major submission to the Panel and attended the hearing most of the time when environmental issues were discussed. Dr Roberts is expert in many of the environmental topics under review and was a major scientific contributor to the Port Phillip Bay Report. The Panel wishes to thank Dr Roberts for his very important contribution to their understanding of scientific matters and his careful and detailed analysis of the scientific material in the EES reports.

The Panel recommends that approval for the dredging should not be given until the turbidity model to be used has been validated in field tests based on some simulated or real small scale dredging.

13. DENITRIFICATION & THE NITROGEN BUDGET

This Chapter develops from the Panel's considerations of hydrodynamics and turbidity to consider the first ecological effect of the project. As was highlighted in the introduction to the last Chapter, Port Phillip is a remarkably clean marine environment given the large population that surrounds it. One of the key reasons for this is that the bay has a remarkable capacity to release nitrogen discharged into it, placing it beyond the capacity of marine life to use that nitrogen as a nutrient. This maintains the bay as a nitrogen limited system, maintaining the clear waters that are valued by bayside residents and providing the context for the bay's existing ecology.

Should this condition change, the entire character and ecology of the bay could change. It is therefore critical that the project is held to demonstrate that it does not pose any significant risk of altering the nitrogen state of the bay.

13.1 THE NITROGEN BACKGROUND

Discussion

Port Phillip Bay receives high levels of nutrient from the Yarra River and from the Western Treatment Plant (Werribee). Nevertheless, the Bay is in a healthy state with only moderate levels of dissolved nutrients and moderate algal growth.

The bay differs from many other marine embayments around the world in being nitrogen-limited at all times and the fact that surficial sediment oxygen concentrations never fall to zero. It has high denitrification rates, low nitrogen:phosphorus (N:P) ratios in the water column and low phytoplankton biomass. As a result of this fortunate set of conditions the Bay is in a mesotrophic state, has a high benthic fauna abundance and biodiversity, few algal bloom problems and a healthy population of marine mammals.

The CSIRO Port Phillip Bay Environment Study (PPBES) has established that nitrogen is the nutrient element limiting algal growth in the Bay. This was found to be the result of a denitrification process, eliminating nitrogen that enters the Bay from both the catchment and as sewage effluent, by transforming it to gaseous nitrogen released to the atmosphere. The PPBES was also able to identify the critical nutrient loading beyond which irreversible damage to the Bay could occur.

The proposed dredging program is vast in scale, long in duration and will affect large areas in the north and the south of the Bay.

The objective of the Panel's efforts has been to assess the likely impacts of the proposed dredging on the ecology of the Bay. In this section the broad issue to be considered is possible effects of dredging on the nutrient status of the Bay. As the nutrient status is clearly nitrogen limited at all times the important processes for consideration are those that may influence nitrogen input or removal.

Nitrogen input will be increased by release from sediments disturbed by dredging. Nitrogen removal will be decreased by interference with denitrification.

The Bay has restricted water exchange with Bass Strait. Residence times for water in the Bay range from a few days near the Head to estimated times of more than 400 days at the north of the Bay.

Within its Terms of Reference the Panel is required to advise on:

> *Whether potential adverse environmental impacts of the project are capable of being effectively managed to achieve acceptable environmental outcomes, in the context of relevant legislation and policy;*

The Assessment Guidelines set out in more detail what is to be considered in the EES:

> *Ecological Processes and Nutrient Cycling*
>
> *Benthic (sea-floor living) invertebrates are important for the health of the Bay's ecosystem, as the water quality and cycling of nutrients (nitrogen, phosphorus and carbon) in the Bay is largely determined by the interaction of sea-floor organisms and sediments. The EES should assess potential impacts on benthic populations and processes in the Bay.*
>
> *The EES should provide an assessment of potential adverse changes – in the short and longterm – and potential risks to marine ecological processes important to the health and environmental quality of the Bay.*
>
> *In particular the EES should include assessment of the effects of the proposed dredging and management of dredged material on:*
>
> - *Potential changes in the biogeochemical activity of seafloor and estuarine sediments.*
> - *Potential impacts on oxygen irrigation of sediments and nutrient cycling (especially of nitrogen), including in intertidal environments.*

This provides the context for the significance of nitrogen related issues and the tasks before the Panel.

13.2 THE DENITRIFICATION PROCESS

Discussion

In most marine areas of the world, the soft tissues of marine planktonic organisms contain the essential elements carbon, nitrogen and phosphorus with numbers of atoms in the ratio C:N:P 106:16:1. When organisms die and decay they return the nutrients N and P to the water in the same ratio of 16:1. Many years of cyclic processes has resulted in the ratio of dissolved forms of N and P in open waters being 16:1.

In Port Phillip Bay the ratio of N:P in the water is different and found to be about 11:1.

When the ratio of 11:1 is compared with the common ratio of 16:1, it is seen that about one third of the expected nitrogen is missing.

N and P incorporated in plants that photosynthesise are returned to the water on decay. This cycle is rapid for phytoplankton suspended in the water and microphytobenthos (MPB) in the near surface layer of sediment.

Cycling in the water column does not change the N:P ratio. In the sediment there are areas that are oxidizing, allowing oxidation of nitrogen compounds to nitrate. In closely adjacent areas there is very low oxygen allowing some of the nitrate to be reduced to nitrogen in the molecular form N_2. This is a gas and it escapes to the overlying water and on to the atmosphere. It is believed that the adjacent areas of oxidising and reducing conditions are related to the burrows of animals living in the sediment. The burrows allow oxygenated water to penetrate into sub-surface sediment that is otherwise oxygen deficient.

The physical, chemical and biological conditions that allow this sequence of chemical reactions are very specific. As both oxidising and reducing conditions must co-exist, the system is in a finely balanced state.

Any change from conditions supporting denitrification to conditions where it ceases is likely to be sharp. The result would be rapid increase in nutrient concentrations promoting algal blooms (eutrophication). The algae would make the water turbid, reducing light levels at the sediment and further inhibiting denitrification. Sinking dead algae would decay on the bottom consuming oxygen and chemically inhibiting denitrification. The condition would get worse and recovery may not occur.

The Panel has set out a brief explanation of the process to allow understanding of the unusual and precarious balance of conditions that are controlling the state of Port Phillip Bay. A consequence of the specific conditions is that they are easily disturbed and the process of denitrification stopped.

In summary the following changes can interfere with denitrification:

- Physical disturbance of the sediment, altering the balance of oxidising and reducing areas or disturbing the organisms that enable gaseous exchange.
- Smothering with deposited silt, disturbing or eliminating the organisms that support gaseous exchange.
- The presence of toxic sediment, with the same effect.
- Reduction of light at the sediment surface by turbid water plumes, reducing the activity of MPB.
- The presence of anoxic water or oxygen consuming conditions.
- The introduction of large numbers of exotic species that may change the sediment structure.

These are to be avoided during dredging or limited in intensity, duration and area such that the effect is acceptable. The first question to be answered is what is acceptable. The second question to be answered is how can acceptable conditions be maintained.

13.3 THE PORT PHILLIP BAY ENVIRONMENTAL STUDY REPORT (PPBES)

The background to the nutrient status of Port Phillip Bay especially in relation to nitrogen cycling was set out in the PPBES Study Report, Murray and Parslow (1999)[144]:

> *They conclude that increases in denitrification efficiency in sediments would have a direct impact on primary production, resulting in a fall as the efficiency increases. What this means is that the Bay may best be described as operating largely as a closed system in relation to nutrient loading: and it is probably very sensitive to changes in denitrification efficiency. That is, the Bay's trophic status depends very much on the balance between incoming nutrient supply (N) and its subsequent loss through the denitrification process in the sediments of the Bay. If the efficiency of this process were to be changed, there would be a direct effect on the trophic status of the Bay. The Bay at this time is considered to be 'mesotrophic': that is, it has relatively low productivity compared with many other coastal embayments (Harris et al., 1996).*
>
> *Murray and Parslow (1997) used the model to explore the effects of changes in nutrient loading to the Bay (assimilative capacity). They concluded that increases in N loading would lead to a progressive shutdown in denitrification rates until the system was no longer able to internally process the nitrogen transformations that lead to nitrogen loss as N2 from the sediments to the atmosphere. Such a situation would lead to the accumulation of nitrogen and the eventual eutrophication of the Bay. Eutrophication refers to a situation where there is greater nutrient loading than can be assimilated, leading to dramatic changes in primary production (in this case phytoplankton blooms). This leads to changes in denitrification processes and loss of oxygen, possibly causing fish kills and other severe impacts on the biology of the Bay. More importantly, it was concluded that, should the critical maximum loading be exceeded, the process might be irreversible. In acknowledgment of this possibility, the Bay Nutrient Management Strategy has set total nitrogen loading targets for the Western Treatment Plant, the Yarra and urban run-off from the greater Melbourne area, which will result in a net reduction of 1,000 tonnes of N per year from the total estimated load to the Bay.*
>
> *Murray and Parslow (1997) suggest that loss of prevailing benthos in the bottom sediments of the Bay may lead to diminished denitrification efficiencies, irrespective of external nutrient loads. They also make the observation that, under conditions of increasing nutrient loads, denitrification is shut down sequentially, starting in locations with highest productivity and sediment respiration. A case in point is the Yarra estuary and Hobsons Bay where nutrient recycling is dominated by anaerobic processes due to high organic loading to the sediments. This results in low denitrifying efficiencies and most of the organic nitrogen is returned to the water column as ammonium nitrogen (Heggie et al., 1999) rather than being lost as N2 from the system. The net effect is an increased in the availability of nitrogen suitable for phytoplankton production and the onset of other eutrophication processes, resulting in changes in water quality and biology of the Bay.*

They warn of the possibility of increased nitrogen loading leading to shutdown of denitrification with a eventual eutrophication of the Bay. The recommend the Bay Nutrient Management Strategy should aim for net reduction of 1,000 tonnes of nitrogen per year from the total estimated load to the Bay.

[144] The PPBES report refers to earlier publications of Murray and Parslow 1997.

13.4 THE EES REPORT

A study of pre-existing information on the Bay, much of it taken from the PPBES Report, was used produce the list of Key Processes in the Bay (Chapter 10) and to create the Key Features (Chapter 26) of the EES.

A summary of the present state of the Bay is contained in the section of the EES Key Processes in the Bay. Items relating to denitrification and nutrient inputs are:

> *10.3 Biological Processes*
>
> *The PPBE Study gave rise to several significant conclusions about biological processes in the Bay:*
>
> - *Nutrient loads are at a level where the assimilative capacity of the Bay has not been exceeded, but loads do need to be managed.*
> - *The composition of the benthic fauna has a critical role to play in maintaining the trophic health (food chains and food webs) of the Bay.*
> - *Toxicants in the Bay do not at present threaten the health of the Bay.*
> - *10.3.2 Nutrient processes*
> - *Internal sinks (such as burial in the sediments) dominate over export (loss from the system). This is because of the relatively long residence time (flushing rate) for the Bay where only 13 per cent of N (1,000 tonnes from the total of 7,500 tonnes of N per year entering the Bay) is lost to Bass Strait. The remainder is lost to denitrification145 in the sediments (87 per cent).*
> - *The flux of N through the Bay's primary producers (phytoplankton, microphytobenthos, algae and seagrasses) is much greater than that available from the total external load as a result of the efficiency of recycling, which leads to a magnification of the nutrient loading.*
> - *Recycling takes place within the water column and to a lesser extent within the sediments.*
> - *Phytoplankton contributes the greatest amount of (gross) primary production within the body of the Bay, with microphytobenthos contributing some 50 per cent less. The role of macroalgae in production is less certain, due to a lack of suitable studies.*
> - *It is estimated that some 30 per cent of phytoplankton production is lost to the sediments, and the magnification of primary production is controlled by rates of recycling efficiency.*

This information is described in a more general way in the section on Key Features. This contains a Section (26.7) on Sediment Chemistry with some references to denitrification and nutrient inputs:

> *The health of the Bay depends on preserving the ability of its sediments, animals and plants to efficiently remove nitrogen entering the Bay's system (this process is called denitrification). To assess the potential impact of channel deepening on denitrification requires an understanding of the chemistry of the Bay's sediments and waters.*
>
> *Studies have indicated that there is a general flow of nutrients from sediments to the water column, and that nutrients in the sediments originate from the breakdown of organic matter in the sediments rather than by diffusion from the water column. Nutrient concentrations in the*

sediments also decrease with depth. This would indicate that much of the nutrient cycling occurs in the sediment layers at the surface.

Nitrogen in the water column is derived mainly from organic (i.e. plankton and dead material) and particulate forms, and lesser contributions of oxidised nitrogen and ammonium. The former are higher in the north of the Bay where algal blooms are more common and the latter are highest around the major inputs from the Western Treatment Plant and the Yarra River.

The part of sunlight used by plants for growth is called photosynthetically active radiation (PAR). This is mostly reduced as it passes through the water by the natural 'colour' of the water. Chlorophyll and suspended sediments contribute little to PAR attenuation in the Bay.

Single-celled algae in the surface layer of sediments (microphytobenthos) play a key role in the nitrogen cycle. Loss of microphytobenthos, or a decline in photosynthesis, may therefore have a significant impact on denitrification efficiency.

It was identified that the next phase of the EES would focus in detail on the potential for the proposed dredging activities to release turbid plumes, nutrients, contaminants and toxic algae cysts. There would also be further assessment for dredging and dredged material management to negatively impact nutrient cycling processes. A key output would be possible management measures to mitigate any possible impacts.

The target outcome of the studies described in the EES presented to the public was the documentation of Residual Risk Assessment.

13.5 THE RISK TO DENITRIFICATION

Discussion

The EES contains the material reproduced below. This is taken from Residual Risk Assessment in Volume 1 Chapter 46 under the heading Denitrification Processes.

The initial risk assessment by Sediment Chemistry and Water Quality Specialist Study found the risk of impacts to denitrification from light attenuation, suspended sediments, sedimentation and change in substrate type to be moderate, moderate, low and moderate respectively. Further assessment of these factors was therefore not required.

Placement of dredged material in the DMGs was assessed as high and moderate for the South East DMG and the Port of Melbourne DMG respectively. The residual risk analysis found that the risks would not be reduced by the measures identified in the EMP. Even so, the impact would be transient and confined to the DMG, and would not impact Baywide denitrification processes.[146]

That is, on the basis of the original calculations of the impact to bay-wide denitrification the initial risk assessment ranked the risk to denitrification below the threshold for action for all threats except at the South East DMG. The final risk assessment then goes on to accept the 'high' ranking at the SEDMG as the smothering of the bottom is an inevitable objective of the project.

The paragraphs below contain the background material leading to the findings above:

Nutrient inputs to the Bay stimulate plant growth, much of which falls to the Bay floor. This material is then broken down by microbial action and the resulting metabolites accumulate in the sediment and are exchanged with the overlying water. These exchanges can be

[146] Main Volume EES p 46-6

measured as an indicator of the efficiency of sedimentary denitrification processes, or the ability of the sediment to process nutrients and flush excess nitrogen from the Bay. Efficient denitrification results in nitrogen gas being produced and lost to the atmosphere (and from the waters of the Bay), and inefficient denitrification results in ammonium or nitrate being returned to the water column. These latter nitrogen forms are available for plant growth and, if excess nitrogen is returned, such growth can become uncontrolled and algal blooms and/or eutrophication may arise.

The denitrification process can be affected by marine pests being brought into the Bay or translocated within the Bay by dredging equipment. Marine pests can potentially reduce or displace benthic infauna species that turn over the sediments and aid in nutrient cycling. Similarly, changes to habitats may result in further species losses. The risk of marine pests impacting denitrification processes was rated as high by the Sediment Chemistry and Water Quality Specialist Study initial risk assessment, and this has been reduced to low by the management measures outlined in the draft EMP.

Denitrification can also be impacted by turbid plumes created during dredging. Initially turbidity in the water column reduces light levels at the sea bed. This, in turn, reduces primary production of the microphytobenthos layer that partly aids nutrient fluxes at the sediment/water interface. Nutrient cycling within the water column (as opposed to within the sea bed) can be enhanced by the elevated suspended sediments within the plume. As these sediments settle out on the sea floor, they then smother the microphytobenthos and reduce infaunal activity, and further reduce denitrification efficiency within the sea bed. Given that microphytobenthos is mobile, sedimentation must occur at relatively high levels to cause smothering. The Marine Ecology study found that the base case scenario, despite having no environmental controls, was not creating sedimentation to a degree that smothering was likely. More of a concern with regard to smothering is the effect of placement of dredged material at the dredged material grounds. Finally, denitrification could be affected further at the South East DMG by the change in substrate type due to the placement of sands from South Channel in an area predominantly composed of fine silts and muds.

The draft EMP stipulates that microphytobenthos primary production will be monitored as part of the Fixed Site Monitoring program. This will include both turbidity and sedimentation effects. Whilst impacts at the DMGs cannot be avoided, the draft EMP includes measures to ensure that the footprint of material placed in the spoil ground (and hence impacts on denitrification) are minimised.

Panel Response

The Panel believes that the approach used in the initial risk assessment for denitrification is flawed. As discussed in an earlier chapter this is a situation when risks should have been ranked for multiple scenarios. At least one additional scenario that should have been considered is that of a baywide catastrophic failure of denitrification, which although a less likely event will result in the more severe risk ranking of either 'high' or 'extreme'. This outcome therefore requires the implementation of additional controls to reduce the level of risk to an acceptable level.

The Panel also finds that the process of denitrification is not sufficiently well understood for reliable threshold limits to be set. In particular, the combined effects of simultaneous changes in conditions such as turbidity, sedimentation, toxicants and nitrogen species is not predictable at present.

Knowledge of the mechanism of denitrification is incomplete and work is in progress to improve that knowledge, especially on the importance of light on deeper sediments. The low confidence that can be placed on turbidity modelling and consequent inability to accurately predict the behaviour of turbid plumes has two consequences:

- The effect of dredging on the behaviour of MPB and hence on denitrification efficiency cannot be predicted with certainty, and
- The plume modelling has not been demonstrated to be capable of fulfilling its role in forecasting the behaviour of dredge plumes as depended upon in the adaptive management process.

In addition, as highlighted by peer reviewer for this subject matter Dr Mick Keough, the baseline has deteriorated from that found in the PPBES. The effect on denitrification as a result of the bottom disturbance by exotic pests such as seastars can be major and has not been assessed. This is a factor that should not be underestimated, with seastar biomass being understood to have multiplied exponentially since the PPBES was undertaken. That being said, the proponent has placed reliance on unadjusted PPBES data in reaching its conclusions.

The above matters were examined in the public hearing and the proponents did not dispel the uncertainties.

The Panel recommends as follows:

The project should not be approved until the requirements for sustainability of the denitrification process are adequately understood and the plume modelling is satisfactorily calibrated and verified.

A specific study should estimate the current bay biomass of the northern pacific seastar and consider the impact that this may have occasioned to the denitrification efficiency of the benthic systems observed in the PPBES.

13.6 MR LONGMORE'S EVIDENCE

Discussion

The Residual Risk assessment in Volume 1 of the EES was derived from the two reports in Volume 3B of Mr Andrew Longmore and his colleagues. Much of the work in the two chapters (140 pages plus an appendix containing many large tables) is summarised in his expert witness statement. The expert witness statement postdates the technical report (September 2003) by more than a year and the risk assessment report (May 2004) by four months. It contains more recent additions and is quoted below.

Mr Longmore personally conducted much of the research that contributes to knowledge on this subject and is actively continuing research aimed at clarifying issues that are presently subject of controversy. The Panel accepts the evidence of Mr Longmore as reliable.

Mr Longmore sets out what influences the processes of denitrification in more detail than the outline given above. The Panel offers this detail to illustrate the very wide range of factors that need to be understood in order that the effects of dredging can be reliably predicted.

> *Denitrification has been identified as a natural process which is critical to the maintenance of the health of Port Phillip Bay, and which may be vulnerable to a number of effects of dredging. Nutrient cycling and denitrification are affected by several factors, including the supply of organic matter, supply of oxygen, and presence of sulphide, and by benthic organisms, which can irrigate the sediment. The supply of organic matter is determined by primary production in the water column and on the Bay floor, which is in turn affected by input of nutrients from the catchment. Oxygen is supplied both from the atmosphere, and by*

> *primary producers during photosynthesis. Sulphide production occurs in sediments by bacterial decomposition of organic matter in the absence of oxygen, and may poison the microbes responsible for the conversion of ammonium to nitrate (the nitrifiers), which is a necessary first step before denitrification. Dredging and subsequent dredged material disposal have the potential to affect benthic organisms, ambient light, nutrient and oxygen concentrations, and therefore affect nutrient cycling and denitrification.*

Mr Longmore then subjected the potential impacts of the Project to a risk assessment, using the “base case" (worst case) dredging scenario provided by lead consultant, Parsons Brinckerhoff.

He used a combination of field measurements, laboratory studies and theoretical calculations to determine the potential for dredging and disposal of material to increase remobilisation of nutrients, change nutrient cycling and affect denitrification processes.

Field measurements included estimates of oxygen consumption, nutrient fluxes and denitrification at the existing Port of Melbourne and Capel Sound Dredged Material Grounds.

He simulated the effects of dredged material disposal at the two DMGs on oxygen consumption, nutrient fluxes and denitrification using laboratory experiments.

He made theoretical calculations of nutrient release during dredging from measurements of nutrients in sediments and from measurements in a dredge hopper carried out during maintenance dredging in the Yarra River in 2002.

He assessed risks by combining estimates of likelihood and consequence, on bay-wide and local scales. He proposed control measures to address those risks identified as “high” or “extreme”. No control measures were proposed for risks assessed as “moderate” or “low” as these risks were deemed to be acceptable (a methodological concern arises in respect of this approach that was beyond Mr Longmore’s control but is considered in detail in the Panel’s consideration of risk above.

For the purpose of the study it was assumed that:

- Dredging will proceed according to the “base case" (worst case) scenario for the purpose of calculating initial impacts.
- The Geotechnical report adequately describes the extent of contaminated sediments.
- The Hydrodynamics report adequately describes plume sediment concentrations and distribution.
- Laboratory studies of nutrient cycling and denitrification accurately reflect the processes likely to occur at the DMGs.
- A change in fauna will lead to changes in nutrient cycling and denitrification efficiency
- The role of microphytobenthos (MPB) in denitrification is minor bay-wide, because low light levels in the deeper waters are likely to limit productivity. If this is not the case, turbidity may lead to a greater impact on denitrification than allowed for. (This relationship will however be clarified experimentally).

Panel Response

The Panel notes that the work done by Mr Longmore and his group is reliable. However, three of these assumptions influence the confidence that can be placed in the outcome of the Residual Risk Assessment:

- It has been shown above that the report dealing with contaminated sediments is unreliable. Until a clear assessment of the nature of sediments and their proposed means of management is available, it is unsound to make detailed conclusions as to the possible effect of these on nitrogen processes.
- The plume sediment concentrations and distribution in the hydrodynamics report of the EES did not provide a valid basis for the impact assessment. The predictions were based on assumption of only two particle sizes and these being so large they would settle quickly. A new study was produced later (Annexure D) showing the plume distributions would be larger and persist longer than the various experts were advised originally, but the implications of this have yet to be fully worked through and factored into examinations of nitrogen processes.
- The magnitude of the contribution of MPB in the south of the Bay was uncertain because a substantial area is deep water and the effect of low light levels at these depths was uncertain. The assumption made was that the contribution by MPB would be minor. However, experimental work to establish (or otherwise) the basis for this assertion was still ongoing when the Panel closed its hearings.

As stated above, the residual risk assessment was made on the basis that the control measures proposed in the Environmental Management Plan (EMP) would be achieved. No evidence was presented to the Panel that described in reasonable detail what the control measures would be. According to the EMP, the control measures would be whatever is necessary to ensure that the threshold limits and performance criteria were met.

The Panel's view is that the EES has treated each topic of concern separately and that there is no overview of the combined effect of the various changes caused by the dredging. This is also the view expressed by EPA in their submission:

13.7 EPA SUBMISSION

Discussion

The EPA is of the view that the following are the risks of most environmental significance arising from the project:

- Reduced primary production (including reduced production of seagrass) resulting from increased turbidity and sedimentation. Primary producers, including seagrass and other aquatic plants, are critical to the overall functioning of the ecosystem, providing habitat, food and other services;
- Reduced denitrification resulting from turbidity and sedimentation (including contaminated sediments). Denitrification by sediment processes is critical to the Bay avoiding eutrophication given the substantial nutrient input from the catchment. Failure of the nutrient processes would result in, amongst other effects, increased algal blooms;
- Similarly, several risks that have a similar outcome (e.g. sedimentation and contamination impacting on denitrification) are assessed separately and the significance of their combined effect not addressed adequately. This is particularly relevant in the case of denitrification. EPA is of the view that the overall risk in respect of denitrification should be regarded as greater than reflected in the initial and residual risk assessments.

13.8 PEER REVIEW

Discussion

As with hydrodynamic and turbidity modelling, this subject was also identified as critical and made subject to an external peer reviewer appointed by the Department of Sustainability and Environment. Dr Mike Keough again provided rigorous and valued analysis and his involvement was sustained to the point of an appearance before the Panel. Again, the Panel commends the Department for the adoption of this process.

The peer reviewer Dr Mike Keough made a number of comments on the limitations of the approach to issues of marine ecology that are associated with denitrification and nutrients.

> *There is uncertainty about the level of risk posed by the additional nitrogen. This uncertainty is derived from uncertainty about the total amount to be released and the denitrification rates within PPB at present.*

Dr Keough has concerns that the conclusions on denitrification are based on few field measurements, and that calculations of changes in denitrification are reported without confidence intervals.

> *Similarly, while one of the authors of this report has been a leader in developing an understanding of denitrification in PPB, the number of in situ measurements remains small. Our estimates of the contribution of different sectors of PPB to denitrification must, therefore, have uncertainty about them, based on the small number of sites for which data are available. This uncertainty should be acknowledged more, and incorporated into overall assessment of uncertainty. It should, for example, be possible to take the existing estimates of denitrification, and use them to generate confidence intervals about the contribution of different sectors of PPB to bay-wide denitrification, and then use the pilot studies, with their own confidence intervals, to generate predictions (with associated confidence) or the larger scale impacts on denitrification. Another source of uncertainty that needs to be addressed is the current denitrification rates in PPB, compared to the values used in the modelling associated with the PPBES. There is some discussion of possible changes since that time, but, again, the issue needs to be made much more explicit, with associated statements of uncertainty. Denitrification rates on disposal grounds for dredged material are estimated using a crude assessment that is not statistically rigorous, leading to additional uncertainty.*[147]

The lack of statistical treatment of data is accompanied by an equal lack of attention to statistical qualification of threshold limits and performance criteria.

> *Third, there are serious problems with the thresholds and performance criteria. The logic of setting thresholds for denitrification is flawed. A value of 20% is suggested as a critical value because it could be detected with existing sampling, and because there may be 10% variation among replicates at a single site. Statistical convenience is not a relevant threshold. The key question should be "what change in denitrification would have significant deleterious effects on other components of the PPB ecosystem, or would alter bay nitrogen targets or nutrient management. Then, what sampling could be done to detect such a change. If the argument is that with our current sampling, we could only detect 20%, the counter argument would be "do more sampling, if you need to detect a smaller change".*[148]
>
> *The problem extends to performance criteria; a criterion of "no statistically significant decline" is not appropriate or useful. If you take very few samples, and you will not get a significant difference; take a lot of samples, and you very likely will, so the achievement of such a*

[147] Keough, Peer Review, p8

[148] Keough, Peer Review, p8

criterion could be manipulated by adjusting the number of samples. The criterion must be a biologically or ecologically derived value, and then a sampling program can be designed that is appropriate for this criterion.[149]

The EES discusses nitrogen inputs to the Bay without placing in the context of the recommendation of the PPBES that for security of environmental quality the annual input of nitrogen to the Bay should be reduced by 1000 tonnes per annum. There is a cost attached to nitrogen removal and the same cost should be considered as applying to the addition of nitrogen by the dredging process.

The release of additional nutrients into PPB is counter to current bay management, which entails a precautionary reduction in nitrogen inputs, based on results from the CSIRO PPB study.[150]

Nitrogen inputs to PPB. Some of the discussion of consequences of changed nutrient regimes is puzzling and values seem to be chosen arbitrarily. For example, there is a large gap between the "moderate" consequence of some loss of denitrification within DMG and the "major" consequence of bay-wide decline in denitrification equivalent to 1000t N annually. A change of this magnitude would seem more than "major", given the current target of a 1000t reduction in N, following results of the PPBES. Even the smaller value quoted of 200t would seem to be a substantial amount, in light of the PPB N target.

There is also little discussion of the N that is thought to be sequestered within the sediments. How much of this might be released as part of the dredging operation?

What do we know of the consequences of either a short-term, but intense nutrient spike, or the release, over a longer time period, of material previously not part of the PPB N budget?

The consideration of nutrient thresholds and performance criteria should also consider the uncertainty, discussed elsewhere in this report, associated with possible changes to denitrification as a result of current marine pests in PPB.

Given that the current nutrient management is based on the CSIRO model, which in turn used denitrification rates that predate, for example, the spread of northern Pacific sea stars, it would seem prudent to assume that any deviation the current nutrient management be approached very cautiously.

Consequences of invasive species. A distinction needs to be made between the introduction of a new pest, and its consequences. It should be acknowledged that not all invaders have major effects. This is reflected, for example, in assigning a high risk for denitrification associated with translocation of marine pests. I do not think that we can confidently predict which of the pests prevalent in northern Port Phillip Bay would become serious pests in the coarser sands of southern PPB. Given the chances for most of these species to have dispersed there already, it may be that this risk is relatively low.[151]

Panel Response

The comments by the peer reviewer, especially in relation to statistical treatment of data and of the attainment of qualification of threshold limits and performance criteria, were not met in any substantial way. Poor to non-existent statistical analysis of components of the proposed program are a major limit in assessing the likelihood of any environmental outcomes.

[149] Keough, Peer Review, p8

[150] Keough, Peer Review, p4

[151] Keough, Peer Review, p10

The Panel notes that the application of even the most basic statistical analysis is absent from almost all the technical reports in the EES and from expert witnesses reports. This indicates either naive unfamiliarity with necessary analytical tools (which the Panel would find hard to credit), or a general management choice to avoid them, applied across the EES project. It has the effect of obscuring the reliability of data and the predictions that are made. Its absence from fields of investigation highly amenable to its use generates a large uncertainty in levels of risks and the consequent responses to each risk.

Significantly, the Panel highlights the objective to reduce nitrogen inputs to the Bay by 1000 tonnes per annum. This is now a clear article of government policy and very considerable public funds have been expended in its implementation. Very substantial efforts must clearly be made by the proponent to (as a first principle) avoid offsetting any of the benefits obtained by the pursuance of this target, or if offsetting is unavoidable, to at list minimise it. In circumstances where offsetting is unavoidable, it also appears clear that the proponent should owe a duty (if only via a commuted payment) to assist in measures necessary to return to full policy compliance.

In this latter regard, the proponent was keen in submissions to emphasise that the project capital works would be temporary and so no nitrogen offset would be due. However, the Panel responds by observing that the use of the Bay to provide shipping channels is not temporary. The project implies its prolongation. There will also be very substantial maintenance dredging campaigns associated with the project in the period to 2030. The Panel's view on balance is that a project lifetime nitrogen input calculation should be made and the proponent should contribute a commuted sum to pay land managers or Melbourne Water to deliver equivalent input reductions staged over the period to 2030.

The Panel recommends that all nitrogen related threshold limits and performance criteria in the EMP should be subject to statistical analysis and confidence limits applied. Careful consideration should be given to the degree to which these adequately respond to factors beyond the control of the proponent, such as inputs due to major flood events, or proposed Parks Victoria dredging higher in the Yarra. A failure to maintain denitrification efficiency has the potential to trigger irreversible change in the state of the bay.

A bay nitrogen input figure should be calculated for the project life to 2030. Staged nitrogen offset payments should be made by the proponent to land managers, to secure targeted action to reduce bay nitrogen inputs by this amount over the period to 2030.

13.9 LATE CHANGES IN NITROGEN CYCLING CALCULATIONS

Discussion

In the very latest stage of the public hearing a paper prepared by Mr Longmore was presented to the Panel. 'Channel Deepening Project Proof of Concept Modelling: Revised Calculations of Nitrogen Cycling and Denitrification Impacts.'

The Panel welcomed this report and the detailed work done by Mr Longmore in coordinating results from different studies. It must however be recognised that this work was in part a response to the submission of Dr Roberts that raised the underlying issues for consideration, and in some cases provided data that was used in the calculations.

This report contained revised calculations taking into account matters raised during the hearing. The two major changes were use of the revised turbid plume predictions in Annexure D, and an increase in the potential release of bio-available nitrogen from the dredged sediments.

The first affects loss of denitrification and the second affects input of nitrogen into the Bay water from dredged sediment.

Mr Longmore also updated the summary of spatial and seasonal distribution of denitrification taken from the PPBES Report. He retained the total annual bay-wide denitrification of 7,000 tonnes N. The most significant change was an increase in the previously assumed very low denitrification efficiency in and south of the Sands, which was not supported by recent experimental observation. The mean annual denitrification efficiency in most areas of the Bay is now estimated to be about 60%.

The effective loss of denitrification predicted as a result of light reduction caused by the turbid plumes predicted in Annexure D is calculated for different areas of the north and south of the Bay. Total loss of denitrification for one year is assumed for all the area of the two disposal grounds and for 20% of Hobsons Bay. The loss of denitrification is reported in units of tonnes of nitrogen. That is tonnes of nitrogen that would have been removed as N_2 if dredging had not occurred but which would not be removed as a direct result of the dredging.

To obtain the likely impact from dredging on nutrient cycling and denitrification it is necessary to add the release of nitrogen (as ammonium) from sediments to the water during dredging. This figure was recalculated using changes from the original in the EES.

- A model was used to estimate the distribution of ammonium with depth in the sediments. The need for this arises in part from failure to sample the sediments adequately. In particular, sediments were not collected or analysed over the full depth of sediment to be dredged (most sediments analysed were from the upper 1m whereas the depth to be dredged was up to 3m). This meant that the distribution of ammonium with depth for much of the material had to be estimated using a mathematical model. There is uncertainty introduced through the use estimated rather than measured values. Mr Longmore used two models and obtained the best possible estimates as the means of the results obtained from the two.
- The analytical methods used to measure nitrogen reported in the EES made no measurement of bio-available dissolved organic nitrogen (DON) in the sediments. Mr Longmore used literature reports to arrive at an estimate of the likely amount of DON. He based calculations on the estimate that DON would be equivalent to 15% of the measured ammonium concentration.
- Sediments contain nitrogen associated with particles (PON) and this nitrogen is released slowly by bacterial action when the particles are suspended in water as part of a turbid plume. Mr Longmore made a number of assumptions, including the initial total amount of PON in the sediment, the rate of nitrogen loss and the time of suspension in the water. The calculations gave an approximate estimate of the bio-available particulate organic nitrogen release.

The sum of the various forms of nitrogen released was added to the loss of denitrification to give a total of the equivalent addition of nitrogen to the Bay as a result of the dredging.

The Conclusions in this report are reproduced here in full:

> *The revised calculations indicate a likely impact from dredging on nutrient cycling and denitrification of 450 tonnes, which is nearly double the impact estimated in the EES, and*

marginally higher than the estimate provided to the Panel in my evidence. The risks are Baywide, in the north and in the south. The upper limit of impact is high enough to be a major consequence. Even though I believe it is unlikely that such an impact will arise, it is prudent to plan for such an occurrence. Prior to these revised calculations, the only monitoring proposed for denitrification was pre- and post-dredging monitoring, to assess impact and recovery after the event. I now believe process monitoring is required to detect any changes to denitrification. Monitoring of dissolved oxygen flux at a number of sites in the north and south at three-week intervals is proposed as the most effective way of estimating impacts of dredging on denitrification.

Panel Response

The Panel accepts these revised calculations as helpful in forming a picture of the magnitude of the likely effects of dredging on the Bay and even more helpful in illustrating the importance of interaction between the various experts working on different aspects of the project.

The Panel notes that Mr Longmore has worked diligently to provide the best possible advice to the Panel and accepts the high degree of reliability that can be placed on the work done.

The fact remains that the calculations done include assumptions that the information supplied by other experts is appropriate and reliable. The two major examples of this are the sediment chemistry and the turbid plume behaviour. Both have these have had major deficiencies. The inappropriate sediment sampling and analysis requires to be rectified. The modelling of turbidity plumes is much improved in credibility post Annexure D. However, the reliability of the quantitative aspects of predictions of plume location, persistence and effect on light budgets remain to be verified, with reference to a ‘proof of concept’ model of a dredge campaign.

The Panel accepts that the results and conclusions presented by Mr Longmore are the best that can be achieved at present but that they are subject to limitations resulting from the degree of reliability of input information and the intrinsic uncertainties of environmental modelling being used in place of real measurements.

13.10 SUMMARY

The Panel finds it disturbing that throughout the public hearings there has been little evidence that information is exchanged and updates on findings shared and acted on. This has been the case in the study phase of the program when time scales are not compressed by the imperatives of the cost of delays in carrying out the dredging. The Panel finds that poor communication exists in the project and that this is unlikely to be improved when time pressures become high after dredging commences.

The Bay is in a healthy state largely as a result of algal growth being limited by low nitrogen levels in the water. This could be altered to a catastrophic degree by increase in nitrogen levels beyond a threshold level.

It is essential that increase in nitrogen levels as a result of dredging is kept below this threshold.

Remaining below this threshold is dependent on limiting nitrogen release from sediments and controlling production of turbid plumes that reduce light reaching the seafloor and reduce denitrification efficiency.

The level of certainty in the results of investigations reported in the EES is not sufficient for the Panel to recommend that the environmental outcomes of the proposal will be acceptable.

The Panel recommends that:

The consequences of denitrification failure are potentially catastrophic and long lasting. To protect against this eventuality dredging should not commence until appropriate threshold limits for light and turbidity can be set with confidence.

Nitrogen inputs from sediments reinforce the effects of possible denitrification failure. The dredging program must be designed to take all practicable steps to minimise nitrogen release from the sediments.

14. ECOLOGICAL EFFECTS

This section addresses the following issues that are relevant to the Minister for Planning's decision:

- marine and aquatic ecology;
- underwater noise; and
- terrestrial ecology.

In commencing the analysis of ecological effects, it should be noted that these are all contingent effects.

They depend upon the means by which the project or components of it are implemented. Recommendations in the chapters above have been made to the extent that the 'offer' in the exhibited EES or as placed before the Panel may need to be significantly changed. If such change takes place, then a critical review of all related ecological impacts will be required.

The assessment of the ecological impacts of the project as currently proposed is also contingent, in that the Panel has identified above that a number of risk identification and modelling approaches that are critical to the assessment process require review.

In such circumstances, it is the over-arching view of the Panel that an assessment of environmental effects as to ecological considerations cannot be finalised at this time. That is not to say that useful work has not been done, for it has. The Panel has focussed on this work with a view to providing guidance in recommendations as to how it may need to be further developed, in response to the major issues of contingency identified in the previous chapter.

14.1 MARINE AND AQUATIC ECOLOGY

Marine and aquatic ecology impacts were then focus of submissions from many parties. This sections addresses the range of issues raised as follows.

- It establishes a background to the relevant marine species and habitats.
- Marine mammals and penguins are considered.
- Marine protected areas are considered
- Marine pest effects are examined.
- Physical habitat removal, placement of dredge material and rock falls are discussed.

14.1.1 MARINE SPECIES AND HABITATS BACKGROUND

Discussion

The specialist marine ecology firm Australian Marine Ecology (AME) examined most aspects of marine ecology. Their reports are found in Volume 3 A1 and Volume 3 A2 of the EES and this section establishes the background from which the AME work proceeded. A separate specialist study of marine mammals and penguins was undertaken and this is considered separately in the following section.

The investigative processes followed by AME are summarised in Section 3.2 of Dr Matthew Edmund's Expert Witness Statement and contained the following major steps:

- existing conditions studies (a combination of literature review and field investigations focused on areas most likely to be disturbed by the Project)
- development of a biological inventory based on the existing conditions outputs and additional information
- identification of threatening processes presented by the Project
- physical effects analysis to examine the likely biological impacts of the "Base Case" dredging scenario provided by Parsons Brinckerhoff
- vulnerability assessment of biological assets
- information reviews for impact assessment related to dredging programs elsewhere, modelling of biological responses and potential environmental management techniques
- prediction of biological responses and assessment of impacts primarily using a model based approach
- use of a shipping incident model to investigate the likelihood of ecological impacts from oil spills
- development of light driven primary production models for benthic primary producers to examine the influence of light reduction from turbidity plumes
- undertaking of a risk assessment for marine ecology
- the development of management considerations
- identification of sites and species of concern due to legislative protection and international obligations
- baywide and regional impact assessment to synthesise other specialist studies affecting the marine environment

An overview of the predominant habitats and communities described in the EES and their general location in Port Phillip is provided by Dr Matthew Edmunds in his Expert Witness Statement in Section 3.2. Volume 3 A1 and A2 should be referred to for the original data and further explanation. The main habitats and communities are[152]:

- *animals living within the sediments, termed infauna – all areas*
- *microalgae living on the sediments, termed microphytobenthos – most sediment areas except highly mobile sediments on shallow banks and beaches*
- *sediment surface dwelling animals, including demersal and epibenthic fauna such as flathead and scallops – all areas*
- *seagrass sediment communities – including Mud Islands, Sorrento, Blairgowrie and South Sand*
- *Pyura (seasquirt) bed sediment communities, including Sorrento, South Channel Pile, Capel Sound, Spoil Ground Shoal, north Port Phillip Bay and eastern Port Phillip Bay*
- *Shallow reef communities including seaweed, megafaunal invertebrates (for example lobster, abalone, seastars, sea urchins) and fish assemblages – The Rip and reefs at Point Lonsdale, Lonsdale Bight, Point Nepean, Point Franklin, Popes*

[152] Section 3.2(b), Expert Witness Statement, Dr Matthew Edmunds

Eye, South Channel Fort, Point Cook, Williamstown/Altona and Ricketts Point, to 12 m depth

- *Intermediate depth kelp bed communities – the Heads region between 12-20m depth*
- *Deep reef sponge garden (sessile invertebrate) communities – The Rip, Portsea Hole and Schnapper Deep, 20-40m depth*
- *Water column communities, including plankton (phytoplankton and zooplankton) and pelagic fishes – all areas*

Volume 3 A1, Volume 13 of the EES describes the impact processes. Key threatening processes are summarised in 3.2 (d) of the Expert Witness Statement of Dr Matthew Edmunds as being:

- sediment suspension and settlement from the dredging plume;
- smothering and habitat changes from placement of dredged material;
- mobilisation of contaminants, nutrients and toxic algal cysts from sediment disturbance;
- translocation of marine pests by vessels;
- oil and chemical spills from vessel incidents; and
- rock falls during rock removal at Port Phillip Heads.

The general approach to managing the impacts of the Project and protecting the ecology of the Bay is discussed in detail in the Project Approach section of his statement. The approach seeks to set performance criteria and then adaptively manage the dredging itself to meet those criteria.

The approach relies on the protection of primary producers in the Bay from the major impacts of turbidity and sedimentation. These primary producers are the seagrasses, kelp beds, microphytobenthos, phytoplankton and other photosynthesising organisms, which provide the building blocks for life in Port Phillip.

To ensure the ecology of the Bay is not affected in the long term, an intensive monitoring program is suggested, the key elements of which are presented in Tables 4.4 – 4.6 of the EMP Version A.

The underlying conclusion is that the primary producers can be protected from major impact, and thus the food chain in the Bay, whilst it may suffer short term effects in some areas, will be essentially unbroken, and thus sustainable in the long term beyond the life of the Project.

To minimise impacts on species, a dredge program has been developed based on ‘ecological windows’ in the north and south of the Bay. These relate to avoiding periods when particular species are most at risk due to a sensitive stage in their life cycle such as spawning. The dredging sensitivities are shown in the Environmental Management Plan Version A (Tables 4.1 – 4.3).

However, given the range of species and habitats in the Bay and the need to consider human use activities, there is no ‘perfect’ time to dredge at any given point in the Bay. The resulting dredge program tabled during the EES Panel hearings attempts a ‘best fit’ balance, taking all the issues into account.

Panel Response

In general the Panel feels the research undertaken across the field of marine ecology has added significantly to the level of knowledge of the Bay's ecosystem. Port Phillip is an extremely complex system, which may never be understood to a high level of certainty.

However, there are some areas where the Panel believes that information on marine ecology in the EES is lacking which makes it difficult to conclude that all impacts can be managed to an acceptable level. The Panel has concerns in the following areas:

- lack of knowledge of primary producer ecology;
- lack of knowledge and of an assessment of rare and threatened fish species in the Yarra River (pursuant to EPBC Act requirements);
- lack of an assessment of non-commercial and non threatened species in some areas (e.g. "other" Yarra river fish species);
- understanding of the trophic pathways within the Bay from primary producers to higher order organisms; and
- understanding of some aspects of the Project technology on the ecology of the Bay (e.g underwater noise from the hydro hammer and effects on fauna).

In addition to this information shortfall, the Panel has some concern with the structural approach to protecting marine ecology in the EES. Many of the specialist studies are highly dependent on the light driven primary production modelling proposed, which in turn is driven by the hydrodynamic and turbidity modelling.

This approach is understandable and in many ways picks up the natural dependencies and interdependencies of ecosystems. However, the Panel believes it places too high an emphasis on the work of one or two individual specialists. It amplifies the potential for unresolved issues in modelling to translate forward to major order errors in impact prediction, entirely beyond the control of the marine ecological consultant.

This issue will be discussed in more detail in the bay-wide ecological assessment section.

14.1.2 MARINE MAMMALS AND LITTLE PENGUINS

Discussion

As highlighted above, separate investigations into marine mammals and penguins were carried out by Simon Mustoe of AES Applied Ecology Solutions Pty Ltd (AES). The studies focused on the Australian fur seal, bottlenose dolphin and little penguin predominantly, due to the importance of the Bay to these species and the importance of these species to a range of recreational industries within Port Phillip and beyond.

Other marine mammals (whales and other seals) occur infrequently in Port Phillip and were considered to be less at risk from the dredging project.

Initial studies by AES showed a paucity of information on seasonal distribution and abundance in Port Phillip of marine mammals and little penguins. Additional baseline studies were undertaken which informed the final risk assessment and management recommendations.

The AES specialist studies can be found in Volume 3 B of the EES.

Mr Mustoe in Section 4.1 of his Expert Witness Statement identified potential long-term impacts on marine mammals and penguins as:

- introduction of marine pests (habitat displacement or alteration)
- bioaccumulation of contaminants
- displacement of anchovy from the Yarra (anchovy are the primary prey species of the little penguin)
- temporary or permanent habitat loss (directly or via loss of primary production with consequent impacts on the food chain)

In the same Section potential short term impacts were identified as:

- suspended sediments (impacts on little penguins via reduced visibility for feeding and to a lesser extent on bottlenose dolphins)
- bioaccumulation of contaminants
- toxic algal cysts
- oil and chemical spills
- underwater noise
- above water noise

Based on his own research and advice from other experts within the consulting team, Mr Mustoe concludes that there is a low likelihood of significant impacts arising from the Project. A range of monitoring and management recommendations around the potential impacts above are made to ensure environmental targets are met and these can be found in Section 4.2 of his Expert Witness Statement.

Mr Mustoe provided further information (letter to PoMC dated 6 December 2004) in the light of the presentation of Annexure D by Dr Provis of Lawson and Treloar. In essence this did not change the position or conclusions of Mr Mustoe's original work.

Panel Response

The Panel notes Mr Mustoe's recommendations regarding review of the oil spill contingency plans for Port Phillip and the placement of adequate emergency response equipment. The Panel understands the PoMC intends to use the existing oil spill response planning and capacity to manage this element of the Project. The Panel finds this approach of some concern and the issue of oils spill response is explored further elsewhere in this Panel report.

One of the main issues of concern to the Panel is the reliance of little penguins on anchovy as their primary prey species. Anchovy may be affected by dredging in the north and south of the Bay and a significant change in their population will impact adversely on little penguins and other predators in the Bay.

In their submission EarthCare St Kilda and Mr Andre Chiaradia from Phillip Island Nature Park impressed on the Panel the importance of anchovies to little penguins, suggesting that the diet at the colony at St Kilda consists of 93% anchovy. Mr Chiaradia also drew the Panel's attention to the work of Plummer and Jenkins who said:

> *Of greatest concern here would be the effect of increased suspended sediment on visual feeding of Anchovy larvae in the north of the bay over the summer.* [153]

[153] Section 7.4.2.1, Page 39, Volume 2 Risk Assessment Report – Aquaculture, Commercial and Recreational Fisheries Specialist Studies, PIRVIC

Anchovies themselves and the little penguins are visual feeders and this has significant implications for the plume modelling undertaken by Dr David Provis in Annexure D which shows large plumes in the north of the Bay over summer. Anchovy are discussed in more detail in the Baywide ecological assessment later in the Marine Ecology chapter of this Panel report.

The Panel also has concerns relating to the effects of underwater noise on marine mammals, from dredging itself and from the hydro-hammer proposed to be used in the Heads. The noise profile from this equipment is unknown and thus an impact assessment on marine mammals can not be undertaken at this time. Underwater noise is considered in more detail separately in this Panel report.

The turbid plumes generated in summer in the north (in Hobsons Bays) and winter in the south (north of the Great Sands) also show a strong overlap with the areas of distribution of avian biomass. This potential impact does not appear to have been adequately assessed.

The Panel also wishes to comment on two species in particular from an economic perspective. The little penguin and the bottlenose dolphin are the foundation of significant tourism industries in the Melbourne region as well as being important components of the Bay's ecosystem, and this aspect must be considered in any impact assessment. In addition the dolphins are considered to be a genetically distinct population with little exchange with populations in Bass Strait. This makes them particularly vulnerable to changes in the Port Phillip environment.

In the light of the above, the Panel recommends:

As the project is currently proposed, the potential for significant adverse effects on marine mammals and penguins has not been sufficiently excluded. Impacts on these species need to be re-evaluated following further refinement of the project approach pursuant to recommendations above, particularly including those relating to turbidity modelling, light driven primary production models and sediment chemistry.

14.1.3 COMMONWEALTH INTERESTS: RARE & THREATENED SPECIES

Discussion

A summary of marine ecosystems and species of conservation concern is provided in the Expert Witness Statement of Dr Matthew Edmunds (Section 4.13). Terrestrial species of conservation concern including avian fauna are discussed in the Terrestrial Ecology section of this Panel report.

A number of geographical areas are protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999 (*EPBC*)*. These are the wetland areas protected under the international Ramsar convention being the western shoreline of Port Phillip, Swan Bay and Mud Islands. Some of these areas are also Marine Protected Areas under Victorian legislation as discussed in the Marine Protected Areas section of this Panel report.

Potential impacts on these areas include changes to the hydrodynamic regime, sedimentation and turbidity from dredging, secondary impacts from loss of seagrass and kelp beds in the south of the Bay, modifications to the nutrient cycling regime in the Bay, oil spills and new or increased levels of marine pests.

Based on specialists studies in the EES, AME conclude that these issues are either of negligible likelihood or can be managed via the performance criteria and adaptive management approach. For example, meeting the criteria for managing sedimentation and turbidity to protect primary producers in the south of the Bay should also ensure these impacts on Commonwealth interests are minimised.

A summary of species and their protection status is shown in the following tables. The acronyms are Victorian Flora and Fauna Guarantee Act (FFG), Victorian Fisheries Act (FA) and the International Union for the Conservation of Nature (IUCN).

Table 27: Marine/Freshwater Fish Conservation Status

Species	Possible Occurrence	EPBC	FFG	FA	IUCN
Australian Grayling	Yarra River/Bay	Vulnerable	Listed		
Yarra Pygmy Perch	Yarra River	Vulnerable	Listed		Vulnerable
Grey Nurse Shark	Bay/Ocean	Critically endangered	Listed		Vulnerable
Great White Shark	Bay/Ocean	Vulnerable	Listed	Listed	
Southern Bluefin Tuna	Ocean		Listed		
Australian Mudfish	Yarra River/Bay		Listed		

Table 28: Marine Mammals Conservation Status

Species	Possible Occurrence	EPBC	FFG	FA	IUCN
Blue Whale		Endangered and Listed Migratory	Listed		
Southern Right Whale		Endangered and Listed Migratory	Listed		
Killer Whale		Listed Migratory			
Humpback Whale		Vulnerable and Listed Migratory	Listed		

Table 29: Other Marine Species Conservation Status

Species	Possible Occurrence	EPBC	FFG	FA	IUCN
Leatherback Turtle	Ocean	Vulnerable	Listed		Endangered
Syngnathids (seadragons, pipefishes, seahorses)	Bay	Listed		Listed	Some species on Red List
Snapper Shrimp	Bay (Geelong Arm/Beaumaris)		Listed		
Chiton	Bay (Point Nepean coast)		Listed		
Burrowing Ghost Shrimp	Swan Bay		Listed		
Holothurian Sea Cucumber	Corio Bay		Listed		

The species above are known to be resident in the Bay and Yarra, visit the Bay occasionally or are likely to be present given the presence of suitable habitat. Potential impacts on these species may include:

- secondary impacts from loss of primary producers and lower order food chain species;
- gill clogging and loss of predation/feeding ability from turbidity;
- mobilisation of contaminants (north of Bay);
- oil spills;
- stimulation of phytoplankton blooms (north of Bay); and
- noise and vibration.

Some of the species (ghost shrimp, snapper shrimp, sea cucumber) are considered by AME to be located in areas not directly affected by the Project. Southern bluefin tuna and leatherback turtles may pass the entrance to Port Phillip on the ocean side and there is expected to be little or no impact on these species.

The level of impact of dredging on the three listed species that inhabit the Yarra (grayling, perch and mudfish) is unknown due to a lack of knowledge about the species and their response to dredging. In addition, it appears that no member of the consultant team was charged with assessing the impact of Yarra River dredging on these species.

The two listed shark species that may periodically visit the Bay are likely to be affected by turbidity plumes and vibration but AME conclude that this will result in minor behavioural modification rather than any substantive impact.

Similarly, the whale species above were considered by AES Applied Ecological Solutions Pty Ltd who concluded that as these whale species sometimes 'visit' the Bay, but it is not a significant part of their range for breeding and feeding, the impact should be negligible.

The syngnathids generally occur in association with seagrasses and kelp. Most species are tolerant of turbid water but are dependent on the health of the seagrasses and kelp and impacts on these communities could have significant secondary impacts on the syngnathids. The EES proposes protection of the seagrass and kelp via the setting of performance criteria for biomass production (light driven) and adaptive management measures which will in turn protect the syngnathids.

The chiton *Bassethullia glypta* occurs on rocky reefs along the Point Nepean coast. Whilst it may be affected by sedimentation, AME consider that the performance criteria established for seagrass and kelps will also protect this species.

In addition to threatened *species*, the *Flora and Fauna Guarantee Act 1988* contains a number of listed threatening *processes*. Those potentially arising from the Project are summarised in Section 4.13(11)(b)(7) of the Expert Witness Statement of Dr Matthew Edmunds and are:

- the introduction of exotic organisms
- input of organotins to marine and estuarine environments
- input of petroleum and related products
- habitat fragmentation for fauna

Dr Edmunds concludes that these threats can be managed within the performance criteria and adaptive management approach taken for the Project.

Panel Response

The Panel has general concerns regarding the state of science surrounding the proposed performance criteria and adaptive management approach. This applies to the Project generally as discussed in the project approach, and specifically in the case of turbidity and sedimentation modelling and its effects on species and areas of conservation concern.

Turbidity was not modelled in the Yarra River, making it difficult to determine impacts on the fish species there.

The linkages are discussed in more detail in the Baywide ecological assessment chapter but in summary the Panel's has significant reservations relating to:

- turbidity and sedimentation modelling
- the ability of the light driven primary production model to be used as a primary management tool;
- the interaction of the above models;
- the degree to which secondary impacts on species of conservation concern can be accurately assessed; and
- underwater noise effects on marine mammals.

As a result of these concerns, the Panel considers that it has not been demonstrated that the marine species of Commonwealth and state conservation concern will be protected during the dredging program.

The Panel also has general concerns relating to the level of knowledge of Yarra River species of conservation concern, notably the Australian grayling, the Yarra pygmy perch and the Australian mudfish. Dr Edmunds in Expert Witness Statement (Page 51) on the Australian grayling notes:

> *The lack of information about this species means it was not possible to conclude whether this species would be at increased risk because of the Channel Deepening Project.*

This may be true, but it also appears that no research to rectify this situation was undertaken as part of this Project.

This sentiment is repeated for the other two species mentioned above. The Panel finds it of concern that at this late stage in the Project's development there are three species of state and/or national conservation relevance that have not been assessed to the point where sound conclusions can be drawn, and if necessary, management measures proposed.

In summary, the Panel considers the level of knowledge of potential impacts on species and areas of conservation concern to the state and Commonwealth Governments is not developed to the point where it can yet be concluded that the impacts are acceptable.

The Panel recommends:

As the project is currently proposed, the potential for significant adverse effects on species and areas of conservation concern with State and Commonwealth legislative protection has not been sufficiently excluded. Impacts need to be re-evaluated following further refinement of the project approach pursuant to recommendations above, particularly including those relating to turbidity modelling, light driven primary production models and sediment chemistry.

Where lack of information on species of conservation concern is a serious impediment to decision making (for example the Yarra native fish species), a research program should be initiated immediately to provide enough information to assess and then mitigate impacts.

14.1.4 MARINE PROTECTED AREAS

Discussion

Four Marine Protected Areas (MPAs) are in Port Phillip being:

- Port Phillip Heads Marine National Park (which covers Swan Bay, Popes Eye, Mud Islands, Portsea Hole and areas to the east and west of the entrance to Port Phillip);
- Point Cook Marine Sanctuary;
- Jawbone Marine Sanctuary; and
- Ricketts Point Marine Sanctuary.

The MPAs are administered by Parks Victoria under the *National Parks (Marine National Parks and Sanctuaries) Act 2002*. Parks Victoria has initiated a management planning process for all the newly established MPAs in Victoria. In Port Phillip a draft Port Phillip Heads National Park Management Plan was released in late 2004 for public comment, which closes in February 2005. Management plans for the other MPAs will be produced over the next two years.

The MPAs in Port Phillip have the highest level of protection for marine community and species protection

There will not be direct loss of habitat in MPAs from dredging although there will be dredging in the Rip immediately adjacent to the Point Lonsdale component of the Port Phillip Heads Marine National Park. The potential indirect impacts from dredging on MPAs are outlined in Section 4.13 (d) of the Expert Witness Statement of Dr Edmunds and are the same as discussed in the introduction to marine ecology.

Dr Edmunds concluded that the Port Phillip Heads Marine National Park is under the greatest threat from the following mechanisms:

- introduced marine pests (particularly the introduction of *Undaria* into the Port Phillip Heads Marine National Park)
- oil and/or chemical spills
- suspended sediment plumes (light reduction for primary producers and smothering/clogging of biological structures)
- rock falls in the Great Ship Channel

Encroachment of dredging on the west side of the Great Ship Channel is also of concern.

The other MPAs were not considered to be at risk as the initial modelling of turbid plumes from the hydrodynamic study of Dr Provis indicated that turbidity from dredging would not reach these areas.

Marine pest impacts and proposed management are discussed in later in this chapter. Oil and chemical spills management are discussed elsewhere in the Panel report.

In the Port Phillip Heads Marine National Park several species and communities may be at risk from turbid plumes. In particular the seagrass communities based on *Amphibolis antarctica* and kelp beds with canopies of *Ecklonia, Phyllospora, Seirococcus* and periodically *Macrocystis* occur in the park and would be affected by reduced light levels from turbid plumes.

As discussed in the project approach section performance criteria are established for minimising the impact of sediment plumes on primary producers and to prevent clogging of biological structures. More stringent criteria for MPAs are proposed as follows from the draft EMP Operational Control Procedure CDP OP446.435.1A (note these are selected quotes related to MPAs):

- No more than 10% decrease in annual production rate over predictions for Ecklonia in Popes Eye MPA and for seagrass in Mud Islands and Swan Bay MPAs
- No more than 10% areal reduction in seagrass beds in Mud Islands and Swan Bay MPAs (although it should be noted that this measure was originally documented as no more than a 5% areal reduction in the EES [154]and the panel is not clear why this was relaxed).

Panel Response

The Panel discusses a number of significant concerns regarding the proposed monitoring and management arrangements for primary production later in this chapter and these will not be reiterated here, except to confirm that these concerns relate to MPAs as well.

The Panel believes that the potential impacts on MPAs raise a number of issues of principle that have not been adequately addressed. The Panel's response commences with a consideration of issues of principle, moves to The Heads region and than considers impacts in other parts of the bay.

It is clear in the literature surrounding the MPAs that they were established to be a representative area of marine ecosystems with human impact (physical removal or disturbance of biota, artefacts and substrate) removed. It thus appears that all reasonable attempts should be made to avoid the close passage of dredging technologies and control regimes that could lead to any significant, ongoing adverse change to these areas. Mention should also briefly be made of the IUCN status of these areas, a matter that was not raised in submissions, that the Panel has not considered in depth but may also require examination.

The position set out above merits comparison by analogy with terrestrial National Parks. If one were to locate a facility such as a smelter causing toxic plume fallout with potential for vegetation death close to the boundary of a Park, it would be accepted that the plume required control, so as impact on vegetation within the park was excluded for all material purposes. One cannot imagine a scenario in which it would be suggested that a 10% areal reduction in relevant vegetation communities due to smelter plume fallout would be viewed as environmentally acceptable in a terrestrial National Park.

Nevertheless, in Section 13.37 of their Part A Submission, the proponent concludes that as the Project does not occur in the MPAs, the National Parks Act does not apply to the Project. Whilst this may be legally correct, it is clear that the activity of dredging undertaken by the PoMC has the potential to impact negatively on MPAs. This position is supported by the

[154] EES Volume 1 at Pg 45-10.

Expert Evidence of Dr Edmunds for the Port Phillip Heads MPA who draws a direct link between the dredging activity and the potential for impacts on plant communities in the MPA.

The draft Port Phillip Heads Marine National Park Management Plan lists sedimentation or siltation from dredging as a key threatening process for subtidal soft sediment communities, intertidal reef communities and subtidal reef communities.

To the Panel this implies a clear responsibility on the proponent to prevent, minimise or otherwise mitigate impacts on the MPAs. The proponent does acknowledge in Section 13.38 of their Part A Submission and Section 12.1 of their Part C Submission that the MPAs do have a high level of significance and that management measures are needed to protect them.

The Panel has noted that higher standards (ie lower threshold of acceptable impact) for primary production and seagrass loss is proposed for the MPAs than for the remainder of the bay. However, it believes that the level of impact that could occur within the proposed thresholds is still significant. The Panel has not sighted any evidence that suggests that these levels of impact on a marine (or terrestrial) conservation area with of National Park status is either acceptable in ecological terms, related to the significance of park assets, is acceptable in policy terms or is acceptable to the community.

A case study example of approaches to MPA regulation is the banning of seismic exploration in MPAs for oil and gas in the Otway Basin in late 2004 by the State Government. This presents a clear statement of the status of MPAs and the high tier of precautionary protection of them intended by government.

Even if the impact on MPAs was acceptable, and the Panel strongly suggests it is not, the Panel is not convinced that there will be enough time to measure and respond to impacts such that the ecosystems in the MPAs will be protected from dredging impacts.

Measurement of an areal decline in seagrass is difficult due to natural variability and the varying response times of natural ecosystems to impacts. The Panel has significant doubts as to whether the proposed prediction and response system based on monitoring will work sufficiently quickly to enable real changes to dredging programmes to be made in real time.

If an impact does occur, the Panel has not sighted any proposed remedial measures to aid recovery of habitat in the MPAs. It should be noted that the literature on seagrasses is strongly suggestive that active revegetation would be difficult.

Another area of significant concern to the Panel is the issue of the likely impacts on the other three MPAs in Port Phillip. Based on Dr Provis' initial turbidity modelling, Dr Edmunds concluded, not unreasonably in the Panel's view, that the primary turbidity and sedimentation impacts would be on the Port Phillip Heads Marine National Park. During the presentation of Dr Provis' Expert Evidence, Annexure D was tabled with updated model outputs. Figure 7 in Annexure D indicated that the sediment plumes in the north of the bay could reach all three northern MPAs (Point Cook, Jawbone and Ricketts Point Marine Sanctuaries) under that scenario.

The concentrations of the plumes appear to be low at the MPAs but the Panel is not clear what the impact will be at these locations from light reduction and sedimentation, if any, over the duration of the dredging program in the north of the bay.

During the hearing, Dr Simon Roberts identified that concentration as low as 2mg/L represented the threshold at which ecological effects may occur.

More specifically, the model runs undertaken by Dr Provis were not assembled into a complete campaign concept that gave the Panel a clear view of the overall likely impact. This was referred to above as 'proof of concept' modelling. The lack of this modelling made it difficult for the Panel to conclude that impacts in a range of areas might be acceptable.

The turbidity plume modelling and the possibility of contaminant mobilisations are discussed more extensively elsewhere in this Panel report. However, in the light these issues and of this uncertainty, the Panel recommends:

Existing policy responses suggest that performance criteria for all Marine Protected Areas should be set to achieve 'no net change' to communities or species during and after dredging. The proponent will need to demonstrate how they will achieve this using dredge technology, dredge timing, silt curtains or by other means. It will be necessary to technically prove proposed controls prior to dredging commencing.

14.1.5 MARINE PEST EFFECTS

Discussion

The introduction and translocation of marine pests was identified early in the EES process as an issue of concern. It was also identified by a number of submitters as a key issue requiring attention. Port Phillip already plays host to a significant number of introduced marine animals and plants including some which are having a serious detrimental effect on the Bay's ecosystem.

Volume 15 (in Volume 3(A2) of the EES) of the work by Australian Marine Ecology (AME) identifies the key existing and potential impacts. Essentially the issues are:

- introduction of new species of pests to the Bay via hull fouling and ballast water of dredging equipment and general shipping (some species may be transported in dredge sediments remnant on dredging equipment)
- translocation of existing or new species of marine pests within the Bay on dredging equipment, when the dredge equipment is moving between the north of the Bay and the South
- the creation of novel new habitat which may be suitable for colonisation by marine pests at the expense of local species

AME identify a range of species that could be of major concern in the Bay if they became established.

A number of management measures for marine pests are proposed in the Environmental Management Plan Version A. These are outlined in the operation control procedure CDP OP 446.4135.1A. The OCP proposes an inspection and removal/cleaning regime prior to the dredge equipment arriving in Port Phillip and for when the dredging equipment is moving within Port Phillip.

This procedure also covers burial of rock from The Rip when deposited at the SE DMG to prevent marine pests taking advantage of the new habitat.

Panel Response

The Panel believes that the regime proposed by the Port of Melbourne Corporation is an acceptable response to the issue of marine pests within the current regulatory and policy framework.

This view of the Panel is separate from its understanding of the implications to the project of potential changes to denitrification capacity arising from marine pests introduced since the Port Phillip Bay Environmental Study.

14.1.6 PHYSICAL HABITAT REMOVAL, PLACEMENT OF DREDGE SPOIL & ROCK FALLS

Discussion

Physical habitat removal from the channels is discussed in Volumes 3(A1) and 3(A2) of the EES and a summary is provided in Section 4.6 of the Expert Witness Statement of Dr Matthew Edmunds.

Habitat removal will impact predominantly on the intermediate depth kelp community in The Rip and sediment communities in the South Channel, Port of Melbourne Channel and Yarra River. Habitat removal will remove the substrate that various communities depend on, the biota itself including permanent and mobile populations and may impact on temporary aggregations of marine fauna such as the spider crab *Leptomithrax gaimardii* (in the South Channel*).*

Following removal of the material and biota from the channel, changed light, substrate and bed material conditions may result in different habitats, species and communities being present or present in different community structures, including the possibility of increased marine pest numbers.

Dr Edmunds identifies the intermediate depth kelp communities in The Rip as being as most risk, due to potential changes in the substratum in this area. The “rumble” effect of dredging debris moved by the tidal current in The Rip is also considered potentially significant as it may prevent the re-establishment of *Ecklonia* in the dredged channel.

A number of potential impacts from placement of dredged material in the spoil grounds are identified including smothering of existing communities, changed soft sediment communities post-placement, changed communities on rock deposited from The Rip and toxicity impacts on infaunal crustaceans in the northern dredged material ground (DMG). Smothering of spider crab aggregations during spoil disposal in the SE DMG is also identified as a potential impact.

Loss of denitrification capacity in areas of dredging and spoil disposal is discussed elsewhere in this Panel report.

The risk to sediment communities from spoil disposal in some areas in Port Phillip is one of the reasons for not choosing other previously used DMG options (Symonds Channel or Capel Sound) or the environmental island concept.

The Environmental Management Plan Version A identifies a range of procedures and processes to manage the environmental effects of physical habitat removal and dredge spoil placement. These include Operational Control Procedure: Removal of Seabed and

Placement of Material (CDP OP446.425.1A) and Process Monitoring Procedure: Epibenthic Fauna Aggregations (CDP OP446.4195.1A).

The management objectives of these procedures are to minimise the amount of habitat removal by accurate dredging control, prevent local extinction of epibenthic fauna (particularly spider crabs) and to maintain suitable habitat post dredging for re-colonisation by indigenous marine species (particular kelp habitat).

In line with the general approach of performance criteria and adaptive management, Chapter 4 of the EMP identifies performance criteria and during/post dredging monitoring for various components of the affected environment. For example this includes pre-dredging video monitoring for fauna aggregations and post dredging monitoring of recovery of the kelp *Ecklonia*.

Sediment contamination in the northern DMG (new contaminants from the Yarra River dredging and existing contaminants) is discussed in the sediment chemistry section of this Panel report.

Rock falls resulting from dredging in the Great Ship Channel are another issue identified in the AME studies. As the hydro-hammer, trailing hopper suction dredge or stone fisher work in this area, the risk is that rocks and debris will fall off the Rip plateau, down the walls of the Entrance Deep.

Rock falls have the potential to affect intermediate depth kelp communities and deep reef sessile invertebrate communities deeper than 20m. AME considers risk to the deep reefs is extreme as they are vulnerable to rock falls and have very slow recovery rates.

The proponent propose to manage the impact of this process by dredging techniques, mainly dredging away from the Rip canyons (although the dredge contractor Boskalis were not clear that such dredging would always be practical) and using a stone fishing vessel to pick up loose rocks and debris. The EMP Version A contains the Operational Control Procedure: Rock Fall (CDP OP446.455.1A) and Process Monitoring Procedure: Rock Fall Inspections (CDP OP446.411115.1A).

These dredging techniques are discussed further elsewhere in this Panel report.

Panel Response

The Panel has considered the material prepared by Dr Matthew Edmunds of AME presented in the EES and generally accepts in principle his major conclusions on this issue. The physical removal of habitat from the channel is an unavoidable consequence, by definition, of the channel deepening project itself.

Laterally containing the dredging program to the required channel width should be an effective way of minimising habitat removal. However, the proponent has not demonstrated to the Panel the accuracy to which this will be possible.

The Panel believes that subject to some residual concerns in The Rip regarding intermediate depth kelp beds and deep reef sessile invertebrate communities, the physical removal of habitat does not pose a long term threat to the ecosystems of Port Phillip and the sediment communities should recover post dredging.

Recovery of the kelp *Ecklonia* in the Great Ship Channel will be aided by creating a suitable "rough" habitat during dredging and the recovery will be monitored over a period of "possibly" ten years (see EMP Table 4.6 M2). Transplanting of *Ecklonia* into the rock is proposed as a response to aid kelp recovery. The Panel believes that if technology exists or can be developed to rehabilitate habitat areas affected by dredging then this must be built into the Project. This issue is discussed in principle in the Baywide ecological assessment section.

The Panel has unresolved concerns regarding the aggregations of the spider crab *Leptomithrax gaimardii*. Page 35-6 of the EES states:

> *Periodically this species aggregates in large numbers, especially but not exclusively during the moulting and mating period in spring. Any dredging of channel areas where and when these aggregations occur could have considerable impacts on the population of this species.*

Under the current dredge program, dredging is proposed in the South Channel East and West during spring, but yet an objective of monitoring will be to survey for and avoid aggregations. The panel is unclear as to the implications of discovery of spider crab aggregations on the dredge schedule and therefore the Project cost. Will spider crab aggregations potentially delay the dredge program for hours, days, or weeks?

The proponent proposes to undertake remotely operated vehicle (ROV) surveys weekly during dredging to determine if aggregations are occurring (and similarly for spoil placement at the South East DMG).

The Panel does not oppose this approach in principle but has concerns regarding the usefulness of these surveys given the probability of low visibility from previous dredging and the proposal to monitor only a narrow strip on each side of the channel. This same concern applies to the placement of spoil in DMGs.

The Panel is also unclear as to the relative weight of impact on the population of this species. For example should dredging be modified to protect this species at the risk of impacting on others in the south of the Bay? The Panel can not draw a conclusion on this issue and believes further research is required to reduce uncertainty. Rather than simply re-examining the specific conservation requirements of the crab, the Panel considers that this work should examine the principles of differential weighting and proportionate response to conservation issues more generally. Why is the crab identified for specific monitoring with the prospect of a strong conservation response, when other habitats or species of apparently greater conservation significance do not merit such clear responses. For these reasons the Panel recommends:

Prior to project implementation, case study research on the scale and timing of *Leptomithrax gaimardii* aggregations should be undertaken with the objective of establishing more accurate impacts on dredge scheduling and project costs. This research could provide a window whereby broader questions as to the relative weighting and proportionality of response to a range of habitats and species of conservation concern can be considered.

The physical placement of spoil in the Port of Melbourne and South East DMGs raises a number of significant ecological issues which are dealt with in detail elsewhere in this Panel Report:

- consideration of feasible alternatives to reduce impact (South East DMG);
- impact on denitrification capacity (PoM and South East DMG);
- turbidity and sedimentation (PoM and South East DMG); and
- contaminated sediments (PoM DMG).

The Panel notes the concern expressed by Dr Matthew Edmunds of AME regarding the impact of rock falls on intermediate depth kelp beds and in particular on the deep reef sessile invertebrate communities.

The Panel considers the degree of impact in this area will be largely dependent on the dredge equipment employed and its use and management in the area of the Rip. Given that none of the major equipment suggested has been used or proven in the Rip environment, the Panel cannot conclude that the risk to these communities from rock falls has been reduced to an acceptable level.

The Panel inspected the site with a high resolution multi-beam sonar and notes that "edge" of the canyon is irregular and indistinct and considers that in principle, the concept of dredging away from the Entrance Deep appears impracticable and it would be necessary to leave a substantial buffer. At the time of "breakthrough" between the dredged channel and the Deep, there will be an increased likelihood of rock falls. Options to fine tolerance dredge and protect the breakthrough zone require re-examination.

The Panel considers the use of a 'stonefisher' to remove debris and mobile rock material in The Heads is not feasible. The efficacy of this equipment has been established as a means of removing isolated rocks in sandy substrate. However, its use on a rocky floor, designed to be provided with a suitably rough dredged surface for *Ecklonia* re-establishment, has not been demonstrated. On balance the Panel considers that a traditional 'stonefisher' would be likely to encounter significant operational difficulties.

One issue of significant concern to the Panel is that of response to the monitoring program if video surveys in the Rip identify impacts substantially greater than predicted. Given that the dredging will be underway, what can feasibly be done to prevent impacts without causing either ongoing environmental damage or causing significant cost implications for the project?

Given the possibility that remediation measures on the Entrance Deep communities may not be effective, prevention of impact is critical.

The Panel recommends:

Prior to implementation of hydro-hammering, dredging and stonefishing close to Entrance Deep, technical and management measures for rock fall prevention should be refined and tested in less sensitive locations. This work should confirm that rock falls will not pose a threat to intermediate depth kelp communities and deep reef sessile invertebrate communities in the canyon.

14.1.7 ECOLOGICAL EFFECTS: PROPOSED MANAGEMENT OF LIGHT REDUCTION FROM TURBIDITY & SEDIMENTATION

Discussion

The influence of turbidity on the ability of marine plants to photosynthesise was recognised as one of the key threatening processes from the project, given their foundation position at the base of the Port Phillip food chain.

Given this, Australian Marine Ecology (AME) developed light driven biological production models. The models are described in detail in the EES in Volume 3 A1 Volume 11 and summarised in Section 3.2 (k) of the Expert Witness Statement of Dr Matthew Edmunds.

The models were developed for the primary producers of concern, being:

- Microphytobenthos (MPB) – algae living in and on bottom sediments;
- the seagrass *Heterozostera tasmanica;*
- the seagrass *Amphibolis antarctica*; and
- the kelp *Ecklonia radiata.*

AME note that there are other primary producers likely to play an important ecological role but their assessment was limited by poor knowledge and time constraints.

The light driven models were developed to aid in impact assessment by predicting species response to light reduction from turbid plumes generated by dredging and spoil dumping. For primary production loss modelling, plume extraction points over representative areas of vulnerable assemblages were used. The plumes (from the Base Case scenario) were generated in the hydrodynamic models by Dr David Provis from Lawson and Treloar. The turbidity modelling is discussed in detail elsewhere in this Panel report.

This process has enabled AME to develop threshold levels for primary production loss across the primary producers listed above. The actual thresholds proposed are shown in Operational Control Procedure: Light Budget (CDP OP446.435.1A) in the Environmental Management Plan Version A .

Dr Simon Roberts showed that these thresholds may occur at turbidity levels of as low as 2mg/l for some species which is at the bottom of the range of modelling undertaken.

The proponent is proposing a general approach to manage environmental, economic (non Project benefit economics) and social impacts which is based on establishing performance criteria for the dredging contractor and then using adaptive management principles to refine management measures and further reduce or minimise real impacts. This approach is discussed in detail in the Project Approach chapter of this Panel Report.

In regard to primary production performance criteria 'triggers' are set which are more stringent than the threshold levels discussed above, to trigger action such as moving the dredging operation elsewhere or closing it down.

Under this approach the threshold levels and performance criteria are set independently of considerations regarding dredge technology and it is incumbent on the dredge contractor to manage how they will meet the performance criteria. This issue links strongly to the Panel's concerns about the limited degree to which the EES has identified specific and practical controls as means of meeting criteria.

Using the light budget approach to manage the impact of turbidity from dredging on primary producers is only proposed for the south of Port Phillip (as described in the Operational Control Procedure: Light Budget (CDP OP446.435.1A) in the EMP Version A). The light budget approach is not proposed for the north of the bay due to the reduced area of plumes predicted in the original plume modelling.

During the Environmental Management Plan sessions in the last week of hearings, Dr Edmunds provided a further presentation on how the proposed model would work in practice.

The PoMC also hosted a Primary Production Expert Workshop on the light budget approach on the 16 November 2004 (independent of the Panel process and with no Panel involvement). The notes from this workshop were provided to the Panel in Annexure GP1 to the proponent's

Governance Paper submission together with an initial response to the workshop recommendations from the proponent.

A similar approach is taken to sedimentation in the EES.

The independent peer reviewer, Dr Michael Keough commented extensively on the seagrasses and other aspects of Port Phillip ecology in his report dated August 2004. His discussion on the lack of systems knowledge and specific aspects of seagrass ecology has been useful to the Panel.

He indicated concern regarding the uncertainties around the modelling approach being pursued due to this lack of knowledge.

As part of the environmental management regime, a range of monitoring of primary producers will be undertaken and this is shown in Table 4.6 of the EMP Version A.

Panel Response

The Panel also notes that AME undertook a prodigious amount of work in the EES in undertaking impact assessment and developing management responses around the Base Case scenario. However, the Panel has already expressed its general dissatisfaction with the general project approach of using a Base Case (worst case) scenario as the starting point for detailed assessment.

The Panel believes that the predictive model for benthic primary producer response to impact (in this case light availability) is, in principle, an innovative and potentially useful approach to environmental impact prediction and management. It notes the great volume of scientific territory crossed by AMC in developing this concept. The Panel considers it adds greatly to existing knowledge of Port Phillip and how the Bay's ecosystems function. However, in this critical area of the light driven primary production model, what is painfully clear is how *little* we know of the Bay's ecosystems.

An example of this is given in Section 3.2 of Volume 3 (A2)(16) of the AME studies dealing with seagrass impact assessment. It is worth quoting the Section at length which deal with basic information about seagrass.

> *There have been few studies of the demographics of seagrass in Port Phillip Bay. Basic information, such as changes in biomass over time, has not been collected. Priority information requirements are:*
>
> - *Seasonal and other temporal variations in biomass and size/age structure*
> - *Estimates of in-situ loss and growth rates*
> - *Internal storage capacity, extracellular production rates and other carbon budget items; and*
> - *Seasonal and depth adaptations to photosynthetic parameters*
>
> *A critical environmental factor for predicting impacts, but is largely unknown, is the natural light attenuation climate (turbidity) of different regions throughout the bay. Long-term, continuous records (daily or sub-day periods) are required before any predictions on photosynthetic production in the marine environment can be accurately predicted."*

Section 5.2 in the same volume discusses knowledge gaps in another area, that of turbidity effects on aquatic ecosystems. Again, it is worth quoting in full.

> *Information on the response of aquatic species to turbidity is generally restricted to foreign freshwater species of fish. The general applicability of turbidity levels causing impact in freshwater systems to marine systems is unknown. There are considerable differences between these environments and resident species so threshold levels could vary considerably. The wide variation in turbidity levels in freshwater systems and the often contradictory effects of turbidity on different species and life stages also makes general comparisons difficult. For the purposes of impact assessment it is assumed that the general nature of impacts described above would be applicable to marine species but the threshold levels could vary considerably.*
>
> *There is no information on natural levels of turbidity on seagrass habitats in Port Phillip Bay. Turbidity levels that seagrass organisms are currently exposed to are not known. It is therefore, difficult to determine the tolerance of seagrass species to natural turbidity levels and to put increases in turbidity due to deepening operations in context."*

The Panel is surprised that given the Bay has been dredged for over 100 years on a regular basis, but yet there is not more background information on turbidity. Given the scale of this project, direct comparisons with previous dredge campaigns would be difficult but background and dredging turbidity levels from past campaigns (including 2002) would have assisted with the assessment. Only recently has it been a recognised that increments of 1-2mg/L can exceed ecological thresholds.

The Panel is aware that AME have been undertaking additional studies during the Panel hearing process but is not clear on how these have advanced the understanding of the issue.

The examples above relate to seagrass but the Panel is equally concerned regarding the other primary producers including kelps, MPB and phytoplankton (the latter of which is not considered for light driven primary production models although it is undoubtedly a significant primary producer in the Bay).

Dr Simon Roberts in his presentation to the Panel on Day 26 of the Panel hearings raised a number of points of interest to the panel on this issue including:

- Lack of consideration of short term (days to weeks) effects on primary production in the models
- Lack of knowledge of large scale spatial suppression of MPB production
- Existing light limited conditions of MPB and phytoplankton, meaning small changes in light climate may have very significant effects

Dr Roberts did not appear as an expert witness, but undoubtedly has expert knowledge in this area and the Panel accordingly values his input.

Continuing with seagrass as an example, AME have set management objectives for seagrass recovery of 1-2 years and deeper kelp bed recovery of 7 years (Volume 3(A2) Volume 22 Section 14.2). To achieve this recovery period of 1-2 years for seagrass a performance criteria of maximum 20% primary production loss per annum is established.

This is translated into the EES Volume 1 document (Page 45-10) as a management objective of recovery within 12 months. This is then repeated in the EMP Version A. The Panel is not clear why the expected recovery time has reduced from 1 to 2 years to 12 months and has sighted no evidence to support the reduction.

The Panel also notes other inconsistencies between documentation. For example, in Volume 3(A2) Volume 22 Section 14.4.1 of the AME studies, the performance criteria for sedimentation is set to not exceed 0.1mm/day (i.e. approximately 3mm/month) during dredging at seagrass and Pyura beds. However in the EMP Version A, the performance criteria E34 suggests a threshold level of 5mm/month for sedimentation as appropriate for seagrass and Pyura. Whatever the value used, using an average includes the possibility of accepting five millimetres in one day, which may be unacceptable.

This concerns the Panel for two reasons. Firstly the rationale for a two-thirds increase in the threshold between the original work and the EMP is not clear. Secondly, the Panel is doubtful that the science is available that demonstrates any real knowledge of impacts of gradual sedimentation rates at 3mm/month or 5mm/month or short term severe events on seagrass or Pyura beds, and this is clearly acknowledged in the AME studies.

The PoMC proposes to use and adapt the light driven primary production model methodology as the Project commences. The Panel believes this poses unacceptable risks to the health of Port Phillip and potentially the Project itself. The Panel can not be confident at this time that the threshold criteria developed for the different primary producers are appropriate and supported to an acceptable level of scientific certainty. This is exacerbated by there being no tested modelling to support management to comply with the thresholds.

The Panel does not believe that the long-term sustainability of the primary producers themselves and the multitude of other organisms that depend on them for survival is proven under the proposed modelling and management regime.

The Panel is also not confident that:

- the modelling predictions will be borne out in the Port Phillip environment;
- the cycle of prediction, monitoring and management response can be carried out effectively in real time during dredging in all weather conditions; and
- there are an appropriate range of management responses and controls available to the dredging contractor to meet environmental criteria without unacceptable financial risk to the Project.

The light driven primary production model sits at a critical point in the environmental management framework and hierarchy of tools used to support this.

Firstly, it is fundamentally dependent on the turbidity and sedimentation modelling and thus light penetration predictions under the responsibility of Dr Provis, about which the Panel retains serious concerns.

Secondly it provides a foundation for many other ecology specialist studies which rely in part or entirety on the proposition that there will be limited disruption to the Bay's primary producers. Given this foundation stone nature and the reliance of other ecological positions on it, the Panel believes further development and field testing under realistic conditions is necessary before it could be considered as one of the primary dredge management tools.

It follows that the Panel believes that the approaches proposed are not yet proven as effective, responsive methods for managing the environmental impact on benthic primary producers in Port Phillip from a real time dredging campaign in which turbidity effects are not minimised.

The Panel believes this position is supported by the recommendations in the Expert Seagrass Workshop, which whilst supporting the modelling concept, raise a number of fundamental scientific issues requiring further consideration. In particular the workshop recommended the use of light saturation as the primary performance indicator rather than carbon production.

The Panel would like to note that it strongly supports the concept of this workshop as a means of injecting the practical responses of expert peers into the resolution of appropriate tools and techniques. It believes that such workshops should continue to be a core part of further development of this modelling approach if it is to be pursued. Development of the peer review process into a procedure in the EMP would add significant rigour to a Project, which is struggling with basic ecological data needs.

The Panel recommends:

The light driven primary production model approach should be refined and developed further with broad peer input, more research at appropriate temporal and spatial scales and extensive field testing utilising trial dredge plumes, prior to deployment in the capital works campaigns.

Notwithstanding the points above regarding the efficacy of using the light driven primary production models to develop and monitor performance against criteria and thresholds, the Panel is concerned that the approach is being adopted for the south of the Bay only. Justification is given for this in the Operational Control Procedure: Light Budget (CDP OP446.435.1A) in the EMP Version A. Namely:

> *However, in the North of the Bay and the Yarra River, turbid plumes will remain close to the area of the dredging and will be amenable to treatment using the SEPP approach. As such, turbidity levels in these areas must stay within SEPP Guidelines.*

The Panel does not agree. Figure 7 in Annexure D to Dr Provis' Expert Witness Statement indicates turbidity may impact on the small but significant northern seagrass areas shown in Figure 3.1 of Volume 5 of the AME suite of reports. There also appears to be a strong correlation between the plume mapping in Figure 7 of Appendix D and high concentrations of MPB shown in Figure 3.3 of Volume 4 of the AME work, which requires further investigation. Further, as highlighted above, the lack of Yarra plume inputs and the lack of proof of concept modelling in the Panel's view combine to suggest that the approach set out above is not sufficiently justified.

To the Panel there is no apparent reason why the north of the Bay should be treated differently in principle. The Panel recommends:

The proponent should adopt a consistent approach to managing ecosystems in the north and the south of the bay.

14.1.8 CONTAMINANTS, NUTRIENTS AND TOXIC ALGAL CYSTS

Discussion

Studies undertaken for the EES identified a range of contaminants and contaminated locations in the project area. These are summarised in the Sediment Chemistry section[155] of the EES and are generally located in the north of the Bay at the existing Port of Melbourne northern dredge material ground (DMG) and within the Yarra River, Hobsons Bay and Port Melbourne channel. Contaminants of concern include metals, organochlorine pesticides and hydrocarbons.

[155] Section 14.3.1, Sediment Chemistry, Volume 1, EES Page 14-11

These contaminants may be released into the water column via dredging at the source and during disposal at the northern DMG. This will potentially include the contaminants transported from the dredged areas and resuspension of contaminants from the northern DMG itself during dumping.

Contaminants may be picked up in particulate form in the dredge plume by filter feeders (e.g. mussels), or as the contaminants settle out to the seabed attached to fine particles they may be ingested (via feeding or gills) by benthic organisms. The impact of these contaminants released into the water column directly affecting fauna is considered to be negligible with some potential for bioaccumulation in the food chain.[156]

Investigations of whole of sediment testing undertaken by Dr Adam Cohen from Sinclair Knight Merz indicated that the dredged material from the Yarra River is acutely toxic to the amphipod *Melita plumulosa*[157] which has implications for its disposal in Port Phillip. As discussed at length above, this was not made clear in the exhibited EES.

In addition to the contaminants mentioned above, dredging may release nutrients such as nitrogen from the sediments. Under the right conditions, increased nutrient levels can stimulate increased growth of organisms such as microphytobenthos, phytoplankton and toxic algae such as the toxic dinoflagellates. The cysts of toxic algae are known to occur in the sediments in the Yarra River and Hobsons Bay and blooms have occurred in this area in the past between December and April[158].

The Environmental Management Plan Version A contains operational control procedures for contaminant[159], nutrient and toxic algal cyst mobilisation[160] and a process monitoring procedure for contaminants and nutrients[161].

Panel Response

The Panel has significant concerns regarding the sediment chemistry investigations undertaken for the Project in the north of the Bay and these are considered in detail in the Sediment Chemistry chapter of this Panel report. The concerns relate to the selection of sediment sample points and depths, the standard of analysis, the interpretation of relevant policy and the implications for the Project approach generally.

From a marine ecology point of view, the uncertainty regarding sediment chemistry makes it difficult to reach a concluded position on the effects of contaminants released by the Project. It is clear that there is some contamination and that in the testing that was done on whole sediment acute toxicity to a marine organism was observed.

The State and National policy framework for this issue make it abundantly clear that material of this nature cannot be placed in the marine environment without isolation to prevent it being accessed by benthic organisms which have the potential to mobilise it into the food chain.

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156 Section 4.1(a)(2)(c), Expert Witness Statement, Andrew Longmore

157 Table 3.7, Stage 2 Additional Environmental Survey Work, Sinclair Knight Merz, April 2004

158 Section 4.1(a)(2)(d), Expert Witness Statement, Andrew Longmore

159 Version A EMP, CDP OP446.465.1A

160 Version A EMP, CDP OP446.475.1A

161 Version A EMP, CDP OP446.41125.1A

The Panel is also concerned that the later turbidity modelling[162] indicates the plume from dredging the Port Melbourne channel and spoil deposition at the northern DMG covers a far greater extent than the one modelled in the EES. This indicates to the Panel that the potential for fine particles to travel well away from the spoil ground, with contaminants potentially bound to them, is high.

The Panel notes the proposed procedures in the EMP Version A but observes that some are incomplete and some are based on monitoring with little or no indication of what action would be taken if the monitoring identifies issues with contamination mobilisation.

There is still considerable uncertainty surrounding the sediment chemistry work. The sediment chemistry findings and the subsequent program for managing contaminated and/or toxic spoil will bear strongly on the issue of contaminant mobilisation.

If the sediments are rigorously characterised and tested for toxicity and appropriate management responses developed, the mobilisation of contaminants into the Bay's ecosystem may be an issue of minor consequence. However, on present information the Panel is not in the position to draw this conclusion and must note that the potential for food chain and consequent human health effects has not been sufficiently excluded.

The Panel recommends:

Following further research into sediment chemistry in the Yarra River, Port Melbourne Channel, Hobsons Bay and the Northern DMG, the potential for mobilisation of contaminants into the Bay ecosystem be should reviewed with particular reference to pathways from the sediment into the food chain.

The Panel notes the issues around the presence of toxic algal cysts in the Yarra and Hobsons Bay sediments. The disturbance of these cysts and the potential release of nutrients at the time of year when light and temperature may contribute to a bloom is of some concern to the Panel.

This concern relates to location and severity of the bloom and its possible impact on other beneficial uses in Port Phillip, and also the impact on the dredge program itself (particularly costs) if a lengthy delay results from a bloom being triggered or exacerbated by dredging.

Given this potential severity of impact in environmental and economic terms, the Panel believes that further research into the triggers and possible response mechanisms to a toxic algal bloom related to dredging should be pursued. The Panel recommends:

Further research into the causes, likely duration and effects of a dredging related toxic algal bloom should be undertaken prior to dredging commencing, to develop a detailed, practical, effective prevention and response plan that protects beneficial uses and project integrity.

14.1.9 OIL AND CHEMICAL SPILLS

Discussion

A summary of the oil spill consideration from an ecological risk point of view by Australian Marine Ecology (AME) is given in Section 4.3 of the Expert Witness Statement by Dr Matthew

[162] Annexure D, Expert Witness Statement, Dr David Provis

Edmunds. This modelling was undertaken by AME using the Port of Melbourne Ship Incident Model (POMSIM) and is reviewed by the Panel elsewhere in this document. This section of the report seeks to examine the ecological impacts related to potential spills. The impact of any spills will be highly variable depending on location, amount spilt, weather conditions, state of the tide and a range of other conditions.

AME have identified a major oil spill as a bay-wide concern and a large number of sites, communities and species are potentially vulnerable. The possible impacts identified from the literature are listed in Dr Edmunds Expert Witness Statement. AME identify oils spills arising from an incident related to dredging as one of the few threats that could impact on RAMSAR wetlands. Only passing reference was made to the proposed introduction of 120,000 tonne+ 'Aframax' oil tankers.

Dr Edmunds concludes that the risk of oil and chemical spills will reduce over the life of the Project due to a reduction in shipping numbers compared to if the Project does not proceed. However, he also concludes that the risk of a collision related to the dredger itself is of greater concern with modelling indicating an increase of incident probability from 1:10,000 per year to 1:10 per year for the Rip with no controls in place.

Panel Response

The Panel has significant concerns relating to oil and chemical spill risk management and response for the Project more generally and this is discussed elsewhere in this Panel Report.

The Panel believes it is clear that the implications of an oil spill in Port Phillip could be widespread spatially and temporally with catastrophic consequences for the ecological, economic and social health of the Bay.

14.1.10 BAYWIDE & REGIONAL IMPACT ASSESSMENT & MANAGEMENT

Discussion

A summary of the potential for Baywide and regional ecosystem assessments is provided by Dr Matthew Edmunds and this considers impacts on the whole Bay, and on the northern and southern regions.

Potential effects on the whole Bay are considered to be[163]:

- changes to tidal ranges and currents;
- water quality and turbidity;
- oil and chemical spills;
- marine pest translocation;
- bioaccumulation of contaminants;
- changes in nutrient fluxes and denitrification capacity;
- changes in nutrient fluxes and impacts on phytoplankton biomass;
- trophodynamic effects on primary producers from light attenuation; and
- effects on larval and juvenile recruitment into Port Phillip.

[163] Section 4.14(a), Expert Witness Statement, Dr Matthew Edmunds

Dr Edmunds concludes that all these potential impacts can be appropriately managed to minimise the risk to Port Phillip at the whole Bay ecosystem scale. The largest residual concerns relate to oil spills and marine pest incursions.

The potential regional impacts on the northern region of the Bay are summarised as[164]:

- release of nitrogen from dredged sediments and the stimulatory effect on phytoplankton biomass (including toxic dinoflagellates in the Yarra River and Hobsons Bay); and
- suppression of microphytobenthos biomass due to turbidity.

The potential regional impacts on the southern region of the Bay are summarised as[165]:

- reduction in primary production of benthic plant communities (seagrasses, kelps, microphytobenthos) and related habitat impacts;
- impacts on areas of high biodiversity; and
- impacts on nutrient cycling processes.

For these regional impacts, performance criteria are proposed and an extensive monitoring program developed to ensure the required levels of protection can be maintained and these are compiled in the Version A EMP.

Acutely toxic sediments and the disposal of acutely toxic sediments is not mentioned in the EMP Version A and was not considered in the EES report.

Panel Response

The Panel appreciates the attempt at system based approach to understand the potential implications of the dredge campaign on the marine and estuarine ecosystems in the Bay. However, the Panel is concerned across a range of areas that the system wide impacts have not been adequately assessed.

These concerns include the following.

- The adequacy of the turbidity modelling and the foundation nature of this work in informing the light driven primary production models.
- The adequacy of the light driven primary production modelling based on the above and the lack of understanding of photokinetic responses on Port Phillip primary producers and ecosystems.
- The dependence of specialists investigating higher order species on the above work in drawing their conclusions regarding environmental impact.
- Lack of understanding of Baywide trophodynamics processes and therefore the potential and magnitude of flow on effects from impacts to different components of the ecosystem.
- The northern regional and potentially Baywide ecological impacts of the poorly designed and managed sediment chemistry assessment program and its associated Project response.
- The use of a “top down” performance based approach to protecting the Bay’s ecosystem with considerable uncertainty on whether the performance criteria are appropriate and whether they can be achieved.

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[164] Section 4.14(b), Expert Witness Statement, Dr Matthew Edmunds

[165] Section 4.14(c), Expert Witness Statement, Dr Matthew Edmunds

- Lack of detailed response measures for ecosystem protection and recovery if predictions and management measures proposed are found to be inadequate during dredging.

The Panel does not propose to discuss these points in detail one by one as many are discussed at a higher level elsewhere in the report. However, examples will be used to illustrate the Panel's concern. The first example will be that of microphytobenthos.

Some of the acknowledgments to the limits in knowledge given by Dr Edmunds, whilst clearly professionally made, give the Panel little comfort in developing recommendations on the environmental acceptability of the Project. For example in discussing microphytobenthos (MPB) Dr Edmunds states[166]:

> *It is currently not possible what the significance(sic) of this production loss would be at the southern region system level, as we know little about energy and matter flows through the ecosystem.*

This is tied with an acknowledgment that microphytobenthos go into rapid decline in low light conditions, in this case under a turbid plume. Australian Marine Ecology provided a map in the EES[167] showing distribution of MPB in Port Phillip. This figure shows two large areas of high MPB biomass in the north and the south of the Bay and other smaller areas in Corio Bay and off the Western Treatment Plant.

According to the Annexure D plume modelling undertaken by Dr Provis, both these areas will be significantly affected by turbid plumes. Due to the lack of proof of concept modelling, the Panel is not clear on how long this impact will last and what the turbidity concentration will be at particular points. Given the spatial and temporal scale of the dredging, the Panel has significant concern that this impact is not adequately understood and has not been adequately assessed.

Whilst MPB is known to recover rapidly, the panel is not convinced of its ability to recover rapidly after a period of light reduced suppression of high MPB biomass areas lasting weeks to months over a broad spatial area. It is difficult to conceive of natural conditions where this level of impact on MPB might be achieved. Whilst storm events do cause considerable turbidity in Port Phillip via wave action in the Bay and inputs from the Yarra, these are usually relatively short duration events, most unlike the dredge campaign proposed.

The impact on other organisms from the suppression of MPB for potentially a considerable time over a large area is not clearly understood and this introduces a level of uncertainty on a Baywide scale that the Panel does not believe is acceptable.

Another example of potential Baywide impact is that of anchovy. The significance of anchovy to little penguins has already been discussed, but anchovy is a significant prey species to a range of other species including upper order fish, marine mammals and predatory birds[168].

The importance of anchovy has increased since a pilchard population crash that occurred in the late 1990s. In winter, high densities of schooling fish aggregate north of the Great Sands, of which anchovy is thought to be a significant component[169]. Annexure D prepared by Dr

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[166] Section 4.14(c), Page 68, Expert Witness Statement, Dr Matthew Edmunds

[167] Figure 3.3, Volume 4, Microphytobenthos, Australian Marine Ecology

[168] Section 1, Annexure C2 - Anchovy

[169] Section 2, Annexure C2 - Anchovy

Provis indicates that turbid plumes may affect this area at times during dredging, affecting visibility for predators and impacting on primary producers.

Similarly, Annexure D also predicts a much greater plume extent in the north of the Bay during summer when the anchovy are most sensitive than that considered in Section 3 of Annexure C2 – Anchovy. Anchovy are a key fish species in the Bay for commercial fishers and as a link in the natural food chain. Uncertainty about the impact of the dredge program on this species highlights the uncertainty around the impact on the Baywide ecosystem more generally. Anchovy are also a key prey species for little penguin. Whilst the rationale for avoiding north of bay dredging in winter has been based on avoidance of direct impacts to the little penguin, it appears that the predator-prey link with anchovy may not have been fully considered.

Another area the Panel wishes to comment on in the context of Baywide impacts is that of the dredge scheduling based on species sensitivity in the north and south of the Bay. The Panel accepts in principle that this approach is desirable, even given that no ‘perfect’ window exists and human use concerns (e.g. diving in the south of the Bay) also impact on the schedule.

However the Panel believes the program should be more specific in identifying critical periods for particular species and relating these to control measures in the EMP Version A rather than having them as a general guide. It would in fact be preferable that the available work windows be defined and then fixed into approval conditions such that the community can be confident that their interests will be protected throughout the duration of the works and the proponent can confidently proceed to schedule its activities.

There may be periods which fall between the ‘can dredge’ and ‘can’t dredge’ windows which may require later consideration. For example a period where there is the commencement of breeding of a particular bird species could be monitored in the field and with approval the dredge program adapted as necessary. Given that these critical points are variable from year to year, real time monitoring and response to increase or decrease the dredge ‘window’ is desirable and necessary.

In considering Baywide ecological impacts, the Panel also wishes to address the issue of offsets. Whilst the PoMC has argued that Victoria’s *Vegetation Management Framework – A Framework for Action* does not apply in the marine environment, the Panel believes the concept is supported in principle in the marine environment in Victoria’s Biodiversity Strategy.

Whilst the science of re-establishing marine habitats (for example seagrass) may be in its infancy, the Panel is of the opinion that the Project should strive to ensure that where there is loss of habitat, that active rehabilitation is considered.

This is recognised to some extent, with the suggestion that *Ecklonia* kelp may be “planted” in The Heads in the EMP Version A if natural recovery is not occurring. The Panel does not believe it is acceptable to consider a situation where an ecosystem may be damaged or destroyed by the Project, directly or indirectly, and no restitution be considered.

In summary, the Panel consider that whilst a genuine attempt has been made to consider the Baywide and regional effects of the Project on the Port Phillip ecosystem, large areas of uncertainty remain that preclude the Panel from recommending that the Baywide environmental impact will be acceptable.

The Panel is deeply concerned, and this concern is expressed throughout this report, at the general approach taken to Project development and environmental management. The approach of setting performance criteria for the dredge contractor with little regard to the technology to be used, with some large gaps in knowledge leading to the development of those criteria, has resulted in considerable ecological and economic uncertainty in the minds of the Panel.

The Panel recommends:

As the project is currently proposed, the potential for significant adverse effects on bay-wide and regional ecosystems has not been sufficiently excluded. The Panel considers they may have been significantly under-estimated. Impacts need to be re-evaluated following further refinement of the project approach pursuant to recommendations above, particularly including those relating to turbidity modelling, light driven primary production models and sediment chemistry.

14.2 UNDERWATER NOISE

Discussion

One key issue raised in submissions but in respect of which there was very little data was that of underwater noise. Dredge technology has the potential to cause significant underwater noise. It was of particular concern to many that the proposed hydro-hammer technology to be deployed in the Rip did not have an available 'noise signature' and its ecological impacts had not been assessed.

Panel Response

The EES is particularly deficient in its assessment of the impacts of underwater noise on non - human (biological) receptors. This section of the report should be read in the context that the panel heard that none of the marine consultants, in particular the noise and marine mammal consultants presented evidence that they were expert in the assessment of noise impacts on biological species.

As earlier stated, The Heads is the gateway for vessels to the bay. It is also the gateway for dolphins, whales, fish, fish larvae, penguins etc migrating into or out of the bay. It is also the permanent home for habitats and species of high conservation significance. There is the potential for prolonged noise in or near this gateway to significantly interrupt normal activities or deter animals from trafficking into and out of the bay for periods which may extend considerably longer than the dredging program itself. These concerns have not been adequately assessed and could have a long-term effect on the viability of some populations.

Sound propagates efficiently through water and it is used extensively by marine creatures to forage, interact socially etc. Underwater noise was correctly identified as a key threatening process in the EES and was noted as arising from a number of sources including:

- Hydro-hammering;
- rock ripping in The Heads (not assessed at all);
- berth works, in particular piling (not assessed at all);
- dredging operations;
- maintenance dredging; and
- operational characteristics of large ships

Whilst the panel recognises that there are differences between hydro-hammering and seismic testing activities, there are also many similarities.[170] The panel suggests that Commonwealth seismic guidelines are able to provide guidance to regulators in respect to establishing construction conditions for the project.

The Panel finds that there are a number of data gaps in the assessment of underwater noise on biological receptors. These are largely a result of the following factors:

- No ambient noise data was collected.
- Noise signature information was not available for most sources of potential underwater noise. A very limited program of ship noise monitoring was undertaken.
- Little information was collected about the zones of audibility, responsiveness, masking, hearing loss, discomfort and injury for the range of species likely to be affected.
- The noise consultant did not assess underwater noise impacts on biological receptors. He predicted noise levels for other consultants (fisheries, marine mammals and marine ecology consultants) who undertook cursory assessments but given the lack of signature information, his and the consequent assessments were not comprehensive.
- Species dependent work windows for noise related events contingent on known movements were not identified.

The Panel draws attention to the following points that have also been taken into consideration when making its recommendations:

- That over the period of the project, and even during the panel hearings, there has been time for the proponent to undertake the basic underwater noise monitoring that could have been used to inform the assessment.
- The Alliance contractor professed to have no noise data relating to their vessels or equipment.
- The limited ship noise monitoring that was undertaken for the EES indicated that larger vessels generate more underwater noise.
- The potential for the impactive noise of the hydro-hammer to propagate through the 'canyon like' structures of the Entrance Deep was not assessed.

As the Alliance contractor has no noise information relating to its equipment, the Panel believes that further evaluation is required before an assessment can be made.

Specialist marine acoustic expertise should be engaged to assist the proponent during the project.

A comprehensive set of ambient marine noise data should be collected for key areas particularly in the Rip, but also including other locations where it is determined that there may be sensitive marine biological receptors.

Appropriate underwater noise criteria should be established for species potentially affected at these locations by DSE (with the advice of DPI, who have experience in the management of marine acoustic noise). The cetacean and penguin protection measures should provide protection to an equivalent standard to that implied in the Commonwealth seismic cetacean guidelines.

[170] Pile driving would usually be less noisy than seismic but more noisy than oil well drilling. Pile driving would also have a higher periodicity of pulses than seismic.

The acoustic signature of all proposed construction equipment should be obtained and a complete underwater noise assessment be undertaken by a specialist marine acoustic consultant.

Mitigation and Proposed Controls

The proponent has included an Operational Control Procedure for Underwater Noise in the EMP Version A. This procedure addresses noise in relation to humans and biological receptors although the comments here relate only to the biological receptors as human effects can be adequately controlled (in principle) through the implementation of appropriate warnings, exclusions and the implementation of an adequate complaints resolution process.

The procedure establishes 'acceptable' noise levels for marine biota for both pulsed and non pulsed noise. It also sets a 100m exclusion zone for marine mammals and little penguins and suggests a gradual increase in hydro -hammering at the commencement of operations.

In respect to these performance criteria the panel notes the following:

- The noise levels may not be appropriate for the range of species that may transit the areas where the most noise is likely to be created (the Rip and the Yarra).
- The pulsed noise levels are specified in dB re 1uPa peak to peak which has been found to be an inappropriate scale for mammals.[171]
- No guidance is provided about the performance criteria for a combination of pulsed and non pulsed noise. This will always be the situation when the hydro-hammer is being used.
- The exclusion zone provisions are significantly less than those required by the Commonwealth for seismic vessels.
- No evidence has been provided that the hydro-hammer can, or can not, be 'soft started' in an effective manner. This approach also assumes that all species will move away from the source to avoid discomfort or injury. This has not been verified by the appropriate environmental consultants.
- The 'exclusion zone' that is monitored prior to startup for seismic activity is 3000 m. No justification has been provided for an exclusion radius of 100 m for the hydro-hammer.
- The ‘watch’ period prior to start up for seismic is 90 minutes yet the Channel Deepening project proposes 30 minutes.
- The procedure does not specify the stopping of noise making activities if marine mammals or penguins enter the exclusion zone during hydro-hammering.
- The procedure does not specify the conditions under which operations can be restarted following the sighting of a marine mammal or penguin.

Procedure Requirements and Controls

In Section 6.1.2 the vessel master is specified as the person who will undertake the visual inspections for marine mammals and penguins. The panel does not agree that this is appropriate. It recommends as follows.

The measures should require the use of an appropriately experienced/trained cetacean observer and include the specification of:

- the length of observation time required before start up;

[171] URS, 2004

- the length of observation time required following the sighting of a marine mammal or penguin within the exclusion zone; and
- the use of night observation devices when dark

The procedure and controls do not mention any use of a bubble curtain or similar mitigation, despite the recommendation for this control and subsequent reduction of risk ranking by the marine mammal and penguin consultant[172]. The proposed controls do include the use of additional baffling and fish guiding systems although no information was provided to the Panel about these.

The Panel draws attention to the recent experience in the development of Hong Kong's Permanent Aviation Fuel Facility which trialed a number of bubble curtains to reduce noise levels by 3dB from levels when no bubble jacket is in place. Acoustic decoupling was also recommended there as an approach to reduce noise. Trials were successfully held in March 2004[173].

In the light of experience elsewhere in the world the Panel recommends:

Development of environmental protection and mitigation strategies including controls such as bubble curtains to meet the specified performance criteria should be considered.

Monitoring

The Operational Control Procedure for underwater noise monitoring (CDP OP446.486.1A) somewhat confusingly does not differentiate between the collection of ambient, hydro-hammer and other noise monitoring data. It does not reference Table 5.1 of the EMP (which includes the monitoring frequency information). Even more confusingly, Table 5.1 indicates (at M29 to M31) that the only underwater noise monitoring proposed will be the baseline monitoring and a one-off campaign associated with the hydro-hammer. This makes the Panel question the function of the rest of the procedure and raised concerns as to its overall adequacy.

The Panel recommends as follows:

The specification for the ambient noise monitoring programme should:
- be undertaken prior to the commencement of works to allow time for analysis and remedial action to be taken;
- specify the required technical equipment (e.g. hydrophones with calibrated amplifiers and high speed logging) and where and how it should be used;
- ensure that the monitoring undertaken includes cumulative noise from sources such as the hydro-hammer, dynamic positioning thrusters of the vessels and passing vessels;
- be designed to give reassurance over time that it continues to meet the specified levels under a range of conditions.

[172] Mustoe Second Report Table 11.1 page 95

[173] Information is available on the web and from the Environment Protection Department of Hong Kong.

14.3 TERRESTRIAL ECOLOGY

It this section considers the following issues:

- land-based ecosystems;
- land-based species (in so far as they are relevant to the project); and
- avian species.

Consideration of land-based ecosystems requires some level of complexity in analysis, in that the lands subject to the highest level of legislative and policy protection are wetlands and intertidal areas, subject to international designation. They sit at the interface between marine and terrestrial ecology, rather than being purely terrestrial. However, such lands are dealt with here rather than as a component of the Panel's consideration of marine ecology above.

In relation to land-based species, this chapter does not consider marine mammals such as seals that make use of land. All marine mammals were part of the body of work in the EES prepared by Dr Simon Mustoe, which has been responded to above as part of the analysis of marine ecology.

Consideration of avian species also requires some level of complexity in analysis, in that the relevant birds, whilst resident on land, typically rely on the marine environment and form part of marine as well as terrestrial ecosystems. However, again, birds of all relevant types are considered here, with one key exception. Penguins again were part of the body of work in the EES prepared by Dr Simon Mustoe. For continuity of reference, although Penguins are birds, they too have remained with the Panel's analysis of marine ecology.

The Panel must commence its response to matters of terrestrial ecology by making clear that, in comparison with many other areas of interest potentially impacted upon by the project, this field was not subject to many detailed or weighty submissions. Nevertheless, it requires rigour in analysis to respond to individual heads of control under the Commonwealth Environment Protection & Biodiversity Conservation Act 1999.

Of the issues emerging from submissions, the Panel considers the most critical to be as follows.

- The relationship between the effect of the project on the marine - terrestrial boundary, and consequent effects on ecosystems and species.
- The physical effects of works on ecosystems and species.
- The potential for chemical effects on ecosystems and species.

These are examined further below, together with a brief but specific summary of the effect of the Panel's consideration of issues on the assessment of impacts on matters of national environment significance (NES matters) under the Environment Protection & Biodiversity Conservation Act.

14.3.1 THE MARINE – TERRESTRIAL BOUNDARY

Discussion

The project has the potential to affect the marine-terrestrial boundary in coastal zones around the bay, due to the degree to which it will facilitate greater volumes of water movement and tidal exchange through Port Phillip Heads, effectively the 'valve' limiting flow between the bay and Bass Strait.

The potential for changes to the marine – terrestrial boundary around the bay and its potential to cause adverse impacts to terrestrial ecology was one of the major concerns of submitters, particularly of those who did not request to be heard before the Panel.

As is better described in Chapter 12 above, many submitters did not accept the assurances of the proponent that implementation of the project would not lead to the significant additional inundation of land at the coast. It followed that many of these expressed considerable doubts that significant coastal flora and fauna would be adversely impacted, to a greater degree than assessed in the EES.

Individual submissions raised different concerns about different locations and different species, ranging from individual Ramsar listed wetlands to the welfare of the Orange bellied Parrot. However, the theme to which such submissions spoke was a common one. It rarely extended beyond generic levels of analysis, to the extent that if there was any additional inundation of land over and above that identified by the proponent, the degree to which this occurred would represent a threat proportional to the extent and significance of the natural environment assets impacted.

Mention must be made of the following specific concerns. A number of submissions raised the issue of native vegetation loss pursuant to the project and the applicability of the 'net gain' principle. The view was presented that where native vegetation in coastal and foreshore communities was lost, it was a requirement of policy that the proponent ensure an equivalent reinstatement on a habitat – hectare basis.

However, Ms Rhodwin Cunningham and Ms Salli Anderson spoke with experience of conducting wetland construction and re-vegetation in association with a very large number of water sensitive urban design and nutrient control projects for Melbourne Water, various municipalities and subdivision proposals around the bay. They made clear their view that whilst the regeneration of freshwater communities was well within current scientific and technical understandings and proved highly successful, salt marsh, alkaline and intertidal communities had proved significantly harder to revegetate. They held out little prospect for the successful short-term rehabilitation of coastal interface land that became subject to new saline influences as a result of the project.

Birds Australia highlighted significant use of the bay and bay foreshores by migratory and otherwise protected species.

The proponent's response to concerns as to coastal processes and changes to patterns and levels of inundation in the bay were to emphasise that this was an area where, in broad terms, it had a high level of confidence in the capacity of modelling to predict the outcome. On the basis that there was predicted to be a consequent maximum increase in tide levels of up to 8 millimetres at high water, Chapter 28 of the EES included the following conclusions:

- *The changes in tidal range caused by the project will be imperceptible and the distribution of sea levels (the frequency of occurrence of a given level) will not change as a result of the project.*
- *Any change in sea level as a result of climate change will not be exacerbated by the project.*

Whilst this chapter summarises considerable bodies of work, the above conclusions continued to be supported by the later evidence of Dr David Provis of Lawson and Treloar and were not subject to change during the EES process.

Peer Reviewer Dr Kerry Black for the Department of Sustainability and Environment concluded that whilst he may not have chosen the word 'imperceptible' to describe the changes in tidal range due to the project, he did not disagree with the proposition that the changes would be of a limited order. However, this assumed that there was no requirement to significantly enlarge the channel at the heads, over and above that predicted in the EES.

It followed in the view of the proponent that whilst the marine - terrestrial boundary would change, this change would be limited in nature and within the range of change to be expected due to existing natural events and or sea level rise due to anthropogenic climate change. Impacts on coastal species and communities would be limited.

Specifically, Chapter 38 of the EES reaches the following conclusions in relation to adverse impacts on environmental assets due to marine – terrestrial boundary change:

- Saltmarsh communities, including those in Ramsar sites, would be subject to greater inundation than at present. Studies referred to by the EES team suggested that natural processes of inland migration of saltmarsh habitat can occur over time. However, the physical situation of some saltmarsh communities, including for example, location hard against assets such as roads or agricultural land, would limit or eliminate some opportunities for migration processes. In relation to the applicability of net gain, the EES acknowledged the need to monitor coastal vegetation and ensure that compensatory provision and revegetation to assist habitat migration occurred as required.
- A slight increase in overall tidal range could result in marginal increases in feeding opportunities for shorebirds and waders, including listed protected and migratory species.
- The extent of and tidal range impacts on Mud Islands for the breeding of listed protected and migratory birds is not expected to change. Nor are there predicted to be changes to artificial structures used by birds, with the exception of Popes Eye, where some monitoring and raising of breeding platform levels may be justified.
- The impact on Orange bellied Parrot habitat is considered to be limited, with some potential for benefits should upshore migration of relevant salt marsh habitat occur.

None of these conclusions were significantly influenced by the introduction of later material in the EES.

Panel Response

Many submissions were deeply concerned about the potential for the project to affect the marine – terrestrial boundary. However, the Panel's starting point is to observe that, further to its analysis of hydrodynamic issues above, it considers that the proponent has reasonably stated the potential for and scale of changes to the marine – terrestrial boundary likely to be brought about by the project.

The Panel has had particular regard to the scale of the likely boundary effects, as against the effects of both individual natural events such as king tides, storms and storm surges, and as against the now clearly likely sea level rise due to anthropogenic global warming. It is fair to say that the impacts of the project are of a similar order to or can be absorbed within the effects of currently expected metocean events. Further, the changes likely to be caused by global warming are likely to absorb the sea level effects of the project in a relatively short timescale – in the order of one decade.

Having reached this position, it therefore follows that the Panel considers the EES to have set out reasonably sound macro scale analysis of the potential effects of the project on ecosystems and species reliant of the current location, ecological character and values of the marine – terrestrial boundary.

The EES is clear that the location, ecological character and values of the marine – terrestrial boundary will change as a result of the project. However, it is also clear that the nature of the change and its effect on relevant listed species and communities will in general terms be limited.

The proponent's terrestrial ecological consultant Mr Brett Lane has placed considerable reliance on the hydrodynamic modelling in reaching general conclusions that the effects of the project in terms of changes to the marine – terrestrial boundary will be minor to insignificant. His justification in doing so is borne out by reference to the Panel's examination of that work in Chapter 12 above and in the peer review of the hydrodynamic and coastal process modelling by Dr Kerry Black.

It flows from this position, that the Panel accepts the large order proposition that the project will not have a material effect on listed communities or species consequent on changes to the marine – terrestrial boundary. It also flows that in particular EPBC and FFG Act assessment against this measure can be regarded as sound. They do not require to be revisited, unless the project design should change in a manner that lead to a significant increase in the capacity for water movement through the heads, over and above that assessed at the present time.

In reaching this position, the Panel has considered with care submissions put to it about the application of the net gain principle and the possible need for compensatory rehabilitation of native vegetation at the marine terrestrial boundary. It has particularly considered the likely swiftness with which vegetation community change due to the die back of salt intolerant plants would take place (immediately upon additional inundation due to the enlargement of the aperture into the bay through the heads). It has placed this consideration against the relative slowness with which the opportunities thus created for additional inshore migration and colonisation by salt tolerant vegetation might take place.

Its starting point is that the net gain principle derived from Victoria's Native Vegetation Management Framework will apply in principle to circumstances where the project can be demonstrated to have had a net reductive effect on the extent of native coastal vegetation. However, in the Panel's mind, the direct proof of causation of such an effect will be very difficult to achieve in circumstances where there are at least two other operating variables that could lead to equivalent or greater orders of net change over a scale of 1 to 10 years. It will be difficult and in the Panel's view onerous to clearly and specifically distinguish adverse vegetation community change due to the project from adverse change due to natural metocean conditions and/or anthropogenic global warming.

Furthermore, the resources deployed towards monitoring to identify the specific effects of the project on coastal vegetation communities are likely to be substantial, a matter to be placed into the balance against the relative inconclusivity with which such monitoring could then attribute a specific impact to the project.

Submissions to the Panel from an entity directly involved in native revegetation was to the effect that whilst the science of and techniques for revegetation of freshwater wetlands were well understood, the prospects for intervention to enhance or revegetate salt marsh communities were still very poor.[174] On balance, the Panel considers that the project gives rise to more primary considerations and higher demands on resources for monitoring. The proponent should not be charged with a direct obligation to monitor water margin native vegetation or placed under a direct obligation to promote salt marsh revegetation, whilst the likely adverse effects are limited, the prospects of success are poor, the resource requirements are high and the direct causative basis for such work will be difficult to establish.

Such a position accepts that there will be changes to species and communities resident in the coastal margin, including those listed under the Flora and Fauna Guarantee and Environment Protection and Biodiversity Conservation (Cwth) Acts (Ramsar sites). However, the effects will on balance not be significant or clearly distinguishable from those caused by natural or anthropogenic climatic events and changes.

Specifically, for the purposes of the EPBC Act, the Panel finds that changes to the marine – terrestrial boundary will not have a distinguishably significant effect on the population viability of the Orange bellied Parrot or on the identified ecological values and character of Ramsar designated wetlands, independent from other operating effects.

That being said, the Panel does observe that there would appear to be a prudent residual requirement for the monitoring and, where necessary/possible, management of significant coastal vegetation communities against the combined adverse effects of predicted sea level change. This should include ongoing efforts to ensure that the existing extent of Ramsar sites and other coastal wetland habitats can broadly be maintained, through medium to long term processes of landward migration (accepting that immediate saline community recreation may be very difficult). Actions seeking to stabilise, increase and enhance Orange Bellied Parrot habitat should also be undertaken and, pursuant to work undertaken for EES and EPBC Act processes for windfarms in Victoria and Tasmania, may have more reasonable prospects of immediate success[175]. However, these appear to be tasks to be coordinated and shared appropriately between government, local government, land managers, landowners and voluntary entities such as Landcare/Coastcare.

For this reason, the Panel considers that the best way forward will be for the project to contribute a commuted sum towards the cost of coastal zone management initiatives for Ramsar sites and other significant areas of native habitat around the bay. The direct monitoring and management would be carried out by others, ensuring that works to be implemented would respond to the full range of coastal process changes and would not have to be individually attributed to a specific effect of the project before action was taken.

The Panel notes that at this stage there is little hard data on which to assess such a contribution. A key contribution component would appear to be to fund works or land acquisition to offset circumstances where existing Ramsar and other wetland communities have constrained capacities for medium to long term landward migration. However, the work by Mr Lane acknowledges that the detailed surveys of levels to determine precisely the locations in which migration will not occur, as against those in which it might, have not been done. There are a number of ways forward in such a circumstance. Either the proponent can undertake additional detailed work, or alternatively and possible more productively, a notional sum could be negotiated. This would be based on a broad identification of potentially affected

[174] Ms Rhodwin Cunningham and others: Ms Salli Anderson

[175] For example, the proposed Orange bellied Parrot habitat actions proposed for Woolnorth windfarm in Tasmania and for the Portland Wind Energy Project in Victoria.

areas (which is possible from Mr Lane's existing data) together with a unit cost obtained from management entities for a suite of relevant rehabilitation works. Assumptions would have to be made about the extent of additional land necessary to support habitat migration and the cost at which this might be obtained.

At the end of the day, the Panel sees the detail of such a mechanism as a matter to be resolved between the proponent and the approving authority(s), should the project proceed.

Finally, the Panel must remark briefly on the observation in the EES that bird breeding on Popes Eye may be vulnerable to tidal range changes due to the project. Birds on this structure include species subject to EPBC Act control. The Panel considers that this matter falls directly within the responsibility of the proponent. A detailed monitoring program of bird population and nesting behaviour at Popes Eye should be put in train and maintained throughout the project.

Popes Eye is an artificial structure, combining cultural and natural environment significance in equal measure. Should increased tidal range have the effect of reducing the acceptability of this structure as a breeding location for birds, action to either add further artificial breeding platforms or augment breeding opportunities through an extension to the structure should be explored.

The Panel recommends as follows:

The proponent should provide a cash contribution towards the cost of coastal zone management in Ramsar sites and other significant areas of native habitat around the bay. The precise basis for, quantum and distribution of this contribution should be set out in a document prepared to the satisfaction of the approving authority.

Monitoring and management measures should be undertaken to maintain the resident and breeding capacity of birds using Popes Eye against changes in tidal range.

14.3.2 PHYSICAL EFFECTS

Discussion

The key potential physical effects are as follows.

- Sedimentation and turbidity.
- Noise.
- Lighting at night.

These are all effects consequent on the actual carrying out of works, as opposed to the ongoing operation of the channels.

Concerns were raised in submissions to the extent that the direct and indirect effects of sedimentation and turbidity would be adverse for bird life, including species listed under the Environment Protection and Biodiversity Conservation Act 1999. The species most at risk were considered likely to be those sea birds resident or breeding within the bay, using the bay as a foraging ground. Direct impacts would relate to the short to medium term reduction in foraging capacity and loss of food consequent on turbid waters in which many species would not be able to effectively hunt fish, or alternatively where those foraging ground were avoided by fish. Indirect impacts would relate to wider losses of ecosystem productivity leading to consequential and medium term reductions in forage prey and feeding success.

Lighting at night was raised as a source of disturbance. Due to the proposal to enable 24 hour use of dredge equipment, this would require for safety purposes to be well lit at night. Night lighting could in turn disturb resident and breeding birds.

Concerns were raised that dredging operations at night could also cause noise impacts, whether these be through the operation of a TSHD, or through the operation of less well documented processes such as the use of a hydro-hammer in the heads. Again, the potential for these to impact on terrestrial wildlife, largely resident and breeding birds were raised.

Panel Response

The Panel does not propose to address issues of turbidity in great detail, beyond observing that there is an in principal coincidence of area between Annexure D turbidity plumes and high bird biomass in the bay. The proximity of plume affected areas to important bird areas including Popes Eye, Mud Islands and South Channel Fort must be observed.

Many birds are visual feeders and turbid plumes have the potential to reduce access to prey, or alternatively to stimulate prey avoidance of plume affected areas. The Panel accepts that birds are mobile species and may avoid such impacts – however regard must also be had to the fact that some species (such as the Cape Gannett) are not observed to be resident in other locations.

However, in the Panel's mind there is little virtue in undertaking a detailed analysis of Mr Brett Lane's evidence on these issues because his work is contingent upon the findings of others in relation to the extent and duration of turbid plumes. It therefore follows that impacts on birds cannot be properly assessed at this time.

Turning to noise, the same caveat must apply, pursuant to analysis in this report above. Without noise signatures for key plant such as the hydro-hammer, it is not possible to assess the degree to which noise disturbance will be relevant to avian species.

The principles of disturbance due to lighting at night appeared to have been better understood and controlled by the proponent.

The Panel makes the following recommendation:

More detailed investigations should be pursued to ensure that either:

- turbidity plumes generated by whole of dredge campaigns using the technology analysed in the EES will not continuously or significantly occlude the foraging grounds of EPBC Act listed birds resident and/or breeding on islands and structures in the south of the bay; and/or
- changes to the dredge technology offer are made, to limit turbidity generation or limit turbidity dispersal in areas of EPBC Act listed bird habitat, or both.

The noise impacts of the chosen dredge technology on bird species remain to be fully assessed.

14.3.3 CHEMICAL EFFECTS

Discussion

The Panel has grouped effects on terrestrial ecology due to the spillage or other discharge of oils, chemicals or contaminated materials together as 'chemical effects'.

It was not a matter of contention that a significant oil or chemical spill from a shipping incident could be an event that, amongst other consequence, would pose severe challenges and risks to terrestrial wildlife using the bay mainly bird life. This had largely been responded to in the terrestrial ecology studies carried out for the proponent as a construction-related issue. Dredging equipment would be deployed to the bay. The presence of fuel tanks, oil tanks and chemical storage areas of vessels and plant would pose a potential threat of spillage when the vessels and plant were at sea. Spill sources could range from minor accidental incidents due to the mishandling of individual containers, through to moderate scale emergencies arising from, for example, a collision between a ship passing through the channels and a dredger on station, with consequent loss of fuel or cargo oils or chemicals.

However, a number of submitters were also concerned that this was or could be an ongoing or operational issue. They were concerned that sufficient steps had not been taken to demonstrate that the new channels could be operated with at least an equivalent risk of shipping incidents as that pertaining to the existing channels. Key amongst these were the Blue Wedges Coalition and Captain Frank Hart. Although their concerns as to safety from a direct shipping incident related and also human perspective have already been related above, they require to be re-engaged here as a possible driver of adverse effects on the terrestrial ecology of the bay.

The response of the proponent to this position rested largely on the view that there should be reasonable confidence in the design and simulation processes used, to enable the community to be assured that the channels would operate safely.

On another matter, Dr Simon Roberts and Ecogen Pty Ltd were key amongst submitters raising concerns as to another potential chemical issue: the levels and certainty and confidence with which the community could view the characterisation of Yarra sediments and the design and management strategies proposed for the disposal of these in the bay. It is fair to record that Dr Roberts' concerns were of a broader ecological nature than simply terrestrial ecology, and were largely focussed in the marine environment. Ecogen again focussed largely on needs of their asset and potential effects in the lower Yarra estuarine environment.

However, the issues that they raise do in the Panel's mind bear some consideration. They assist in determining whether Yarra sediment characterisation, disposal and management issues could have any potential bearing on terrestrial ecological questions, in circumstances where there is uncertainty about the base material on which the proponents terrestrial ecological witness has relied.

Panel Response

The EES identified the potential for the effects of oil and chemical spills to have a significant adverse chemical effect on terrestrial ecology. However, in addition to these effects and in the light of its findings on the chemical characterisation of Yarra sediments above, the Panel also considers that consideration requires to be given to the ecotoxicological effects of the disposal of contaminated Yarra sediments in the bay.

The Panel's response to these issues is to remark that they are both contingent. Whilst the terrestrial ecology evidence provided before the Panel was largely sound as a response to its input assumptions, the conclusions drawn are only sound in so far as the input assumptions themselves remain sound. The consequences of this view are set out in more detail for each topic below.

Oil and chemical spills

In relation to the potential for oil and chemical spills to adversely affect terrestrial species and communities, the Panel divides its response between the construction phase and the post construction phase of channel operations.

During the construction phase, the degree to which the project might give rise to an increased risk for oil and chemical spills relates primarily to the degree to which the presence of dredging and associated vessels in the channels might increase the risk of third party vessel incidents causing spills, above that already pertaining in Port Phillip Bay.

Mr Lane's analysis clearly addresses this risk and finds it to be potentially catastrophic if it occurred during the breeding season in respect of resident listed species. It could be in the range of moderate to catastrophic even outside the breeding season in respect of wintering resident listed species.

In terms of the analysis of risk against the construction phase of the project, the Panel has made findings in Chapters 8.2 and 9.2 above. These are to the extent that:

- the current dredge technology 'offer' is not yet demonstrated to be a best practice offer, most closely attuned to the environmental needs of the project and the bay.
- An optimised dredge technology 'offer' requires to be developed.
- Until this takes place, it is not possible to assess the detailed effect of onboard handling protocols or the shipping incident implications of chosen dredge technology.

To this extent, the Panel takes the view that issues of oil or chemical spill risk contingent on the construction phase require to be re-considered by Mr Lane in the light of possible changes to the likely risk effects of the dredge technology, before a final assessment can be made.

The degree to which the project might give rise to an increased potential for oil and chemical spills during the operational phase is discussed in detail elsewhere in this report and has recommended that this body of work needs to be revisited. The Panel notes the seriousness with which Mr Lane views the potential effects of an oil or chemical spill. Clearly there are incidents and incidents, but the Panel's concern rests most with major events pursuant to ship collisions or groundings that result in a major loss of fuel or cargo oils or chemicals into the bay. In circumstances where it is undisputed that the bay has a limited tidal exchange with the Bass Strait, leading to a long average residence time for water within the bay, a major spill event could clearly by catastrophic.

Again, the Panel has made findings in chapters above. These are as follows.

- An apparently high level of ship incidents have been observed in the ship simulation studies carried out to validate the operational safety of the proposed channel design.
- The ship simulation studies did not commence from a properly calibrated simulation of existing channel navigational conditions.
- The sea pilot operators of the simulator were not sufficiently trained in the operation of the simulator using ships and channel configurations with which they were familiar, before the testing of the proposed design with 'design maximum' vessels commenced.
- For this reason, it has not been possible to properly understand the effects of a number of critical but independently operating variables in producing the apparently high level of simulated ship incidents in the proposed channel design, for example:
  - were the incidents due to pilot unfamiliarity with the simulator or with the behaviour of 'design maximum' vessels;

- were the incidents due to the effects of adverse metocean conditions;
- were the incidents due to insufficient allowance having been made in channel design dimensions; and/or
- were they due to a combination of the above?

Taking the above into account alongside Mr Lane's assessment of the highly significant effects of a major oil or chemical spill on listed communities and/or species in the bay, the Panel finds as follows:

- It is necessary to understand the current risk of a major shipping related oil or chemical spill in Port Phillip.
- It is then necessary to a form a clear view (with comparative reference to other major seaways) of the policy acceptability of this known risk, having regard to the nature of the bay's behaviour as a hydrodynamic and ecological system. The proponent has not sought to make this judgement in detailed terms and the Panel cannot do so on the material before it.
- If the current risk is viewed as being unacceptable in ecological terms, then clear steps require to be taken, completely independently of this project, to reduce it.
- However, if the current risk is viewed as being acceptable, then the project should proceed subject to the following design objective and criterion:
  - Objective:
    To minimise the quantitative risk of ecological harm to the bay due to spillage of oil or chemicals pursuant to a shipping incident arising from the transit of vessels through the channels.
  - Criterion:
    To seek to limit the quantitative risk such that the implementation of new shipping channels reduces or at minimum maintains existing levels of risk.

Having regard to the existing ship incident modelling and channel design response, the Panel is not satisfied that this process has occurred and that the objective and criterion articulated above could be met. Indeed, if the existing channel design were implemented, the potential for a significant and in the Panel's view unacceptable exacerbation of oil and chemical spill risk due to shipping may occur. The project should not proceed until this risk has been adequately considered and controlled.

It follows that the Panel further finds that an assessment of terrestrial ecological impact for the purposes of the Flora & Fauna Guarantee and Environment Protection and Biodiversity Conservation (Cwth) Acts cannot be properly made until Mr Lane has had a chance to review such final risk and design analysis as may be produced to respond to the above recommendations.

Making its position clear, the Panel recommends as follows:

Assuming that a revision of channel design and/or the technology proposed to be used to carry out dredging works leads to a revised analysis of construction and operational risk pursuant to recommendations above, the results of this work should be used to revisit and further validate conclusions as to terrestrial ecological effects due to oil and chemical spills. Unless such a revalidation takes place, it will not be possible to reach sound assessments of species and community effects for the purposes of the Flora & Fauna Guarantee and Environment Protection and Biodiversity Conservation (Cwth) Acts.

Sediment management

Turning to sediment management and the potential for bioaccumulation, this is a topic that is not remarked upon at great depth in the terrestrial ecology work carried out for the EES. The primary position set out in the marine ecological analysis (see above) is that bioaccumulation will be limited and will not lead to untoward adverse effects. At one further step remove from the primary source of potential contamination, the same basic approach has been taken to terrestrial ecology also.

In his analysis volume 2 of his background reports, the terrestrial ecology risk assessment, Mr Brett Lane, made clear his primary input assumptions.

> *The reports by Sinclair Knight Merz (2003a and 2003b) indicated that moderate levels of contamination existing in some sediments … The majority of these contaminants are bound to fine particulates. The northern dredged material ground is proposed to be uncapped after the works cease, but remobilization of any contaminated dredged material is not expected due to the depth of the area (>15m), which is beyond the influence of wave action.*
>
> *For the contaminants for which the northern area of the bay and Yarra River rated as contaminated [sic] , none was found to have accumulated in the flesh of mussels collected from the area (SKM 2003b). Therefore, bioaccumulation is not currently occurring in the area. Elutriate tests of sediment from moderately contaminated sediments in the Yarra by SKM (2003b) indicated that planktonic fauna was not affected by toxins whereas benthic fauna was. This suggests that mobilisation of contaminants into the water column is unlikely to have ecological consequences. Benthic effects are likely to be confined to the affected areas which are well away from coastal ecosystems. Hydrodynamic and sediment modelling by Lawson and Treloar (2004) shows that the sediment plume … will not reach the shore of the bay. Therefore, no coastal ecosystems will be affected by any contamination bound to sediments.*

This view is clearly expressed as being reliant on assumptions drawn from the sediment chemistry work of Sinclair Knight Merz, interpreting potentially acutely toxic material as moderately contaminated. It assumes that Yarra sediments will be effectively placed or will fall-out and be contained within the Port of Melbourne DMG bunded area. To this extent, it relies on the detailed strategy of bund containment advanced in the Boskalis submission but which the Panel understands never to have been formally communicated to Mr Lane whilst he was making his initial assessment. It relies on aspects of hydrodynamic analysis by Lawson and Treloar which have been the subject of qualifying statements relating to the interpretation of bay bed ‘current spikes’ reported in the Port Phillip Bay Environment Study (CSIRO). It also relies on aspects of the turbidity plume analysis by Lawson and Treloar in respect of plume loadings and destinations, when, as the Panel has observed, the maximum period of plume modelling has been for a fortnight over a set of meteorological conditions that are not necessarily representative.

Once again, the Panel finds itself in a condition where an independent expert analyst needing to make findings consequent on the work of others, has done so, generally in reliance that the work is sound. However, the Panel also notes that Mr Lane’s work has placed strong reliance on instructions.

For an example, one might examine the following statement:

> *Elutriate tests of sediment from moderately contaminated sediments in the Yarra by SKM (2003b) indicated that planktonic fauna was not affected by toxins whereas benthic fauna was. This suggests that mobilisation of contaminants into the water column is*

unlikely to have ecological consequences. Benthic effects are likely to be confined to the affected areas which are well away from coastal ecosystems.

Even taking a beneficial construction of the sediment chemistry work, to make such a statement one still needs to be clear that:

- the potential for the unplanned fall-out or remobilisation of contaminants to areas other than the Port of Melbourne DMG has been reasonably excluded; or
- if there is any potential for unplanned fall-out or remobilisation, that benthic impacts in those unplanned and hence unknown locations will still result in negligible or no impacts on coastal terrestrial ecosystems.

Similarly, to make such a statement, one ought to have a good and clear understanding that there are known technologies available to manage and contain the contaminated sediments at the point of disposal. However, it remains the Panel's understanding that Mr Lane had not been provided with detail about the proposed bunded disposal solution when he wrote his background report in May 2004 (and indeed that position did not change up to the current time).

Taking these issues together, it appears that Mr Lane has been asked to rely on an assertion to the extent that a relevant issue will be well managed, as distinct from relying on evidence or justified opinion to that effect.

The Panel finds it unsatisfactory that expert analysts should be asked to rely on assertions that something will be so, in contrast to relying on actual evidence or the clearly articulated, reasoned and independent opinion of an expert colleague to the extent that something can be so. The first is a leap of faith. Only the second starts to provide the solid foundation for a justified act of impact assessment.

The Panel would not necessarily expect the primary findings of Mr Lane to be sensitive to other than significant order variations in the impact of the chosen means of disposal of Yarra sediments. However, the uncertainty around the Sinclair Knight Merz bodies of work does lead to the possibility of the following scenarios eventuating, should the project immediately proceed with no further analysis or design change.

- The nature and characterisation of sediment for disposal from the Yarra is insufficiently described, but the material is nevertheless disposed of as proposed: in an uncapped, bunded facility at the Port of Melbourne DMG.
- Significant volumes of the material eventuate to be acutely toxic.
- Concerns raised as to the chosen dredge technology, fluidisation, placement with consequent turbidity and fall-out, bund construction, wave action, currents, bed load movement or more than one of these, become manifest to the extent that acutely toxic placed material is found in quantities and or locations other than those assumed for the purposes of Mr Lane's assessment.
- These changes lead to changes in the location and order of impact on the benthos from those assessed in the EES.
- For this reason, currently unassessed vectors to bioaccumulation in higher trophic orders, including species listed under the Flora and Fauna Guarantee Act of the Environment Protection and Biodiversity Conservation Act (Cwth) become apparent.
- Additionally or alternatively, unassessed orders of impact to segments of the marine ecology of the bay have the effect of making long term adjustments to the food supply of species listed under the Flora and Fauna Guarantee Act of the Environment

Protection and Biodiversity Conservation Act (Cwth), even though bioaccumulation is not occurring at higher levels.

It follows that the Panel finds that there is an unexcluded potential for implementation of the project to lead to significant adverse effects on both species and communities listed under the Flora and Fauna Guarantee Act or the Environment Protection and Biodiversity Conservation Act (Cwth).

Using the likelihood measures as defined in table 38.1 of the EES, the Panel would note that a likelihood of 'almost certain' is assigned to an event with a probability of 1 occurrence in 25 years (over the project lifetime) or less. A 'likely' event is one with a 10% probability of occurrence (over the project lifetime), or 1 in 250 years. Examining the unexcluded potential for adverse effects due to the handling of contaminated sediments according to current proposals with no further analysis, the Panel would qualitatively consider that the probability of an unassessed adverse outcome in terrestrial ecological terms as resting within the range expressed by 'almost certain' to 'likely'. Having regard to the consequences of such an event (see table 38.2), the possibility of 'major' or indeed 'catastrophic' consequences cannot be sufficiently excluded.

Assuming that significant volumes of acutely toxic and mobile material were added to the bay and that bioaccumulation events or benthic change sufficient to bring about adverse terrestrial ecology were observed, the capacity for recovery would be likely to be very limited and the necessary works very demanding and expensive.

On a precautionary basis therefore, the Panel does not consider that it is sufficient to revisit the sediment chemistry, plume modelling and consequent project design and dredge technology analysis, allowing Mr Lane's analysis of terrestrial ecological effects made on the basis of earlier assumptions to stand without further test. If the sediment chemistry and turbidity plume analysis is changed, the new results should be referred to Mr Lane for his further consideration. Any changes to the proposed project design or technology consequent on changed sediment chemistry or plume analysis should also be referred to Mr Lane for his further consideration. Should that advice change the current position of the EES on the potential for an ecotoxicological effect on terrestrial species, additional expert assistance should also be provided to Mr Lane to interpret and apply this material. (In this regard, the Panel is conscious that the core of Mr Lane's expertise lies in field ornithology/ecology and he has not sought to advance himself before the Panel as an expert in ecotoxicology.)

Making its position completely, the Panel recommends as follows:

Assuming that a revision of sediment chemistry and/or turbidity plume analysis takes place pursuant to recommendations above, the results of this work should be used to revisit and further validate conclusions as to terrestrial ecological effects. Unless such a revalidation takes place, it will not be possible to reach sound assessments of species and community effects for the purposes of the Flora & Fauna Guarantee and Environment Protection and Biodiversity Conservation (Cwth) Acts.

14.3.4 EPBC ACT CONSIDERATIONS

Panel Response

EPBC Act considerations bearing on terrestrial ecology have been drawn out and referred to as necessary in the Panel's consideration of issues throughout this report. However, as will be apparent to the reader, the nature of the Panel's issues is such that matters of national environment significance (NES matters) emerging from the requirements of that Act have tended to be dealt with at the level of general principle rather than of individual detail. It should also be noted that the field of terrestrial ecology contains a large range of NES matters. For these reasons, the Panel sees there as being a need to specifically and transparently identify and address (albeit briefly) the NES matters that are the triggers for Commonwealth tier assessment.

In terms of terrestrial ecology, the Panel notes that the project has the potential to impact on the following broad NES matters with relevance to terrestrial ecology:

- wetlands of international importance (Ramsar sites);
- listed threatened species; and
- listed migratory species.

In relation to wetlands of international importance, the Panel has noted above the capacity for the project to impact on the Port Phillip Bay and Bellarine Ramsar Sites. These impacts are due to the acknowledged likelihood of increased inundation of the coastal zone, with some time then being required for the establishment of compensatory habitat or habitat migration inland. However, it has also set out its view that the project is but one of three main causative processes of change and that on balance, it will be very difficult to determine which effects are caused by the project as opposed to the other effects (natural variation and anthropogenic sea level rise). The Panel considers its recommendation that the proponent contribute a commuted sum to (inter alia) manage habitat change processes in these wetlands to be a sufficient response.

Mention must be made of the Edithvale Seaford Wetlands Ramsar site, where some submitters were concerned that sea level rise due to the project might result in the penetration of that wetland by salt water. The Panel has considered the detailed examination of the hydrogeology of that wetland provided in a study by Jeff Morgan (Sinclair Knight Merz) for the proponent. In that study, Morgan makes clear his view that the wetland would not be directly inundated as a result of sea level change due to the project. The primary risk in his view is due to minor consequent rises in groundwater and or penetration by saline groundwater. Having identified that much of the area potentially subject to groundwater change (a coastal dune region) already has saline groundwater, Morgan continues to provide his view that groundwater changes potentially due to the project would be within the limits of current natural variation. Not having been directed to any persuasive contrary view, the Panel endorses this position.

In relation to listed threatened and migratory species, the Panel commences by making clear its view that the project is likely to have only a marginal impact on the habitat and foraging range of the over wintering Orange Bellied Parrot. The EES has not concluded as to whether that impact might be negative (pursuant to uncompensated and ongoing losses of relevant salt marsh vegetation communities for foraging) or positive (pursuant to revegetation or habitat migration increasing the foraging area). As the Panel has made clear above, the issue of impact on the parrot is also closely tied together with other change processes that are outside the control of the proponent. The Panel has recommended that the proponent contribute a commuted sum towards the wider public and voluntary endeavour of coastal zone management and enhancement. The Panel considers that the proponent's contribution is most likely to benefit the Orange Bellied Parrot and its habitat if it is available as part of a coordinated deployment of resources to a bay wide range of habitat and vegetation management measures, delivered by many other agencies in addition to the Port of

Melbourne. Assuming this step to be taken, the Panel is satisfied that the project will not have a significant impact on the Orange Bellied Parrot.

The Panel is less sanguine in relation to impacts on EPBC Act listed bird species resident in the south of the bay, particularly on Mud Islands and artificial structures such as Popes Eye and South Channel Fort. As outlined above, in its discussion of physical impacts, the Panel retains a concern that turbidity modelling conducted for the proponent has not yet sufficiently expressed an understanding of the likely effect and duration of effect on the waters surrounding Mud Islands, Popes Eye and South Channel Fort. These locations experience the largest concentration of Australasian Gannet activity in the bay and are the only location in Australia at which the Cape Gannet is regularly recorded. The Panel was concerned to note that a site visit by the terrestrial and avian consultant to Mud Islands appeared not to have taken place.

Such sea birds are of course mobile. One possible response to the temporary occlusion of their foraging grounds by turbidity would be relocation. However, having particular regard to the Cape Gannet, when an impact is likely to affect an area that contains Australia's only regular record of a bird, an effect leading to 'relocation' might amount to the loss of that species as resident. Such effects are not to be taken lightly and appear to the Panel to require greater investigation than has been undertaken in the EES to date.

The burden of such investigations would appear to be to provide a firmer understanding of turbidity and noise effects using the currently chosen dredge technology, such that it could be more clearly demonstrated that EPBC Act listed populations could remain resident. The Panel has elsewhere recommended that turbidity modelling for the project be developed to indicate a range of more realistic range and duration predictions for turbid plumes. The conservation needs of sea birds in the south of the bay provide a further justification for such work. Alternatively, the use of technology to minimise and control turbid plumes around areas of significant bird habitat should be investigated.

14.4 SUMMARY

In drawing its views on ecological considerations to a close, the Panel can only emphasise that whilst much work has been done by the proponent's respective consultants, this has tended to rest strongly on the precursor assumptions arising from work in relation to which the Panel has made significant recommendations above.

It follows that it is very likely that the form or technology options used to implement the project might change and that its primary impacts might change.

Where such changes occur, it will be unavoidable to revisit all affected ecological studies, before any concluded assessment of environmental effects can be made.

15. HUMAN EFFECTS

This section addresses the following issues that are relevant to the Minister for Planning's decision:

- Economic effects.
- The effects of the project as proposed on beneficial uses of the bay environment.
- Social impacts
- Cultural and heritage effects of the project.
- Native title considerations.
- Service and infrastructure effects.

There are a number of other issues related to human effects that the Panel believes need further assessment and management (e.g. terrestrial noise). These are important matters to be addressed in the project, however, they are not of a foundation stone nature and in principle can be managed through the implementation of existing management techniques and regulatory frameworks. These matters are not discussed in detail in this Panel Report.

15.1 ECONOMIC EFFECTS

Discussion

The overall economic impact analysis for the Project was undertaken by Meyrick and Associates Pty Ltd, specialists in transport economics. Their reports are contained in Volume 4(A) of the EES and relevant findings used in the EES Main Report Volume 1.

The Meyrick work was peer reviewed by Mr Matthew Lee of Essential Economics following exhibition of the EES. Mr Lee presented the results of his review in his Expert Witness Statement to the Panel and generally concurred with the conclusions of the Meyrick Reports.

The scope of the Meyrick and Associates study is outlined in Table 1.2 of the *Channel Deepening Project – EES Economic Impacts Study* contained in Volume 4 (A) of the EES.

The key tasks can be summarised as:

- data review;
- legislative and policy review;
- assessing the nature and extent of economic impacts of the Project including construction, operation and maintenance including;
  - direct economic benefits for shipping and port activity;
  - direct economic impacts on other Bay uses and coastal activities;
  - flow on effects for Victorian industry; and
  - impacts on overall level of Victorian economic activity;
- assessing the nature and extent of the costs and benefits of the Project including construction, maintenance and operation;

- identifying and explaining other direct impacts (non-market impacts);
- discussing issues in quantifying non-market traded impacts; and
- preparing cost benefit analyses and an economic evaluation.

The economic case was presented in the EES as the driver for the project, and it was argued that without the project, the Port of Melbourne will become less competitive in relation to other Australian trading ports. Trade through the Port has grown rapidly in recent years (predominantly in the container trade) and is predicted to grow into the future.

The Port of Melbourne is a very significant component of the Victorian economy. An outline of its contribution in dollar and employment terms can be found in Section 2.1 of Volume A of the EES.

Channel deepening will allow larger vessels to visit the Port with a consequent in principle reduction in per unit freight costs. In the EES Meyrick and Associates have costed estimated the daily operating cost per container (TEU or twenty foot equivalent unit) of a 6000-6499 TEU capacity ship (average draught 14m) at $10.33 and for a 2500-2999 TEU capacity ship (average draught 12.12m) at $13.26[176]. This equates to a potential saving of $2.93 per TEU per day. The daily operating cost saving per container obtained by using larger ships assumes the cost of the channel deepening is not offset against freight charges.

Some ships are currently depth limited for entry to Port Phillip and may need tidal assistance or to enter and depart partly loaded to meet the current design draught of 11.6m (or 12.1 m with tidal assistance). Channel design, depth and draught effects are discussed in detail in a separate chapter in this Panel report.

The Port of Melbourne Corporation (PoMC) in their Part A Submission, Section 3.11 has estimated the proportion of ships currently entering and leaving underloaded to meet the declared depth was greater than 30%.

Projections for the percentage of container vessels calling at Melbourne of different drafts over time are shown in the table in Annexure IP4, Item 4.2 of the PoMC response to the Panel's Issue Paper 2. This shows that the smallest ships (2% of total numbers) calling at the Port of Melbourne will be in the 2500-2999 TEU range with an average draught of 12.12 metres.

The largest ships (7% of total numbers) will be in the 6000-6499 TEU range with an average draught of 14 metres.

There was some confusion during the Panel hearings regarding shipping numbers over the life of the project due to different sets of numbers being used (with different assumptions) and different descriptions of numbers such as "vessel movements" versus "voyages". In response to the Panel's request for clarification on this issue in Issues Paper 2, Meyrick and Associates provided a table for crude oil tankers and container vessels in Annexure IP4.

This provides a clear summary for these two trades but again has some shortcomings when viewed in the light of other information presented. A stark example is that of crude oil tanker voyages which are shown as decreasing from 45 to 42 voyages per annum from 2007 – 2030 without the deepening project or decreasing from 33 to 31 voyages per annum with the deepening over this period. In the latter case the decline in vessel numbers is attributed to a movement from "Aframax" vessels (85,000 tonnes) to "Suezmax" vessels (120,000 tonnes).

[176] Table 10, Economic Impacts Study, Meyrick and Associates, June 2004

Both these scenarios appear inconsistent with Table 1 in Annexure A of Mr Meyrick's expert witness statement which forecasts an increase in crude oil imports to the Altona refinery over generally the same period of 85%.

Shipping numbers are important because they feed in to issues of risk management for collision and oil spills, both with dredging equipment and for the life of the Project. Oil spill prediction and risk management are discussed in more detail elsewhere in the Panel report.

The findings of the Meyrick and Associates cost benefit analysis are shown in Annexure A to the Expert Witness Statement of Mr Stephen Meyrick. The figures changed over the course of the EES development as Project parameters changed or underlying assumptions were refined.

The Project benefit is presented by Mr Meyrick in Table 4 of Annexure A as a present value of $1.449 billion. This is predominantly driven by reduced costs per unit of freight as discussed earlier in this section.

From these figures the container industry is predicted to receive 83.5% of the benefits of the Project, crude oil imports 13.7% and smaller benefits to the other sectors. The benefits in general are avoidance of future costs and are itemised in Section 5.2 of the Meyrick and Associates June 2004 Economic Impact Assessment.

Of these benefits Meyrick and Associates have concluded based on their research that 95% of benefits in the liner trades (containerships) and 99% of the benefits in the bulk trades will be passed to cargo interests rather than being held in the shipping lines or intermediaries such as stevedores.

Distribution of the direct benefits on a geographical basis of the projects are summarised below.

Table 30: Direct Project Benefits

	EES Figures	Revised Figures Calculated Using EES Percentages
Direct Project Benefit to Non Australian Interests	$426 million (1316 – (409+481) below)	$479 million
Direct Project Benefit to Australian Interests (excluding Victoria)	$409 million[177]	$447 million
Direct Project Benefit to Victoria	$481 million[178]	$523 million
Total Direct Project Benefit (mainly reduction in transport costs)	$1,316 million[179]	$1,449 million[180]

[177] Section 8.3, Economic Impacts Study, Meyrick and Associates, June 2004

[178] Section 8.3, Economic Impacts Study, Meyrick and Associates, June 2004

[179] Table 14, Economic Impacts Study, Meyrick and Associates, June 2004

[180] Table 4, Mr Stephen Meyrick, Expert Witness Statement

Meyrick and Associates have calculated the direct and indirect (including flow on effects) economic benefit of the project to Australia to be $3,208 million[181] of which $1,734 million[182] will accrue to Victoria. This calculation is based on the EES present value figure of $1,316 million and does not include the revised figure of $1,449 million in the table above.

Section 6(c) of the Part D Submission of the PoMC provides an overall breakdown of Project cost and table is reproduced below. This information was also presented by Mr Brad Richards of the PoMC in the opening sessions of the panel hearing.

Table 31: Project Cost

Dredging (based on final engineering design and including environmental management)	$240 million
Infrastructure upgrades	$110 million
Relocation of services	$160 million
Miscellaneous	$35 million
TOTAL	$545 million

A full breakdown of these costs was not provided and it is unclear what level of contingency is built into these figures. There was some suggestion late in the Panel process in media reports that relocation of the Werribee main sewer under the Yarra River is now not being proposed, however, this was not confirmed in the hearings by the PoMC.

Some costs that were discussed in the Panel hearings include:

- approximately $50 million in environmental management measures
- vessel delay due to dredging operation ($200,000) and channel blockage due to incident with dredger ($175,000)

Meyrick and Associates in Section 6.2.2 of their Economic Impact Assessment report (based on work by GHD) state that although the deeper channels will likely result in increased settlement rates of mobile material (and thus presumably increased maintenance dredging), the cost of maintenance dredging is not likely to increase from the current $3 million per annum.

Meyrick and Associates calculated the external (non – PoMC) negative costs of the project to be $11.5 million across commercial fishers, recreational fishers and recreational divers. This impact is considered in detail in the light of the Sinclair Knight Merz studies on tourism and recreation in the discussion of beneficial use in this Panel Report.

A range of other indirect economic impacts were identified and considered in Section 6.2.4 of the June 2004 Meyrick and Associates Economic Impact Assessment. It was stated that these were not costed as:

- there was advice from other specialist consultants indicated there was no or negligible impact, or
- the costs are internalised in the Project via management measures, or
- the impact could not be quantified due to a lack of reliable economic tools.

181 Table 24, Economic Impact Assessment, Meyrick and Associates, June 2004

182 Table 24, Economic Impact Assessment, Meyrick and Associates, June 2004

As shown below the Project costs have increased during the development of the EES due to revision and finalisation of engineering costs and environmental management measures.

Table 32: Change in Project Cost 2001 - 2004

	November 2001[183]	June 2004 (EES)	August 2004[184]	September 2004[185]
Project Cost	$201 – 231.4 million	$377 million	$498 million	$545 million

Mr Meyrick in his Expert Witness Statement Annexure A concluded the Net Present Value of the project at $951 million being benefits of $1,449 million less costs of $498 million. Using the PoMC revised costs figure of $545 million, the Net Present Value can be calculated at $904 million. This translates to an overall cost benefit ratio of approximately 2.7.

Many submitters, particularly industry groups, supported the economic rationale for the project including Shipping Australia, the Australian Industry Group, VECCI and the Victorian Freight and Logistics Council.

Many submitters argued that the economic case for the project had not been demonstrated. Some submissions of note include those of the Blue Wedges Coalition, the Frankston Beach Association and Mr Barry Robinson.

A range of submitters raised economic issues including terms of trade, import substitution and globalisation. Whilst these issues are of interest, the Panel has not responded to them as they are beyond its terms of reference or the scope of the individual project decision to be taken here.

Panel Response

The Panel notes the outcome of the cost benefit analysis undertaken by Meyrick and Associates and peer reviewed by Mr Michael Lee and accepts that, in general, the economic case for the project is strong and that there will be significant negative economic implications of depth limits to the Port of Melbourne in 2030 if the Project does not proceed.

However the Panel believes it should highlight a number of areas where it has concerns which preclude the recommendation that the project is acceptable at this time in economic terms.

The Panel's concerns are in the following areas:

- the distribution of benefits;
- maintenance dredging costs;
- costs of environmental management proposals;
- dredging technology and volumes;
- consideration of external Project impact costs (ecosystem services);
- contingency planning costing;

[183] Table 5.3, Economic Benefits of Channel and Berth Deepening in the Port of Melbourne, Booz, Allen & Hamilton, November 2001

[184] Table 5, Annexure A, Expert Witness Statement of Mr Stephen Meyrick

[185] Submission by Mr Brad Richards, Port of Melbourne Corporation

- project impact costs to others that have not been internalised; and
- project risk costs (particularly where these are unquantified).

The Panel notes a Net Present Value of the Project as a whole of approximately $904 million (made up of a present value of $1,449 million and costs of $545 million).

The Panel believes the distribution of the costs and benefits is worth noting. In particular it appears that the State of Victoria may bear all the costs for the Project and yet receive only a proportion of the benefit. Consideration of the funding of the Project is clearly outside the Terms of Reference for the Panel. However, the Panel considers it is extremely difficult to consider the economic case for the Project in isolation from the funding. Distributions of costs and benefits will clearly change, dependent on the funding models used (particularly if a significant user pays element were to be introduced) and hence understandings of the broader concept net community benefit may be adjusted.

The Panel notes the issues around the cost and quantities of maintenance dredging for the life of the Project. The Panel has not seen any evidence that supports the premise that maintenance dredging will not increase in cost relative to current expenditure, particularly as the likelihood of sedimentation in the channels is expected to increase and there are significant new areas dredged in the South Channel.

The Panel has calculated that maintenance dredging volumes of approximately 428 000 m3 on an annualised basis over the 25 year project life (10.7 million m^3 given for maintenance dredging in Section 4.6 of the PoMC Part A submission) are expected. The Panel is unable to conclude whether this has been adequately costed. Further comment on the maintenance dredging program is given elsewhere in this Panel report.

The environmental management proposals for the Project are considered in detail in several sections of this Panel Report. In relation to the economics of the environmental management approach the Panel has particular concerns related to the light driven primary production model.

This model is as yet untested in Port Phillip for a project of this scale. If the model either is not effective in predicting effects on primary producers and a blanket regulatory approach is developed and enforced during dredging, or if the model approach works but results in significant limitation to dredging ability, the Panel believes the economic consequences in terms of additional project costs could be severe. However, assuming the model to be based on appropriate productivity or light budget assumptions, it would be very difficult to justify the taking of a decision to infringe the performance standard supported by the model. This issue relates back to consideration of whether a best practice dredge technology portfolio has been assembled to address the environmental conditions. The Panel is clear that some time should be spent at this stage in the project to ensure that by adopting a best practice dredge technology portfolio, the risk of exposure to the cost effects of applying light controls can be limited.

In general terms there is little discussion in the EES regarding what will happen if the proposed environmental management framework is ineffective. Given the proposed approach and the untried nature of some of the key components, this will not be discovered until works have commenced. The light example having been stated above, it remains the case that uncertainty as to whether relevant standards can be met by a known control equates to a significant level of uncertainty as to dredge duration and cost.

The Panel is also concerned about the economic consequences of untried dredging technology, particularly the rock ripping and hydro hammer in The Heads. The Heads are the key to the whole Project and if it can not be dredged effectively and efficiently, the economic case for the Project as a whole may be in question.

The feasibility of The Heads dredging technology is discussed elsewhere and indeed is questioned elsewhere and the Panel considers it to be untested technology which presents a significant and unquantified economic risk at this time.

The key concern relating to all of these issues will be the mobilisation, personnel and establishment costs. The cost of bringing dredge technology on site from overseas, including the use of specialist crews, will be a significant component of project costs. If uncertainty over performance of environmental requirements causes significant dredging delays, these costs will still have to be covered during the unproductive time.

Dredge volumes for the Project are quantified in the EES but appear to be subject to further refinement. Reducing or increasing dredge volumes could have a significant impact on Project cost.

The Panel is interested in the proponent's proposition that more than 30% of containerships currently entering and leaving the Bay are under-loaded to meet depth limitations, as the Panel saw no evidence to support this figure. The Panel is clear that some container ships are currently depth limited and that this has economic consequences for trade. The Panel, however, is not clear what the proportion is and whether this proportion is exclusively due to channel depth limitation or ships being under-loaded due to trading quantities and patterns.

The Panel heard that the Port of Melbourne is a net generator of empty containers and its location at the end of international trade routes has logical consequences, resulting in significant under-loading, regardless of channel depth. The train at the furthest station on the line is always more likely to be part empty. Building a bigger station alone will not resolve this fact.

Mention must also be made of the costs of delay in entering Port Phillip due to depth limitations as opposed to other causes, for example, waiting for berths or stevedoring capacity issues. The Panel does not consider that these issues have been considered to the extent that clear costing distinctions have been made and justified.

The Panel believes this is a significant issue as it raises a number of questions:

- If the proportion of ships limited by depth currently is as high as one third, does this place additional emphasis on the benefits to be obtained from short term deployment of other technologies such as (but not limited to) DUKC® to achieve maximum economic efficiencies?
- If the proportion of current ships depth limited by the channels is significantly lower, does it remove the immediacy of the Project and allow further time to consider the Project design without significantly impacting on economic efficiency?

Meyrick and Associates (June 2004 Economic Impact Study, Page 25) stated in the EES that the major benefits of the Project (to the container trade) will come in the longer term as the larger vessels start to ply Australian waters. Again, this is suggestive that some space is available for a reconsideration of issues requiring resolution around the project, without significant scale changes in the delivery of benefits.

The Panel understands that the information on ship loading is held by the shipping lines and may be difficult to obtain, but it is hard to draw conclusions on this issue without firm data.

The EES Volume 1 Main Report (Table 49.2, Page 49-21) states there will be a benefit to the container trade of $1,316 million in Net Present Value (NPV terms), benefit to oil importers of $100 million in NPV terms and benefit to the refined products trade of $5 million in NPV terms. This would appear to be incorrect, as the figures above are in Present Value terms not NPV terms. In addition, the figures in the EES also seem to be incorrect and overstate the benefit case. This appears to be an error in the translation of the Meyrick and Associates expert report into the main EES report, which makes it extremely difficult for both decision-makers and the public to understand the economic case.

The Panel has considered the approach of the economic specialists to indirect project costs. The situation relating to other Bay users and industries is discussed in the beneficial use section.

However, it is clear in the example of Bay tourism benefits, that the risk to this part of the Victorian economy is not fully explored in the economic case for the Project. For example it would have been useful to be able to compare an annualised benefit from the Project with the value of tourism in the Bay as against possible assumptions of tourism shift, to determine if the short, medium and long term adverse economic impacts are acceptable.

Another area where the Panel is not satisfied that a complete and rigorous consideration of indirect project costs has been attempted is in the area of ecosystem services. The clearest example of this relates to the nitrogen cycle in the Bay and denitrification.

There are examples of nitrogen costing for achieving nitrogen reduction inputs to Port Phillip under the Port Phillip Bay Environmental Management Plan (PPBEMP). These include the expenses incurred by Melbourne Water in reducing nitrogen outputs from the Western Treatment Plant and many other examples where Government agencies, Local Government and the private sector are developing wetlands for nitrogen (and other pollutants) reduction in stormwater.

The Panel believes the PoMC has not made a significant case as to why they should not be required to address nitrogen inputs beyond the management measures proposed for the Project. The Government policy framework (State Environment Protection Policy and PPBEMP) clearly sets targets for nitrogen reduction in Port Phillip and the Panel believes it is incumbent on the PoMC to work within and assist implementation of this framework.

The Panel takes the view that catchment offsets should be considered as a possible measure. As outlined in the chapter on nitrogen issues above, a project annualised nitrogen input could be calculated and used as the basis for a charge for the provision of nitrogen offset services by other land based entities such as Melbourne Water.

Whilst nitrogen is used as an example, the Panel believes there are other ecosystem services that also are not properly considered from a cost perspective such as habitat offsets and replacement.

The Panel believes that the lack of a clear project appraisal framework for the economic analysis for the Project has identified a general weakness in major project and environmental impact assessment in Victoria. The consideration of external economic issues in the Project is not strong and the Panel believes it downplays some of the key economic threats to other public and private enterprises and assets which in turn, may negatively affect the Channel Deepening Project itself.

This issue is formalised in other jurisdictions, such as New South Wales, where during the project appraisal phase all the economic issues in a major project are given due weight and consideration, and an approach such as this should be considered in Victoria.

The Panel also notes with some concern the escalation of costs of the Project during the EES development process. The Panel understands that assumptions underlying major projects change during project development with consequent impacts on costs and benefits. However, taking into account the future potential for cost shifts related to other parts of this report including sediment chemistry, dredging technology, spoil disposal and environmental management, the Panel recommends:

The economic case for the project should be reviewed following further project development work and refinement of Project definition, project technology and environmental management proposals. This review should include specialists in maritime economics, resource economics, economic risk management and major projects specialists.

15.2 BENEFICIAL USE EFFECTS & ECONOMIC LOSS

The purpose of this section is to address issues raised before the Panel in relation to the effects that the project may have on the beneficial uses made of the environment of the lower Yarra River and Port Phillip Bay.

The beneficial uses examined are those broadly defined in schedules F6 and F7 of SEPP (Waters of Victoria) as 'protected beneficial uses' in relevant sectors of the river and the bay, which include the following:

- industrial water use;
- commercial and recreational use of edible fish and crustacea;
- production of molluscs for human consumption;
- water based recreation and tourism;

Maintenance of aquatic ecosystems are not identified here as these are considered above.

Consideration is also given to the economic effects emerging from impacts on beneficial uses and the principles which might apply to the balance between mitigation and compensation.

Specifically this section addresses:

- the principles applicable in cases of economic loss,
- operational concerns raised in respect of Newport Power Station by Ecogen Pty Ltd (an industrial user),
- effects on other industrial users of water,
- effects on marine and land based aquaculture,
- effects on commercial and recreational fishing,
- effects on recreational boating,
- effects on recreational diving, and
- effects on broader beach and bay based tourism and recreation.

To the extent that a number of these effects also entail consideration of economic effects, it is in this section where relevant economic effects on third party uses are considered.

15.2.1 APPROACHES TO ECONOMIC LOSS

Discussion

In evaluating impacts on beneficial use, the Panel must observe that the primary position of a number of parties before the Panel was that means should be found to:

- Control and mitigate foreseeable economic losses due to the project; and
- Where losses could not be foreseen and controlled, or where mitigation appeared insufficient, to explore the basis for direct financial compensation as part of the cost of the project.

The approach of the proponent before the Panel was to emphasise its basic view that in public policy terms, no compensation was payable for those affected by public works programs unless a proprietary right is infringed. It was noted that rights in (for example) the law of negligence or nuisance were not extinguished and that legal action for compensation may thus be pursued through the courts, subject to the normal rules of law. For this reason, it had declined to enter into any debate with stakeholder groups such as the dive or ecotourism industries about means of controlling economic loss. Further, it had also declined to enter into any discussions with Newport Power Station about the principle of indemnities for losses occasioned by generation shutdowns not provided for in that entity's power supply contract.

The proponent also took the view that such questions were not primary matters for the Panel or EES process.

The being said, the Panel notes that a considerable number of parties before it enjoying beneficial uses of the Bay would probably not have been before it, could they have been led to one or another conclusion:

- the proponent had acted prudently to identify and minimise their exposure to loss; and/or
- that it was prepared to discuss the principle of limited and agreed compensation, in circumstances where unforeseen or otherwise avoidable losses could be proved to have occurred as a result of the project.

Panel Response

The Panel opens its consideration by remarking that the proponent's examination of the principles of loss and compensation appears to have been unduly narrow and constricted. In seeking to exclude the consideration of principles for the management of economic loss from the EES and Panel process, a significant body of otherwise avoidable controversy and conflict over the project has been generated. An opportunity to properly ventilate and settle these concerns in a timely manner and at limited risk to the project has thereby been lost.

The Panel would also remark that in terms of the practice of environment assessment in Victoria and Australia, it does have jurisdiction to consider matters of economic impact, loss and the appropriateness of means by which such losses might be addressed. EES processes for linear infrastructure typically do consider issues of community, and indeed individual, economic loss. It is germane to the Minister's assessment of environmental effects to understand the nature and causation of losses that might be occasioned and to assure himself that reasonable steps have been taken to mitigate these.

Despite the proponent's submission that 'as a matter of public policy, compensation is not ordinarily payable to those affected by public works programs unless a particular proprietary right is removed or infringed' this is a policy that is honoured in breach rather than observance. For example, in freeway alignment cases, VicRoads do offer advance purchase of dwellings and businesses impacted by alignment option planning, even when an alignment has not been adopted and is not their preferred alignment. In doing so, they recognise the need for a responsible infrastructure agency to control and minimise both the sum of net economic loss occasioned by a project and, of humanity, to seek where possible to offset individual adverse effects.

Furthermore, the Panel is conscious that in this case it is examining the marine environment. Principles of compensation and proprietary right that are well established on land do not necessarily apply and are certainly less well established at sea. To the extent that any principles emerge at sea, it appears that practice in relation to government action with industries such as the fishing industry has been to establish schemes of compensation when public action is taken that affects the industry.

The Panel is also conscious that Port Phillip Bay is a confined marine environment. It is surrounded and used by millions of people. It offers different environmental economic circumstances to the open ocean, together with a more limited capacity for response by diverting activities elsewhere.

For all of these reasons, the Panel does not consider that it is either possible or appropriate to take the view that losses occasioned to private entities should lie where they fall. It is essential that the proponent clearly demonstrates that occasions of potential loss have been considered, controlled, and to the extent possible, minimised. If such a demonstration is not provided, civil action is likely to ensue, with the prospect that this could result in exposures to liability of a far more significant nature than more immediate, timely and agreed settlements.

It follows that the Panel considers that where losses arise directly from the impact of the project upon a protected beneficial use of the Bay, there would be benefit in examining a scheme of agreed compensation, on the basis that this will maximise public benefit by providing a means of expedited recourse and keeping potentially complex and costly disputes from the courts.

15.2.2 SOCIAL IMPACT

It appears to the Panel that because of the absence of a group of stakeholders resident in the project area that the proponent may have considered that a traditional social impact assessment need not be done. The rigour of a traditional social impact assessment framework would have provided an integrated framework in a way that transcends the individual components of the economic and tourism impacts assessments and the community consultation thereby avoiding many of the concerns that the proponent now faces in moving forward with this project. In this regard the Panel recommends that:

The proponent should undertake a social impact assessment as part of the project environmental impact assessment. This body of work should be fully integrated with other aspects of the project work.

15.2.3 NEWPORT POWER STATION

Discussion

Ecogen Pty Ltd as owners and operators of Newport Power Station appeared and called evidence before the Panel, both it its main hearings and during the Panel's Governance and Environmental Management Plan workshop processes.

In addition to legal submissions, submissions were heard on plant operation by Mr Peter Fitzgerald, Station Engineer and Environmental Manager. Evidence was heard from:

- Mr Richard Coldham, a Corrosion Engineer of HRL Technology Pty Ltd (a privatised former research and engineering division of the Victorian SEC) in respect of the capacity of entrained materials in water of raised turbidity to result in physical and chemical damage to the plant. He made references to research in similar plant overseas.
- Mr Chris Black (Manager, Environment & Performance, HRL technology P/L).
- Mr Pieter Goldie of GHD, a Marine Civil Engineer with dredging experience, in respect of the capacity of the proposed dredge technology to address concerns by limiting turbidity generation and entrainment in the power station.

The Panel also carried out a visit to the Newport Power Station, a gas fired peak load power plant, to ensure that it had a complete comprehension of the way in which plant's design and operational characteristics might be affected by the proposed dredge program.

Ecogen's starting point was that it did not of principle oppose the project. It acknowledged the potential for significant economic and social benefit to flow from the retention and further development of Melbourne as Australia's primary container port. However, it was most concerned to ensure that the delivery of the project did not compromise its own interests in:

- the immediate operability of the plant,
- ensuring that undue damage or maintenance requirements did not eventuate,
- preventing breaches of contract in the provision of power and wider community, and
- maintaining power provision to meet market needs.

Weighing these factors together, Ecogen had come to the conclusion that the project as currently configured was unable to provide reasonable assurances that appropriate steps had been taken to control and minimise damage to their asset with consequential adverse contractual, social and economic effects. At the end of the Governance and Environmental Management Plan workshop process, it made clear its regretfully considered opinion that it must oppose the project until these issues were resolved. This was a position it had reached in its submission, largely due to its determination through cross-examination that key aspects of its concerns simply had not been considered at all by many of the proponent's relevant expert witnesses. Others had considered it, but only at an apparently cursory level.

The key concerns of Ecogen relate to the use made by Yarra River water to cool the power station. In summary terms, this use is as follows.

- The power station extracts great volumes of water from the base of the Yarra River: at 17500 litres/second. This extraction amounts to approximately 50% of the non flood flow of the Yarra at this point.
- Notably, water in the Yarra estuary is stratified. Salt water from the bay is dense and rests at the base of the River: this is referred to in the literature as the 'salt water wedge'. Fresh water is less dense and effectively 'floats' as a layer above the salt

wedge. The two water layers are clearly distinct and unmixed at this location. Furthermore, whilst the surface fresh water layer tends to be visibly turbid (with turbidity levels varying broadly in response to rates of precipitation and run-off in the upper catchment), the salt wedge typically retains very low levels of turbidity.

- The distinction between these water bodies is critical for the operation of the power station which has been designed to extract water from the salt wedge, to ensure the minimal entrainment of chemical contaminants and abrasive particles which can significantly adversely affect the performance of power station plant.
- It must be noted that the general quality of the extracted water is such that, whilst a physical screening process is employed to ensure that power station remains free of gross physical and biological contamination (for example through the accidental entrainment of plastic bags or fish), no filtration is necessary before the water is employed in system critical processes. Furthermore, the volume and speed of water extraction is such that the introduction of a filtration system would be very difficult, implying redesign of the power station's cooling water inlet structures and processes.
- Once within the power station, the river water is pumped through a sequence of cooling systems. Typically, the water passes through the medium to be cooled in small pipes. Both pumps and pipes are vulnerable to chemical and physical attack. Most of the processes cooled by Yarra water are system critical and, the effect of a loss of cooling would at best be a loss of power generation efficiency and at worst a total loss of plant output.
- Having been employed in cooling processes, water is then discharged by a purpose designed cooling channel to Greenwich Bay in Williamstown. It should be noted that the power station has no cooling towers, pondages or similar land based systems to facilitate the return of the cooling water to ambient temperature. The river and bay provide this facility. The EPA licence allows the water in the channel to be up to 15° C above the ambient river temperature. The channel has been the subject of detail design studies to ensure that it optimises mixing of the heated water body with the surrounding waters of Hobsons Bay.
- EPA discharge temperature requirements are a primary driver of the volume and speed of water extraction from the river. Sufficient water must be extracted to ensure that ongoing power station processes are sufficiently cooled and that the discharged cooling water does not exceed the discharge temperature limit.

Ecogen were concerned that dredging works within the Yarra will have the following effects.

- Dredging would raise turbidity in the Yarra waters, including in the otherwise 'clean' base salt wedge.
- This will result in the entrainment of waters containing considerably higher volumes of suspended solids than are within the in principle design parameters of the power station. Of primary concern are the potential for significantly raised rates of abrasion and erosion in pipes, shortening maintenance periods, raising costs and increasing risks of critical plant failure. Entrained suspended solids can also abrade and damage rotating componentry in pumps, including bearings and turbine blades. Whilst there is a double redundancy on critical pump systems, the pumps require individually manufactured componentry. The unplanned loss of both pumps would have the effect of shutting the station for the period necessary to obtain replacement parts.
- Increased turbidity may also result in the entrainment of chemical contaminants (particularly sulphates) that can cause chemical attack, principally the pitting of pipes, with the potential to significantly shorten maintenance periods, raise costs and increase risks of critical plant failure.

Ecogen had made what it considered to be a number of attempts to engage the proponent and its consultants in the process of responding to and providing means of mitigation for these concerns. It was therefore a matter of grave concern to them that:

- The EES contained no detailed investigation of the sediment plumes to be generated by dredging works in the Yarra and hence the potential for sediment entrainment in the power station.
- Whilst mention was made in material advanced by the proponent of the use of silt curtain technology to shield the power station intake from turbidity, no evaluation of the technical feasibility of this technology to respond to the power station's water demand had been made. (It should be noted that by the end of the Panel hearing, the proponent had conceded the general impracticability of such technology.)
- The proponent had alternatively sought to rely on the intermittent nature of generation at the power station to support the view that dredging would take place when the station was not operational. However, minimal attempt had been made by the proponent to ascertain the operating pattern of the power station or its maintenance schedules to determine whether such an approach was feasible. It remained the view of Ecogen that if the power station were to cease generation for the period required for Yarra dredging works, this could not be accommodated within its current contractual arrangements and hence would drive the power station rapidly into breach and the application of penalty provisions.
- Further, the dredge schedule proposed by Boskalis Australia required the Yarra to be dredged in summer, in principle the period of peak demand for the power station, in which power outages to respond to dredge related incidents would be likely to have their most significant adverse effects. Attention was drawn to the high spot prices for electricity at times of peak demand, noting that the loss of revenue to the power station over days in such periods could amount to sums that would be only one to two orders of magnitude lower than the entire capital cost of the project.
- It should be noted in this regard that a hearing was provided to Ecogen at which commercial in confidence data as to contractual and revenue arrangements was provided. The Panel does not consider that it is necessary to refer to this material in any detail. Sufficient verification can be obtained by monitoring publicly available data on the NEMMCo website.

Mention must also be made at this stage of the ecological and human recreational effects of the power station's current cooling discharge system. The cooling channel exiting into Greenwich Bay has become a highly attractive location for fish, largely Taylor, which are not typically found in the bay in high numbers. The result has been that the cooling channel has passed into the folklore of the western suburbs as an excellent recreational fishing location, known as the "Warmies" or the "Hotties". The channel attracts hundreds of recreational fishers on typical weekends. It is suggested that, despite this level of visitation, the Warmies is still a place in which a recreational fisher is relatively certain of a reasonable bag. It is further suggested that much of the recreational fishing bag from the Warmies passes into the human food chain following transformation into (amongst other products) Vietnamese smoked fish delicacies.

Having heard the evidence of Dr Adam Cohen for the proponent in respect of the characterisation of sediment chemistry in the Yarra and the submissions of Boskalis Australia Pty Ltd in terms of the dredge technology to be used, Ecogen raised the following concerns:

- There appears to be the insufficiently controlled or excluded potential for contaminated sediments to be entrained within the power station cooling system.

- The nature of the design and operation of that system would then be such as to emit these contaminants into the cooling water channel at high speed, in a manner designed to ensure significant dispersal within Hobsons Bay.
- This in turn could pose an operational threat to the power station should its EPA discharge license conditions be inadvertently breached.
- It could pose a significant ecological threat in terms of exacerbating the distribution of contaminants, particularly within the dense fish populations of the Warmies environment.
- Should contaminants prove to be bioavailable to fish, the level of recreational fishing at the Warmies could also provide a contaminant vector into the human food chain.

It was Ecogen's significant concern that the proponent should undertake water quality monitoring and research to exclude these potential effects, but had not done so. Further, Ecogen saw the capacity to sustain recreational fishery at the Warmies as being culturally significant, and as bearing strongly on their corporate reputation in the local community. They did not wish to become the unwitting agents by which this much loved fishery became contaminated, leading to concerns as to human health impacts and closure.

Finally, mention must be made of channel design considerations and the scope for deepening works to result in the failure of structures associated with the Newport Power Station cooling water inlet and outlet. Ecogen were concerned that analysis should demonstrate a sufficient factor of safety for existing structures such that there was no reasonable likelihood of their catastrophic failure, potentially precipitating the unplanned and long term closure of the power station. Ecogen were also concerned that wash associated with the passage of larger ships in the channel might adversely affect the long term integrity of their structures.

The proponent's response to these the bulk of these concerns in the EES was to acknowledge a potentially extreme risk, without corrective action. It set a performance criterion (EES Chapter 45):

> *There is to be no increase from natural variation in material to be drawn into the Newport Power Station's cooling water intake pipeline.*

(The Panel takes from this a commitment to there being no increase from natural variation in turbidity and chemical composition.) Flowing from this performance criterion, the EES (in Chapter 46) assessed the residual risk as low.

Beyond the establishment of the performance criterion in relation to turbidity , the proponent turned its mind only cursorily to practical means whereby it could be met. No detailed modelling of turbid plumes in the Yarra was undertaken by the proponent's expert Dr Provis, to the extent of predicting the likely concentrations and settling times that might affect the power station. Some effort was put into consideration of the potential use of silt curtain technology. However, as at the close of the Panel hearings, this was acknowledged not to have been fruitful.

The EES itself passes little comment about matters of structural design and engineering risk to the power station. The proponent's structural engineering experts Messrs Newcombe, Day and Boyd noted in their initial report to the proponent that whilst the passage of the channel dredging works should leave the inlet structure with a factor of safety of 2, the 'extreme' consequences of structural failure would suggest a need for further detailed evaluation in consultation with the asset owner. Their evidence before the Panel later re-assessed this consequence rating to 'high', associated with the use of 'fine tolerance dredging techniques' although the Panel was not provided with a clear understanding for the rationale behind this reduction in consequence. These experts concluded that the risk to the outlet channel from dredging works was on balance ‘possible’ but no more and did not merit specific action.

No particular analysis of the potential for vessel wash or wake damage on the Newport structures was said to have been undertaken by the proponent.

Beyond these approaches, the proponent largely sought to deny the significance of the issues raised by Newport, although without the detailed presentation of supporting evidence. Various measures were employed in cross-examination to suggest that Ecogen were overstating their case, for example by seeking to qualify the significance of the plant within the national electricity market (NEM) or the consequences of its failure to generate power.

Reference must be made to a detailed exchange that took place in respect of a flood incident on the Yarra during the period of the Panel hearing. The proponent sought to assert that, as significant sources of turbidity, flood events would have exposed the power station to the same sorts of physical (if not chemical) effects that it was concerned would likely arise from dredging. Photographic data was tabled in cross-examination by the proponent to suggest that in a particular flood incident on 16 November 2004, the power station had clearly entrained volumes of turbid water, as was apparently demonstrated by the visibly turbid condition of the cooling water channel. In response, Ecogen sought leave to introduce its own recently commenced inlet water turbidity monitoring data as evidence. This showed that the entrained water on the day of the flood incident had been recorded at a level of 5NTU, when intake water was typically measured at less than 1NTU. Furthermore, one of the primary cooling water intake pumps had overheated in the period immediately following the flood and, on being taken out of service, was found to contain significant volumes of sedimentary material. This pump had only shortly before completed its planned maintenance.

Reference must be made to exchanges about historic dredge campaigns adjacent to the power station. The proponent was clear from historical records that significant dredge campaigns had taken place in waters adjacent to the power station cooling water intake, but yet these did not appear to have been the source of complaints of the nature raised in Ecogen’s submission.

Responding to this position, Ecogen made clear that at all relevant times, the power station had been a government owned entity and, as the Port had also been such an entity, mechanisms for the allocation of liability between them had not been used. Further, detailed records of river turbidity at the inlet had not been kept or correlated with incidents of unplanned maintenance or plant outage. Some level of correlation might now be possible, marrying Port, EPA and power station data sets over time. However, this work could only now commence. It was too early for conclusions to be drawn.

Reference must also be made to an exchange about the possible chemical contamination of the Warmies with consequent human health effects that took place during the Panel’s Governance and Environmental Management Plan workshop processes. It had been an agreed position following the proponent’s evidence from Dr Greg Jenkins of PIRVic that turbidity may occasion a 50-90% reduction in recreational fish catch at the Warmies. However, this would be due simply to turbidity. There had been no monitoring of levels of chemical contamination of recreationally caught pelagic fish in the Warmies, the Yarra and the northern bay. Dr Jenkins had given evidence to the effect that whilst fish monitoring had been proposed from time to time, no body had been found to fund it and hence there was no ongoing time series of fish contamination data. Further, no specific fish monitoring had been commissioned as part of the EES. However, during the workshop, the proponent’s Marine Ecologist Dr Matt Edmunds of Australian Marine Ecology, passed comment to the extent that, from a perspective of causation, he considered it likely that the fish in the Warmies were already potentially contaminated. He did not consider it likely that dredging works would significantly alter this position. His conclusion was that there was probably an immediate precautionary basis for the closure of the Warmies recreational fishery.

It was put to Dr Edmunds that he had no specific data on which to raise this somewhat concerning assertion, a position that he agreed. It was also put to Dr Edmunds that if levels of chemical contamination in the Warmies were such as to justify an immediate precautionary closure of fisheries, much the same could be said about other stretches of the lower Yarra, (or indeed about locations on the Port of Melbourne DMG, to which Yarra sourced sediments had been disposed, but which happened also to comprise a popular snapper ground). Again, he agreed with this position. It was also put to Dr Edmunds that has position was in any case reliant on sediment data in the evidence of Dr Cohen and subject to any caveats that may emerge as to the reliability of that, a position to which he also agreed.

Panel Response

The Panel must open by making clear its view that it found the approach of the Port of Melbourne Corporation and its consultants to the issues raised by Ecogen Pty Ltd profoundly unsatisfactory. This assessment is most critical, not in that the Panel considers that situation and concerns of the power station to be irresolvable; far from it. It is critical because the situation and concerns of the power station are key technical concerns that the proponent ought and indeed must in some way be able to resolve, before the project proceeds.

The Panel observes at the outset that Newport Power Station is plant of consequence. As a major gas fired intermediate load generator, it provides considerable flexible response capacity in the generation of electricity to meet demand across the national electricity market (NEM). It is somewhat sterile to engage in debates about the precise contribution that the power station makes to meet demand in Melbourne, Victoria or the NEM more broadly and at which particular times. The performance of an integrated electricity market is such that the immediate demand for power from Newport may in fact arise in New South Wales or Queensland, or may not arise at all and the plant may remain on standby. However, it is clear to the Panel that stations such as Newport are valuable generating assets and that the NEM relies on the ready availability of such assets to ensure that power demand is met throughout eastern Australia.

Perusal of data available from the NEM demonstrates clearly that Victoria and the entire NEM pass through significant phases in which total available generating capacity provides only the slenderest of margins above demand. Whilst the bringing on stream of Basslink is expected to mitigate this position in Victoria in 2005, that mitigation will, in the context of the rapidly growing market demand for electricity, provide us with a buffer extending to little more than a year. In such circumstances, any project that might have the necessary effect of taking a power station off-line, albeit for even the shortest of periods, must provide a very clear basis for doing so and strategy for minimising the social and economic disruption that might be occasioned thereby.

The Panel is equivalently clear that evidence currently before it demonstrates that unconstrained dredging operations without mitigating measures undertaken in the vicinity of Newport Power Station would have the almost inevitable consequence of taking that plant off-line.

It flows that there was a reasonable requirement for the project to have considered from the outset:

- Whether there is any reasonable prospect of its affecting the operating parameters of the station; and if so
- What measures can and should be taken to mitigate such effects.

Similar major infrastructure projects (such as freeways or pipelines) pass before the front doors of existing plant. The owners and operators of plant are not typically in the business of opposing infrastructure development: in general terms and in this case, they welcome it. However, they are sensibly concerned that the operating parameters of their plant are safeguarded through the construction and operational phases of the passing infrastructure project.

A key task for the project managers of any infrastructure project is therefore to identify the likely concerns of plant operators at an early stage, and engage in effective dialogue with them to ensure that they are provided with comfort that:

- Their operating parameters are known and understood by those responsible for the project.
- Prudent and reasonable steps have been taken in terms of design and operation to exclude or minimise harm to the plant.
- Effective monitoring and liaison measures are in place to ensure that unlooked for outcomes of a potentially harmful nature are identified and responded to in a timely fashion.

Much of this is about the demonstration of effective project management practices. Typically, a plant operator will not expect a prior solution to every possible problem, preferring to see demonstrated in action a problem solving culture that gives them the confidence to expect that problems (whether currently foreseen or not) will be capable of resolution with expedition and economy.

It is therefore a considerable surprise and concern to the Panel that the proponent's project management practices in this case did not identify Newport Power Station as requiring anything more than a most cursory examination until the point of public submissions. Further, once the potential seriousness of the issues raised had become apparent through the lodging of a submission by Ecogen Pty Ltd., little tangible effort appeared to be put into the delivery of potential solutions.

The Panel is clear from responses given in cross examination of its witnesses by Counsel for Ecogen that the proponent did not provide detailed briefs to its expert team to consider possible integrated solutions to the power station's issues.

The Panel is also concerned that the proponent appeared to place more effort into the frustration diversion of the Panel's attention from substantive issues raised by Ecogen than into the productive resolution of those issues.

The Panel must remark as examples on the discussions of the effect of flood incidents, previous dredge campaigns and the role of recreational fishing in the Warmies.

In relation to the discussion of the effect of flood incidents and previous dredge campaigns on the power station, the proponent did have some apparently sound points in logic. However, in the Panel's view, these did not withstand any more than the most cursory of scrutiny and application to the evidence. In relation to the November 2004 flood event discussed before the Panel, the Panel must make clear that the simple adducing of photographic evidence showing apparent visible turbidity in the power station outlet channel, in fact stands as proof for very little.

Consider for example:

- Two closely timed aerial photographs were the only evidence that the Panel was being asked to consider by the proponent in this regard.
- The proponent had not inquired as to the nature of the flood event (it in fact turned out to be an event of considerable significance, being on normal data a flood likely to repeat over a 2-5 year period, but in the recent drought conditions unexperienced on the Yarra for a decade, or approximately half the entire operating period of the power station).
- The proponent had not inquired as to the state of the tide and the influence that this may have on the distribution of the turbid flood plume at the mouth of the Yarra. (Aerial photographs subsequently viewed by the Panel suggest that the location of the Yarra plume is considerable variable in the vicinity of the cooling water channel and Greenwich Bay.) It flows that it is not possible to infer that the visual presence of turbidity in the outlet channel indicates that turbid water has been entrained in the power station.
- The proponent had not inquired as to the state of the wind and the influence that this may have on the distribution of the turbid flood plume at the mouth of the Yarra. Again it flows that that it is not possible to infer that the visual presence of turbidity in the outlet channel indicates that turbid water has been entrained in the power station.
- The proponent did not seek to refer the Panel to depth profiled turbidity data for the river during the flood event, so it is not possible to infer that the visibly turbid surface water in the river was also present at depth, where the power station was extracting water from the salt wedge.

The only hard data that the Panel has to hand turns out to be water quality monitoring data tabled by Ecogen in response to what their Counsel characterised as an attempted ambush. Whilst this demonstrates that, during the flood, exposure of the plant to suspended solids is likely to have risen by a factor of five, the Panel cannot claim that this one data instance stands as proof of the contention that regular flood events expose the power station to turbidity of an equivalent order to that generated by dredging. Clearly further study is required. This incident stands as an indicator of the degree to which the proponent was prepared to resort to television court-room methods, which the Panel considers have little place in the objective field of environment impact assessment, in an attempt to persuade us to reduce the weight to be placed on Ecogen’s evidence. The Panel was not persuaded.

Turning to previous dredge campaigns, the Panel would acknowledge that the proponent has what appears to be a basically sound position in logic. On the face of historic dredge records, there have been several campaigns to remove material from the river immediately fronting Newport Power Station. There is no immediately apparent record of these campaigns having caused outages or damage to the plant. However, again here the Panel takes the view that this is likely to be for lack of study. Without the careful parallel consideration of dredge data from the Port, EPA river water quality data and such monitoring and maintenance data as the power station may possess, it will not be possible to determine whether there has been a causal relationship between previous dredge campaigns and plant damage. The Panel considers that the data to demonstrate such a relationship is to hand and deserved to be investigated. There appears to have been time available to investigate it, even during the Panel hearing: but the proponent appeared to prefer not undertake such substantive investigations. The Panel however concludes that such a study should still be made.

That being said, before one could conclude from a study of previous dredge campaigns that there was no causal relationship between dredging per se and damage to the power station, one would also have to relate the technology, sediment volume and duration of each historic campaign, to the present campaign. In circumstances where no previous instance of damage was found, one could not generalise to the current dredge proposal until one was satisfied that the significantly larger order of sediment to be removed and campaign duration would not materially affect the power station.

Turning to the Warmies and the proponent's concern to avoid the unwitting distribution of contaminated materials. The Panel would state from the outset that the significance or otherwise of this issue rests in the approach taken to the characterisation of sediment chemistry in the Yarra and the choice of a best practice dredge technology for this aspect of the work. It follows that little can be concluded in respect of possible effects contingent on both sediment chemistry analysis and the choice of dredge technology, when both are subject to the findings set out elsewhere in this report. However, the Panel must remark on the participation of the proponent's witness Dr Edmunds in the Governance and Environmental Management Plan workshop processes, which appeared to raise potentially significant new issues in this regard

As outlined above, Dr Edmunds stated his view that the existing toxicological condition of the Warmies were likely to justify cessation of recreational fishing in that location on a precautionary basis. The burden of this assertion appeared to be that Ecogen should worry less about its potential future position in relation to the entrainment and distribution of contaminated dredged material through the cooling channel. It should worry more about its existing potential liability arising from the potential current condition of the channel.

The Panel finds this position somewhat difficult to support for a number of reasons.

- Firstly, it appears to rely on assertion, without reference to any evidence brought before the Panel. There was no evidence to hand to suggest that the Warmies (or any other part of the lower Yarra) is so contaminated as to make the closure of recreational fisheries a necessary step to limit corporate liabilities or safeguard public health. (Although it must also be remarked that there is equivalently none to say that it is not.)
- Secondly or alternatively, if such evidence is known to Dr Edmunds and/or the proponent, it is most clearly material of public interest and should be disclosed for consideration by relevant arms of government forthwith. For clearly, if there is such evidence, it could suggest that the lower Yarra might be in a significantly more seriously contaminated condition than the window provided by Dr Adam Cohen's sediment chemistry evidence considered above would suggest. The Panel takes this position because, on the limited data available to it, it can see no reason in principle why the Newport Power Station cooling water outlet channel would be likely to suffer significant contamination, in circumstances where this was not already more broadly present in the river sediments. The power station cooling process alone is not likely to have been a significant source of chemical contamination. In short, if this is a real problem, it is most likely to be a problem for the river, its managing authority (about which questions have been raised but not answered in the policy appendix) and for the citizens of Melbourne, not just for Ecogen Pty Ltd.
- Thirdly, if such a position appears soundly based and was the logical and reasonable professional opinion of Dr Edmunds, a relevant expert member of the proponent's team, why did the proponent not then seek to recommend an independent analysis of toxic accumulation in fish recovered from the lower Yarra? The same question should also be asked of the Port of Melbourne DMG, the destination to which Yarra sediments have been removed in recent years, but which is understood to be a good snapper fishing

ground. Such work would in any case appear to be necessary now, if only to resolve and set to rest the concern that has been raised by the proponent's team.

- Fourthly however, if such a position was not the professional opinion of Dr Edmunds, but was more of an aside, then it would appear to have crossed the necessary boundary between independent expertise and advocacy before a Panel.
- Fifthly and finally, the Panel must again express considerable concern that more effort and ingenuity appears to have gone into the generation of a line of argument designed to frustrate the position of Ecogen before the Panel, than to address a potentially significant underlying environmental issues.

So it was that by the end of the hearing, little if any progress had been made on the delicate balance of monitoring, scheduling and technological measures that might be necessary to re-assure the power station that its interests were in safe hands.

Some time was apparently spent by the proponent in pursuing the use of silt curtain technology despite the prospective physical proposition that the sheer volume of water entrained by the power station, together with low turbidity level on which it currently relies, would result in either the rapid clogging and failure of such a curtain, or the need for a curtain of an infeasibly large extent. Other potential solutions were not identified.

Turning its mind to potential components of a solution, the Panel would summarise these as follows:

- It will be necessary for the proponent to undertake modelling factoring in the anticipated dredge technology for use in the Yarra, so the turbidity levels likely to be faced by the power station are properly understood. At present, no such modelling has been undertaken, on the basis that turbidity modelling has been used to understand the likely extent of plumes in the bay, but not their likely concentration and duration in the river.
- Particle sizes in potentially suspended sediments will need to be understood, to determine the potential for physical abrasion and erosion of station plant and equipment.
- Chemical analysis of potentially suspended materials will also be necessary, to enable views on the capacity for chemical attack of station plant and equipment to be reached.
- It will be necessary for Ecogen and the proponent jointly to monitor water quality and particularly turbidity at the point of the cooling water intake and in the outlet channel.
- Joint attempts should also be made to correlate power station, EPA, port and other data on river flow conditions, turbidity in the river, water quality within the power station and any unplanned maintenance or equipment failures at the power station.
- Productive round table discussions should then take place between the proponent and the power station to identify whether particular levels of turbidity, with given ranges of particle sizes and chemical compositions are or are not of operational concern to the power station.
- Such discussions will enable the proponent then to consider the degree to which choices of dredge and work area screening technology might assist in mitigating concerns.
- If the lowest economically practicable and otherwise environmentally acceptable means of dredging are still found on the balance of probabilities to cause operational concerns at the power station, round table dialogue must then commence to relate dredge scheduling (and its environmental consequences) to power station operating requirements. The Panel considers that options for productive dredge deployment

during periods when the power station is non-operational have yet to be fully and productively explored.

- Round table discussions should also examine the minimum feasible notice period, under which dredge works can (if necessary) be halted and the power station be set to run within acceptable operating parameters for cooling inlet water.

All of this will of course have a bearing on the cost of the project and, if effective works scheduling cannot be agreed, the availability and hence ability to meet contractual, social and economic obligations of the power station.

The Panel does not consider that it should be naturally assumed by the proponent that lawfully enjoyed beneficial uses of resources such as the waters of the Yarra can be removed occasioning potentially significant business disruption and substantial economic losses, without there being:

- An obligation on the proponent to take reasonable steps to ensure the minimisation of foreseeable third party consequential losses; and
- An obligation on the proponent to compensate for immediate loss and damage unavoidably caused to the power station.

The first of these is, matters of project approval processes aside, a clear obligation in law. Notwithstanding that the proposed Channel Deepening Facilitation Bill will exclude the availability of injunctive and prerogative remedies, the Panel reads it as leaving common law rights in damages in the law of negligence and nuisance unchanged.

The submissions and evidence before the Panel to date make clear that, if the project were to proceed commencing in March 2005, the proponent would not in the Panel's view have taken reasonable steps to ensure the minimisation of power station losses. In such circumstances, should civil action be pursued, the effect of the Channel Deepening Facilitation Bill (if passed unamended) would appear to be to enable the continuation of dredging operations and the potential compounding of damages that, in respect of an operation such as Newport Power Station, could be very substantial indeed.

The second of these matters would presently be subject to the normal operation of the law of negligence and or nuisance and to processes in the civil courts. However, it appears to the Panel that consideration should be given by the proponent and the State government to means whereby liability and the quantum of damages recoverable for loss or damage to the power station occasioned by the project could be swiftly determined outside the courts. In the context of such a scheme, there may in turn be a justification for the statutory limitation or barring of common law negligence or nuisance claims. Such a scheme would also be likely to assist in concretising and limiting the exposure of the project to liabilities that may otherwise be most substantial.

Finally, the Panel notes that one of the key concerns of Ecogen is their lack of confidence in the capacity of existing communication channels to enable their soundly based concerns to be considered and responded to. Somewhat of a logjam has developed. As Ecogen has found it necessary to become more strident in the advocacy of its concerns, they believe that the response of the Port has apparently been to sideline the issues raised. A self perpetuating spiral of dispute appears to have been created. This spiral needs to be replaced with a much more open and genuine culture of mutually negotiated problem solving. The Panel considers that an early high level meeting between the Port and the power station should be convened to pursue this objective.

Four recommendations flow from this analysis in the mind of the Panel. In considering these recommendations, it should be noted that they do proceed on the basis that other matters of a more fundamental nature addressed in primary recommendations above are capable of being resolved such that the project can proceed. These recommendations are contingent and secondary by nature. Should further assessment pursuant to primary recommendations suggest that the project or key aspects of it cannot proceed, then these recommendations must of necessity be discounted.

An early board level meeting should be held between the proponent and Ecogen Energy Pty Ltd, with a view to establishing a basis for mutually negotiated and practical problem solving.

Before the commencement of dredging works in the Yarra, the proponent in collaboration with Ecogen Energy Pty Ltd should undertake a detailed operational study of Newport Power Station. This study should determine:

- The necessary operational water quality parameters for the power station.
- The capacity of dredge works to exceed these.
- An optimum combination of dredge scheduling and dredge technology to minimise foreseeable loss or damage to the power station.
- This study should then form the basis of a memorandum of understanding between the parties.

Should sensible and timely agreement not be reached on the content of a memorandum of understanding, or on its execution thereafter, an independent arbitration mechanism should be available to the parties.

Before the commencement of the project, the proponent and State government should turn their minds to an agreement or other scheme whereby compensation for direct loss and damage to businesses and associated plant is unavoidably caused by or due to the effects of project works. Means of determining liability and the quantum of compensation should be agreed and formalised. The presence of such an agreement or scheme could provide a basis for statute limiting common law actions against the proponent.

Further to the appropriateness of continued recreational fishing for human consumption in the 'Warmies', Lower Yarra and Port of Melbourne DMG an independent study of the presence and concentration of key toxic materials in pelagic fish taken from these areas is required. Desirably, work should continue as an ongoing component of Bay environmental monitoring.

15.2.4 OTHER INDUSTRIAL USERS OF WATER

Discussion

Schedules F6 and F7 of SEPP (Waters of Victoria) define the uptake of water for industrial processes as a protected beneficial use. Similar to Newport Power Station, two issues of principal apply to the Panel's consideration of other such protected beneficial users:

- Reliance is placed on the quality of water at the uptake point, as a plant and process design determinant, as a driver of process/product quality and in relation to its effect on plant the continuance of operations within an economic planned maintenance regime.
- Discharges to water (if any) should be controlled by EPA licenses, which will limit the quality of water discharge with reference to key monitoring values.

Like the situation at Newport Power Station, it is likely that discharge licenses will take no specific account of dredging as a possible source of change to discharge water composition and quality.

However, other than Newport Power Station, relatively little can be said about other industrial users of water potentially affected by the project.

Great Southern Waters (a land based aquaculture undertaking) appeared before the Panel expressing concerns about water quality from their uptake and its effects on abalone culture. This issue is examined further as part of the Panel's consideration of aquaculture below.

The Panel is aware that Sugar Australia has industrial plant that is a beneficial user of water from the Yarra in the dredge-affected area. However, CSR did not submit or seek to appear before the Panel.

The table below is based on a list provided to the Panel by the EPA during the panel hearings. It should be noted that this is not a comprehensive review and it is therefore possible that others beneficial users exist. The EPA's knowledge focuses on processes that uptake and discharge water. They do not control the simple extraction of water. Extraction points may have predated any Coastal Management Act consents for works.

Table 33: Entities Making Beneficial Use of Bay/Yarra Waters[186]

Organisation	Use	Location
Ecogen Energy	Cooling water	Yarra
Sugar Australia	Cooling water	Yarra
Shell refinery	Cooling water	Corio
Cheetham Salt	Salt production	Geelong Arm
Cheetham Salt	Salt production	Corio
Existing land based aquaculture zones	Aquaculture	Great Southern Waters, Avalon, etc
Existing marine aquaculture areas	Aquaculture	Beaumaris, etc
Undeveloped but designated Aquaculture zones	Aquaculture	Pinnace Channel, etc

Panel Response

The Panel is concerned that the EES did not appear to include as a primary input, a study of existing lawful beneficial industrial users of water in locations likely to be affected by dredging and dredge plumes.

The experience of Newport Power Station leads the Panel to the conclusion that it is not currently secure to assume that there are no such industrial users potentially affected by the project, but unknown to or unconsidered within the project program. Furthermore, should it

186 EPA Source.

transpire that significant plant has the potential to be adversely affected, the economic, social and environmental consequences of failing to plan for such effects could potentially (as outlined in respect of Newport above) be severe. For this reason, the Panel recommends as follows:

Before the project proceeds, the proponent should undertake a thorough and systematic study of industrial uptakes from and discharges to all waters potentially affected by dredging or disposal works or by turbid plumes from these. The study should identify:

- The location of all lawful uptakes and discharges;
- The nature of each industrial process requiring the uptake;
- Its dependence (if any) on the particular quality or constituents of the water abstracted and the influence (if any) that dredging works might have on this (including its capacity to influence the performance or maintenance requirements of plant);
- The condition of water discharged and the influence (if any) that dredging works might have on this (including its capacity to influence performance against a discharge license); and
- The views of the process operator on the measures necessary to safeguard operations and comply with discharge obligations.

The industrial uptake study should identify the measures to be implemented by the proponent in terms of:

- Information sought from the industrial process operator;
- The choice of dredge technologies and or industrial process changes available to minimise potential dredge impacts on the industrial process;
- The design of monitoring and early warning frameworks to safeguard against unlooked for outcomes; and
- Consideration of the needs of the industrial process in the dredge schedule.

Where necessary, the principles of the agreement or scheme of compensation proposed for Newport Power Station above could be extended to other industries.

Turning to Great Southern Waters, the Panel notes that this entity uptakes water from a location that, in principle, is reasonably well separated from the source turbid plumes. However, without 'proof of concept' whole of campaign turbidity modelling, an absence of relevant impact cannot be assumed. The Panel considers that it should be included in the systematic evaluation of industrial beneficial use impacts called for above, and if necessary may be included as a potential beneficiary in an agreement or scheme of compensation.

15.2.5 MARINE AND LAND BASED AQUACULTURE

Discussion

Marine and land based aquaculture are a relatively small, but significant and growing beneficial user group of the waters of Port Phillip Bay.

Marine based aquaculture consists largely of the mussel industry, with an annual harvest of 1260 tonnes, worth $3.7 million and supporting 140 jobs. That being said, the scale and value of this industry are very dynamic. The advent of new aquaculture zones, new production technologies and the early development of new markets for cultured species suggest that this is a sector that could grow very significantly over the years during which the project is proposed to be implemented.

Marine aquaculture takes place in eight designated locations, the status of which is summarised in the table below.

In relation to marine aquaculture locations, it must be recorded that the designed aquaculture zones have been the product of a long and complex process of designation.

Table 34: Aquaculture Zones

Zone Name	Surface Area	Status
Grassy Point	252 ha	Existing – to be expanded
Clifton Springs	315 ha	Existing
Bates Point	25 ha	New
Kirk Point – Werribee Port	200 ha	New
Beaumaris	25 ha	Existing – to be expanded
Mount Martha	150 ha	Existing – to be expanded
Dromana	20 ha	Existing – to be expanded
Pinnace Channel	1000 ha	New
Total area	1987 ha	

Land based aquaculture is noted in the EES as taking place over a combined area of 57 ha at Point Lillias and Avalon, although it should be noted in addition to this that the previously mentioned submitter, Great Southern Waters made the Panel aware of their private land based aquaculture holding on the Bellarine Peninsula. Land based aquaculture is understood largely to consist of abalone culturing. Whilst still in its infancy, this industry has significant potential to produce high value output and provide employment.

Both uses rely significantly on the quality of bay waters. Marine based aquaculture is subject to the quality of the waters in and surrounding the designated aquaculture areas. Mussels fundamentally require water with limited turbidity to be effectively grown and marketed. They can also bioaccumulate toxins from sediments in certain circumstances.

Land based aquaculture is in many respects similar to an industrial process. Water is extracted, passed through culture tanks, cleaned and then discharged to the bay, subject to an EPA discharge license. High volumes of water flow through are required to maintain the health of cultured seafood species. Turbidity is again a source of concern in respect to animal health and marketability. A particular concern raised by Great Southern Waters was the potential for raised levels of turbidity to promote parasitic worm attacks on the shell of abalone.

It should be noted that in addition to the social and economic value of aquaculture fisheries, the culturing of filter feeders in the bay or using bay waters serves an additional environmental purpose, in that it assists in the removal and hence net reduction of nutrient from the bay.

The EES acknowledges that the primary adverse impacts of the project on marine based aquaculture would arise from turbid plumes from dredging works and or dredged material disposal. These would tend to require increased maintenance work at affected locations and to lead to disturbances through the clogging of filter feeding, reproductive and respiratory apertures.

Suspended sediments may have significant effects on aquaculture, particularly in the Mount Martha, Dromana and Pinnace Channel Aquaculture Zones. These areas will potentially receive elevated turbidity and suspended sediments. As conceded by Dr Jenkins, a lack of experiment data on long-term (ie greater than 20 day) exposure of mussels to suspended sediments reduces confidence in the assessment of this threat and requires conservative management thresholds. This led Dr Jenkins to recommend that in addition to monitoring of suspended sediments with feedback to dredging already proposed for the Pinnace Aquaculture Zone, this monitoring should also be conducted at the Mount Martha and Dromana Aquaculture Zones.

Panel Response

In relation to turbid plumes from channel deepening works and disposal, the Panel retains concerns that whilst the post Annexure D modelling holds out the hope of progress towards an effective impact assessment, that assessment has yet to be made. As turbidity modelling has not been carried out for realistic campaign durations with a range of foreseeable metocean conditions the potential for unidentified adverse turbid plume effects on aquaculture zones cannot be ruled out.

The Panel departs from the analysis of the EES in respect of the Dromana and Mt Martha aquaculture zones, which in principle it considers to be very close to the preferred location of the EMG in the south of bay (SEDMG). Whilst the Panel notes that the Mt Martha aquaculture zone is currently vacant, and that it is likely to remain so during the capital dredging program, the Panel does not consider that it will remain vacant for the years over which maintenance dredging will take place at the project. As the processes for identifying and designating aquaculture zones are both rigorous and slow, involving many stakeholders (viz ECC (2000), Marine, Coastal and Estuarine Investigation), the Panel does not consider that the effective 'sterilisation' or even significant reductions to the future productive capacity of a zone should be viewed lightly.

Another concern of the Panel is the acknowledgment by the EES that there has been little scientific study of medium term and moderate exposure of cultured filter feeders to turbidity. Studies undertaken over periods up to 20 days have demonstrated that short term and high exposure to turbidity can cause the death of these organisms. The Panel expresses its concern that the EES has not demonstrated that the project is unlikely to be the source of such an impact. Of greater potential significance could be the prolonged exposure (for weeks to months) of an aquaculture asset to moderate but raised levels of turbidity. The EES notes in Chapter 36 that instances of mussel detachment from culture ropes and death were recorded during the Geelong capital dredging. Whilst the EES has taken the view that turbidity control measures necessary for the protection of aquatic ecosystems will of necessity protect aquaculture assets, the Panel is of the view that this proposition is untested. It appears that relatively little additional study would be necessary to expose key aquaculture species to predicted levels of moderate turbidity for periods relevant to the duration of a dredge campaign, to validate the position set out in the EES. If the position cannot be validated and significant instances of cultured species death are recorded at moderate levels of turbidity over a dredge campaign period, the Panel considers that two options require to be explored:

- Further studies should be undertaken with a view to adopting further turbidity control measures sufficient to protect existing aquaculture assets; or
- Should it be concluded that additional turbidity controls are not on balance economically feasible, an agreement or scheme of compensation on the same principles as that

recommended above for Newport Power Station could be applied to the aquaculture industry.

In relation to ecotoxicology and the potential accumulation of toxins in cultured filter feeders, the Panel notes that in principle that the EES raises this as a short term issue and only in the south of the bay, in relation to the Pinnace Aquaculture Zone. The key marine and land based aquaculture locations in the south are significantly removed from the Port of Melbourne DMG. As this is the location at which most moderately contaminated (or possibly acutely toxic) materials are due to be disposed of, the Panel considers that the potential for harm through bio-accumulation in existing southern aquaculture areas is limited. However, the potential for this to be a problem in the north at aquaculture zones such as Beaumaris have not been excluded.

The Panel would also note that it is an implication of its recommendations above in relation to the management of moderately contaminated materials, that methods of placement and containment will be re-evaluated. The Panel would expect the adoption of best practice methods to lead to further reductions in both the likelihood and consequence of toxic accumulation in aquaculture species. Nevertheless, should this re-analysis lead to circumstances in which either new locations or methods for the disposal of moderately contaminated materials, not examined in the EES, were under consideration, it would be necessary to re-visit the EES aquaculture analysis to ensure that its results either continue to hold good or better still can be improved upon.

The following recommendations flow from the Panel's examination of aquaculture issues:

A further study of cultured mussels should be undertaken, to determine the likely economic effects of moderate levels of turbidity exposure, over the likely duration of a dredge campaign (as opposed to 20 days). Further exploration of the following should occur if the study shows significant adverse impacts:

- additional means of turbidity control; or
- mechanisms for industry compensation.

Subject to the recommended re-appraisal of dredged material disposal options recommended above, should the SE DMG be retained as a disposal option, a further study should be undertaken to provide assurance that its location and management will not prejudice the future function of the Mt Martha, Dromana and Pinnace Aquaculture Zones. Particular reference should be made to the use of the DMG during proposed maintenance dredging. The study should seek to minimise turbid plume events on the Aquaculture Zones. Re-location of this zone should not be ruled out until the study is complete.

15.2.6 COMMERCIAL & RECREATIONAL FISHING

Discussion

Maintaining the health of the commercial and recreational fishing industries is important for the economy of the state, as well as the livelihood and enjoyment of thousands of Victorians and tourists. Commercial and recreational fishing was covered over a large number of EES chapters. Key witnesses for the proponent were Dr Greg Jenkins (in respect of commercial fish species), Mr Steve Meyrick and Mr Alex King (in relation to economic impacts) and Mr David Cotterill (in respect of recreational fishing and tourism considerations).

The first table below summarises the key commercial and recreational species sought in the bay by fishers and their common locations. In addition to the species recorded, mention must also be made of the recreational fishery, mainly for tailor, in the 'Warmies' adjacent to Newport Power Station and discussed above. The second table is adapted from Table 19.1 in the EES and shows the key features of the Bay aquaculture and commercial fishery. The third table is adapted from Table 19.2 in the EES. It summarises the effort and character of the Bay recreational fishery.

The potential impact the Project could have on the commercial and recreational fishing industries was a key concern for a number of third parties, including the Fishing Party, the Blue Wedges Coalition, Seafood Industry Victoria and the Fisheries Co-Management Council.

For the purposes of the Panel's analysis, 'recreational fishing' includes both individual recreational fishers and fishing charter operators, although it is recognised that there is some overlap between charter and commercial fishing operations.

Recreational fishing is the highest participation recreational activity in Victoria, providing a substantial contribution to the economy of Victoria through fees, licenses, equipment and tourism. From his study, Mr Cotterill for the proponent estimated that approximately 350,000 recreational anglers fish along the Bay each year, generating $200 million and providing 1800 direct ongoing jobs. He estimated that the 14 recreational fishing charters that operate within the Bay generate an annual value of $1.3 million.

For the purposes of the Panel's analysis of 'commercial fishing', this section focuses on the commercial catch of wild fish stocks within Port Phillip Bay. By using the term 'commercial catch', the Panel intends to include within this definition all catch by persons in the regular business of catching fish for sale. Included within the Panel's understanding of commercial fishery are all commercial catches of wild pelagic fish, together with the wild abalone fishery. Mussel and cultured abalone fisheries are considered above under the general head of aquaculture.

While finfish production in Port Phillip Bay is relatively low in comparison with other Australian locations such as Sydney Harbour, Jervis Bay, Botany Bay, Tuggerah Lakes and Cockburn Sound, it remains the most productive bay and inlet commercial fishery in Victoria. King George Whiting is the most valuable finfish fishery, with other key commercial species including Pilchards, Snapper, Anchovy, Australian Salmon, Yellow-eye Mullet, Garfish and Gummy Shark. In all, the EES states that over 60 species of finfish are recorded from commercial catches.

According to the EES the commercial wild-harvest finfish industry in the Bay represents more than one-quarter of the total value of all Victorian finfish fisheries, producing 727 tonnes of fish valued at more than $3 million during the 2001-2002 fiscal year. While most of the commercial catch in the Bay is derived from the Geelong Arm, the Panel recognises that areas near the proposed Project are also important fishery grounds. A situation recognised by submitters in this regard.

The key potential effects on fisheries of the project are as follows:

- Changes to the hydrodynamic regime in the bay, leading to changes in the entry and movement of fish larvae into and within the bay.
- Introductions of pest species with adverse effects on fisheries.
- Adverse impacts on seagrass beds, in terms of their function as fish habitat.

- Turbidity effects leading to reductions in underwater visibility and physiological effects on fish.
- Effects of dredged material disposal.
- Consequential economic effects on fishery related sectors.

The combined effect of these issues in the view of submitters also requires to be examined.

The Hydrodynamics and Sediment Transport Study in Chapter 28 of the EES concluded that there was likely to be little impact from the Project in relation to changes to hydrodynamics and coastal processes. However, Dr Jenkins for the proponent had concerns that changes these processes could affect larval transport and the integrity of supporting habitats for aquaculture, commercial and recreational fish species.

Table 35: Distribution of Key Recreational and Commercial Fish Species

Species:		Common Locations:
Anchovy	–	Mostly north-west half of the Bay, particularly Altona Bay and Hobsons Bay, although some catch from the eastern end of the Channel
Australian Salmon	–	Mainly western edge of the Bay, including Mud Islands, Altona Bay and Hobsons Bay
Calamari	–	Mostly western half of the Bay, including areas around South Channel, Mud Islands and the Rip
Flounder	–	Mostly western half of the Bay, including areas around South Channel, Mud Islands, Indented Head and Grassy Point
Gummy Shark	–	Across the Bay, including northern DMGs
Pilchard	–	Mostly western half of the Bay, including areas around Mud Islands, South Channel and Altona Bay
Rock Flathead	–	Mostly western half of the Bay, including areas around South Channel, Mud Islands, Indented Head and Grassy Point
Sand Flathead	–	Across the Bay, including Altona Bay and Northern DMGs
Sandy Sprat	–	Northern Bay, including Hobsons and Altona Bay
Southern Sea Garfish	–	All around the edge of the Bay, including Mud Islands, Altona Bay and Hobsons Bay
Yank Flathead	–	Mostly western shore of the Bay, including Hobsons Bay, Altona Bay and around Mud Islands
Yellow-eye Mullet	–	Mainly western edge of the Bay, including Mud Islands, Altona Bay and Hobsons Bay

Table 36: Key Features of the Bay Commercial Fishery 2001-2002

	Finfish	Abalone
Commercial production(tonnes)	727	87
Commercial market value($ million)	3	3
Key commercial species	Abalone, Pilchards, King George Whiting, Snapper	
Other commercial species	Anchovy, Australian Salmon, Yellow-eye Mullet, Garfish, Gummy Shark	

Table 37: Recreational Fishery Estimates for the Bay (2000)

	Recreational Fishery Estimates
Annual recreational effort (boat)	– 1.84 million hours
Annual recreational effort (shore)	– 0.44 million hours
Key recreational species	– Sand Flathead, King George Whiting, Snapper
Other recreational species	– Yellow-eye Mullet, Garfish, Calamari
Annual recreational catch	– 415-691 tonnes, or 2-4 million fish (all species)

In his witness statement Dr Jenkins stated that if channel deepening results in marked changes to transport patterns that prevent larvae from reaching important juvenile habitat then there would be a potentially significant long-term impact on commercial fishing. Changes to currents or wave patterns could also lead to alterations in the extent of important habitats such as seagrass, again leading to long-term impacts.

Dr Jenkins conducted a study on the likely effect of the project on the larval transport of King George Whiting. He took the scenario from a previous published study of whiting larval transport based on hydrodynamic modelling, verified against field data on larval abundances, and repeated the simulation using the deepened channel scenario. The modelling used was based on an existing model provided by Dr Kerry Black, the hydrodynamics peer reviewer. In general, Dr Jenkins found that the distribution of larvae in the pre- and post-dredging scenarios was similar, indicating no major changes in transport pathways for this species. However, there were some subtle changes in the results, with slightly fewer larvae reaching the northern extremity of the Port Phillip Bay, and slightly less larvae overall in Port Phillip Bay.

King George whiting larvae settle in seagrass beds throughout Port Phillip Bay, including the northern Bay. Dr Jenkins was uncertain of the significance of less larvae reaching this area. He estimated that seagrass beds in the northern extremity of the Bay may hold between 5 to 20% of the whiting larvae settling in seagrass in Port Phillip Bay. However, Dr Jenkins noted that this estimate was subject to uncertainties arising from data input and calibration issues.

Concerns were raised by a number of parties that the introduction and translocation of marine pests by dredging equipment may impact on commercial and recreational fisheries. This issue is dealt with fully in the marine ecology section, suffice to say here that most experts did not believe the direct impacts to be major however the secondary impacts on matters such as denitrification have the potential to be significant.

Another long-term risk for the fishing industry is the potential loss of seagrass beds as a result of dredging, with Dr Jenkins predicting the loss of some *Heterozostera* and *Amphibolis* beds as a result of turbidity and siltation. Dr Jenkins recommended that the EMP should ensure that while some primary production may be lost, reduction in cover would be unlikely. However, uncertainty surrounding turbidity of seagrass production models would impact on the capacity of the EMP to deliver this requirement.

Reduction in underwater visibility from suspended sediments could have significant effects on migration and feeding of important commercial fish species.

Dr Jenkins outlined that in the south of Port Phillip Bay species such as snapper and pilchards are thought to undertake migration into the Bay in spring and out from the Bay in autumn. Other species such as salmon also migrate into the Bay. King George whiting larvae enter the Bay in spring and are visual plankton feeders, meaning that they could also be adversely affected by reduced underwater visibility.

The north of Port Phillip Bay is the spawning area for Australian anchovies, with spawning occurring from November and February. Anchovies are one of the key species within the commercial fishing industry, and are also a prey species for a number of commercial and recreational fish species and birds such as penguins. As well as reduced visibility, Dr Jenkins raised concerns that increased turbidity could "clog gill structures of this pelagic filter-feeding species", as well as reduce the visual feeding efficiency of its larvae. Dr Jenkins also made the assessment that the greatest impact would occur over the summer period of spawning and larval development, and that dredging over summer should be avoided where possible.

In order to manage any potential impacts on migration of fish from reduced underwater visibility during dredging activities, Dr Jenkins recommended monitoring of underwater visibility/turbidity.

Turbidity and suspended sediments could also have an impact on the benthic flora and fauna, as these are vulnerable to extended periods of light reduction that may result from dredging-related activities. Benthic flora and fauna are important parts of the food chain for many fish species, and habitats such as seagrass and benthic algae are important nursery and feeding grounds for many fisheries species. In his witness statement and submission, Dr Jenkins discussed how the King George whiting settles from the plankton directly on to seagrass and shallow reef algal habitats in the spring. He predicted that any reduction in the production of post-larval whiting in seagrass beds would translate to the fishery approximately 3 years later.

The sediment transport modelling indicates that turbidity and suspended sediments may have an impact on abalone fishing on the Bass Strait coast between Point Nepean and Flinders. This area yields approximately a third of the abalone quota for the central zone, meaning that any impact on this area could have a serious effect on the abalone industry.

While it is generally accepted that juvenile King George whiting, salmon, adult snapper and pilchards all migrate into Port Phillip Bay in the spring, the full migration patterns of these species are not well understood. In addition, the behavioural responses of these species to factors such as elevated turbidity, suspended sediments, noise and light at night in terms of migratory behaviour are virtually unknown. Dr Jenkins predicts that the strategies outlined in the EMP would lessen the effect on migration.

The use and disposal of dredged material would have a number of impacts on both recreational and commercial fishing.

The Fisheries Co-Management Council raised concerns that filter-feeding organisms would uptake and accumulate any chemicals resulting from the sea disposal of contaminated spoil. The Council was concerned that this issue was not given the emphasis and importance it deserved by the proponent in their EES and EMP.

Dr Jenkins admitted he was concerned the effect the SEDMG may have on commercial fishing in the area, as it is located immediately offshore from a popular snapper fishing zone. He also foresaw short-term impacts occurring where new or expanded DMGs cover important supporting habitat for juvenile fish. Due to the potential seriousness of this impact, Dr Jenkins' recommendation that in the first instance the DMG be moved to a different location and that if this was not done then the need for a fixed site monitoring station be investigated. The Fisheries Co-Management Council supported this monitoring.

In terms of economic impacts, whilst the fish catch value appears small in terms of the value and benefits of the project, it should be remarked that significant impacts could have the potential to cause significant losses to existing bay based commercial fishing businesses.

Mention must also be made of the wild caught abalone industry. This high value industry is generally acknowledged as being sustainably managed. Key abalone grounds are found immediately outside the Heads, in waters that could be subject to significant turbid plumes in the tidal outflow. The reduction of visibility for diving activities could also adversely affect this industry.

The study conducted by Mr Cotterill predicted that turbidity and sedimentation could have an adverse effect on shore-based anglers at two main locations:

- the breeding grounds of the Black Bream adjacent to the Yarra/Maribyrnong Estuary; and
- the 'Warmies' of Williamstown

In his witness statement, Mr Cotterill predicted that it would be unlikely for there to be any overall significant impact on recreational fishing in the Bay, and consequently little financial impact. Mr Cotterill based his prediction on two main factors:

- boat-based anglers have already moved further north of the shipping channel in the Bay due to the advent of the Marine National Parks; and
- that both shore-based and boat-based recreational anglers would continue to fish and move within the Bay as required to avoid dredging activity.

However, Mr Cotterill also predicts that the potential effect on recreational fishing could be fairly significant in very localised areas in the north of the Bay, as dredging is likely to occur during significant recreational fishing periods. This is supported by evidence from Dr Jenkins, who stated that elevated turbidity in the Yarra River has the potential to seriously affect important recreational fisheries, particularly bream and the mixed species fishery at the Warmies at the Newport Power Station water outfall. Dr Jenkins estimated that recreational catches could be reduced by 50 to 90% when turbidity levels are elevated as a result of dredging. This is a significant reduction that would have a severe impact on recreational fishing in one of the Bay's most popular recreational fishing spots.

Mr Cotterill predicts that charter fishing operations in the South of the Bay would be impacted by the plume activity associated with dredging, particularly during the summer periods. Overall, Mr Cotterill predicts that charter fishing income would be reduced by approximately $150,000 per year while dredging took place.

Mr Cotterill also notes that any reduction in recreational fishing activity could also lead to indirect effects, such as a reduction in expenditure on associated items such as bait, food and drink, travel expenses and so on.

Panel Response

In opening its response to fisheries issues, the Panel shares the concerns of submitters that fisheries impacts may not be sufficiently conservative. The Panel notes the significant variations that can emerge in fisheries productivity between seasons, with many species being subject to cyclic fluctuations. Whilst the EES analysis has sought to quantify the effects which may occur on the production cycles, this simply cannot be achieved with any degree of confidence by restricting fish/species catch analysis to a single year. Instead, a detailed analysis of data from a number of years is required, so that conservative assumptions as to the effects on a fishery of reducing stocks in a bottom of cycle year can be assessed. In order to undertake a sufficiently conservative analysis, the fisheries experts should use the lowest productivity value for each commercial fish species from data collected over the past decade.

Perusal of the data put forward by the proponent in relation to turbidity suggests that the current loss of bay waters available for catch or potential loss of catch is not yet reliably quantifiable. Before the dredging works commence, the proponent should be in a position to better understand the extent of impact that turbidity could have on fish catch and hence fisheries viability. The relevant fisheries experts should be provided with the output of any 'proof of concept' turbidity modelling and other fish relevant impact data (such as an evaluation of the marine acoustic impact of the hydro-hammer) in order to complete their evaluation.

Of further concern to the Panel and a number of submitters is that the proponent appears to have made little effort to minimise the potential losses arising in commercial fisheries, should production values for commercial fishing within the Bay prove to be unsustainable during or after dredging works. Following a similar line of reasoning to that taken in relation to Newport Power Station and in relation to the diving industry below, the proponent has not yet demonstrated that the project is a best practice project and that such impacts have been minimised. Work to complete the 'proof of concept' turbidity modelling, together with a re-appraisal of dredge technology appear likely to offer improvements and impact reductions.

That being said, commercial fishery in the Bay and abalone diving outside the Heads are industries that may, almost unavoidably, face some significant level of economic loss. Should this transpire to be the case, the Panel considers on balance that attention should be paid to means of compensating commercial fishers and abalone divers for specified classes of direct production losses. Whilst the Panel notes the principle that compensation is not normally paid to those impacted by public works, other than where their property is to be acquired, it also notes that this principle has evolved and largely been applied within the terrestrial environment subject to freehold tenure. It is therefore clear that major projects such a freeways, powerlines, pipelines and the like are not implemented in a manner that directly prevents (say) a farmer from farming, without there being some right in compensation or accommodation for land or easements acquired.

In the context of the bay, fishers use the marine environment without having any title to it. However, their use is lawful and businesses have been constructed on that basis. To take action that has the potential to damage or extinguish such businesses without consideration of some measure of compensation does not appear an appropriate course of action to the Panel. If nothing else, it would appear to push stakeholders to a point at which they may perceive themselves as having no alternative to civil litigation in an attempt to protect their positions.

The commercial fishing and abalone industries are small and bounded. It appears to the Panel that principles of impact, loss and compensation could be identified quite readily for these industries and set out in a simple scheme. On acceptable proof of significant loss and causation, an industry player could become eligible for an expedited but capped compensatory payment. It appears to the Panel that in the context of the likely cost and proffered community benefit of the project, such a scheme could be funded without too much difficulty.

The Panel has considered whether the same principles should apply to the recreational fishing industry. Whilst it notes that this industry has a significant infrastructure of tackle and bait outlets and boat charters, and that these may be affected, the direct nexus to the bay enjoyed by the commercial fishers is not so clearly made out. The Panel considers it likely that recreational fishers will be in large part diverted from their hobby location of choice, as opposed to being deterred. Bay fishing will decline for a period, but river and ocean beach and charter fishing are likely to offer alternative options, as suggested in Mr Cotterill's analysis. The emphasis here should be on the provision of clear information and encouragement for fishers and charter outfits to use the unimpacted parts of the bay. This is an issue that is taken up in more detail in the Panel's consideration of the diving and tourism industries below.

A best practice approach to dredging should be pursued, as it will provide significant opportunities to reduce or better control the likely impacts on the commercial fishing and abalone industries. The detailed impact of the project on these industries cannot be assessed until relevant changes to the means of implementation are known and assessed.

Should impacts entailing significant economic loss to the industry be unavoidable, before the commencement of the project, the proponent and State government should turn their minds to an agreement or other scheme whereby compensation for direct loss and damage to commercial fishing and wild abalone businesses is unavoidably caused by or due to the effects of project works. Means of determining liability and the quantum of compensation should be agreed and formalised. The presence of such an agreement or scheme could provide a basis for limiting common law actions against the proponent.

Finally, the Panel would note that, with reference to submissions about chemical contamination, it considers that its recommendations in respect of sediment characterisation and re-appraisal of disposal options above should resolve this issue.

15.2.7 RECREATIONAL DIVING

Discussion

The recreational diving industry is one industry that stands to be significantly affected by the project as currently proposed. This is a diversified industry consisting of:

- Operators of dive schools and training establishments (including the provision of some specialist transport and accommodation).
- Operators of dive boat charters.
- Vendors and hirers of dive equipment.

The recreational diving industry also supports a community of individuals who participate in recreational diving as a sport, but who may make greater or lesser use of industry infrastructure. For example, a 'first time' diver will be unable to dive without formal training from a school, and will most likely use a charter boat and hire dive equipment. In contrast, an experienced recreational diver will own much of his or her own equipment and will rely less directly on industry infrastructure.

Like other broadly 'tourism' related sectors of the economy considered below, the provision of dive services also has multiplier effects in the wider economy, for example, through the provision of general accommodation, food, transport and related services.

Dive industry operators (largely represented by their peak body DIVA) were greatly troubled by the project. The starting point for their concerns can be summarised in the following terms.

- Most dive operators are small businesses.
- Many claimed to be under-capitalised or operating with small profit margins. Industry players identified that their participation in the industry was predicated on a love of diving and the marine environment, more than on the (limited) opportunities that it provided to make profits.
- Dive operators are already subject to natural meteorological and seasonal contingencies: their assets cannot be continuously utilised to increase their returns.
- Whilst some operators have flexible operations, others have large fixed assets and cannot easily relocate.
- Port Phillip Bay is the major marine recreational diving location in Victoria, offering excellent diving experiences in clear waters. The natural environment and visual experience of Port Phillip Bay diving was likened to some of the best in Queensland.
- Areas of Port Phillip Bay provide sheltered safe dive locations.
- The Rip offers some of the best deep wall adventure diving in Australia.
- It followed in their view that if Port Phillip Bay (or large areas of it) became excluded to or unattractive to divers for a period extending to two years, a considerable number of dive businesses would not survive. Recruitment rates of new divers (a significant source of training revenue) could be strongly affected.

In such circumstances, the industry sought the following assurances:

- Performance standards for turbidity should ensure that underwater visibility would be retained at levels sufficient to enable diving to occur.
- Key dive sites concentrated around The Heads should be safeguarded from adverse impact. The loss of or damage to sites would affect the reputation of the Bay diving experience and the viability of the industry.
- Visually attractive flora and fauna, but hence the ecosystems that support them should be safeguarded from adverse impact. The loss of or damage to habitats or species would affect the reputation of the Bay diving experience and the viability of the industry.
- Alternatively, if the above could not be achieved, the dive industry considered that the direct impacts experienced by it would warrant some measure of compensation to be paid to adversely impacted players.

Dive industry stakeholders were not convinced that in setting out the economic impact of the project on their industry, the proponent had based its assessment on accurate inputs. It considered the industry to be significantly undervalued in the EES reports. It had undertaken its own industry research to support this view.

Finally, owing to the non best practice nature of the proposed technology, the industry did not consider that reasonable efforts had been undertake to minimise direct adverse impacts upon it, or upon the natural environment assets on which it depended.

The proponent's response to these concerns was to make clear that dredge scheduling will enable ongoing dive activities at key dive sites during the summer season. It considers that approximately 50% of existing winter diving activities will still be able to take place. It had committed to the avoidance of impacts on key dive sites due to the direct loss of sea bed. However, it was strongly opposed to the principle of compensation for dive industry entities.

However, dive industry parties responded by making clear their view that the relevant underwater visibility standard in the EMP was insufficient. It would reduce visibility below the margins considered acceptable and safe for existing diving training.

Some level of agreement appeared to be possible around the proponent's proposal to provide 'dive information', highlighting where dredging activities were taking place and what visibility conditions would apply.

Panel Response

The Panel opens by noting its view that the most significant specific problem raised by the dive industry submissions before the Panel has been the lack of a clear dialogue between the proponent and the industry about issues and impacts from the early stages of the project. In other major EES projects, it is normal to establish at an early stage who the key impacted stakeholders are and then to carry out ongoing discussions and briefings such that:

- The proponent and its consultant team remain fully updated on likely effects to that stakeholder group; and
- The stakeholder group remain fully updated on progress in assessing the impact of the project on their interests and measures to limit this.

In this context, the Panel is concerned to note that dialogue between the proponent's consultant team and the dive industry appears to have been limited even though the dive industry were identified from an early stage as a likely key stakeholder group.

The Panel also observes that the research undertaken for the proponent by Sinclair Knight Merz appears to have been conducted somewhat cursorily. Having regard to this work as against the diving industry's own research, the Panel does take the view that the proponent's data understates the value of the industry and hence undervalues the economic and social effects of losses to it.

It is clear to the Panel that, should the project proceed as proposed in the EES, the potential for significant losses to the dive industry has not been sufficiently excluded. Annexure D turbidity plume modelling has yet to be applied in 'proof of concept' modelling. It is not yet possible to assess with clarity the extent of plume effects and hence the degree to which diving could continue through the project implementation phase at a significant level or not.

The remaining issues raised by the diving industry are ones of physical impact, contingent on the chosen means of dredge implementation in the EES. Having regard to the fact that this was not best practice and to the fact that the Panel considers that changes are required, it does not propose to make detailed and individual comments on each instance of suggested impact. As with other contingent issues above, the likely effects of the project on the dive industry cannot be properly assessed until the detailed portfolio of dredge technology is known. It will then be necessary for the proponent to re-engage with the dive industry and seek to apply new controls to minimise adverse effects.

The Panel notes that given the nature of the dive industry, it may not be possible to avoid a significant level of disruption and economic loss, even in a 'best practice' project. Should this be the case, the Panel considers on balance that attention should be paid to means of compensating dive business for specified classes of direct losses on the same basis as suggested for commercial fishers and the abalone industry above.

The dive industry is a small and bounded industry. It appears to the Panel that principles of impact, loss and compensation could be identified quite readily for such an industry and set out in a simple scheme. On acceptable proof of significant loss and causation, a dive industry player could become eligible for an expedited but capped compensatory payment. It appears to the Panel that in the context of the likely cost and proffered community benefit of the project, such a scheme could be funded without too much difficulty.

The Panel does note with approval the proponent's proposal for a 'dive information system' to ensure that dive trips are not lost due to lack of public and diver awareness of ongoing good dive opportunities through the dredge campaign period. However, it would not be prudent to place too much weight on the benefits of such a system until it is clear that its underlying assumption is sound: namely that there will be sufficient low impact or no impact areas in the bay to sustain a viable recreational diving industry.

For these reasons, the Panel recommends as follows:

Efforts are required to inspire confidence in the dive industry that their issues are being effectively considered by the proponent.

A best practice approach to dredging should be pursued, as it will provide significant opportunities to reduce or better control the likely impacts on the dive industry. The detailed impact of the project on the dive industry cannot be assessed until the relevant changes to the means of implementation are known and assessed.

Should impacts entailing significant economic loss to the industry be unavoidable, the proponent and State government should turn their minds to a mechanism whereby compensation is provided for direct loss and damage to dive businesses unavoidably caused by, or due to, the effects of project works.

Means of determining liability and the quantum of compensation should be agreed and formalised before the commencement of the project. The presence of such an agreement or scheme could provide a basis for limiting common law actions against the proponent.

In relation to the proposed dive information system proposed by the proponent as a means of mitigation, the Panel agrees that this could offer benefits and recommends that it should be structured along the lines of the general tourism impact mitigation program recommended further below.

15.2.8 RECREATIONAL BOATING

Discussion

The Panel heard submissions from a number of individuals and entities representing recreational boaters on Port Phillip Bay. Not all of these entities opposed the project, but all had varying levels of concern about it or suggestions as to the opportunities that it might create.

The Royal Yacht Club of Victoria (RYCV) at Williamstown was concerned that they were already exposed to the adverse effects of ships passing through the channels. Wash and wave effects were alleged to have been identified as sources of damage to moored yachts, some in respect of which insurance settlements had been reached. The club was concerned that larger vessels proceeding at or above the channel permitted speed would generate larger wash and wave effects (most specifically Bernoulli Waves), which could further exacerbate damage to yachts at mooring. A paper from Curtin University was introduced to support this contention (see further discussion elsewhere).

The Club had sought advice as to the cost of commissioning its own independent monitoring of wake and wave effects, but had not proceeded with this on the grounds of expense. Further, it took the view that in principle it was for the proponent to design and operate a channel that would not exacerbate the potential for damage to moored craft.

Dr Bob Norlin was an independent yachtsman with a mooring at Williamstown. He supported the project on the basis that lack of flushing and slow rates of water exchange posed health risks to recreational users of bay waters. He shared the RYCV's concern about the potential for wave and wake damage to moored craft, but saw the project as providing a significant opportunity to impound much of Greenwich Bay at Williamstown to create a very substantial marina and safe harbour facility.

Beaumaris Motor Yacht Squadron and Sail Sorrento also had views as to the beneficial use of dredged material to establish artificial islands as safe harbours or yachting destinations in the Bay. Sail Sorrento had formed an alliance with urban design and real estate interests to examine the feasibility of such an approach, although stressing its in principle position that it was opposed to the project and that island creation represented in its view a secondary or alternative position, only to be explored if the project went ahead.

It should be noted that a number of third party submitters were of the view that proposals such as that of Dr Norlin or in relation to the creation of islands as part of the dredged material disposal strategy had not been canvassed as 'live' options in the exhibited EES. Nor had they been the subject of detailed investigations, necessary to determine whether they should be supported. It followed that they took the view that the Panel should not recommend that proposals proceed in specific terms.

Panel Response

In relation to the concerns of the RYCV at Williamstown, the Panel thanks the club for its efforts in seeking data from Curtin University, but notes that the material presented, whilst expert in nature, was not subject to cross examination and cannot be highly weighted. That being said, having perused the EES and proponent evidence with considerable care, the Panel cannot find a detailed examination of the proposition put that boats at existing moorings may be subject to adverse effects from wake and wave effects generated by shipping in the channel. The Panel considers that the potential implications of this issue in relation to larger vessels requires study by the proponent. If significant effects are likely, works to remediate those effects at the proponent's cost would be justified.

In Chapter 8 of this report, the Panel has already recommended a study to address issues arising from ship generated waves. This study should assure the proponent that moored small craft at existing wharfage and marina areas in Williamstown will not experience additional levels of damage due to motion arising from larger vessels using the channel or changes to vessel speed limits. Should the study determine that moored small craft would be at additional risk, consideration should then be given potential wave attenuation strategies, sufficient to restore water conditions at Williamstown to their current state.

It should also be noted that the cost that the proponent can reasonably be expected to bear amounts to the cost of the restoration of existing wave conditions within the existing wharfage and marina. The Panel notes that potential wave attenuation structures provided by the proponent might also be capable to provide additional moorings, or might facilitate expansion of the existing wharfage and marina. However, the proponent should not be required to contribute any cost over and above the minimum necessary to assure restoration of existing wave conditions. Maximisation of the public benefit from such a structure (for example through dual use) may in turn require capital contributions from the Club or other interested parties.

In relation to the detailed submission of Dr Norlin, his support for the project is noted. Whilst proposals for wave protection of the existing marina area at Williamstown may have merit (see above), broader and apparently opportunistic proposals for the impoundment of Greenwich Bay to create a 'greater marina' appear to have little nexus with the project. Further, as they could interfere with the operation of the cooling water channel from Newport Power Station, they would appear likely to generate unlooked for adverse environmental effects, consequent on the inability of large volumes of heated water to undergo their intended mixing and dispersal. Consistent with its treatment of other specific proposals brought to its table without the benefit of a detailed environmental assessment, the Panel declines to recommend on Dr Norlin's proposals.

Turning to the proposals by Sail Sorrento and the Beaumaris Motor Yacht Squadron, the Panel considers that similar principles apply. It has considered generic submissions on waste hierarchy and the beneficial use of dredged materials above. It has concluded there that additional efforts to make beneficial uses of clean dredged material should be investigated. As part of such a process, it does not completely rule out land reclamation or island construction as an option. However, nor is it prepared to endorse or recommend specific reclamation processes, until a detailed environmental assessment of the effects of such proposals has already taken place.

15.2.9 BEACH & BAY TOURISM & RECREATION

Discussion

In addition to the specific individual and classes of beneficial uses identified above, the Panel has also turned its mind to the general interests of bay users engaged in beach and bay tourism and recreation.

Specific submissions were received from entities providing ecological tours reliant on the marine environment, (for example Polperro Dolphin Swims Pty Ltd), from business and residents engaged in tourism related undertakings and from the Mornington Peninsula Shire Council, concerned at the potential effects of loss of tourism income on its local economy and employment. The Shire highlighted the significance of tourism to its local economy and its relative remoteness (in metropolitan terms) from alternative employment and public transport options. Highlighting that tourism is a key employer of people in lower socio-economic bands, the Shire was concerned that fluctuations in the tourist economy would occasion significant hardship.

Concerns raised included the immediate and aesthetic, for example, that Bay waters would be subject to turbid plumes that would deter those seeking recreation and enjoyment in and on the water. These again translated into concerns as to economic impacts on these industries, should currently expected levels of visitation and expenditure decline. Again, as with the diving industry, the key concern was for the duration for which tourism market segments could absorb a downturn, before significant adverse economic effects were caused due to the loss of tourism infrastructure and employment opportunities. Concerns as to the effects on liquidity of the largely small businesses active in this sector were also raised.

The response of the proponent to these issues was to highlight that prudent scheduling measures would be taken to safeguard tourism in the key summer season and peak public holidays in the south of the Bay. The dredge schedule advanced to the Panel proposed to avoid the period between mid December and Easter, the Queen's Birthday and the Melbourne Cup.

Mr Cotterill for the proponent also highlighted the virtue of effective communications between the project and the public. Methods such as a web site, leaflets, press releases and local radio reports ought in his view be used to ensure that potential visitors do not obtain an unduly gloomy perspective of the prospects for their beach trip. In such ways, visits could be 'targeted' to less or unimpacted areas in a manner that was closely attuned to progress on dredging campaigns. It was his opinion that if this was undertaken the overall net effect on the quality of the visitor experience and regional tourism income would be small.

The proponent also stated that the effects of the capital dredge campaign would be transitory. Beyond the anticipated two winters of works, local tourism in the Peninsulas could be expected to have no ongoing adverse effects, other than in programmed maintenance dredge campaigns. They were of the view that the impact of these in local terms would be no different to that of existing maintenance dredge campaigns. The proponent noted that no hard economic analysis had been produced demonstrating a significant rise in visitor complaints or an adverse economic effect on tourism emerging from previous maintenance dredging. Other parties took the view that this was more a product of the fact that possible economic effects had not been monitored in previous campaigns and, most particularly, that there had been no clear and transparent means of registering complaints about visitor experiences adversely impacted by dredging.

In terms of physical effects, Dr Provis for the proponent was of the view that the movement of turbid plumes into inshore shallow waters would be relatively unlikely, as for such movement to take place, the turbid water body would have to displace water already present. However, it must again be noted that the lack of turbidity modelling extending to the duration of a dredge campaign and tested against a range of metocean scenarios, made it difficult for many submitters to accept such a position.

Panel Response

The Panel commences by noting the in principle significance of beach and Bay tourism and recreation to those living and working around Port Phillip Bay. Melbourne has a 'beach culture'. Residents of bayside suburbs use their foreshores extensively, particularly in the summer months. Residents of non-bayside suburbs enjoy their weekend trips to the beach. Melbourne residents more generally also enjoy the combination of small town, rural and beach environments provided close at hand by the Mornington and Bellarine Peninsulas.

As analysis of generic expenditure and employment statistics demonstrates, even relatively limited levels of tourist visitation do contribute significant volumes of expenditure and generate significant expenditure in regional economies such as those of the Peninsulas. Whilst the economic effects of this visitation and expenditure can be significant, it is also appropriate to note that (in comparison with other sectors of the economy), the benefits can be somewhat fragile and fickle, for the following reasons:

- Tourism to regions such as the Peninsulas relies on large numbers of short duration visits. They are destinations of immediate opportunity and choice. They are dependent to a high degree on the perceptions of the prospective visitor that they will provide an attractive environment for a visit. They are also subject to strong place competition, in that if perceptions emerge that they are no longer attractive, or are of reduced attractiveness, some prospective visits can be lost to other nearby regions with different but also high quality tourism offers.

- Tourism visitation is in any case seasonal and is also subject to fluctuation due (for example) to weather events.
- Tourism expenditure translates into business incomes that are variable.
- Tourism employment opportunities tend as a result to be casual and poorly paid.
- A compounding of adverse visitor experienced with reduced visitor perceptions of the quality of a tourist area could result in significant reductions in tourism income and consequent loss of employment. Should this occur, immediate alternative employment will be harder to come by in the Peninsulas than in other parts of metropolitan Melbourne.

These issues do underscore the concerns of the Mornington Peninsula Shire Council. The Panel has also noted above in its economic analysis, the concern that a direct statement of annualised tourism yield has not been calculated and tested against impact assumptions due to the project. That being said, the Panel does not consider that they are in principle insoluble. It also considers that regard must be had to the temporary nature of ongoing impacts and that, in relation to general tourism (as opposed to specific activities such as fishing and diving considered above), direct adverse effects generating reasons for non visitation can be expected to cease when works cease.

In the mind of the Panel, the keys to proper management of this issue lie in:

- dredge scheduling, where all attempts compatible with sound ecological management should be taken to maintain summer and peak holiday windows in the south of Bay dredge campaigns;
- transparent attitudinal research and complaints monitoring, to provide the proponent with a clear understanding of the drivers of visitors decisions about prospective visits to the bay coast; and
- active communications and promotion, to ensure that all reasonable opportunities to sustain high quality regional tourism offers through dredge campaigns are taken

The approach to dredge scheduling is in the Panel's view clear and is discussed in more detail in relation to ecological matters elsewhere. Some remarks are necessary in relation to attitudinal research, complaints monitoring, communications and promotion. In the Panel's view, each of these will form a necessary part of a tourism impact mitigation strategy to be delivered by the proponent.

In terms of attitudinal research, it will be necessary to understand the drivers that assist beach and Peninsula visitors to select their destinations and to understand the quality of experience that they expect once there. This will enable some correlation of dredge impact against key elements of visitor experience to be made. It will also enable 'alternative tourism offers' to be tested, with a view to discovering whether a combination of different destinations and experiences could maintain a visit that might otherwise be lost. This will be a key input into the mitigation strategy.

In terms of monitoring, it will be critical to establish and publicise a responsive 'complaints' system. This will ensure that, once works are underway, the project team always has up to date information about:

- effects that the project might be having on tourism businesses; and
- effects that the project might be having on visit quality.

Such data will provide early warning of the possibility that adverse effects are of a more than planned significance or duration. Operational procedures would have to provide for the potential to amend the dredging activity or dredge schedule to control avoidable third party economic harm. The system must be well publicised. The Panel noted with concern and supports the view that the lack of complaint and impact data for previous dredge campaigns is largely a product of the fact that people did not know to whom such complaints should be put. They had the perception that there would be 'no point' in complaining as complaints would not be effective in changing project delivery. In this case, an adaptive management framework is proposed. One key benefit of such a framework is the capacity to change project delivery to mitigate unpredicted adverse impacts. A well publicised and effective complaints system will enable this to occur.

However, there is little point in receiving and analysing complaints and adapting the dredge schedule accordingly, if the benefits of such efforts are not well communicated to the public. For this reason, the Panel strongly supports the following measures:

- The PoMC website or a dedicated project portal should carry a detailed breakdown of the anticipated impacts of the project on general tourism quality experience by visitor location. This should contain long range data (about complete dredge campaigns and the anticipated location and movement of works) and short range data, compiling metocean forecasts with plume modelling to forecast water quality effects for the immediately coming days. The reporting should not be exclusively technical. For example, accessible measures should be developed to describe the likely visible effect of turbidity.
- Opportunities should be taken to integrate bay dredge forecast data into mainstream media offers, for example:
  - Weather, air quality, surf and snow data provided in the Age and the Herald Sun;
  - Weather watch reports on local radio; and
  - Meteorology columns in local newspapers.

The Panel also considers that proactive and promotional economic mitigation measures should be pursued to target visitation to least impacted locations and promote a diversification of visitor experience. The aim would be to sustain or even enhance regional tourism visitation overall. Although noting that individual tourism offers in directly impacted locations would still experience adverse effects, a net adverse economic effect on tourism as a sector could potentially be eliminated. Actions could include:

- Promoting unimpacted locations. For example, if significant turbidity was to be expected offshore Mount Martha for a three week period, promotions for that period might focus on Portsea or the Westernport side of the Peninsula. The aim would be to sustain net visitation, albeit recognising that some individual locations will experience short term declines.
- Promoting diversified offers. For example, campaigns to promote the unaffected offers of the Mornington or Bellarine peninsulas might focus on walking, cycling, golf, horse riding, winery visits, farmers markets and produce sales, antiques and bric a brac, heritage towns, steam railway visits, arts and cultural attractions… The aim would be to sustain and develop net visitation, encouraging visitors to move beyond the foreshore and make more active use of the hinterlands. (It should be noted that such campaigns could have an ongoing benefit in terms of setting the regional tourist industry onto a more secure and diversified footing).
- Promoting the 'all clear' and holding 're-launches'. For example, once works in the dredge schedule are likely to leave a location free of further impact, significant efforts should be made to promote visitation to that location. When a dredge campaign is

concluded, a wider regional ‘re-launch’ would also be justified, emphasising that the entire coast is open for business.

In undertaking this analysis, the Panel has not provided much focus on individual economic loss: it has tended to focus on aggregate effects. It has done this because it takes the view that there is normally a public policy that direct and individual compensation is not provided for the indirect effects of public works (a position distinct from that of say the dive industry or Newport Power Station which are likely to experience direct effects). Much of the general tourism economy does not have the immediate link to particular areas of the Bay waters or environmental values that are key to the dive industry. It therefore follows that whilst losses to individual businesses might be experienced, direct causation from the project will be very difficult to establish with precision. The Panel considers that the best, fairest and most efficient approach in such circumstances will be to take mitigation action in the affected region, as opposed to compensating individual businesses.

In this section of the work the only exception to this principle in the Panel’s mind appears to flow from ecotourism businesses that conduct bay swims. These businesses are in the Panel’s mind directly analogous to dive industry business and should be treated in the same fashion.

The Panel makes the following recommendation:

A clear tourism, recreational diving and fishing mitigation strategy for the Bay should be prepared. Key elements of this strategy will include:

- Dredge scheduling to minimise economic impacts on tourism, insofar as this is compatible with the minimisation of ecological impacts;
- Attitudinal research and complaints monitoring to discover people’s motivations for and expectations of Bay visits and to provide a means of immediate response if unplanned adverse tourism effects are noted;
- Provision of widely disseminated data on project effects to support decision making by those planning visits. Web and traditional media outlets should be used;
- Active promotion of the tourism offers of affected regions, focussing on the promotion of alternative beach locations, the promotion of diversified hinterland activities and promotion of the ‘all clear’, with ‘re-launches’ held as dredging effects diminish;
- In relation to recreational fishing, open water and beaches not impacted by plumes should be publicised; and
- In relation to diving, a horizontal visibility figure for key locations should be published and regularly updated.

15.3 NON-ABORIGINAL CULTURAL & HERITAGE EFFECTS

Discussion

Non-Aboriginal heritage investigations were conducted by Terra Culture Pty Ltd. The aim of the investigations was to advise the Port of Melbourne on the condition of non-Aboriginal heritage items and places around and within Port Phillip that may be affected by the project and the consequences of any impact on them.

Non-Aboriginal heritage in Victoria is protected primarily under the *Heritage Act 1995,* which is administered by Heritage Victoria. A range of other legislation in the Commonwealth and State domain may also have implications for heritage protection and these are listed in Section 6 of the Existing Conditions Report for Non-Aboriginal Heritage in Volume 4(A) of the EES.

The methodology for the investigations is outlined in Section 1 of the Existing Conditions Report and combined a desktop review of known sites and legislation with supplementary field verification in some areas. Consultation was also undertaken with Heritage Victoria (which sits under the umbrella of the Department of Sustainability and Environment), the National Trust, the Maritime Archaeology Association of Victoria, the Minesweepers Association and 11 historical societies.

Within the project study area (shown in Figure 23.1 of the EES Main report) 76 maritime heritage sites are identified with 88% of these being shipwrecks. The wreck of the *Goorangai* in the west of the South Channel is of national significance, with most of the remainder being of State significance and two of local significance. However all are protected under legislation. For many of the wrecks only an approximate location is known.

Terra Culture identified the following issues related to dredging in their impact assessment for maritime non-Aboriginal heritage (from the summary in Section 4.2 (a) (2) of the Expert Witness Statement of Sarah Myers from Terra Culture):

- risk to unknown sites from dredging;
- impacts on the degaussing range in the mouth of the Yarra River;
- residual risk to the *Goorangai* from vessel grounding;
- the impact on remnant piles and the artefact scatter at the South Channel Pile Light site;
- risk to the Hobsons Bay Anchorage from subsidence related to channel deepening; and
- oil spill risk.

The proponent has altered the dredging works to avoid or reduce impacts on the *Goorangai* and the *Elizabeth Ramsden*.

Terra Culture have made a number of management recommendations related to their findings for sites assessed as being of high and extreme risk of impact which can be found in Section 4.4 of the Expert Witness Statement of Sarah Myers. In summary they are that:

- side scan sonar survey be undertaken of areas not previously dredged to record any new sites;
- a protocol be developed to report any new structures discovered during dredging and reported to Heritage Victoria for assessment;
- a protocol be developed for responding to items and/or sites discovered during dredging and in particular “stone fishing”;
- an archaeological survey of the degaussing range should be undertaken;
- an isolated danger mark should be placed over the *Goorangai* wreck to ensure the dredge operation can avoid it;
- an archaeological survey to record the South Channel Pile Light remains should be undertaken;
- an archaeological survey of the Hobsons Bay anchorage (specifically any parts at risk from subsidence) should be undertaken;

- a response protocol for oil spills to protect maritime and coastal sites should be developed, together with broad area surveys to identify any new sites, particularly along the southern and eastern shorelines of Port Phillip;
- archaeological surveys of Mud and Swan Islands should be undertaken to address gaps in the dataset – due to the fact that site visits to these locations by the consultants were not undertaken.

There are 174 coastal heritage sites within the project study area primarily related to piers and infrastructure. Based on the hydrodynamic investigations carried out by Dr David Provis of Lawson and Treloar, Terra Culture concluded that there will be no impact on coastal heritage from changes to coastal processes from the Project. Separately they concluded that there will be an increased risk to coastal heritage sites from oils spills during dredging.

In addition to the results of the Terra Culture investigation, the proponent have advised they have been approached by Heritage Victoria (Part A Submission, Section 14.7) to determine if additional material could be placed on the significant shipwreck the City of Launceston to aid its preservation.

The Project Environmental Management Plan (EMP) Version A makes a number of references to Heritage including in Appendix C, the Risk Assessment and Appendix D (Operational Control Procedure for Heritage (CDP OP446.4165.1A) and the Operational Control Procedure for Oil and Chemical Spills (CDP OP446.4156.1A).

Panel Response

One of the issues of interest to the Panel is that of “unknown” sites of archaeological interest, particularly in areas of proposed dredging that have not been dredged before or where channel wall slumping may uncover new sites.

The multi-beam sonar survey undertaken by the proponent has the potential to be useful to heritage experts in identifying any new sites on the surface of the existing channels. However, having observed the technical capabilities of the proponent’s system during its site visits, the Panel understands that it provides only surface detail and will give no insight into the potential for buried artefacts or sites that may be disturbed by dredging. To the extent that Heritage Victoria and Terra Culture have proceeded on the basis that this technique will disclose sub-surface significance, some re-consideration is warranted. The Panel notes the regional procedure M2 in Table 4.4 of the EMP Version A proposes a multi-beam sonar survey. The Panel’s comments earlier in this section on the efficacy of this technology for assessing buried artefacts should be noted.

Terra Culture has recommended that a protocol be developed to alert Heritage Victoria to new sites uncovered during dredging for assessment. The proponent has responded in Annexure F2 that they believe this is not feasible due to the scale of the operation of the dredger proposed and the rate at which material is drawn through the intake pumps and deposited in the hopper.

The Panel is not clear how large pieces of structural timber or iron from a shipwreck would be before they would affect the operation of the dredging plant or be noticed by the operators. However, it tends to the view that unless new sites include very substantial artefacts, there are likely to be few feasible opportunities to prevent their complete destruction by dredging works and entrainment in dredged sediment.

The Panel believes there should be further discussion between the proponent, Heritage Victoria and a dredging expert to determine the feasibility and necessity of "live" monitoring during dredging. Regular multi-beam surveys will be undertaken during dredging to determine channel progress and it may be possible to have Heritage Victoria staff review images from these runs to determine the ongoing feasibility of a developing a project monitoring programme.

The Panel is not convinced that potential maritime heritage impacts in the north of Port Phillip have been adequately identified and the impacts assessed. The Panel therefore concurs with the view of Terra Culture that the degaussing range in the Yarra River mouth and those parts of the Hobsons Bay anchorage potentially affected by the slumping of channel walls post dredging should be further investigated. As multi-beam sonar was a proposed technique, the Panel's comments above again require to be noted.

Whilst land side development in the Yarra River is outside the Terms of Reference for the Panel, there are a number of dredging based activities that will impact on the Yarra River banks including berth upgrading related to dredging and the expansion of the Swanson Dock turning basin. There is also expected to be some degree of slumping of channel walls post dredging along the Yarra Channel.

In their letter dated 3 November 2004 to Freehills, Terra Culture stated that if there are to be impacts on the Yarra Banks, then further study is required, particularly in relation to the Heritage Victoria Maritime Infrastructure Assessment Project which is in progress. The Panel concurs with this view.

The Panel recommends:

Prior to project approval the proponent should reach agreement with Heritage Victoria on the range of further investigations to be carried out and resulting protective measures that are to be implemented during and following dredging. This agreement should include (but not be limited to) the following areas:

- Remnant Yarra River banks and bed historic items/places
- The degaussing range and Hobsons Bay anchorage

Finally, as a technical note in relation to environmental impact assessment under the EPBC Act, the Panel notes the view that the Commonwealth Land trigger under that legislation requires a holistic assessment of environmental effects to include consideration of heritage effects.

The Panel notes that the following potentially relevant places are on the Register of the National Estate:

- Swan Island Defence Precinct, Queenscliff.
- Swan Island and Naval Waters, Queenscliff.
- Point Nepean Commonwealth Area, Portsea.

The Panel considers these areas to be potentially relevant as they contain marine, intertidal and foreshore areas that may be germane to the basis for their registration. Having examined the Terraculture reports with some care and questioned the consultant in the hearing, it does note that there appears not to have been a site visit undertaken to Swan Island. Further, there is little discussion of Point Nepean. It therefore appears that there is insufficient basis for a Commonwealth level assessment of non-aboriginal heritage effects at this time. The same considerations hold good in respect of Aboriginal heritage in these places.

The Panel recommends:

Site visits by the project heritage consultants to relevant Commonwealth Places must take place and the results must be documented, before the assessment of this project under the EPBC Act.

15.4 ABORIGINAL CULTURAL & HERITAGE EFFECTS

Discussion

Specialist heritage consultants Terra Culture Pty Ltd and Heritage Insight undertook the investigation into Aboriginal cultural heritage to determine if the project would impact on terrestrial and submerged archaeological sites and places.

The investigation included:

- a desktop assessment of known sites in Port Phillip;
- consideration of the potential for submerged sites on along proposed channel deepening route;
- an attempted consultation with all indigenous community stakeholders;
- an archaeological field survey of terrestrial indigenous sites;
- identification of relevant heritage protection legislation;
- assessment of the potential impact on indigenous archaeological sites and places; and
- recommended mitigating actions to protect such sites.

The results of the assessment show that there are 574 recorded terrestrial sites registered with Aboriginal Affairs Victoria within 300m of the Port Phillip coast, and 74% of these are within 25m of the coast. There are some areas that have had relatively little survey work carried out and thus the actual number of sites will almost certainly be higher than this. The coastal sites are generally in poor condition and vulnerable to new sources of disturbance with erosion (coastal, terrestrial or both) being a major threat.

No known Aboriginal sites or relics occur in the submerged areas proposed for dredging. However, geological evidence suggests that the floor of Port Phillip was originally a river valley (for the Yarra and tributaries) during the pre-European period of Aboriginal habitation. Thus there is potential for submerged Aboriginal sites and relics underlying parts of the Bay. Heritage Insight has concluded that it cannot be established with any certainty that sites do or do not exist under the shipping channel. The most likely area of possible sites is considered to be an area of calcarenite in The Rip (Nepean Bank).

Aboriginal archaeological sites are protected under the Commonwealth *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* and the Victorian *Archaeological and Aboriginal Relics Preservation Act 1972*.

Consent is required under the Commonwealth legislation to damage an Aboriginal place or object. In Port Phillip the power to issue this consent is held by two Indigenous community groups being the Wathaurong Aboriginal Cooperative and the Wurundjeri Tribe Land Compensation and Cultural Heritage Council Inc. The Victorian Minister for Aboriginal Affairs holds the power for an area of the project generally covering the south east of the Bay and the Mornington Peninsula. The exact descriptions of the areas are provided in Section 14.9 of the PoMC Part A Submission.

A summary of Indigenous community consultation was provided by David Rhodes of Heritage Insight in Section 6 of the Aboriginal Heritage Existing Conditions Report and repeated with additional consultation added in Annexure IP1.1 to the Port of Melbourne Corporation's (PoMC) response to the Panel's Issues Paper 2.

The consultation occurred over the period from March 2003 to September 2004 and the following groups were involved at different times:

- Wathaurong Aboriginal Co-operative;
- Wathaurong Aboriginal Corporation;
- Bunurong Land Council Aboriginal Corporation;
- Victorian Boonerwrung Elders Land Council Aboriginal Corporation; and
- The Wurundjeri Tribe Land Compensation and Cultural Heritage Council Incorporated.

A number of issues were raised during these meetings by Indigenous interest groups and these are summarised in Table 15 of the Aboriginal Heritage Existing Conditions Report in the EES. Concerns appear to have been raised about:

- impacts on marine and terrestrial natural environment;
- impacts on Swan Bay and Mud Islands;
- increased erosion of coastal Archaeological sites due to bow waves and increased storm surge that may occur with the project and global sea level rise;
- impacts from oil spills;
- containment of silt and spoil grounds; and
- impact on submerged sites.

As discussed elsewhere the proponent advised via its Response to Issues Paper 2 issued by the Panel that the EES documentation for exhibition was not forwarded to the majority of Indigenous community groups until the 12 August 2004 and for one of them until the 16 August 2004. The formal exhibition period for the EES ran from 5 July 2004 until 16 August 2004. David Rhodes has stated in Annexure IP1.1 that this occurred despite his instructions to PoMC and Parsons Brinkerhoff to release the EES documents to the Aboriginal groups at an earlier date.

This situation is likely to have contributed to the limited engagement of Aboriginal communities in the Panel process (although the Panel also acknowledges that Panel processes themselves are not necessarily viewed as 'user friendly' or culturally appropriate modes of engagement with Aboriginal communities).

Based on the findings of Dr David Provis in the hydrodynamics study, Heritage Insight concludes that there will be no changes to terrestrial archaeological sites as a result of the project from sea level rise, wave action, waves from larger vessels or coastal erosion. Residual concerns remain regarding oil spill response and the protection of coastal archaeological sites.

Monitoring of the dredging project to determine if any submerged sites have been impacted on will be necessary and unless further geological testing is done in The Rip it may be impossible to identify or protect any sites that may occur there.

Dr Rhodes from Heritage Insight makes a number of management recommendations in Section 4.1 (d) of his Expert Witness Statement, which can be summarised as requiring:

- further consultation with Indigenous communities regarding impacts and monitoring;

- additional archaeological surveys around Mud Islands and Swan Island to identify any low lying sites at risk; and
- development of protocols for the involvement of Indigenous communities in oil spill response and recovery during dredging operations (in addition to those that already exist).

Panel Response

The conclusion that there will be no change in impact to terrestrial archaeological sites is intrinsically tied to the hydrodynamic studies of Dr Provis. The hydrodynamic study and the Panel's views on its appropriateness and conclusions can be found above.

Whilst the Panel concurs that the likely hydrodynamic effects of the Project are likely to be limited, it believes the risk of impact to coastal heritage sites is such that monitoring of selected sensitive sites would be prudent prior to, during and after dredging.

Many of the identified terrestrial sites are coastal and thus particularly vulnerable to oil spills. Planning for oil spill response should ensure the effective implementation of existing protocols with Indigenous communities and Aboriginal heritage experts and to ensure that sites have been identified for protection.

The issue of submerged Aboriginal archaeological sites is somewhat problematic. In summary it is very difficult to determine prior to dredging if any sites exist, but if they do exist they will undoubtedly be destroyed in the dredging process and given the scale of equipment proposed, it is unlikely their presence will be even noted.

The Panel notes that geological cores have been taken in The Rip to provide a clearer understanding of The Rip geology and thus develop a technology suitable for removing the calcarenite material there. In his evidence Dr Rhodes stated he was not aware of these cores and certainly had not sighted them. If these cores are still held, it may be instructive in the first instance for Dr Rhodes to liaise with the geology consultants to view and pass comment on them.

Beyond this, without an intensive drilling programme in areas to be dredged (which is in itself a disturbance), the Panel does not believe it is feasible to further investigate the potential for submerged archaeological sites. This does not of course remove the legal protection of any sites that exist and the proponent would be advised to seek advice on whether it is necessary to seek approval to disturb unknown or potential sites from the relevant responsible communities.

Through its specialist consultants the Panel believes the proponent has made reasonable attempts to consult with Indigenous communities potentially affected by the Project. These were however considerably let down by the failure to circulate the EES documentation to the interested parties until the final days of the exhibition period.

Whilst the proponent has identified the development a communication strategy which will include Indigenous communities, the Panel believes further targeted communication is essential to identify and respond to concerns regarding the Project. It is relevant to ensure that such consultation takes place before project approval.

The Panel is also acutely aware of the limitations of traditional exhibition processes and panel hearings in eliciting engagement by and representation of Indigenous communities. The Panel itself desired to hear directly from the relevant communities as to their thoughts about and senses of the impact of the Project, but this was not possible in the timeframe of the hearings. The Panel's eventual decision not to proceed with such inquiries was taken, having regard to the fact the issues of the adequacy of Aboriginal community involvement were not the only issues that would require to be addressed pursuant to its recommendations. It therefore considered that there should be sufficient time for a meaningful engagement of Aboriginal groups around the impacts of the project after the submission of this report but before project approval.

The Panel noted issues above in respect of the lack of documented site visits and appraisals of non-indigenous heritage values on Commonwealth Places. Without reiteration, the same concerns existing in relation to indigenous heritage values.

The Panel recommends:

Prior to project approval, further consultation with Indigenous communities should be undertaken to determine key inputs and opportunities for involvement.

Site investigations and documentation of potential Aboriginal heritage interest on Commonwealth Lands should occur before EPBC Act assessment takes place.

15.5 NATIVE TITLE ISSUES

Discussion

Specialist heritage consultants Terra Culture Pty Ltd and Heritage Insight coordinated the investigation into Native Title, which may arise under the Commonwealth *Native Title Act 1993*. A search of the register of Native Title Claims at the National Native Title Tribunal indicates there are no current claims over Port Phillip or its coastline that would affect the project.

There are three groups representing Native Title interests in the region being the Bunurong Land Council Aboriginal Corporation, the Victorian Boonerwrung Aboriginal Elders Association and the Wathaurong Aboriginal Corporation.

Whilst there are currently no claims for Native Title registered, the Port of Melbourne Corporation (PoMC) acknowledges in Section 14.11 of their Part A submission that the project will occur on unalienated Crown land, and thus will be subject to the provisions of the *Native Title Act 1993.*

The proponent sought advice from the Victorian Government in July 2004 on the issue of Native Title and the response from the Department of Sustainability and Environment (DSE) contained the following key points:

- dredging prior to the introduction of the *Native Title Act 1993* may have extinguished Native Title in some areas;
- extinguishment of Native Title in all areas proposed for dredging is unlikely and therefore the *future act* requirement of the *Native Title Act 1993* will apply;
- the Project would likely be a *valid future act* under section 24KA of the *Native Title Act 1993*, being facilities for services to the public and the non-extinguishment principle would apply;
- Native Title holders would have the same procedural rights as the holders of ordinary title but there are no procedural rights in this case for ordinary title holders and thus none for Native Title holders; and

- thus no statutory obligations appear to exist under the *Native Title Act 1993* in relation to the Channel Deepening Project but "good faith" consultation may still be appropriate.

The proponent has indicated that whilst it accords with this assessment, it has invited those with Native Title interests to project meetings and further informal consultation will be sought.

No written submissions from Native Title interest groups were received during the EES exhibition. As described in the previous section there were some difficulties with distribution of the exhibited material and thus the ability of interest groups to provide a formal response may have been limited.

Panel Response

Whilst the Panel is not in a position to comment on the legal position of the Project and PoMC in relation to Native Title, it believes there is a level of uncertainty surrounding the issue that should be further resolved prior to Project commencement.

Native Title is a complex area with some history in Port Phillip, which requires further definition for the Project; to both minimise risks to the Project and ensure that Native Title interests are adequately and fairly engaged.

Whilst the proponent have indicated the intent to seek ongoing "good faith" consultation with Native Title interest groups, it is not clear when and how this will occur or what outcomes will be sought. The Draft Environmental Management Plan (EMP) Version A mentions ongoing communication with Aboriginal groups (Sections 7.1 and 7.1.4) but again is not specific.

Given the scale of the Project and its importance to the State, the Panel believes it would be prudent for the proponent to reach a concluded, agreed position with Native Title interests groups, prior to project implementation.

It is not apparent from the proponent's case whether advice was sought from the National Native Title Tribunal in addition to the register search for Native Title claims and in addition to the advice from the Department of Sustainability and Environment. The Panel recommends:

Prior to project approval the proponent should undertake further consultation with the National Native Title Tribunal and Native Title interest groups with a view to reaching a resolved position on Native Title issues.

15.6 SERVICE AND INFRASTRUCTURE EFFECTS

Discussion

The reader of this section of the report needs to be mindful that the Panel's Terms of Reference specifically exclude it from consideration of the environmental impacts arising from the relocation of infrastructure services crossing the lower Yarra. The Panel notes that the proponent referred these works separately under the EPBC Act (Referral 2003/1298) and that these works mainly include relocation of the:

- Hobsons Bay (Yarra) sewer;
- WAG oil transmission pipeline;
- Telstra communications cable; and
- CitiPower electrical cable.

The Commonwealth determined that the works, as described, are not controlled under the EPBC Act.

The panel heard during the hearings that the proponent now no longer appears to be proposing to relocate the sewer.

Attention is now turned to matters that are within the Panel's Terms of Reference. The EES contains a limited survey of services and infrastructure in the bay. This was principally done in the Coastal Engineering Report, which deals mainly with the project impacts on infrastructure non-port related public wharves, ramps, drains and seawalls. The findings of this study were largely not remarkable, as a result of the relatively small hydrodynamic changes.

> *Other than clogging of water intake structures for the Newport Power Station, there are no identified potential impacts of the Project on coastal processes and coastal infrastructure in the Bay. Consequently, no detailed management strategies to protect coastal engineering assets around the Bay are required.* [187]

Panel Response

Whilst noting that relocation of the Yarra sewer is beyond its Terms of Reference, the Panel also notes that it is now proposed that this remain in situ. If this is the case, then the potential impacts associated with leaving the sewer in place have not been assessed as part of this EES, in particular, whether there is any additional risk of sewerage spills in the Yarra and other spills or incidents related to groundings. No information has been provided in the EES or to the panel about protection works to the sewer nor the operational impacts resulting from the reduced channel depth in this location. Issues are also raised in relation to the resultant declared depth of adjacent sections of the Yarra channel, which is now unclear.

Turning to coastal infrastructure, it is noted that there is significantly more coastal infrastructure than the Coastal Engineering Report identified. The Panel is more concerned about the unassessed impacts from works proposed in relation to services, structures and infrastructure not noted in the Coastal Engineering report rather than those that are noted. These include:

- the ethane pipeline which crosses the channel near Fawkner Beacon. Very little information was presented about potential works required to deepen it or protect it.
- non commercial structures in the port area between Beacon 16 and the Bolte Bridge including the Swanson Turning Basin, South Wharf, 31,32 & 33, Yarraville 6, lengths of embankments, Newport Power Station and the Westgate Bridge. Maunsell Australia presented information at the hearings in respect to these structures but very little about the required works.
- operational wharves of the port for which no information was presented about the impacts despite requests to the proponent for data.
- potential interruptions to ferry services.

These works were not assessed by the EES consultant team, nor are they proposed to be undertaken by the Alliance. They involve a substantial quantum of work and will generate a significantly different range of impacts to those generated by dredging (eg pile driving noise).

[187] EES Volume 1 at Pg 32-4

The proponent should identify all services, structures and infrastructure that may be affected by the project. It should fully describe works related to, or that could impact on, these services, structures and infrastructure and ensure that further impact assessment is undertaken as part of the EES. This include impacts on/works to structures including:

- non commercial structures in the Port;
- operational wharves in the Port;
- the ethane pipeline; or
- the West Gate Bridge.

In contrast to the proposed contracting strategy for the dredging, the panel was told that the works on the non-commercial structures is proposed to be undertaken as a 'design and construct' contract.

The Maunsell study determined that the works are not likely to affect the structural integrity of the cooling water and stormwater outlet structure and outlet channel rockwalls. Ecogen Energy however remain to be convinced: the Panel recommends that action be taken similar to that often used during the construction of road infrastructure:

The proponent should commission a full 'before' survey of all third party infrastructure that has some reasonable potential of impact. This includes the inlet and outlet structures associated with Newport Power Station. The survey should include photographic records and survey at an appropriate level of accuracy. Monitoring for movement shall be undertaken at least annually for at least five years following the completion of dredging, including maintenance dredging. A mechanism for agreeing repair costs should be available.

The Maunsell study also indicated that in respect to Westgate Bridge

> *..that the asset owner is advised of the assessment; that they commission detailed analysis by the original designer to confirm that the structure remains stable under all load cases; and that dredging be performed by fine tolerance equipment to minimise any risks.* [188]

The proponent should be responsible for any costs, including management costs, incurred by Vic Roads as a result of any structural assessment of the Westgate Bridge required as a result of the Channel Deepening project.

15.7 SUMMARY

This section has addressed a number of matters where the project is likely to have an impact on the ‘human’ aspects of life. It can be seen that additional work remains to be done in respect to many of these, particularly those relating to ensuring that the economics of the project are robust.

As stated previously there are a number of other issues related to human effects that have not been discussed in this report as they are not of a foundation stone nature and can in principle be managed through the implementation of existing management techniques and regulatory frameworks.

[188] Maunsell 2004 at Pg 51

16. CAPITAL WORKS DELIVERY

This section addresses the following issues that are relevant to the Minister for Planning's decision:

- General issues of project governance.
- Alliance contracting.
- The proposed Environmental Management Plan framework.
- Issues around emergency management planning.
- Issues of project scheduling.

16.1 GOVERNANCE & EXTERNAL RELATIONS

Discussion

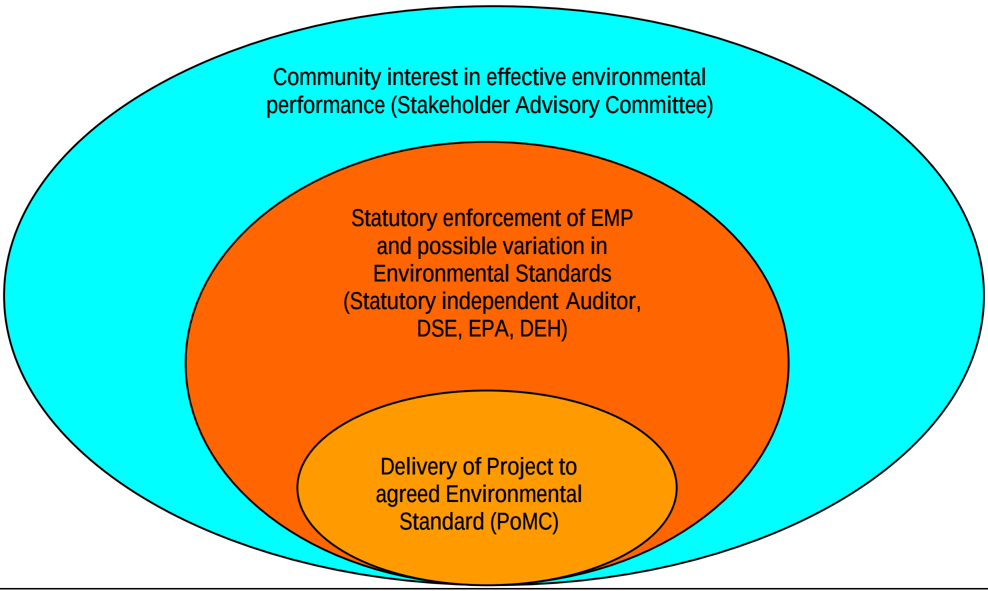
In terms of project governance, issues raised before the Panel were as follows:

- What modes of external assurance, monitoring, variation and where necessary enforcement are proposed for the project?
- How will third parties be involved in managing the project?
- How will project effects be communicated to third parties?

These are matters of external relations.

The Panel is also conscious that submissions raised issues of interest in relation to 'internal governance': mechanisms whereby the proponent within an alliance contract would manage the delivery of the project and performance to relevant environmental standards. These issues are deal with further below in sections on alliance contracting and the Environmental Management Plan (EMP).

Figure 8: Governance: Representation and Responsibilities



The proponent characterised the necessary responsibilities and relationships in the above diagram from Chapter 2 of EMP Version A.

Within these related groups, the EMP identified that the following tasks required to be carried out:

> *Governance arrangements must support three requirements:*
>
> 1. *Statutory enforcement of EMP environmental standards.*
> 2. *Possible tightening of EMP environmental standards through a commitment to continuous improvement.*
> 3. *Community interest in being assured that the Project is being conducted in accordance with the EMP environmental standards and that the recovery from impacts arising from the Project is as predicted.*
>
> *A Stakeholder Advisory Committee, a statutory Independent Auditor (audit team) and a Standing Panel of Independent Technical Experts will be established to help address these requirements.[…]. These bodies are in addition to existing arrangements within the Department of Sustainability and Environment and the Environment Protection Authority to coordinate administration in relation to the environmental management and protection of the Bay. (Note: that these governance arrangements are separate to those established by PoMC to assist it with internal processes to commercially complete the Project in an environmentally effective and operationally efficient way).*[189]

In relation to statutory enforcement, the Panel also identifies statutory approval within the Victorian jurisdiction as a matter requiring to be addressed by external governance arrangements.

Statutory Approval and Enforcement

The proponent proposes that the project would be statutorily approved under the Coastal Management Act.

> *The Coastal Management Act 1995 (Vic) consent will be the primary instrument by which the environmental standards set for the Project will be given legal effect. Relevant environmental performance standards will be incorporated in the EMP and compliance with the EMP will be a condition of any consent.*

The Coastal Management Act consent would be subject to a condition requiring ongoing compliance with the EMP.

More detailed compliance would be via the use of EPA powers as follows:

> *A range of tools are available under the Environment Protection Act 1970 which may be used to require action by the PoMC or other parties to protect the environment. The Coastal Management Act 1995 consent will be the primary ongoing authorising and control instrument applicable to the Project. Powers within the Environment Protection Act 1970 to require action (including the power to require that works cease) will be held in reserve. Circumstances that may result in use of powers under the Environment Protection Act 1970 may include:*

[189] All remaining quotes from the draft Environmental Management Plan Version A

- *A significant failure to comply with the EMP*
- *A significant and unexpected environmental impact is identified which has not been adequately addressed through the EES and EMP.*
- *In the event that there is a need for EPA to exercise these powers, it is envisaged that the following statutory tools be of use:*
- *Pollution Abatement Notice issued pursuant to s.31A of the Environment Protection Act 1970*
- *A direction pursuant to s.62B of the Environment Protection Act 1970. Such a direction may be given where there is an "imminent danger to life or limb or to the environment".*

Continuous Improvement

The proponent proposed that the project be implemented via a framework that facilitated continuous improvement. Relevant EMP provisions would be drafted in a way that would enable regulatory authorities and/or the proponent to vary the required environmental performance. The variation process would operate on a ratchet principle. Variation of delivery or requirement in a manner that was more onerous to the project or required a higher or better standard of environmental provision or care than that in the initially approved version of the plan would be permitted subject to the satisfaction of the Minister for the Environment, but without an external review process. Variation of delivery in a way that was less onerous to the project or required a lower standard of environmental provision or care than that in the initially approved version of the plan would not be permitted without external review.

The proponent considered that the Minister's approval mechanism could be formalised in the following terms:

> *To ensure that improvements in environmental performance are formally recognised and adhered to when tightened, a process is required to allow the consideration of a request for a tightening of standards. In assessing written requests the Minister for Environment could consider written comment in relation to a request provided by:*
>
> - *Environment Protection Authority*
> - *Department of Sustainability and Environment*
> - *Independent Auditor*
> - *Chair Stakeholder Advisory Committee*
> - *Such other parties as the Minister considers appropriate.*

Auditing and Expert Advice

The proponent proposed external means of providing audit and expert advice in the conduct and monitoring of the project.

Project auditing would be provided for in the following manner:

> *It is proposed that an Environmental Auditor be appointed to undertake an independent assessment of the implementation of the full scope of the EMP and the environmental impact of the Project. The scope of the EMP includes ecological, cultural heritage, noise and visual amenity considerations for example. The Environmental Auditor will be engaged by EPA on behalf of the Minister for Environment and will report to EPA and DSE. The independent Environmental Auditor forms a key element of the environmental*

assurance and oversight mechanisms for the project – providing an independent and transparent assessment for use by EPA, DSE and PoMC.

The purpose of the auditor would be:

> *To undertake an environmental audit pursuant to Part IXD of the Environment Protection Act 1970, which:*
>
> - *independently assesses the implementation of the EMP, including a critical review of monitoring programs*
> - *independently gathers such information necessary to verify information arising from the monitoring program set out in the EMP – this will include field verification, sampling and measurement*
> - *independently assesses whether the environmental impacts of the Project are consistent with those predicted in the EES*
>
> *To advise PoMC of any breaches of the EMP. Note that the Environmental Auditor has a statutory obligation to inform EPA of any imminent environmental hazard as soon as practicable (s.53ZB(3) of the Environment Protection Act 1970)*
>
> *To provide regular reports to EPA, DSE and PoMC.*

The proponent considered that the Environmental Auditor would be appointed from the pool established pursuant to the Environment Protection Act 1970. An Environmental Auditor would be selected by seeking expressions of interest from appointed auditors. The Environmental Auditor would be required to set out relevant experience and to nominate an expert support team to provide assistance to them in the conduct of the audit.

Selection of the Environmental Auditor would be undertaken by the EPA based on demonstrated experience and expertise of the auditor and his/her support team. The Environmental Auditor would also be required to demonstrate that he/she has no conflict of interest in relation to work already or currently being undertaken in relation to the Project.

The auditor and his/her support team would need to have skills/experience including (but not limited to):

- *Marine ecology*
- *Environmental chemistry, focussing on the marine environment (including sediments)*
- *Environmental toxicology*
- *Sampling design*
- *Quality assurance/quality control*
- *Management system, environmental management planning and auditing*
- *Environmental impacts associated with dredging*
- *Cultural heritage and visual amenity*
- *Noise.*

Expert advice would be provided in the following terms:

> *The environmental issues associated with the Project are complex and it is prudent to ensure that the regulation and evaluation of the project is supported by a high level of technical expertise and that such expertise is available from credible, independent sources. To this end an expert panel is proposed primarily to assist EPA and DSE in the*

conduct of their functions and to provide information to the Stakeholder Advisory Committee as required.

The purpose of the expert panel would be:

To provide independent technical advice on matters referred to it by:

- *Minister for Environment*
- *EPA*
- *DSE*
- *Environmental Auditor.*

The proponent considered that appointment of the panel under s.13(1)(h) of the *Environment Protection Act 1970* by the EPA would provide it with independent status and weight.

The proponent proposed that the expert advisory committee would represent the following expertise.

- Shallow water marine ecosystem processes
- Shallow water marine hydrodynamics
- Dredging.

Stakeholder Involvement

The proponent proposed a stakeholder committee, to which regular reports on project actions, progress and environmental monitoring would be made. The purpose of the committee would be to enable the views of relevant stakeholders to be provided to the Minister for Environment and the Minister for Transport and to provide a channel for information about the project to interested and affected communities. The suggested membership of the committee in the draft EMP was as follows.

- *Port Phillip Conservation Council*
- *Victorian National Parks Association*
- *VRFish (Victorian Recreational Fishing Peak Body)*
- *Dive Victoria [although the proponent clarified that it had actually intended to nominate the dive industry peak body DIVA].*
- *Shipping Australia*
- *Australian Industry Group or Victorian Employers' Chamber of Commerce and Industry*
- *Association of Bayside Municipalities*
- *Victorian Freight and Logistics Council.*

Panel Response

The Panel response to the governance and external relations provisions of the EMP are as follows:

- The Panel has concerns about the use of the Coastal Management Act as the primary means of statutory approval and as sole basis for the implementation of the EMP.
- The Panel broadly supports the other external relations proposals of the EMP, subject to consideration of some issues of detail outlined below.

Statutory Approval and Enforcement

Referring to its comparative analysis of the Environment Protection Act and the Coastal Management Act in Volume 2 Appendix F, the Panel must note that it has an underlying concern that the Coastal Management Act alone does not provide the best statutory approvals framework for the project.

The Panel's first concern is that it is not clear that all of the project would be carried out on coastal Crown land subject to the control of the Act. It appears possible that components of the project site may comprise land in other forms of title. The Panel does not claim to have carried out a rigorous investigation of this question in the limited time at its disposal and bases its position on departmental advice as opposed to a detailed individual sightings of relevant documents. However, if the Coastal Management Act is to be used as the primary means of consent, the approving authority must be clear by detailed reference to documentation in relation to the title of all relevant parcels of land and water that the Act and its approval requirement applies to all. It would not be acceptable in the Panel's view for there to be any significant parcel of land or water where works might take place and it might be discovered that conditions of a Coastal Management Act consent did not in law apply.

The Panel's second concern is that the Coastal Management Act and the policy environment that it sets out for decision making is less well adapted to the needs of the project and its possible effects than other legislation. In this regard, the Panel has considered the Environment Protection Act and the Planning & Environment Act.

The Panel's third concern is that the enforcement mechanisms of the Coastal Management Act are limited, in comparison with those of the Environment Protection Act and the Planning & Environment Act.

In short, the Coastal Management Act is an instrument that was largely designed to approve and manage relatively small scale projects on public land. It is not a major project approval or regulatory instrument. It does not contain mechanisms such as can be delivered through the Pollution Abatement Notice (PAN) under Section 31A or the 'stop notice' direction making power of Section 62B of the Environment Protection Act. It does not include the detailed strategy forming and decision support provisions of the Planning and Environment Act. It does not enable significant, proportional or ongoing penalties to be levied in case of significant breaches.

It follows that the Panel has considered possible options for an approval framework using each of these pieces of legislation.

Commencing with the Environment Protection Act, the Panel must remark that this legislation contains the most complete codification of relevant environmental principles, makes direct reference to relevant SEPPs (particularly SEPP (Waters of Victoria)) and to best practice guidelines for dredging. This must be contrasted with the more limited articulation of environmental principles in the Coastal Management Act and its underlying policies (primarily the Victorian Coastal Strategy).

The Panel also notes that the EPA is a body that in principle has the scientific and technical expertise whereby to undertake detailed regulation of the project. The Panel considers that situation to contrast with the resourcing of decision making under the Coastal Management Act.

The EMP proposes the Environment Protection Act powers mentioned above would form ‘backstop’ powers, to be used only if there is:

- *A significant failure to comply with the EMP [or]*
- *A significant and unexpected environmental impact is identified which has not been adequately addressed through the EES and EMP.*

However, noting the 30 day period before a PAN can come into effect, the Panel considers that a PAN would not form a particularly effective tool unless it had been crafted as a strategic tool, put into effect before the commencement of works. This was the measure that was used to regulate the Geelong capital dredging project, and was reasonably effective in so doing. By having a ‘strategic’ PAN in place before the commencement of works, compliance measures can bind with immediate effect. If the use of a PAN is left as a ‘backstop’ power, and a PAN is not prepared until an incident takes place, the time lag before it comes into effect could be sufficient to enable substantial environmental harm to take place.

The Panel notes that the direction making powers under s62B of the Environment Protection Act do enable the EPA to take immediate action. However, these powers are clearly designed to be specific incident related and are more of the nature of emergency powers, as opposed to being powers of ongoing regulation. On balance, the advance preparation of a PAN appears to be one well-adapted tool to enable the construction of a detailed regulatory framework for the project.

The Panel has also considered the possibility of a works approval or licensing requirement under Section 19A of the Environment Protection Act. The environment review committee for the Geelong capital dredging program recommended that this would provide the optimum way forward for the regulation of future Bay dredging campaigns. Whilst this would have the effect of bringing the project indisputably under the control of the legislation, this Panel considers that it would be somewhat difficult to make an expedited provision for the Bay to be scheduled premises under the Act. The option (or related options) may still be worthy of consideration by government for the medium to long term. However, on balance it is not likely to provide an immediate approvals framework.

Turning to the Planning & Environment Act, the Panel must express some surprise that this does not appear to have been considered to offer a practical means whereby to base a project approval framework. Port Phillip Bay is an intensively used water body, in which the competing interests of Port and shipping, recreation, aquaculture, industrial abstraction and wastewater treatment functions must be balanced with the need for ongoing provision of valuable natural systems services and the conservation of biodiversity and landforms. The Planning & Environment Act supports a primarily land based system of strategic planning and control. The mechanisms in the Act would be well adapted to strategy formation and detailed control over major projects in the Bay. There is no reason in principle why it should not be used.

Furthermore, in the favour of the Planning & Environment Act, it appears that an (at least interim and simple) planning scheme for the Bay could be prepared and approved in relatively short time. This is considered further in Appendix F.

The Panel recommends as follows:

Whilst Coastal Management Act consent is required, it should not be viewed as the primary vehicle of project approval and regulation.

The Panel notes that the review of the Geelong dredging campaign recommended a regulatory amendment to provide that dredging require a Works Approval under the Environment Protection Act. If this can be achieved, the Panel would consider it to be a sound response.

Alternatively, consideration could be given to the preparation and approval of a Planning and Environment Act planning scheme for Port Phillip.

If these options do not prove to be possible, the main means of project regulation should be the advance preparation and service of a Pollution Abatement Notice under section 31A of the Environment Protection Act 1970, before the commencement of works.

Continuous Improvement

A project of this nature and scale has enormous potential for change, especially if it is to be adaptively managed. There is potential for project change which refines techniques of delivery and the precision of controls or monitoring to be beneficial. Change that leads to an improved likelihood of better environmental outcomes or reduced levels of environmental risk should be supported. However, changes that have the potential for significant additional adverse environmental impacts will require proper assessment. This requires that sound engineering project management tools be used to ensure that all proposed changes are fully assessed, managed and implemented. These tools have a range of names such as 'change control' procedures, 'change request' procedures, 'engineering change control', 'management of change' etc.

If the condition of information control across the EES and Panel hearing documents provides any guide as to the proponent's management of change procedures to date, they do not appear well developed or else were not well implemented. There have been significant consistency gaps between studies that have been undertaken for both the design and environmental assessment. It is important that such gaps do not roll forward into the project implementation stage.

The PoMC needs to develop or improve rigorous ‘management of change’ procedures to control changes to the project to ensure that:

- project changes occur smoothly and that risks are assessed in a manner appropriate to their level;
- all documentation and decisions are traceable and authorised;
- design decisions, plans, schedules, models, drawings etc are updated and kept current and implemented in a timely manner once authorised; and
- that all parties are aware of changes, changed responsibilities and changed requirements - as they occur.

In addition to the above, government approval and monitoring agencies should recognise the need to be able to facilitate change within any conditions of approval, particularly given the prospective scale and long project timeframes. The Panel supports the ‘ratchet’ principle adopted in the EMP Version A as the basis of its approach to continuous improvement. A clear statutory basis for this will have to be agreed and put into effect.

Government agencies need to establish change control procedures within and between themselves to ensure that proposed Channel Deepening project changes undergo an appropriate level of risk assessment, public review and authorisation. This framework should be facilitative of changes that are demonstrably reductive of risk or impact. It should require rigorous review of changes that are not.

Auditing and Expert Advice

The Panel strongly supports the basic concept that the project be subject to the supervision of an independent environmental auditor appointed by the EPA. Similarly, the Panel supports the view that there should be an independent expert panel, capable of advising on and reviewing key aspects of the project, also appointed by the EPA.

Turning to the detailed tasks of the environmental auditor, the Panel is of the view that the specification sought to be addressed is a very broad ranging one to be met by a single auditor, albeit with a sound support team. It was for this reason that the Panel put the possibility of using the appointment power under the Environment Protection Act to appoint an auditor consisting of more than one individual, exercising their powers in a collegiate manner (much after the fashion of a Panel appointed under the Planning & Environment Act).

Legal advice from both the proponent and Ecogen Energy Pty Ltd concurred on the view that such a concept was alien to the existing statutory framework for environmental audit and could not be achieved without institutional reform. In these circumstances, the Panel is happy to accept that a joint auditor appointment not be pursued.

However, the Panel considers that attention must be given to ensuring that the auditor receives the best possible support, enabling his or her functions to be delivered in detail, depth and over a long duration. One possible means of supporting the auditor would be to better integrate the role of the auditor with that of the expert panel. By broadening the remit of the panel to the same subject matter as that of the audit, the panel could be appointed from persons of considerable standing and expertise, able to provide sound, robust and timely advice to the auditor, increasing the resources and staying power available to the auditor.

The Panel considers that both the auditor and the panel should be appointed with a shared subject matter as follows:

- Hydrodynamics, including shallow water marine hydrodynamics
- Marine ecology, including shallow water marine ecosystem processes
- Environmental chemistry, focussing on the marine environment (including sediments)
- Environmental toxicology
- Sampling design
- Quality assurance/quality control
- Management systems, environmental management planning and auditing
- Dredging techniques and environmental impacts associated with dredging
- Cultural heritage and visual amenity
- Noise.

The Panel recommends as follows:

The proposed environmental auditor (appointed by the EPA) and the proposed expert panel should be appointed across the same fields of expertise. Opportunities for joint working between the environmental auditor and the expert panel should be maximised to provide each with the broadest access to relevant expertise in the discharge of their obligations. However, care must be taken to ensure that the audit function is not compromised by such links.

One of the issues to which the Panel has turned its mind to is the means by which powerful and ongoing oversight can be provided for a continuing act of environmental impact assessment, further to the recommendations of this report. The Environment Effects Act provides a 'one size fits all' assessment process. Whilst independent Panels have been appointed under this Act, they have tended only to provide a limited public review function at the point when an environment effects statement is exposed to public review. They have generally been appointed subject to Terms of Reference that anticipate their production of a single report, supporting a single 'one off' approvals process. They have tended to be required to produce their report in a delineated time frame. The resources available to support their investigations have tended to be limited.

Having carried out many environment effects inquiries under the Environment Effects Act, this Panel observes that a project of the scale of that before it probably needs something more sophisticated. In many ways it is more of a program than a project. It is likely to require a more than one act of impact assessment, within the scope of an overarching project strategy. It should have oversight from an independent body, capable of conducting its own inquiries and investigations to support a sequential program of impact assessment to address the provisions of the strategy. It is likely to need a body with an ongoing life, able to follow the project through detailed implementation and monitoring. The key concept here is of an impact assessment process that supports approval and ongoing environmental management to deliver optimised sustainability. This is in contrast with the current 'one off' model.

The Panel considers that the project could benefit from the establishment of a well resources and broadly representative expert panel with a strong chair to deliver the coming environmental assessment processes.

This reasoning in turn supports a number of the Panel's primary recommendations.

Stakeholder Involvement

The Panel broadly supports the proposed a stakeholder committee. The Panel considers that in addition to enabling the views of relevant stakeholders to be provided to the Minister for Environment and the Minister for Transport and to providing a channel for information about the project to interested and affected communities, the committee should provide a direct mechanism for engagement between the proponent and stakeholders. As proposed to be constituted, the Panel is concerned that the committee would not provide stakeholders with a direct mechanism to table implementation related issues with the proponent. Reporting to the relevant Ministers, it would appear most likely that issues would not be raised or translated to the proponent until they had become 'serious' and hence the committee would not enable the most timely possible response to and minimisation of adverse effects. As proposed to be constituted, it would also be possible that Ministers would be asked to attend to a range of minor committee business that would be better directly resolved directly between the stakeholders and the proponent. The Panel's basic position is that the role of the Ministers in the operation of the committee should be to determine significant matters that remain disputed or unresolved, not to act as an ongoing channel between the community and the proponent.

Channels between the stakeholder committee, the independent auditor and the expert panel should also be made more clear. The committee should have a direct means of requesting review by the auditor or requesting the expert panel to undertake research or provide advice, subject to clear reasons for such requests being provided. That being said, those bodies should retain to themselves the discretion to dispose of their resources as they see fit and should not be bound to respond to all references from the committee.

Given the potential that the Panel sees for the pursuit of dispute resolution through the committee structure, the Panel also considers that it too would benefit from having a strong independent chair, not aligned to the proponent or to any one of the represented stakeholder bodies.

The Panel considers that some regional peak tourism representation on the committee would be justified.

The Panel recommends as follows:

A project stakeholder committee should be constituted broadly as provided for in EMP Version A, but with the addition of a regional tourism peak body or bodies. Its constitution should provide for direct engagement, liaison and problem-solving between the project proponent and stakeholders. To facilitate this role, it should be provided with a strong independent Chair. Issues should only require to be reported to Ministers when they are of an intractable or unresolved nature that cannot be settled within the committee.

The committee Terms of Reference should entitle it to request that issues be investigated or considered by the auditor and/or the expert panel.

16.2 ALLIANCE CONTRACTING

Discussion

Whilst many submitters had concerns about the nature of the Alliance Agreement proposed to implement the project and sought assurances as to its appropriate, relatively little hard data was available from which to deal with these issues.

The proponent submitted (and the Panel broadly accepted) that such an agreement will contain terms commercially in confidence and that furthermore it was not for an EES Panel to turn to their detailed investigation. However, some remarks on Alliance contracting are germane to questions as to appropriate performance management to deliver environmental outcomes.

Panel Response

The Panel notes that the PoMC has entered into an Alliance Agreement with Boskalis Australia Pty Ltd[190]. Whilst the panel is pleased to see this approach, no evidence was provided of previous POMC experience in the successful delivery of Alliance Contracts nor

[190] ABN 83 099738333.

that the gain share and key performance indicators/key result areas had been benchmarked to determine their appropriateness for this project.

The Alliance has established an executive team consisting of four representatives, two appointed by PoMC and two appointed by Boskalis. The Panel is told that decisions of the executive team are required to be unanimous.

A gain share regime is included in the agreement with both parties able to share in the up and downsides of the project as measured against a range of key performance indicators. Requests by the Panel and other parties for specific information in relation to the key performance indicators were refused by the proponent:

> *…due to the commercial in confidence arrangement, PoMC is only at liberty to outline the general details of the Alliance Agreement*[191]

Information that environmental performance was a 'non financial outcome' [192] was contradicted in the same document which also states that 'environment' is one of three key result areas that will be scored out of 10 when determining gain-share bonuses.

Details of the both the Scope of Work and Risk Allocation Matrix for the agreement were not presented to the Panel and cannot be commented upon.

It is noted that Alliance agreements are better suited to projects where there is flexibility in maximum price and that under usual Alliance contracting arrangements the POMC will be responsible for its share of cost overruns.

The EES also states that a pre-qualification for selection as the Alliance contractor will be:

> *Evidence of an implemented EMS consistent with the requirements of ISO14001. This requirement will ensure that the Dredging Alliance will be able to operate under an EMS that is consistent with ISO14001.* [193]

The Panel finds that the selected Alliance Contractor, Boskalis Australia Pty Ltd, is quality systems certified but does not have environmental management systems certification and that the stated pre-qualification conditions for contractor selection appear not to have been adhered to.

The Alliance contract arrangements should be benchmarked against those of other similar large-scale projects to ensure beneficial environmental outcomes within acceptable economic parameters.

In the absence of the dredging contractor being ISO14001 certified as indicated would be the case in the EES, the Alliance management systems for the full scope of works should be audited against the requirements of ISO14001. Compliance with the standard should be achieved prior to the commencement of any works on the ground.

[191] .POMC Part A Submission at p18

[192] as above at Pg 19

[193] EES Volume 1 at Pg 45-6

16.3 ENVIRONMENTAL MANAGEMENT

Discussion

Whilst the Panel provided a means in its hearing processes whereby interested parties could engage with the proponents proposed EMP, this option was only taken up by Ecogen Energy Pty Ltd, whose issues have largely been responded to in the beneficial use section of the report above. That being said, there are some general issues that bear consideration in relation to the environmental management framework for the project.

Panel Response

The Panel recognises that at the end of the day there are a large number of environmental management tools that contribute to ensuring acceptable environmental project outcomes. These include environmental management plans, environmental management systems, audits, monitoring plans, procedures, oil spill contingency plans etc.

The following sections of the Panel report examines some of the proposed environmental management arrangements for the Channel Deepening Project from construction to 2030 that have not already been dealt with elsewhere in this report

16.3.2 EMP SCOPE

Panel Response

The scope of the EMP does not include:

- works on the berths and banks of the Yarra;
- maintenance dredging; and
- ongoing operations of the channels and port.

Beyond stating that it is beyond the scope of the Alliance Agreement, the proponent has made no indication or commitment about how this work is to be managed and what management systems are to be used.

The Alliance EMS that is being developed will be a useful resource document for these other works but it would be inappropriate to transfer it in its entirety to other entities and works.

The environmental management arrangements for the works outside the Alliance contract need to be specified in more detail and their potential to impact upon critical environmental assets examined. At present the Panel can not assess these.

16.3.3 EMP CONTENT

Panel Response

Part D of the main volume of the EES contained a section on environmental management and introduced an environmental management plan. The EES notes that the purpose of the part was to describe the environmental management framework for the project. It also suggests that the EMP will serve the purpose of the Environment Improvement Plan as required by the

BPEMGD. [194] The Panel notes that the EES version of the EMP is now superseded by the EMP Version A produced pursuant to Panel directions during the hearing process.

The EES contained a large number of environmental management recommendations. Many of these were loosely brought together in the EMP, although it must be noted that other recommendations did not translate into the plan, a position justified in the following terms.

> *It is fair to say that not all specialist recommendations have been adopted, and not all of the specialists have agreed with all of the decisions of the EES management team.* [195]

The primary difficulty was that there was no transparent statement as to why recommendations had not been adopted. The problem of recommendation tracking was partially resolved during the panel hearings when the Proponent prepared Annexure F2 -Fate of Expert Management Recommendations. This document summarised the management recommendations of the consultants and whether or not these were accepted. Unfortunately Annexure F2 does not appear to include the various commitments made in the Main Report of the EES and another significant body of work is required to track these.

The EES Main Report (Volume 1) should be searched for 'commitments' that did not translate to the EMP. These should be added to a table based on Annexure F2 - Fate of Management Recommendations, together with explanations as to why they were not carried forward.

The Panel considers that the EMP Version A represented a reasonable framework for a future EMP. However, in making this statement, it must be recognised that many of its provisions are the subject of contingency issues, further to recommendations of the Panel above. For this reason, the Panel has embedded its comments on the content of this document in its subject based analysis. It does not proposed to comment further on the EMP Version A at this stage, beyond observing that the document will require to be updated to respond to the issues raised in this report.

The EMP Version A will require a systematic update to respond to issues raised in this Panel Report.

16.3.4 ENVIRONMENTAL MANAGEMENT SYSTEMS

Panel Response

The EMP Version A states that a project specific (Alliance) EMS consistent with ISO14001 is being prepared[196]. The Panel observes that in the absence of an EMS for either the PoMC or the dredging contractor that it supports this approach.

The EMP reveals that of the 16 main management system procedures forming the framework of the EMS, only four are available and only as a draft. A review of these procedures shows that they are not 'mature' and require a significant amount of work prior to implementation. For instance the non-conformance procedure does not:

- define a non conformance;
- state whether there different 'levels' of non conformance;

[194] EES Volume 1 at Pg 45-3

[195] POMC Part A Submissions at Pg 23

[196] EMP Version A Pg 1-2

- provide notification requirements and emergency response actions required by each level; and
- outline the nature, scope and level of review of investigation that may be required.

The procedure also allows one month to complete all corrective actions, which is likely to be entirely inappropriate in an emergency.

In essence, implementation of the EMS will take a long time and it will be even longer before it becomes effective.

The PoMC is also required under the Port Services Act 1995 section 91C (1) to ensure that:

> *(a) a safety management plan; and*
>
> *(b) an environmental management plan*
>
> *are prepared and certified in accordance with this Part for the port or part of the port that the port manager manages, superintends or controls.*

The Act also notes that these plans must be prepared and certified within 12 months after the declaration of the port or any later date that is fixed by the Minister in respect to the Port.

The EES states, and Panel was informed, that the PoMC is preparing an environmental management system consistent with the Australian Standard ISO14001 but that it will not be ready for several months and it is not intended that the EMS be certified to JASANZ[197] standards. It was implied that the EMS is being prepared at least in part as fulfilment of the requirement of the Port Services Act requirements.

No information was made available about:

- whether the Minister had agreed a later date for the certification of environmental management plan; and
- the status of the required safety plan.

The Panel notes that the proponent predecessor Melbourne Ports Corporation produced a Whole of Port Environmental Management Plan in 2001 for the then scope of activities of that corporation (ie not including the channels). The Whole of Port EMP was not referenced in the EES or Panel process and the document's status was not clarified.

The Alliance management systems for the full scope of works should be audited against the requirements of ISO14001. Compliance with the standard should be achieved prior to the commencement of works.

The PoMC should clarify the arrangements with respect to the EMP and SMP required under Section 91C of the Port Services Act and outline how these documents interface with the project.

There is insufficient information for the Panel to provide detailed comments in relation to all of the EMS management procedures. It is assumed that any concerns raised in respect to the procedures will be addressed as part of the proposed EMS audit.

[197] Joint Accreditation System of Australia and New Zealand

16.3.5 ENVIRONMENT IMPROVEMENT PLAN (EIP)

Discussion

An Environment Improvement Plan is a document developed by the proponent and/or contractor detailing how dredging operations will be conducted to minimise environmental impacts. The EPA publishes guidelines on EIPs (Publication 739).

The Best Practice Environmental Management Guidelines for Dredging state that:

> *…. a Coastal Management Act 1995 consent will only be issued if adequate long term planning is evident and **an adequate EIP** exists.*[198]

They go on to note that an EIP is designed to minimise impacts during the operational phase should impacts prove larger than anticipated and that the EIP also should identify those aspects of the dredging that can be modified after dredging commences.

The BPEMGD note that the EIP should cover all relevant environmental issues discussed below and that contingency plans should also be developed to ensure prompt control of adverse environmental impacts caused by unintended events.

Minimise Effects on Water Quality

- Increase monitoring for turbidity (this will identify but not minimise turbidity).
- Incorporate or reorientate silt screens.
- Reduce the overflow of barges or bunds.
- Increase the travel path of fluid within bunds to increase sedimentation.
- Decrease the rate of dredging.
- Select appropriate dredge technology for the material being dredged.
- Relocate the dredge to an alternative location.
- Use silt screens where practical and sediments are fine.
- When necessary, monitor water quality including turbidity, as well as seagrass and other sensitive species.

Minimise Effects of Contaminated Sediments

- Monitor water quality near dredging operations removing highly contaminated sediments.
- Dredge contaminated sediments first and dispose of to land or place on the spoil grounds first and cover with clean sediments.
- Use silt screens to contain contaminated sediment.

Sensitive Biological Communities

- Map the location of sensitive communities.
- Detail measures to protect sensitive communities when dredging.

Land Disposal

- Site any bunded area to minimise impacts. Control the water quality of any discharge.
- Monitor discharge to ensure that excessive sediment is not discharged.

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198 *BPEMGD p36*

- Minimise potential salt impacts on soils.

Prevent Noise Nuisance in Residential Areas

- Liaise with the local community to identify areas and times sensitive to noise.
- Alter or enclose equipment to reduce noise at the source.
- Use sound-absorbing materials to prevent the spread of noise by isolating the source.
- Monitor noise levels.

Ensure that Small Odour Problems do not Alarm Nearby Residents

- Inform residents of the temporary nature of any odours and grey sediment.
- Cease dredging on very hot days (greater than 35°C) or times of high public use.
- Inform the public of works using on-site signs.

As required by the Best Practice Environmental Management Guidelines for Dredging, the proponent should prepare an Environment Improvement Plan for the project incorporating all the requirements of an EIP into other plans and systems, with a bridging document to show how the requirements of the EIP have been satisfied.

16.4 EMERGENCY PREPAREDNESS & RESPONSE

Discussion

A number of submitters drew attention to the proponent's lack of attention to emergency response, particularly in relation to contingency planning for oil spills. Earlier in this report, the Panel found that the risk of spills both during dredging and operations has not been adequately assessed and this is not revisited here. This part of the report seeks to look at the proponent's readiness to respond to any emergencies that may eventuate during the construction and operational activities.

Panel Response

The Panel has not had a significant opportunity to examine the preparedness of the Port in respect to emergency response. This issue was not dealt with well in the EES documentation and little emphasis was placed on this matter by the proponent in its presentations to the panel. No expert witness was offered to the Panel in respect to this matter with questions being answered either by proponent submission or persons from the proponent EES team.

The EMP Version A refers to a number of emergency plans, these include:

- Existing port or government documentation
  - Victorian Marine Pollution Contingency Plan (2002)
  - Port Phillip Region Marine Pollution Contingency Plan
  - Victorian State Emergency Response Plan
  - Port of Melbourne Emergency Management Plan (2004)
  - Port Waters of Geelong and Melbourne Operating Handbook (2002)
  - Various national plans and anti terrorism plans.

- Vessel specific documentation
  - a Vessel Emergency Preparedness and Response plan
  - the Shipboard Oil Pollution Emergency Plan (as required by MARPOL)

The panel obtained copies of the port and state plans and has considered the broader emergency response framework in Appendix I. Without moving through those documents in great detail here it suffices to say that their individual content and interrelationships did not leave the Panel with a high level of confidence that project related incident responses were well provided for. They did not persuade the Panel that it would be sufficient for the project to rely on generic external documents and for no further consideration to be given to emergency response as a means of controlling environmental risks pursuant to the project.

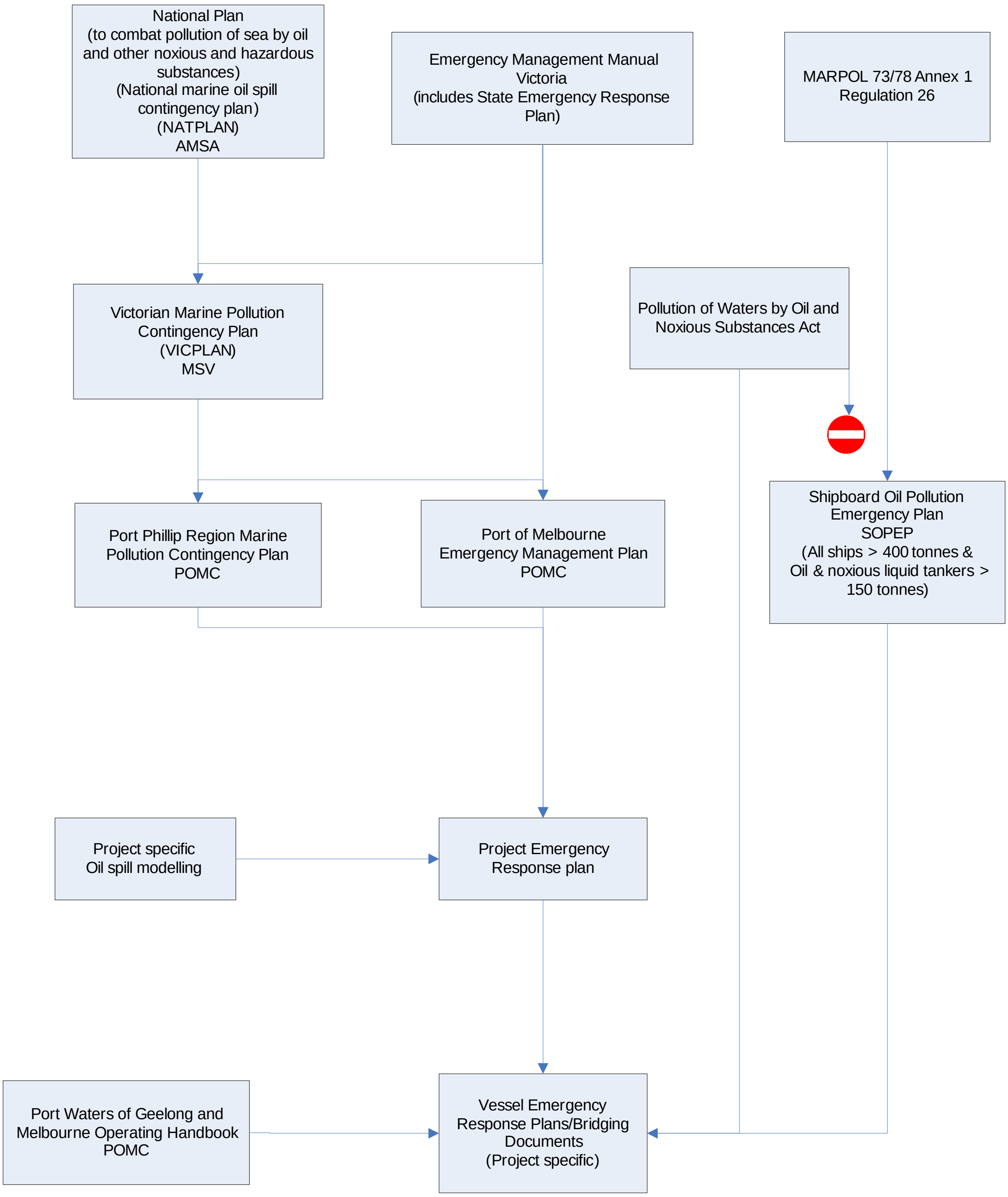
The capital works phase in which shipping uses the existing or construction channels in close proximity to operational dredge plant will raise risks that require a project specific emergency planning response.

Additionally, the government level plans need to be up to date, simple to use and integrated with each other, so that can be no confusion of roles and responsibilities. The project implementation phase should be identified as a high risk period. Efforts should be made to bring generic and specific plans into high states of readiness and integration before the commencement of this period. Relationships between the generic plans and a project specific plan are set out on the figure overleaf.

The Panel recommends:

At a project level there needs to be a hierarchy of project and vessel specific emergency response plans that are well integrated. Work needs to be done to identify any additional response equipment required as a result of the project and all persons require training at an appropriate level in the implementation of the plans. All plans need to be bridged (linked) to other relevant documents.

Figure 9: Panel Emergency Response Planning Framework Summary



16.5 SCHEDULING

Discussion

The EES contained indicative timeframes for dredging works to occur but did not provide any indication of the proposed schedule that might be followed for the capital or maintenance dredging program. Early during the panel hearing process the proponent presented a Boskalis Australia Channel Deepening Dredging Program outlining the proposed timing of works commencing March 2005. The dredging program provided is an uncontrolled document. The panel understands from questioning that this program includes project float however no detailed information was ever provided to the panel in this regard.

In circumstances where that program cannot be met, but yet the detailed programming of works is still and essential response to a range of ecological and economic windows identified for the project, some consideration of the principles for future scheduling is required.

Panel Response

The Boskalis dredging program was not amended during the panel process. This was despite the very obvious facts that, with the length of scheduled hearings and even an expedited time allowed for the panel to report, combined with the necessity for both Victorian and Commonwealth approvals, the starting date and everything that relied upon it were simply unachievable. The proponent did not present the panel with alternative schedule scenarios that would also meet the project objectives and therefore the panel is unable to provide an opinion on whether a specific schedule with a start date later than March 2005 is feasible or environmentally sound.

The panel was also not provided with any information about whether the schedule has been 'risked' and, if it has, whether this occurred as part of a group process involving persons who are knowledgeable in respect to the environmental and social constraints of the project.

The panel also notes that the Boskalis program presents activities occurring simultaneously on a number of work fronts. The proponent has not sufficiently investigated the additive effect of impacts arising from a number of work fronts nor have they identified other projects occurring simultaneously such as the proposed dredging of the Yarra by Parks Victoria in the middle of 2005 and investigated the cumulative impacts thereof.

Work Windows

The panel is pleased to see in the EMP Version A that commencement of work on the preparation of tables defining 'work windows' showing the times of the year that works can be undertaken based on environmental sensitivities. The panel would like to encourage the further development of this concept and to see a requirement for such a schedule written in to approval conditions. At present not, only are some of the key environmental constraints omitted, such as EPBC listed native fish species in the Yarra, but the tables also omit to include a number of one off periods that are likely to impact on the economics of the project once dredging commences. For instance, the Commonwealth Games are not recognised as driving a requirement for works to cease or to be confined to particular areas, nor is the stopover for the Volvo 60 yacht race. Both events present a platform from which Melbourne will be seen by the world. The public benefit to be obtained from ensuring excellent water conditions during those times are likely to outweigh the benefits of a continued dredge campaign.

The panel also notes in relation to these tables that the apparent 'block out' periods for assets such as diving appear to be much more extensive than have been proposed elsewhere in the EES documentation. The panel was not able to explore the adequacy of this with the proponent in any detail, particularly noting the decision of the Diving Industry to depart the hearings prior to the Panel's examination of the EMP.

The panel therefore makes the following recommendation:

The approval authority should review the final environmental approval documentation to develop a series of 'work windows' that will allow the proponent to schedule works whilst protecting the beneficial uses of the Bay. These beneficial uses include ecosystem (marine habitat, fish migration & spawning, bird reproduction etc), water contact recreation; commercial and recreational fishing, aquaculture etc. These windows should separate out:

- **dredging (extraction) activities by site and beneficial use to be protected, and**
- **dredging dumping activities by site and beneficial use to be protected.**

Sequencing Works

The panel has considered a number of issues above in respect to the sequencing of works.

Perhaps the most important of these is the need to schedule and contract the works in a manner that minimises the risk to the State if it proves impossible to complete the works for reasons that may be:

- technical;
- economic;
- environmental; or
- social.

From a technical viability perspective, the 'gateway' at The Heads is the key to whole project. It should be implemented before and independently of other parts of the project. Only one existing method of works has been proven to undertake this task - blasting, but the commitment has been made to the Victorian public that this will not be used again. Given this commitment there is a risk that these works cannot be undertaken in an environmentally acceptable manner in the unique conditions of The Heads that include a narrow opening, severe wave and current climate and a rocky bottom.

Without this 'gateway' there is no project and no need for the balance of the works.

Similarly, the disturbance of contaminated sediments in the Yarra may, subject to further assessment, also prove either environmentally or economically unacceptable, again negating the need for the balance of the works. The Panel has remarked above that it is not essential to the success of the project that the dredging of the entire Yarra proceed at the same time as that of the bay channels. Indeed, some conceivable options include the possibility that some higher Yarra facilities might remain shallow draft facilities for some time, or even for the foreseeable future.

Between The Heads and the Yarra, the remainder of the project appears subject to less immediate drivers as to strategy, options and sequencing. However, the Panel would remark that it is imperative that sufficient time be allowed before the commencement of works to resolve and validate the many issues outlined above, in short to ensure that before the project (or a relevant part of it) commences:

- Necessary background science, such as MPB productivity and light evaluations are complete and fully documented.
- Turbid plume extents have been validated using proof of concept modelling for the whole of that dredge campaign.
- It is clear that the campaign can be delivered to meet relevant light budget requirements using known equipment and controls.
- It is clear that the campaign has been structured having full regard to the identification of relevant ecological windows or seasonalities.
- A proven disposal location and management method, again with known technologies and controls has been approved.
- Clearly established and known monitoring procedures exist, within a context of sufficiently resource access to monitoring, independent audit and expert advice.
- A sound analysis has been undertaken of the residual risk to bay systems and ecology.

The Panel would also remark that one major issue with the project has been its mega scale, a fact that appears to have daunted many who have engaged with it. One means of both sensibly scheduling the project and responding to its scale could be to break it down into a further sequence of defined and structured 'campaigns' to meet the overall objective, but enabling project delivery planning to take place at the necessary level of rigour and detail for each phase. There would be considerable learning and project management benefits from such an approach, not the least being the capacity that it would create for genuine adaptive management. One individual campaign could be scaled such that it was never of the scale necessary to put bay systems or ecology under broad-scale threat. Learnings from unlooked for events (as there will inevitably be) in early campaigns could be closely applied to the relevant performance standards, technologies, controls and monitoring frameworks for later phases.

Subject to consultation with the Commonwealth about EPBC Act processes, it may even prove possible to subject elements of the project to tiered or subsidiary environmental approvals, adapting and refining each tranche of approval documentation to the lessons learned in the preceding tranche.

In proposing the channel deepening, the proponent seeks to carry out a project of immense scale, inherent within which are many of the uncertainties that have been examined at such length by this Panel. By recognising this reality and seeking to move forward in a slightly more measured pace, the Panel considers that the proponent and the people of Victoria can have their benefits and can so reduce the scale of uncertainties and risks that many of the concerns will be satisfactorily resolved.

The Panel recommends as follows.

For a balance of reasons flowing from its considerations throughout this Report, the Panel considers that serious attention must be given to the potential benefits of dividing the project into a sequenced program of works. For example:

- The viability of dredging The Heads provides the key to the viability of the project overall. Plans should be made to prove the concepts and technologies necessary to achieve this objective as a first step.
- Assuming the viability of dredging the Heads, the second step could be to develop a strategy (if necessary including a range of physical works and disposal options) for resolving the Yarra sediments.
- The third step could be to develop a staged dredge program for the bay, in units of a scale whose impacts are sufficiently reduced to be absorbed within existing environmental capacities without significant order risks.

16.6 SUMMARY

The Panel has considered a broad range of approvals, internal and external governance, management and emergency response planning issues in this Chapter. Its overview has been brief and at a relatively high level, seeking to provide broad guidance.

However, it must remark in general that it considers that considerable additional thought requires to be given to all of these processes as critical elements in ensuring satisfactory delivery of the project.

17. MAINTENANCE

This section addresses the following issues that are relevant to the Minister for Planning's decision:

- Maintenance dredging implications.
- Prematurity.

Discussion

The Panel opens by remarking that the approvals sought by the proponent include an ongoing approval for maintenance dredging associated with the project for the period from the present to 2030. Maintenance dredging in the south of the bay is estimated to produce 6.67 million m^3 of material in addition to that generated by capital works, or some 31% of the total material production due to the project. In the north of the bay, maintenance is estimated to produce some 4.42 million m^3 additional material, or 42% of total production. For the project as a whole, maintenance dredge production is estimated to be some 11.09 million m^3 of material, or 34% of total production. It is clear from these statistics that the maintenance dredging program is no small undertaking.

That being said, regard must be had to the degree to which the maintenance program post the implementation of channel deepening would need to be larger than the maintenance program necessary to keep the existing channels fit for navigation. The proposed maintenance works are estimated to result in the production of 20% more material from the South Channel than would otherwise have been required to maintain that channel, had the project not proceeded. It is the Panel's understanding that maintenance dredging after project implementation is not anticipated to significantly increase the volume of material that would otherwise have been necessary to recover from the Yarra and Port of Melbourne Channels. This would suggest that the project will result in an additional maintenance dredge based production of in the order of 1.3 million m^3 of material, over and above that which maintenance of the existing channels would have produced.

The volume of the existing Port of Melbourne DMG (as extended) and the proposed South East DMG have been calculated by the proponent as sufficient to contain all maintenance dredge material to 2030. These DMGs had been selected over and above other options, based on their modelled capacity to retained both capital and maintenance generated material in situ with greatest reliability. Most importantly in the south of the bay, they offered the what the proponent considered to be the best prospects of keeping already dredged materials out of the channel and hence reduced the long term requirement for maintenance dredging from what it might otherwise have been.

Submissions raised relatively few direct concerns about the implications of the project for future maintenance dredging requirements. Typically, reasons advanced for this position related to submitters' primary concern with the adequacy of the capital phase of the project. They took the view that a detailed examination of this was premature, pending (in the views of some) a better resolution of the capital works or (in the views of others) determination that the project ought not proceed.

Concerns were raised in some detail by the diving, fishing and tourism industries about the historic effects of maintenance dredging campaigns. Reference was made to a major maintenance campaign in 2002, which the proponent acknowledged as having been carried out using very limited environmental evaluation and control in comparison with that proposed to be applied in this case. Nevertheless, the 2002 campaign had been a widespread generator of anxieties about adverse impacts through turbidity on bay ecology and activities such as fishing and diving.

The proponent's corresponding submissions on maintenance dredging before the Panel were brief. It can be summarised as proceeding on the basis that only minor changes to bay floor sediment transport rates were predicted by the sediment modelling conducted by Lawson and Treloar. It followed that only minor changes to the ongoing requirement for maintenance dredging could be predicted as a consequence of the project. In relation to the governance and environmental management of maintenance dredging, documentation was also limited. The draft EMP Version A does make clear the proponent's intent to develop a new EMP for each phase of maintenance dredging works, whilst ensuring that the baseline monitoring programme in place for the capital works is rolled forward to provide a knowledge base to assist in managing maintenance works.

Panel Response

The response of the Panel to these issues is to observe that there is no primary nexus between the project as advanced before it and the need to conduct maintenance dredging campaigns in the shipping channels of Port Phillip Bay.

As long as there have been artificially constructed shipping channels in the bay and as long as these continue to require to be maintained to a specific declared depth, there will be a need for periodic maintenance dredging campaigns. The project can only have a secondary effect on this need, to the extent that:

- increases in the channel area will lead to some increases in the volume of maintenance dredge material over the existing channels; and/or
- changes to bay floor sediment transport caused by the project might change the rate and location of material deposition in the channels, in turn changing the maintenance dredge period or volume.

As has been seen above, whilst the volumes of material proposed to be generated by maintenance dredging in the 25 years to 2030 are very large indeed, the additional volume calculated by the proponent as being directly generated by the project is quite small: 1.3 million m^3 of material. It follows that if one compares the scale and scope of the project with the scale and scope of additional maintenance dredging that appears to be directly caused by the project, the impact of this additional material appears to be small. That being said, the Panel's analysis of sediment transport above has led it to express doubts about the integrity of sediment transport modelling in the south of the bay over the medium to long term. Small volumes of transport over single tide events can, if repeated over a scale of decades, aggregate into astonishing volumes of sediment, relocated pursuant to even very localised changes to the tide and current regime within the channels.

It follows that the Panel does not accept the EES prediction of the scale of the additional maintenance dredging due to the project as being a certain enough basis on which to plan for future maintenance dredging campaigns. It also follows that there is a residual uncertainty as to whether the additional products of maintenance dredging will be able to be accommodated within the DMG capacity identified in this EES process.

Setting aside the maintenance dredging requirements generated by this proposed capital dredging and returning to the maintenance dredging campaigns as complete entities in themselves, these will clearly be very large. It can be expected that there would need to be at least 4 significant maintenance dredge campaigns over the whole length of the channels in the period between 2007 and 2030, each of which might amount to approximately 9% of the volume of the capital works. In short, these maintenance campaigns will be major projects in their own right, with potentially major effects. The proponent acknowledges this position through its agreement to the necessity for the preparation of a new EMP for each maintenance campaign.

Depending on the sediment transport modelling issues raised above, there remains a possibility that the scale of these campaigns could increase due to tidal and current changes. If this is the case, these campaigns could also be accompanied by a need to investigate further DMG options. At such a point, they would clearly extend beyond current understandings of their scale and scope set out in this EES.

Further, if environmental regulation, policy, scientific understandings of the bay, monitoring and dredge technology change over the coming 25 years as significantly as they have since 1980, it follows that it is very difficult from our current perspective to determine for 2030:

- what dredge technology comprises best practice;
- what its impacts are likely to be; and
- what monitoring and controls ought be put in place.

It follows from this position that although the proponent is seeking an ongoing approval to include maintenance dredging, that which has been advanced before this Panel in very great part amounts to:

- a capital dredge proposal; and
- a proposal for an ongoing baseline monitoring programme.

In such circumstances, the Panel is reluctant to conclude that any approval should be granted 'in principle' for the carrying out of maintenance works as part of this EES. As has been seen in many sections of this report above, the environmental acceptability of dredging in Port Phillip will in large part be contingent on the precise choice and management of techniques and technologies to be used. One of the difficulties of this EES process has been the struggle that it has had in providing environmental scientists with a sound basis on which to predict impacts, when particular technological approaches to dredging and their effects have not been studied in detail. To approve maintenance dredging 'in principle' at this stage and without further study could be to roll such difficulties forward for a further 25 years. It would appear to establish a basis for the possibly less than rigorous or adequate study of future dredge technology offers and their effects. Having regard to the acknowledged difficulties and environmental under-performance of the 2002 maintenance dredging campaign, such an approval might also provide encouragement for the view that a 2030 maintenance campaign could legitimately be carried out using the technologies and environmental controls available in 2005. If advance approval were to have such an effect, it would be to the detriment of the environment and would run against the philosophies of continuous improvement and best practice.

Further, what would be the benefits of such an approval in real terms? In circumstances where the dredge technology, dredge location, sediment type, chosen DMG, turbidity and available turbidity controls are not known, a wide range of pre-commencement assessment would have to take place to enable the drafting of an effective maintenance dredge campaign EMP. If the design and conduct of a dredging campaign are subject to this level of necessary prior investigation before it can proceed, there appears little practical benefit in stating that the campaign has 'in principle approval'. The only significant and meaningful benefit flowing from 'in principle' approval would appear to be a public acknowledgment of legitimacy of the use of the channels for shipping purposes to their proposed declared depths, to 2030, with the certainty created thereby.

It follows that the Panel finds that, subject to resolution of other issues raised in its findings and recommendations, the approval for this project should make clear that it extends to the permission of capital works and the establishment of a long running requirement for environmental monitoring. Future maintenance dredging campaigns should be subject to separate approvals processes, subject to the operational law, policy, knowledge and technology base available at the relevant time. In relationship to the benefit of public acknowledgment of the legitimacy of the use of the channels, the Panel considers that this could be provided for in the terms of reference of any maintenance dredging approval processes. These could make clear that the purpose of the proposal is to seek to minimise the environmental effects of necessary works, as opposed to determining whether the works ought proceed.

Taking all of these considerations into account in the context of its governance findings, that Panel does consider that there is again a significant imperative for specific legislation to provide the project with a sound operational footing and a basis for multiple approvals. Specific legislation could clearly define the tasks to be carried out in approvals processes for maintenance dredging and put the function of any studies and inquiries beyond doubt, whilst ensuring that questions around best practice technology and the minimising of environmental impacts are always considered afresh for each campaign.

The Panel recommends as follows:

Should the project be approved, the approval should not include an 'in principle' approval of necessary maintenance dredging works to the year 2030. This should be separately approved, having regard to the state of knowledge of the bay, the availability of best practice dredge technology and the need to minimise environmental harm, at the relevant time.