URS
Business Risk Strategies

26 July 2007
Project No. 43283148

Port of Melbourne Corporation
Nick Easy
General Manager
Channel Deepening Project
GPO Box 261
Melbourne Victoria 3001

Attention: Hilary Chapman
Manager - Environment

Dear Mr Easy,

**Subject: Entrance Channel Depth – Sensitivity Analysis**

## 1. Introduction

The Port of Melbourne Corporation (PoMC) is currently submitting a Supplementary Environment Effects Statement (SEES) to an Inquiry set up by the Minister for Planning for the Port Phillip Bay Channel Deepening Project (CDP).

URS' report within the SEES is URS Australia (2007) Channel Deepening Project Risk Assessment for SEES, URS Australia, Southbank, Victoria, Appendix 6.

The design for the channel profile in The Entrance is to dredge to a level of RL -17.3 Chart Datum (CD) with an over-dredge level of up to RL -19.1m. The Trial Dredge Program (TDP) occurred in August 2005. Post dredging surveys in January and June 2007 confirmed that scour holes had developed in the trial dredge area and most likely in the adjacent Great Ship Channel (GSC). PoMC engaged SKM to estimate the final indicative profile at Rip Bank and Nepean Bank that might occur post-dredging, for the purpose of sensitivity analysis. SKM stated that "[a]fter a period in the order of 10 years it is possible that the scour hole development would extend over the dredged areas and would stabilize at a depth of 3m below the finished dredge level..."[i]n reality the seabed levels in the dredged areas will range in the long term from RL 17.3m to RL -22m in the deepest scour holes." SKM concluded that RL-22m was appropriate to be used for the hydrodynamic analysis of the impact on tidal ranges in Port Phillip Bay (SKM 2007b).

PoMC engaged Cardno Lawson & Treloar to conduct a sensitivity analysis of the hydrodynamic and coastal processes model. The outputs of this analysis are contained in

URS Australia Pty Ltd (ABN 46 000 691 690)
Level 6, 1 Southbank Boulevard Southbank
VIC 3006, Australia
Tel: 61 3 8699 7500
Fax: 61 3 8699 7550

CLT (2007a) and CLT (2007b) and have been used in this assessment. It is noted that this analysis is conservative because it assumes that the entire Great Ship Channel will be at RL-22m. As noted in SKM's letter, "In reality the seabed levels in the dredged areas will range in the long term from RL [-]17.3m to RL -22m in the deepest scour holes" (SKM 2007b).

Scouring impacts could affect two key pathways in the analysis. The pathway examined in this supplementary report relates to design and operations leading to a deepened (and wider channel) and a change in hydrodynamic processes. Scouring may also have an impact in the Entrance relating to leaving behind loose material (rockfall), however these impacts will be considered as part of a separate analysis and do not form part of the conclusions for this report.

## 2. Objective

The objective of this supplementary report is to set out the results of the sensitivity analysis conducted for the *overall risk assessment* for a Great Ship Channel with a depth to RL-22m in comparison to the planned depth of RL-19.1m.

## 3. Methodology

The risk assessment methodology used is consistent with that described in (URS Australia (2007) Channel Deepening Project Risk Assessment for SEES, URS Australia, Southbank, Victoria, Appendix 6 in SEES) and has been guided by URS as Risk Advisor to PoMC.

A scouring sensitivity workshop was held on 12 July 2007. All subject matter specialists who had identified any impacts or consequences within these event pathways were invited to attend. Where a subject matter specialist was unable to attend the workshop, they were provided with all relevant background information and asked to provide PoMC and URS with any changes via correspondence. Table 1 outlines how the subject matter specialists provided their input to the sensitivity analysis.

## Table 1. Subject Matter Specialists Method of Engagement

| Topic | Specialist | Supplementary Statements |
|---|---|---|
| Marine Ecology | Scott Chidgey | CEE 2007. Channel Deepening Project: Supplementary Statement - Entrance Channel Depth, Marine Ecology, July 2007. |
| Fish | Greg Jenkins | Jenkins, G.P. 2007 "Channel Deepening Supplementary Environment Effects Statement – Aquaculture and Fisheries: Supplementary Report on Entrance Channel Depth". Primary Industries Research Victoria, Queenscliff. |
| Nutrient cycling | Andy Longmore | Longmore, A 2007. "Supplementary Statement, Entrance Channel Depth," Primary Industries Research Victoria, July 2007. |
| Seabirds and terrestrial ecology | Inka Veltheim | Brett Lane & Associates 2007 "Entrance Channel Depth supplementary letter," July 2007. |
| Social impacts | Bridget Cramphorn | SKM 2007. "Channel Deepening Project - Social Impact Assessment: Supplementary Risk Assessment Based on Revised Depth at Entrance," July 2007. |
| Economic effects | David Cotterill | SKM 2007. "Channel Deepening Project - Social Impact Assessment: Supplementary Risk Assessment Based on Revised Depth at Entrance," July 2007. |
| Property damage | David Provis | Cardno Lawson Treloar 2007c. "Supplementary Statement – Entrance Channel Depth," July 2007. |
| Penguins | Simon Mustoe | Applied Ecology Solutions 2007. "Supplementary Statement – Entrance Channel Depth," July 2007. |
| Heritage – Aboriginal | David Rhodes | Heritage Insight 2007. 'Supplementary Statement - Entrance Channel Depth", July 2007. |
| Heritage– non-Aboriginal | Cos Coroneos | Cosmos Archaeology 2007. "Channel Deepening Project: Supplementary Statement - Entrance Channel Depth," July 2007. |
| Greenhouse | Mark O'Brien | O'Brien Consulting. 2007 "Supplementary Statement – Entrance Channel Depth," July 2007. |

All impacts and consequences outlined in the above table were reviewed by the subject matter specialists. A total of 43 pathways was considered sequentially for changes. The

subject matter specialists were asked to identify any changes to any of the impacts or consequences as a result of the deeper channel.

The next section outlines the results of the sensitivity analysis and identifies only new and/or altered predicted effects or risk events.

## 4. Results

The relevant risk assessment pathways for the purposes of this sensitivity analysis are:

- Design and operations
- Deepened (and wider) channel
- Change in hydrodynamic processes

The relevant potential impacts are related to:

- Change in sea levels (in the bay)
- Change in currents
- Change in wave patterns in the bay
- Change in wave patterns in the Entrance
- Change in tidal flushing of the bay

Table 2 outlines each pathway considered in the sensitivity analysis. Results of the initial analysis are shown in the "Consequence – RL-19.1 m" column, whilst the sensitivity analysis results are shown in "Consequence – RL-22 m". Changes are highlighted in grey, all other items are unchanged.

**Table 2. Sensitivity Analysis – Comparison of channel depth RL-19.1m and RL-22m**

| Impact Pathway | Impact Pathway (cont.) | Potential Impact | Consequence – RL-19.1 m | Consequence – RL-22m | Accountability |
|---|---|---|---|---|---|
| Change in sea levels (in the bay) | Change in salt marsh communities | Coastal ecosystem | No predicted impact | No predicted impact | Inka Veltheim (Brett Lane) |
| | | Terrestrial ecology | No predicted impact | No predicted impact | Inka Veltheim (Brett Lane) |
| | Direct Impact | Property damage | No predicted impact | No predicted impact | David Provis |

| Impact Pathway | Impact Pathway (cont.) | Potential Impact | Consequence – RL-19.1 m | Consequence – RL-22m | Accountability |
|---|---|---|---|---|---|
| | | Shallow habitats | No predicted impact | **Negligible** | Scott Chidgey |
| | | Marine ecosystems | No predicted impact | **Negligible** | Scott Chidgey |
| | | Shorebirds | Negligible | Negligible | Inka Veltheim (Brett Lane) |
| | | Seabirds | Negligible | Negligible | Inka Veltheim (Brett Lane) |
| | | Amenity / perception | Minor | Minor | Bridget Cramphorn |
| | | Heritage - non-Aboriginal | Negligible | Negligible | Cos Coroneos |
| | | Heritage - Aboriginal | Negligible | Negligible | David Rhodes |
| | | Fish | No predicted impact | **Negligible** | Greg Jenkins |
| | | Seabirds | No predicted impact | **Negligible** | Inka Veltheim (Brett Lane) |
| Change in currents | Change in areas of sand deposition and erosion | Marine Ecology | No predicted impact | No predicted impact | Scott Chidgey |
| | | Social | No predicted impact | **Negligible** | Bridget Cramphorn |
| | | Coastal ecosystems | Negligible | Negligible | Inka Veltheim |
| | | Seabirds | Negligible | Negligible | Inka Veltheim |
| | | Heritage – Non-Aboriginal | Minor | Minor | Cos Coroneos |
| | Larvae dispersal | Fish | Negligible | **Minor** | Greg Jenkins |
| | | Social | No predicted impact | **Negligible** | Bridget Cramphorn |
| | Direct Impact | Property damage | No predicted impact | No predicted impact | David Provis |

| Impact Pathway | Impact Pathway (cont.) | Potential Impact | Consequence – RL-19.1 m | Consequence – RL-22m | Accountability |
|---|---|---|---|---|---|
| | | Fish | No predicted impact | **Negligible** | Greg Jenkins |
| | | Recreation – diving | No predicted impact | No predicted impact | David Cotterill |
| | | Amenity - perception | Negligible | Negligible | Bridget Cramphorn |
| | | Penguins | No predicted impact | **Negligible** | Simon Mustoe |
| | Accelerated corrosion of iron hulled shipwrecks | Heritage – Non-Aboriginal | Negligible | Negligible | Cos Coroneos |
| Change in wave patterns in Bay | Change in coastal processes | Shallow habitats (seagrass) | No predicted impact | No predicted impact | Scott Chidgey |
| | | Amenity / perception | Negligible | Negligible | Bridget Cramphorn |
| | | Heritage - non-Aboriginal | Negligible | Negligible | Cos Coroneos |
| | | Seabirds | Negligible | Negligible | Inka Veltheim (Brett Lane) |
| | Direct Impact | Amenity / perception | No predicted impact | No predicted impact | Bridget Cramphorn |
| Change in wave patterns in Entrance | Change in coastal processes | Property damage | No predicted impact | No predicted impact | David Provis |
| | | Marine ecology | No predicted impact | No predicted impact | Scott Chidgey |
| | | Amenity / perception | Negligible | Negligible | Bridget Cramphorn |
| | | Heritage - non-Aboriginal | Negligible | Negligible | Cos Coroneos |
| | | Heritage - Aboriginal | Negligible | Negligible | David Rhodes |

| Impact Pathway | Impact Pathway (cont.) | Potential Impact | Consequence – RL-19.1 m | Consequence – RL-22m | Accountability |
|---|---|---|---|---|---|
| | | Seabirds | No predicted impact | No predicted impact | Inka Veltheim (Brett Lane) |
| | Direct Impact | Property damage | No predicted impact | No predicted impact | David Provis |
| | | Shallow habitats | No predicted impact | No predicted impact | Scott Chidgey |
| | | Penguins | No predicted impact | **Negligible** | Simon Mustoe |
| | | Recreation - beach use | Negligible | Negligible | Bridget Cramphorn |
| | | Tourism | Negligible | Negligible | David Cotterill |
| | | Fish | No predicted impact | **Negligible** | Greg Jenkins |
| | | Seabirds | No predicted impact | **Negligible** | Inka Veltheim (Brett Lane) |
| Change in tidal flushing of the bay | Changes in temperature / salinity profiles | Amenity / perception | No predicted impact | No predicted impact | Bridget Cramphorn |
| | | Greenhouse | Negligible | Negligible | Mark O'Brien |
| | | Heritage - non-Aboriginal | Negligible | Negligible | Cos Coroneos |
| | Change in nutrient flushing | Nutrient cycle | Negligible | **Minor** | Andy Longmore |
| | | Marine Ecosystems | No predicted impact | **Negligible** | Scott Chidgey |
| | | Penguins | No predicted impact | **Negligible** | Simon Mustoe |
| | | Seabirds | No predicted impact | **Negligible** | Inka Veltheim (Brett Lane) |

## 4.1 Predicted Effects

This discussion is based on extracts from the relevant expert reports. Changes to predicted effects (those with overall probability of 50% or greater) were identified. Channel design (a deepened (and wider) channel) is anticipated to cause changes in hydrodynamic processes leading to a number of new Negligible and Minor predicted effects.

The sensitivity analysis identified one new Minor predicted effect. Several new (or increased from no predicted impacts) Negligible predicted effects were identified in the sensitivity analysis.

Figure 1 illustrates predicted effects by initiating events for channel design and operations. Figure 2 illustrates predicted effects by assets. The results of the original analysis (-19.1 m) are compared with sensitivity (-22 m). Note that both of these figures show predicted effects of Minor or higher (i.e. Consequence Level 1 or higher, this is consistent with the methodology in the SEES (URS 2007, Appendix 6).

### *Change in Sea Levels (in the bay)*

A Negligible predicted effect is anticipated on shallow habitats due to changes in sea levels in the Bay (intertidal seagrass habitats), but is unlikely to have any impact on subtidal habitats such as seagrasses, reefs and soft seabeds. In the SEES, this pathway was assessed as having no impact. This will result in flow-on effects to fish, causing a Negligible impact. Indirect impacts due to flow-on impacts from fish are anticipated to have a Negligible effect on seabirds.

Changes in sea levels will lead to a direct, Negligible impact on rocky intertidal communities (marine ecosystems).

### *Change in Currents*

Areas of sand deposition and erosion may change due to changes in currents, and are anticipated to have a Negligible impact on amenity/perception (social) due to the possibility of some erosion at Point Nepean (an icon destination).

A direct impact of changes in currents is the potential to influence migration behaviour of juvenile/adult fish. This is predicted to have a Negligible impact, although there is considerable uncertainty as to how fish will be affected.

Penguins may also be impacted by a change in currents. A Negligible predicted effect is anticipated due to a slight reduction in wave heights on flood tide. It is possible that penguins could benefit from this, although surface-current conditions are unlikely to be altered.

### *Change in wave patterns in Entrance*

In the Entrance, changes in wave patterns in the Entrance are expected to have a direct, but Negligible impact on penguins and marine mammals. A direct impact due to changes in currents is also expected to have a Negligible impact on fish due to flow-on effects from shallow habitats. This increased impact on fish is anticipated to have an indirect, Negligible flow-on effect on seabirds.

### *Change in Tidal Flushing of the Bay*

A change in tidal flushing of the bay is anticipated to alter nutrient flushing and lead to three new predicted effects. A change in tidal flushing of the bay will have a Minor impact on the nutrient cycle due to changes in nutrient flushing caused by reduced efficiency of denitrification. This is considered “extremely conservative” (Longmore, 2007). This will lead to flow-on impacts on marine ecosystems, where a Negligible predicted effect due to increased flushing is anticipated. Negligible flow-on effects are anticipated for shorebirds that feed on benthic invertebrates that are vulnerable to marine ecosystem changes. Community concerns about environmental impacts are predicted to have a Negligible flow-on impact for social (amenity/perception).

No other additional or altered predicted effects have been identified.

**Figure 1. Design and Operations - Predicted Effects by Initiating Event (excluding risk events, consequence level >=1)**

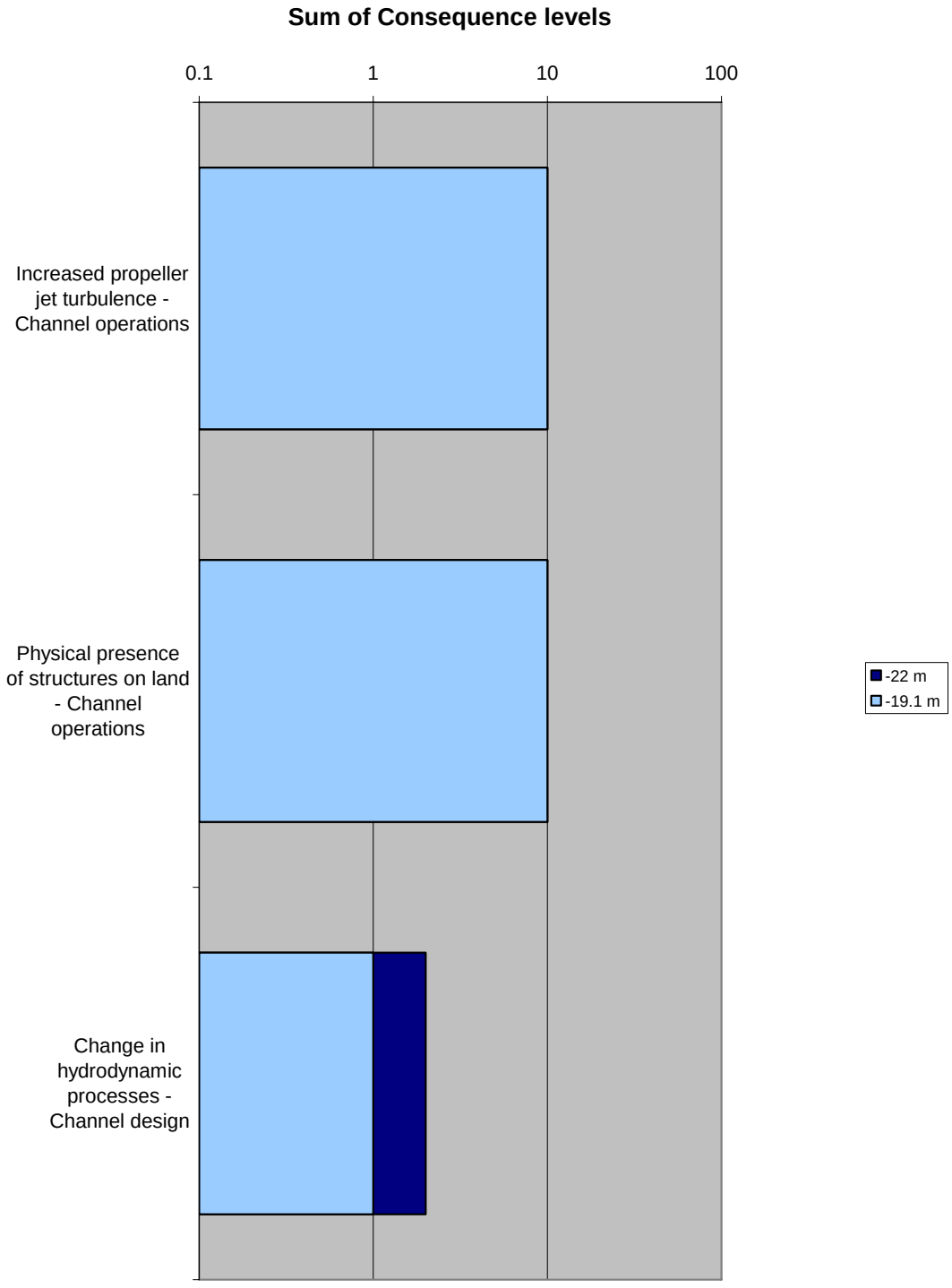
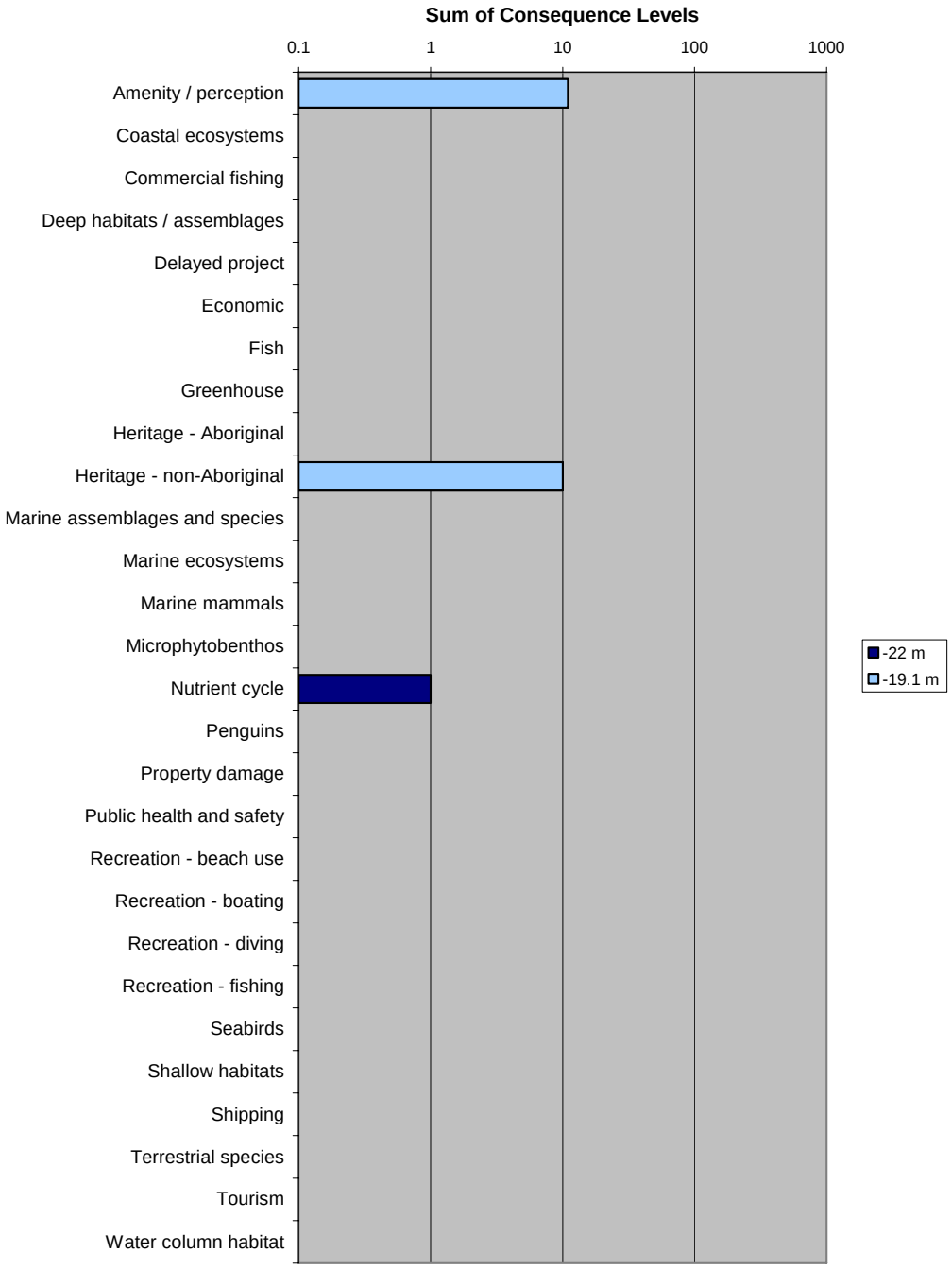


**Figure 2. Design and Operations - Predicted Effects by Asset Categories (consequence level >=1)**



## 4.2 Risk Events

The sensitivity analysis identified one new risk event due to scouring.

A deepened and widened channel could lead to a change in hydrodynamic processes and currents, altering larval dispersion. There is a chance (a Very Low risk level, risk quotient 0.01) that this will have a Minor impact on fish, with the most affected species being those that spawn outside the bay. The potential impact on whiting larval dispersal is unknown. Although a possible Negligible flow-on effect from larval dispersal was identified for amenity/perception (social), the risk level is so low that it is not considered to be a risk event (this is consistent with the methodology adopted for the SEES (URS 2007)).

Figure 3 illustrates risk events by initiating events for channel design and operations. Figure 4 illustrates risk events by assets. The results of the original analysis (-19.1 m) are compared with sensitivity (-22 m).

**Figure 3. Design and Operations - Risk by Initiating Event (excluding predicted effects, risk quotient >=1E-6)**

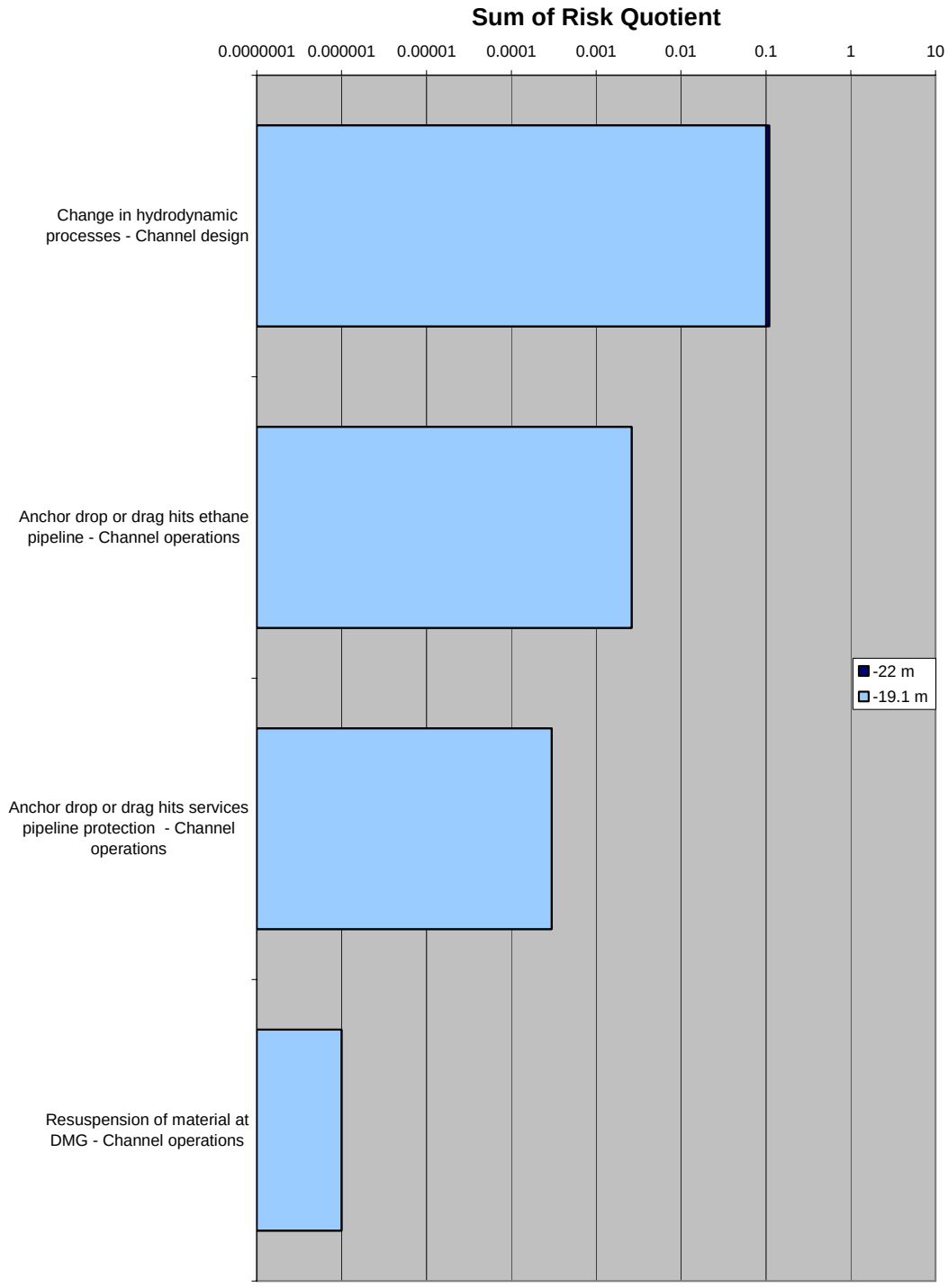
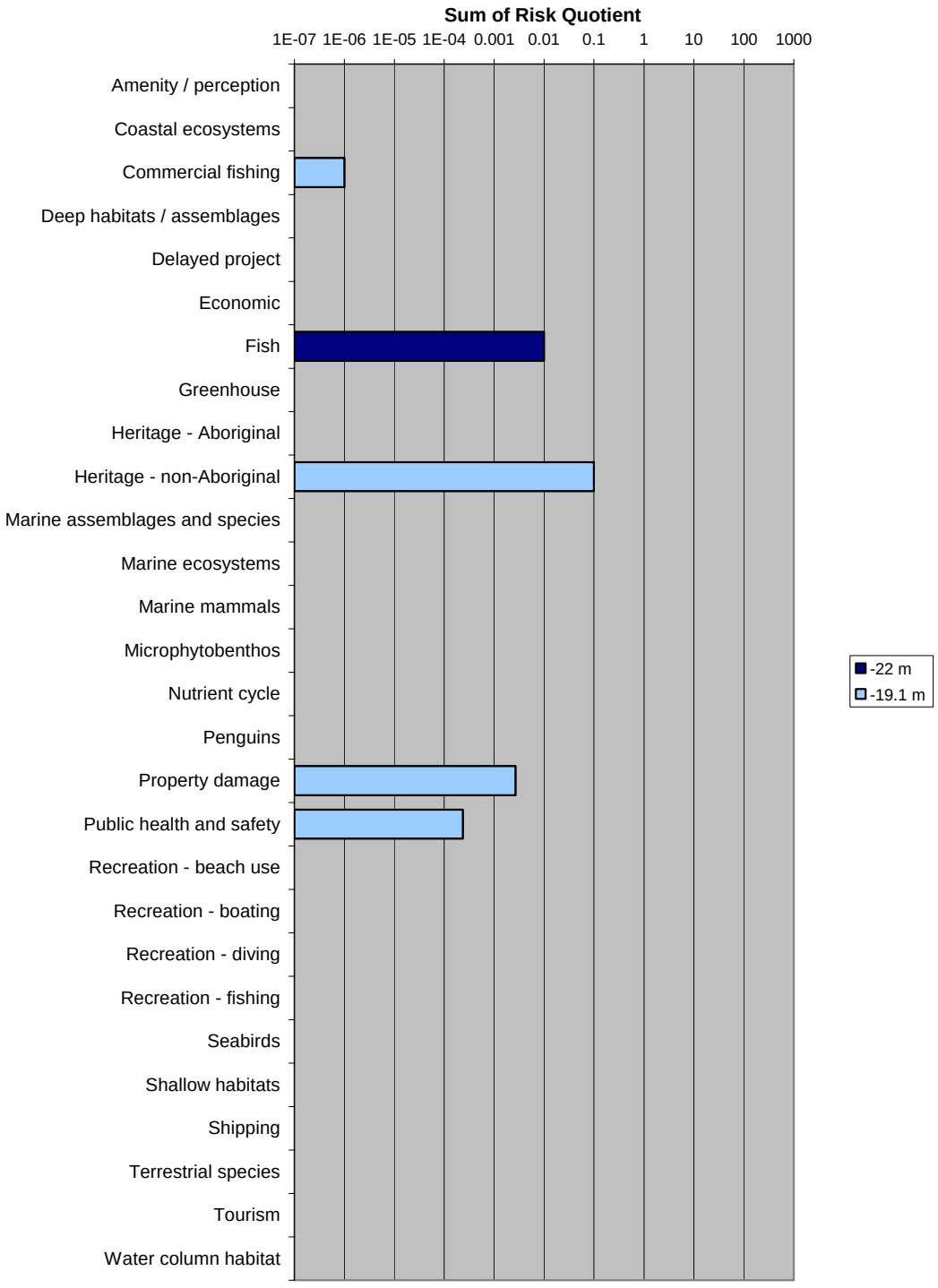


**Figure 4. Design and Operations - Risk Levels by Asset Categories (excluding predicted effects, risk quotient >=1E-6)**



# 5. Recommendations and Mitigation Measures

The following is a summary of the recommendations and mitigations included in the supplementary reports prepared by the specialists (Refer Table 1).

- Provis (property damage) – Nil
- Longmore (nutrient cycling)– "Any longer-term changes due to erosion in the Entrance, if greater than natural variation, should be detectable at the DSE monitoring sites. There would then be no need to continue the PoMC monitoring beyond two years after completion of dredging."
- Chidgey (marine ecology) – Nil
- Jenkins (fish) – "Additional modelling of dispersal of King George whiting larvae in the RL-22m scenario could be considered to reduce uncertainty in this area, although the reassessed consequence in this area is still considered to be "Minor"
- Veltheim (seabirds) – Nil
- Cramphorn (social)– "In terms of overall community response to the information about the scouring and hence deeper channel it is possible that this information will heighten community concerns about the overall environmental impact of the project and the levels of uncertainty that may remain . The situation will need to be clearly communicated to key community groups and the public at large."
- Mustoe (penguins) – Nil
- Rhodes (Aboriginal heritage) "While there will be some increase in wave action at Point Nepean and Point Lonsdale, the Cardno Lawson Treloar report (2007) indicates that this will not be significant. However, as the report also states that there is a slight risk of an increase in coastal erosion, any long-term monitoring programme of wave action at the heads which arises from the Channel Deepening Project, should also consider an assessment of impacts on Aboriginal archaeological sites."
- Cosmos (Non-Aboriginal heritage) - "In broad and brief terms, the mitigation measure for the possible exposure of marine heritage sites at Point Nepean and Point Lonsdale should the Great Ship Channel (GSC) be scoured to a depth RL-22m would be to monitor the site of the Edward for signs of long term loss of sand cover. The site would need to be inspected at least 4 times a year, five years after RL -22 m was reached in the GSC. To obtain baseline data, the site should be inspected at least twice prior to the commencement of dredging the site."

Should the Edward show signs of a net loss of sand cover in the long term, site stabilisation measures may be required. In addition, the examination of other marine heritage sites at Point Nepean and Point Lonsdale to assess their condition could be considered. The routine inspections need not be undertaken with a qualified maritime archaeologist present. The inspections could be undertaken by divers under contract to PoMC whom the maritime archaeologist considers suitable for the task.

In broad and brief terms the mitigation measure for the accelerated corrosion of iron hulled shipwrecks would require obtaining baseline data with respect to corrosion potential for the HMAS Cerberus. Such data is already available for the City of Launceston. If the tidal ranges at Williamstown and Hovel Pile reach the levels presented in Table 1 and Figure 1 of the (CLT) supplementary report "Entrance Channel Depth" (July 2007), within 5 years after the completion of the dredging programme, monitoring of both sites should commence. This would involve obtaining corrosion potential measurements from both sites based on one annual visit up to 5 years after the completion of the dredging programme. Should either site show an increase in the rate of corrosion, site stabilisation measures such as the installation of anodes may be required."

- O'Brien (Greenhouse) - Nil

## 6. Conclusion

The sensitivity analysis identified only one new Minor predicted effect (from which recovery is anticipated within a year, or within the range of natural variation), and one new Very Low risk level risk event. The results of the risk assessment are not substantially changed, with no new Moderate, Major or Extreme events predicted effects or risk events identified.

## 7. References

Applied Ecology Solutions 2007. "Supplementary Statement – Entrance Channel Depth," July 2007.

Brett Lane & Associates 2007 "Entrance Channel Depth supplementary letter," July 2007.

Cardno Lawson Treloar 2007a. "Supplementary Report – Entrance Channel Depth" July 2007.

Cardno Lawson Treloar 2007b. "Supplementary Report – Waves and Coastal Processes" (July 2007).

Cardno Lawson Treloar 2007c "Supplementary Statement – Entrance Channel Depth," July 2007.

CEE 2007. Channel Deepening Project: "Supplementary Statement - Entrance Channel Depth, Marine Ecology," July 2007.

Cosmos Archaeology 2007. "Channel Deepening Project: Supplementary Statement - Entrance Channel Depth," July 2007.

Heritage Insight 2007. 'Supplementary Statement - Entrance Channel Depth", July 2007.

Jenkins, G.P. 2007 "Channel Deepening Supplementary Environment Effects Statement – Aquaculture and Fisheries: Supplementary Report on Entrance Channel Depth". Primary Industries Research Victoria, Queenscliff.

Longmore, A 2007. "Supplementary Statement, Entrance Channel Depth," Primary Industries Research Victoria, July 2007.

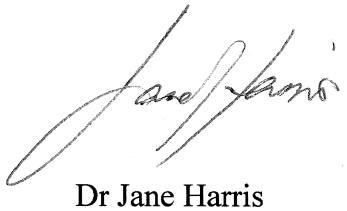
O'Brien Consulting. 2007 "Supplementary Statement – Entrance Channel Depth," July 2007.

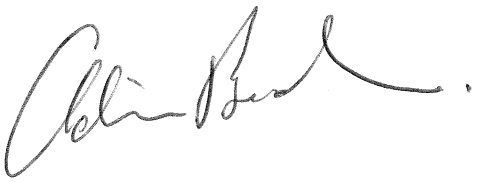
SKM 2007a. "Channel Deepening Project - Social Impact Assessment: Supplementary Risk Assessment Based on Revised Depth at Entrance," July 2007.

SKM 2007b. "SEES Channel Deepening Project. Scour Assessment - The Entrance", SKM letter to PoMC, 11 July 2007

URS Australia 2007. "Channel Deepening Project Risk Assessment for SEES", URS Australia, Southbank, Victoria. In: PoMC (2007) "Supplementary Environmental Effects Statement", Port of Melbourne Corporation, Melbourne, Victoria, Appendix 6.

Yours sincerely,
**URS AUSTRALIA PTY LTD**





Dr Jane Harris
Senior Environmental Scientist

Dr Adrian Bowden
Senior Principal

Att.:
Attachment 1 - Key Pathways for all Predicted Effects and Risk Events for Design and Operations

# Attachment 1. Key Pathways for all Predicted Effects for Design and Operations

| Name | Activity_name | Initiating_event_name | ImpactA_name | ImpactB_name | Consequence_level | Consequence_attribution | Consequence_comment | Consequence_for_graph | Risk_quotient_or_consequence | Pathway Priority Level for Asset Category | Project Area Priority Level for Asset Category | Baywide Priority Level for Asset Category |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Channel operations | Physical presence of navigation aids - on land | Physical presence of structures on land | Alteration to current visual condition | | 10 | BC | Considered visually unattractive. New navaids next to caravan park and residential areas - moderate. | Amenity / perception | 10 | Moderate | Medium | Medium |
| Channel operations | Deeper draught vessels in Bay | Increased propeller jet turbulence | Disturbance of located heritage site (non-Aboriginal) | | 10 | CC | Moderate. Unidentified Dromana, assuming mitigation. | Heritage - non-Aboriginal | 10 | Moderate | Medium | Medium |
| Channel design | Deepened (and wider) channel | Change in hydrodynamic processes | Change in sea levels (in the bay) | --> | 1 | BC | Social perception, flooding, property damage - min. | Amenity / perception | 1 | Minor | Medium | Medium |
| Channel design | Deepened (and wider) channel | Change in hydrodynamic processes | Change in tidal flushing of the bay | Change in nutrient flushing | 1 | AL | Minor, an increase in flushing would lead to a further decline in denitrification efficiency in this area. | Nutrient cycle | 1 | Minor | Low | Low |

URS Australia Pty Ltd (ABN 46 000 691 690)
Level 6, 1 Southbank Boulevard Southbank
VIC 3006, Australia
Tel: 61 3 8699 7500
Fax: 61 3 8699 7550

# Attachment 2. Key Pathways for all Risk Events for Design and Operations

| Name | Activity_name | Initiating_event_name | ImpactA_name | ImpactB_name | Consequence_level | Consequence_attribution | Consequence_comment | Consequence_for_graph | Risk_or_predicted_effect_probability | Risk_quotient_or_consequence | Pathway Priority Level (Risk Level) | Project Area Priority Level (Risk Level) for Asset Category | Baywide Priority Level (Risk Level) for Asset Category |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Channel design | Deepened (and wider) channel | Change in hydrodynamic processes | Change in currents | Change in areas of sand deposition and erosion | 1 | CC | Erosion can possibly have a minor impact on site integrity and significance. | Heritage - non-Aboriginal | 0.1 | 0.1 | Low | Low | Low |
| Channel design | Deepened (and wider) channel | Change in hydrodynamic processes | Change in currents | Larvae dispersal | 1 | GJ | Minor. Most affected species are those that spawn outside the bay, but uncertain of impact on whiting larval dispersal. | Fish | 0.01 | 0.01 | Very low | Very low | Medium |