ENVIRONMENTAL IMPACT STATEMENT

VOLUME 2

Appendices

February 2013

Kurnell Ports and Berthing Facility

URS

CALTEX

Appendix A

Director-General's Requirements

Appendix A1

Director-General's Requirements

Director General's Environmental Assessment Requirements

Section 78A(8A) of the *Environmental Planning and Assessment Act*
Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*

Application Number	SSD-5353
Development	Proposed Port and Berthing Project, Botany Bay, including necessary dredging and berth upgrade works to improve ship access to the Kurnell Wharf. This includes increasing the navigable depth of the berths and approaches around Kurnell Wharf and upgrading port and berthing infrastructure.
Location	Botany Bay
Applicant	Caltex Australia Petroleum Pty Ltd
Date of Issue	9 August 2012
General Requirements	The Environmental Impact Statement (EIS) must be prepared in accordance with and meet the minimum requirements of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* (Regulation), and include the following: 1. the information required by clause 6, including but not limited to: • the description of the development should include construction, operation and staging components, constraints on Botany Bay activities during construction, and required infrastructure to enable construction and operation of the development. 2. the content required by clause 7, including but not limited to: • a summary of the EIS; • a statement of the objectives of the development; • a description and an analysis of feasible alternatives to carrying out the development, having regard to its objectives, including the consequences of not carrying out the development; • an analysis of the development, including an assessment of environmental impacts, with a particular focus on the requirements of the listed key issues, in accordance with clause 7(1)(d) of the Regulation; • an identification of how relevant planning, land use and development matters (including relevant strategic and statutory matters) have been considered in the impact assessment (direct, indirect and cumulative impacts) and/or in developing management, mitigation, and monitoring measures, including section 79C of the *Environmental Planning and Assessment Act 1979* (EP&A Act), applicable State Environmental Planning Policies (SEPPs) including *State and Regional Development SEPP 2011, Infrastructure SEPP 2007, SEPP 14 Coastal Wetlands, SEPP 33 Hazardous and Offensive Development, SEPP 55 Remediation of Land, SEPP 62 – Sustainable Aquaculture* and *SEPP 71 Coastal Protection*; and Local Environmental Plans (LEPs) including draft instruments where relevant, and the nature and extent of any prohibitions that apply to the development; • a compilation (in a single section of the EIS) of the measures proposed to mitigate adverse effects of the development on the environment; • justification of the development taking into consideration the objects of the EP&A Act; • detail how Ecologically Sustainability Development principles (as

	defined in clause 7(4) of the Regulation) will be incorporated in the design, construction and ongoing operation phases of the development. The EIS must also demonstrate that any building works will be capable of meeting relevant Building Code of Australia standards.
Key issues	The EIS must address the following specific matters: **1. Hydrology** – including but not limited to: • hydrodynamic and coastal process changes to Botany Bay, including flushing, tidal flow and velocity, wave dynamics, storm surge impacts and effects on the shoreline of Botany Bay; • potential for the project to alter the tidal range and water levels, and saline intrusion to upstream water bodies and environments (including wetlands), stratification and anoxia; • scouring and erosion of shore line by natural forces and passing vessels; and • impacts to the development resulting from climate change including the consideration of the NSW sea level rise planning benchmarks. **2. Water Quality** – including but not limited to: • impacts on water quality, including sediment dispersion and suspension, and identification of methods for sediment containment; • effects of the development on: o siltation; o groundwater; o the stability of any structures adjacent to the dredge area; and o commercial and recreational fishing and aquaculture, aquaculture leases and oyster farming; • operational impacts including impacts associated with ballast water management; and • taking into account the *Water Quality Guidelines for Fresh and Marine Waters* (ANZECC, 2000) and associated guidelines. **3. Spoil and Contamination** – including but not limited to: • an assessment of the volume and type of sediment materials to be dredged, including the potential for the dredging of Acid Sulfate Soils, taking into account the *Acid Sulfate Soil Manual* (ASSMAC, 1998); • potential for contaminated sediments and groundwater (including Tributyltin), their disturbance during excavation and dredging works, and identification of potential risk to human health, aquaculture activities or the environment; • sampling and characterisation of the distribution of contamination, taking into account the *Sediment Quality Guidelines* (CSIRO Handbook, 2000); • spoil disposal and reuse options, including identification and description of potential disposal locations and associated impacts; and • if contamination is identified and remediation of material is necessary, preparation of a Remediation Action Plan (RAP) or other appropriate materials handling procedures taking into account the *Contaminated Land Management Act 1997.* **4. Flora and Fauna –** including but not limited to: • potential impacts on flora and fauna (including aquatic mammals and reptiles), nature and aquatic reserves and habitat including habitat loss, fragmentation, movement barriers and changed hydrodynamic

	conditions; • impacts on threatened/ endangered species, populations, and ecological communities and/or critical habitat; • consideration of estuarine and groundwater dependent ecosystems, wetlands (including Towra Point Nature Reserve and Towra Point Aquatic Reserve) and mangroves adjacent to and up-river from the development; • potential mobilisation of sediments and increased turbidity levels (including contaminated sediments) on aquatic flora and fauna; • consideration of impacts associated with hydrodynamic changes; • details of how impacts would be managed during construction and operation, the suitability of measures and adaptive management and maintenance protocols and monitoring programs; • details of available offset measures to compensate the biodiversity impacts of the proposal, if necessary. Where offset measures are proposed these should be consistent with the *Principles for the use of biodiversity offsets in NSW*; and • taking into account the *Threatened Species Assessment Guidelines* (NSW DPI, 2008)) and the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (DEC, 2004), *Guidelines for Developments Adjoining Land and Water Managed by the Department of Environment, Climate Change and Water* (DECCW, 2010) and *Policy and Guidelines for Aquatic Habitat Management and Fish Conservation* (DPI, 1999). **5. Heritage** – including but not limited to: • Aboriginal and historic heritage items and values of the site and surrounding area (including known or probable maritime heritage sites and appropriate surveys); and • taking into account of the *NSW Heritage Manual* (NSW Heritage Office, 1996), *Assessing Heritage Significance Guidelines* (NSW Heritage Office, 2001) and *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC, 2005). **6. General Construction** – including but not limited to: • noise and vibration from all activities and sources on and offsite, and impacts to adjoining receivers, • hazards and risks associated with the upgrade of a major hazardous facility, including potential impacts on the fuel supply pipeline, and on the operations at Berth No. 2; • Port Botany operations, including impacts on shipping lanes and queues; • air quality impacts associated with the dredging, handling, stockpiling and disposal of dredged material (as relevant), including odours beyond the site(s) boundary; and • taking into account the *Interim Construction Noise Guideline* (DECC, 2009) and the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005), *Hazardous Industry Planning Advisory Paper (HIPAP) 4 – Risk Criteria for Land Use Planning* and *HIPAP 6 - Guidelines for Hazard Analysis* (DoP, 2011). **7. General Operation** – including but not limited to: • Changes to operational impacts including noise, air quality, hazards and risks and operation of Port Botany, as relevant.

Environmental Risk Analysis	Notwithstanding the above key assessment requirements, the EA must include an environmental risk analysis to identify potential environmental impacts associated with the project, environmental performance criteria and development standards and other mitigation measures, and any significant residual environmental impacts. Where additional key environmental impacts are identified through this environmental risk analysis, an appropriately detailed assessment of this key environmental impact must be included.
Plans and Documents	The EIS must include all relevant plans, architectural drawings, diagrams and relevant documentation required under Schedule 1 of the *Environmental Planning and Assessment Regulation 2000*. Provide these as part of the EIS rather than as separate documents.
Consultation	During the preparation of the EIS, you must consult with the relevant local, State or Commonwealth Government authorities, service providers, community groups and affected landowners. In particular you must consult with: • Office of Environment and Heritage; • Environment Protection Authority; • Heritage Council of NSW; • Department of Trade and Investment (Primary Industry, Mineral Resources and Office of Water); • Department of Sustainability, Environment, Water, Population and Communities; • City of Botany Bay Council; • Randwick City Council; • Sutherland Shire Council; • Rockdale City Council; • Roads and Maritime Services; • Sydney Ports Corporation; • WorkCover; • specialist interest groups, including Local Aboriginal Land Councils; and • the public, including community groups and adjoining and affected landowners. The EIS must describe the consultation process and the issues raised, and identify where the design of the development has been amended in response to these issues. Where amendments have not been made to address an issue, a short explanation should be provided.
Further consultation after 2 years	If you do not lodge a development application and EIS for the development within 2 years of the issue date of these DGRs, you must consult further with the Director General in relation to the preparation of the EIS.

Sutherland Shire
COUNCIL

Administration Centre
4-20 Eton Street, Sutherland
NSW 2232 Australia
Please reply to:
General Manager,
Locked Bag 17,
Sutherland NSW 1499
Australia
Tel 02 9710 0333
Fax 02 9710 0265
DX4511 SUTHERLAND
Email ssc@ssc.nsw.gov.au
www.sutherlandshire.nsw.gov.au
ABN 52 018 204 808
Office Hours
8.30am to 4.30pm
Monday to Friday

Peter Barber
File Ref: 771864645

PCU035801

10 July 2012

Lisa Chan
A/Senior Planning Officer
Infrastructure Projects
Major Projects Assessment
NSW Department of Planning & Infrastructure
23-33 Bridge St
Sydney NSW 2000

Department of Planning
Received
17 JUL 2012
Scanning Room

Dear Ms Chan,

Proposed Port and Berthing Project, Botany Bay - SSD-5353
[In response, please quote File Ref: 771864645]

In response to your request for comment on the draft Director General's environmental assessment Requirements (DGR's) and Environmental Assessment Scoping and Approvals Report (URS, 2012) for the above project, Council has undertaken a review of the aforementioned documents.

Following a review of the documentation, Council believes that the draft DGR's have largely included the key environmental issues requiring consideration and assessment as part of the proposed works.

In relation to the proposed works, Council offers the following comments:

Tributyltin

The positive identification of Tributyltin in sediments within the proposed dredging area is of concern. Tributyltin compounds have the potential for significant adverse impacts upon the marine environment, which can have flow on effects to humans.

A detailed assessment of the impacts associated with the dredging of contaminated sediments and flow on ecological and environmental effects should be undertaken. This should include both the proposed project area and the offshore disposal area. The assessment should outline any treatment methods that can be utilised to reduce the risk from Tributyltin contaminated sediments. The assessment should include all impacts upon the environment and human health associated with the proposed works.

Any use of "clean dredged sediment" should be justified by appropriate sediment sampling and analysis to clearly demonstrate the suitability of such reuse.

Disposal Options

A review of the Environmental Assessment Scoping and Approvals Report (URS, 2012) (EA) indicates that the proposal is heavily dependent upon disposal of the dredged sediments at the Sydney offshore spoil ground. This will require approval from the Australian Government (SEWPaC) under the Commonwealth *Environment Protection (Sea Dumping) Act (SD Act)*. It is Council's opinion that the required approval under the SD Act should be sought prior to finalisation of the EIS so that if approval is not granted for this disposal method and an alternative method is required, the environmental impacts associated with the proposal can be adequately assessed.

Ballast Water Management

The EA (URS, 2012) states that ballast water discharge will be undertaken utilising the "same testing and approvals process.... in order to meet Caltex's requirements". Council recommends that this procedure be clearly outlined in the EIS.

Seagrass Impacts

The area immediately surrounding the proposed works area contains significant areas of seagrass. Of particular importance to note is that "*Posidonia australis* seagrass in Port Hacking, Botany Bay, Sydney Harbour, Pittwater, Brisbane Waters and Lake Macquarie" is listed as an Endangered Population under Schedule 4 of the *NSW Fisheries Management Act 1994 (NSW FM Act 1994).*

Dredging and changes to the physical environment (e.g. altered wave heights) have been identified as some of the key processes threatening the ongoing persistence of the populations. As such, the proposal has the potential to have significant impacts upon key seagrass beds, some of which are listed as an endangered population under the *NSW FM Act 1994* and therefore requires appropriate assessment of the impacts associated with the proposed works. This should be a detailed assessment based on a combination of survey work and scientific literature review and must assess all direct and indirect impacts associated with the proposed works.

Marine Mammal Management

The EIS should include a Marine Mammal Management Plan which addresses any impacts associated with the proposal upon marine mammals. The assessment and management protocols identified should include both the dredging area and the transportation route to the offshore disposal area.

Works should ideally be conducted outside of the whale migration seasons.

Waste Management

Waste management procedures for the proposed works should be clearly outlined in a waste management plan which should be included in the EIS.

Monitoring

A clearly outlined and scientifically robust monitoring program should be included in the EIS. This program should include all potential environmental impacts and must include a suitable spatial and temporal scale to quantify any impacts associated with the proposed works.

The monitoring program must be designed to provide statistical robustness to identify changes resulting from the proposed works and must include a suitably identified temporal scale to identify any potential changes resulting from the proposed works.

Contingency Planning

Given the potential for significant adverse impacts associated with the proposed works, a contingency plan should be prepared and included in the EIS to address any observed changes identified as part of ongoing monitoring requirements.

The measures outlined in the contingency plan should be designed to address any changes observed as part of the monitoring of the proposed works, both during and post construction. Any proposed mitigation or rehabilitation measures identified should be justified in the scientific context to confirm the suitability of the proposed measures. For example, the restoration of *Posidonia* seagrass meadows has proven to be largely unsuccessful (Gannasin & Gibbs, 2008) and therefore reliance on this method would be unsuitable.

Scientific Justification

A number of assumptions have been made in the draft EA with respect to predicted impacts resulting from the proposed works. Whilst the reported assumptions may be accurate, any such statement, particularly in regards to predicted impacts or negating the requirement for further assessment, should be justified with appropriate scientific literature.

Conclusion

Overall, Council believe that the DGR's have largely covered the key environmental issues associated with the proposed works, however recommend that the aforementioned issues be included as part of the DGR's issued for the proposal.

Council thanks you for the opportunity to provide comment on the draft EA and DGR's and look forward to commenting on the proposal as part of the public exhibition process.

Should you need to discuss any aspect of this matter further, please do not hesitate to contact Council's Manager Coastal Assessment Team, Peter Barber, on 9710 0373 during normal business hours.

Yours faithfully

Peter Barber
for J W Rayner
General Manager

Please reply to: General Manager
LOCKED BAG 17 SUTHERLAND NSW 1499 AUSTRALIA
PHONE (02) 9710 0333 DX4511 SUTHERLAND
ABN 52 018 204 808 ADMINISTRATION FAX: (02) 9710 0265

Australian Government
Department of Sustainability, Environment, Water, Population and Communities

Ref: 2010/08999

PCU035521

Lisa Chan
A/g Senior Planning Officer
NSW Department of Planning and Infrastructure
23-33 Bridge Street
Sydney NSW 2000

Dear Ms Chan

Request for DGRs for proposed Port and Berthing Project, Botany Bay – SSD-5353

Thank you for your letter dated 3 July 2012 providing the opportunity to comment on the Director General's environmental assessment Requirements (the DGRs) for the above proposal submitted by Caltex Australia Petroleum Pty Ltd.

I advise that this project has not been referred to the department and is not currently being assessed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The department has no comments to provide on the DGRs, however, the proponent should be advised to consider their obligations under the EPBC Act. Further information on the EPBC Act is available at www.environment.gov.au/epbc.

Should you have any further enquiries regarding this letter, please do not hesitate to contact Matthew Kuntsi on (02) 6274 1536 or by email at matthew.kuntsi@environment.gov.au.

Yours sincerely

Barbara Jones
Assistant Secretary
Environment Assessment Branch
5 July 2012

Department of Planning
Received
9 JUL 2012
Scanning Room

ROCKDALE
CITY COUNCIL
On Historic Botany Bay

13 July 2012

Our Ref: F12/50, 12/46428 (CM:ph)
Contact: Colin Mable - 9562 1647

Ms L Chan
A/Senior Planning Officer
Infrastructure Projects
NSW Planning & Infrastructure
GPO Box 39
Sydney 2001

Dear Ms Chan

Re: Proposed Port and Berthing Project at Kurnell, Botany Bay (SSD-5353)

I refer to your letter received by Council on 4 July, 2012 seeking comments on the draft DGR assessment prepared by the Department for the above project.

I wish to advise that Council is very concerned at the potential impact the proposed dredging may have on wave patterns in Botany Bay.

Over the last 50 years due to a combination of major developments and natural processes in Botany Bay severe erosion has occurred along the western foreshore of Botany Bay (Lady Robinsons Beach). This foreshore is the eastern boundary of Rockdale City Council.

To address this problem Council in conjunction with various State and Federal Government Agencies has undertaken a range of works to restore the beach and foreshore. In fact between 1996/97 and 2004/05 works to the value of $13.3M were undertaken to restore the foreshore between President Avenue, Brighton Le Sands and Sandringham Bay, Sans Souci. This work comprised the construction of 13 groynes and the placement of 326,000m^3 of sand for beach nourishment.

Therefore, Council requests, as part of any Environmental Review of this project, that a detailed study to be undertaken to ensure the proposed Kurnell dredging does not adversely affect the wave patterns in Botany Bay and the foreshore along Lady Robinsons Beach.

Further, any approvals for this project should include a condition to undertake pre and post hydro survey in the Bay to assess the impacts of the dredging.

If it is established that the dredging has had an adverse impact on the western foreshore of Botany Bay then the Proponent "Caltex" to undertake remediation works as determined by a Specialist Coastal Engineering Consultant.

Should you have any further enquiries with the above please contact Council's Executive Engineer, Mr Colin Mable on 9562-1647.

Yours faithfully

Wayne Carter
Director – City Operations

2 Bryant Street Rockdale NSW 2216 Australia
PO Box 21 Rockdale NSW 2216 Australia
Tel 02 9562 1666 Fax 02 9562 1777 Email rcc@rockdale.nsw.gov.au
DX 25308 Rockdale www.rockdale.nsw.gov.au
ABN 66 139 730 052

Lisa Chan - SSD 5353 - Botany Bay

From: Susannah Webb <Susannah.Webb@rms.nsw.gov.au>
To: '"lisa.chan@planning.nsw.gov.au"' <lisa.chan@planning.nsw.gov.au>
Date: 13/07/2012 2:26 PM
Subject: SSD 5353 - Botany Bay

Hi Lisa

I tried to call you earlier today. In respect to the request for comments regarding the DGRs for the above project, RMS – Maritime Division have not matters to add to the DGRS. It is noted however, the applicant will be required to seek RMS' land owner consent as part of the SSD process.

If you have any questions please feel free to give me a call.

regards

Susannah Webb
A/Manager
Property Planning and Infrastructure Section | Planning, Environment and Spatial Information
T 02 9563 8697
www.rmservices.nsw.gov.au

Roads and Maritime Services
James Craig Road Rozelle 2039
Locked Bag 5100 Camperdown NSW 1450

Before printing, please consider the environment.

IMPORTANT NOTICE: This e-mail and any attachment to it are intended only to be read or used by the named addressee. It is confidential and may contain legally privileged information. No confidentiality or privilege is waived or lost by any mistaken transmission to you. Roads and Maritime Services (RMS) is not responsible for any unauthorised alterations to this e-mail or attachment to it. Views expressed in this message are those of the individual sender, and are not necessarily the views of RMS. If you receive this e-mail in error, please immediately delete it from your system and notify the sender. You must not disclose, copy or use any part of this e-mail if you are not the intended recipient.

Lisa Chan - Proposed Kurnel Wharf Works (SSD-5353)

From: David Ongkili <David.Ongkili@randwick.nsw.gov.au>
To: "lisa.chan@planning.nsw.gov.au" <lisa.chan@planning.nsw.gov.au>
Date: 18/07/2012 10:48 AM
Subject: Proposed Kurnel Wharf Works (SSD-5353)
CC: Sima Truuvert <Sima.Truuvert@randwick.nsw.gov.au>, Kerry Kyriacou <Kerry.Kyriacou@randwick.nsw.gov.au>

Dear Lisa,
I refer to the proposed works for the Kurnell Wharf upgrade (SSD - 5353). Randwick Council raises the following issues to be addresses in the DGRs for this State Significant Project:

- The potential impact of the proposed works on the operation of the Sydney Ports in the Randwick City and adjoining Botany Bay City Council areas, including any impacts on shipping lanes and queues to and from Port Botany.

- The works must be undertaken with appropriate risk management measures to prevent any spillage of pollutants into Botany Bay including environmental management systems to prevent potential marine oil spills.

- The EA should assess the potential ecological impacts, including, but not limited to, the following:

    - Impacts on the hydrodynamics of Botany Bay
    - Loss of biodiversity in Botany Bay
    - Disturbance of acid sulphate soil particularly related to dredging and use of dredged material for fill
    - Impacts on water quality
    - Impact on the groundwater levels and quality including the Botany Aquifer
    - Impact on wetland areas

- Ensure comprehensive community consultation.

If you have any query, please do not hesitate to call or e-mail me.

Regards

David Ongkili
Co-ordinator - Major Assessment
Development Assessments Section
Randwick City Council
30 Frances Street
RANDWICK NSW 2031
Phone: (02) 9399 0793
Fax: (02) 9399 0799
www.randwick.nsw.gov.au

PCU035802

Our reference: LIC06/45-29: DOC12/26939:CP
Contact: Craig Patterson (02) 4224 4100

Department of Planning
Received
17 JUL 2012
Scanning Room

Department of Planning
(Attention: Lisa Chan)
GPO Box 39
SYDNEY NSW 2001

Dear Ms Chan

DIRECTOR GENERAL REQUIREMENTS
PROPOSED PORT AND BERTHING PROJECT, BOTANY BAY (SSD-5353)
CALTEX AUSTRALIA PETROLEUM PTY LTD, KURNELL

I refer to the Department of Planning and Infrastructure's request for the Environment Protection Authority (EPA) to review the draft Director General Requirements (DGRs) prepared for the above development application.

On 13 October 2011, the EPA provided its key Environmental Assessment requirements to Caltex's consultants at the time being Worley Parsons Resources and Energy. A copy of these requirements is attached to this letter.

The EPA requests that these key Environmental Assessment requirements be included in the DGRs for the project.

Should you have any further enquiries, please contact the above officer.

Yours sincerely

13/7/12

PETER BLOEM
Manager Illawarra
Environment Protection Authority

Att:

(N:\FINALS\2012\PLANNING\CP DOC12-26939 CALTEX DREDGING AT KURNELL WHARF.DOC)

PO Box 513 Wollongong NSW 2520
Level 3, 84 Crown Street, Wollongong NSW
Tel: (02) 4224 4100 Fax: (02) 4224 4110
ABN 43 692 285 758
www.environment.nsw.gov.au

NSW GOVERNMENT | Environment, Climate Change & Water

Your reference:
Our reference: LIC06/45-24;DOC11/46608:CP
Contact: Craig Patterson, (02) 4224 4100

WorleyParsons Resources and Energy
(Attention: Orla Murray)
141 Walker Street
NORTH SYDNEY NSW 2060

Dear Ms Murray

ENVIRONMENTAL ASSESSMENT REQUIREMENTS
PROPOSED MAINTENANCE DREDGING AT CALTEX KURNELL WHARF

I refer to your request for the Office of Environment and Heritage (OEH) to identify key requirements for the development of an Environmental Assessment (EA) for the above proposal received by OEH on 29 September 2011.

Based on the information provided at the Planning Focus Meeting on 16 September 2011 and in the documentation prepared by Worley Parsons, there are a number of key environmental issues that should be investigated as part of the approval process. These issues are identified in Attachment A and include:

- Licensing requirements
- Water Quality including Acid Sulfate Soils and contamination
- Noise and Vibration
- Biodiversity
- OEH Estate
- Air Quality
- Waste

Guidance and supporting documents which may be useful in addressing these issues are included in Attachment B.

If you have any queries regarding this matter please contact the officer above.

Yours sincerely

13 October 2011

CATE WOODS
Acting Manager Illawarra
Environment Protection and Regulation

Att: A and B

(R:\2011\Scheduled Industry holds EPL\L637 CALTEX\CALTEX DREDGING AT KURNELL WHARF - EARS)

PO Box 513 Wollongong NSW 2520
Level 3, 84 Crown Street Wollongong NSW
Tel: (02) 4224 4100 Fax: (02) 4224 4110
ABN 30 841 387 271
www.environment.nsw.gov.au

ATTACHMENT A

The following are the Office of Environment and Heritage's (OEH) key environmental requirements to be addressed in the development of an Environmental Assessment (EA) for the proposed development.

Environmental Impacts of the Project

1. The following environmental issues need to be assessed, quantified and reported on:
   - Licensing requirements
   - Water Quality including Acid Sulfate Soils and contamination
   - Noise and Vibration
   - Biodiversity
   - OEH Estate
   - Air Quality
   - Waste

2. EAs should address the specific requirements outlined under each heading below and assess impacts in accordance with the relevant guidelines mentioned. A full list of guidelines is at Attachment B.

The Project

1. The EA should fully scope the project including details on the location of the proposed project. This should include details on the affected environment to place it in its local and regional environmental context including surrounding landuses, planning zonings, potential sensitive receptors and environmental sensitivity.

2. Describe mitigation and management options that will be used to prevent, control, abate or mitigate identified environmental impacts (including any cumulative impacts) associated with the project and to reduce risks to human health and prevent the degradation of the environment. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented. Appropriate Best Management Techniques (BMT) should also be outlined.

3. The EA should consider how operational aspects of the project could be coordinated with the proponents of other projects occurring in the vicinity to minimise noise impacts on sensitive receivers.

4. The EA should consider the potential for any cumulative impacts to occur as a result of the proposed dredging activities. Where necessary, the EA should consider how operational activities of the project could be coordinated with the proponents of other projects occurring in the vicinity to minimise impacts arising from the development including water quality, noise impacts, construction traffic, dust impacts, aquatic ecology and waste management.

Licensing Requirements

3. On the basis of the information submitted to date, the proposal may be classified as a scheduled activity under the *Protection of the Environment Operations Act 1997* (POEO Act) and may therefore require an Environment Protection Licence (EPL) if approval is granted. The EA should determine whether an EPL will be required for the proposed works and provide sufficient information where necessary to enable OEH to determine appropriate licence limits. The requirements of Section 45 of the *Protection of the Environment Operations Act 1997* should also be addressed should a licence be required.

   Should project approval be granted, the proponent will need to make a separate application to OEH for an EPL (if required) for the proposal prior to undertaking any on site works. Additional information is available through the OEH Guide to Licensing document:
   www.environment.nsw.gov.au/licensing/licenceguide.htm

Water Quality

The goal of the project should be to ensure:

- There is no pollution of waters (including surface and groundwater), except in accordance with licence requirements.

The EA should identify the relevant Water Quality Objectives for the waters of Botany Bay and demonstrate how the project will be designed and operated to protect these water quality objectives. These measures should be consistent with the NSW Government's Statement of Intent for Georges River Botany Bay System (2002).

The EA should also describe the nature and degree of any likely impacts that the proposed project may have on the receiving environment and clearly outline the proposed mitigation, monitoring and management measures the proponent intends to apply to the project to ensure the above goals are satisfied.

Dredging

The EA will need to describe the proposed dredging methodology and document an assessment of the proposed dredging activities within the waters of Botany Bay including the management of any dredged spoil. OEH understands that the dredged spoil may contain some level of contamination. The EA should undertake a comprehensive assessment of the suitability of the material for the preferred disposal option whether this be beneficial reuse or offshore disposal. A map of the distribution of any contaminated sediment in Botany Bay with details on the quality and estimated quantity should also be included.

Hydrological Impacts

OEH's broad environmental goal is that the proposal should not result in any hydrodynamic changes that adversely affect conservation and cultural heritage outcomes elsewhere in Botany Bay. The EA will need to assess whether the proposed works may have any potential affects on the hydro-dynamics of Botany Bay.

Acid sulfate soils

The potential impacts of the development on acid sulfate soils must be assessed in accordance with the relevant guidelines in the *Acid Sulfate Soils Manual* (Stone *et al* 1998) and the *Acid Sulfate Soils Laboratory Methods Guidelines* (Ahern *et al* 2004). Acid Sulfate Soils Planning Maps can be located at http://canri.nsw.gov.au/download/.

Describe mitigation and management options that will be used to prevent, control, abate or minimise potential impacts from the disturbance of acid sulfate soils associated with the project and to reduce risks to human health and prevent the degradation of the environment. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.

Noise and Vibration

The goal of the project should be to minimise adverse impacts due to noise from the project.

OEH notes that the community at Kurnell has been impacted by various infrastructure projects occurring in Botany Bay and the Kurnell peninsula in the recent past and projects will continue in the near future.

The assessment must clearly outline the noise mitigation, monitoring and management measures the proponent intends to apply to the project to minimise noise pollution. The assessment should include, but need not be limited to: identification and assessment of all potential noise sources associated with the development, the location of all sensitive receptors, proposed hours of operation and proposed noise mitigation measures.

On 5 September 2011 the Department of Planning and Infrastructure granted approval for the Caltex Jet Fuel Pipeline Upgrade Project. This project involves undertaking works at both the Kurnell Refinery and the Banksmeadow Terminal. Depending on the timeframe for the proposed dredging works, the noise assessment may need to consider the cumulative impacts of the dredging activities as well as the Jet Fuel Pipeline activities being undertaken around the Kurnell area.

Construction noise and operational noise associated with the proposed project should be assessed in accordance with the attached guidelines.

Biodiversity

The EA should include a detailed biodiversity assessment, including assessment of impacts on threatened biodiversity, native vegetation and habitat. The assessment should be carried out in accordance with the relevant guidelines contained in Attachment B and include the following information as a minimum:

a. The requirements set out in the *Guidelines for Threatened Species Assessment* (Department of Planning, July 2005).
b. Identification of national and state listed threatened biota known or likely to occur in the study area and their conservation status.
c. Description of the likely impacts of the proposal on biodiversity and wildlife corridors, including direct and indirect and construction and operation impacts. Wherever possible, quantify these impacts such as the amount of each vegetation community or species habitat to be cleared or impacted, or any fragmentation of a wildlife corridor.
d. Identification of the avoidance, mitigation and management measures that will be put in place as part of the proposal to avoid or minimise impacts, including details about alternative options considered and how long term management arrangements will be guaranteed.
e. Description of the residual impacts of the proposal. If the proposal cannot adequately avoid or mitigate impacts on biodiversity, then a biodiversity offset package is expected (see the requirements for this at point 6 below).

An assessment of the significance of direct and indirect impacts of the proposal must be undertaken for threatened biodiversity known or considered likely to occur in the study area based on the presence of suitable habitat.

There are a number of marine mammals and marine reptiles that have been recorded within the waters of Botany Bay including Humpback and Southern Right Whales, Australian and New Zealand Fur Seals as well as Loggerhead and Green Turtles. OEH suggests that the assessment should also consider any potential impacts that the dredging activities may have on marine mammals and marine reptiles that frequent the waters of Botany Bay.

OEH Estate

Where appropriate, likely impacts (both direct and indirect) on any adjoining and/or nearby OEH Estate reserved under the *National Parks and Wildlife Act 1974* or any marine and estuarine protected areas under the *Fisheries Management Act 1994* or the *Marine Parks Act 1997* should be considered. Refer to the *Guidelines for developments adjoining land and water managed by the Department of Environment, Climate Change and Water* (DECC, 2010).

Towra Point Nature Reserve includes important remnant terrestrial vegetation and wildlife habitats, and is surrounded by seagrass beds, mangroves and migratory wading bird habitats. Towra Point Nature Reserve and the adjacent Towra Point Aquatic Reserve form the largest and most diverse estuarine wetland complex remaining in the Sydney region.

The EA should include a description of the mitigation and management options that will be used to prevent, control, abate or minimise any potential impacts that are likely to occur on the Towra Point Nature Reserve associated with the project. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.

Air Quality

The goals of the project should be to ensure:

- Unacceptable impacts do not occur on human health or the environment; and
- No potentially offensive odours occur beyond the boundary of the premises.

The EA should include a detailed description of the proposal and identify and describe all processes that could result in air emissions. Sufficient detail to accurately communicate the characteristics and quantity of all emissions must be provided. A description of any proposed mitigation, monitoring and management measures the proponent intends to apply to ensure the above goals are satisfied should also be included.

The EA should also include an assessment of the risk associated with potential discharges of fugitive and point source emissions for all stages of the proposal. Assessment of risk relates to environmental harm, risk to human health and amenity.

OEH's experience from other projects is that dredging of organic rich materials can become sources of fugitive odours. Whilst it is acknowledged that the material to be dredged is mainly sand with minimal amounts of clay and silt, the risk of genorating potentially offensive odours from the proposed dredging activities should be assessed. All necessary mitigation measures to minimise any potential impacts should also be included.

Waste

The goal of the project should be to ensure waste is managed:

- In accordance with the principles of the waste hierarchy and cleaner production
- The handling, processing and storage of all materials used at the premises does not have negative environmental or amenity impacts
- The beneficial reuse of all wastes generated at the premises are maximised where it is safe and practical to do so; and the EA should identify, characterise and classify all waste that will be generated and disposed of as a result of the dredging activities. Proposed quantities of waste and disposal locations should be detailed in the assessment.

All waste must be classified in accordance with OEH's *Waste Classification Guidelines.*

ATTACHMENT B - GUIDANCE MATERIAL

Title	Web address
Licensing	
DECCW Guide to Licensing	www.environment.nsw.gov.au/licensing/licenceguide.htm
Aboriginal Cultural Heritage	
Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (2005)	Available from DoP.
Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW, 2010)	http://www.environment.nsw.gov.au/licences/consultation.htm
Code of Practice for the Archaeological Investigation of Aboriginal Objects in New South Wales (DECCW, 2010)	http://www.environment.nsw.gov.au/licences/archinvestigations.htm
Aboriginal Site Impact Recording Form	http://www.environment.nsw.gov.au/licences/DECCAHIMSSiteRecordingForm.htm
Aboriginal Heritage Information Management System (AHIMS) Registrar	http://www.environment.nsw.gov.au/contact/AHIMSRegistrar.htm
Air Issues	
Air Quality	
Approved methods for modelling and assessment of air pollutants in NSW (2005)	http://www.environment.nsw.gov.au/resources/air/ammodelling05361.pdf
POEO (Clean Air) Regulation 2002	http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+642+2002+cd+0+N
Biodiversity	
BioBanking Assessment Methodology (DECC, 2008)	http://www.environment.nsw.gov.au/resources/biobanking/08385bbassessmethod.pdf
BioBanking Assessment Methodology and Credit Calculator Operational Manual (DECCW, 2008)	http://www.environment.nsw.gov.au/biobanking/operationalmanual.htm
Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna -Amphibians (DECCW, 2009)	http://www.environment.nsw.gov.au/resources/threatenedspecies/09213amphibians.pdf
Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft (DEC, 2004)	http://www.environment.nsw.gov.au/resources/nature/TBSAGuidelinesDraft.pdf
Guidelines for Threatened Species Assessment (Department of Planning, July 2005)	Draft available from DoP
DECCW Threatened Species website	http://www.environment.nsw.gov.au/threatenedspecies/
Atlas of NSW Wildlife	http://wildlifeatlas.nationalparks.nsw.gov.au/wildlifeatlas/watlas.jsp
BioBanking Threatened Species Database	http://www.environment.nsw.gov.au/biobanking/biobankingtspd.htm
Vegetation Types databases	http://www.environment.nsw.gov.au/biobanking/vegtypedatabase.htm
PlantNET	http://plantnet.rbgsyd.nsw.gov.au/
Online Zoological Collections of Australian Museums	http://www.ozcam.org/
Threatened Species Assessment Guideline - The Assessment of Significance (DECCW, 2007)	http://www.environment.nsw.gov.au/resources/threatenedspecies/tsaguide07393.pdf
Principles for the use of biodiversity offsets in NSW	http://www.environment.nsw.gov.au/biocertification/offsets.htm
DECCW Estate	

Title	Web address
Aquatic Reserves	
List of aquatic reserves	www.environment.nsw.gov.au/nationalparks/parktypes.aspx?type=aquaticreserve
Land reserved or acquired under the NPW Act	
List of national parks	http://www.environment.nsw.gov.au/NationalParks/parksearchatoz.aspx
Guidelines for developments adjoining land and water managed by the Department of Environment, Climate Change and Water (DECCW, 2010)	http://www.environment.nsw.gov.au/resources/protectedareas/10509devadjdeccw.pdf
Noise and Vibration	
Interim Construction Noise Guideline (DECC, 2009) and Industrial Noise Policy Application Notes	http://www.environment.nsw.gov.au/noise/constructnoise.htm
Assessing Vibration: a technical guideline (DEC, 2006)	http://www.environment.nsw.gov.au/noise/vibrationguide.htm
Industrial Noise Policy (EPA, 2000) and Industrial Noise Policy Application Notes	http://www.environment.nsw.gov.au/noise/industrial.htm
Environmental Criteria for Road Traffic Noise (EPA, 1999)	http://www.environment.nsw.gov.au/noise/traffic.htm
Waste, Chemicals and Hazardous Materials and Radiation	
Waste Classification Guidelines (DECC, 2008)	http://www.environment.nsw.gov.au/waste/envguidlns/index.htm
Water and Soils	
Acid sulphate soils	
Acid Sulfate Soils Planning Maps	http://canri.nsw.gov.au/download/
Acid Sulfate Soils Manual (Stone et al. 1998)	Manual available for purchase from: http://www.landcom.com.au/whats-new/the-blue-book.aspx Chapters 1 and 2 are on DoP's Guidelines Register at: Chapter 1 Acid Sulfate Soils Planning Guidelines: http://www.planning.nsw.gov.au/rdaguidelines/documents/NSW%20Acid%20Sulfate%20Soils%20Planning%20Guidelines.pdf Chapter 2 Acid Sulfate Soils Assessment Guidelines: http://www.planning.nsw.gov.au/rdaguidelines/documents/NSW%20Acid%20Sulfate%20Soils%20Assessment%20Guidelines.pdf
Acid Sulfate Soils Laboratory Methods Guidelines (Ahern et al. 2004)	http://www.derm.qld.gov.au/land/ass/pdfs/lmg.pdf This replaces Chapter 4 of the Acid Sulfate Soils Manual above.
Water	
Water Quality Objectives	http://www.environment.nsw.gov.au/ieo/index.htm
ANZECC (2000) Guidelines for Fresh and Marine Water Quality	http://www.mincos.gov.au/publications/australian_and_new_zealand_guidelines_for_fresh_and_marine_water_quality
Applying Goals for Ambient Water Quality Guidance for Operations Officers – Mixing Zones	http://deccnet/water/resources/AWQGuidance7.pdf
Approved Methods for the Sampling and Analysis of Water Pollutant in NSW (2004)	http://www.environment.nsw.gov.au/resources/legislation/approvedmethods-water.pdf

NSW GOVERNMENT | Department of Primary Industries

Re: Request for DGRs for Proposed Port and Berthing Project, Botany Bay – SSD-5353

Fisheries NSW
In this response Fisheries NSW have addressed all potential impacts the proposal may have on issues considered under the *Fisheries Management (FM) Act*, including aquatic habitat protection, aquaculture, aquatic reserve and recreational fishing matters.

Aquatic Habitat Protection
DPI-Fisheries is responsible for ensuring that fish stocks are conserved and that there is no net loss of key fish habitats upon which they depend. To achieve this, the Aquatic Habitat Protection Unit ensures that developments comply with the requirements of the *Fisheries Management (FM) Act 1994* (namely the aquatic habitat protection and threatened species provisions in Parts 7 and 7A of the Act, respectively), and the associated *Policy and Guidelines for Aquatic Habitat Management and Fish Conservation (1999).*

The proposed dredging activity is situated in the vicinity of the largest estuarine wetland in Sydney. This includes valuable seagrass, mangrove and saltmarsh communities that are considered to be important key fish habitat. The conservation significance of this area is recognised in its protection through the Towra Point Aquatic Reserve (managed by DPI-Fisheries) and the Towra Point Nature Reserve (managed by the Office of Environment and Heritage – OEH). The area also contains Internationally significant Ramsar wetlands. Situated off Kurnell, the proposed dredging is in close proximity to a significantly large area of the Endangered Population of *Posidonia australis* seagrass in Botany Bay, as listed under the FM Act.

Considering the provisions of the FM Act and the above mentioned policy, aspects of this proposal of concern to DPI - Fisheries include potential:

- direct and indirect impacts to marine vegetation (i.e. algae, seagrasses, mangroves and saltmarsh) from activities including:
  - direct removal, or smothering from dredged spoil
  - turbidity and sedimentation during dredging activities
  - erosion and sedimentation from any changes to currents, waves and coastal processes that may result from the final dredged configuration and significant changes to boat wakes from larger vessels and more frequent boating activity.
- impacts to aquatic and intertidal habitats from disposal of dredged material within Botany Bay. Note that DPI-Fisheries recommends that dredged spoil is to be deposited appropriately on land or at the approved Commonwealth offshore spoil dumping grounds. Any excavated material to be deposited on land is to be done so according to its contamination and acid sulphate characteristics.
- impacts to water quality during dredging, particularly turbidity related impacts.
- impacts to the Endangered Population of *Posidonia australis* seagrass and aquatic habitats within the sensitive areas mentioned above and surrounding the proposed dredge site in general. Potential impact sources are mentioned in the points above.

The extent of these potential impacts is to be assessed in the EA and proposed measures to mitigate such impacts are to be detailed. DPI-Fisheries will seek options that avoid or adequately mitigate any impacts on sensitive aquatic habitats in Botany Bay.

NSW Department of Primary Industries – Cronulla Fisheries Centre
PO Box 21, Cronulla NSW 2230
202 Nicholson Pde, Cronulla NSW
Tel: 02 9527 8411 Fax: 02 9527 8576
www.dpi.nsw.gov.au

To further assist in the preparation of an EA of this proposal, specific assessment requirements required by this Department to assess impacts on aquatic habitat are attached (Attachment 1). In particular, it is important that a hydrological survey is conducted to predict ongoing impacts to nearby sensitive aquatic habitats, and other surrounding aquatic habitats. The EA should also include an assessment of potential impacts to aquatic habitats within and immediately surrounding the proposed dredge site.

Aquatic Reserves

As the proposed dredging activities are situated in the locality of Towra Point Aquatic Reserve, potential impacts to the aquatic reserve, identified in the section above, are to be addressed in the environmental assessment. The aquatic reserve contains valuable seagrass and mangrove habitat that could be impacted by any hydrology related changes resulting from this dredging.

Aquaculture

In reviewing the preliminary information submitted to the department it is noted that it has been identified that the substrate has potentially high levels of TBT. If TBT is resuspended into the water column then it could potentially impact on the viability of molluscs within that environment particularly spat and other aquatic fauna. This is to be addressed in the environmental assessment of these works. Without a clear understanding of the TBT levels that may be attained at the oyster farming areas it is difficult to ascertain any potential impacts.

The *NSW Oyster Industry Sustainable Aquaculture Strategy* (OISAS) and enabling amendments to State Environmental Planning Policy 62 – Sustainable Aquaculture were gazetted in December 2006. This policy requires that all development which has the potential to have an adverse impact on oyster aquaculture is referred to NSW DPI for comment. In determining a development application the consent authority must take any NSW DPI comments into consideration.

OISAS and the associated estuary maps can be accessed at the following web address: (http://www.dpi.nsw.gov.au/fisheries/aquaculture/publications/oysters/industry/nsw-oyster-industry-sustainable-aquaculture-strategy).

At the initial planning focus meeting Marcel Green indicated that the nearest commercial fishing occurs in the Georges River (oyster farming) and that the fish farm adjacent to the Caltex wharf was no longer there. It should be noted that the aquaculture lease adjacent to the Caltex wharf is still current and occupies 4ha. An assessment on the impacts to this aquaculture lease and any structures thereon should also be considered.

Recreational Fishing

Botany Bay is a Recreational Fishing Haven (RFH). In 2002, commercial fishing effort was removed from 30 locations (including lakes and rivers) along the NSW coast to improve recreational fishing opportunities. The RFHs are one of the first initiatives to be funded by the NSW recreational fishing fees and provides recreational anglers a fairer share of NSW fish stocks.

The EA should outline recreational and competitive fishing activities that may be affected by the proposal, including popular recreational fishing sites. An indication of the area where recreational fishing opportunities may be limited by the dredging activity and any ongoing activities around the wharf and when this is likely to occur should be provided in the EA.

The Department recommends that ongoing recreational angler access is maintained to the Botany Bay RFH.

Comment on draft DGRs and Environmental Assessment Scoping and Approvals Report

Fisheries NSW requests that the following changes are made to the draft DGRs:

- State Environmental Planning Policy 62 – Sustainable Aquaculture is referred to in the 6th dot point under the 2nd 'General Requirement'.
- 'and storm surge impacts' is added to 1st dot point under the 'Hydrology' section.
- the 3rd point under the 'Flora and Fauna' section is to be changed to 'consideration of all potential impacts to estuarine ecosystems, wetlands and mangroves adjacent to or up-river from the dredging operations.
- The last point under the 'Flora and Fauna' section is to include reference to the *Threatened Species Assessment Guidelines* (NSW DPI, 2008). This is to cover the assessment of potential impacts to threatened species and populations listed under the FM Act.

Note: consideration of potential risk to human health from the re-suspension of contaminated is to include the nearby oyster aquaculture lease areas and impacts recreationally fished species.

Regarding the Environmental Assessment Scoping and Approvals Report for this project, Fisheries NSW wishes to state that:
- contrary to what is stated in this report seahorses and pipefish are not listed as 'threatened' species under the FM Act. These species are listed as 'protected' under this Act. Further information on this is available from NSW DPIs website at: http://www.dpi.nsw.gov.au/fisheries/species-protection/protected-species
- Figure 2.1 of the extent of the proposed works is unclear. Fisheries NSW requests a clear map showing the specific dredging locations within the dredge footprint is provided in the environmental assessment.

Should you require any further information concerning this proposal, please contact Carla Ganassin on 9527 8552 or carla.ganassin@industry.nsw.gov.au.

ATTACHMENT 1: NSW DPI - Fisheries Aquatic Habitat Protect Unit's Information Requirements for an Environmental Assessment of the proposed Caltex Dredging Project, Kurnell

A: General Requirements

- site address and contact details
- property description (e.g. Lot and DP numbers)
- a clear description of the proposal including details of construction methods and materials
- map(s) of the development area and adjacent areas - this should include nearby waterways, adjacent infrastructure (such as jetties) and land use
- clear photographs of the site (at low and high tide in estuaries), including photographs of any aquatic vegetation present (including pest species such as *Caulerpa taxifolia*),
- a clear description of the physical and hydrological features of the development area (which may extend upstream and downstream of the development site in the case of tidal waterways)
- approximate depth contours within 20 metres of the proposal
- a clear description of aquatic environments including:
    - including threatened and protected species, populations, ecological communities, pest species or presence of 'critical habitat' under the FM Act and EPBC Act,
    - an aquatic and riparian vegetation survey map of the area which shows the location and/or coverage of saltmarsh, mangrove, seagrass, and macroaglae,
- details of the nature, timing, magnitude and duration of the proposed disturbance to the aquatic environment
- assessments of predicted impacts upon any threatened species (fish and marine vegetation) (i.e. completion of a 7 part test and/or species impact statement(s)) and other aquatic flora and fauna
- details of any mitigation measures to limit environmental impacts
- details of the general regional context, any protected areas, other developments in the area, and/or cumulative impacts
- In defining the proposal area, discussion must be provided in regard to possible indirect effects of the proposal on species/habitats in the area surrounding the subject site: for example, through altered currents, waves and coastal processes or pollution.

Dredging and reclamation activities

- Purpose of works
- Type(s) and distribution of marine vegetation in the vicinity of the proposed works that may directly or indirectly be impacted by the proposal
- Method of dredging to be used
- Timing and duration of works
- Dimension of area of works including levels and volume of material to be extracted or placed as fill
- Nature of sediment to be dredged, including Acid Sulphate Soil, contaminated soils etc
- Method of marking area subject to works
- Environmental safeguards to be used during and after works
- Measures for minimising harm to fish habitat under the proposal
- Spoil type and source location for reclamation activities
- Method of disposal of dredge material
- Location and duration of spoil stockpiling, if planned

Activities that damage marine vegetation

- Type of marine vegetation to be harmed
- Map of distribution and density of marine vegetation
- Reasons for harming marine vegetation
- Methods of harming marine vegetation
- Construction details
- Duration of works/activities
- Measures for minimising harm to marine vegetation under the proposal and details of compensatory habitat development to replace lost vegetation
- Method and location of transplanting activities or disposal of marine vegetation

B. Aquatic habitat assessment

The aim of the aquatic assessment should be to define the presence of 'key fish habitat' within the study site, adjacent areas. Some points to consider include:

- description of local wave and current regimes (in tidal areas),
- description of the water quality (e.g. discolouration, sedimentation, turbidity, pH, dissolved oxygen, nutrients),
- types of surrounding land use (e.g. agricultural, urban, aquaculture),
- description of aquatic habitat components such as stream morphology, in-stream and riparian vegetation, flow characteristics.
- condition of marine vegetation (i.e. information on type, species, shoot density and/or percentage cover, Is the vegetation continuous or sparse in coverage? What is the aerial extent? Is the vegetation healthy or degraded? Is wrack (dead seagrass or macroalgae) present?),
- substrate type (e.g. rock, sand, gravel, silt, coral reef),
- presence of any listed threatened or protected aquatic species or 'critical habitat' under the FM Act and EPBC Act.

C. Assessment of likely impacts

- indicate the location, nature and extent of habitat removal or modification (both direct and indirect) which may result from the proposed action;
- discuss the potential impact of the modification or removal of habitat (potential direct and indirect sources of impact are stated in the letter to this attachment);

D. Ameliorative measures

The environmental assessment should consider and provide detail on how the proposal has been or may be modified and managed to minimise impacts and conserve aquatic habitat on the subject site and in the study area.

NSW GOVERNMENT | Office of Environment & Heritage

PCU035923

Your reference: SSD-5353
Our reference: DOC12/28064
Contact: Richard Bonner 9995 6833

Ms Lisa Chan
A/Senior Planning Officer
Infrastructure Projects
Department of Planning and Infrastructure
GPO Box 39
SYDNEY NSW 2001

Department of Planning
Received
20 JUL 2012
Scanning Room

Dear Ms Chan

I refer to your letter of 3 July 2012 seeking input from the Office of Environment and Heritage (OEH) on the Director General's environmental assessment Requirements (DGRs) for Proposed Port and Berthing Project, Botany Bay (SSD-5353).

As you would be aware, OEH provided detailed advice in October 2011 on the key environmental issues that should be investigated as part of the approval process for this project. A copy of this advice is provided at Appendix A of the June 2012 Environmental Assessment Scoping and Approvals Report (the Report).

OEH has reviewed the Report and provides the following comments in relation to additional matters that should be addressed in the Environmental Impact Statement (EIS):

- In justifying the preferred dredging methods, the EIS should address the potential impacts on threatened marine fauna. In addition to direct impacts, the impacts of associated works and activities (e.g. number of ship movements, refuelling requirements, waste disposal and the management of silt plumes through the installation of silt curtains) should also be addressed.
- In addressing the timing and duration of dredging works and shipping movements in the EIS potential biodiversity impacts should be considered (e.g. avoidance of the whale migration periods, impacts of night lighting on migratory and threatened marine birds, particularly during times when these birds are most likely to be using habitat in Botany Bay).
- Additional assessment and survey work is required in the EIS to: monitor the use of the proposed dredging and construction area by threatened marine fauna before, and particularly during, construction to ensure that any potential or actual impacts can be minimised and appropriately managed
- The list of threatened species, populations and ecological communities identified as potentially impacted by the proposal needs to be refined and those entities most at risk should be identified and detailed in the EIS.
- The areas of ecological significance should be expanded to include the shorebird habitat at Taren Point and around Dolls Point. The EIS should also recognise that Botany Bay National Park is located on both the northern and southern sides of the Botany Bay entrance.
- The EIS should map important intertidal habitat and use the results of hydrodynamic and wave modelling to predict any losses which may result from dredging and either mitigate or compensate for these. Depending on the outcome of sediment sampling and dredge plume

PO Box 668 Parramatta NSW 2124
Level 7, 79 George Street Parramatta NSW
Tel: (02) 9995 5000 Fax: (02) 9995 6900
ABN 30 841 387 271
www.environment.nsw.gov.au

modelling, supplementary monitoring of biota in nearby intertidal areas should be instigated to determine whether any toxicants released by dredging are likely to bioaccumlate and affect migratory and threatened shorebirds.

- The EIS should address the increased risk the upgraded terminal presents to adjacent sensitive environments in the event of a pollution incident. This may require an updated risk/response management plan that reflects the increased quantities of petroleum products proposed to be handled by the upgraded wharf.
- Preliminary Ecology Assessment (Appendix B) - Consistent with OEH's interpretation of 'locality', it is recommended a 5 km (not 3 km) buffer as the limit of the dredge footprint to capture relevant threatened species records be applied in the EIS. This would encompass the whole of Towra Point Nature Reserve as well as important habitat for the Taren Point endangered shorebird community and the western shoreline of Botany Bay.

OEH recommends the following amendments (*in italics*) to the draft DGR Key Issues:

1. Hydrology:
   - *potential for the project to change currents and deposition patterns (and the associated impacts on flora and fauna).*
2. Sediment and Water Quality:
   - *Impacts on coastal hazards and shoreline sediment transport rates within Botany Bay.*
3. Spoil Handling and Contamination:
   - *Assessment of the impacts on flood behaviour if any land disposal of spoil is proposed. This must be undertaken in accordance with the 'NSW Government's Floodplain Development Manual (2005)' and relevant Sutherland Shire Council flood-related development controls.*
4. Flora and Fauna:
   - impacts on threatened species, populations, and ecological communities and/or critical habitat *(including the risks of injury from collision or entanglement with dredging equipment and piling works).*
   - potential mobilisation of sediments and increased turbidity levels (including contaminated sediments) on aquatic flora and fauna *(including the potential for toxins from dredged sediments entering the food chain and affecting threatened and migratory shorebirds that feed on adjacent intertidal mudflats and other marine fauna).*
6. General Construction:
   - hazards and risks associated with the upgrade of a major hazardous facility *(including any increased risk of adverse impacts on Botany Bay ecosystems).*

Should you have any queries in regard to these comments please contact Richard Bonner on 9995 6833.

Yours sincerely

17/07/12

LOU EWINS
Manger Planning and Aboriginal Heritage
Conservation and Regulation, Metropolitan
Office of Environment and Heritage

NSW GOVERNMENT | Department of Primary Industries

OUT12/16859

19 JUL 2012

Ms Lisa Chan
Infrastructure Projects
NSW Department of Planning and Infrastructure
GPO Box 39
Sydney NSW 2001

Email: Lisa.Chan@planning.nsw.gov.au

Dear Ms Chan

Re: Proposed port and berthing project, Port Botany (SSD 5353) - input into Director-General requirements.

Reference is made to your letter of 3 July 2012 in respect to the above matter. The proposal is relevant to Fisheries NSW and the NSW Office of Water, agencies within the Department of Primary Industries. I attach the advices of those agencies.

For further information regarding the advices by Fisheries NSW, contact Carla Ganassin on 9527 8552 or carla.ganassin@industry.nsw.gov.au.

Note that Fisheries NSW should be included in the list, within the Director-General's requirements, of agencies that are to be consulted by the proponent when preparing the environmental assessment.

The NSW Office of Water advises that the following key issues should be addressed in the environmental assessment, in addition to the expanded list of assessment requirements attached to this letter:

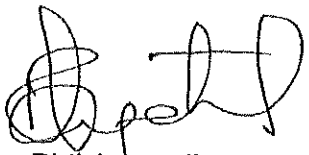
- compliance with the rules in any relevant Water Sharing Plan (WSP) and legislation.
- assessment of the impact of the proposal on the shoreline of Botany Bay, riparian areas, groundwater dependent ecosystems and RAMSAR wetlands
- adequate mitigating and monitoring requirements to address impacts.

The Office of Water also requests that all following referrals from the Department for this proposal include one (1) hard copy and one (1) CD copy of the environmental assessment and any other accompanying documentation.

For further information regarding the advices by the Office of Water please contact Janne Grose, Planning and Assessment Coordinator (Penrith office) on (02) 4729 8262 or at: Janne.Grose@water.nsw.gov.au.

The proposal has also been discussed with the coastal engineering unit within Crown Lands, also within the Department of Primary Industries. Although the draft Director-General requirements include reference to the investigation of re-use options for the dredged material it is considered this matter should be given greater prominence given the known shortage of sand for construction purposes within the Sydney metropolitan area, the need for beach nourishment in certain areas, and the environmental implications of the dumping of this material at sea.

Yours sincerely



Phil Anquetil
Executive Director Business Services

Fisheries NSW – requirements for Environmental Assessment
Proposed port and berthing project, Port Botany (SSD 5353)

In this response Fisheries NSW has addressed the potential impacts the proposal may have on issues considered under the *Fisheries Management 1994* (FM Act), including aquatic habitat protection, aquaculture, aquatic reserve and recreational fishing matters.

Aquatic Habitat Protection

DPI-Fisheries is responsible for ensuring that fish stocks are conserved and that there is no net loss of key fish habitats upon which they depend. To achieve this, the Aquatic Habitat Protection Unit ensures that developments comply with the requirements of the FM Act (namely the aquatic habitat protection and threatened species provisions in Parts 7 and 7A of the Act, respectively), and the associated *Policy and Guidelines for Aquatic Habitat Management and Fish Conservation (1999).*

The proposed dredging activity is situated in the vicinity of the largest estuarine wetland in Sydney. This includes valuable seagrass, mangrove and saltmarsh communities that are considered to be important key fish habitat. The conservation significance of this area is recognised in its protection through the Towra Point Aquatic Reserve (managed by DPI-Fisheries) and the Towra Point Nature Reserve (managed by the Office of Environment and Heritage – OEH). The area also contains internationally significant RAMSAR wetlands. Situated off Kurnell, the proposed dredging is in close proximity to a significantly large area of the Endangered Population of *Posidonia australis* seagrass in Botany Bay, as listed under the FM Act.

Considering the provisions of the FM Act and the above-mentioned policy, aspects of this proposal of concern to DPI - Fisheries include potential:

- direct and indirect impacts to marine vegetation (i.e. algae, seagrasses, mangroves and saltmarsh) from activities including:
  - direct removal, or smothering from dredged spoil
  - turbidity and sedimentation during dredging activities
  - erosion and sedimentation from any changes to currents, waves and coastal processes that may result from the final dredged configuration and significant changes to boat wakes from larger vessels and more frequent boating activity.
- impacts to aquatic and intertidal habitats from disposal of dredged material within Botany Bay. Note that DPI-Fisheries recommends that dredged spoil is to be deposited appropriately on land or at the approved Commonwealth offshore spoil dumping grounds. Any excavated material to be deposited on land is to be done so according to its contamination and acid sulphate characteristics.
- impacts to water quality during dredging, particularly turbidity related impacts.
- impacts to the Endangered Population of *Posidonia australis* seagrass and aquatic habitats within the sensitive areas mentioned above and surrounding the proposed dredge site in general. Potential impact sources are mentioned in the points above.

The extent of these potential impacts is to be assessed in the EA and proposed measures to mitigate such impacts are to be detailed. DPI-Fisheries will seek options that avoid or adequately mitigate any impacts on sensitive aquatic habitats in Botany Bay.

To further assist in the preparation of the EA, specific assessment requirements required by Fisheries NSW to assess impacts on aquatic habitat are attached (**Annexure 1**). In particular, it is important that a hydrological survey is conducted to predict ongoing impacts to nearby sensitive aquatic habitats, and other surrounding aquatic habitats. The EA should also include an assessment of potential impacts to aquatic habitats within and immediately surrounding the proposed dredge site.

Aquatic Reserves

As the proposed dredging activities are situated in the locality of Towra Point Aquatic Reserve, potential impacts to the aquatic reserve, identified above, are to be addressed in the environmental assessment. The aquatic reserve contains valuable seagrass and mangrove habitat that could be impacted by any hydrology related changes resulting from this dredging.

Aquaculture

In reviewing the submitted preliminary information, it is noted that it has been identified that the substrate has potentially high levels of TBT. If TBT is re-suspended into the water column then it could potentially impact on the viability of molluscs within that environment particularly spat and other aquatic fauna. This is to be addressed in the environmental assessment of these works. Without a clear understanding of the TBT levels that may be attained at the oyster farming areas it is difficult to ascertain any potential impacts.

The *NSW Oyster Industry Sustainable Aquaculture Strategy* (OISAS) and enabling amendments to State Environmental Planning Policy 62 – Sustainable Aquaculture were gazetted in December 2006. This SEPP requires that all development which has the potential to have an adverse impact on oyster aquaculture is referred to NSW DPI (Fisheries NSW) for comment. In determining a development application the consent authority must take any NSW DPI comments into consideration.

The OISAS and the associated estuary maps can be accessed at: (http://www.dpi.nsw.gov.au/fisheries/aquaculture/publications/oysters/industry/nsw-oyster-industry-sustainable-aquaculture-strategy).

At the initial planning focus meeting the proponent indicated that the nearest commercial fishing occurs in the Georges River (oyster farming) and that the fish farm adjacent to the Caltex wharf was no longer there. It should be noted that the aquaculture lease adjacent to the Caltex wharf is still current and occupies 4ha. An assessment on the impacts to this aquaculture lease and any structures thereon should also be considered.

Recreational Fishing

Botany Bay is a Recreational Fishing Haven (RFH). In 2002, commercial fishing effort was removed from 30 locations (including lakes and rivers) along the NSW coast to improve recreational fishing opportunities. The RFHs are one of the first initiatives to be funded by the NSW recreational fishing fees and provides recreational anglers a fairer share of NSW fish stocks.

The EA should outline recreational and competitive fishing activities that may be affected by the proposal, including popular recreational fishing sites. An indication of the area where recreational fishing opportunities may be limited by the dredging activity and

any ongoing activities around the wharf and when this is likely to occur should be provided in the EA.

Fisheries NSW recommends that ongoing recreational angler access is maintained to the Botany Bay RFH.

Specific comment on draft DGRs and Environmental Assessment Scoping and Approvals Report

Fisheries NSW requests that the following specific changes are made to the draft DGRs:

- State Environmental Planning Policy 62 – Sustainable Aquaculture is referred to in the 6th dot point under the 2nd 'General Requirement'.
- 'and storm surge impacts' is added to 1st dot point under the 'Hydrology' section.
- the 3rd point under the 'Flora and Fauna' section is to be changed to 'consideration of all potential impacts to estuarine ecosystems, wetlands and mangroves adjacent to or up-river from the dredging operations.
- the last point under the 'Flora and Fauna' section is to include reference to the *Threatened Species Assessment Guidelines* (NSW DPI, 2008). This is to cover the assessment of potential impacts to threatened species and populations listed under the FM Act.

Note: consideration of potential risk to human health from the re-suspension of contaminated is to include the nearby oyster aquaculture lease areas and impacts recreationally fished species.

Fisheries NSW also advises that:

- contrary to what is stated in this report seahorses and pipefish are not listed as 'threatened' species under the FM Act. These species are listed as 'protected' under this Act. Further information on this is available from NSW DPIs website at: http://www.dpi.nsw.gov.au/fisheries/species-protection/protected-species
- Figure 2.1 of the extent of the proposed works is unclear. A clear map showing the specific dredging locations within the dredge footprint must be provided in the environmental assessment.

Should you require any further information concerning this proposal, please contact Carla Ganassin on 9527 8552 or carla.ganassin@industry.nsw.gov.au.

ANNEXURE 1 to the Fisheries NSW requirements for Environmental Assessment of the proposed port and berthing project, Port Botany (SSD 5353)

A: General Requirements

- site address and contact details
- property description (e.g. Lot and DP numbers)
- a clear description of the proposal including details of construction methods and materials
- map(s) of the development area and adjacent areas - this should include nearby waterways, adjacent infrastructure (such as jetties) and land use
- clear photographs of the site (at low and high tide in estuaries), including photographs of any aquatic vegetation present (including pest species such as *Caulerpa taxifolia*),
- a clear description of the physical and hydrological features of the development area (which may extend upstream and downstream of the development site in the case of tidal waterways)
- approximate depth contours within 20 metres of the proposal
- a clear description of aquatic environments including:
  - including threatened and protected species, populations, ecological communities, pest species or presence of 'critical habitat' under the FM Act and EPBC Act,
  - an aquatic and riparian vegetation survey map of the area which shows the location and/or coverage of saltmarsh, mangrove, seagrass, and macroaglae,
- details of the nature, timing, magnitude and duration of the proposed disturbance to the aquatic environment
- assessments of predicted impacts upon any threatened species (fish and marine vegetation) (i.e. completion of a 7 part test and/or species impact statement(s)) and other aquatic flora and fauna
- details of any mitigation measures to limit environmental impacts
- details of the general regional context, any protected areas, other developments in the area, and/or cumulative impacts
- In defining the proposal area, discussion must be provided in regard to possible indirect effects of the proposal on species/habitats in the area surrounding the subject site: for example, through altered currents, waves and coastal processes or pollution.

Dredging and reclamation activities

- Purpose of works
- Type(s) and distribution of marine vegetation in the vicinity of the proposed works that may directly or indirectly be impacted by the proposal
- Method of dredging to be used
- Timing and duration of works
- Dimension of area of works including levels and volume of material to be extracted or placed as fill
- Nature of sediment to be dredged, including Acid Sulphate Soil, contaminated soils etc
- Method of marking area subject to works
- Environmental safeguards to be used during and after works
- Measures for minimising harm to fish habitat under the proposal
- Spoil type and source location for reclamation activities
- Method of disposal of dredge material
- Location and duration of spoil stockpiling, if planned

Activities that damage marine vegetation

- Type of marine vegetation to be harmed
- Map of distribution and density of marine vegetation
- Reasons for harming marine vegetation
- Methods of harming marine vegetation
- Construction details

- Duration of works/activities
- Measures for minimising harm to marine vegetation under the proposal and details of compensatory habitat development to replace lost vegetation
- Method and location of transplanting activities or disposal of marine vegetation

B. Aquatic habitat assessment

The aim of the aquatic assessment should be to define the presence of 'key fish habitat' within the study site, adjacent areas. Some points to consider include:

- description of local wave and current regimes (in tidal areas),
- description of the water quality (e.g. discolouration, sedimentation, turbidity, pH, dissolved oxygen, nutrients),
- types of surrounding land use (e.g. agricultural, urban, aquaculture),
- description of aquatic habitat components such as stream morphology, in-stream and riparian vegetation, flow characteristics.
- condition of marine vegetation (i.e. information on type, species, shoot density and/or percentage cover, Is the vegetation continuous or sparse in coverage? What is the aerial extent? Is the vegetation healthy or degraded? Is wrack (dead seagrass or macroalgae) present?),
- substrate type (e.g. rock, sand, gravel, silt, coral reef),
- presence of any listed threatened or protected aquatic species or 'critical habitat' under the FM Act and EPBC Act.

C. Assessment of likely impacts

- indicate the location, nature and extent of habitat removal or modification (both direct and indirect) which may result from the proposed action;
- discuss the potential impact of the modification or removal of habitat (potential direct and indirect sources of impact are stated in the letter to this attachment);

D. Ameliorative measures

The environmental assessment should consider and provide detail on how the proposal has been or may be modified and managed to minimise impacts and conserve aquatic habitat on the subject site and in the study area.

******

NSW Office of Water – requirements for Environmental Assessment
Proposed port and berthing project, Port Botany (SSD 5353

Relevant Legislation
The EIS should take into account the objects and regulatory requirements of the *Water Act 1912* and *Water Management Act 2000* (WMA 2000), as applicable. Proposals and management plans should be consistent with the Objects (s3) and Water Management Principles (s5) of the WMA 2000.

Water Sharing Plans
Water Sharing Plans (WSPs) prepared under the provisions of the WMA 2000 establish the rules for access to, and the sharing of water between the environmental needs of the surface water or groundwater source and water users. The EIS needs to:

- Demonstrate how the proposal is consistent with the relevant rules of the WSP including rules for access licences, distance restrictions for water supply works and rules for the management of local impacts in respect of surface water and groundwater sources, ecosystem protection, water quality and surface-groundwater connectivity.
- Provide a description of any site water use (amount of water from each water source) and management including all sediment dams, clear water diversion structures with detail on the location, design specifications and storage capacities for all the existing and proposed water management structures.
- Provide an analysis of the proposed water supply arrangements against the rules for access licences and other applicable requirements of any relevant WSP.

Refer to: *http://www.water.nsw.gov.au/Water-Management/Water-sharing/default.aspx* .

Relevant Policies
The EIS should take into account the following policies (as applicable):

- NSW State Rivers and Estuary Policy (1993);
- NSW Wetlands Management Policy (1996);
- NSW State Groundwater Policy Framework Document (1997);
- NSW State Groundwater Quality Protection Policy (1998);
- NSW State Groundwater Dependent Ecosystems Policy (2002); and
- NSW Office of Water Guidelines for Controlled Activities.

http://www.water.nsw.gov.au/Water-management/Law-and-policy/Key-policies/default.aspx

Botany Bay shoreline, riparian areas and wetlands
The EIS needs to assess potential impacts of the dredging proposal on the shoreline of Botany Bay, particularly at key sensitive locations, such as Towra Point Nature Reserve and the significant RAMSAR wetlands.

The EIS should assess the potential for shoreline erosion or sedimentation to occur caused by the dredging potentially changing the hydrological regime, tidal circulation, wave energy distribution etc and the subsequent impacts of shoreline erosion / sedimentation on remnant riparian vegetation, the RAMSAR wetlands, groundwater dependent ecosystems (GDEs) etc.

Surface Water
Sections 2.5.2 and 4 of the Environmental Assessment Scoping and Approvals Report indicate the dredged materials contain elevated concentrations of Tributylin (TBT) associated with the mobile and base sediments across the dredge footprint (pages 14 and 34). The EIS needs to assess potential impacts of disturbing the elevated TBT sediments on water quality, GDEs and sensitive locations around the Bay and provide measures to avoid and mitigate the risk of pollution with monitoring and contingency plans for remediation in the event of any impacts.

Groundwater Dependent Ecosystems
The EIS should provide details on the presence and distribution of GDEs potentially affected by the proposal. GDEs are ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater.

GDEs represent a vital component of the natural environment and can vary in how they depend on groundwater, from having occasional or no apparent dependence through to being entirely dependent. GDEs occur across both the surface and subsurface landscapes ranging in area from a few metres to many kilometres. Surface and groundwaters are often interlinked and aquatic ecosystems may have a dependence on both.

Seagrasses are the most likely GDEs to be affected by the proposal but the EIS should also assess the potential impacts on other potential GDEs including the RAMSAR wetlands and other dependent ecosystems along the Kurnell Peninsula.

It is recommended the EIS assess the distribution, extent and species composition of seagrasses and the potential impacts on the seagrass areas. The EIS needs to provide safeguard measures for any GDEs and demonstrate there will be minimum impacts on GDEs.

Disturbance of sediments with elevated TBT, potential changes to wave energy etc in the Bay as a result of the dredging proposal could potentially affect the seagrasses and other GDEs.

*****

NSW GOVERNMENT | Planning & Infrastructure

Contact: Lisa Chan
Phone: 02 9228 6226
Fax: 02 9228 6355
Email: lisa.chan@planning.nsw.gov.au

Our ref: 12/10987-1

Mr Scott McInnes
Senior Environmental Planner
URS Australia
Level 4, 407 Pacific Highway
ARTARTMON NSW 2064

Dear Mr McInnes

Director-General's Requirements for Port and Berthing Facilities, Botany Bay

Please find attached a copy of the Director General's environmental assessment requirements (DGRs) for the preparation of an Environmental Impact Statement (EIS) for the above development. These requirements have been prepared in consultation with relevant government agencies based on the information you have provided to date. I have also attached a copy of the government authorities' comments for your information. Please note that the Director-General may alter these requirements at any time.

If you do not lodge a Development Application and EIS for the development within 2 years, you must consult further with the Director General in relation to the preparation of the EIS.

Prior to exhibiting the EIS that you submit for the development, the Department will review the document in consultation with the relevant agencies to determine if it addresses the DGRs. I would appreciate it if you would contact the Department at least two weeks before you propose to submit your EIS. This will enable the Department to:

- confirm the applicable fee (see Division 1AA, Part 15 of the *Environmental Planning and Assessment Regulation 2000*); and
- determine the number of copies (hard-copy and CD-ROM) of the EIS that will be required for reviewing purposes.

If your development is likely to have a significant impact on matters of National Environmental Significance, it will require an approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This approval would be in addition to any approvals required under NSW legislation and it is your responsibility to contact the Department of Sustainability, Environment, Water, Population and Communities to determine if an approval under the EPBC Act is required (http://www.environment.gov.au or 6274 1111).

Your contact officer, Ms Lisa Chan, can be contacted on the above contact details. Please mark all correspondence regarding the proposal to the attention of the contact officer.

Yours sincerely

9/8/12

Glenn Snow
A/Director
Infrastructure Projects
as delegate for the Director General

Lisa Chan - Request for DGRs for Proposed Port and Berthing Project, Botany Bay - SSD-5353

From: "McMahon, Cathy" <mcmahonc@botanybay.nsw.gov.au>
To: <lisa.chan@planning.nsw.gov.au>
Date: 16/07/2012 2:10 PM
Subject: Request for DGRs for Proposed Port and Berthing Project, Botany Bay - SSD-5353
CC: "Dowsett, Rodger" <dowsettr@botanybay.nsw.gov.au>

Ms Chan, Council has reviewed the draft DGRs and the *Environmental Assessment Scoping and Appravals Report* dated June 2012 prepared by URS and has no further issues to include.

I advise that I will be Council's contact for this project.

regards

Catherine McMahon
Chief Town Planner
City of Botany Bay
(02) 9366 3520

Any views expressed in this message or any attachments are those of the individual sender and cannot be relied upon for any legal relationship and is for information only, except where the sender specifies and with authority states them to be the views of the City of Botany Bay Council. The City of Botany Bay Council expressly disclaims liability for any loss or damage following from the content of this message or attachments, where direct of consequential.

Appendix A2

Director-General's Requirements Response Table

CALTEX KURNELL DREDGING WORKS AND ASSOCIATED WHARF AND INFRASTRUCTURE UPGRADE- SUTHERLANDSHIRE AND BOTANY BAY LOCAL GOVERNMENT AREAS

Appendix A2 Director-General's Requirements: EIS Cross-Reference Table

Government Authority	Requirement	Relevant EIS Chapter
NSW Department of Planning and Infrastructure (DP&I)	**General Requirements** The Environmental Impact Statement (EIS) must be prepared in accordance with and meet the minimum requirements in clauses 6 and 7 Schedule 2 of the Environmental Planning and Assessment Regulation 2000 (Regulation), and include the following:	
	1. The information required by clause 6, including but not limited to:	
	• The description of the development should include construction, operation and staging components, constraints on Botany Bay activities during construction, and required infrastructure to enable construction and operation of the development.	Chapter 4
	2. The content required by clause 7, including but not limited to:	
	• A summary of the EIS;	Executive Summary
	• A statement of the objectives of the development;	Executive Summary
	• A description and an analysis of feasible alternatives to carrying out the development, having regard to its objectives, including the consequences of not carrying out the development;	Chapter 2
	• An analysis of the development, including an assessment of environmental impacts, with particular focus on the requirements of the listed key issue, in accordance with clause 7(1)(d) of the Regulation;	EIS Volume 1 and Volume 2
	• An identification of how relevant planning, land use and development matters (including relevant strategic and statutory matters) have been considered in the impact assessment (direct, indirect and cumulative impacts) and/or in developing management, mitigation, and monitoring measures, including section 79C of the *Environmental Planning and Assessment Act 1979* (EP&A Act), applicable State Environmental Planning Policies (SEPPs) including *State and Regional Development SEPP 2011, Infrastructure SEPP 2007, SEPP 14 Coastal Wetlands, SEPP 33 Hazardous and Offensive Development, SEPP 55 Remediation of Land, SEPP 62 – Sustainable Aquaculture* and *SEPP 71 Coastal Protection*; and Local Environmental Plans (LEPs) including draft instruments where relevant, and the nature and extent of any prohibitions that apply to the development;	EIS Volume 1 and Volume 2 Appendix A - J
	• A compilation (in a single section of the EIS) of the measures proposed to mitigate adverse effects of the development on the environment;	Chapter 19
	• Justification of the development taking into consideration the objects of the EP&A Act;	Chapter 20
	• Detail how Ecologically Sustainability Development principles (as defined in clause 7(4) of the Regulation) will be incorporated in the design, construction and ongoing operation phases of the development.	Chapter 4
	• The EIS must also demonstrate that any building works will be capable of meeting relevant Building Code of Australia standards.	

Government Authority	Requirement	Relevant EIS Chapter
	Hydrology	
	• Hydrodynamic and coastal process changes to Botany Bay, including flushing, tidal flow and velocity, wave dynamics, storm surge impacts and effects on the shoreline of Botany Bay;	Chapter 8, Appendix C
	• Potential for the project to alter the tidal range and water levels, and saline intrusion to upstream water bodies and environments (including wetlands), stratification and anoxia;	Chapter 8, Appendix C
	• Scouring and erosion of shore line by natural forces and passing vessels; and	Chapter 8, Appendix C
	• Impacts to the development resulting from climate change including the consideration of the NSW sea level rise planning benchmarks.	Chapter 8, Appendix C
	Water Quality	
	Impacts on water quality, including sediment dispersion and suspension, and identification of methods for sediment containment;	Chapter 10, Appendix D
	• Effects of the development on:	
	– Siltation;	Chapter 10
	– Groundwater;	Chapter 10
	– The stability of any structures adjacent to the dredge area; and	Chapter 17
	– Commercial and recreational fishing and aquaculture, aquaculture leases and oyster farming;	Chapter 17
	• Operational impacts including impacts associated with ballast water management; and	Chapter 10
	• Taking into account the Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 2000) and associated guidelines.	Chapter 10
	Spoil and Contamination	
	• An assessment of the volume and type of sediment materials to be dredged, including the potential for the dredging of Acid Sulfate Soils, taking into account the Acid Sulfate Soil Manual (ASSMAC, 1998);	Chapter 9, Appendix D
	• Potential for contaminated sediments and groundwater (including tributyltin), their disturbance during excavation and dredging works, and identification of potential risk to human health, aquaculture activities or the environment;	Chapter 9, Appendix D
	• Sampling and characterisation of the distribution of contamination, taking into account the Sediment Quality Guidelines (CSIRO Handbook, 2000);	Chapter 9, Appendix D
	• Spoil disposal and reuse options, including identification and description of potential disposal locations and associated impacts; and	Chapter 16
	• If contamination is identified and remediation of material is necessary, preparation of a Remediation Action Plan (RAP) or other appropriate materials handling procedures taking into account the *Contaminated Land Management Act 1997*.	Chapter 9, Appendix D

Government Authority	Requirement	Relevant EIS Chapter
	Flora and Fauna	
	• Potential impacts on flora and fauna (including aquatic mammals and reptiles), nature and aquatic reserves and habitat including habitat loss, fragmentation, movement barriers and changed hydrodynamic conditions;	
	• Impacts on threatened/ endangered species, populations, and ecological communities and/ or critical habitat;	
	• Consideration of estuarine and groundwater dependant ecosystems, wetlands (including Towra Point Nature Reserve and Towra Point Aquatic Reserve) and mangroves adjacent to and up-river from the development;	Chapter 11, Appendix E
	• Potential mobilisation of sediments and increased turbidity levels (including contaminated sediments) on aquatic flora and fauna;	
	• Consideration of impacts associated with hydrodynamic changes;	
	• Details of how impacts would be managed during construction and operation, the suitability of measures and adaptive management and maintenance protocols and monitoring programs;	
	• Details of available offset measures to compensate the biodiversity impacts of the proposal, if necessary. Where offset measures are proposed these should be consistent with the *Principles for the use of biodiversity offsets in NSW*; and	
	• Taking into account the *Threatened Species Assessment Guidelines* (NSW DPI, 2008)) and the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (DEC, 2004), *Guidelines for Developments Adjoining Land and Water Managed by the Department of Environment, Climate Change and Water* (DECCW, 2010) and *Policy and Guidelines for Aquatic Habitat Management and Fish Conservation* (DPI, 1999).	
	Heritage	
	• Aboriginal and historic heritage items and values of the site and surrounding area (including known or probable maritime heritage sites and appropriate surveys); and	Chapter 12, Appendix F
	• Taking into account of the *NSW Heritage Manual* (NSW Heritage Office, 1996), *Assessing Heritage Significance Guidelines* (NSW Heritage Office, 2001) and *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC, 2005).	Chapter 12, Appendix F
	General Construction	
	• noise and vibration from all activities and sources on and offsite, and impacts to adjoining receivers;	Chapter 13, Appendix G
	• hazards and risks associated with the upgrade of a major hazardous facility, including potential impacts on the fuel supply pipeline, and on the operations at Berth No. 2;	Chapter 15, Appendix I
	• Port Botany operations, including impacts on shipping lanes and queues;	Chapter 17
	• air quality impacts associated with the dredging, handling, stockpiling and disposal of dredged material (as relevant), including odours beyond the site(s) boundary; and	Chapter 14, Appendix H

Government Authority	Requirement	Relevant EIS Chapter
	• taking into account the *Interim Construction Noise Guideline* (DECC, 2009) and the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005), *Hazardous Industry Planning Advisory Paper (HIPAP) 4 – Risk Criteria for Land Use Planning* and *HIPAP 6 - Guidelines for Hazard Analysis* (DoP, 2011).	Chapters 13-15, Appendices G-I
	General Operation	
	• Changes to operational impacts including noise, air quality, hazards and risks and operation of Port Botany, as relevant.	EIS Volume 1 and Volume 2
	Environmental Risk Analysis	
	• the EA must include an environmental risk analysis to identify potential environmental impacts associated with the project, environmental performance criteria and development standards and other mitigation measures, and any significant residual environmental impacts; and • Where additional key environmental impacts are identified through this environmental risk analysis, an appropriately detailed assessment of this key environmental impact must be included.	Chapter 15, Appendix I
	Plans and Documents	
	• The EIS must include all relevant plans, architectural drawings, diagrams and relevant documentation required under Schedule 1 of the Environmental Planning and Assessment Regulation 2000. Provide these as part of the EIS rather than as separate documents.	EIS Volume 1 and Volume 2
	Consultation	
	• During EIS preparation, you must consult with the relevant local, State or Commonwealth Government Authorities, service providers, community groups and affected landowners. In particular you must consult with: – Office of Environment and Heritage; – Environment Protection Authority – Heritage Council of NSW – Department of Trade and Investment (Primary Industry, Mineral Resources and Office of Water); – Department of Sustainability, Environment, Water, Population and Communities; – City of Botany Bay Council; – Randwick City Council; – Sutherland Shire Council; – Rockdale City Council; – Roads and Maritime Services; – Sydney Ports Corporation; – WorkCover; – Specialist interest groups, including Aboriginal Land Councils; and – The public, including community groups and adjoining and affected landowners. The EIS must describe the consultation process and the issues raised, and identify where the design of the development has been amended in response to these issues. Where amendments have not been made to address an issue, a short explanation should be provided.	Chapter 6, Appendix B Chapter 6, Appendix B

Government Authority	Requirement	Relevant EIS Chapter
NSW Office of Environment and Heritage (OEH)	**Flora and Fauna**	
	• In justifying the preferred dredging methods, the EIS should address the potential impacts on threatened marine fauna. In addition to direct impacts, the impacts of associated works and activities (eg. number of ship movements, refuelling requirements, waste disposal and the management of salt plumes through the installation of silt curtains) should also be addressed.	Chapter 11, Appendix E
	• In addressing the timing and duration of the works and shipping movements in the EIS, potential biodiversity impacts should be considered (eg. avoidance of the whale migration periods, impacts of night lighting on migratory and threatened marine birds, particularly during times when these birds are most likely to be using habitat in Botany Bay).	Chapter 11, Appendix E
	• Additional assessment and survey works is required in the EIS to monitor the use of the proposed dredging and construction area by threatened marine fauna, before, and particularly during construction, to ensure that any potential or actual impacts and be minimised and appropriately managed.	Chapter 11, Appendix E
	• The list of threatened species, populations and communities identified as potentially impacted by the proposals needs to be refined and those entities most at risk should be identified and detailed in the EIS.	Chapter 11, Appendix E
	• The areas of ecological significance should be expanded to include the shorebird habitat at Taren Point and around Dolls Point. The EIS should recognise that Botany Bay National Park is located both on the northern and southern sides of the Bay entrance.	Chapter 11, Appendix E
	• The EIS should map important intertidal habitat and use the results of hydrodynamic and wave modelling to predict any losses that may result from dredging and either mitigate or compensate for these. Depending on the outcome of sediment sampling and dredge plume modelling, supplementary monitoring of biota in nearby intertidal areas to be instigated to determine whether any toxicants released by the dredging works are likely to bio-accumulate and affect migratory and threatened shorebirds.	Chapter 11, Appendix E
	• The EIS should address the increased risk the upgraded terminal presents to adjacent sensitive environments in the event of a pollution incident. This may require an updated risk/response management plan that reflects the increased quantities of petroleum products proposed to be handled by the upgraded wharf.	Chapter 11, Appendix E
	• Preliminary Environmental Assessment (Appendix B) – Consistent with OEH's interpretation of 'locality', it is recommended that a 5 km (not 3 km) buffer as the limit of the dredge footprint to capture relevant threatened species records be applied to the EIS. This would encompass the whole of Towra Point Nature Reserve as well as important habitat for the Taren Point endangered shorebird community and the western end of Botany Bay.	Chapter 11, Appendix E

Government Authority	Requirement	Relevant EIS Chapter
Environment Protection Authority (Environment Climate Change & Water) (EPA)	**General Requirements** Based on the information provided at the Planning Focus Meeting on 16 September 2011 and in the documentation prepared by Worley Parsons, there are a number of key environmental issues that' should be investigated as part of the approval process. These issues are identified in Attachment A and include: • Licensing requirements; • Water quality including Acid Sulfate Soils and contamination; • Noise and vibration • Biodiversity • OEH Estate • Air Quality • Waste	EIS Volume 1 and Volume 2
EPA (OEH)	**Environmental Impacts of the Project** The following environmental issues need to be assessed, quantified and reported on: • Licensing requirements; • Water quality including Acid Sulfate Soils and contamination; • Noise and vibration • Biodiversity • OEH Estate • Air Quality • Waste	EIS Volume 1 and Volume 2
	EAs should address the specific requirements outlined under each heading below and assess impacts in accordance with the relevant guidelines mentioned.	EIS Volume 1 and Volume 2
	The Project	
	• The EA should fully scope the project including details on the location of the proposed project. This should include details on the affected environment to place it in its local and regional environmental context including surrounding landuses, planning zonings, potential sensitive receptors and environmental sensitivity.	Chapter 4, Chapter 18
	• Describe mitigation and management options that will be used to prevent, control, abate or mitigate identified environmental impacts (including any cumulative impacts) associated with the project and to reduce risks to human health and prevent the degradation of the environment. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented. Appropriate Best Management Techniques (BMT) should be outlined.	EIS Volume 1 and Volume 2
	• The EA should consider how operational aspects of the project could be coordinated with the proponents of other projects occurring in the vicinity to minimise noise impacts on sensitive receivers.	Chapters 18 and 19
	• The EA should consider the potential for any cumulative impacts to occur as a result of the proposed dredging activities. Where necessary, the EA should consider how operational activities of the project could be coordinated with the proponents of other projects occurring in the vicinity to minimise impacts arising from the development including water quality, noise impacts, construction traffic, dust impacts, aquatic ecology and waste management.	Chapter 18

Government Authority	Requirement	Relevant EIS Chapter
	Licencing Requirements	
	• The EA should determine whether an EPL will be required for the proposed works and provide sufficient information where necessary to enable OEH to determine appropriate licence limits. The requirements of Section 45 of the Protection of the Environment Operations Act 1997 should also be addressed should a licence be required.	Chapter 5
	• Should project approval be granted, the proponent will need to make a separate application to OEH for an EPL (if required) for the proposal prior to undertaking any on site works.	Chapter 5
	Water Quality:	
	• The goal of the project should be to ensure there is no pollution of waters (including surface and groundwater), except in accordance with licence requirements.	Chapter 10
	• The EA should identify the relevant Water Quality Objectives for the waters of Botany Bay and demonstrate how the project will be designed and operated to protect these water quality objectives. These measures should be consistent with the NSW Government's Statement of Intent for Georges River Botany Bay System (2002).	Chapter 10
	• The EA should also describe the nature and degree of any likely impacts that he proposed project may have on the receiving environment and clearly outline the proposed mitigation, monitoring and management measures the proponent intends to apply to the project to ensure the above goals are satisfied.	Chapter 10
	Dredging:	Chapter 4, Chapter 9, Chapter 16, Appendix D
	• The EA will need to describe the proposed dredging methodology and document an assessment of the proposed dredging activities within the waters of Botany Bay including the management of dredged spoil.	
	• The EA should contain a comprehensive assessment of the suitability of the material for the preferred disposal option, whether this be beneficial reuse or offshore disposal.	Chapter 16
	• A map of the distribution of any contaminated sediments in Botany Bay with details on the quality and estimated quantity should also be included.	Chapter 9, Appendix D
	Hydrological Impacts:	
	• OEH's broad environmental goal is that the proposal should not result in any hydrodynamic changes that adversely affect conservation and cultural heritage outcomes elsewhere in Botany Bay.	Chapter 8, Appendix C
	• The EA will need to assess whether the proposed works may have any potential effects on the hydrodynamics of Botany Bay.	
	Acid Sulphate Soils:	
	• The potential impact on acid sulphate soils must be assessed in accordance with the relevant guidelines in the *Acid Sulphate Soils Manual* (Stone *et al.*1998) and the *Acid Sulfate Soils Laboratory Methods Guidelines* (Adhern *et al.* 2004).	Chapter 9, Chapter 10, Appendix D

Government Authority	Requirement	Relevant EIS Chapter
	• Describe mitigation and management options that will be used to prevent, control, abate or minimise impacts from the disturbance of acid sulphate soils associated with the project and to reduce risks to human health and prevent the degradation of the environment. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.	Chapter 9, Chapter 10, Appendix D
	Noise and Vibration:	
	• The goal of the project should be to minimise adverse impacts due to noise from the project.	
	• The assessment must clearly outline noise mitigation, monitoring and management measures the proponent intends to apply to the project to minimise noise pollution. The assessment should include but need not be limited to: Identification and assessment of all potential noise sources associated with the development, the location of all sensitive receivers, proposed hours of operation and proposed noise mitigation measures.	Chapter 13, Appendix G
	• On the 5 September 2011 the Department of Planning and Infrastructure granted approval for the Caltex Jet Fuel Pipeline Upgrade Project. This project involves undertaking works at both the Kurnell Refinery and the Banksmeadow terminal. Depending on the timeframe for the proposed dredging works, the noise assessment may need to consider the cumulative impacts of the dredging activities as well as the Jet Fuel Pipeline activities being undertaken around the Kurnell area.	Chapter 18
	Biodiversity:	
	The EA should include a detailed biodiversity assessment, including assessment of impacts on threatened biodiversity, native vegetation and habitat. The assessment should be carried out in accordance with the relevant guidelines contained in Attachment B and include the following information as a minimum: a. The requirements set out in the Guidelines for Threatened Species Assessment (Department of Planning, July 2005). b. Identification of national and state listed threatened biota known or likely to occur in the study area and their conservation status. c. Description of the likely impacts of the proposal on biodiversity and wildlife corridors, including direct and indirect and construction and operation impacts. Wherever possible, quantify these impacts such as the amount of each vegetation community or species habitat to be cleared or impacted, or any fragmentation of a wildlife corridor. d. Identification of the avoidance, mitigation and management measures that will be put in place as part of the proposal to avoid or minimise impacts, including details about alternative options considered and how long term management arrangements will be guaranteed. e. Description of the residual impacts of the proposal. If the proposal cannot adequately avoid or mitigate impacts on biodiversity, then a biodiversity offset package is expected (see the requirements for this at point 6 below).	Chapter 11, Appendix E
	An assessment of the significance of direct and indirect impacts of the proposal must be undertaken for threatened biodiversity known or considered likely to occur in the study area based on the presence of suitable habitat.	Chapter 11, Appendix E

Government Authority	Requirement	Relevant EIS Chapter
	• There are a number of marine mammals and marine reptiles that have been recorded within the waters of Botany Bay including Humpback and Southern Right Whales, Australian and New Zealand Fur Seals as well as Loggerhead and Green Turtles. OEH suggests that the assessment should also consider any potential impacts that the dredging activities may have on marine mammals and marine reptiles that frequent the waters of Botany Bay.	Chapter 11, Appendix E
	OEH Estate:	
	• Where appropriate, likely impacts (both direct and indirect) on any adjoining and/or nearby OEH Estate reserved under the National Parks and Wildlife Act 1974 or any marine and estuarine 'protected areas under the Fisheries Management Act 1994 or the Marine Parks Act 1997 should be considered. Refer to the Guidelines for developments adjoining land and water managed by the Department of Environment, Climate Change and Water (DECC, 2010).	Chapter 11, Appendix E
	• The EA should include a description of the mitigation and management options that will be used to prevent, control, abate or minimise any potential impacts that are likely to occur on the Towra Point Nature Reserve associated with the project. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.	Chapter 11, Chapter 19, Appendix E
	Air Quality:	
	The goals for the project should be to ensure: • Unacceptable impacts do not occur on human health and the environment; and • No potentially offensive odours occur beyond the boundary of the premises.	Chapter 14, Appendix H
	The EA should identify and detailed description of the proposal and identify all processes that could result in air emissions. Sufficient detail to accurately communicate the characteristics and quality of all emissions must be provided. A description of the proposed mitigation, monitoring and management measures the proponent intends to apply to ensure the above goals are satisfied should also be included.	Chapter 14, Appendix H
	The EA should also include an assessment of the risk associated with potential discharges of fugitive and point-source emissions for all stage of the proposal. Assessment of risk relates to environmental harm, risk to human health and amenity.	
	The dredging of organic rich materials can become sources of fugitive odour. Whilst it is acknowledged that the material to be dredged is mainly sand with minimal amounts of clay and silt, the risk of generating potentially offensive odours from the proposed dredging activities should be assessed. All necessary mitigation measures to minimise any potential impacts should also be included.	

Government Authority	Requirement	Relevant EIS Chapter
	Waste: The goal of the project should be to ensure waste is managed: • In accordance with the principles of the waste hierarchy and cleaner production; • The handling, processing and storage of all materials used at the premises does not have negative environmental or amenity impacts • The beneficial reuse of all waste generated at the premises are maximised where it is safe and practical to do so; and • The EA should identify, characterise and classify all waste that will be generated and disposed as a result of the works. Proposed quantities of waste and disposal locations should be detailed in the assessment. All waste must be classified in accordance with OEH's Waste Classification Guidelines.	Chapter 16
Department of Trade and Investment Primary Industries (DTI (PI))	**Key Assessment Requirements:** It is important that a hydrological survey is conducted to predict ongoing impacts to nearby sensitive aquatic habitats, and other surrounding aquatic habitats. The EA should include an assessment of potential impacts to aquatic habitats within and immediately surrounding the proposed dredge site.	Chapter 8, Chapter 11, Appendix C, Appendix E
	As the proposed dredging activities are situated in the locality of Towra Point Aquatic Reserve, potential impacts to the aquatic reserve, listed below, are to be addressed in the environmental assessment: • Direct and indirect impacts to marine vegetation (i.e. algae, seagrasses, mangroves and saltmarsh) from activities including: – direct removal, or smothering from dredged spoil – turbidity and sedimentation during dredging activities – erosion and sedimentation from any changes to currents, waves and coastal processes that may result from the final dredged configuration and Significant changes to boat wakes from larger vessels and more frequent boating activity. • Impacts to aquatic and intertidal habitats from disposal of dredged material within Botany Bay. Note that DPI-Fisheries recommends that dredged spoil is to be deposited appropriately on land or at the approved Commonwealth offshore spoil dumping grounds. Any excavated material to be deposited on land is to be done so according to its contamination and acid sulphate characteristics.	Chapter 11, Appendix E Chapter 11, Appendix E
	• Impacts to water quality during dredging, particularly turbidity related impacts.	Chapter 10, Chapter 11
	• Impacts to the Endangered Population of Posidonia australis seagrass and aquatic habitats within the sensitive areas mentioned above and surrounding the proposed dredge site in general. Potential impact sources are mentioned. in the points above.	Chapter 11, Appendix E
	If TBT is resuspended in to the water column then it could potentially impact on the viability of molluscs within that environment particularly spat and other aquatic fauna. This is to be addressed in the EIS. Without a clear understanding of the TBT levels that may be attained at the oyster farming areas it is difficult to ascertain potential impacts.	Chapter 11, Appendix E

Government Authority	Requirement	Relevant EIS Chapter
	The *NSW Oyster Industry Sustainable Aquaculture Strategy* (OISAS) and enabling amendments to State Environmental Planning Policy 62 - Sustainable Aquaculture were gazetted in December 2006. This policy requires that all development which has the potential to have an adverse impact on oyster aquaculture is referred to NSW DPI for comment. In determining a development application the consent authority must take any NSW DPI comments into consideration.	Chapter 11, Chapter 17, Appendix E
	An assessment on the impacts to the aquaculture lease area west of the Caltex wharf and any structures thereon should also be considered.	Chapter 17
	The EIS should outline the recreational and competitive fishing activities that may be affected by the proposal, including popular recreational fishing sites. An indication of the area where recreational fishing opportunities may be limited by the dredging activity and any ongoing activities around the wharf and when this is likely to occur.	Chapter 17
	Fisheries NSW recommend that ongoing angler access is maintained to the Botany Bay RFH.	Chapter 17
	Consideration of the potential risk to human health from the re-suspension of contaminated sediment is to include the nearby oyster aquaculture lease areas and impacts to recreationally fished species.	Chapter 17
	Fisheries NSW request a clear map showing the specific dredging locations within the dredge footprint is provided in the EIS.	Chapter 4
Department of Trade and Investment NSW Office of Water (DTI (NOW))	• Compliance with the rules in any relevant Water Sharing Plan (WSP) and legislation.	Chapter 16
	• Assessment of the impact of the proposal on the shoreline of Botany Bay, riparian areas, groundwater dependent ecosystems and RAMSAR wetlands.	Chapter 8, Chapter 11, Appendix C, Appendix E
	• Adequate mitigating and monitoring requirements to address impacts.	Chapter 19
Randwick City Council	The potential impact of the proposed works on the operation of Sydney Ports in the Randwick City and adjoining Botany Bay City Council areas, including any impacts on shipping lanes and queues to and from Port Botany.	Chapter 17
	The works must be undertaken with appropriate risk management measures to prevent any spillage of pollutants into Botany Bay including environmental management systems to prevent potential marine oil spills.	Chapter 15, Appendix I
	The EA should assess the potential ecological impacts, including but not limited to, the following:	
	• Impacts on the hydrodynamics of Botany Bay;	
	• Loss of biodiversity in Botany Bay;	
	• Disturbance of acid sulphate soil particularly related to dredging and use of dredged material for fill;	Chapter 11, Appendix E
	• Impacts on water quality;	
	• Impacts on groundwater levels and quality including the Botany Aquifer; and	
	• Impacts on wetland areas.	
	Ensure comprehensive community consultation.	Chapter 6, Appendix B

Government Authority	Requirement	Relevant EIS Chapter
Sutherland Shire Council	• A detailed assessment of the impacts associated with the dredging of contaminated sediments and flow on ecological and environmental effects should be undertaken. This should include the both the proposed project area and the offshore disposal area. The assessment should outline any treatment methods that can be utilised to reduce the risk of Tributyltin contaminated sediments.	Chapter 9, Chapter 11, Chapter 16, Appendix D, Appendix E
	• The assessment should also include all impacts upon the environment and human health associated with the proposed works.	EIS Volume 1 and Volume 2
	• The use of clean dredged sediment should be justified by appropriate sediment sampling and analysis to clearly demonstrate the sustainability of such reuse.	Chapter 9, Chapter 16, Appendix D
	• Approval under the SD Act should be sought prior to finalisation of the EIS so that if approval is not granted for this disposal method an alternative method is required, the environmental impacts associated with the proposal can be adequately assessed.	Chapter 5, Chapter 16
	• The EA (URS, 2012) states that ballast water discharge will be undertaken utilising the "same testing and approvals process… in order to meet Caltex's requirements". Council recommends that this procedure be clearly outlined in the EIS.	Chapter 10, Chapter 16
	• Dredging and changes to the physical environment (e.g. altered wave heights) have been identified as some of the key processes threatening the ongoing persistence of the populations. As such the proposal has the potential to have significant impacts upon key seagrass beds, some of which are listed as an endangered population under the NSW FM Act 1994 and therefore requires appropriate assessment of the impacts associated with the proposed works. This should be a detailed assessment based on a combination of survey works and scientific literature review and must assess all direct and indirect impacts associated with the proposed works.	Chapter 11, Appendix E
	• The EIS should include a Marine Mammal Management Plan which addresses any impacts associated with the proposal upon marine mammals. The assessment and management protocols identified should include the dredging area and the transportation routes to the offshore disposal area.	Chapter 11, Appendix E
	• Works should ideally be conducted outside of the whale migration seasons.	Chapter 11, Appendix E
	• Waste management procedures for the proposed works should be clearly outlined in a waste management plan which should be included in the EIS.	Chapter 16
	• A clearly outlined and scientifically robust monitoring program should be included in the EIS. This program should include all potential environmental impacts and must include a suitable spatial temporal scale to quantify any impacts associated with the proposed works.	Chapter 19
	• A contingency plan should be prepared and included in the EIS to address any observed changes identified as part of the monitoring of the proposed works, both during and post construction. Any proposed mitigation and rehabilitation measures identified should be justified in the scientific context to confirm the suitability of the proposed measures.	Chapter 19

Government Authority	Requirement	Relevant EIS Chapter
	• A number of assumptions have been made in the draft EA with respect to predicted impacts resulting from the proposed works. Whilst the reported assumption may be accurate, any such statement, particularly in regards to predicted impacts or negating the requirement for further assessment, should be justified with appropriate scientific literature.	EIS Volume 1 and Volume 2
Rockdale City Council	• The Council requests that as part of any environmental review of this project that a detailed study should be undertaken to ensure the proposed Kurnell dredging does not adversely affect wave patterns in Botany Bay and the foreshore along Lady Robinsons Beach. • Any approvals for this project should include a condition to undertake pre and post hydro surveys in the Bay to assess the impacts of the dredging. • If it is established that the dredging has had an adverse impact on the western foreshore of Botany Bay then the Proponent Caltex is to undertake remediation work as determined by the Specialist Coastal Engineering Consultant.	Chapter 8, Appendix C Chapter 8, Appendix C Chapter 9, Appendix D

Appendix B

Consultation

Consultation and Responses

Introduction

The **first set of tables** below outlines the main issues raised by the relevant Government Authorities. These issues have been grouped under the following headings:

- The proposed works;
- Legislation and Planning Policy;
- Consultation;
- Hydrodynamics and Coastal Processes;
- Spoil and Contamination;
- Water and Sediment Quality;
- Ecology;
- Noise;
- Air Quality and Odour;
- Hazards and Risks Assessment;
- Waste and Resource Management;
- Amenity, Land Use, Recreation and Navigation; and
- Cumulative Assessment.

The **set of second tables** outlines the main issues raised by members of the community.

Key issues raised by Government Agencies and Authorities

General Issues Raised Through the Consultation Process

Issue	Raised by	Addressed in EIS
Undertake an adequate monitoring program and contingency plan, to identify changes resulting from the proposed works, including all potential impacts.	Sutherland Shire Council	Chapter 19
Justify any assumptions of predicted impacts with scientific literature.	Sutherland Shire Council	Chapters 8-19
Include all relevant details of the proposed works in the EIS (e.g. land uses, sensitive receptors) including clear maps of the proposed works.	NSW Environment Protection Authority (EPA) (NSW Office of Environment and Heritage (OEH); NSW Department of Primary Industries (DPI) (Fisheries NSW)	Chapter 3-4
Identify the nature and degree of potential impacts, and mitigation and management options to eliminate/minimise risks to human health and the environment, outlining Best Management Techniques.	NSW EPA/OEH	Chapters 8-19
The EIS must assess the impacts of the additional rock revetment wall.	Sutherland Shire Council	Chapters 10, 11 and 13
Requests that a two week extension to provide comments be granted, as two weeks is insufficient to gather a reasonable level of responses.	RFA of NSW	Chapter 4
Appropriate safety controls are to be devised in accordance with the requirements of the Harbour Master and the Port Procedures Guide.	SPC	Chapter 4
Any proposed works that will disturb the bed of the Special Port Area of Botany bay will require written approval from the Harbour Master. All necessary information must be provided as part of the application for Harbour Master approval.	SPC	Chapter 5
Advises that there are two protection zones off the Sydney coast. If the Study Area is situated within these protection zones, it is subject to any offences for damaging a cable or breaching prohibitions and restrictions. Matters affecting areas outside the protection zones should be notified to the relevant government authorities.	ACMA	Chapter 5

Legislation and Planning Policy (Chapter 5)

Issue	Raised by
The noted requirement to seek RMS' land owner consent as part of the SSD process.	NSW Roads and Maritime Services (RMS)
The EIS should consider SEPP No. 62: Sustainable Aquaculture.	NSW DPI: Fisheries NSW
Licencing requirements need to be assessed and reported on,	NSW EPA

Issue	Raised by
and the EIS should determine whether an EPL is required (to be obtained from NSW EPA) and address all necessary requirements if a licence is granted.	
Approval from the Harbour Master is required for the proposed works under Clause 67 of the Management of Waters and Waterside Lands Regulations – NSW, and all plans and procedures are to be approved by the Harbour Master before the commencement of the works.	SPC
Seek Commonwealth approval to dispose dredged sediments at the Sydney offshore spoil ground prior to EIS finalisation.	Sutherland Shire Council NSW EPA
If only 6,000 m^3 of extracted material will be reused as part of the proposed works, an EPL for the scheduled activity of water based extractive activities would not be required. However, the EIS would need to determine whether a licence to regulate water pollution under Section 120 of the POEO Act 1997 would be required given that the sediments to be dredged may be organic rich and may contain contamination.	NSW EPA

Consultation (Chapter 6)

Issue	Raised by
The SMCMA should be consulted regarding any activities or projects that may be relevant to the proposed development.	NSW EPA/OEH
Ensure comprehensive community consultation.	Randwick City Council
Fisheries NSW should be included in the list of Government agencies that are to be consulted with in the Final DGR requirements.	NSW DPI: Fisheries NSW
Concern regarding inadequate consultation with the recreational fishing clubs in the area.	ANSA (& SSAFA)
Concern over the lack of information available to the public and difficulty in accessing adequate information regarding the proposal.	RFANSW and USFA
Concern surrounding inadequate consultation with recreational fishers regarding the proposed works, and the impacts on recreational fishers following impacts of previous projects in the area.	RFA of NSW
Requested to be kept informed on the progress of the proposal, outcome of determination, and program plan.	CYCA
Notice should be given to advise anglers of when the sea dumping period begins.	NSW ACoRF
Requests the proponent notify fishers (Commercial Fishing Management and Commercial fishers within the Ocean Trap and Line Fishery set traps and dropline the reefs within the Sydney Offshore disposal ground) of the details surrounding disposal operation, such as duration, dumping times and quantity and composition.	DPI
The applicant must liase with the Harbour Master to determine vessel movements during the proposed works to minimise commercial shipping operation delays.	SPC

Issue	Raised by
There is an offshore petroleum exploration permit just off Sydney that should be contacted in regards to the proposal as it may have an impact on their work.	DTI
Recommends the proponent advise the Australian Hydrographic Office who will issue a Notice to Mariners. The Rescue Coordination Centre of AMSA should also be consulted a few days before operations commence, who may issue an AusCoast Warning to shipping.	AMSA
Recommends consulting with the Commonwealth Fisheries Association regarding any specific concerns fishing operators may have surrounding the Project.	AFMA

Hydrodynamics and Coastal Processes (Chapter 8)

Issue	Raised by
Modelling of hydrological impacts should include any changes in wave energy and direction (including storm surge impacts) that may result from the final dredge footprint.	NSW DPI: Fisheries NSW
Dredging should be designed to minimise hydrological impacts if they become evident during environmental investigations, and all areas that could be impacted by altered hydrological and wave regimes in Botany Bay should be covered.	NSW DPI: Fisheries NSW NOW
The proposed works should not result in hydrodynamic changes that adversely affect conservation and cultural heritage in Botany Bay.	NSW EPA
A hydrological survey should be conducted to predict ongoing impacts to nearby sensitive aquatic habitats.	NSW DPI
The EIS should address any hydrodynamic changes under the proposed works (including wave heights and angles), in particular the impacts on Botany Bay beaches, Port Botany shipping operations, recreational boat users, and the airport runways.	SPC

Spoil and Contamination (Chapter 9)

Issue	Raised by
A map of the distribution of any contaminated sediments in Botany Bay should be provided along with details on the quality and estimated quantity.	NSW EPA
Caltex should ensure that the works do not exacerbate the issue of additional sand accumulation at foreshore beach that is blocking drainage pipes, due to recent port extensions.	City of Botany Bay Council
Impacts on coastal hazards and shoreline sediment transport rates within Botany Bay, Acid Sulfate Soils and contamination, and flood behaviour, should be considered in accordance with relevant legislation and guidelines.	NSW EPA
The proposed works should ensure all water pollution is in accordance with relevant licence requirements.	NSW EPA
The EIS should describe the proposed dredging methodology	NSW EPA

Issue	Raised by
and document an assessment of the proposed dredging activities including the management of any dredged spoil, flow on ecological and environmental effects, and include a detailed map of the contaminant distribution.	Sutherland Shire Council; NSW DPI: Fisheries NSW
Consideration of potential human health risks from resuspension of contaminants to include nearby recreational fishing and aquaculture lease areas.	NSW DPI: Fisheries NSW
More detail is required regarding the process surrounding the disposal of dredged spoil, and the management and monitoring measures to be put in place under the proposed works.	RFANSW
Consider a method to reduce the volume of material to be dumped offshore before works commence.	NSW ACoRF
The EIS should provide additional detail regarding timing and total quantities of spoil to be dumped at the offshore facility.	DPI
Questions whether any additional dredged material (not already identified in the EIS) can be treated and re-used considering the great demand for Construction Materials in the Sydney market.	DTI
If the project is approved, the Alliance strongly recommends disposal and treatment of dredged spoil on land, due to possible impacts from disturbed contaminated sediment.	RFANSW
Concern surrounding ASS and contaminated silt arising from the dredged material.	RFANSW
The EIS should include additional information on proposed containment of spoil in the area under different current strengths and suspended solids in the water column.	NSW DPI
Concern expressed over the potential for contaminated spoil to be disposed at the offshore dumping site, and questions over other disposal options for any contaminated spoil.	

Water and Sediment Quality (Chapter 10)

Issue	Raised by
A *Spill Management Plan* should be prepared as part of the *Construction Environmental Management Plan* (CEMP) and SPC should be contacted in the event of a spill.	SPC
Water Quality Objectives should be identified and protected through project design, and be consistent with NSW Government's Statement of Intent for Georges River Botany Bay System: 2002.	NSW EPA
Details should be included on the procedure of ballast water discharge (including approvals and testing) in the EIS.	Sutherland Shire Council
An assessment of the impact on water quality, including turbidity and contamination particularly turbidity related impacts, should be undertaken to ensure water pollution only occurs in accordance with licence requirements.	NSW DPI: Fisheries NSW NSW EPA/OEH
The nature and degree of any likely [water quality] impacts should be described and the proposed mitigation monitoring and management measures to be implemented should be clearly set out.	NSW EPA

Issue	Raised by
The EIS (including management plan) should take into account the objects and regulatory requirements of the *Water Act 1912* and *Water Management Act 2000* (WMA 2000), as applicable.	NOW
The proposed works should give greater consideration to the reuse of dredged material.	NOW
A Spill Management Plan must be developed before undertaking works.	SPC
Caltex must develop adequate procedures to ensure no pollution will result from a pipeline being breached by the dredge, and that the sea bed remains over the pipelines to protect them from the impact of an anchor being dropped from a vessel.	SPC
The proposed works should ensure that pollution of waters does not occur as a result of product discharge and/or spills in compliance with EPL (№ 837).	NSW EPA
In relation to the re-use of dredged sediment, Caltex must implement best management practice to ensure pollution of water does not occur, activities are not carried out in an environmentally unacceptable manner and the EPA is notified immediately of any pollution incidents or harm to the environment under the POEO Act.	

Ecology (Chapter 11)

Issue	Raised by
Seagrass mapping information should be used as a guide only, and a more accurate finer scale on-ground habitat mapping should be undertaken during the assessment.	NSW DPI: Fisheries NSW
The EIS should assess potential direct and indirect harm to sensitive wetlands and seagrasses from the proposed dredging and final dredging configuration and boat wake should be considered along with necessary mitigation measures.	NSW DPI: Fisheries NSW Sutherland Shire Council
The EIS should consider direct and indirect impacts to threatened marine fauna when justifying preferred dredging methods.	NSW OEH Sutherland Shire Council
Consideration should be given to biodiversity impacts when addressing timing and duration of works and shipping movements.	NSW OEH
Areas of ecological significance should be expanded to include shorebird habitats at Taren Point and around Dolls Point, and Kamay Botany Bay National Park should include the area on the northern and southern sides of the Bay entrance.	
Additional monitoring of biota should be undertaken in nearby tidal areas if required following results of sediment sampling and dredge plume monitoring.	
Surveying and monitoring should be undertaken before and during construction to ensure impacts under the works are identified and managed.	
The list of threatened species, populations and communities	

Issue	Raised by
potentially impacted by the proposed works should be refined and those most at risk detailed in the EIS.	
Consideration should be given to all obligations under the EPBC Act.	SEWPaC
The EIS should assess the potential ecological and environmental impacts, including those under impacts to hydrodynamics, loss of biodiversity, disturbance of acid sulfate soil, dredged material for fill, water quality, groundwater levels and quality, and wetland areas.	Randwick City Council; Sutherland Shire Council; NSW OEH NSW DPI: Fisheries NSW NOW
This EIS should assess impacts to threatened marine mammals and include an adequate Marine Mammal Management Plan in the EIS.	Sutherland Shire Council; NSW OEH
There would be a requirement to make a separate application to NSW EPA for an EPL (if required) for prior to undertaking works.	NSW OEH
This EIS should assess likely direct and indirect impacts to OEH estate under relevant legislation and guidelines.	
This EIS should include a description of the mitigation and management options for impacts to the Towra Point Nature Reserve and Towra Point Aquatic Reserve.	NSW OEH NSW DPI: Fisheries NSW
The proposed works must comply with all relevant legislation and guidelines including *Fisheries Management Act 1994*.	NSW DPI: Fisheries NSW
This EIS should include direct and indirect impacts to marine vegetation (i.e. algae, seagrasses, mangroves and saltmarsh), and aquatic and intertidal habitats, and conduct a hydrological survey.	
This EIS should assess impacts of suspended tributyltin (TBT) on molluscs such as spat and other aquatic fauna.	
This EIS should consider impacts to estuarine ecosystems, wetlands and mangroves adjacent to or up-river from the works.	
This EIS should include details surrounding dredging and reclamation activities.	
This EIS should include details surrounding the activities that damage marine vegetation to include the type of vegetation to be impacted, information surrounding the existing environment, and measures to minimise impact and rehabilitate.	NSW DPI: Fisheries NSW NOW
An aquatic habitat assessment should be undertaken to inform the EIS that identifies 'key fish habitats' within and adjacent to the study area, and consider hydrology, water quality, surrounding land use, condition of marine vegetation, substrate type and presence of any necessary species under the FM and EPBC Acts.	NSW DPI: Fisheries NSW
The EIS should provide details on the presence and distributions of groundwater dependent ecosystems potentially affected by the proposals and demonstrate that there will be minimum impacts.	NOW
The EIS should map important intertidal habitat and use the results of hydrodynamic and wave modelling to predict any	NSW OEH

Issue	Raised by
losses that may result from dredging and either mitigate or compensate for these.	
Supplementary monitoring of biota in nearby intertidal areas should be undertaken to determine impacts on migratory and threatened shorebirds, if sampling and modelling results require it.	NSW OEH
Concern surrounding the ecological impacts under the proposed works, including dredge induced stress related diseases.	RFANSW
Concern over the impact of the proposal on recreational amenity or income, including effects on fish movement and passage, habitat destruction, sedimentation, eutrophication and acid.	RFANSW
No major baseline habitat mapping or monitoring has taken place in recent years, making it difficult to adequately determine the cumulative ecological impacts under the proposed works. There is also limited public information available on the monitoring that has taken place	RFANSW

Noise (Chapter 13)

Issue	Raised by
This EIS should consider noise and vibration impacts and implement measures to minimise adverse impacts.	NSW EPA
Operational phase of the proposed works should be coordinated with other projects in the vicinity to minimise noise.	
The assessment should clearly outline the noise mitigation, monitoring and management measures to minimise noise pollution.	
Construction noise and operational noise associated with the proposed project should be assessed in accordance with the relevant guidelines (including *Assessing Vibration: A Technical Guideline*).	
In accordance with the *Interim Construction Noise Guidelines* (see Chapter 13), the works that are proposed to be undertaken outside recommended standard hours require clear justification other than convenience.	
The EIS should detail appropriate management measures such as community consultation and notification programs and consider including appropriate respite periods for the local community to reduce ongoing noise impacts	
The EIS should detail the duration and times of day for any piling works and identify potential suitable alternative methods of piling (such as pile drilling) and compare noise impacts from each method.	

Air Quality and Odour (Chapter 14)

Issue	Raised by
This EIS should include an assessment of air quality impacts, and implement measures to prevent unacceptable impacts, and ensure no potentially offensive odours occur beyond the premise boundary.	NSW EPA
The EIS should include a detailed description of the proposal and identity and describe all processes that could result in air emissions.	
This EIS should assess the risk of generating offensive odours from the dredge works, and identify mitigation measures to minimise impacts.	
This EIS should include an assessment of the risk associated with potential discharges of fugitive and point source emissions.	

Hazards and Risks Assessment (Chapter 15)

Issue	Raised by
This EIS should assess hazards and risks associated with the upgrade of a major hazards facility.	NSW EPA
This EIS should implement appropriate risk management measures to prevent spillage of pollutants including environmental management systems to prevent potential marine oil spills.	Randwick City Council

Waste and Resource Management (Chapter 16)

Issue	Raised by
This EIS should include a detailed waste management plan, including any reuse options, waste classification in accordance with appropriate guidelines, and details surrounding waste disposal.	Sutherland Shire Council; NSW EPA
This EIS should assess waste management measures in accordance with appropriate principles and ensure waste management does not produce negative impacts to the amenity or environment.	NSW EPA
The proposed works should comply with rules set out in Water Sharing Plans (WSP) and legislation.	NOW
This EIS should provide adequate detail regarding water use and management measures to be implemented.	NOW

Amenity, Land Use, Recreation and Navigation (Chapter 17)

Issue	Raised by
Liaison with the Harbour Master should be undertaken to prevent delay to commercial shipping operations and devise appropriate safety controls.	SPC
All vessels involved in the works must be identified to the Harbour Master.	
The EIS should assess potential impacts to the operation of the	Randwick City Council

Issue	Raised by
Sydney Ports.	
This EIS should assess impacts to the aquaculture lease and any structures adjacent to the Caltex wharf which is still current and occupies 4ha (Georges River oyster farming).	NSW DPI: Fisheries NSW
This EIS should outline recreational and competitive fishing activities that may be affected by the proposal including an indication of the area there opportunities may be limited.	
Ongoing recreational angler access should be maintained to the Botany Bay Recreational Fishing Haven (RFH).	
Under *Section 74 and 75 of the Marine Safety Act 1998 no 121* pilotage is compulsory in every pilotage port for every vessel 30m or over in length unless the master holds a marine pilotage exemption certificate or a certificate of local knowledge.	SPC
General concerns surrounding the safety of boat users in the area under the proposed works and new mooring points.	ANSA (& SSAFA)
A 50 metre increase in the mooring point of the wharf would place boats in the dangerous position of having to navigate a very small corridor between the new mooring point and the sub berth moorings.	ANSA (& SSAFA)
The EIS should clarify how current shipping movements and product deliveries will be managed during the proposed upgrade works to ensure the existing EPL (No 837) is complied with.	NSW EPA
Caltex is to liase with the Harbour Master to develop procedures to ensure that the spoil barge movements do not interfere with or impeded the movements of seagoing ships.	SPC
Requests that movements of vessels related to the offshore dumping site be restricted to periods of time when fishing activity is reduced.	NSW ACoRF
Concern over the impact on recreational fishing areas, particularly on a recreational fishing area "12 mile" SE of the dumping area at 33 55.6 S, 151 28.5 E, under strong currents flowing in that direction.	NSW DPI and NSW ACoRF
All vessels to be used in the proposed works are to be identified to the Harbour Master for consideration of navigation issues such as movement and timing.	SPC

Cumulative Assessment (Chapter 18)

Issue	Raised by
Consideration should be given to the potential for cumulative impacts under the proposed works and the need to coordinate operational activities with proponents of other projects in the vicinity to reduce environmental impacts.	NSW EPA/OEH
This EIS should include a more detailed schedule of activities to assist in assessing potential cumulative impacts with activities and/or projects being carried out in the Kurnell area.	
Concern surrounding the cumulative impacts of the spoil grounds used off-shore and inshore effects, as fishers have witnessed previous impacts under several major developments that have permanently altered the environment throughout Botany Bay.	RFANSW

The following organisations were also invited to comment on the proposal for the disposal operations although at the time of submission Caltex have not received response.

Abbreviation	Stakeholder	Date
Non-Government		
NSW FCA	NSW Fishing Clubs Association Inc.	
CFA	Commonwealth Fisheries Association	
SEFTIA	South East Trawl Fishing Industry Association	
ANSA	Australian National Sportfishing Association (NSW Branch)	
USFA	Underwater Skindivers & Fishermen's Association	
BOUNTY	Bounty Oil & Gas NL	
NCC	Nature Conservation Council of NSW	

Key Community Issues Raised

Issue	Meeting in which issue was raised	Relevant EIS Chapter/Appendix
Comments regarding the dredging works: permissions that are required to undertake dredging? What is the public consultation process? Details surrounding how much dredging will take place and how often? Does Caltex dredge currently? Where will Caltex deposit the dredging fill? Who pays for dredging?	Kurnell Community Briefing – the future of Kurnell Refinery 15/08/2012	Chapter 5, Chapter 6, Appendix B, Chapter 4, Chapter 16,
Community advice on progress of application (Environmental Impact Statements, public consultations/development applications).		Chapter 6, Appendix B
How large are the ships – now and in the future? How many ships? How long will it take to unload the ships? Will Product ships be noisier? Will they require larger buffers near the jetty?		Chapter 4, Chapter 13, Appendix G
Will the off shore ship to ship transfers still take place?		Chapter 4
Is there greater risk of oil spills? Has Caltex had any spills previously?		Chapter 15, Appendix I
Will the wharf structure be larger under the proposed works? What visual impacts can we expect at the wharf?		Chapter 4, Chapter 17
How many shipping movements a year?		Chapter 4,
Will there be more road tankers in use under the proposed works?		Chapter 4
Members of the community requested more detail about the environmental assessment process and the community consultation process.		Executive Summary, Chapter 6, Appendix B
Assurances sought about information sharing - concerned they might not hear about or be made aware of information related to the transition. In particular any state/local government environmental and development approvals lodged on internet for review.	Kurnell Community Briefing – the future of Kurnell Refinery 15/08/2012	Chapter 6, Appendix B
Question regarding the progress of the jet fuel remediation	Quarterly Community Meeting 28/11/2012	Chapter 4
What is the orange coloured barge near the wharf?		Chapter 4
What will happen to the CLOR site in the future and will the tank farm be demolished?		Chapter 4
Will the dredging impact any underwater pipelines/cables in the bay?		Chapter 4, Chapter 10
Will additional mooring points need to be installed at the sub berth for the terminal?		Chapter 4
How will the sub berth and fixed berths be used by the terminal?		Chapter 4

Issue	Meeting in which issue was raised	Relevant EIS Chapter/Appendix
Will the distribution pipelines (to airport, Banksmeadow, Silverwater) remain the same?		Chapter 4
Will Caltex supply the jet fuel to the new Sydney airport?		Chapter 4
A ship at the wharf recently was creating a lot of black smoke. Are they allowed to do this, and should we call the hotline when we see these types of events occurring?		Chapter 6, Appendix B

.

Annex A – Caltex Community Information Flyer

September 2012

THE CALTEX KURNELL REFINERY

INFORMATION FOR THE COMMUNITY ABOUT THE PROPOSED CONVERSION OF THE REFINERY TO A FUEL IMPORT TERMINAL

In July, Caltex announced a restructure including the proposal to close the Kurnell refinery and convert it to a fuel import terminal.

The decision followed a 12 month review of our refineries which lost more than $200 million in 2011. While Caltex's Refining operation broke even in the first half of 2012, the Kurnell refinery continued to lose money.

Our refineries are relatively small and, in their current configuration, remain disadvantaged when compared to the modern, larger, more efficient refineries in Asia against which we compete.

The long-term challenges, including projected surplus regional refining capacity, contributed to our proposal to close the Kurnell refinery. The proposal is to secure the long-term future of Caltex and to help ensure that we continue to deliver reliable and competitive products to our customers.

Our Commitment

Caltex is staying in Kurnell.

It is important to recognise that there is no immediate change to Caltex's Kurnell operation. However, we are looking ahead at how we can make the proposed transition to a terminal in the second half of 2014 as smooth, safe and environmentally-responsible as we can.

We are committed to supporting our people with the highest level of care, attention and respect. We continue to work closely with our Kurnell refinery people to discuss their individual needs – whether that is retention, redeployment and retraining, or outlining generous redundancy entitlements.

We are also continuing to meet regularly with our neighbours and provide updates about our current operations and the proposed conversion. We believe the Kurnell community should be fully informed throughout the process.

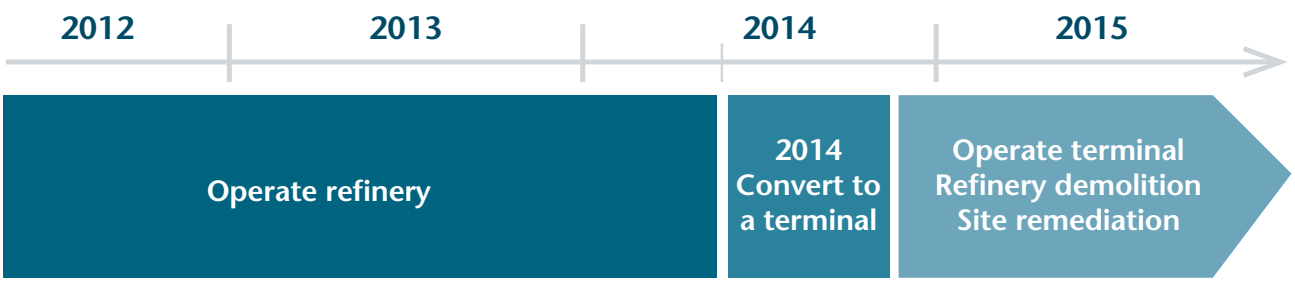
While we have proposed to change the function of our Kurnell site, our commitment to safe and environmentally-responsible operations will not change.

Next Steps

Over the next two years we will continue to run the refinery. At the same time we are proposing to carry out work to convert the site to a fuel import terminal. The conversion is classified as a "State significant development". The approval process including environmental assessments and public exhibition for comment is within the jurisdiction of the NSW Department of Planning & Infrastructure, and Caltex is working closely with the government and interested parties.

The conversion project would involve work inside the refinery as well as at the Caltex wharf and sub berth. The final stage of conversion would include the shut down and demolition of the refinery process units (which convert crude oil to products), and site remediation.

Timeline



The difference between the existing refinery and a terminal

The Kurnell refinery is a process plant where crude oil is processed and refined into a range of fuel products including petrol, diesel, jet fuel and fuel oil. Petroleum by-products such as sulphur, LPG and other gases are also produced. Crude oil is delivered to the refinery by ship, pumped into large crude oil tanks and then treated by the various process units to make different products. Finished fuel products are stored in product tanks before being distributed to other terminals by pipeline or ship. Finished by-products are primarily distributed by trucks.

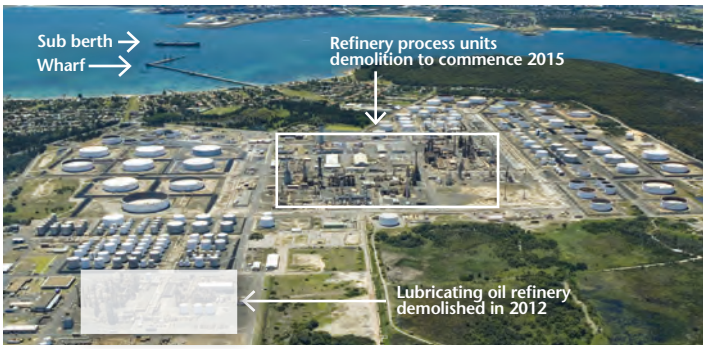
The proposed Kurnell terminal would import, store and distribute petrol, diesel, jet fuel and fuel oil. These fuel products would be delivered to the refinery by ship and pumped into product tanks, before being distributed to other terminals by pipeline.

The proposed conversion from a refinery to a terminal would involve a reduction in employee positions from around 430 to less than 100. Similarly, while work for site contractor companies would continue as the conversion projects and demolition of the refinery are carried out, eventually this would decrease.

As a terminal there would be less traffic mainly due to the absence of refinery by-products being distributed by truck and the smaller number of people working on site. There would no longer be background noise from the refinery, so Kurnell would be a much quieter place. The flare would be demolished so there would be less light at night. Over time, odours from the facility should decrease as crude oil would no longer be processed.

Caltex's longstanding relationship with the Kurnell community would remain. As a terminal, we would continue to communicate with, support and be an active member of the local community.

The proposed conversion of Kurnell refinery to a fuel import terminal



The proposed conversion project would involve work inside the refinery as well as at the wharf and the sub berth (located in the bay beyond the wharf).

The purpose of this work is to:

> Provide flexibility to import fuel products in a broader range of ship sizes

> Reconfigure the site to import and store fuel products in place of crude oil

The final stage of conversion would include the shut down and demolition of process units, and remediation.

Shipping

Conversion of the refinery to a terminal would see crude oil imports replaced by fuel imports. The overall number of shipping movements would be about the same, however the mix of ships would change. Currently the refinery receives large crude ships up to 245 metres in length as well as a mix of smaller product ships. The proposed terminal would receive a mix of product ships up to a maximum of 245 metres in length. Caltex is seeking approval from the NSW Department of Planning & Infrastructure to carry out dredging at the wharf (#1 and #2 berths) and at the sub berth, and to upgrade wharf facilities and reconfigure moorings. The purpose of this work is to provide the flexibility to import fuel in a broader range of ship sizes from MR (180 metres) up to LR2 (245 metres) at both the wharf and sub berth.

Dredging

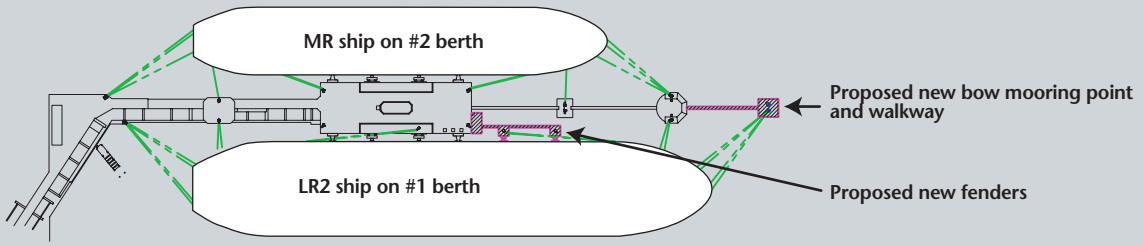
Caltex is proposing to carry out dredging of #1 and #2 berths at the wharf, the sub berth, and approaches to the berths. Dredging was last carried out at the wharf when the refinery was constructed, and at the sub berth in 1969. The intent of the dredging would be to remove sediment that has accumulated over the past 40 years at spot locations, and increase the depth, length and width of the #1 berth.

The proposed dredging at the wharf would increase the existing depth from around 11.2 metres, to around 12.8 metres for #1 berth and around 12.2 metres for #2 berth. Dredging at the sub berth would restore the depth back to the original design depth of 14 metres. The dredged materials would be disposed of in a federal government designated offshore disposal area.

Wharf upgrade

To enable the #1 berth at the wharf to receive larger product ships Caltex proposes to install a new bow mooring point and new fenders. The new mooring point would extend approximately 50 metres beyond the end of the existing wharf structure. A narrow walkway out to this mooring would also be built.

Caltex would also install hydraulic loading arms and quick release moorings on #1 berth and upgrade the entire wharf fire system, to improve safety. At the sub berth Caltex proposes to upgrade and reconfigure the mooring system to comply with the latest industry standards, and to allow a range of different sized ships to berth.



Caltex wharf: scale of proposed maximum terminal ship sizes and proposed wharf extension

While there would be some minor changes to pipelines, there would be no need to install any additional pipelines between the refinery and the wharf.

Looking after the marine environment

The approval process for the proposed work at the Caltex wharf and sub berth is being managed by the NSW Department of Planning & Infrastructure. As part of their approval process a comprehensive Environmental Assessment (EA) has been carried out.

The EA examined issues such as changes in water movement, the management and disposal of the dredged material, impacts on flora and fauna, impacts on Aboriginal and non-Aboriginal heritage, and general construction issues such as noise. The results of the EA are being incorporated into the project's Environmental Impact Statement (EIS). The purpose of the EIS is to report the potential environmental impacts of the proposed development and to outline measures to manage or control the identified impacts.

The project's EIS will be made available for review and comment by the public as part of the approval process in the first quarter of 2013. Caltex will ensure the Kurnell community is informed of the exhibition period.

Trucks

The refinery distributes petrol, diesel, jet fuel and fuel oil to terminals by pipeline or ship. This would remain the same after closure of the refinery.

The refinery receives deliveries by truck of chemicals for use in the process units and also distributes petroleum by-products such as sulphur and LPG by truck. As a terminal the process unit chemicals would not be required and the refinery by-products would not be produced, so these trucks would no longer come to Kurnell.

Trucks also visit the refinery to deliver general equipment used to run and maintain the plant. While the number of trucks might increase slightly while the conversion projects are being carried out, longer term there would be a decrease in these truck movements.

Tanks

The refinery has more tanks than are needed for a terminal, however many of these tanks are designed to store crude oil. Work needs to be done to convert the existing crude oil tanks to tanks that can store finished fuel products. As part of the refinery demolition process, a number of tanks would be demolished.

Refinery closure

The refinery will continue to operate until the second half of 2014. At this time there would be a transition period over a few months during which the refinery process units would be progressively shut down and the facility would commence terminal operations.

Demolition

Once Caltex has explored all opportunities to re-use, redeploy or sell equipment that would not be required in the proposed terminal, the remaining refinery process units, some pipelines, and some small tanks would be demolished. This activity would involve cleaning the plant, then demolishing the equipment and removing the scrap from site for recycling. Asbestos would be removed from site prior to demolition.

This is a licenced activity and specialists would be brought in to ensure it is done safely.

Remediation and future land use

Caltex would work with the NSW Environment Protection Authority (EPA) to plan and carry out remediation to those parts of the site no longer in use. We anticipate this would take several years.

At this time there are no alternate plans for the use of either the demolished lubricating oil plant (CLOR) site or the land that would be freed following demolition of the fuels refinery process units.

The terminal plans have already included the potential for a growth in product demand. We do not anticipate the need to expand the terminal in the foreseeable future.

Safety and emergency response

The volume of materials that are classified as "Dangerous Goods" would decrease significantly with the site operating as a terminal.

A new Safety Case, describing the risks associated with the proposed terminal, would be provided to WorkCover NSW for its review and approval. This is a legal requirement for granting of a licence to operate the terminal and must comply with all NSW legal requirements and Caltex's corporate standards.

Just like for the refinery, Caltex would conduct extensive studies for the terminal to understand the risks. This includes studying the severity and likelihood of any potential incident. To minimise the risk of incidents the terminal would have multiple safety systems and procedures. Everyone who works at the terminal would be required to understand the potential incidents which might occur, their role in preventing them and how to respond immediately and efficiently to any incident.

As a terminal, we would continue to work with government authorities, regulatory groups and emergency services to help make sure our operations are safe for our people, our neighbours and the environment.

How to stay informed

Caltex will continue to meet regularly with our neighbours and provide updates about our current operations and the proposed conversion.

We will do this through:

- Our quarterly community briefings on site at the refinery
- Attending monthly Kurnell Progress & Precinct Resident's Association meetings
- Writing the "Caltex report" in the Kurnell Village News
- The Caltex website: www.caltex.com.au
- Talking to you by phone or in person.

If you have any questions or concerns please contact:

The refinery's 24-hour Community Hotline
T: 1800 802 385

Community Relations Manager, Kylie Gordon
T: 9668 1984

KEY FACTS ABOUT THE PROPOSED TERMINAL CONVERSION

The proposed conversion to a terminal would involve:

- Dredging at the wharf and sub berth to remove sediment build-up at spot locations, and increase the depth, length and width of the #1 berth.
- Approximately the same number of shipping movements, with the same maximum ship size at the sub berth and #2 berth, and an increase in ship size at #1 fixed berth from 180 to 245 metres.
- Upgrading wharf equipment and installing a new mooring point and access walkway, extending the wharf by approximately 50 metres.
- A detailed Environmental Impact Statement, which would be made available for public review and comment in first quarter 2013 as part of the project's approval process.
- A reduction in the number of tanks and volume of dangerous goods stored on site.
- A significant reduction in the number of trucks coming to the Caltex Kurnell site.
- Less noise and odours.
- Demolition of refinery process units and site remediation in consultation with the NSW Environment Protection Authority (EPA).
- A continuation of Caltex's commitment to safe and environmentally-responsible operations.
- Caltex continuing to communicate with, support and be an active member of the local community.

Appendix C

Coastal and Hydrodynamic Process

Cardno
Shaping the Future

Kurnell Port and Berthing Facility Upgrade

Coastal and Hydrodynamic Processes

LJ3008/R2774

Prepared for URS Corporation

19 December 2012

Cardno (NSW/ACT) Pty Ltd
ABN 95 001 145 035

Level 9 The Forum
203 Pacific Highway
St Leonards NSW 2065
Australia

Telephone: 02 9496 7700
Facsimile: 02 9439 5170
International: +61 2 9496 7700

sydney@cardno.com.au
www.cardno.com.au

Document Control:

Version	Status	Date	Author		Reviewer	
			Name	Initials	Name	Initials
1	Draft	13 September 2012	Doug Treloar	PDT	Arjen Overduin	AO
2	Draft Final	3 October 2012	Doug Treloar	PDT	Arjen Overduin	AO
3	Final	23 October 2012	Doug Treloar	PDT	Arjen Overduin	AO
4	Revised Final	19 December 2012	Doug Treloar	PDT	Arjen Overduin	AO

"© 2012 Cardno (NSW/ACT) Pty Ltd All Rights Reserved. Copyright in the whole and every part of this document belongs to Cardno (NSW/ACT) Pty Ltd and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or in or on any media to any person without the prior written consent of Cardno (NSW/ACT) Pty Ltd."

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

This report has been prepared by Cardno for URS who have been engaged by Caltex Australia to prepare the EIS required for proposed dredging in Caltex' marine operations area of Botany Bay, which form part of the proposed upgrade to the Kurnell Port and Berthing Facility.

This dredging comprises maintenance and capital dredging to return seabed levels to the declared levels and to allow larger, more economical vessels to use the fixed berths on the Kurnell wharf. A total of about 153,000m^3 of seabed sediment is proposed to be dredged using a back-hoe dredge and barge system, with most spoil being discharged in a designated offshore spoil ground. Depending upon the dredging area, the dredging may include barge overflow.

Cardno have investigated the potential effects of this dredging on tidal currents, wave climate and the beaches of the Bay, as well as the major infrastructure constructed in the Bay. Additionally, the potential production of suspended sediment plumes and associated release of adsorbed tributyl tin has been investigated.

These investigations have been conducted using hydrodynamic and wave models that have been set-up and calibrated for previous studies.

The outcomes of these investigations are that the proposed works will have no effect on tidal currents, near shore wave conditions or the shorelines. Moreover, there will be no effects on the important infrastructure within the Bay.

1 INTRODUCTION

1.1 General

Caltex undertake shipping from a submarine berth (sub-berth) offshore from Kurnell in Botany Bay for their petroleum operations. The facility was constructed in the 1950's and was dredged to a bed level of -12.2m Chart Datum CD, which is LAT in Botany Bay. Other petroleum operations are undertaken from the east and west fixed berths, FB1 and FB2, respectively, alongside the Kurnell wharf. The submarine berth was upgraded circa 2000 after a severe storm in 1997 affected operations there. The locations of those facilities are shown on **Figure 1.1**.

Caltex is currently undertaking preliminary investigations into the feasibility of undertaking dredging at this site. URS Corporation have been engaged by Caltex to prepare the required EIS and Cardno have been engaged by URS to investigate potential changes in the wave and current environment of the Bay that might be caused by the dredging, as well as the extent of suspended sediment plumes that would be caused by the proposed dredging activities.

For this part of the project, Cardno has undertaken the following investigations using numerical models:-

1. Effects of the dredging works on coastal processes including:
    - wave climate at the shoreline;
    - shoreline processes at Lady Robinsons Beach, Towra Beach, Quibray Bay entrance, Bonna Point and Silver Beach; and
    - tidal currents in the Caltex operational area and beyond.
2. Estimating extents of suspended sediment plumes from dredging and spoil disposal operations, as well as describing the dilution of a conservative substance representing a contaminant that might be released by the dredging work for example, tributyl tin (TBT).

This report provides the outcomes of the investigations of the potential changes to wave and current conditions and the estimated effects on shorelines that would occur as a consequence of any such changes.

1.2 Dredging Plan

The proposed dredging works would remove sediment at patch/spot locations across the original, dredged footprint. The sediments to be dredged as part of the work have accumulated gradually over the past forty years. The work would increase the depth and plan areas of the two fixed berths to increase the capacity, type and size of ship berthing and loading/unloading at the Kurnell jetty.

The dredging plan would be to 'spot-dredge' these locations to leave a broadly flat area across the base of the dredged footprint. The perimeter of the footprint would be profiled to create side 'batter' slopes that would not exceed a 1V:4H profile to the existing seabed.

The extent of the footprint of the proposed works is provided in **Appendix A**. **Appendix B** provides details of the proposed extraction volumes.

In total about 152,750m^3 of sediment would require dredging to achieve the desired navigation access and depths across the marine operations area. The preference is to dispose of this material offshore, with the exception of some re-use within the operations area. Approximately 1,500m^3 of clean sand would be reused to cover an exposed part of the subsea fuel pipeline located westward behind the sub-berth. This exposed pipeline area cannot be identified in the seabed survey data, but is visible in the sonar data. An additional volume of 4,500m^3 of clean sand would be placed in the anchor scoured hole, without affecting the declared, based on available survey data depth.

The result of the dredging would be to return the turning circle and approaches to an overall declared depth of 12.8m below CD, whilst the sub-berth would be returned to a depth of 14m below CD. Both the fixed berths would be dredged to increase their navigation depths to 12.8m below CD; as well as their plan extents. The turning circle would be shifted north-east slightly, see **Appendix C**. These berths would be increased as described in **Table 1.1**.

Table 1-1 Proposed Berth Upgrade Dimensions

Berth	Final Depth (meters below CD)	Length (m)	Width (m)	Ship Size Length Overall (LOA)	Ship Deadweight tonnes (DWT)
Fixed Berth #1					
Existing	Various	233	35	180	50,000
Proposed	-12.8	310	135	250	100,000
Fixed Berth #2					
Existing	Various	250	35	180	50,000
Proposed	-12.8	245	100	200	50,000

Table 1.2 provides a summary of the proposed dredging works (more detail is provided in **Appendices A** and **B**), showing the areas, depths to Chart Datum (LAT - Lowest Astronomical Tide) and insitu sediment volumes of the proposed maintenance and capital works dredging.

Table 1-2 Proposed Dredging Areas, Bed Levels and Volumes

Location	Required Dredge Depth to CD* (excluding over dredging)	Design Area (m^2)	Required Dredge Volume (m^3)	Additional Dredge Volume to allow for over dredging (m^3)	Total Volume (including over dredging (m^3)
Approaches & Turning Circle	-12.8	98,750	30,500	29,750	60,250
Sub Berth	-14	16,750	7,750	5,000	12,750
Fixed Berths	-12.8	62,500	61,250	18,750	80,000

1.3 Project Scope

The project proposal was submitted to the Office of Environment and Heritage (OEH) on 29 September 2011. On 13 October 2011 the OEH provided a response to a request from Worley Parsons to identify key requirements for the development of an Environmental Assessment (EA) for the proposed project. Accordingly OEH defined a series of Environmental Assessment Requirements (EARs) to be addressed in the preparation of the Environmental Assessment for the proposed project. The requirements have now been expanded to be at Environmental Impact Statement (EIS) level.

This report describes the investigations undertaken by Cardno to address the hydrodynamic assessment matters, turbidity modelling and shoreline effects components of the EIS to be prepared by URS. These investigations were:-

1. Hydrodynamic and wave investigations to identify any changes in wave and current conditions around Botany Bay as a result of the proposed dredging project.

2. Assessment of potential shoreline and wave climate effects as a result of the dredging works. This item focussed particularly on sensitive areas including Silver Beach, Bonna Point, Towra Beach, Lady Robinsons Beach, airport runways and port facilities.

3. Modelling of dredge plumes (suspended sediment and deposition) and the dispersion of elutriate TBT.

Normal direction conventions have been adopted, namely:-

- Winds and waves – coming from
- Currents – flowing towards

Unless stated otherwise, all depths and levels are to chart datum (CD) – equivalent to lowest astronomical tide (LAT). Australian Height Datum (AHD) is 0.928m above LAT.

2 STUDY APPROACH - OUTLINE

This section provides a concise description of the investigations undertaken for this report. Consistent with the request for a proposal from URS, Cardno has broken the methodology down into the following components:-

- Hydrodynamic and Wave Effects Assessment.
- Turbidity and Water Quality Modelling (Conservative Marker Contaminant).

2.1 Hydrodynamic and Wave Effects Assessment

Previous numerical modelling undertaken by Cardno for Botany Bay projects has included current modelling using a calibrated Delft3D hydrodynamic model of Botany Bay and the Georges River. Current model results are presented as pre-and post-development vectors using two vector colours. Spring tide peak flood and ebb cases have been addressed in terms of potential changes in current structure.

The key process that was assessed in this phase was the identification of any potential effects on shorelines within Botany Bay caused by the proposed dredging and consequent changes in shoreline wave conditions and beach form. Details of the proposed dredging were provided by URS, see **Appendices A** to **C**. The proposed dredging areas, indicated therein by 'reddish' patches, were digitised in GDA94 coordinates to provide dredge area work perimeters to be included in the modelling. The post-dredging seabed was then prepared from the Existing bathymetry of Botany Bay by adjusting the bed levels at those patches to the declared (design dredging) depths. Where the existing seabed was deeper than the design bed levels, those greater depths were maintained, except where backfilling of the anchor hole and sub-berth pipeline were proposed.

The 'Existing Conditions' seabed included the Port Botany Expansion project and Energy Australia's dredging and disposal work; though the latter was not likely to affect ocean wave penetration to or current speeds in the Caltex operational area. The Bay seabed has been re-instated following completion of works for the Sydney Desalination Plant and would have no effects on waves and currents in the Bay.

The set of wave model output locations is the same as those adopted for previous EIS investigations – Port Botany Expansion, Sydney Desalination Plant and EA's seabed cable work. They are identified later in the report. Changes in effective, significant wave heights and weighted mean wave directions have been determined by transferring offshore time-series of wave data (MHL Long Reef wave data because it includes wave direction – about 13 years of data) to selected near shore locations and plotted/tabulated to assess any changes in these wave parameters – see **Appendix D** for near shore wave parameter description.

Shorelines and facilities at Silver Beach, Towra Beach, Lady Robinsons Beach, Brotherson and Hayes Docks, the airport runways and recreational boat user facilities were investigated in terms of potential changes in near shore wave conditions. Results have been provided as tables and colour contour plots of wave height change, together with analysis/commentary results. No changes in near shore wave conditions were expected on Foreshore Beach – and none expected north of about Dolls Point on southern Lady Robinsons Beach.

2.2 Suspended Sediment and Contaminant Investigations

A range of sediment plume and marker contaminant modelling analyses were undertaken. In terms of dredge plumes for this project, the greatest risk of plume development is at the discharge point of any overflow water from the dredging activity, which will be near the sea surface. Typical one-week dredging scenarios over spring to neap tide periods were investigated and plan plots and time-series presentations of suspended sediment concentrations have been prepared. Realistic extraction rates and dredging operational information was provided by URS. Median and 95%ile exceedance plan-plots of suspended sediment concentration have been prepared.

The modelling has also included the simulation of the transport and dispersion of a conservative contaminant material for spring to neap tide conditions. The outputs from this modelling have included contour plots of contaminant concentration for the specified dredging and environmental scenarios – median and 95%ile plots of marker contaminant concentration have been prepared, one set for each of three selected dredging scenarios. In themselves they cannot be applied directly, but provide bases for calculating concentrations at selected sites, given the rate of contaminant release by the dredge plant (kg/s). For this study only TBT has been assessed – adsorbed by the fine fraction of the seabed sediments and released to the water column during dredging. Based on contaminant to sediment proportion data (95%ile contaminant concentrations), Cardno have prepared median and 95%ile plan plots of TBT concentration and GIS files for URS' ecological assessments.

3 PHYSICAL PROCESSES

Appendix E provides descriptions of those physical processes that are important to this project in Botany Bay.

4 PREVIOUS STUDIES

Other than the Port Botany Expansion investigations (Lawson and Treloar, 2003) and investigations undertaken for Sydney Water (Cardno Lawson Treloar, 2007a and b) and Energy Australia, the most recent compendium of physical processes within Botany Bay and the Georges River is presented in the Healthy Rivers Commission (HRC) Report (2001). That document deals mainly with planning and management issues. However, HRC did seek technical input from various bodies, for example, the Coastal Studies Unit of Sydney University. That latter document was directed mainly at geomorphological issues and drew substantially on historical data and previous investigations. A principal outcome of the HRC investigations was the suggestion that future investigations should address the whole of Botany Bay and its catchment, and that planning of future works should be undertaken within a comprehensive planning framework.

The draft EIS (Kinhill, 1991) prepared for the Parallel Runway of Sydney Airport addressed wave climate, current and likely shoreline effects. Wave climate and current issues were investigated by Lawson and Treloar (Working Papers prepared for Kinhill Engineers, 1990).

During the construction program for the Parallel Runway, detailed wave climate studies were undertaken (Sydney Ports Authority, 1993). Significant within that program was the extensive long term beach monitoring program involving shore normal beach surveys initiated in the early 1970's by SPC's SPA's predecessor, the Maritime Services Board. That data has been used to estimate rates of longshore sediment transport and shoreline changes on Lady Robinsons and Towra Beaches.

More recently current and wave data were recorded at sites MID and SOUTH, see Figure 5.1, (Lawson and Treloar, 1999). That data provide useful information for this study because it follows construction of the Parallel Runway. It was applied in part to calibrate numerical current and wave models used for investigations undertaken for Sydney Ports Corporation and for the present studies for Caltex' proposed works.

Most recently, detailed investigations have been undertaken for the Port Botany Expansion EIS (Lawson and Treloar 2003a and b). Calibrated wave and current models developed as part of those studies have been applied to this investigation.

Many other site or issue specific investigations have been undertaken. However, those cited above provide the principal framework and information for this study.

These studies have generally shown that observed shoreline changes are attributable to both natural changes and anthropogenic changes arising from developments in the Bay since the early 1950's.

5 MODEL SYSTEMS

The present EIS investigations were based on a range of numerical modelling systems used to describe currents, waves and sediment transport processes in the Bay and at shoreline locations. They are described below.

2D and 3D hydrodynamic modelling has been adopted in this study, with the suspended sediment investigations requiring 3D current field and sediment concentration descriptions. 2D modelling was applied to assessing potential changes in bay-wide current structure

5.1 Delft3D

Cardno have used the Delft3D model system to undertake much of the numerical modelling required for this investigation. Delft3D is a world leading hydrodynamic, sediment transport and water quality modelling system developed by Deltares (formally Delft Hydraulics) in the Netherlands. Delft3D has been applied in major coastal and ocean investigations and engineering studies throughout Australia – including those for Port Botany, Port of Melbourne and at Port Hedland. In the field of sediment transport and morphological modelling, Delft3D is arguably the world's leading model system. In the last 10-years Delft3D has led modelling innovations such as coupled online wave and hydrodynamic forcing, and also the implementation of the latest generation of sediment transport algorithms such as van Rijn (2004), which are significantly more accurate than earlier sediment transport algorithms.

The Delft3D modelling system includes wind, pressure, tide and wave forcing, three-dimensional currents, stratification, rainfall/evaporation, sediment transport and water quality descriptions and is capable of using irregular, rectilinear or curvilinear coordinate systems that are used to describe the seabed bathymetry.

The site is suited ideally to the curvilinear grid and domain decomposition systems, which have enabled a detailed description of the flow structure in the estuary.

The Delft3D modelling system has been applied to morphological investigations at many international locations, as well as within Australia by Cardno, other consultants and Griffith University. It comprises several modules that provide the facility to undertake a range of studies. All studies generally begin with the Delft3D-FLOW (hydrodynamic) module. From Delft3D-FLOW details such as velocities, water levels, density, salinity, vertical eddy viscosity and vertical eddy diffusivity can be provided as inputs to the other modules. The wave and sediment transport modules work interactively with the FLOW module through a common communications file.

5.1.1 Hydrodynamic Numerical Scheme

The Delft3D FLOW module is based on the robust numerical finite-difference scheme developed by G. S. Stellling (1984) of the Delft Technical University in The Netherlands. Since its inception the Stelling Scheme has undergone considerable development and review by Stelling and others. Other programs utilising the Stelling scheme include the floodplain applications of Delft-FLS (WL|Delft).

The Delft3D Stelling Scheme arranges modelled variables on a staggered Arakawa C-grid. The water level points (pressure points) are designated in the centre of a continuity cell and the velocity components are perpendicular to the grid cell faces. Finite difference staggered grids have several advantages including:

- Boundary conditions can be implemented in the scheme as basic time-series.
- It is possible to use a smaller number of discrete state variables in comparison with discretisations on non-staggered grids to obtain the same accuracy
- Staggered grids minimise spatial oscillations in the water levels.

Delft3D can be operated in 2D (vertically averaged) or 3D mode. In 3D mode, the model uses the σ coordinate system (Phillips, 1957). The σ coordinate system is a variable layer-thickness modelling system, meaning that over the entire computational area, irrespective of the local water depth, the number of layers is constant. As a result, a smooth representation of the bathymetry is obtained. As opposed to fixed vertical grid size 3D models, the full definition of the 3D layering system is maintained into the shallow waters and until the computational point is dried.

It is most common to define more resolution at the surface and at the bed where the largest vertical gradients occur. Boundary conditions can be adjusted from depth averaged to specific discharges and concentrations per layer.

Horizontal solution is undertaken using the Alternating Direction Implicit (ADI) method of Leendertse for shallow water equations. In the vertical direction (in 3D mode) a fully implicit time integration method is applied. Vertical turbulence closure in Delft3D is based on the eddy viscosity concept. Rainfall and evaporation rates can be included.

5.2 Standard and Special Features

Delft3D has several pre- and post-processing tools.

5.2.1 Ability to Incorporate a Varying Mesh Size

As mentioned previously, bathymetric discretisation and modelling can be undertaken in Delft3D on a rectilinear or curvilinear grid, and includes domain decomposition. The Delft3D model is specifically written and most widely used to undertake hydrodynamic flow and transport modelling arising from tidal and meteorological forcing on a curvilinear boundary fitted grid.

The curvilinear grid system enables grid sizes to vary so that better resolution can be used within the estuary and adjacent interconnecting channels, with less resolution in the sea where less detail is required. Additionally, the curvilinear grid system can be better set-up to follow the flow streamlines and boundaries, thereby providing a better description of the current structure.

The domain decomposition module has been used also to prepare a fine grid area near the Caltex jetty in order to ensure that the hydrodynamic and morphological processes are resolved adequately. The Delft3D numerical scheme is very robust and stable and can simulate steep hydraulic gradients such as those that occur near headlands.

5.3 Wetting and Drying of Intertidal Areas

Many estuaries and embayments contain shallow intertidal areas; consequently Delft3D incorporates a robust and efficient wetting and drying algorithm for handling this phenomenon. Significant wetting and drying occurs in areas such as Quibray Bay.

Cardno have utilised Delft3D in many applications where inter-tidal flats exist. Through experience in these areas of application, Cardno use a method of careful refinement in the intertidal areas and appropriate setting of dry depths to minimise discontinuous movement of the boundaries. Quibray Bay, close to Caltex' operating area is such an intertidal region.

This process ensures oscillations in water levels and velocities are minimised and that the characteristics of the intertidal effects are modelled accurately.

With regard to water quality modelling and conservation of mass, when a cell dries out, the substance mass is still kept within the cell. When the cell re-wets, as occurs on a rising tide, this mass is then re-diluted.

5.4 Conservation of Mass

The model is mass conserving.

5.4.1 Model Boundary Conditions

The downstream model boundary has been set in the open sea in a depth of about 70m and defined as a water level (predicted tides) boundary. Constant salinity, temperature, sediment concentration and contaminant concentration were set.

5.5 Sediment Transport Processes

The module applied to the sediment transport analyses (suspended sediment plume transport and siltation) is the Online Sediment Module. This system makes it possible to undertake time-series sediment transport modelling using combined tide, wind, wave and fresh water flows. The bed levels, water levels and currents within the wave module are updated every hour and the calculated wave conditions (wave heights and radiation stress maps) used for the next hydrodynamic phase. Separate current and wave modelling was adopted for this study.

Sediment re-settling on the seabed is controlled by fall velocity, water column turbulence and water depth, which varies with the tide. A fall velocity of 0.4mm/s was adopted for this study – in common with previous investigations undertaken for Sydney Water's cross-bay pipeline construction EIS investigations for the Sydney Desalination Project. This fall velocity has been applied in Cairns (by Cardno) and Hong Kong (by Delft Hydraulics).

Sediment plume modelling was undertaken using the Delft3D model system using 3D. This model has been calibrated as part of EIS studies undertaken for Sydney Ports Corporation's Port Botany Expansion project (Lawson and Treloar, 2003a).

The Delft3D model applied to these analyses is a far field model and hence, in the immediate vicinity of the discharge point, sediment mixing processes that are occurring on a sub-grid size scale are not described well. Only when one assesses results at about four grid points from the discharge source do the model results become more realistic. Sites that may be affected by sediment plumes, such as sea grass areas, are at distances greater than four grid points from the sediment discharge points in the model.

The model was operated using five vertical layers for these simulations over periods of 6 to 7 days to include spring-neap tide conditions. Vertical eddy viscosity in the model is described by a k-ε turbulence model and depends on current speed and depth. This eddy viscosity model provides the most reliable description of current structure and sediment settling rates. Plume modelling has not included flocculation because most of the fines are silt, rather than clay and concentrations are low except at the plume generation locations (dredge head and overflow funnel); where the higher turbulence would break-up the flocs. The model process includes current driven transport of the plume and settlement, which is a balance between fall velocity and upward turbulent flow.

Figure 5.1 describes the Delft3D model grid applied to this investigation. Grid sizes of about 10m x 10m were used in the region of the Kurnell Jetty.

5.6 SWAN Wave Modelling System

The wave model Cardno used in this study is based on the third generation wind/wave modelling system, SWAN, which is incorporated as a module into the Delft3D modelling system. This model was developed at the Delft Technical University and includes wind input (wind-wave cases), combined sea and swell, offshore wave parameters (swell cases), refraction, shoaling, non-linear wave-wave interaction, a full directional spectral description of wave propagation, bed friction, white capping, currents and wave breaking. SWAN also models phase-averaged diffraction based on the model of Holthuijsen et al.

SWAN includes a nested grid capability that allows coarser grids in deeper water and finer grids in shallow water, where better definition of seabed form and depth are needed. Output from the model includes significant wave height, dominant wave direction, spectral peak and mean periods and (optionally) the full directional wave spectra at selected grid points.

Offshore waves were propagated into Botany Bay to a large number of near shore locations in a depth of about 2m at AHD. This wave propagation process was undertaken using the directional wave data from the MHL Waverider buoy system at Long Reef. This near shore wave data was needed for longshore sediment transport change investigations in terms of changes in wave directions near the Bay shorelines.

Figure 5.2 describes the SWAN grid system applied to this investigation.

The proposed works include a sub-tidal hard surfaced sheet pile and rock wall at the southern end of Fixed Berth 1. This structure is of sub-grid scale and cannot be modelled in detail in the wave and current modelling. The depth change from the seabed to the berth area is the same with this structure as it would be with a dredged batter (which has been modelled) and the overall wave refraction effect would therefore the same for both the battered and rock wall. Similarly, Section 8 shows that the proposed dredging would have no identifiable change on the depth-averaged currents speed and direction. This steep seabed feature will have little or no effect on these currents, but there would be a difference in near seabed currents in its immediate vicinity.

6 SEDIMENT PLUME SIMULATIONS

6.1 Scenario Descriptions

Due to availability and cost pressures, Caltex has decided to use a back-hoe dredge with sufficient barges to allow 22 hours of dredging operations per day. Nevertheless, the operational procedures were a little different between Area 3 on one hand and Areas 1 and 2 on the other. The dredging process is described below.

Based on an assessment of the sediment core descriptions and particle size analyses presented in Worley Parsons (2012), the fines content of the spoil to be extracted from dredging of areas A1, A2 and A3, see **Appendix A**, would typically be 10.2 % (all areas), 7.5 % approaches and turning circle, 8% sub berth, 15% in the fixed berths.. Advice was received from URS that the BHD would work at a weekly rate of 9,000m^3. The bulk of the dredged spoil would be taken to the offshore spoil dumping ground. However, volumes of uncontaminated spoil of about 1,500m^3 and 4,500m^3 would be used to re-cover a section of a seabed petroleum pipeline, observed by divers to be exposed and backfill a deeper area that has been 'excavated' by dragging ship's anchors – see **Figures 6.1** and **6.2**.

Only the fines fractions are included in the plume modelling because the sand fractions will resettle quickly on the seabed near the dredge. This is a conservative position from the point of view of sediment plume concentrations because all of the sediments re-suspended by the dredging work are considered to be fines with a fall velocity of 0.4mm/s – consistent with van Rijn (1990) and (Cardno Lawson Treloar (2007).

Two dredging options were investigated in terms of the dredging scenario proposed for this project. These were back-hoe dredging with and without overflow. Results have been presented as time-series plots of suspended sediment concentrations at two locations – defined to be the aquaculture (Fish Farm) area and the sea grass beds in the near shore region of Silver Beach. These locations are shown on **Figure 6.1**. The rate at which the BHD removes sediment from the seabed and the percentage of fines to be found in those sediments defines the rate of sediment production. About 10% of the fines in the bottom sediments are re-suspended by the dredging work – Barnard (1978). This leads to a silt production rate in kg/s.

Plan plots of suspended sediment concentration contours in the near surface and near seabed model layers for median and 95%ile results were prepared. They were based on the modelled time–series results at each grid point and on the 6-day runs described below. Because the model is a flow model, all simulations require a source point (a flow) to introduce the silt as a source into the model as a flow and a concentration of suspended sediment. A flow rate of 0.2m^3/s was adopted. This source flow is a nominal flow that does not affect the tidal hydraulics, being many orders of magnitude smaller than the tidal flow rate. The sediments that are put into suspension then enter the model as slurry. In the end it is the actual mass rate of sediment production caused by the dredging, in kg/s of fines that is effectively modelled.

Scenario 1

- Scenario 1: use of BHD with no overflow in the fixed berths (FB1, Area 3).
- Scenario 1: was undertaken according to the operational assumptions that follow:-

- 7 day simulation (spring to neap) inshore to offshore, see **Figure 6.1**, which shows consecutive daily dredge positions.
  - 22 hours operation (2 hours back-hoe shift) – to represent the 'continual working' under this method over 7 days.
  - Fines release rate of 2.25 kg/m^3 as 0.45kg/s of fines.
  - 7 discharge points (commence dredging closest to shore) – different work area every day, eastern side of the jetty – see **Figure 6.1**.

Scenario 2

- Scenario 2 applies to Areas 1 and 2 and was modelled in the turning circle, just seaward of the fixed berth, see **Figure 6.1**.
- Within these two areas, this dredging scenario is closest to the aquaculture area and near shore sea grass beds and would maximise sediment plume concentrations at those locations.
- In order to maximize suspended sediment concentrations, Cardno adopted the shorter times described by URS to fill the hopper (45 minutes, rather than 60 minutes), in order to maximizese suspended sediment concentrations, which condition is associated with the 45 minutes dredging time, a spill rate of 15kg/s at a rate of 20m^3/minute (0.333m^3/s) = 45kg/m^3 discharge concentration (15/0.333) – base data provided by URS.
- The backhoe only generated suspended sediment at the seabed for the first 45 minutes (0.22kg/s as at the fixed berth, but adjusted 10.2 % (all areas), 7.5 % approaches and turning circle, 8% sub berth, 15% in the fixed berths, and then 20 minutes of overflow (45kg/m^3) discharged near the sea surface), plus the seabed suspended sediment generation over the last 20 minutes also.
- The hoppers discharge at sea and the effects of that process are not part of this analysis.
- This sequence begins every two hours over 6 days – 24 hours operation see Scenario 1 above, > 22 hours of continuous back-hoe dredging with hopper barges being available for continuous work over 22 hours. The dredge was shifted once a day. **Figure 6.1** presents the BHD daily work locations adopted for this analysis.

Scenario 3

This scenario is the same as Scenario 2, except for the working area of the dredge, which is closer to the Kurnell Headland, see **Figure 6.2**.

6.2 Sediment Plume Results

Figures 6.3 to **6.20** describe the time-series of tide level, tidal currents, sediment production by the dredging process and the near surface and near seabed suspended sediment concentrations at the aquaculture site (fish farm) and the sea grass model output location, see **Figure 6.1**, for the three scenarios.

The near surface results can be used to assess visibility effects, whereas the near seabed results can be used to assess the potential effects on sea grass. The results show very low concentrations, principally because the rates of production are low and the model sampling sites are some distance from the dredge. Only in the immediate vicinity of the dredge will there be high concentrations – within about 50m.

Figures 6.21 to **6.32** present plan plot contours of suspended sediment concentrations at the surface and seabed for the median and 95%ile suspended sediment concentrations for the three dredging scenarios. Note that these plots relate to the dredging scenarios described in **Figure 6.2**. When the dredge is operating in other areas the outcomes will be similar, only shifted spatially. However, the modeled cases are closest to the aquaculture and sea grass areas and would cause the highest concentrations of suspended sediments in those areas.

These results can be compared with background concentrations presented in Cardno Lawson Treloar (2007c). That information shows that depth averaged concentrations of suspended sediments in natural conditions range from about 5 to 25mg/L. The maximum concentrations determined from the modelling, beyond the immediate area of the dredge and overflow, are less than 10mg/L.

6.3 Sedimentation

Figure 6.33 describes the estimated depth of siltation arising from settlement of suspended sediments from the plumes of suspended sediment caused by the dredging process. This figure was prepared from the combination of results from the three dredging scenarios cited above, and then accounting for the full 23 weeks of expected dredging. Hence this result overestimates the maximum depth of sedimentation (about 3.5cm), because some of the dredging would occur further north. However, it does describe the siltation depths that would not be exceeded by the dredging work. Most of the sedimentation would occur within the Caltex operational area.

From discussions with URS, it is understood that sea grass occurs in areas that show up to 10mm of siltation on the southern side of the depositional patch. However, given the computational method adopted, this depth of siltation is unlikely to occur.

6.4 Spud Installation

Installation of the spuds would cause some disturbance of the seabed and some re-suspension of seabed fine sediments. However, this process only occurs about once each day and only occurs over a short period of time (less than 5 minutes per spud). The suspended sediment plumes described above show that the plume disperses quickly following cessation of work and the same would apply in this case. There would be a small cloud of suspended sediment, noting that the backhoe would not be operating while the spuds were being placed and so this would not be an additional mass of coincident suspended sediments being swept away by the prevailing tidal currents.

7 CONTAMINANT CONCENTRATION

Re-suspension of fine sediments by the dredging and overflow processes may release contaminants, which were adsorbed to those particles, into the water column. From there they are transported to other parts of the Bay by the prevailing currents – predominantly tidal.

As part of the three dredging scenarios described above, a conservative contaminant was released into the surface layer at a constant rate over the 22 hours of dredging in the Berth 1 – Area 3, Turning Circle – Area 1 and the eastern 'finger' section of Area 1 dredging scenarios. The concentration of this marker contaminant was set at 100 in a discharge of 0.2m^3/s.

In this instance the contaminant of concern was tributyl tin (TBT) which leaches from the hulls of vessel anti-fouling paint and is gradually adsorbed to the fine fractions of the seabed sediments. The highest concentrations occur in Area 2. Based on seabed sediment and elutriate testing, URS advised that the following mean elutriate concentrations, in terms of micrograms Sn/L/kg (sediment) be adopted, and to be proportional to the amount of fine sediment identified at each dredging scenario site. These parameters are presented in **Table 7.1**. This data was used to modify the general conservative contaminant results to describe TBT concentrations.

Worley Parsons (2011) has shown that the contamination of bound TBT adsorbed to the dredged sediments is sufficient to cause the solution of TBT into the surrounding marine waters at concentrations that could exceed relevant Commonwealth water quality limits set for environmental protection. The degree of solution would depend on the extent of disturbance and agitation. A degree of disturbance to these sediment would occur during dredging (through the use of the back hoe). An additional release could take place as a result of overflow operations. Once in suspension however it would be likely that the sediments would not support the solution of TBT for the reasons described in the EIS.

To understand this, plots have been produced (**Figures 7.1** to **7.6**) to show the dispersion of the mean elutriate concentrations from each of the dredged areas using the 95%ile. These parameters are shown in **Table 7.1**. The plots assume the maximum elutriate concentration being produced at the seabed and through overflow operations. In reality however, this is anticipated to be considerably less as the agitation used to create elutriate results is likely to be much more than the disturbance caused during dredging (especially when using a back-hoe method).

Table 7-1 Elutriate Testing Results

Criteria	Standard	Threshold Limit (μgl^{-1})
	Aquatic Ecology Threshold Limit	*0.006*
	Aquaculture Protection	**0.01**
Area	**Results**	**TBT (μgl^{-1})**
Approaches and Turning Circle	Mean	**0.941**
	95% UCL of the Mean	**1.884**
Sub Berth	Mean	**0.015**
	95% UCL of the Mean	**0.038**
Fixed Berths	Mean	*0.006*
	95% UCL of the Mean	**0.016**
Note: Figures in italics show exceedances of the Aquatic Ecological Threshold Limit. Figures in bold show exceedances of the Aquaculture Protection threshold limit.		

Figures 7.1 to **7.6** present these results as contour plots of the 95%ile concentrations. Note that, with a typical grid size of 10m x 10m (approximately), and a water depth of about 12m in the Caltex operational area, there is a large initial dilution within the receiving model cell. Hence the results are only realistic at distances of about 50m from the dredger at any instant. Nevertheless, these plots provide a reliable statistical description of the likely higher concentrations of TBT in southern Botany Bay during the proposed dredging work.

URS may use this information to infer potential ecological effects of the proposed dredging in terms of TBT release from the seabed sediments.

The basic model results could be adjusted to describe other released, dissolved contaminants if required.

Re-suspension of fine sediments by the dredging and overflow processes may release contaminants, which were adsorbed to those particles, into the water column. From there they are transported to other parts of the Bay by the prevailing currents – predominantly tidal.

As part of the three dredging scenarios described above, a conservative contaminant was released into the surface layer at a constant rate over the 22 hours of dredging in the Berth 1 – Area 3, Turning Circle – Area 1 and the eastern 'finger' section of Area 1 dredging scenarios. The concentration of this marker contaminant was set at 100 in a discharge of 0.2m^3/s.

In this instance the contaminant of concern was tributyl tin (TBT) which leaches from the hulls of vessel anti-fouling paint and is gradually adsorbed to the fine fractions of the seabed sediments. The highest concentrations occur in Area 2. Based on seabed sediment and elutriate testing, URS advised that the following mean elutriate concentrations, in terms of micrograms Sn/L/kg (sediment) be adopted, and to be proportional to the amount of fine sediment identified at each dredging scenario site. These parameters are presented in **Table 7.1**. This data was used to modify the general conservative contaminant results to describe TBT concentrations.

Worley Parsons (2011) has shown that the contamination of bound TBT adsorbed to the dredged sediments is sufficient to cause the solution of TBT into the surround marine waters at concentrations that could exceed relevant Commonwealth water quality limits set for environmental protection. The degree of solution would depend on the extent of disturbance and agitation. A degree of disturbance to this sediment would occur during dredging (through the use of the back hoe). An additional release could take place as a result of overflow operations. Once in suspension, however, it would be likely that the sediments would not support the solution of TBT for the reasons described in the EIS.

To understand this, plots have been produced (**Figures 7.1** to **7.6**) to show the dispersion of the mean elutriate concentrations from each of the dredged areas using the 95%ile. These parameters are shown in **Table 7.1**. The plots assume the maximum elutriate concentration being produced at the seabed and through overflow operations. In reality however, this is anticipated to be considerably less as the agitation used to create elutriate results is likely to be much more than the disturbance caused during dredging (especially when using a back hoe method).

Table 7-2 Elutriate Testing Results

Criteria	Standard	Threshold Limit (μgl^{-1})
	Aquatic Ecology Threshold Limit	*0.006*
	Aquaculture Protection	**0.01**
Area	**Results**	**TBT (μgl^{-1})**
Approaches and Turning Circle	Mean	**0.941**
	95% UCL of the Mean	**1.884**
Sub Berth	Mean	**0.015**
	95% UCL of the Mean	**0.038**
Fixed Berths	Mean	*0.006*
	95% UCL of the Mean	**0.016**
Note: Figures in italics show exceedances of the Aquatic Ecological Threshold Limit. Figures in bold show exceedances of the Aquaculture Protection threshold limit.		

Figures 7.1 to **7.6** present these results as contour plots of the 95%ile concentrations. Note that, with a typical grid size of 10m x 10m (approximately), and a water depth of about 12m in the Caltex operational area, there is a large initial dilution within the receiving model cell. Hence the results are only realistic at distances of about 50m from the dredger at any instant. Nevertheless, these plots provide a reliable statistical description of the likely higher concentrations of TBT in southern Botany Bay during the proposed dredging work.

URS may use this information to infer potential ecological effects of the proposed dredging in terms of TBT release from the seabed sediments.

The basic model results could be adjusted to describe other released, dissolved contaminants if required.

The rapid dilution of TBT concentrations shows that flushing is not really a concern at this site. Tidal currents will transport any contaminants along the coast readily and the proposed works would not change the current structure and speeds within the Bay, see Section 8. The proposed works would not change the tidal prism near the site or in a bay-wide sense because all dredging work is below low tide level and hence flushing would remain as it is now. In fact, being deeper there would be an imperceptible improvement because of the lower seabed friction and hence unquantifiable increase in the tidal prism.

7.1 Anoxic Conditions Potential

Although water quality issues have not been addressed within this report, the hydrodynamics of Botany Bay have a significant influence on water quality. Anoxic conditions can develop within depressions on the seabed where currents are not sufficiently strong to mix the near seabed water, and where oxygen is consumed by organisms and not replenished by the hydrodynamic processes. Currents at this site are much stronger than those within the Port Botany area (a comparable area of the Bay where anoxia is a concern) and dredged conditions are much deeper; especially within the recently expanded shipping area and residual dredged borrow area. Moreover, the proposed Caltex dredging is more open sided and is unlikely to cause stagnant areas. Constant shipping movements and propeller caused currents are most likely to cause a constant exchange of sea water.

8 CURRENT VECTORS

The calibrated numerical current model has been used to describe spring tide flood and ebb current speeds in the existing and post-dredging Bay conditions throughout the Bay and near the Caltex operational area itself. These results are presented as vector plots in **Figures 8.1** to **8.4**. Vectors demonstrate current direction and speed as shown by the scales. These results show that the proposed dredging work will cause no identifiable changes in tidal currents in Botany Bay.

The model does not resolve the caisson and pile details of the Kurnell Wharf, but the currents around the jetty have been shown to be realistic. Some minor changes to the currents may occur at the Fixed Berth.

Seabed scouring has not been reported as a matter of concern at the Caltex berths. Introduction of larger ships with greater propulsion power and propeller diameter may cause additional scour in the early operational period and the influence of those currents may extend further landward towards existing seabed areas. Hence additional seabed scour protection has been included at some points on the Wharf and there may be increased seabed scour beyond the port operations area and into existing seabed areas. However, the increase in effects beyond those of existing operations is likely to be minor, noting that fewer ship movements may occur. Scour protection in these areas is part of the design work for the proposed works.

9 WAVE PARAMETER CHANGES

The SWAN wave model of Botany Bay has been developed to accommodate the recently completed Port Botany Expansion works and then modified to describe the post-dredging seabed in the Caltex operational area. The model was then used to prepare wave transfer coefficients at LAT, MSL and HAT for all offshore wave directions from north through east to south and for wave periods (T_z) from 3 to 11 seconds.

This model has previously been calibrated (Lawson and Treloar, 2003b) using Waverider buoy data from sites offshore of and within Botany Bay; as recorded and provided by Sydney Ports Corporation.

No changes would occur to local wind wave conditions because fetches would not be changed.

The results of SWAN modelling of swell wave propagation into Botany Bay provided a 9 x 9 matrix of wave coefficients and weighted average wave directions at the model output locations shown in **Figure 9.1**. These locations were in a depth of about 1m at AHD. Each entry in a location specific wave coefficient transfer matrix represents one offshore wave direction-wave period (T_z)-tide level case. Those wave coefficients and inshore wave directions were then combined with the offshore time-series wave data to provide inshore time-series and then wave parameters in terms of H_e (effective significant wave height) and ϕ_m (weighted mean wave direction), see **Appendix D**. These results are presented in **Table H.1** (**Appendix H**). **Figures 9.2** to **9.4** describe the potential changes in wave heights caused by the dredging for three offshore wave directions at low tide and for a typically long wave period. These changes occur only on Silver Beach and only within the groyne field.

These parameters encapsulate the integrated sediment transport potential of the long term swell wave parameters at each location, when combined with the physical characteristics of the shoreline and sediment at each location. Inspection of **Appendix H** shows that there will be small changes in swell wave parameters at some locations along the Botany Bay shoreline. There will be no changes at the runways or in Port Botany. Wave height changes are very small. Of more importance is change in wave direction, described by change in weighted mean wave direction. Only direction changes greater than 0.1^o might be realistic.

An inspection of **Appendix H** shows that there would be no changes in wave direction west of about Location 30, which is in the entrance to Quibray Bay. These changes are very small and will be mainly contained within the Silver Beach groyne field. The changes shown on Towra Beach are all less than 0.1^o and would have no identifiable effect on that beach. Lawson and Treloar (2003b) showed that changes in wave conditions of this magnitude caused changes in longshore transport rates of less than 0.2%. The results of the present analyses are of the same or lesser order of magnitude at the locations considered in this investigation.

10 CONCLUDING REMARKS

This report describes the data, methods and outcomes of numerical modelling investigations undertaken to describe the outcomes of maintenance and capital dredging proposed by Caltex in their operations area in the southern region of Botany Bay.

The hydrodynamic and wave models applied to these investigations have been setup and calibrated for previous investigations (Lawson and Treloar, 2003b) and remain valid for the present study.

The investigations have examined changes in tidal currents, wave conditions and the production of suspended sediment plumes.

The general outcomes are that there would be no identifiable changes in wave and current conditions. Only within the immediate vicinity of the dredging activities would any suspended sediment plume be identified.

Hence there would be no effects on the beaches of Botany Bay, infrastructure or navigation; nor would recreational boating be affected.

11 REFERENCES

Ahrens (2003): Calculation of Fall Velocity. ASCE Vol. 129, No. 3. WPCOE.

Barnard, W.D (1978): Prediction and Control of Dredged Material Dispersion around Dredging and Open-Water Pipeline Disposal Operations. Technical Report DS-78-13, US Army Engineers Waterway Experiment Station, Vicksburg, MS.

Cardno Lawson Treloar (2007a): Proposed Sydney Region Desalination Plant. Pipeline Crossing of Botany Bay. Coastal Processes. Report (LJ2609/R2330) Prepared for Sydney Water.

Cardno Lawson Treloar (2007b): Desalinated Water Delivery System – Pipeline Crossing of Botany Bay; Sediment Plume Simulations. Report (LJ2609/R2331) Prepared for Sydney Water.

Cardno Lawson Treloar (2007c): Proposed Sydney Region Desalination Plant. Pipeline Crossing of Botany Bay. Water Quality Monitoring. Report (LJ2609/R2332) Prepared for Sydney Water.

Cardno Lawson Treloar (2007c): Kurnell Submarine Berth Dredging – Preliminary Coastal Processes Investigations. Report (LJ2591/R2349). Prepared for Caltex Refineries Pty Ltd.

Cardno Lawson Treloar (2007): Kurnell Submarine Berth Upgrade. Concept Design and Preliminary Coastal Processes Investigations. Report (LJ2591/R2419). Prepared for Caltex Refineries (NSW) Pty Ltd.

GHD Geotechnics (2006): Report for Desalination Blueprint Design – Bay Pipeline Vibrocoring (North Botany Bay). Report Prepared for Sydney Water Corporation.

Healthy Rivers Commission (2001): Independent Inquiry into the Georges River – Botany Bay System, Draft & Final Reports.

Kinhill Engineers (1991): Proposed Parallel Runway. Sydney (Kingsford Smith) Airport. Supplement to the Draft Environmental Impact Statement. Volumes 1 and 2.

Kuo, A. Y., Welch, C. S. and Lukens, R. J. (1985): Dredge Induced Turbidity Plume Model. ASCE Jnl WPC & O Eng, Vol. III. No. 3, pp 476-494.

Lawson & Treloar (1999): Long and Short Wave Recording, Botany Bay. Report Prepared for Sydney Ports Corporation.

Lawson and Treloar Pty Ltd (2003a): Proposed Expansion of Container Port Facilities in Botany Bay, NSW. Coastal Process and Water Resources Issues. Volume 2: Water Quality Investigations, Report (J2076/R1999). Prepared for Sydney Ports Corporation.

Lawson and Treloar Pty Ltd (2003b): Proposed Expansion of Container Port Facilities in Botany Bay, NSW. Coastal Process and Water Resources Issues. Volume 3: Waves, Currents and Coastal Process Investigations, Report (J2076/R1999). Prepared for Sydney Ports Corporation.

Monypenny, P and Middleton, J (1997): An Analysis of Winds at Sydney Kingsford Smith Airport. Australian Meteorological Magazine, Vol. 46, No. 4.

Roy, P and Crawford (1979): Holocence Geological Evolution of Southern Botany Bay - Kurnell Region, Central NSW Coast. Records of the Geological Survey of NSW 20(2): pp159-250.

Willoughby, M. A. and Crabb, D J (1983): The Behaviour of Dredge Generated Sediment Plumes in Moreton Bay. Sixth Australian Conference on Coastal and Ocean Engineering, I E Aust.

Worley Parsons (2012): Caltex Dredging. Sediment Sampling and Analysis Plan. Implementation Report (Final). Report (301015-02448/07) Prepared for Caltex Refineries NSW.

Church, J., Hunter, J., McInnes, K. L. and White, N. J. (2006) *Sea-Level Rise Around the Australian Coastline and the Changing Frequency of Extreme Sea-Level Events*. Australian Meteorological Magazine, 55(4), pp: 253-260.

CSIRO (2007) *Climate Change in Australia – Technical Report*. Published by Commonwealth Scientific and Industrial Research Organisation and Bureau of Meteorology. October 2007

Dean (2002) *Beach Nourishment Theory and Practice*. World Scientific Advanced Series on Ocean Engineering – Volume 18.

DECCW (2009a) *NSW Sea Level Rise Policy Statement.* NSW Department of Environment, Climate Change and Water.

DECCW (2009b) *Derivation of the NSW Government's Sea Level Rise Planning Benchmarks. Technical Note.* NSW Department of Environment, Climate Change and Water.

DECCW (2009c) *Draft Coastal Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Coastal Risk Assessments.* NSW Department of Environment, Climate Change and Water.

DECCW (2010, in prep.) *Sea Level Rise Design Parameters for Sydney Harbour.* NSW Department of Environment, Climate Change and Water.

Hennessy, K., McInnes, K., Abbs, D., Jones, R., Bathols, J., Suppiah, R., Ricketts, J., Rafter, T., Collins, D., and Jones, D. (2004) *Climate Change in New South Wales. Part 2: Projected changes in climate extremes*. CSIRO consultancy report prepared for the NSW Greenhouse Office.

IPCC (2007) *Climate Change 2007: Synthesis Report. An Assessment of the Intergovernmental Panel on Climate Change*. IPCC: Geneva, Switzerland.

Lord, D., and Kulmar, M. (2000) *The 1974 Storms Revisited: 25 Years Experience in Ocean Wave Measurements along the South-East Australian Coast.* Proceedings of the 27th International Conference on Coastal Engineering, Sydney, VI pp 559-572, July 2000.

McInnes, K., Walsh, K., Whetton, P., and Pittock, B. (1998) *The Impact of Climate Change on Coastal NSW, Final Report: Report on Research Undertaken for the National Greenhouse Advisory Committee*. CSIRO Atmospheric Research, July 1998.

MHL (1992) *Mid New South Wales Coastal Region Tide-Storm Surge Analysis*. Manly Hydraulics Laboratory. Report No. MHL621 – October 1992.

National Tide Tables (2010) *Australian Hydro-graphic Publication 11*. Department of Defence, Commonwealth of Australia.

NSW Government (1990) *NSW Coastline Management Manual.* New South Wales Government, September 1990.

NSW Government (2007) *Coastal Zone Management Manual Draft.*

Roy, P.S. (1984) *New South Wales Estuaries: Their Origin and Evolution*, In B.G. Thom (Ed.) Coastal Geomorphology in Australia. Academic Press, Australia, pp. 99-121.

Stelling, G. S., and Duinmeijer, S. P. A. (2003) *A staggered conservative scheme for every Froude number in rapidly varied shallow water flows*. International Journal Numerical Methods In Fluids 43: 1329-1354.

USACE (2002) *Coastal Engineering Manual*. U.S. Army Corps of Engineers, Washington, DC April 2002.

Van Rijn, L. C. (1990): Principles of Sediment Transport in Rivers, Estuaries and Coastal Seas. Aqua Publications.

Figures

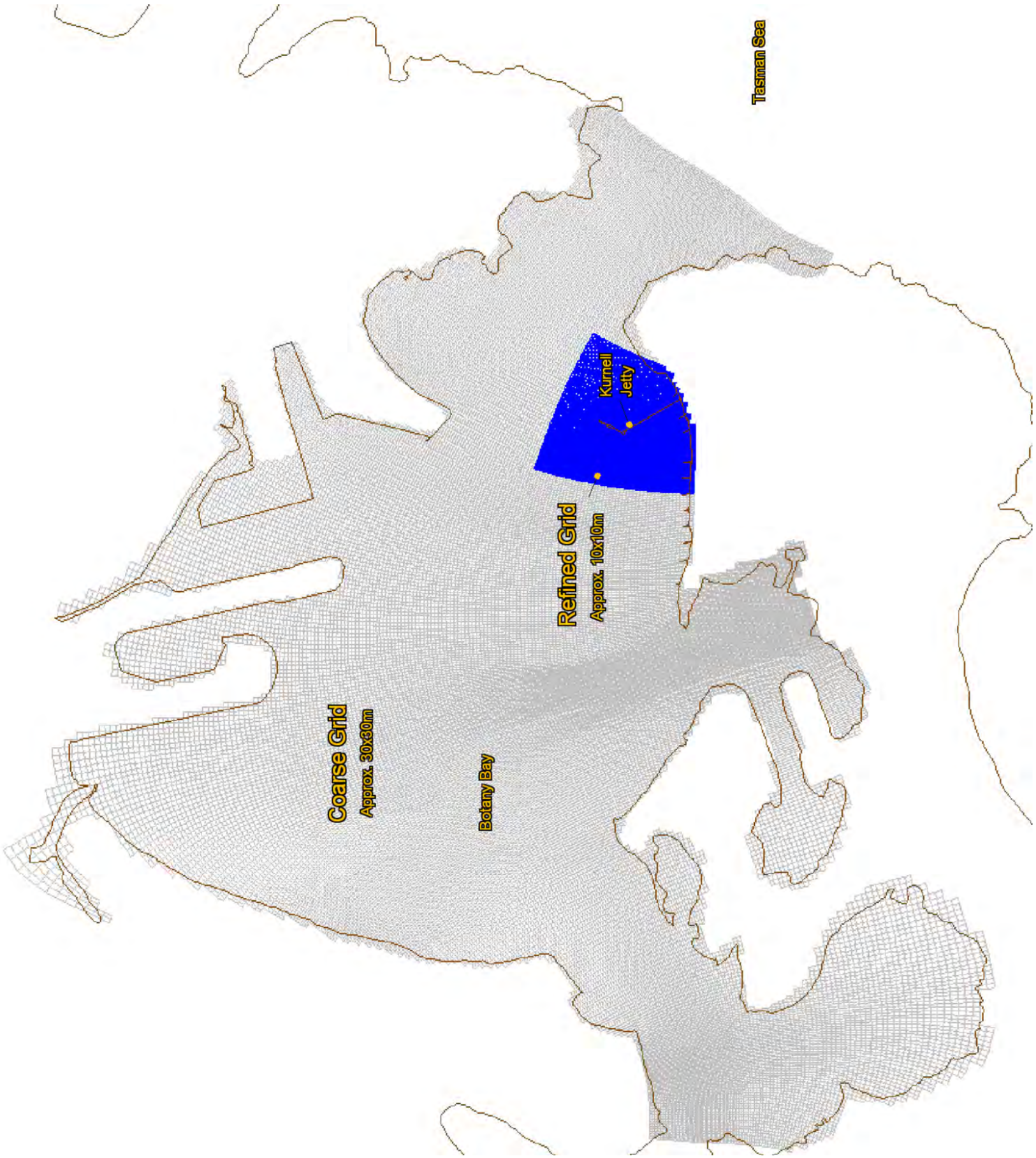
Figures

Kurnell Port and Berthing Facility Upgrade

Locality Plan − Kurnell Jetty

Figure 1.1

LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures

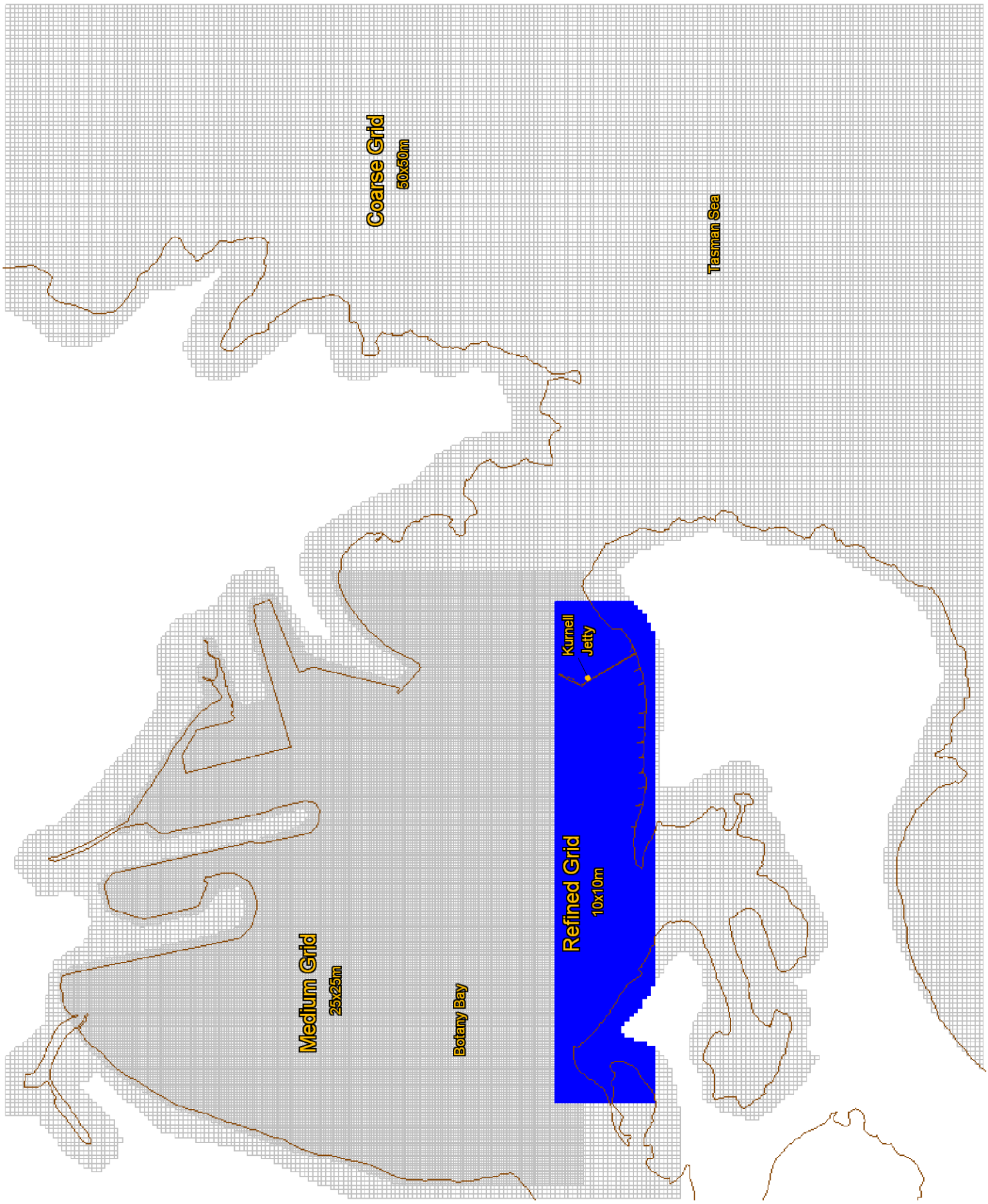


Kurnell Port and Berthing Facility Upgrade

Delft3D Model − Grid Layout

Figure 5.1

LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures

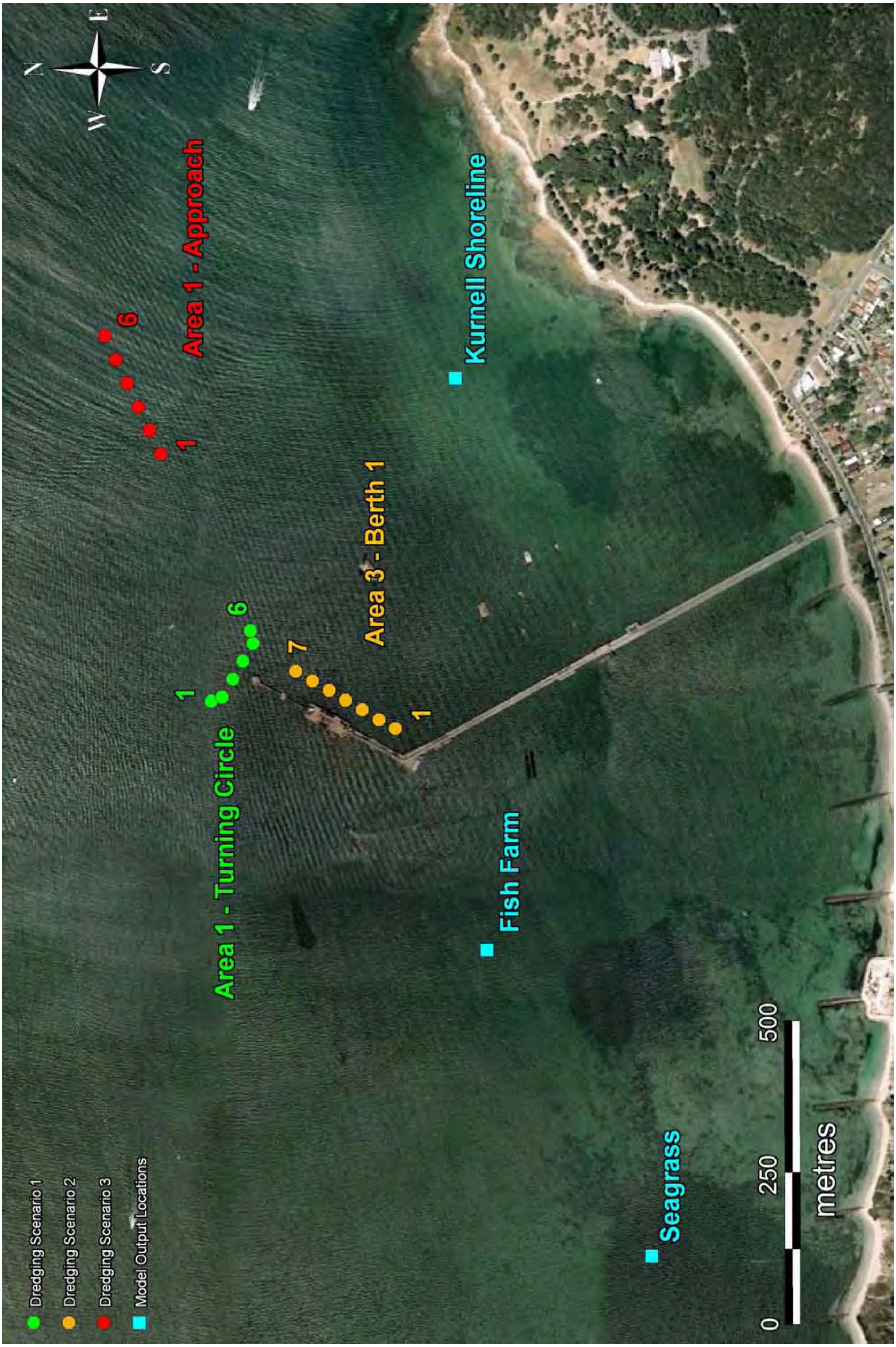


Kurnell Port and Berthing Facility Upgrade

SWAN Model − Grid Layout

Figure 5.2

LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures

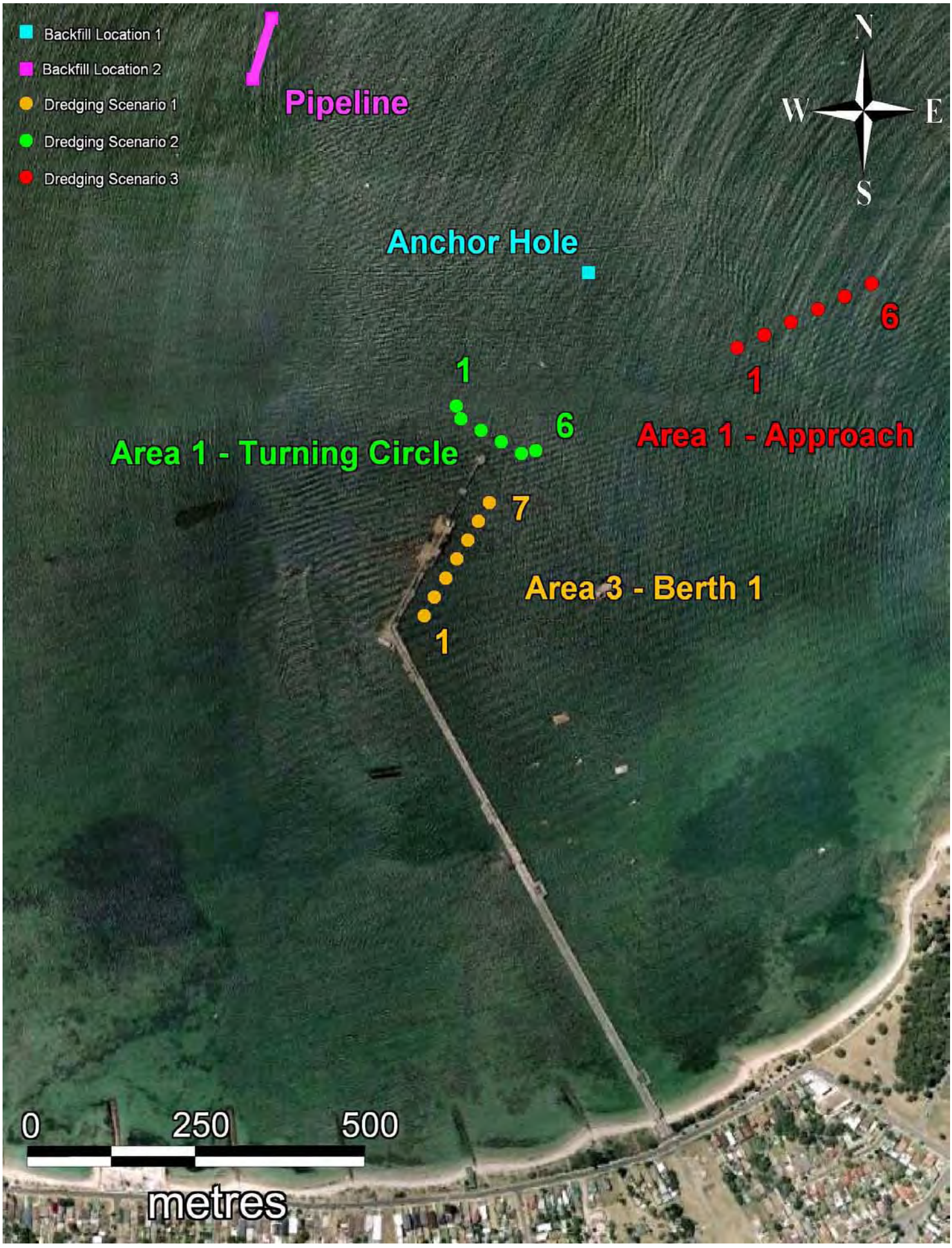


Kurnell Port and Berthing Facility Upgrade

Locality Plan − Dredging Operations and Model Output Locations

LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures

Figure 6.1

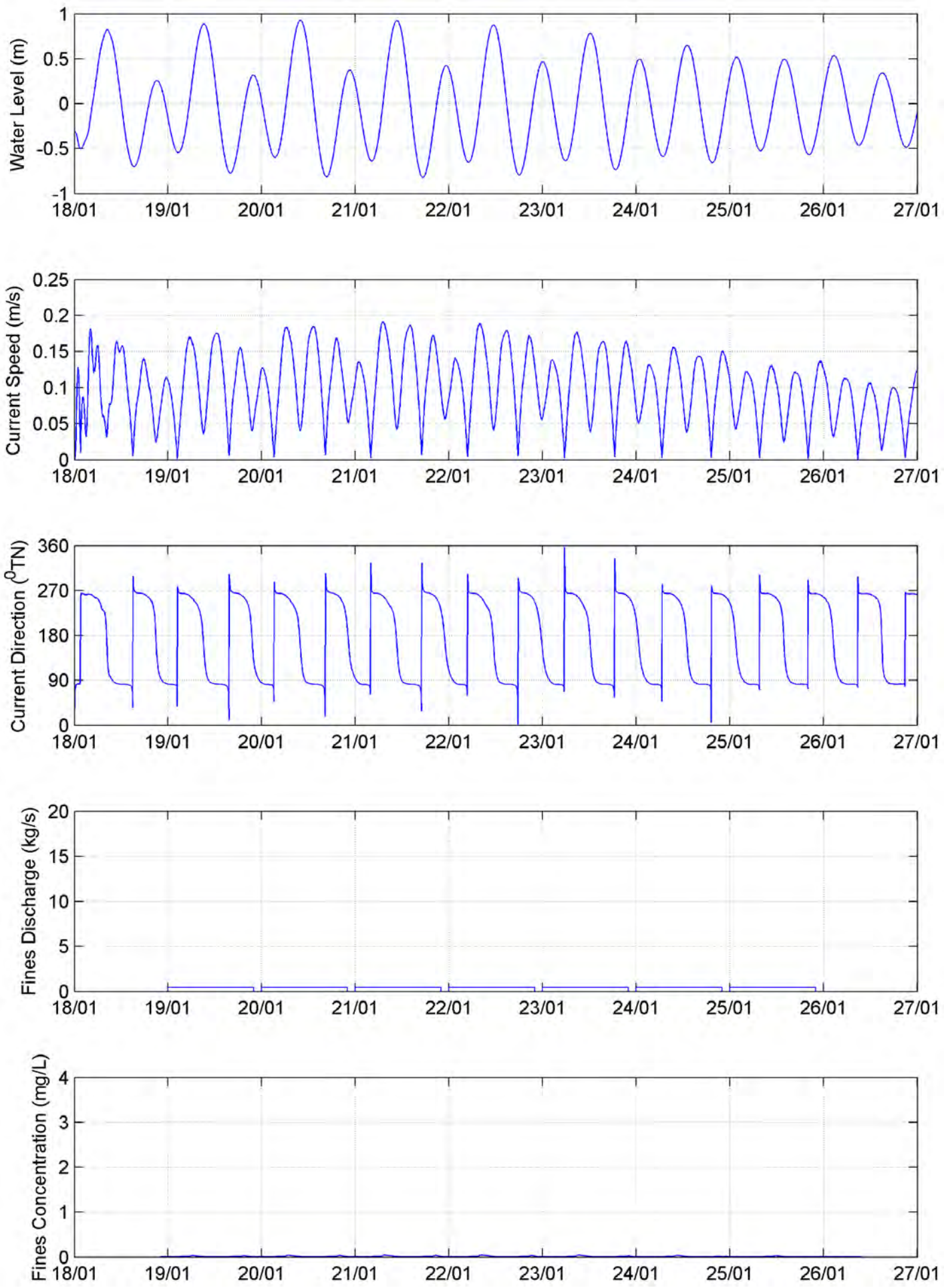


Kurnell Port and Berthing Facility Upgrade

Locality Plan − Dredging Operations and Backfill Locations

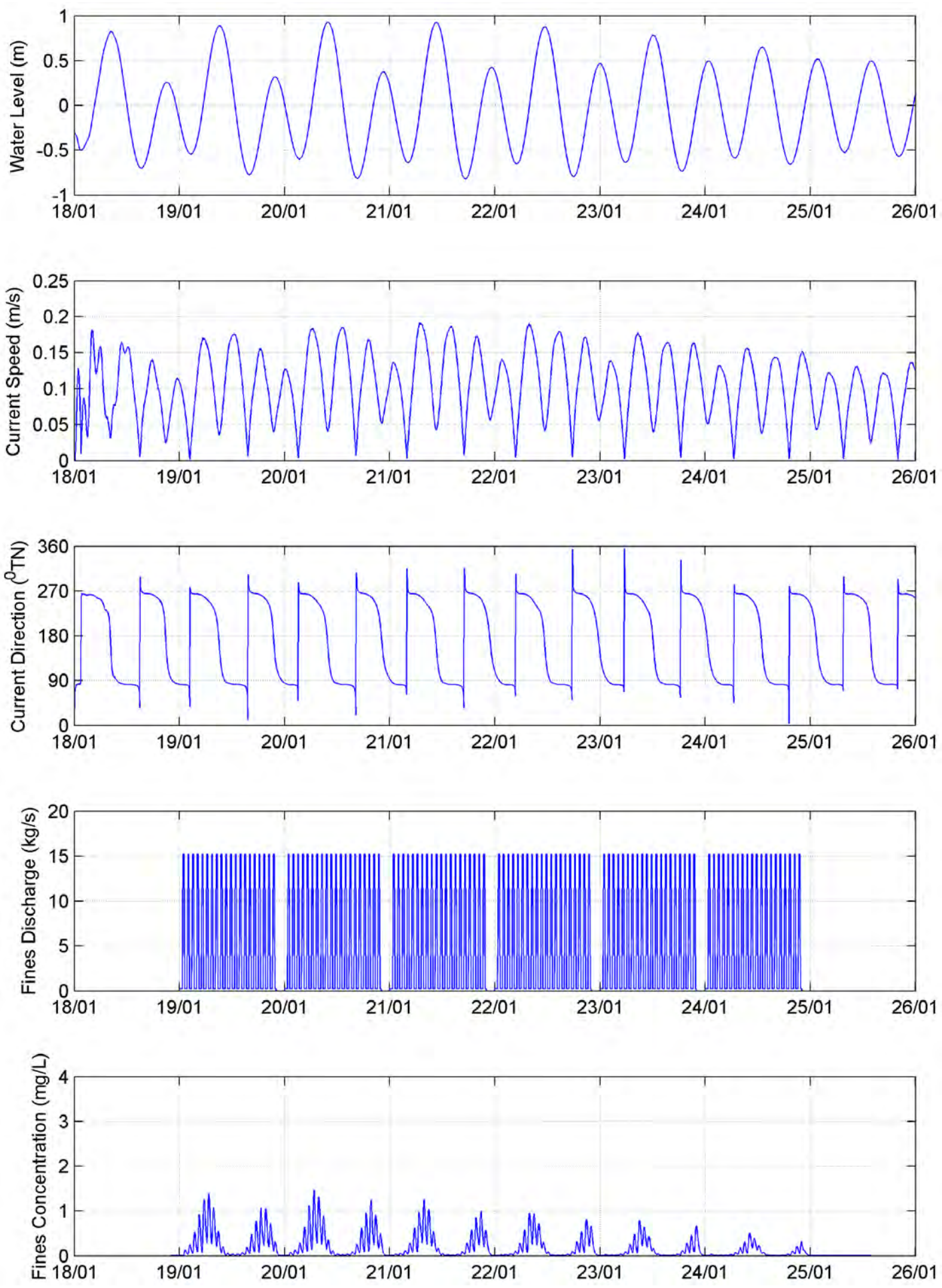
LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures

Figure 6.2



Kurnell Port and Berthing Facility Upgrade

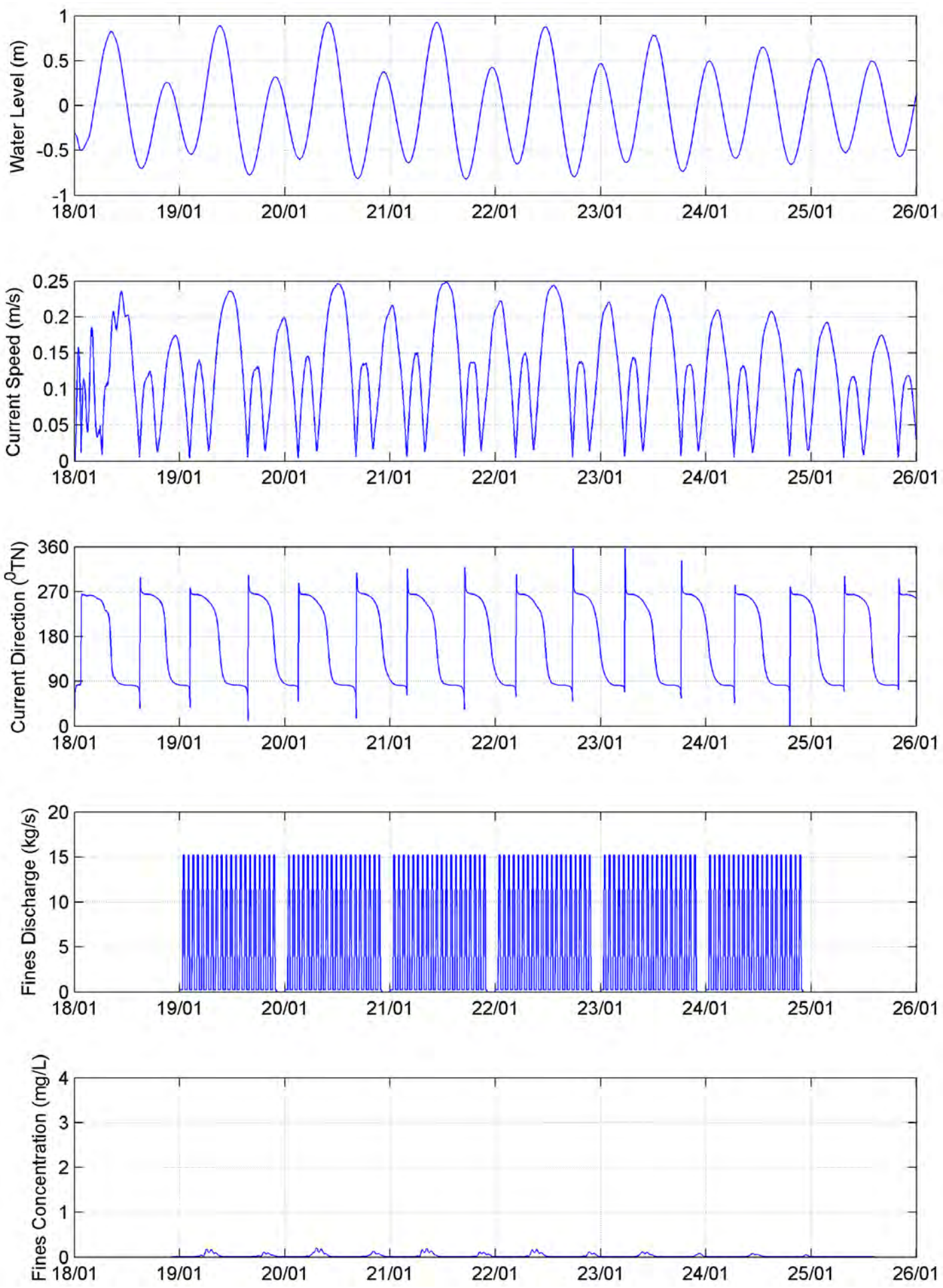
Fish Farm − Scenario 1 (Dredging of Area 3 − Berth 1)
Surface Layer (modelled for January 2012)
Figure 6.3



Kurnell Port and Berthing Facility Upgrade

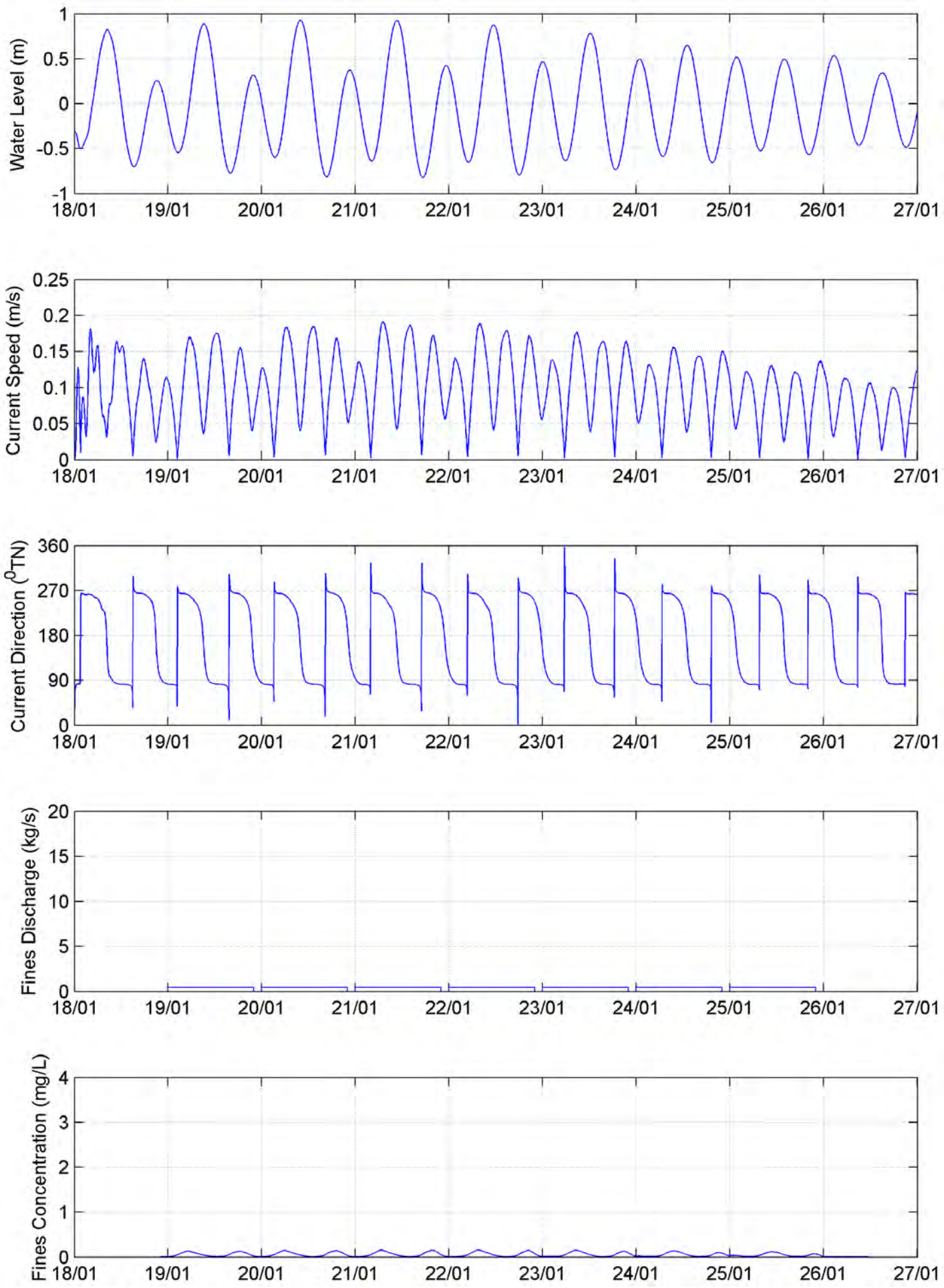
Fish Farm − Scenario 2 (Dredging of Area 1 − Turning Circle)
Surface Layer (modelled for January 2012)
Figure 6.4

LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures



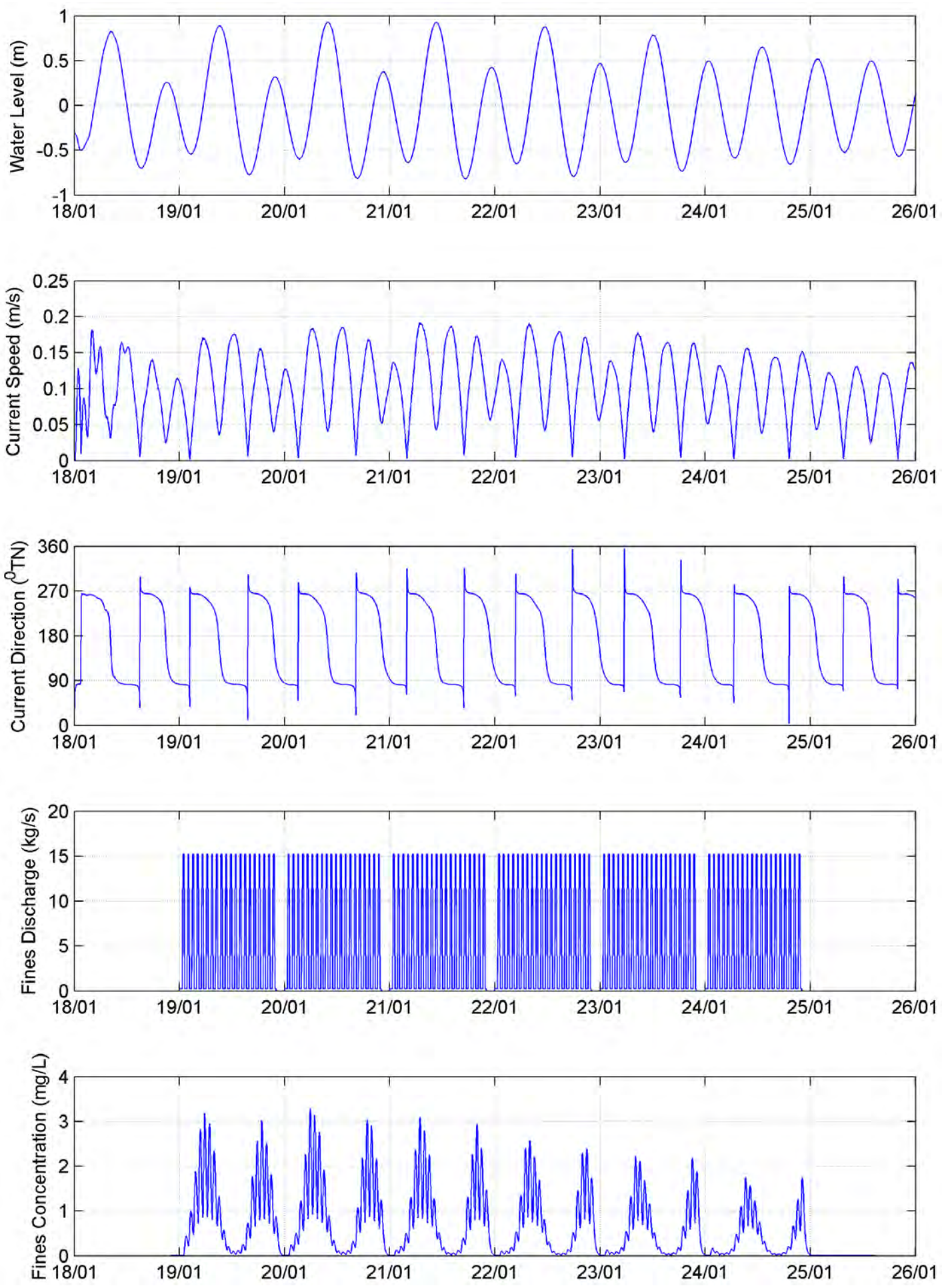
Kurnell Port and Berthing Facility Upgrade

Fish Farm − Scenario 3 (Dredging of Area 1 − Approach)
Surface Layer (modelled for January 2012)
Figure 6.5



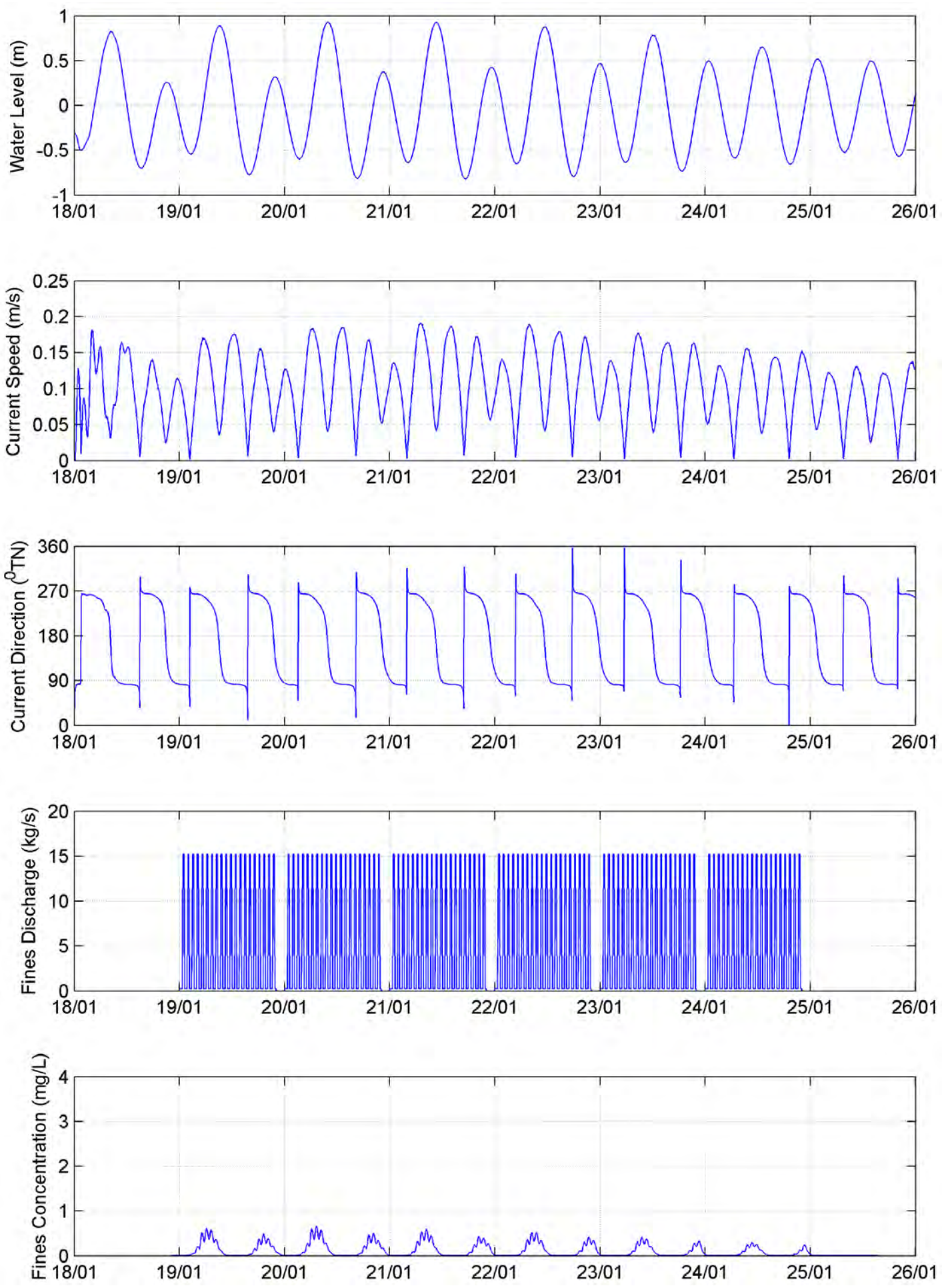
Kurnell Port and Berthing Facility Upgrade

Fish Farm − Scenario 1 (Dredging of Area 3 − Berth 1)
Bottom Layer (modelled for January 2012)
Figure 6.6



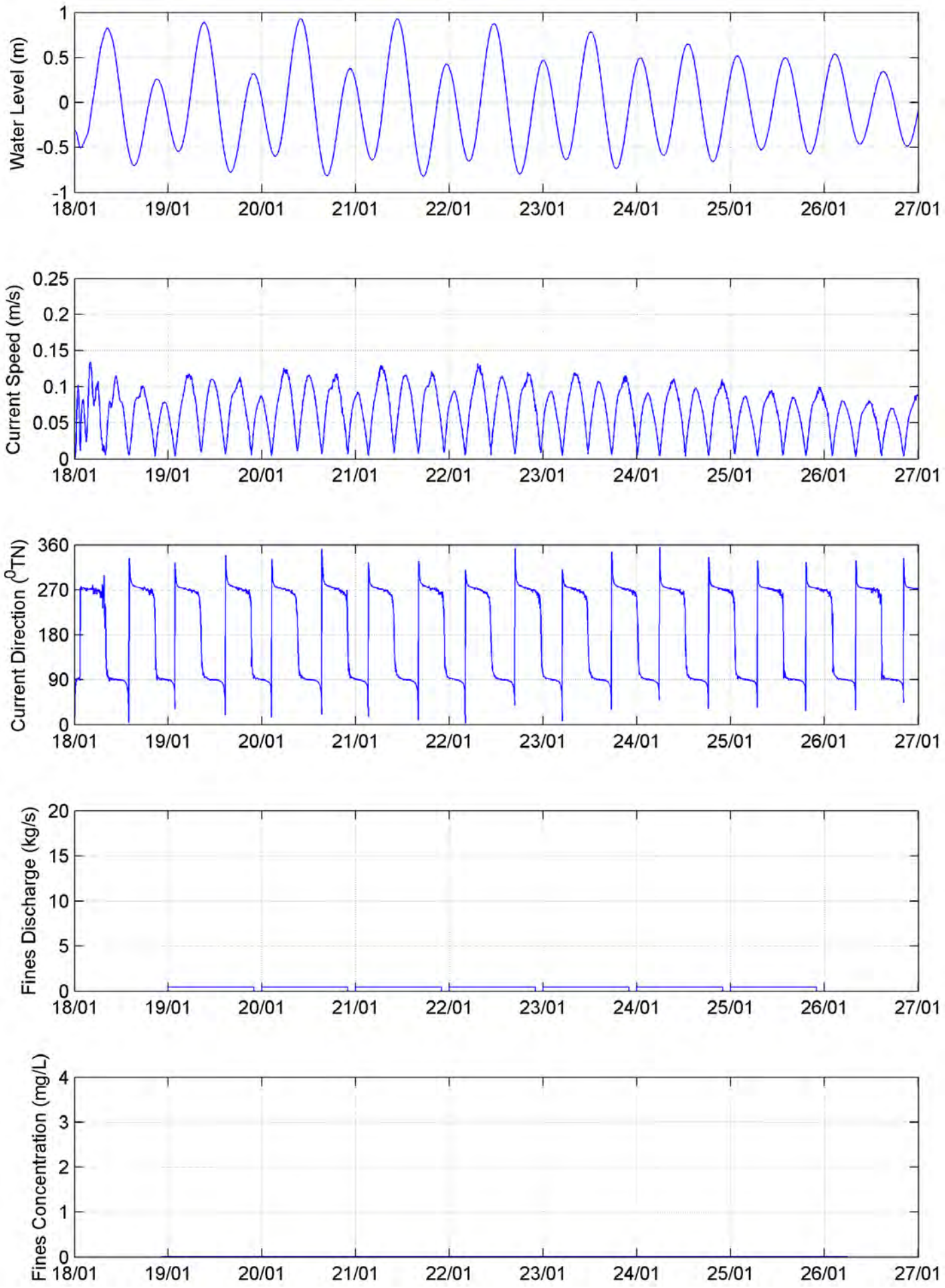
Kurnell Port and Berthing Facility Upgrade

Fish Farm − Scenario 2 (Dredging of Area 1 − Turning Circle)
Bottom Layer (modelled for January 2012)
Figure 6.7



Kurnell Port and Berthing Facility Upgrade

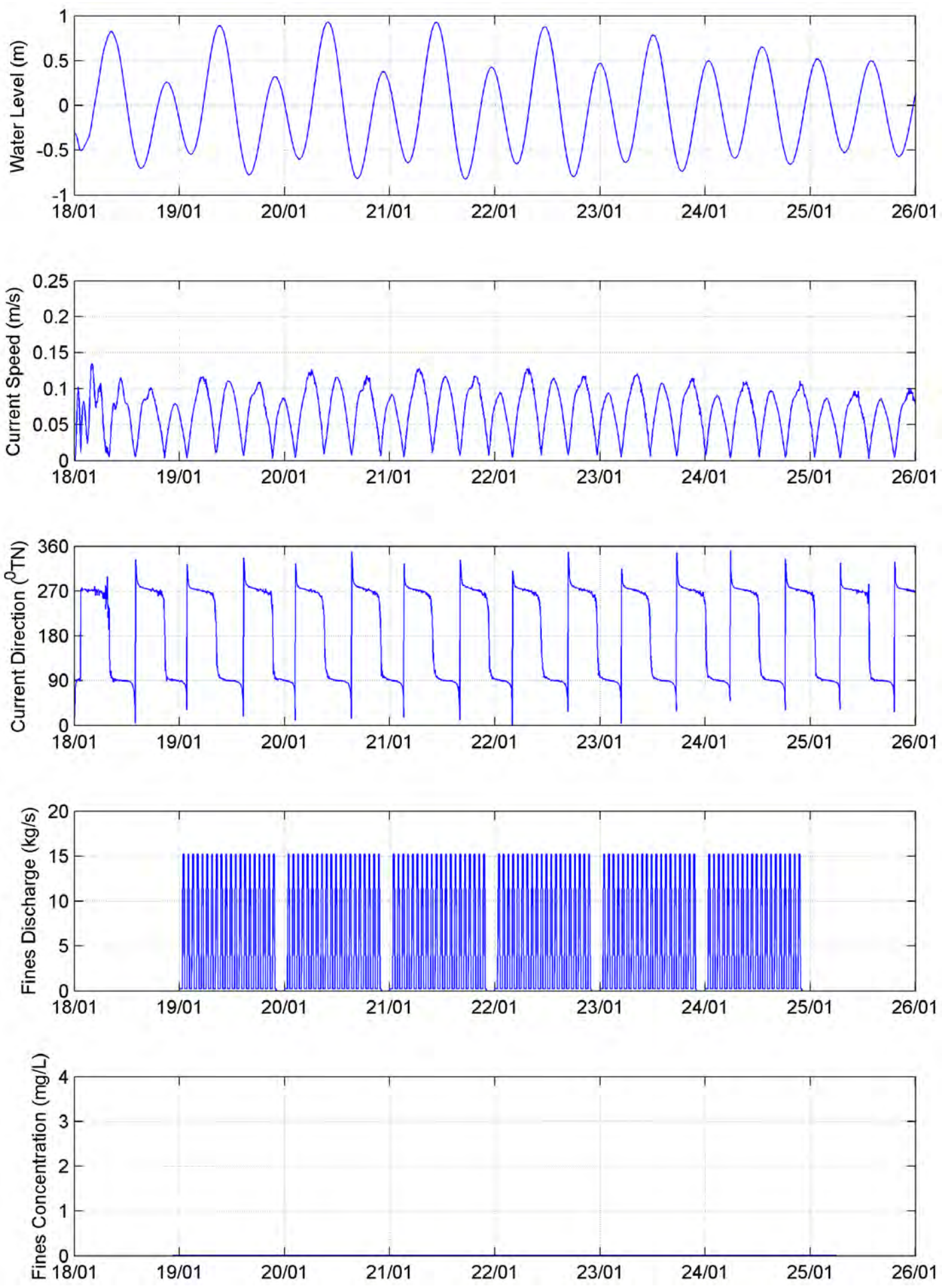
Fish Farm − Scenario 3 (Dredging of Area 1 − Approach)
Bottom Layer (modelled for January 2012)
Figure 6.8



Kurnell Port and Berthing Facility Upgrade

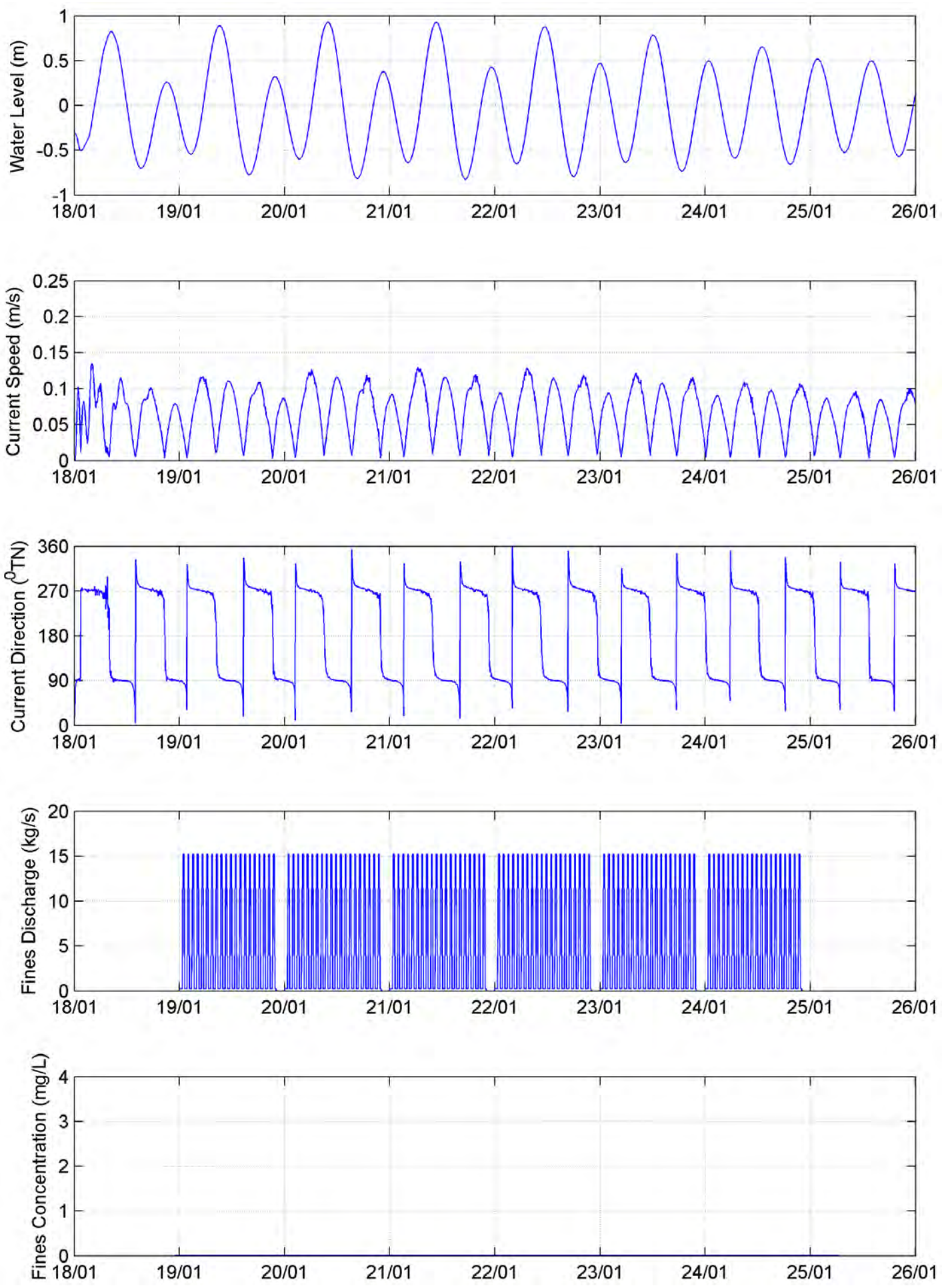
Sea Grass Area − Scenario 1 (Dredging of Area 3 − Berth 1)
Surface Layer (modelled for January 2012)
Figure 6.9

LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures



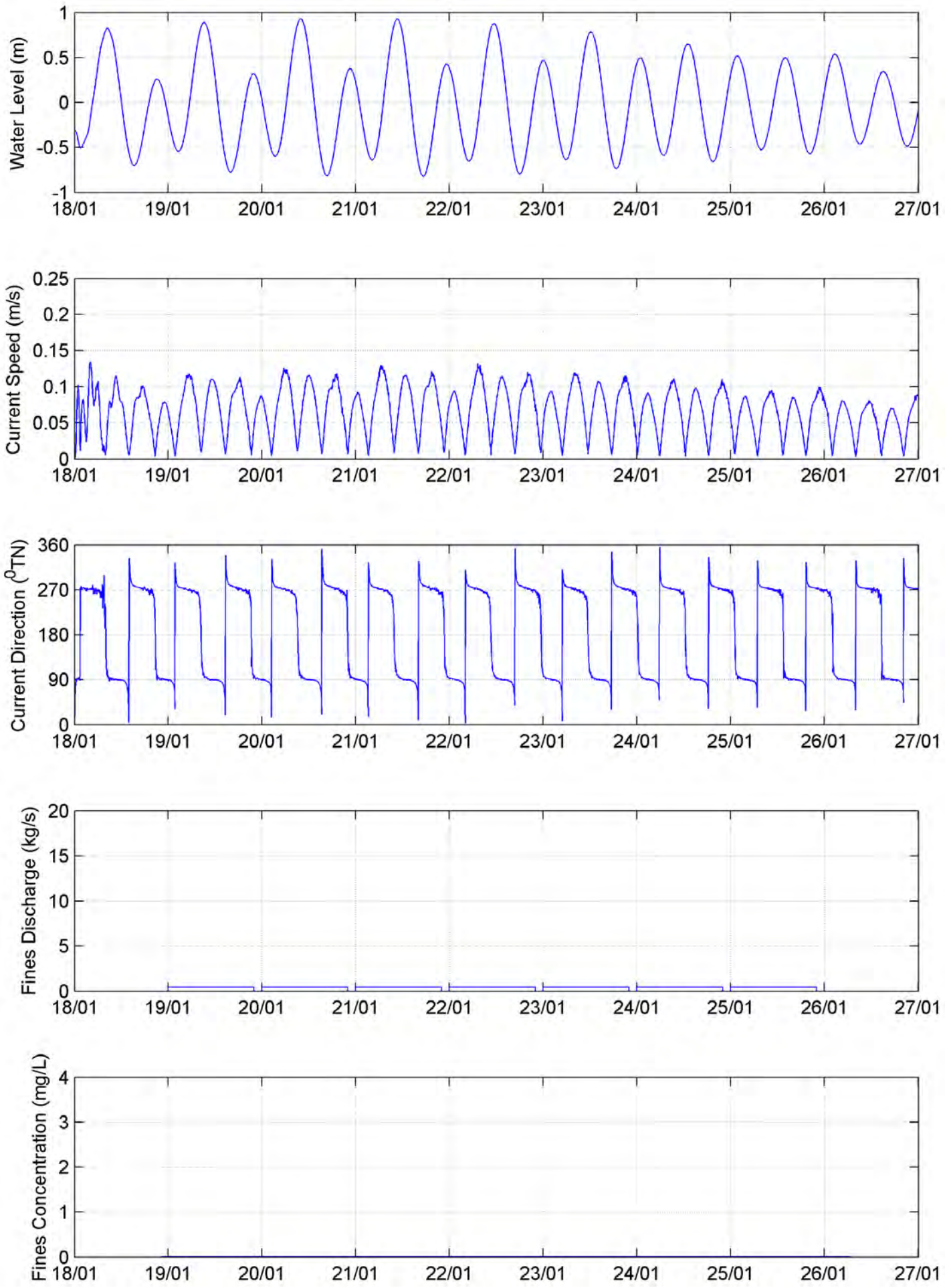
Kurnell Port and Berthing Facility Upgrade

Sea Grass Area − Scenario 2 (Dredging of Area 1 − Turning Circle)
Surface Layer (modelled for January 2012)
Figure 6.10



Kurnell Port and Berthing Facility Upgrade

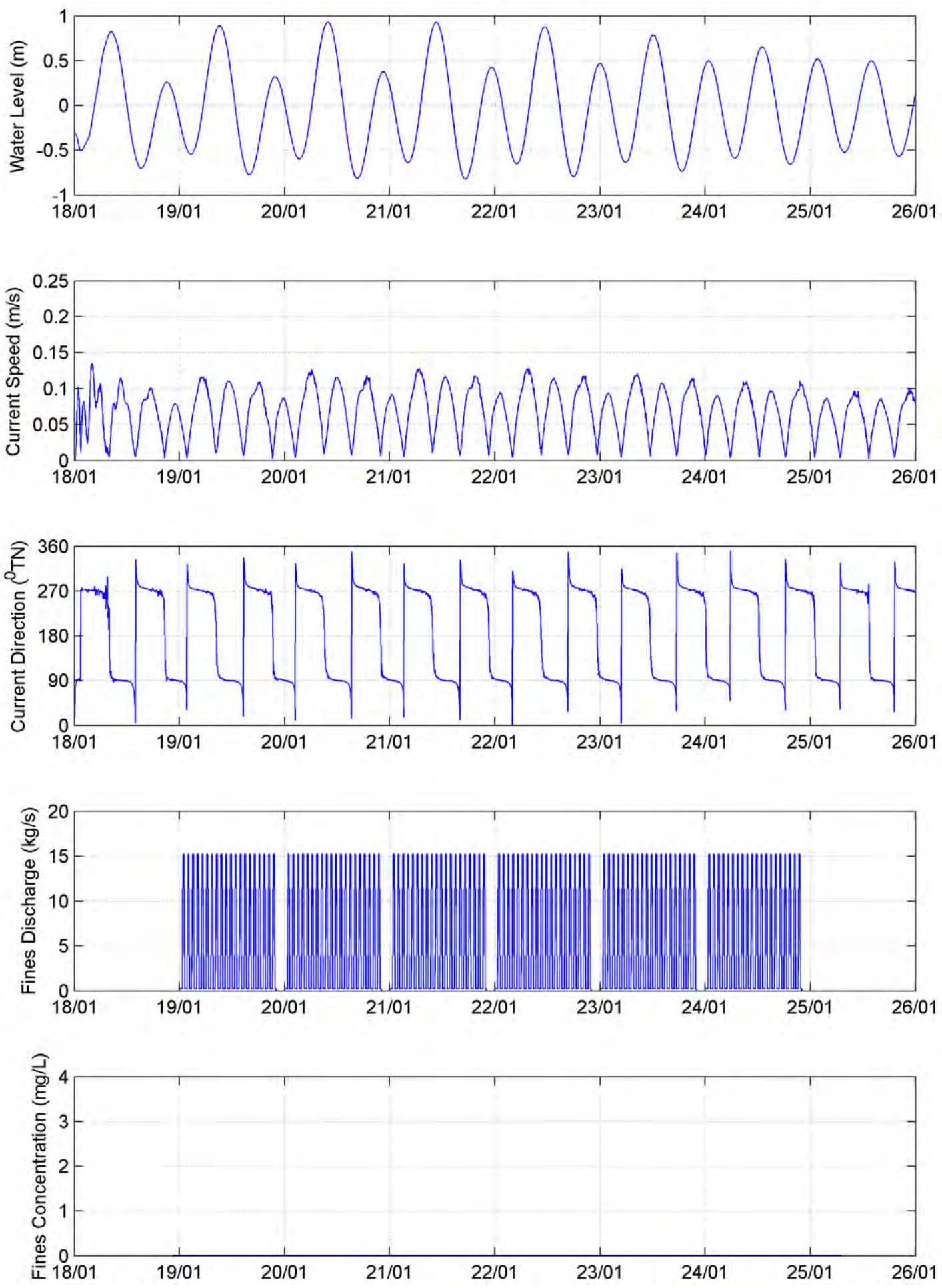
Sea Grass Area − Scenario 3 (Dredging of Area 1 − Approach)
Surface Layer (modelled for January 2012)
Figure 6.11



Kurnell Port and Berthing Facility Upgrade

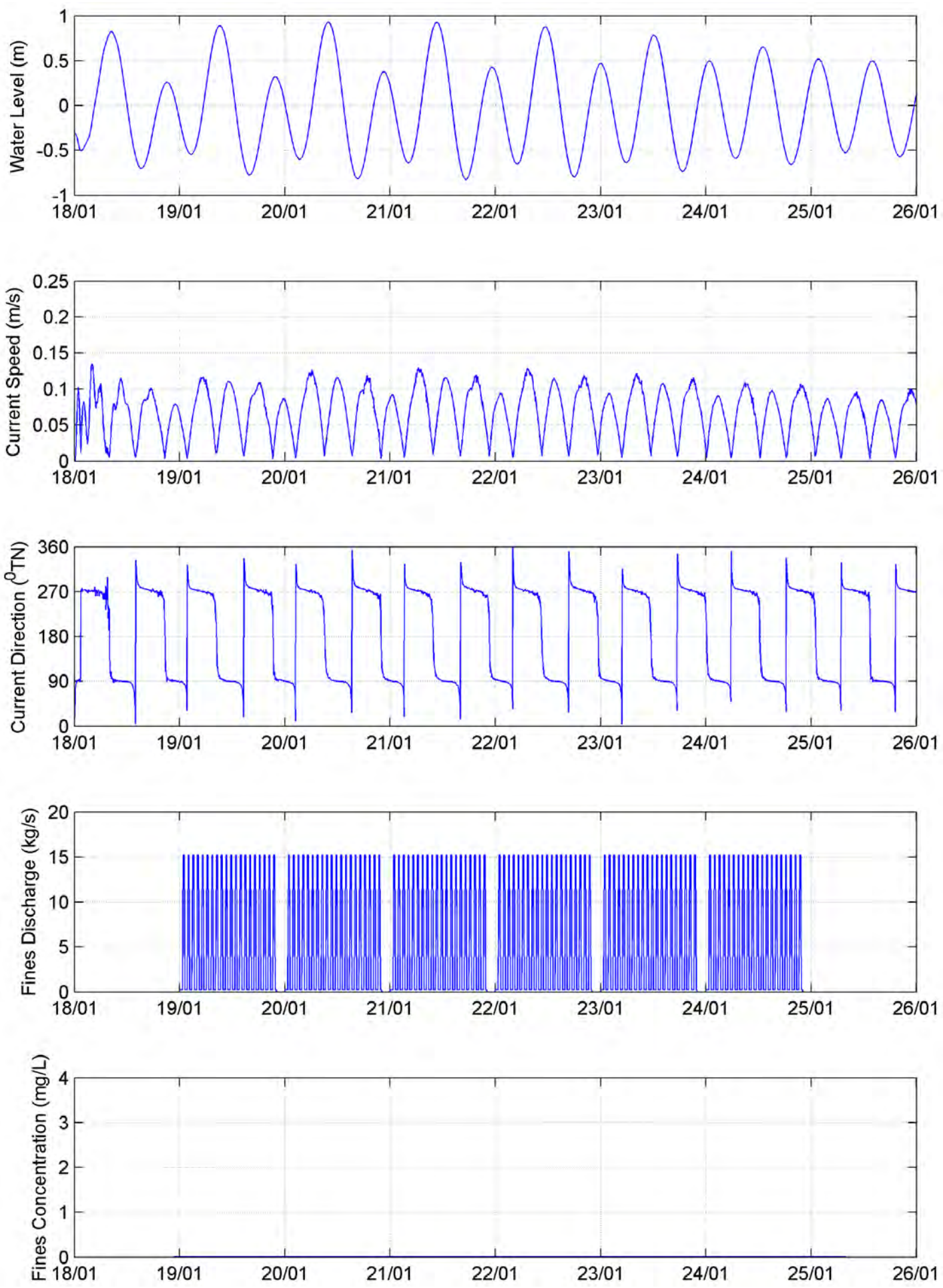
Sea Grass Area − Scenario 1 (Dredging of Area 3 − Berth 1)
Bottom Layer (modelled for January 2012)
Figure 6.12

LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures



Kurnell Port and Berthing Facility Upgrade

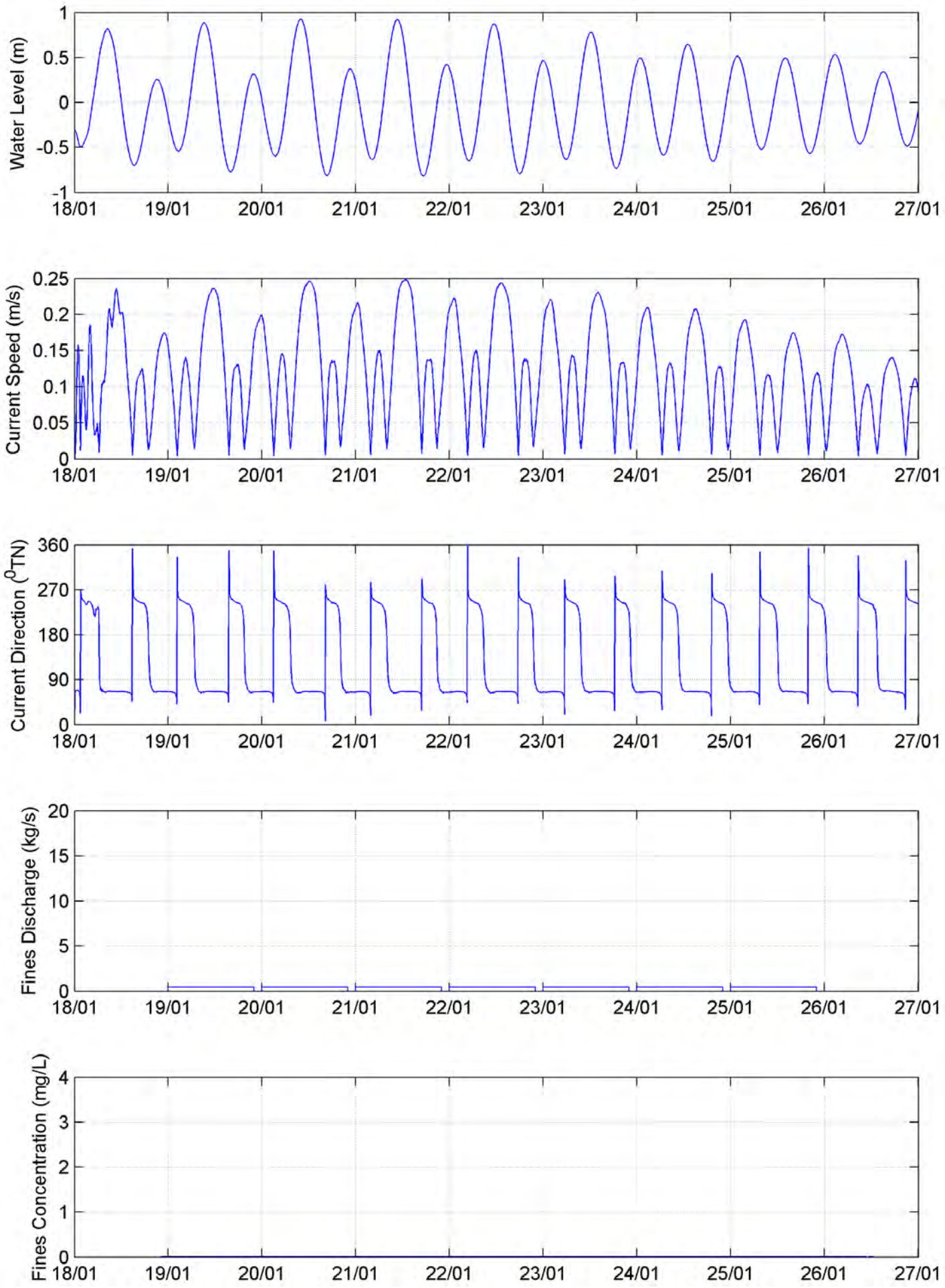
Sea Grass Area − Scenario 2 (Dredging of Area 1 − Turning Circle)
Bottom Layer (modelled for January 2012)
Figure 6.13



Kurnell Port and Berthing Facility Upgrade

Cardno

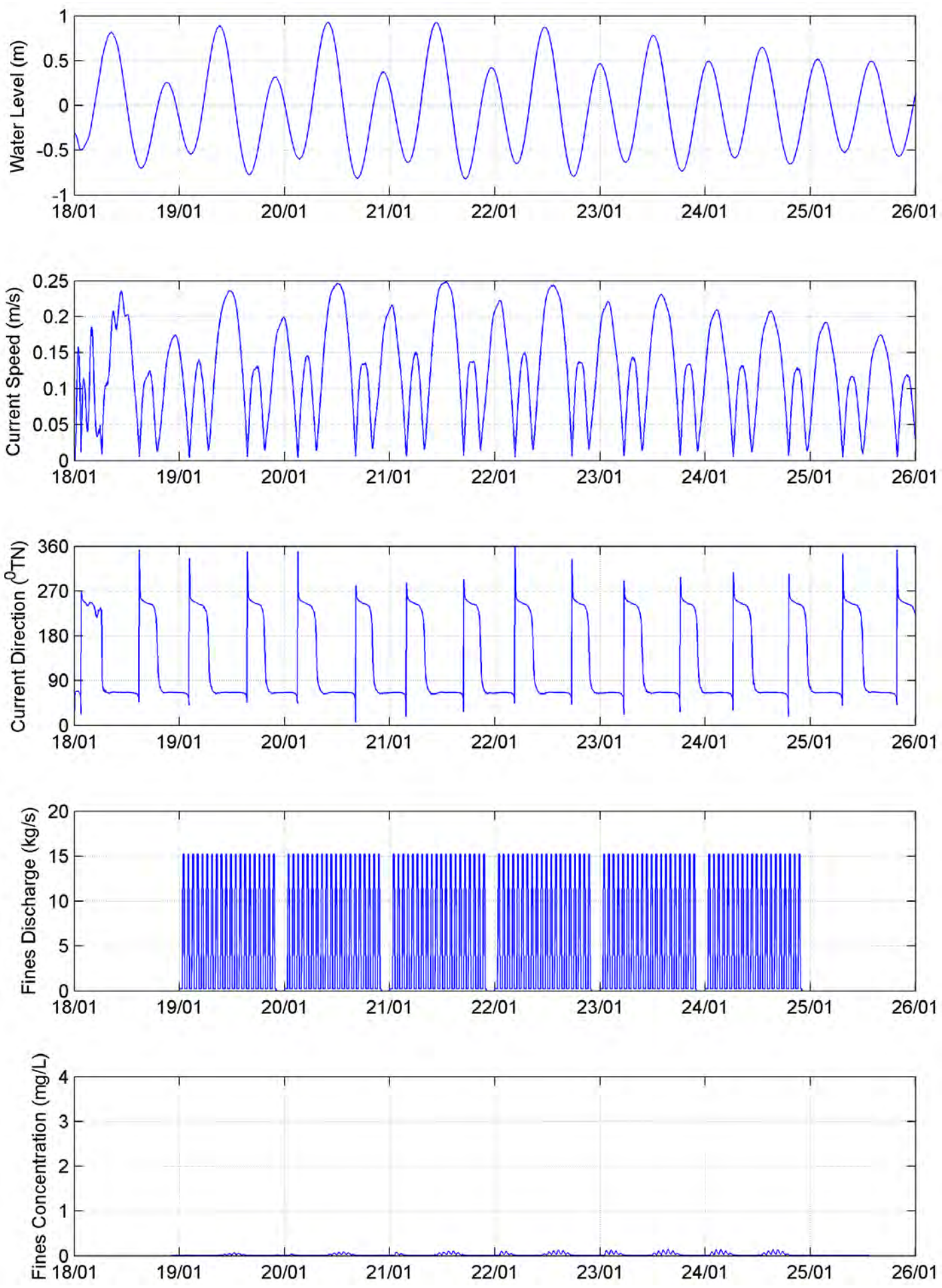
Sea Grass Area − Scenario 3 (Dredging of Area 1 − Approach)
Bottom Layer (modelled for January 2012)
Figure 6.14



Kurnell Port and Berthing Facility Upgrade

Kurnell Shoreline − Scenario 1 (Dredging of Area 3 − Berth 1)
Surface Layer (modelled for January 2012)
Figure 6.15

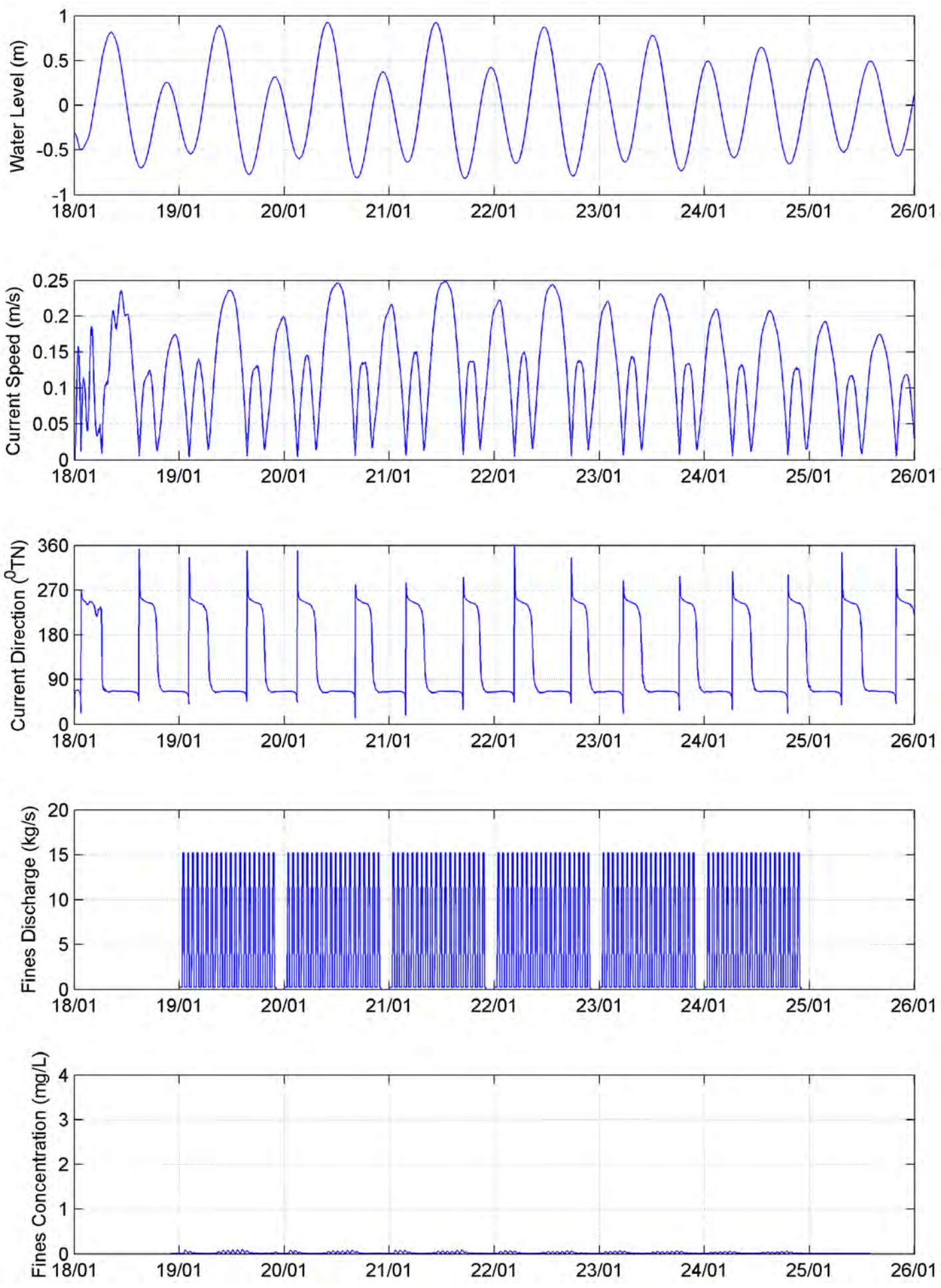
LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures



Kurnell Port and Berthing Facility Upgrade

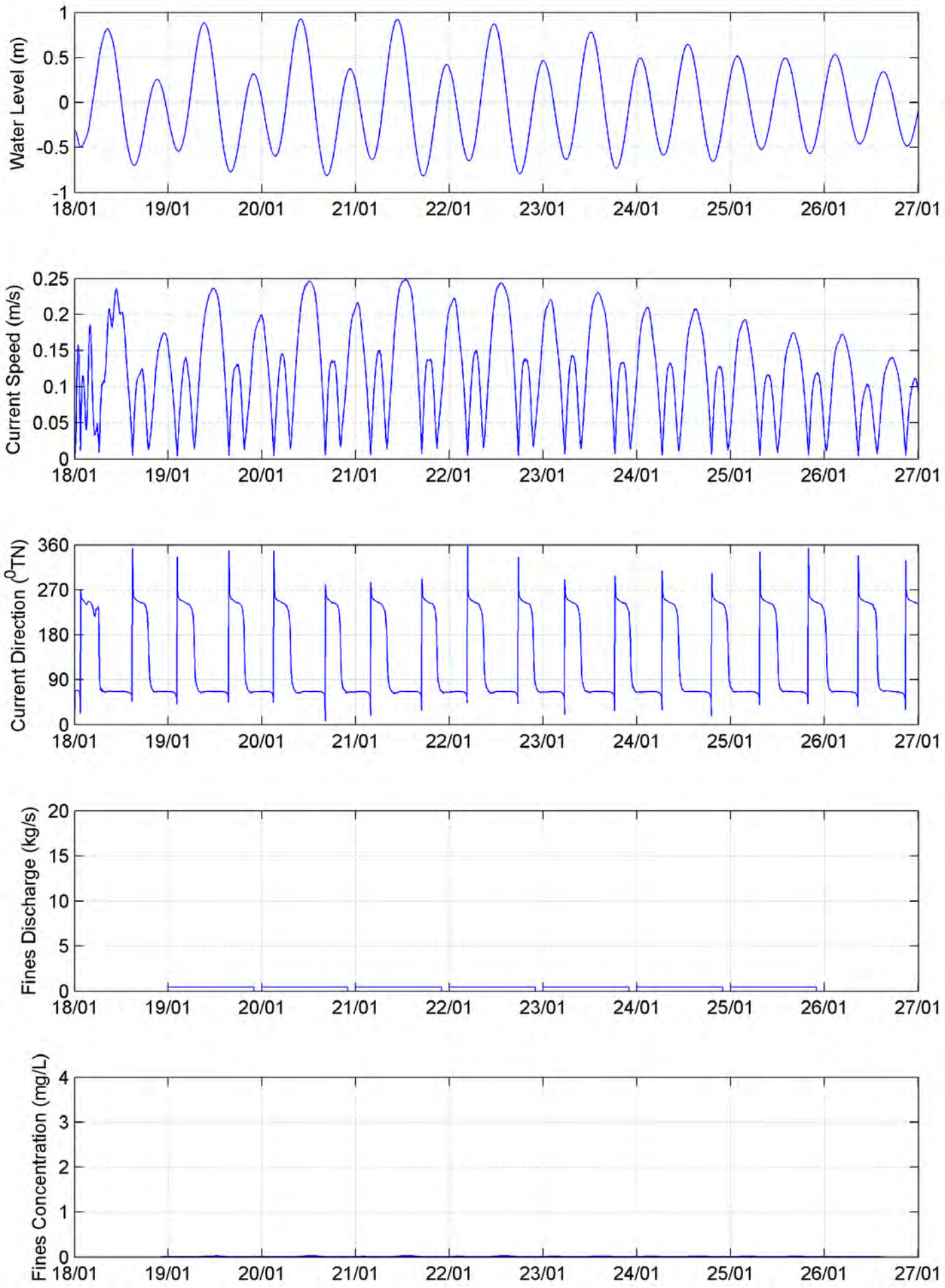
Kurnell Shoreline − Scenario 2 (Dredging of Area 1 − Turning Circle)
Surface Layer (modelled for January 2012)
Figure 6.16

LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures



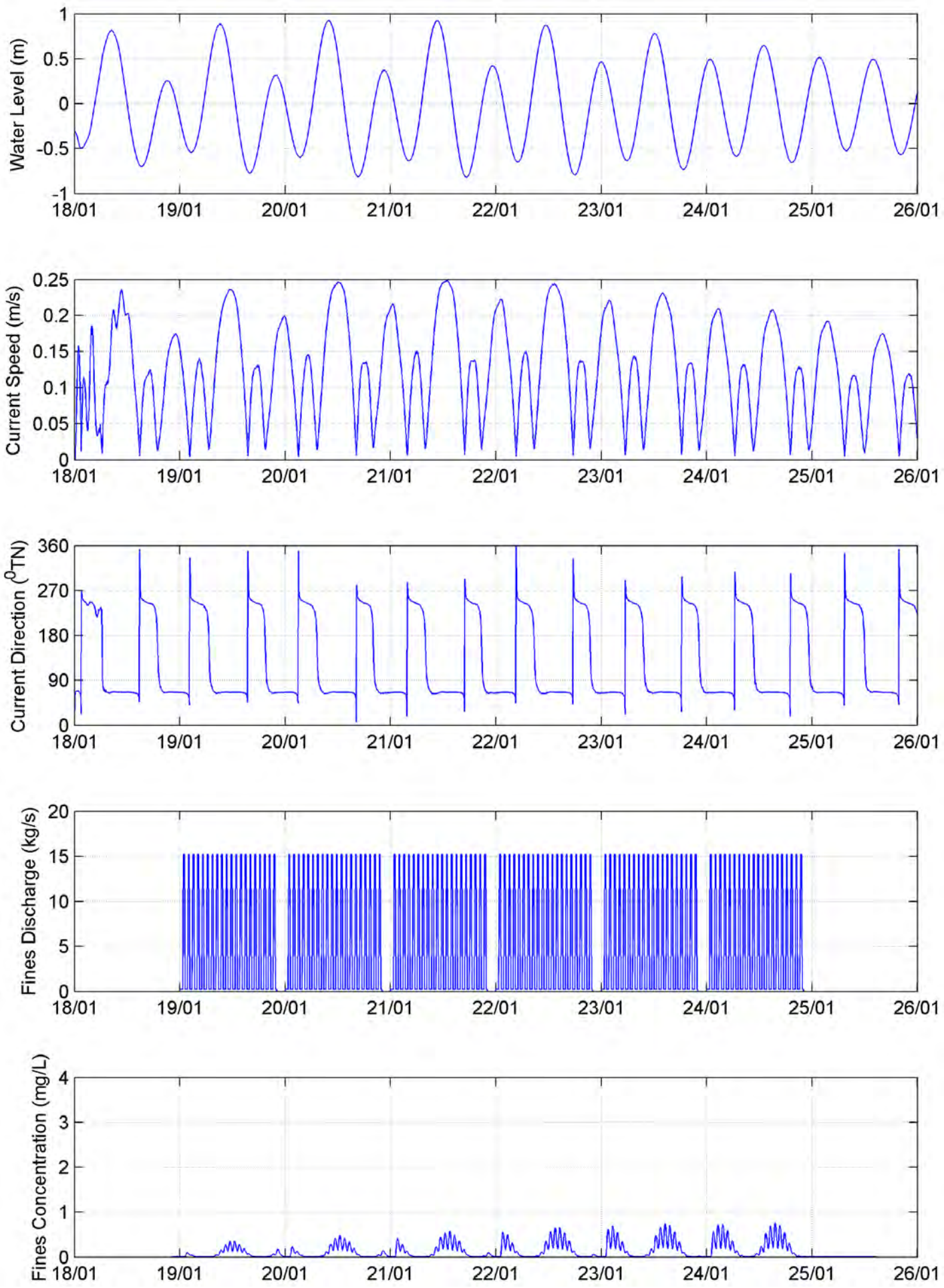
Kurnell Port and Berthing Facility Upgrade

Kurnell Shoreline − Scenario 3 (Dredging of Area 1 − Approach)
Surface Layer (modelled for January 2012)
Figure 6.17



Kurnell Port and Berthing Facility Upgrade

Kurnell Shoreline − Scenario 1 (Dredging of Area 3 − Berth 1)
Bottom Layer (modelled for January 2012)
Figure 6.18

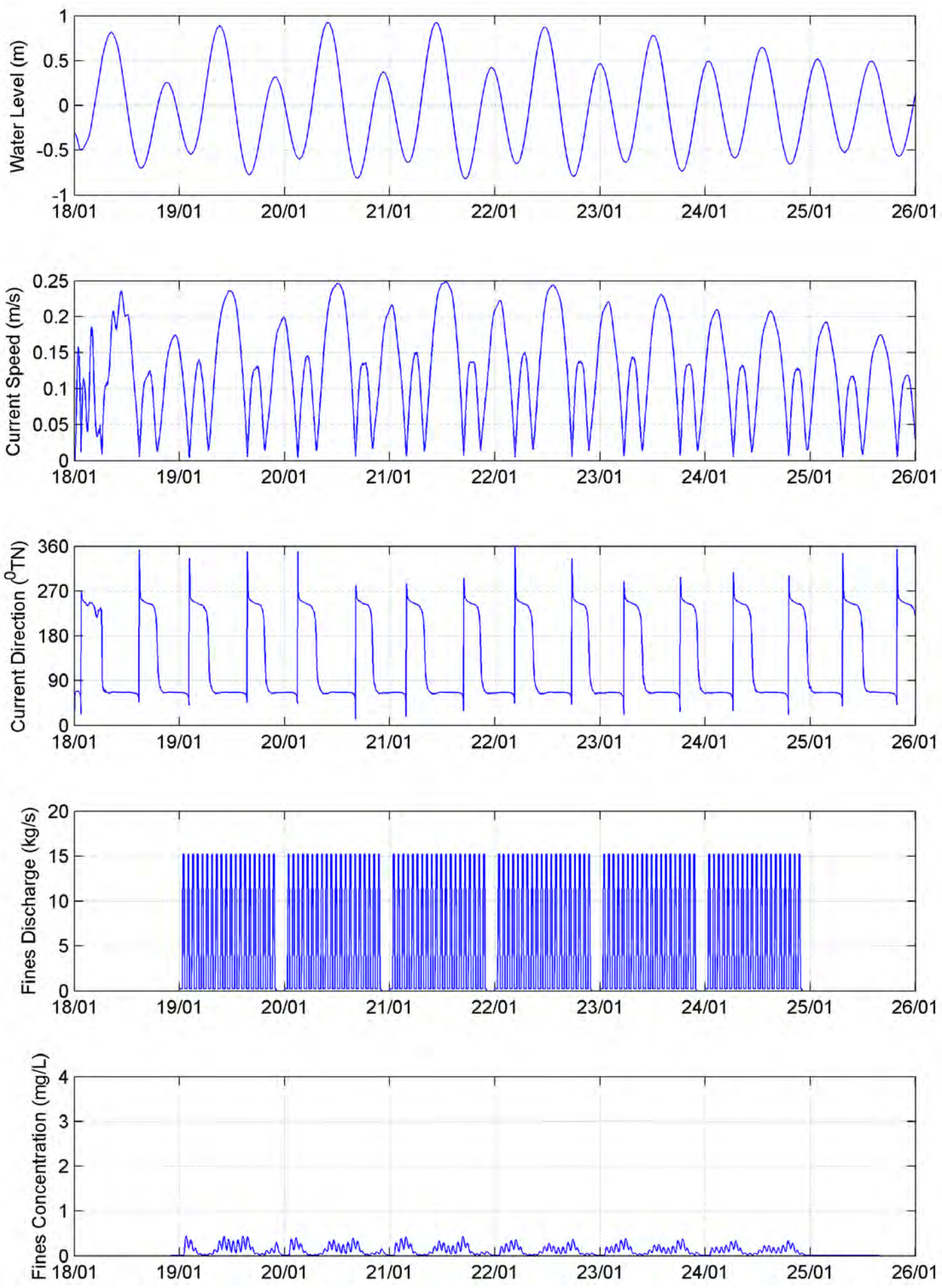


Kurnell Port and Berthing Facility Upgrade

Cardno

Kurnell Shoreline − Scenario 2 (Dredging of Area 1 − Turning Circle)
Bottom Layer (modelled for January 2012)
Figure 6.19

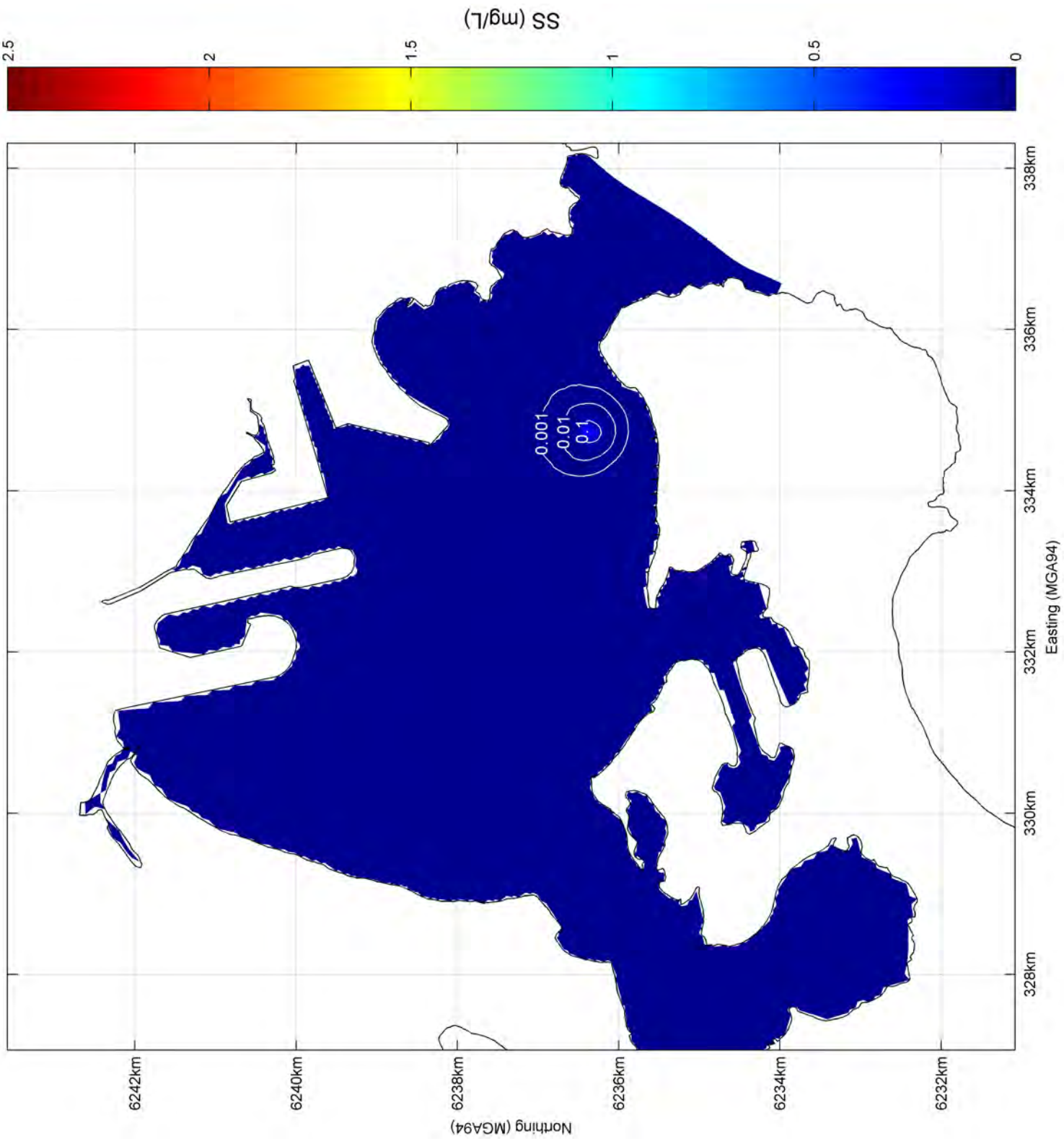
LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures



Kurnell Port and Berthing Facility Upgrade

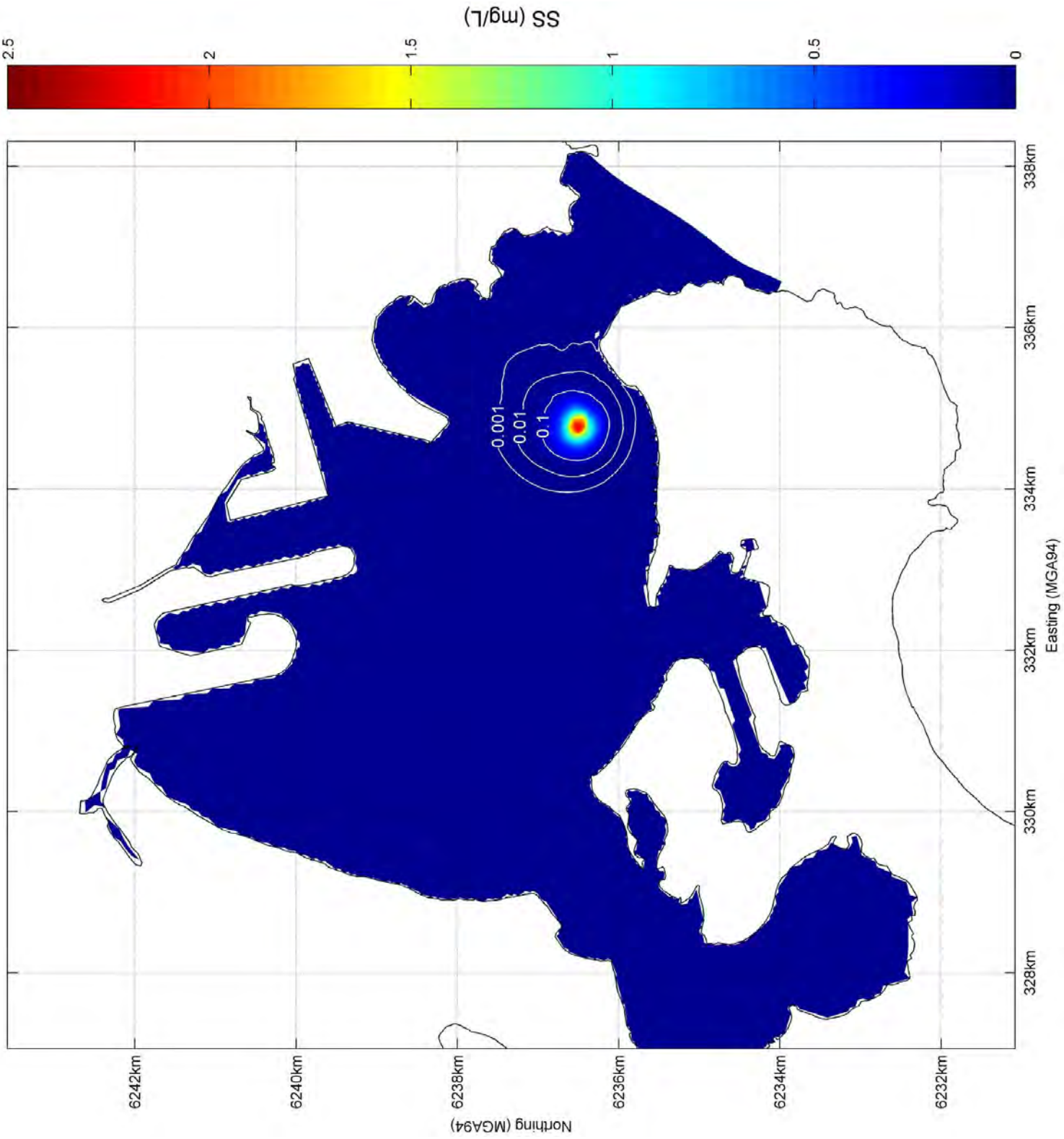
Kurnell Shoreline − Scenario 3 (Dredging of Area 1 − Approach)
Bottom Layer (modelled for January 2012)
Figure 6.20

LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures



Kurnell Port and Berthing Facility Upgrade

Median SS Concentration − Scenario 1 (Dredging of Area 3 − Berth 1)
Surface Layer (modelled for January 2012)
Figure 6.21

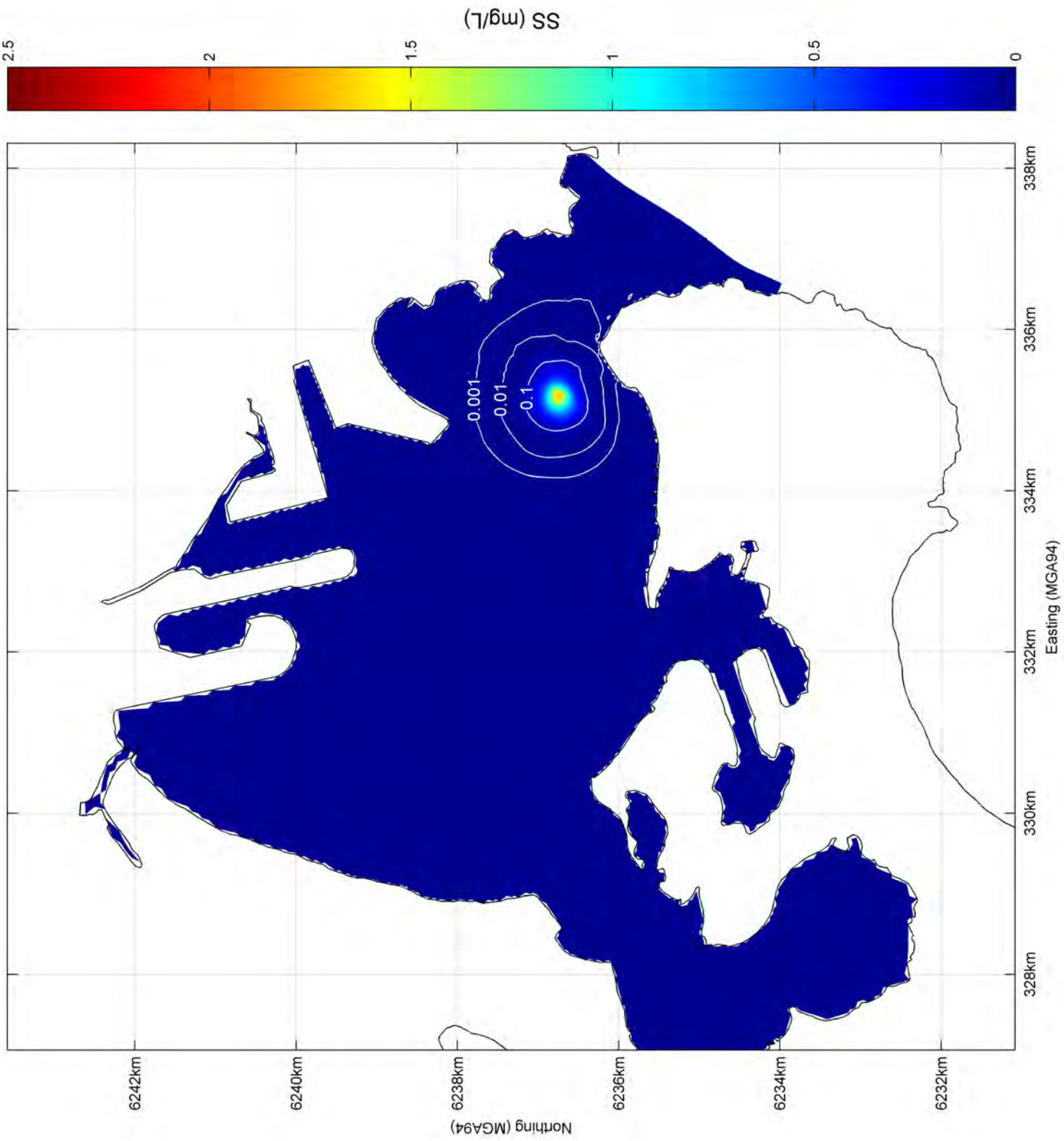


Kurnell Port and Berthing Facility Upgrade

Cardno

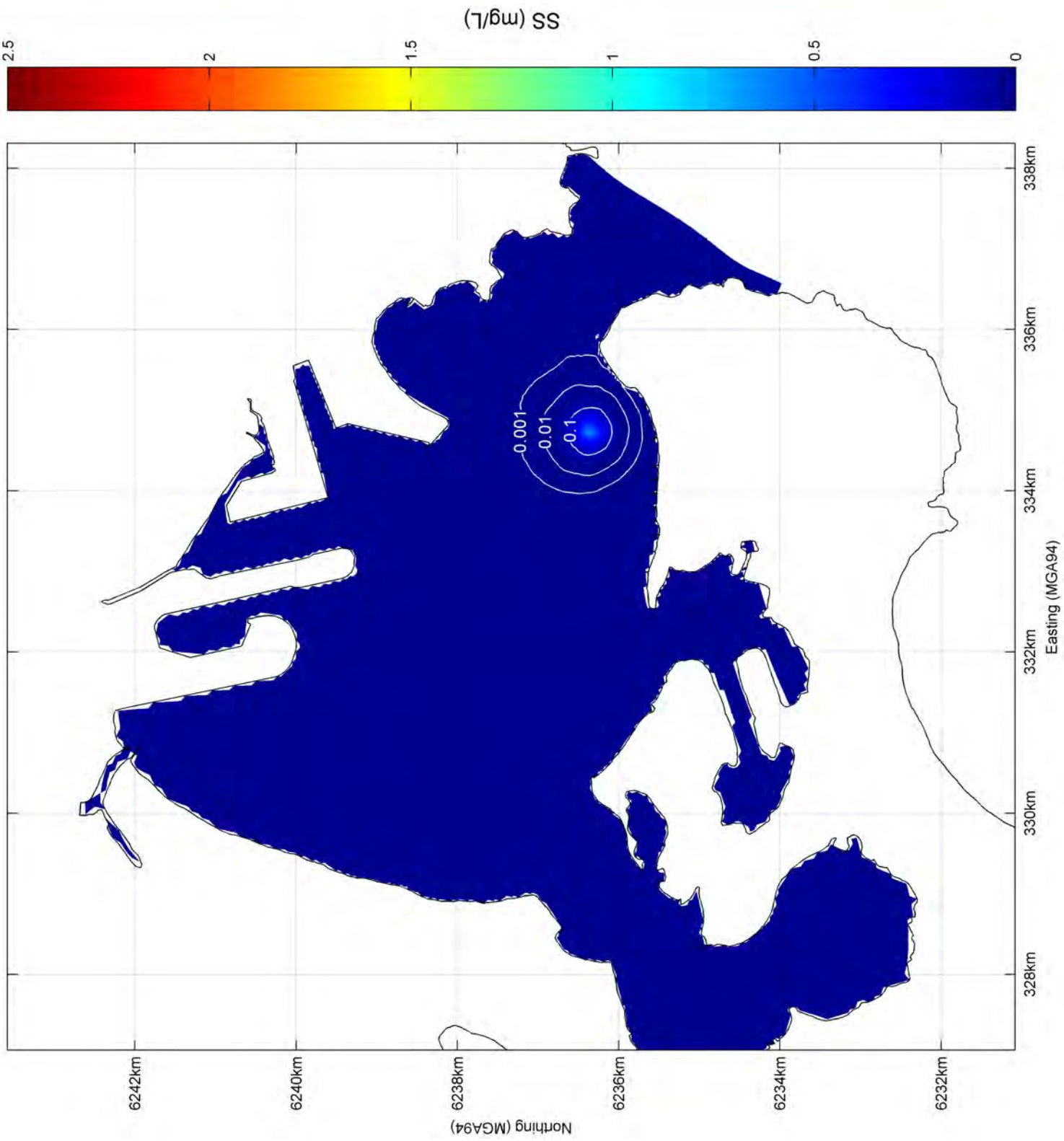
Median SS Concentration − Scenario 2 (Dredging of Area 1 − Turning Circle)
Surface Layer (modelled for January 2012)

Figure 6.22



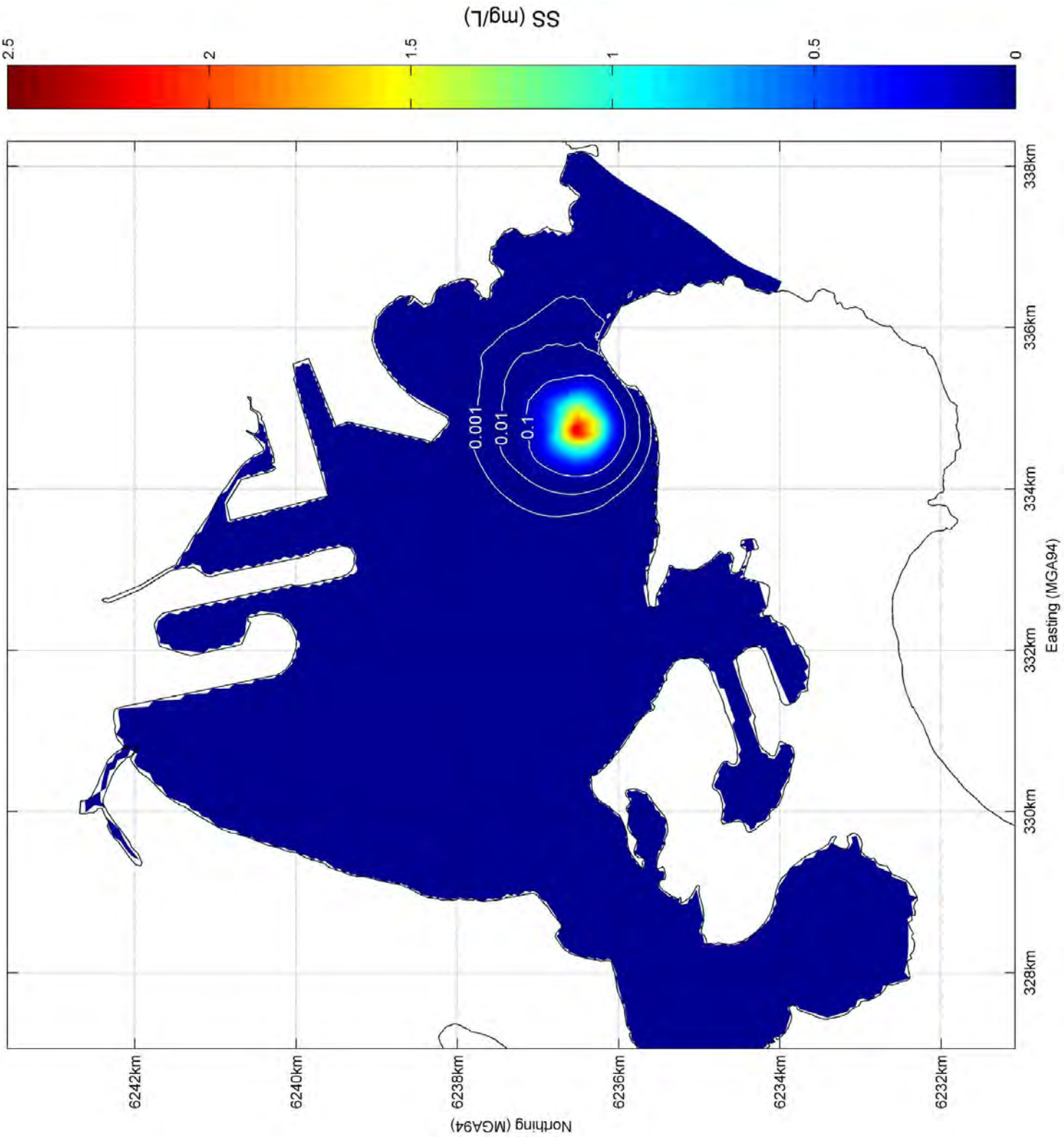
Kurnell Port and Berthing Facility Upgrade

Median SS Concentration − Scenario 3 (Dredging of Area 1 − Approach)
Surface Layer (modelled for January 2012)
Figure 6.23



Kurnell Port and Berthing Facility Upgrade

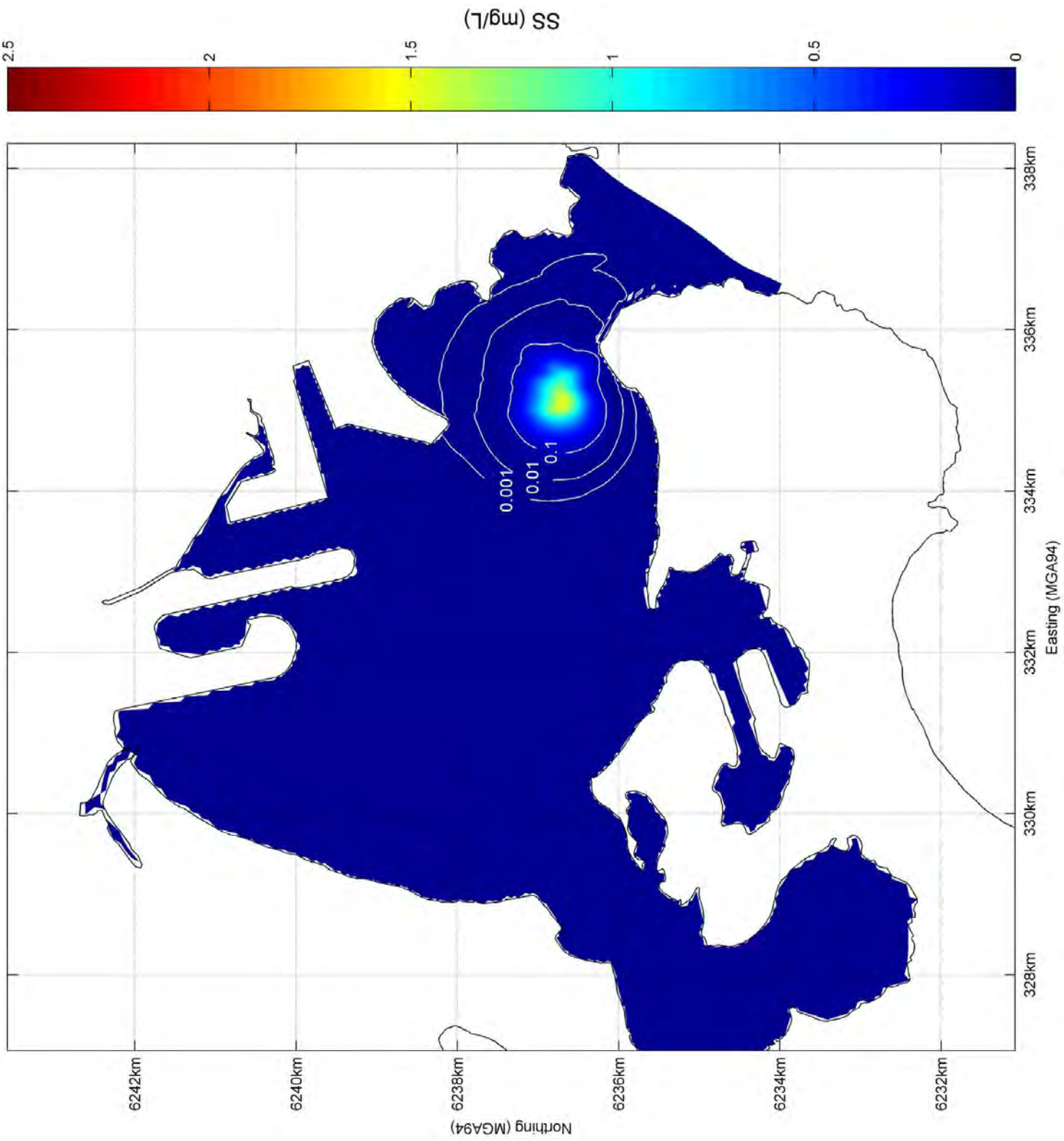
Median SS Concentration − Scenario 1 (Dredging of Area 3 − Berth 1)
Bottom Layer (modelled for January 2012)
Figure 6.24



Kurnell Port and Berthing Facility Upgrade

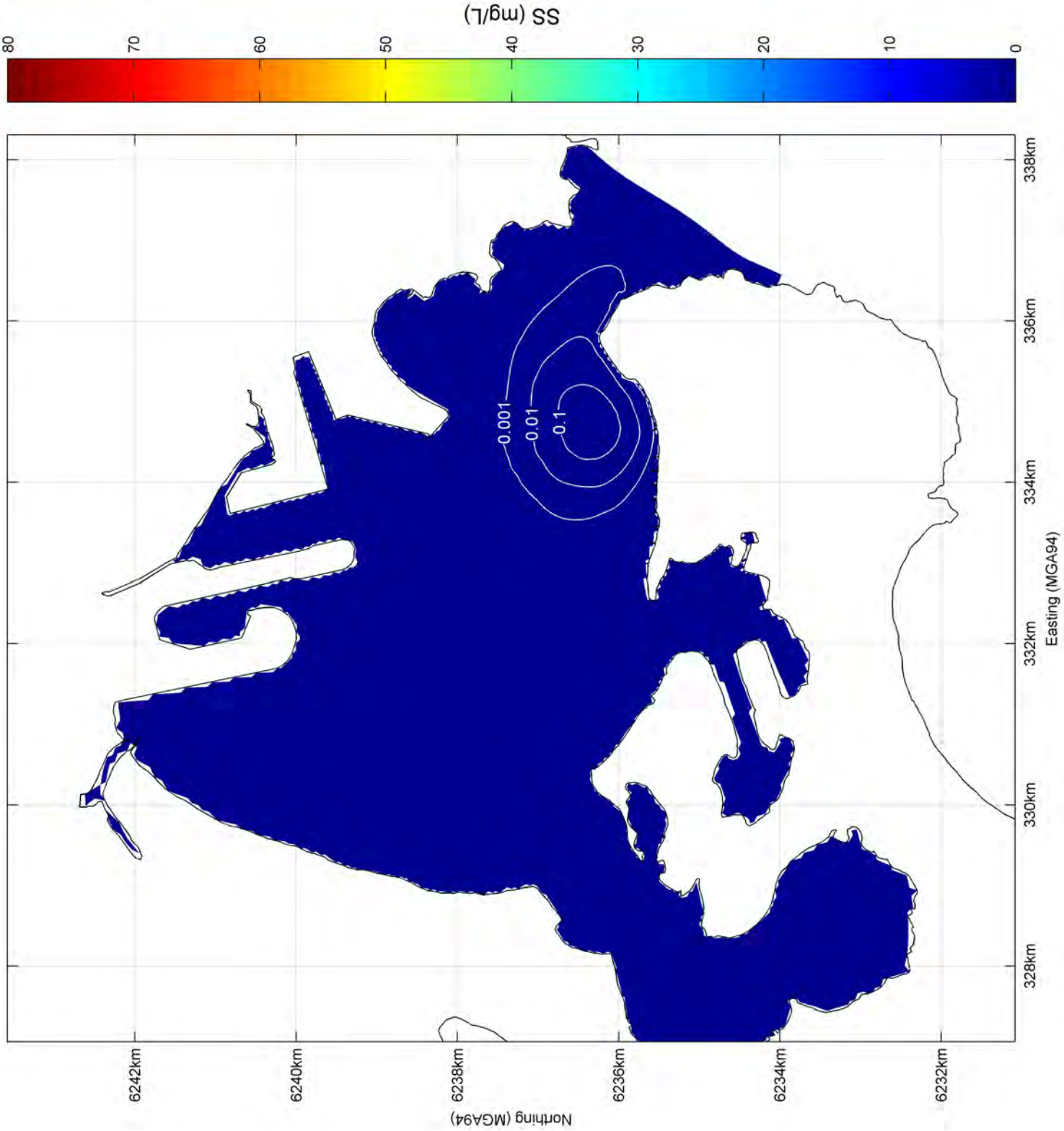
Cardno

Median SS Concentration − Scenario 2 (Dredging of Area 1 − Turning Circle)
Bottom Layer (modelled for January 2012)
Figure 6.25



Kurnell Port and Berthing Facility Upgrade

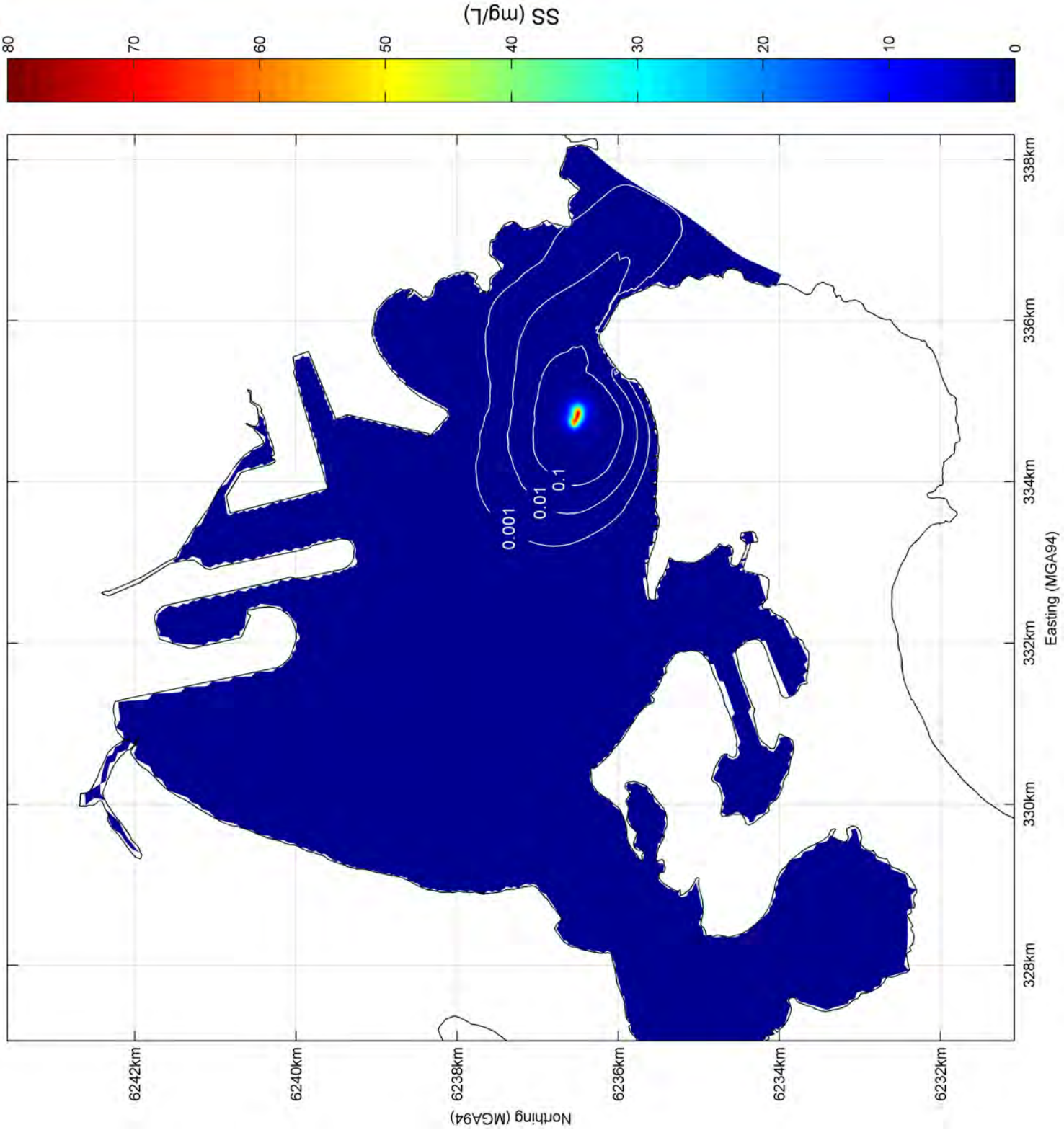
Median SS Concentration − Scenario 3 (Dredging of Area 1 − Approach)
Bottom Layer (modelled for January 2012)
Figure 6.26



Kurnell Port and Berthing Facility Upgrade

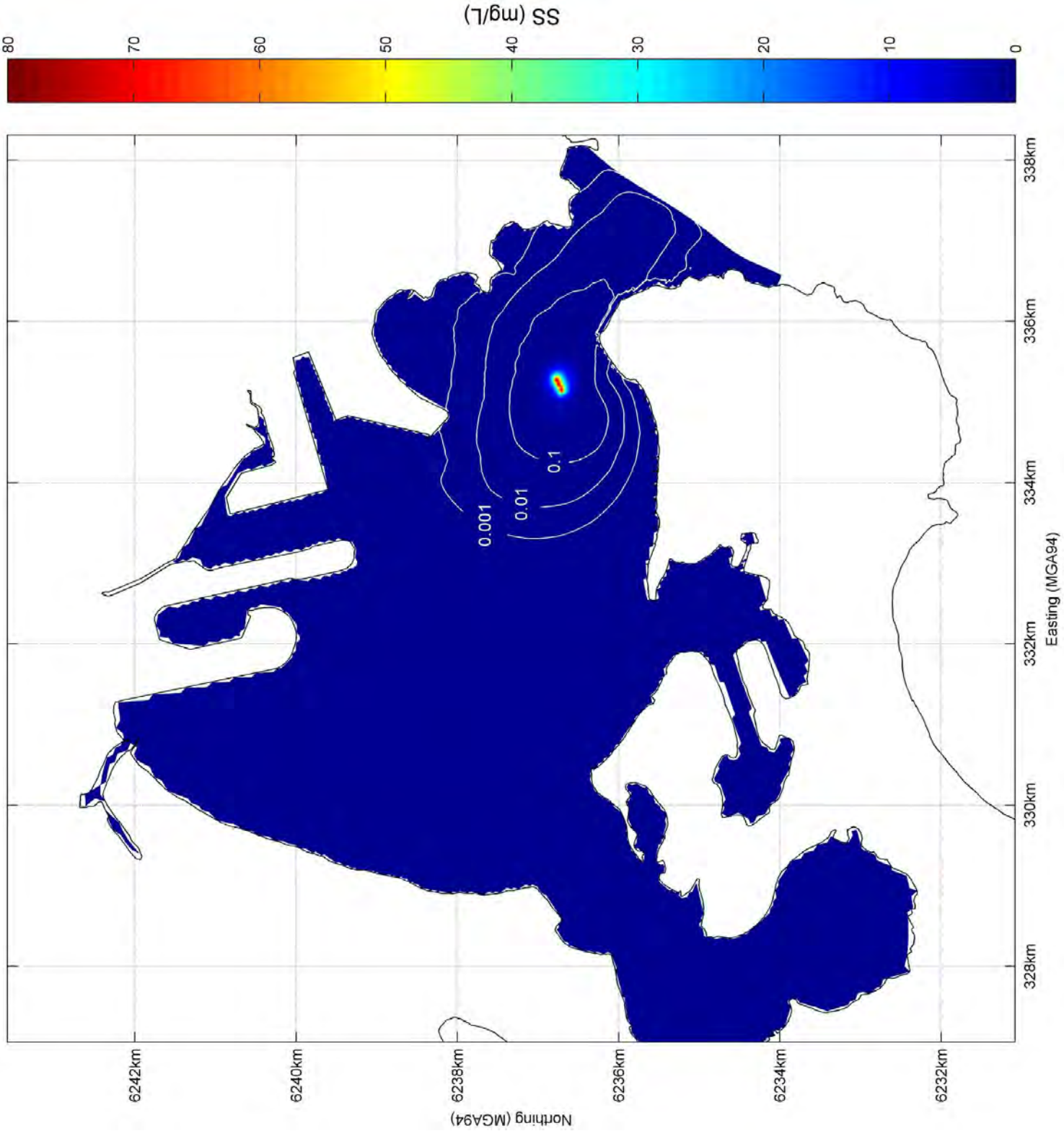
95th %ile SS Concentration − Scenario 1 (Dredging of Area 3 − Berth 1)
Surface Layer (modelled for January 2012)
Figure 6.27

LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures



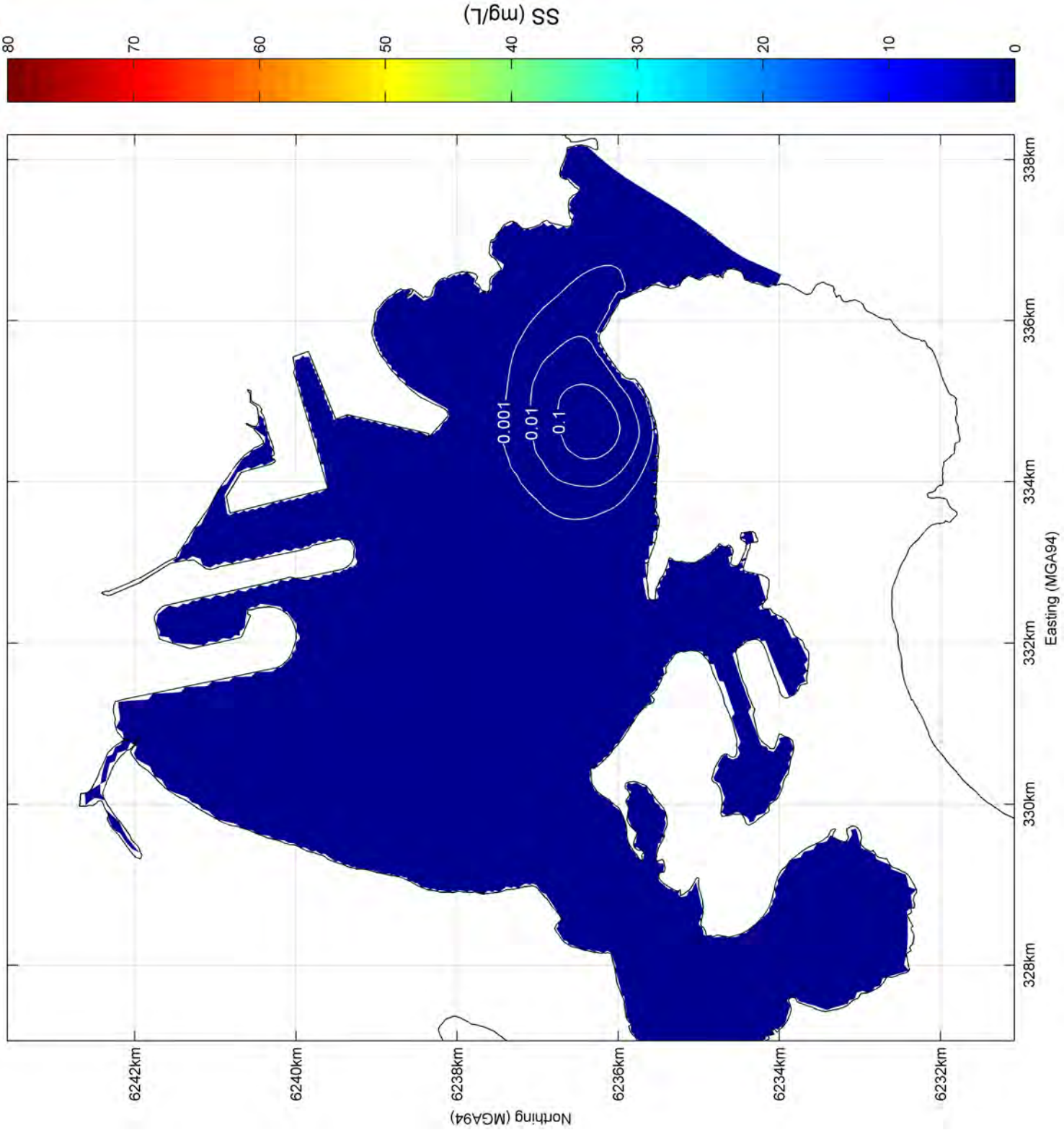
Kurnell Port and Berthing Facility Upgrade

95th %ile SS Concentr. − Scenario 2 (Dredging of Area 1 − Turning Circle)
Surface Layer (modelled for January 2012)
Figure 6.28



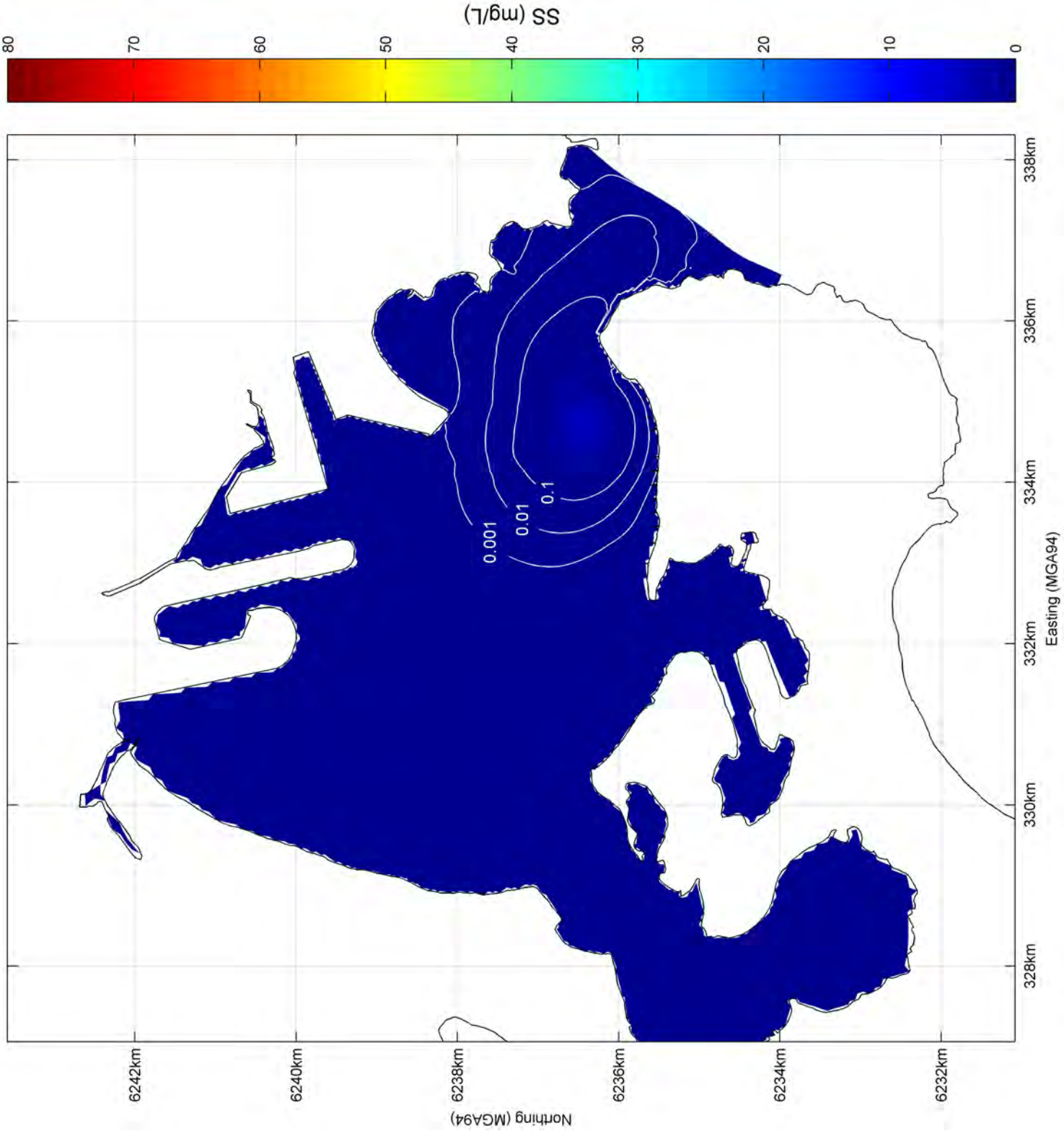
Kurnell Port and Berthing Facility Upgrade

95th %ile SS Concentration − Scenario 3 (Dredging of Area 1 − Approach)
Surface Layer (modelled for January 2012)
Figure 6.29



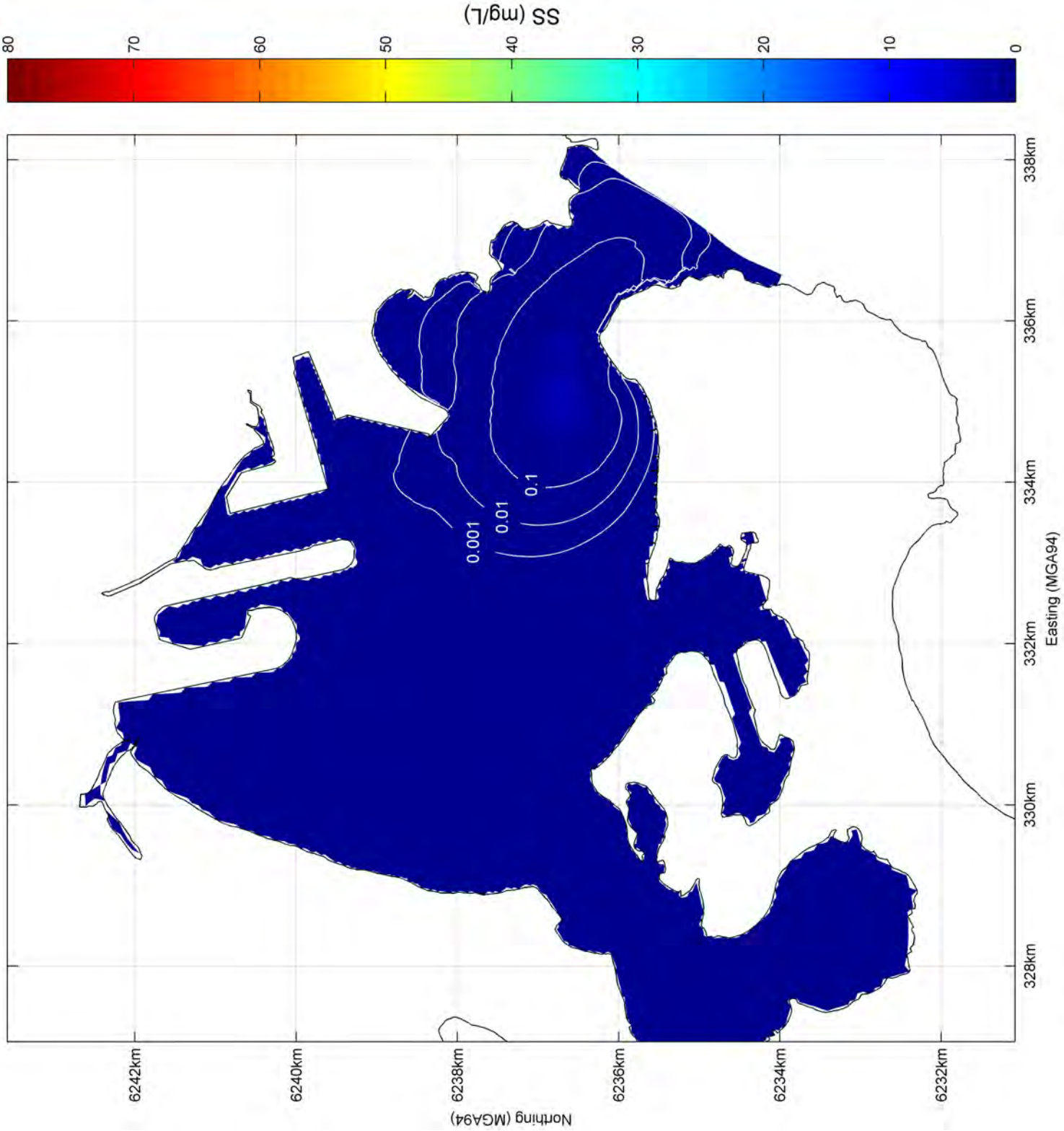
Kurnell Port and Berthing Facility Upgrade

95th %ile SS Concentration − Scenario 1 (Dredging of Area 3 − Berth 1)
Bottom Layer (modelled for January 2012)
Figure 6.30



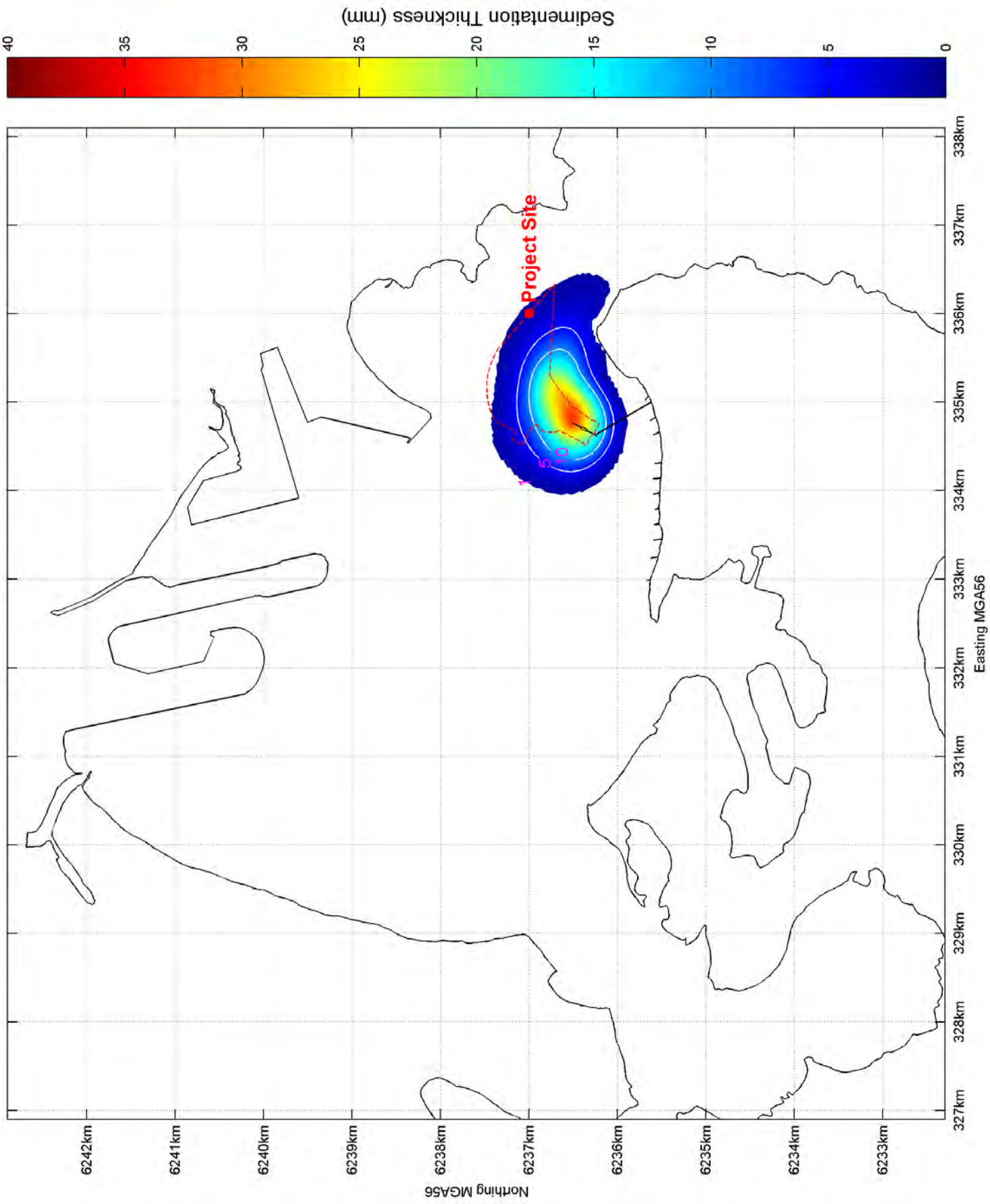
Kurnell Port and Berthing Facility Upgrade

95th %ile SS Concentr. − Scenario 2 (Dredging of Area 1 − Turning Circle)
Bottom Layer (modelled for January 2012)
Figure 6.31



Kurnell Port and Berthing Facility Upgrade

95th %ile SS Concentration − Scenario 3 (Dredging of Area 1 − Approach)
Bottom Layer (modelled for January 2012)
Figure 6.32

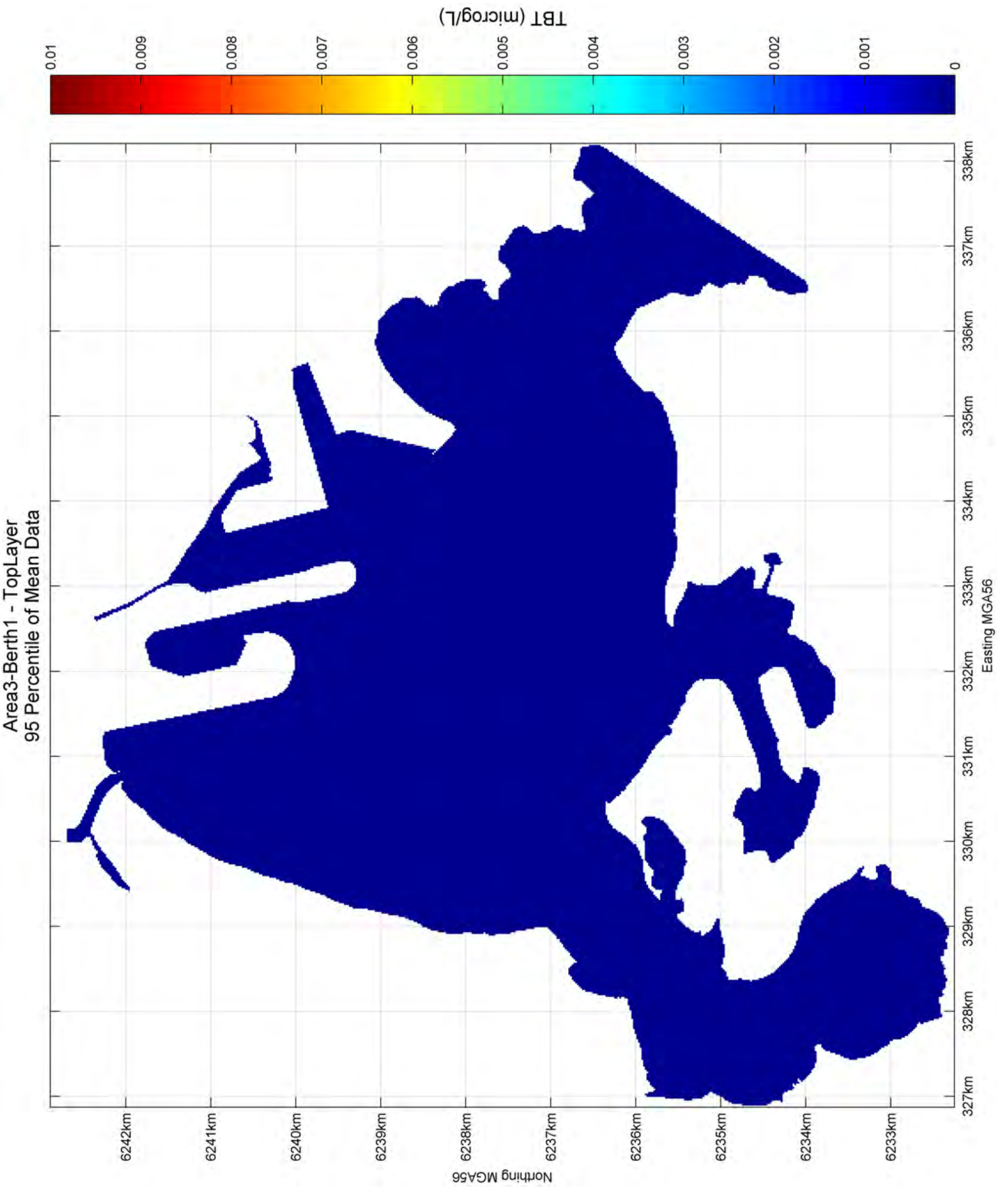


Kurnell Port and Berthing Facility Upgrade

Sedimentation Thickness Post−Dredging
(Modelled for January 2012)
Figure 6.33

Cardno

LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures

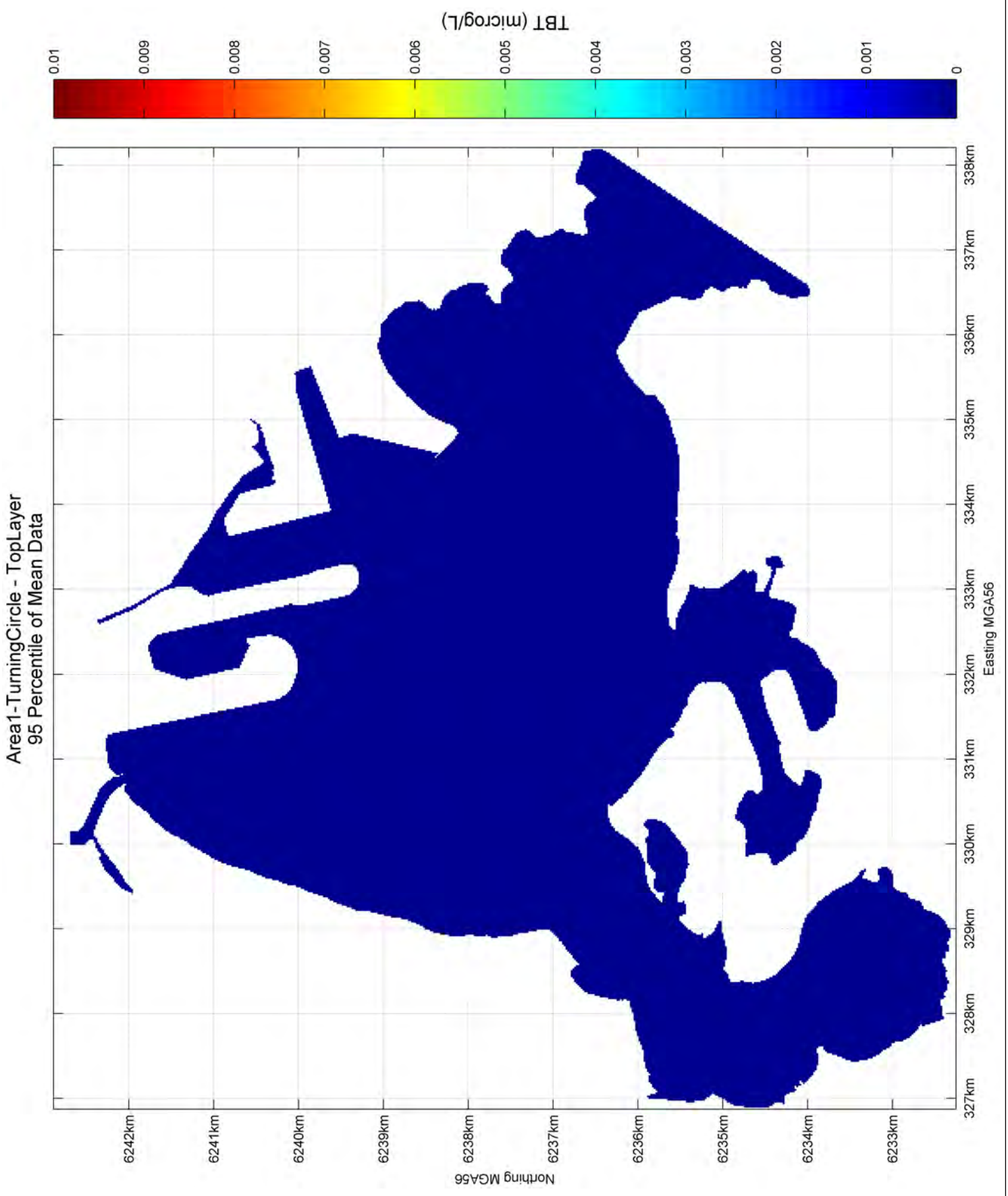


Kurnell Port and Berthing Facility Upgrade

95th %ile Dissolved TBT − Scenario 1 (Dredging of Area 3 − Berth 1)
Surface Layer (modelled for January 2012)
Figure 7.1

Cardno

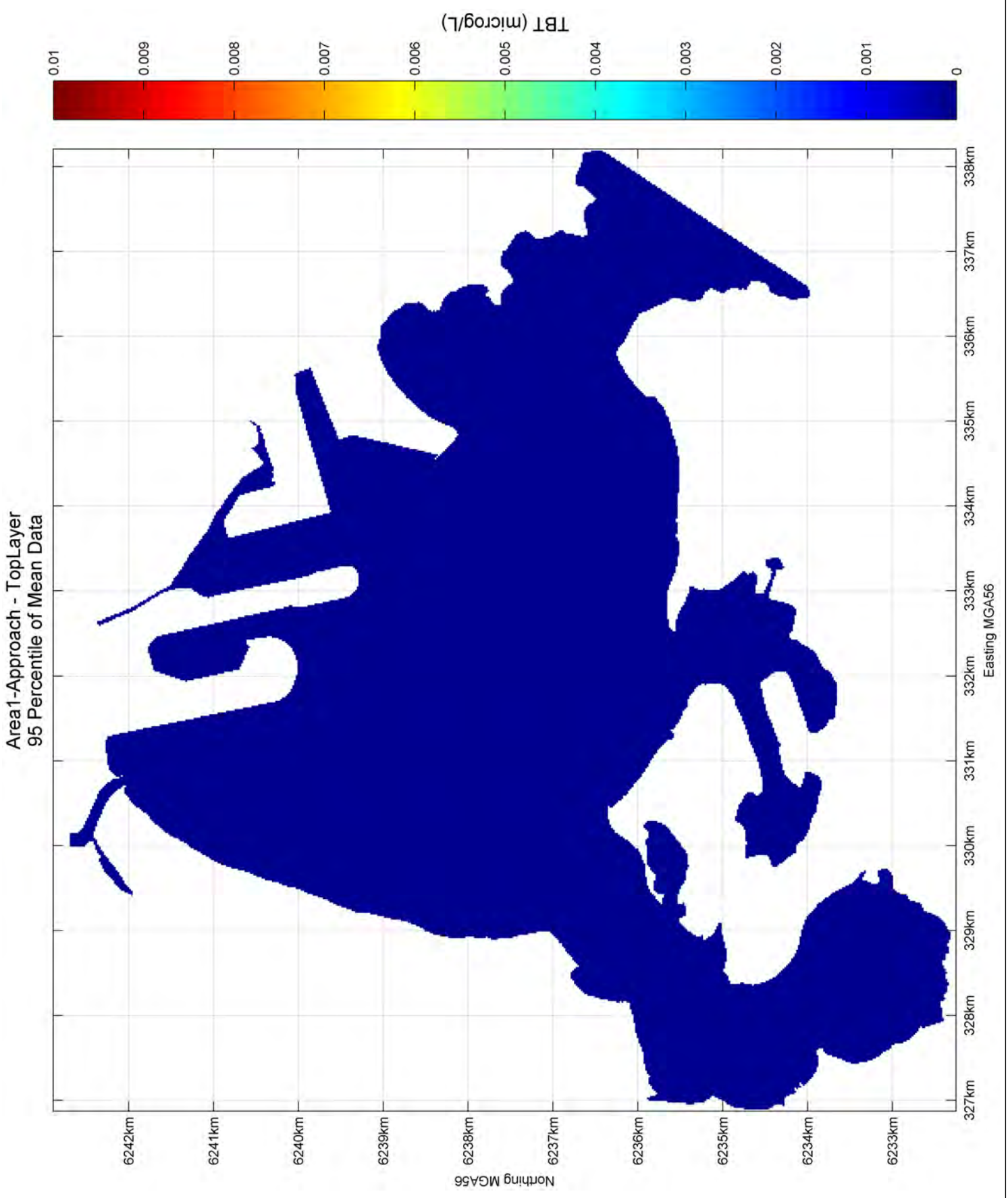
LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures



Kurnell Port and Berthing Facility Upgrade

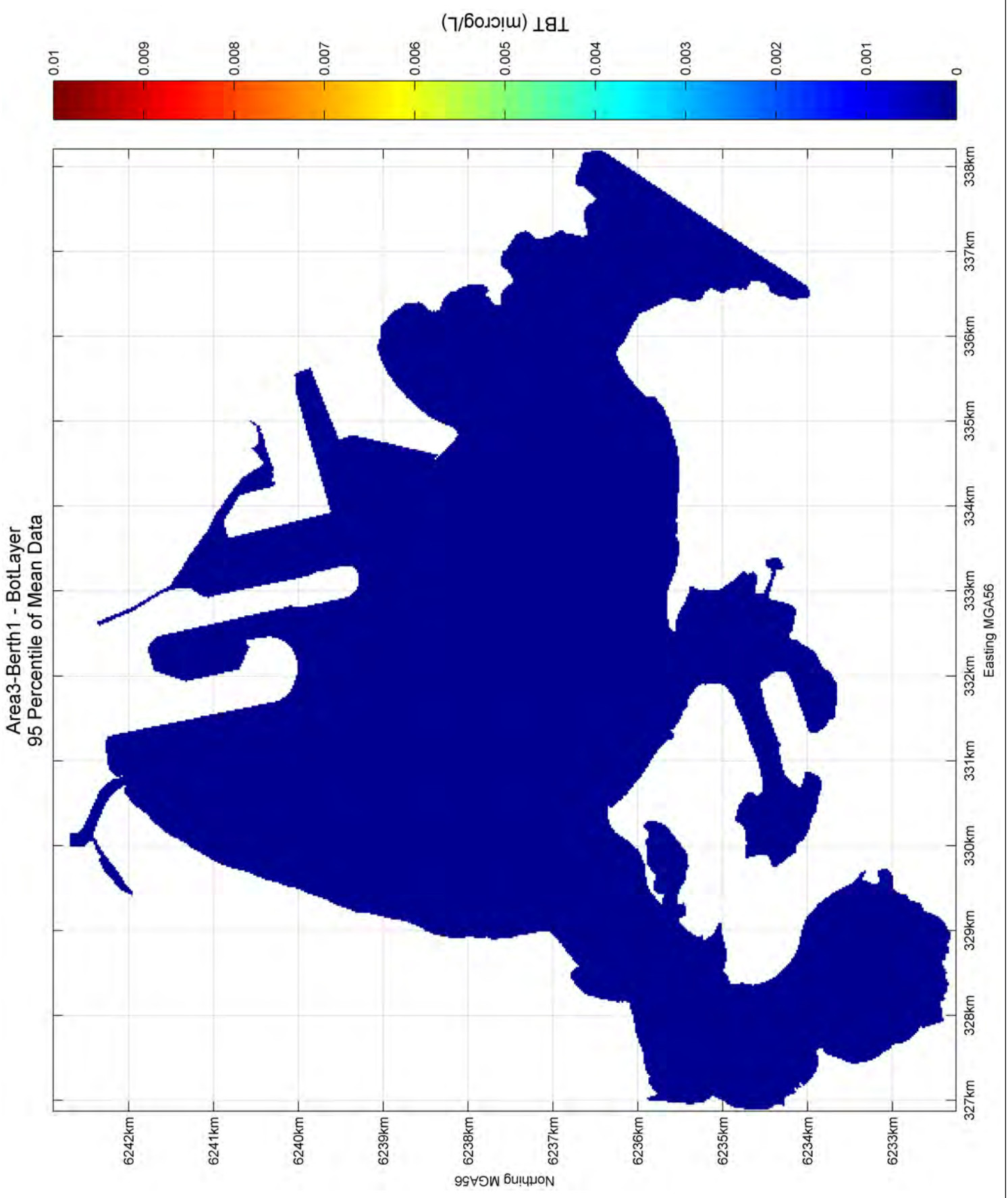
Cardno

95th %ile Dissolved TBT − Scenario 2 (Dredging of Area 1 − Turning Circle)
Surface Layer (modelled for January 2012)
Figure 7.2



Kurnell Port and Berthing Facility Upgrade

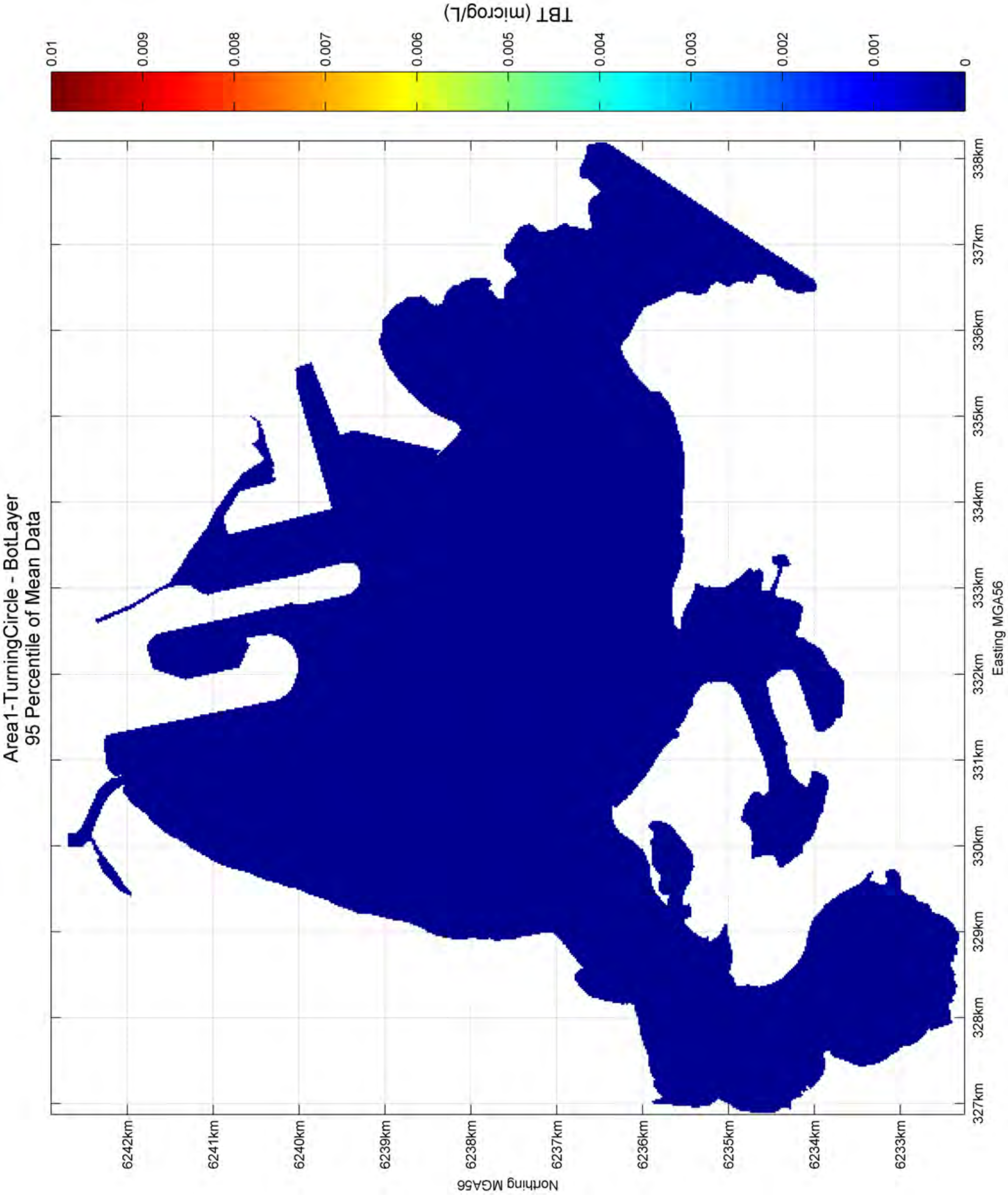
95th %ile Dissolved TBT − Scenario 3 (Dredging of Area 1 − Approach)
Surface Layer (modelled for January 2012)
Figure 7.3



Kurnell Port and Berthing Facility Upgrade

95th %ile Dissolved TBT − Scenario 1 (Dredging of Area 3 − Berth 1)
Bottom Layer (modelled for January 2012)
Figure 7.4

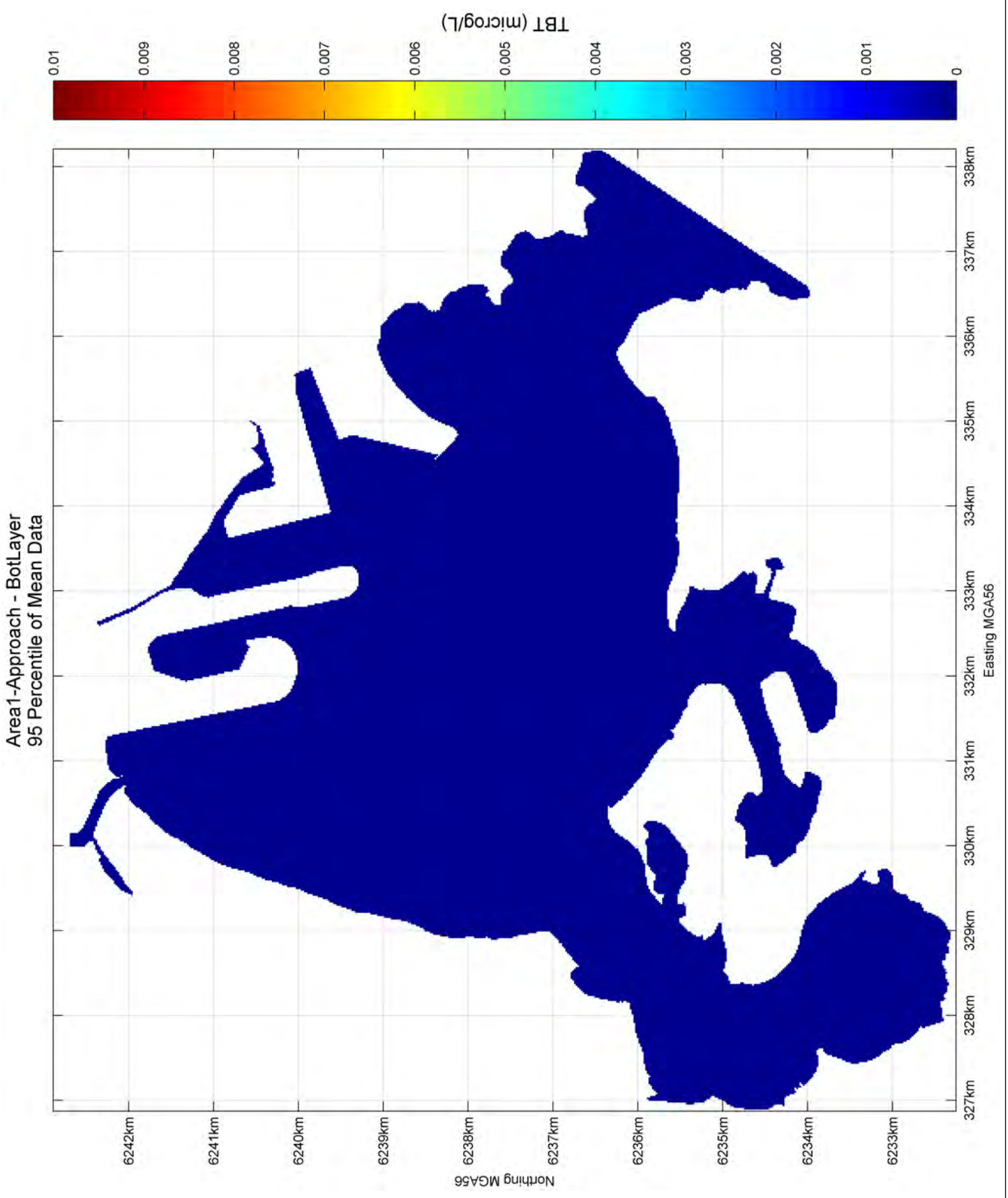
LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures



Kurnell Port and Berthing Facility Upgrade

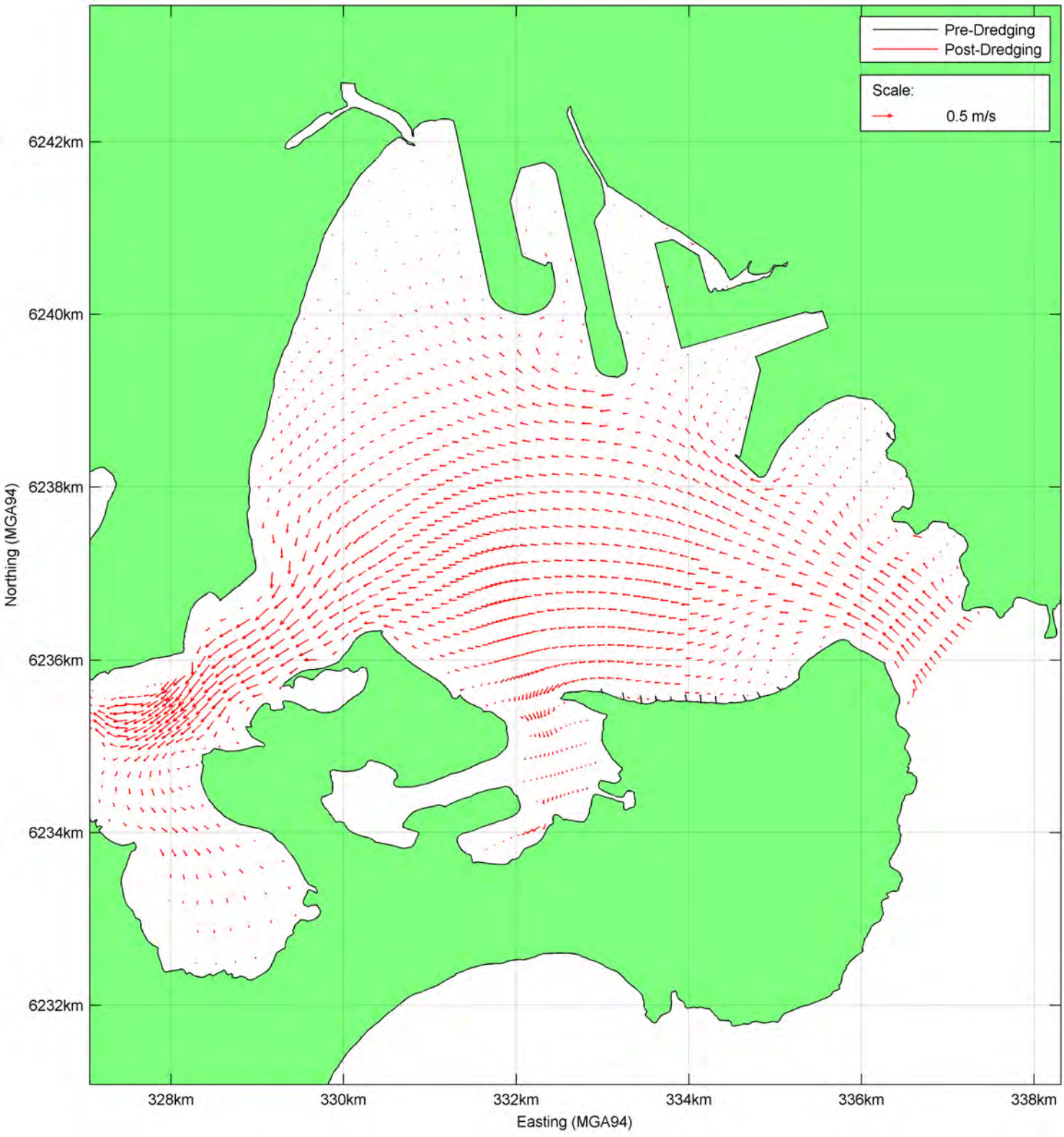
95th %ile Dissolved TBT − Scenario 2 (Dredging of Area 1 − Turning Circle)
Bottom Layer (modelled for January 2012)

Figure 7.5



Kurnell Port and Berthing Facility Upgrade

95th %ile Dissolved TBT − Scenario 3 (Dredging of Area 1 − Approach)
Bottom Layer (modelled for January 2012)
Figure 7.6

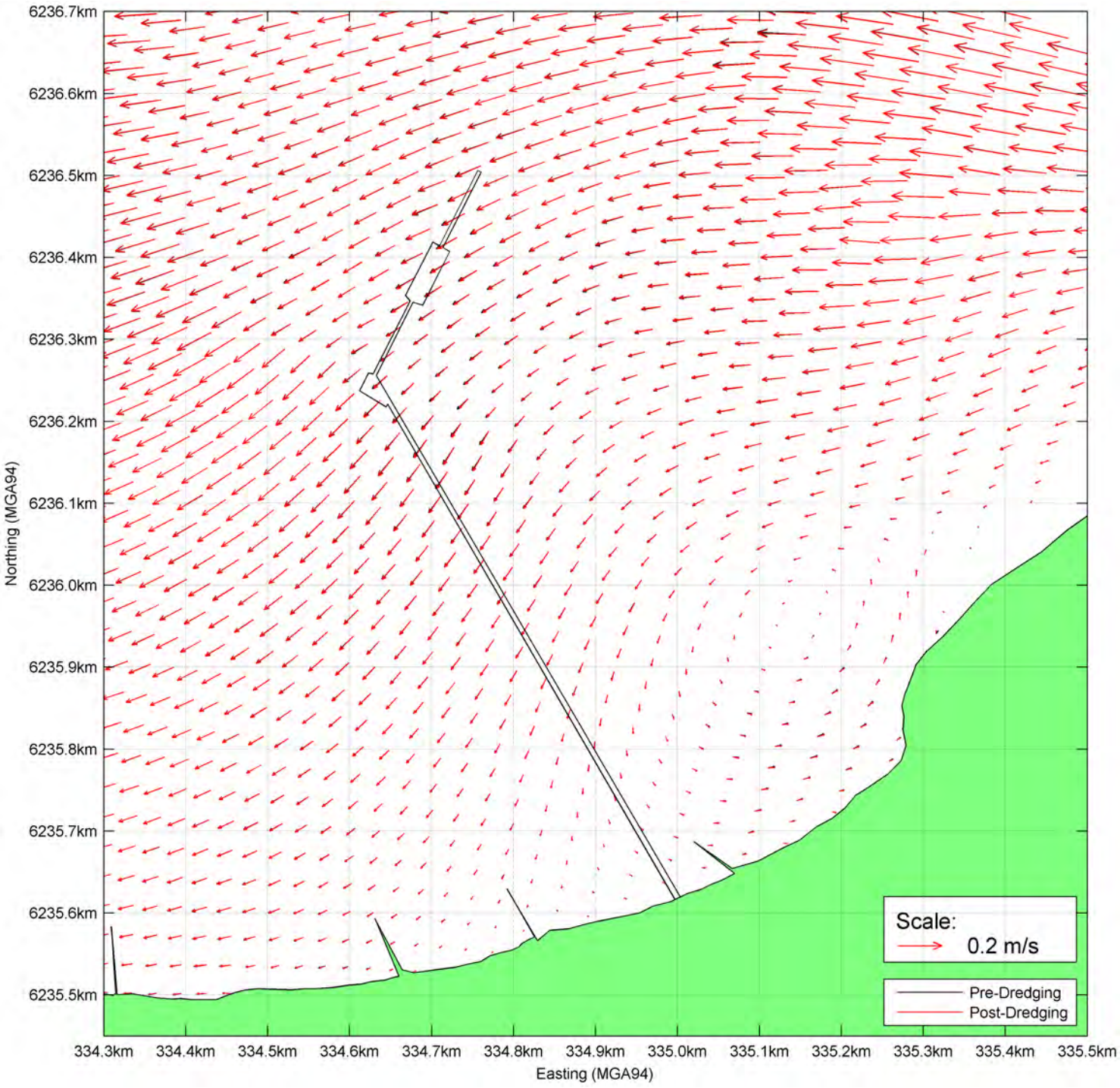


Kurnell Port and Berthing Facility Upgrade

Peak Flood Currents − Botany Bay
Comparison Existing and Developed Case
Figure 8.1

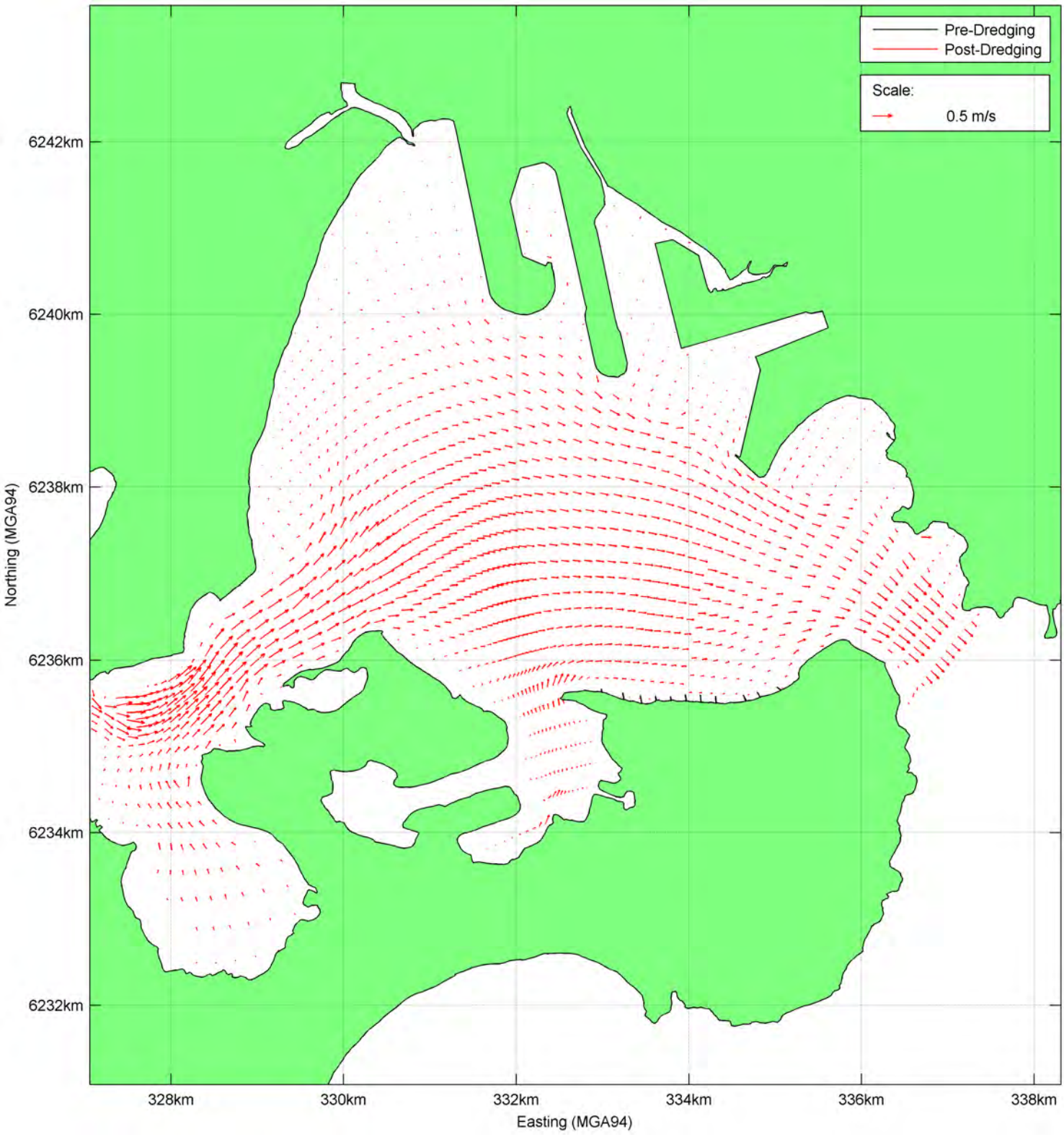
Cardno

LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures



Kurnell Port and Berthing Facility Upgrade

Peak Flood Currents − Caltex Jetty
Comparison Existing and Developed Case
Figure 8.2

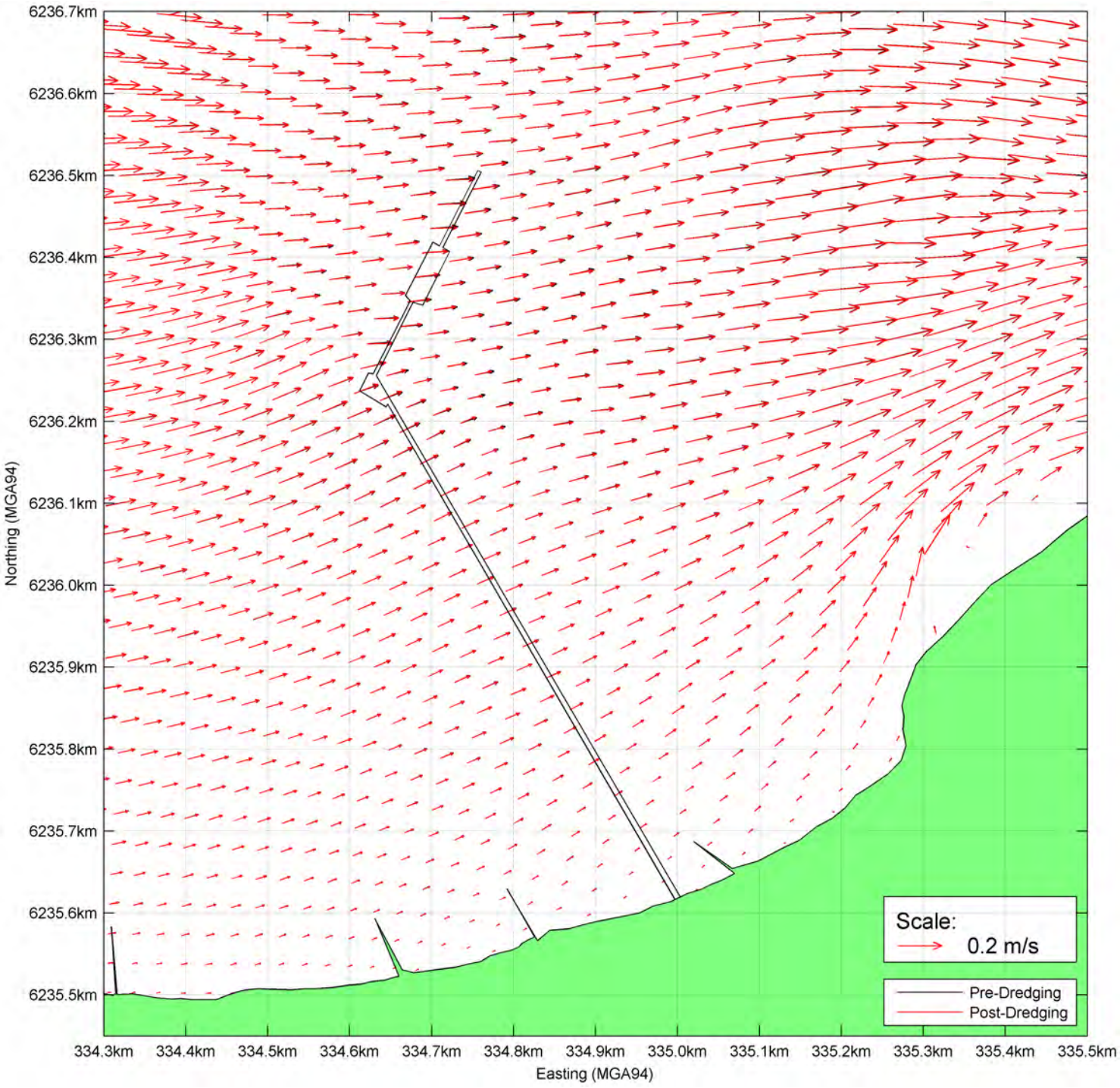


Kurnell Port and Berthing Facility Upgrade

Peak Ebb Currents − Botany Bay
Comparison Existing and Developed Case
Figure 8.3

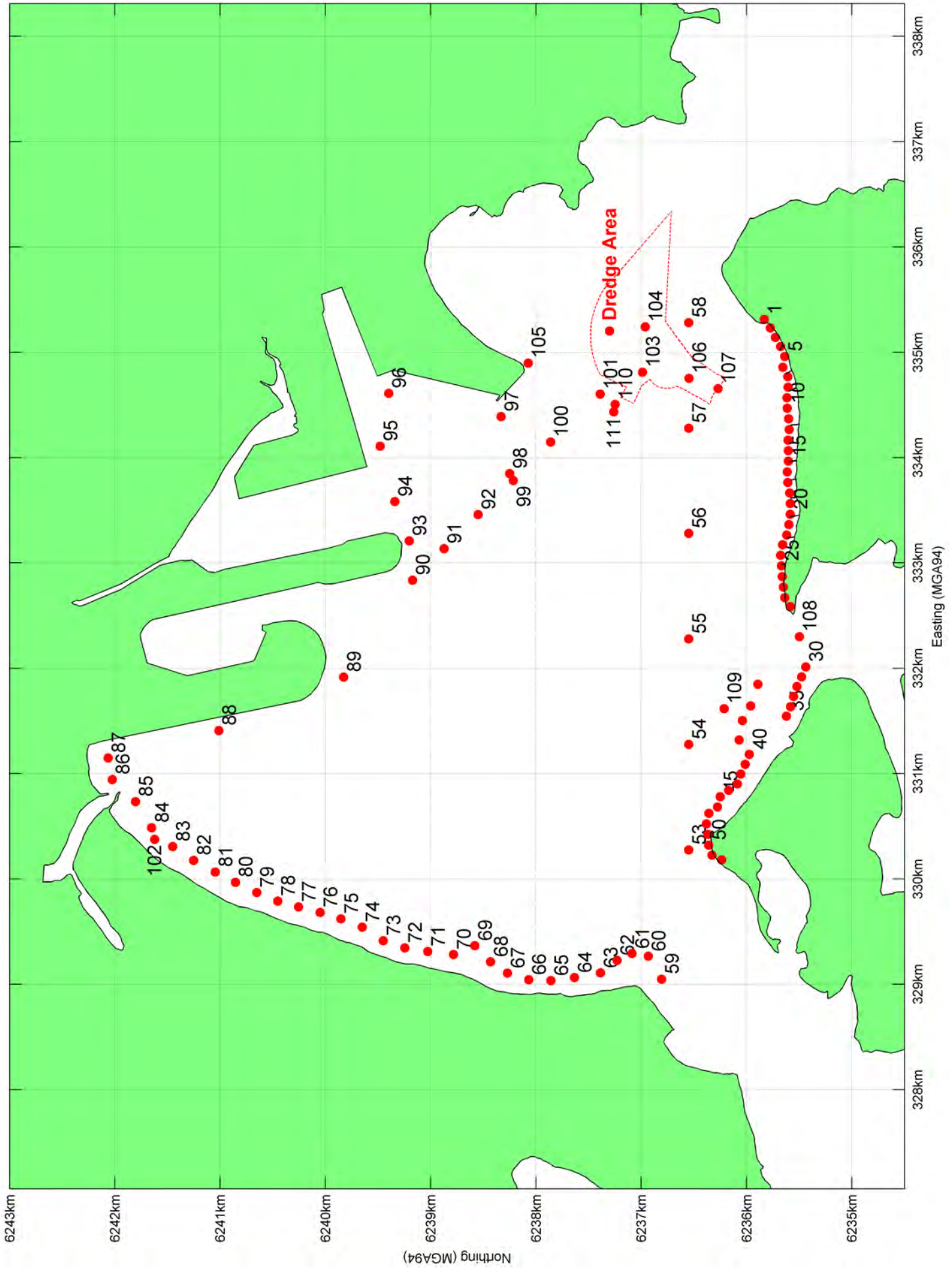
Cardno

LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures



Kurnell Port and Berthing Facility Upgrade

Peak Ebb Currents − Caltex Jetty
Comparison Existing and Developed Case
Figure 8.4

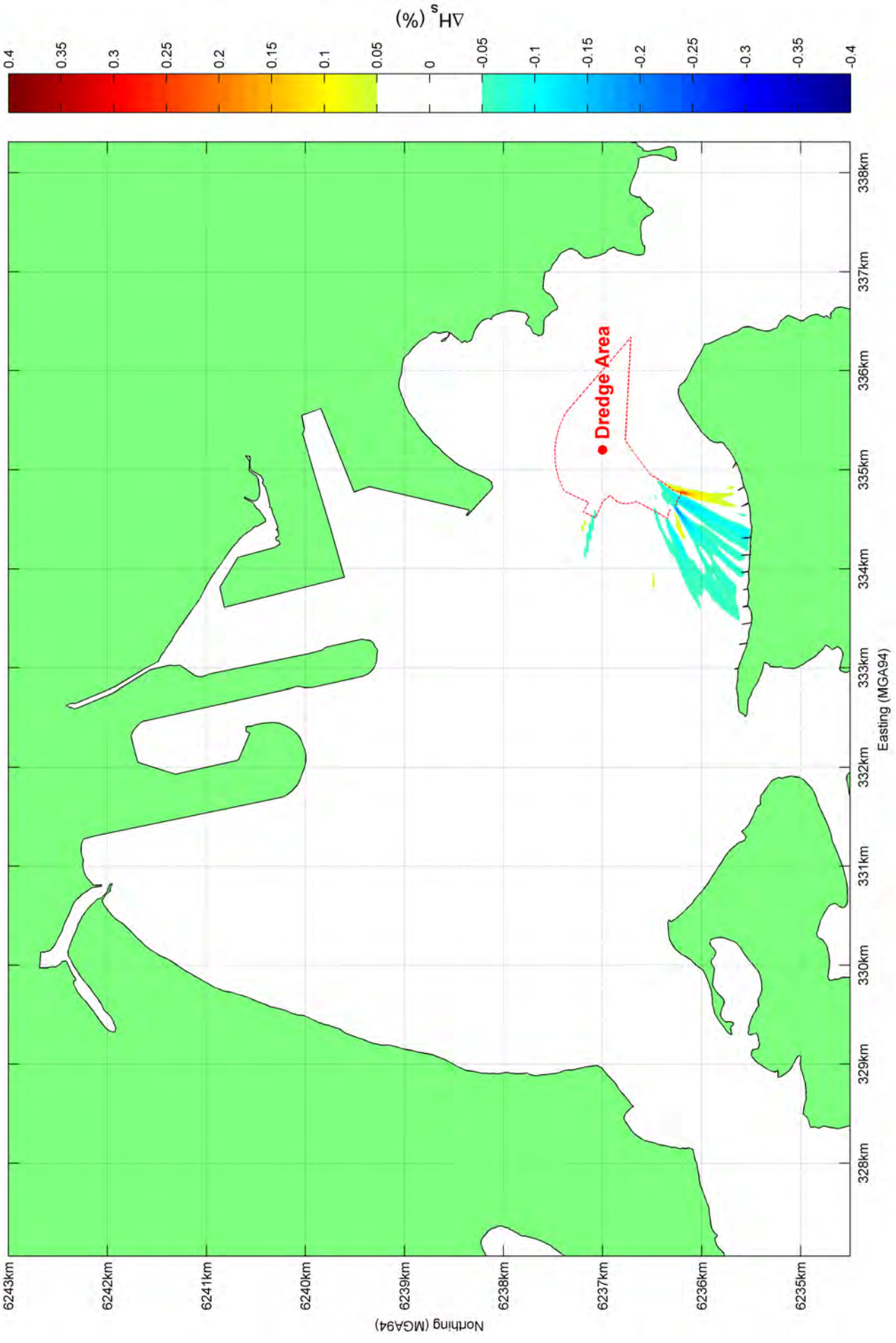


Kurnell Port and Berthing Facility Upgrade

Wave Parameter Output Locations

Figure 9.1

LJ3008/R2774 October 2012
J:\CM\LJ3008-Caltex\009-ReportingDocsandFigures

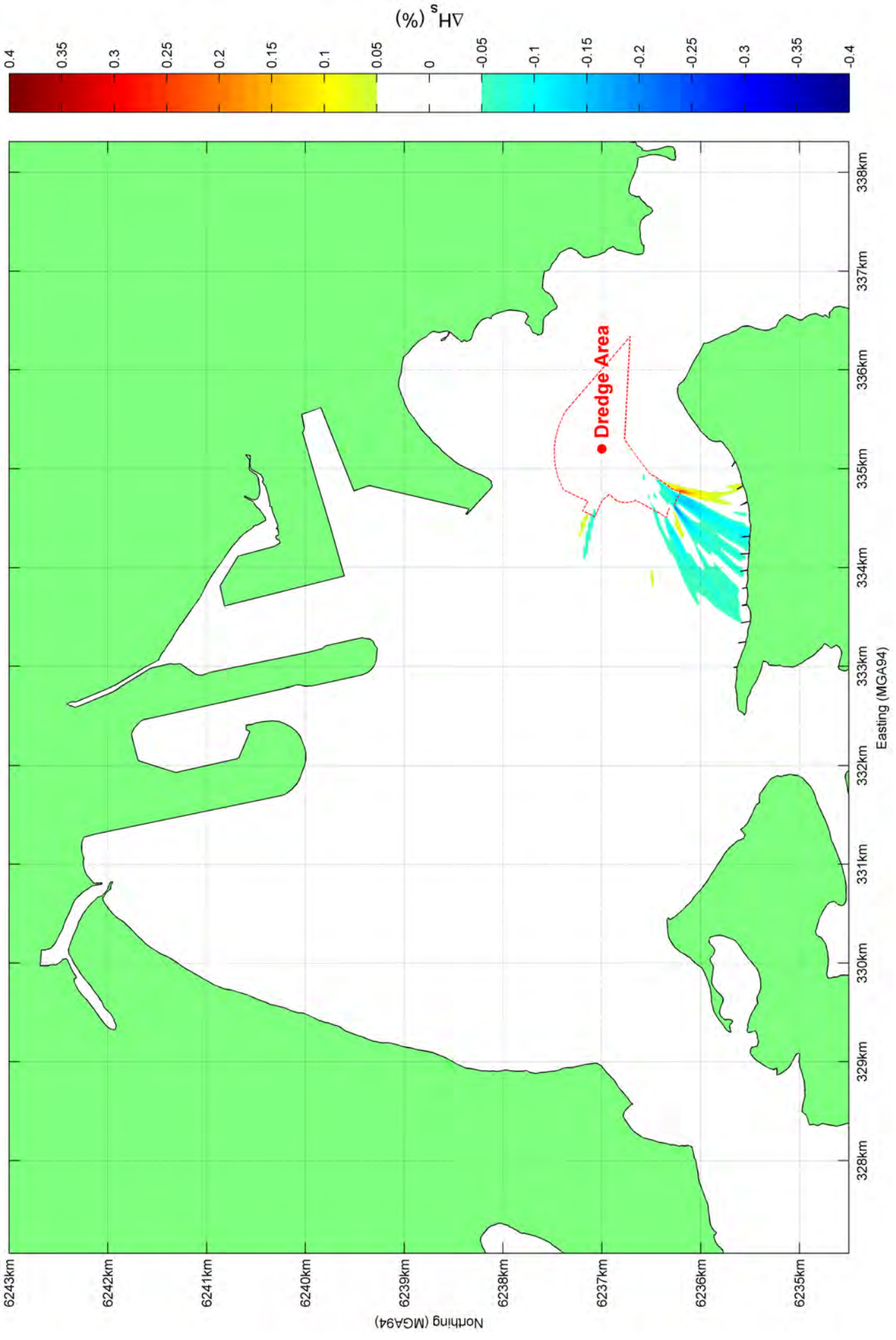


Kurnell Port and Berthing Facility Upgrade

Hs Changes (%)
Offshore Direction: ESE, Period Tz = 8s, WL = −1mAHD
Figure 9.2

Cardno

LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures

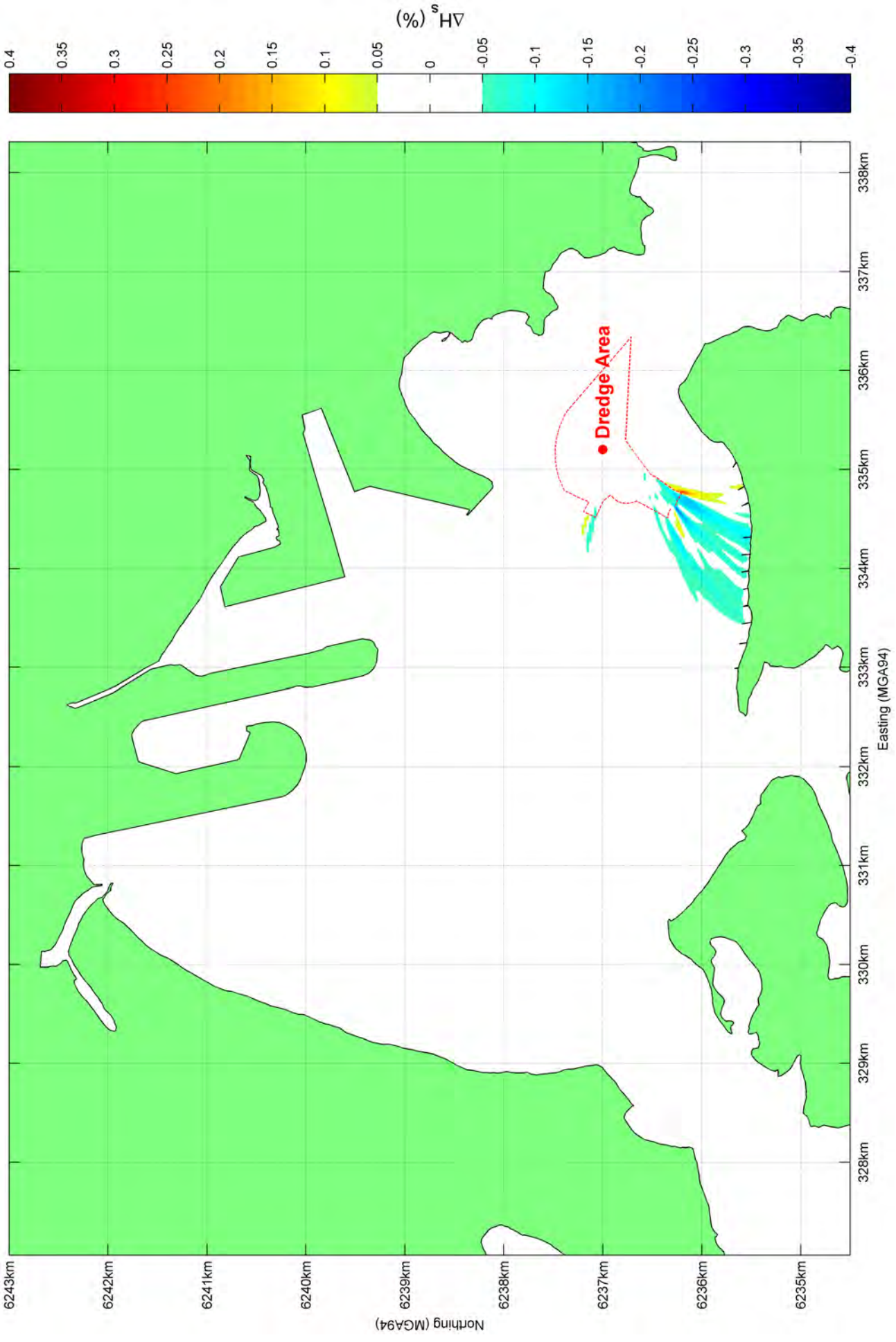


Kurnell Port and Berthing Facility Upgrade

Hs Changes (%)
Offshore Direction: SE, Period Tz = 8s, WL = −1mAHD
Figure 9.3

Cardno

LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures



Kurnell Port and Berthing Facility Upgrade

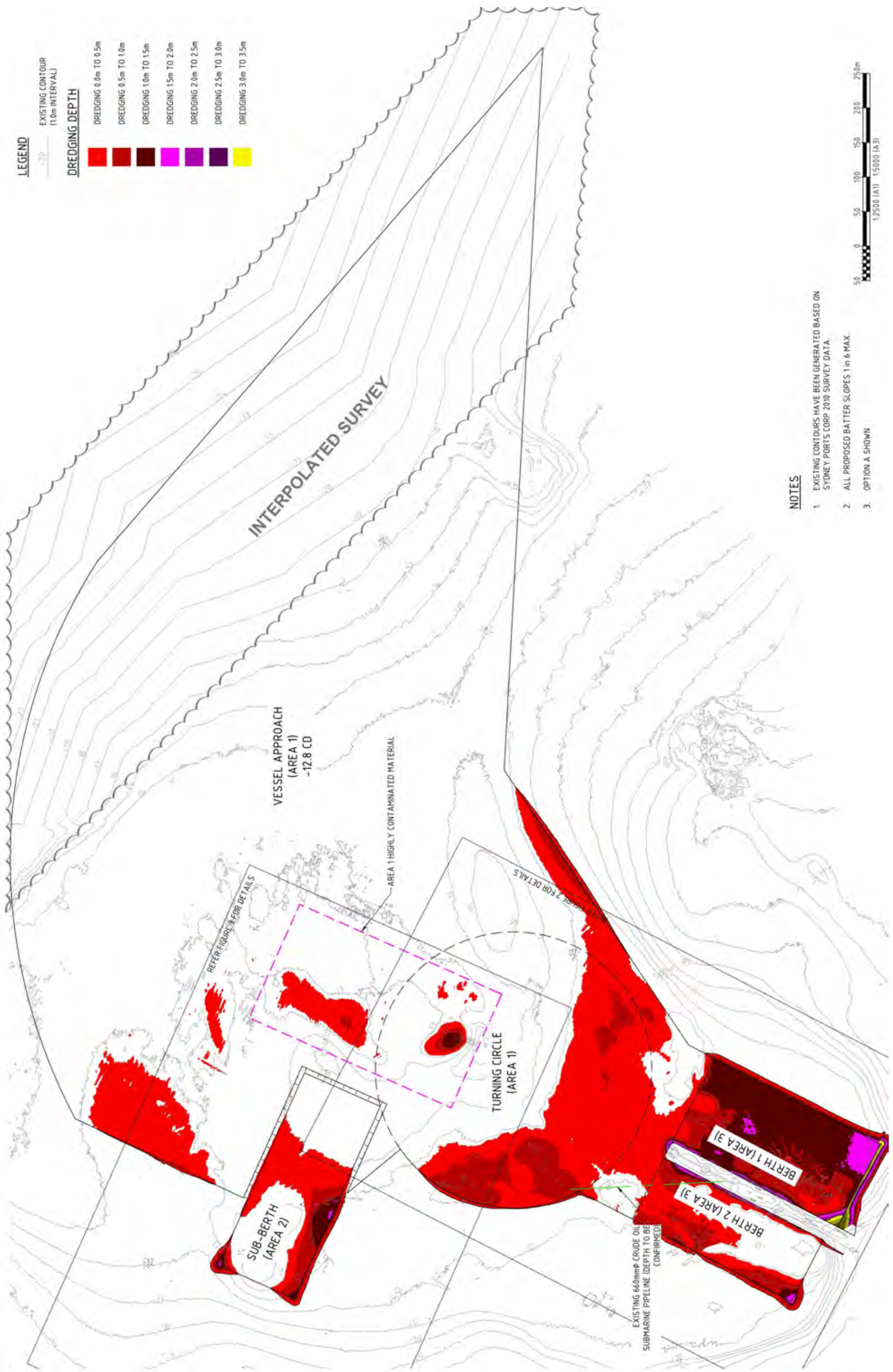
Hs Changes (%)
Offshore Direction: SSE, Period Tz = 8s, WL = −1mAHD
Figure 9.4

Cardno

LJ3008/R2774 October 2012
J:\CM\LJ3008−Caltex\009−ReportingDocsandFigures

Appendix A

Proposed Dredging Areas



Proposed Caltex Dredging of their Marine Operations Area, Botany Bay

Dredge Extent
(Provided by URS)
Figure A.1

Proposed Caltex Dredging of their Marine Operations Area, Botany Bay

Dredge Extent − Fixed Berths Area
(Provided by URS)
Figure A.2

Appendix B

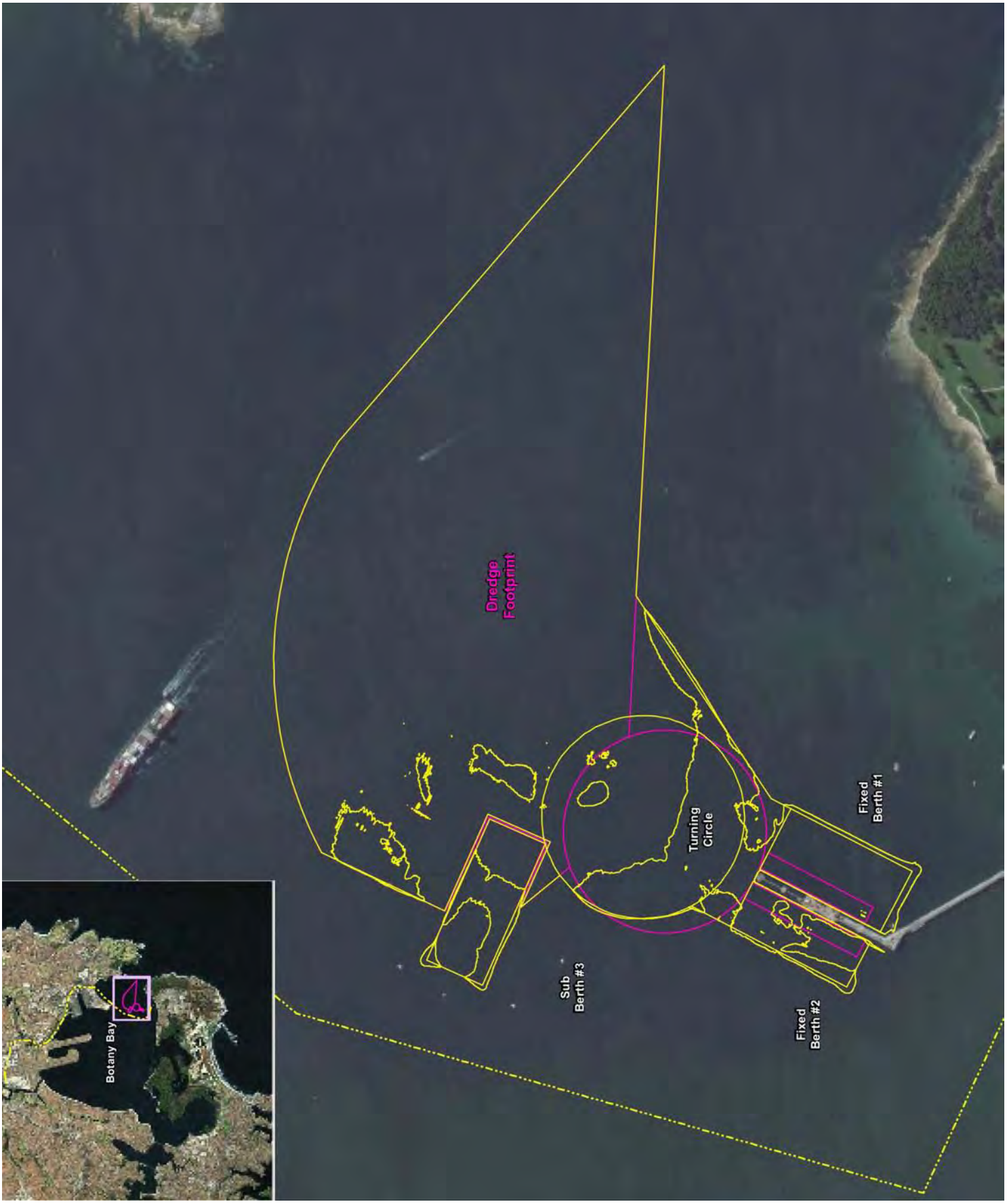
Estimated Dredging Volumes

Table B1 Summary of Dredging Volumes

Location	Required Dredge Depth to CD* (excluding over dredging)	Design Area (m^2)	Required Dredge Volume (m^3)	Additional Dredge Volume to allow for over dredging (m^3)	Total Volume (including over dredging (m^3)
Approaches & Turning Circle	-12.8	98,750	30,500	29,750	60,250
Sub Berth	-14	16,750	7,750	5,000	12,750
Fixed Berths	-12.8	62,500	61,250	18,750	80,000

Appendix C

Outline of Caltex Present and Proposed Operations Area



Proposed Caltex Dredging of their Marine Operations Area, Botany Bay

Dredge Footprint
(Provided by URS)
Figure C.1

Cardno

LJ3008/R2774 September 2012
J:\CM\LJ3008-Caltex\009-ReportingDocsandFigures

Appendix D

Nearshore Wave Parameter Calculation

The quantity of littoral drift along a shoreline is proportional to $T \times He^2 \times \sin 2\Phi$

where T is wave period

He is effective wave-height

Φ is the angle between the shoreline and breaking wave crests

He is a significant or root-mean-square wave-height which must incorporate the description of long term wave occurrence near the shoreline. First, nearshore wave heights were computed using the longterm offshore Botany Bay wave climate and computed wave coefficients, (combined Kr, Ks and Kf). At each nearshore location the log-normal probability of exceedence distribution describing wave climate was prepared for swell waves. He was then calculated from:-

$$He^2 = \Phi H^2 p(H)\, dH$$

where p(H) is the log normal distribution

with the result that

$$He = H_{50}\, e_{\sigma y}^2$$

where H_{50} is the median wave-height defined by the log normal distribution = $(H_{10} \times H_{90})1/2$

$y = \ln(H)$

σy = standard deviation of $y = 1/2.563 \ln (H_{10}/H_{90})$

Weighting factors Eij for coastal process analyses are defined by the wave energy input

$$Eij = Pij \times Heij \times Tj$$

where Pij is probability of the occurrence of waves in direction band i period band j

A similar procedure was applied to local sea analyses. In that case Pij relates to wind speed and direction occurrence.

Weighted mean wave direction, Φm, is estimated from:-

$$\Phi m = \sum Pij \times Hij^2 \, Tj \, \Phi i \; / \; \sum Pij \times Hij^2 \, Tj$$

Appendix E

Physical Processes

General

The purpose of this section is to describe the physical processes that are important to the overall physiography of Botany Bay and any ongoing changes. These processes are:

- Waves
- Currents
- Water Levels
- Winds
- Sediment Transport

A glossary of terms is presented in **Appendix F**.

Wave Processes

Ocean waves that propagate to the study area may have energy in three distinct frequency bands. These are principally related to the generation and propagation of ocean swell (7 to 20 seconds) and local seas (less than 7 seconds), as well as infra-gravity waves. Large waves generated by a storm are generally categorised as wind waves because wind energy is still being transferred to the ocean. However, this distinction was not made in this study for offshore storm waves and they were considered as swell. Long waves (wave periods greater than 25 seconds) in Botany Bay generally occur during storms and are caused by wave grouping (Willoughby & Treloar, 1997). They are generally not important to this study because they do not affect coastal processes, but may affect dredge and barge motions.

Ocean waves are irregular in height and period and so it is necessary to describe wave conditions using a range of statistical parameters. In this study the following have been used:-

- H_{mo} significant wave height (H_s) based on where is the zeroth moment of the wave energy spectrum (rather than the time domain $H_{1/3}$ parameter).
- H_{max} maximum wave height in a specified time period
- T_p wave energy spectral peak period, that is, the wave period related to the highest ordinate in the wave energy spectrum
- T_z average zero crossing period based on upward zero crossings of the still water line (seconds). An alternative definition is based on the zeroth and second spectral moments.

Wave heights defined by zero up-crossings of the still water line fulfil the Rayleigh Distribution in deep water and thereby provide a basis for estimating other wave height parameters from $H_{1/3}$. In shallow water, that is, within Botany Bay, significant wave height defined from the wave spectrum, H_{mo}, is normally larger (typically 5% to 8%) than $H_{1/3}$ defined from a time series analysis.

Ocean waves also have a dominant direction of wave propagation and directional spread about that direction that can be defined by a Gaussian or generalised cosine ($\cos^n$) distribution (amongst others), and a wave grouping tendency. Directional spreading causes the sea surface to have a more short-crested wave structure in deep water. Directional spread is reduced by refraction as waves propagate into the shallow, near shore regions and the wave crests become more parallel with each other and the seabed contours. Although neither of these characteristics is addressed explicitly in this study, directional spreading was included in the numerical wave modelling work.

Waves propagating into shallow water may undergo changes caused by refraction, shoaling, bed friction, wave breaking and, to some extent, diffraction.

Wave refraction is caused by differential wave propagation speeds. That part of the shoreward propagating wave which is in the more shallow water has a lower speed than those parts in deeper water. When waves approach a coastline obliquely these differences cause the wave fronts to turn and become more coast parallel. Associated with this directional change there are changes in wave heights. On irregular seabeds, wave refraction becomes a very complex process. Waves propagating over steep sided seabed slopes at a small angle to the seabed alignment, such as proposed in this project, undergo a spatially rapid refraction process.

Waves propagating shoreward develop reduced speeds in shallow water. In order to maintain constancy of wave energy flux, (ignoring energy dissipation processes) their heights must increase. This phenomenon is termed shoaling and leads to a significant increase in wave height near the shoreline.

A turbulent boundary layer forms above the seabed with associated wave energy losses that are manifested as a continual reduction in wave height in the direction of wave propagation; leaving aside further wind input, refraction, shoaling and wave breaking. The rate of energy dissipation increases with greater wave height and reducing depth.

Wave breaking occurs in shallow water when the wave crest speed becomes greater than the wave phase speed. For irregular waves, this breaking occurs in different depths so that there is a breaker zone rather than a breaker line. Seabed slope, wave period and water depth are important parameters affecting the wave breaking phenomenon. As a consequence of this energy dissipation, wave set-up (a rise in still water level caused by wave breaking), develops shoreward from the breaker zone in order to maintain conservation of momentum flux. This rise in water level increases non-linearly in the shoreward direction and allows larger waves to propagate shoreward before breaking. Field measurements have shown that the slope of the water surface is normally concave upward. Wave set-up at the shoreline can be in the order of 15% of the equivalent deep-water significant wave height. Lower set-up occurs in estuarine entrances, but the momentum flux remains the same. Wave set-up is smaller where waves approach a beach obliquely, but then a longshore current can be developed. Wave grouping and the consequent surf beats also cause fluctuations in the still water level.

In a random wave field, each wave may be considered to have a period different from its predecessors and successors and the distribution of wave energy is often described by a wave energy spectrum. In fact, the whole wave train structure changes continuously and individual waves appear and disappear until quite shallow water is reached and dispersive processes are reduced. In developed sea states, that is swell, the Bretschneider modified Pierson-Moskowitz spectral form has generally been found to provide a realistic wave energy description. For developing sea states the JONSWAP spectral form, which is generally more 'peaky', has been found to provide a better spectral description. Long waves have very irregular spectral forms.

For structural design in the marine environment it is necessary to define the H_{max} parameter related to storms having average recurrence intervals (ARI) of a pre-determined number of years. However, the expected H_{max}, relative to H_s in statistically stationary wave conditions, increases as storm/sea state duration increases. Based on the Rayleigh Distribution the usual relationship is:-

$$H_{max} = H_s \sqrt{0.5 \ln Nz}$$

where Nz is the number of waves occurring during the time period being considered, where individual waves are defined by T_z

ln is the natural logarithm.

This relationship has been found to overestimate H_{max} by about 10% in severe ocean storms. In shallow water the relationship is not fulfilled. In very shallow water H_{max} is replaced by the breaking wave height, H_b.

Waves propagating through an area affected by a current field are caused to turn in the direction of the current. The extent of this direction change depends on wave celerity, current speed and relative directions. Wave height is also changed. Opposing currents cause wave lengths to shorten and wave heights to increase and may lead to wave breaking. When the current speed is greater than one quarter of the phase speed, the waves are blocked. Conversely, a following current reduces wave heights and extends wave lengths.

Within Botany Bay, flood and ebb tidal currents will move wave energy focal points, but will be generally similar for the Existing and post-dredging cases.

Currents

Currents within Botany Bay are caused by a range of phenomena, including: -

- Astronomical Tides
- Winds
- River Discharges
- Coastal Trapped Waves and Other Tasman Sea Processes
- Near Shore Wave Processes
- Density Flows

The astronomical tides are caused by the relative motions of the Earth, Moon and Sun, see **Section 3.4**. The regular rise and fall of the tide level in the sea causes a periodic inflow (flood tide) and outflow (ebb tide) of oceanic water to the Bay and mixed oceanic and bay/river water from the Bay to the sea. A consequence of this process is the generation of tidal currents. The volume of sea water that enters the Bay or leaves the Bay on flood and ebb tides, respectively, is termed the tidal prism; which varies due to the inequality between tidal ranges. The tidal prism is affected by changes in inter-tidal areas, such reclamations, but not by dredged areas below low tide, such as navigation channels and trenches.

Wind forcing is applied to the water surface as interfacial shear, the drag coefficient and consequent drag force varying with wind speed. Momentum from the wind is gradually transferred down through the water column by vorticity, the maximum depth of this effect being termed the Ekman depth. At the surface, wind caused currents are in the direction of the wind, but in the southern hemisphere they gradually turn to the left of the wind direction until they flow in the opposite direction at the Ekman depth. Botany Bay is too shallow for this condition to develop fully and wind driven currents are affected by the seabed boundary layer and contours. Wind driven currents diminish with depth. Because wind forcing is applied at the water surface, the relative effect is greater in shallow water where there is less water column volume per unit plan area. Therefore, wind driven currents are greater in more shallow areas. Maximum surface current speed is in the order of 1% to 3% of the wind speed, depending on water depth. Where water is piled up against a coastline by wind forcing, a reverse flow develops near the seabed.

Density currents may be caused by freshwater inflows, for example, when the Georges River is in flood. The freshwater is more buoyant and tends to spread across the Bay surface until mixing with the ambient seawater occurs.

Coastal Trapped Waves (CTW) are long period wave phenomena that propagate northward along the continental shelf, Freeland et al, (1986). These waves are irregular and cause approximate coast parallel currents and variations in water levels. They are trapped on the continental shelf by refraction and the Coriolis force – hence their wave heights are largest at the coastline. CTW are known to occur on the continental shelf of NSW and will affect observed water levels and currents in the Sydney – Botany Bay region.

The propagation of ocean waves (swell) into the near shore region leads to wave breaking and energy dissipation. Where waves propagate obliquely to the shoreline this process leads to the generation of a longshore current in the surf zone, and to some extent seaward of that line. These currents are of some importance to shoreline processes in the Bay generally. Wave breaking and subsequent wave run-up are discussed further in **Section 3.4**.

Water Levels

Water level variations in the Bay and at the coastline result from one or more of the following natural causes:-

- Tides
- Wind Set-up and the Inverse Barometer Effect

- Wave Set-up
- Wave Run-up
- Fresh Water Flow
- Tsunamis
- Greenhouse Effect
- Global Changes in Meteorological Conditions

Tides are caused by the relative motions of the Earth, Moon and Sun and their gravitational attractions. While the vertical tidal fluctuations are generated as a result of these forces, the distribution of land masses, bathymetric variation and the Coriolis force determine the local tidal characteristics.

In addition, the drop in atmospheric pressure, which accompanies severe meteorological events, causes water to flow from high pressure areas on the periphery of the meteorological formation to the low pressure area. This is called the 'inverse barometer effect' and results in water level increases up to 1cm for each hecta-Pascal (hPa) drop in central pressure below the average sea level atmospheric pressure in the area for the particular time of year, typically about 1010 hPa. The actual increase depends on the speed of the meteorological system and 1cm is only achieved if it is moving slowly. The phenomenon causes daily variations from predicted tide levels up to 0.05m. The combined result of wind set-up and the inverse barometer effect is called storm surge. When the meteorological event tracks over water at a speed equal to the long wave celerity, resonance may occur and the inverse barometer effect can be bigger than the normal inverse barometer effect. This process is included in the storm tide data prepared for the Sydney region.

Wave run-up is the vertical distance between the maximum height a wave runs up the beach or a coastal structure and the still water level, comprising tide plus storm surge. Additionally, run-up level varies with surf-beat, which arises from wave grouping effects. Wave set-up is implicitly included in wave run-up.

Tsunamis are caused by sudden crustal movements of the Earth and are commonly, but incorrectly, called 'tidal waves'. They are very infrequent and unlikely to occur during a storm and so have not been included in this study. Nevertheless, in the context of events having recurrence intervals in the order of 100 years, one should keep this phenomenon in mind. They can cause sudden and significant currents that affect berthed ships.

Tidal planes derived from long-term records at Fort Denison, Sydney Harbour, are shown in **Table D.1**, (Manly Hydraulics Laboratory, 1992). Tidal planes for Botany Bay and the study area are similar to those for Sydney Harbour, (MSB Sydney Ports Authority, 1993). Tides in Botany Bay are semi-diurnal, that is, there are two high and two low tides each day, normally. On rare occasions there may be only one high or low tide because the lunar tidal constituents have a period of about 25 hours. There may also be a significant diurnal difference, that is, a significant difference between successive high tides and successive low tides.

Table E-1 Tidal Planes for Botany Bay

Tidal Plane	Water Level	
	m LAT	m AHD
Mean High Water Springs (MHWS)	1.61	0.69
Mean High Water Mark (MHWM)	1.48	0.56
Mean High Water Neaps (MHWN)	1.36	0.44
Mean Sea Level (MSL)	0.93	0.01
Mean Low Water Neaps (MLWN)	0.54	-0.39
Mean Low Water Springs (MLWS)	0.29	-0.64

Table E.2 presents extreme water levels for typical Average Recurrence Intervals (ARI), also derived from the Fort Denison water level records (MSB Sydney Ports Authority, 1993). These levels exclude wave set-up and relate to locations seaward of the breaker zone.

Table E-2 Extreme Water Levels (Offshore)

Average Recurrence Interval (years)	Water Level	
	m LAT	m AHD
20	2.26	1.34
50	2.35	1.43
100	2.37	1.45

Winds

Wind affects both the wave and current climates in Botany Bay. Wind data has been recorded at Sydney Airport since 1939, Moneypenny et al (1997).

The location and effects of airport development have changed since then. From 1939 to 16 August, 1994, a Dines anemometer was used to record 10-minute averages of wind speed and direction.

Since the early 1960's, at least, this anemometer was located on a 10m mast near the intersection of the east-west and north-south runways.

Recommended WMO clearances from buildings and other obstructions were maintained. During its period of service, the Dines anemometer was maintained well.

Since 16 August, 1994, wind data at the airport has been recorded using a Synchrotac anemometer installed on a 10m mast near the threshold of the main north-south runway, which is more exposed than the previous Dines anemometer site.

Analyses of these wind records (Monypenny and Middleton, 1997) showed that there had been a gradual error (reduction) in wind speed recorded by the Dines anemometer. This reduction amounted to 2.6m/s by August, 1994. Monypenny and Middleton (1997) advise that a simplified linear adjustment be made to Sydney airport wind speeds up to 16 August, 1994 and this adjustment was made for this study.

Appendix G presents a description of wind speed and direction joint occurrence at Mascot. Note that calms occur for about 17% of the time.

Local wind waves will not be affected by the proposed Caltex dredging works because fetch lengths would not be changed and very little depth change would occur.

Sediment Transport - Coastal Stability

The near shore and shoreline regions of Botany Bay are formed from marine sands and rocky headlands, with some muddy areas in the more sheltered regions such as Quibray and Woolooware Bays, and a small area within the recently formed Penrhyn Estuary. Additionally, the perimeters of some existing development works provide hard-edge areas.

The principal shoreline features of the Bay near Caltex operations are Silver Beach and Bonna Point at Kurnell, Towra Beach, and peninsula, and Lady Robinsons Beach. Most of the features of this area have formed over the last 10,000 years of the Holocene period, (Roy and Crawford, 1979) during a period of sea level rise. Relative to that period, sea level is now stable. However, natural changes to the near shore area continue and are caused by storm waves, especially when they occur during periods of higher water level.

Development in Botany Bay since European settlement has caused other wave climate related changes.

- *Silver Beach* - this area is now protected from storm erosion by a groyne field, with the more protected eastern end near Captain Cook's Landing Place remaining in a more natural state. The western-most end at Bonna Point and the entrance to Quibray Bay are also in a nearly natural state. Generally, these groynes have functioned satisfactorily for nearly forty years and small changes in wave height and direction on Silver Beach will have no effect on the shoreline.
- *Towra Beach* is a very dynamic area and long-term changes to this area are continuing as a result of natural processes and the effects of previous development work in the Bay. Changes are also occurring to the western trunk of the peninsula. Detailed investigations reported in Sydney Ports Authority (1993) describe shore normal surveys that have been undertaken since 1972 and which have been analysed to determine the rates of beach erosion there. Generally, Towra Beach is receding at about 1 to 2m/year as a result of natural and present development causes. The shore normal surveys continue to the present – once or twice per year. Changes on the beach are irregular and are caused mainly by storm events accompanied by high tides. Previous dredging works in Botany Bay have caused small changes in wave direction and height at Towra Beach, thereby causing changes in the sediment transport regime.
- *The Georges River* enters south-west Botany Bay near Dolls Point. The tidal flow has incised a wide, shallow entrance waterway that has steep sides in some areas. It has inter-acted with wave processes to form the Taylor Bar spit at Dolls Point.

- *Lady Robinsons Beach* extends from north to south along the western shoreline of the Bay. Significant changes have occurred to that shoreline since European settlement and the development of port and airport facilities in the Bay. However, SPC have managed the construction of groyne fields along southern Lady Robinsons Beach up to just south of President Avenue. These works include continuing planned re-nourishment of the area north of the northern-most groyne, as shoreline recession may occur there. Generally, south of about President Avenue, sediment transport has been caused by swell, whereas wind-wave action is more important near Kyeemagh, especially since construction of the two north-south runways and entrance dredging for Port Botany. There is a null point near Pasadena Street in Monterey - south of that general location, long shore transport is southward, and north of that point, long shore transport is northward. Generally, these groynes are functioning satisfactorily and small changes to wave conditions that affect individual groyne compartments are unlikely to have any deleterious effect. A number of beach nourishment programmes were undertaken from the 1970s until the groynes were completed in about 2004.

Sediment transport is caused by the water particle motions of waves and currents that lead to a shear stress on the seabed sediment particles. In some parts of the Bay waves and currents cause combined shear stresses. Generally, sediment motion commences when the seabed shear stress exceeds a threshold value, which depends on particle size and density. Sediment may be transported as bed load or suspended load. Bed load transport is effected as a series of saltations or hops. Suspended sediment transport occurs when the turbulent mixing of the flow counteracts the fall velocity of the finer sediment particles that disperse upward from the seabed.

Where a seabed is disturbed, for example, by dredging, and where the threshold condition for sediment movement is exceeded, wave and current caused sediment transport may act to restore the pre-condition of the seabed. Experience based on historical hydrographic surveys has shown that in Botany Bay, other than at near shore locations, the bed of the Bay is essentially stable under natural forcing.

At shoreline locations sediment transport may be alongshore and/or onshore/offshore. Where waves break obliquely to the shoreline, a longshore current may cause longshore transport. Offshore transport normally occurs during a storm, with a longer term onshore transport following storm abatement. However, post-storm onshore transport may not occur in very low wave energy regions such as that near Kyeemagh. These regions are characterised by a flat inter-tidal area with a steep drop-off near the low tide line.

Waterways that enter the Bay may transport fine silt particles from the catchments to the Bay. These fine particles eventually settle in the most sheltered regions of the Bay, or leave the Bay to sea.

Dredging would cause re-suspension of seabed sediments, mainly the finer fractions, which are likely remain in the water column near the seabed. Using a back-hoe dredge as is planned for the work would see the bucket head drawing most of the finer sediments to the surface and into the barge and there would be minimal suspended sediment to cause a plume. However, some suspended sediment production will occur near the seabed and significantly more when overflow from the barge occurs.

Climate Change Issues

For the purposes of this study, the regional coastal projections of climate change are discussed under the following sub-headings:

- Sea level rise (SLR);
- Wind;
- Frequency of extreme events; and
- Adopted climate change scenarios.

Sea Level Rise

At the regional scale, sea levels can be influenced by variations in ocean currents and in the atmosphere due to different wind regimes McInnes et al*.,* (1998). Coastal responses to SLR can be highly variable and often unpredictable, and are greatly influenced by the local geomorphology. Temporary flooding/inundation associated with storm systems is generally short duration, due to the infrequent and large-magnitude nature of these events, as well as the dependence of these processes on tide level, which varies from high to low water over 6 hours. On the other hand, the cumulative erosion and inundation of presently affected sites that would be associated with global SLR or land subsidence processes would be of longer duration and may be associated with low-magnitude events. Although the magnitude of future SLR may be relatively small in isolation, where severe storms coincide with elevated sea levels, wave attack and storm surge will result in significant effects on presently and newly vulnerable coastal areas.

Research into the long term SLR estimates for Australia indicates that the rate of SLR is slightly less than the global average. Church et al (2006) analysed two of Australia's longest tide gauge records: Fort Denison, Sydney, and Fremantle, in Western Australia. That study determined that the local SLR from 1950 to 2000 was 1.3 (± 0.5) mm/year, compared with a global average of 1.8mm/year. The difference is primarily to be due to the more frequent and intense El Niño events that have occurred since the mid-1970's, which caused lower sea-levels around Australia Holper et al, (2005).

The NSW OEH, in planning for climate change, have produced a Sea Level Rise Policy Statement DECCW, (2009a) that sets SLR planning benchmarks of 40cm by 2050 and 90cm by 2100 (relative to 1990 mean sea levels). These benchmarks are derived from both IPCC projections and CSIRO research. The manner in which they were calculated incorporates a range of variables, as shown in **Table E.3**. The SLR component is derived from the IPCC SRES A1F1 climate change scenario due to the fact that, in the last decade, the observed global average of sea level from satellite data is tracking along the upper bound of the Intergovernmental Panel on Climate Change (IPCC) projections.

Table E.3: Water Level Components of SLR Planning Benchmarks (after DECCW, 2009a and b)

Component	2050	2100
SLR	30 cm	59 cm
Accelerated ice melt	(included above)	20 cm
Regional SLR variation	10 cm	14 cm
Rounding*	-	-3 cm
Total	***40 cm***	***90 cm***

OEH's SLR Policy has been given statutory effect through SEPP71 – Coastal Protection and through a Ministerial Direction to local councils under Section 117 of the *Environmental Planning and Assessment Act 1979*. The *Sea Level Rise Policy Statement* (DECCW, 2009a) supersedes the 1988 NSW Coastline Hazard Policy. Most objectives from that policy have been included in the NSW Coastal Policy 1997, which remains current. Other objectives from the 1988 NSW Coastline Hazard Policy are updated by the Sea Level Rise Policy Statement.

Wind

At present, the prevailing winds in the Botany Bay area are from the south-east during the winter months and from the north-east and east during the summer months. During the day, sea breezes dominate (Hazelwood, 2007).

CSIRO (2007) undertook a climate change study for NSW and concluded that predictions relating to wind changes for the state contained large uncertainty in most seasons. In general, mean wind-speed projections showed a tendency for increases across much of the state in summer, with decreases in wind from the north-east. In autumn, there was a tendency towards weaker winds from the south and east, and stronger winds from the north-west. In winter, increases in winds were from the north-west and south, with wind speeds decreasing elsewhere. Lastly, there was a general tendency for stronger winds to occur in spring across the state.

Extreme winds have similar patterns to mean wind speed changes in summer and autumn, although the magnitudes of the changes are larger; particularly over the continent due to frictional effects. In winter, the ocean region in the south of NSW showed a tendency for increasing extreme winds with only the north-east of NSW indicating decreasing winds Hennessy et al *(* 2004).

Frequency of Extreme Events

There is no current consensus on the effect of climate change on coastal storms in the Botany Bay region of NSW. While the IPCC (2007) warns of a potential increase in the frequency and intensity of coastal storms and cyclonic events, recent studies, for example, CSIRO (2007) and McInnes et al, (2007) present climate change predictions that indicate both increased and decreased wind speeds along the NSW coast, depending on the model and/or climate change scenario applied.

Botany Bay is not located in an active tropical cyclone region and even studies that predict the largest increase in the southern extent of the east Australia cyclone region due to climate change processes do not predict cyclones off the region within the next 50 to 100 years (CSIRO, 2007).

Of more importance for this area is the potential change in east coast low (ECL) event frequency and/or intensity due to climate change. Current understanding on ECL events is limited, although it is widely believed that the El Nino Southern Oscillation (ENSO) cycle has a significant influence on the frequency of ECL events. A study of ECLs along the Queensland coast identified that ECLs have doubled in frequency over the 30 years to 2000 (AGSO, 2000), most notably due to the 1970-1980 period of high frequency of events, and while it identifies that this is significant, it also makes the point that this "*appears linked to broader climatic variations*" such as the Southern Oscillation Index, rather than to climate change. Some of these meteorological formations move southward and affect the Sydney Region.

Climate change models developed to date have not been able to investigate changes to wind conditions generated by small scale systems such as ECL events. CSIRO (2007) concludes that for ECL events "*model studies do not as yet indicate how the occurrence of east coast low pressure systems may change*".

Due to the lack of consensus related to climate change effects on the frequency and/or intensity of these events it is considered appropriate to adopt coastal storm conditions based on the current climatology and historical records. For the purposes of this study, the offshore design wave climate is based on measured offshore data from the Manly Hydraulics Laboratory from 1992 to the present time because it includes offshore wave direction.

Adopted Climate Change Scenarios

For the purposes of this study it has been assumed that current tidal planes (relative to the rising mean sea level), wind prominence and storm intensity and frequency will remain unchanged into the future. Due to the uncertainty in the various climate change projections for these features it is considered appropriate to adopt conditions based on the current climatology and historical records; any implications for an alternative position would be very minor over the life of the current project.

Appendix F

Glossary of Terms

GLOSSARY

Advective Transport		The transport of dissolved material by water movement.
Australian Height Datum (AHD)		A common national plane of level corresponding approximately to mean sea level.
Amenity		Those features of an estuary/beach that foster its use for various purposes, eg. Clear water and sandy beaches make beach-side recreation attractive.
ARI		Average Recurrence Interval
Bed Load		That portion of the total sediment load that flowing water moves along the bed by the rolling or saltating of sediment particles.
Calibration		The process by which the results of a computer model are brought to agreement with observed data.
Catchment		The area draining to a site. It always relates to a particular location and may include the catchments of tributary streams as well as the main stream.
CD		Chart Datum, common datum for navigation charts - 0.92m below AHD in the Sydney coastal region. Typically Lowest Astronomical Tide.
Discharge		The rate of flow of water measured in terms of volume per unit time. It is to be distinguished from the speed or velocity of flow, which is a measure of how fast the water is moving rather than how much is flowing.
Dispersive Transport		The transport of dissolved matter through the estuary by vertical, lateral and longitudinal mixing associated with velocity shear.
Diurnal		A daily variation, as in day and night.
Ebb Tide		The outgoing tidal movement of water within an estuary.
Eddies		Large, approximately circular, swirling movements of water, often metres or tens of metres across. Eddies are caused by shear between the flow and a boundary or by flow separation from a boundary.
EIS		Environmental Impact Statement
Estuarine Processes		Those processes that affect the physical, chemical and biological behaviour of an estuary, eg. predation, water movement, sediment movement, water quality, etc.

Estuary		An enclosed or semi-enclosed body of water having an open or intermittently open connection to coastal waters and in which water levels vary in a periodic fashion in response to ocean tides.
Flocculate		The coalescence, through physical and chemical processes, of individual suspended particles into larger particles ('flocs').
Flood Tide		The incoming tidal movement of water within an estuary.
Fluvial		Relating to non-tidal flows.
Fluvial Processes		The erosive and transport processes that deliver terrestrial sediment to creeks, rivers, estuaries and coastal waters.
Fluvial Sediments		Land-based sediments carried to estuarine waters by rivers.
Foreshore		The area of shore between low and high tide marks and land adjacent thereto.
Fortnightly Tides		The variation in tide levels caused by the monthly variation of Spring and Neap Tides.
Geomorphology		The study of the origin, characteristics and development of land forms.
H_s (Significant Wave Height)		H_s may be defined as the average of the highest 1/3 of wave heights in a wave record ($H_{1/3}$), or from the zeroth spectral moment (H_{mo}), though there is a difference of about 5 to 8%.
Hydraulic Regime		The variation of estuarine discharges in response to seasonal freshwater inflows and tides.
Intertidal		Pertaining to those areas of land covered by water at high tide, but exposed at low tide, eg. intertidal habitat.
Isohaline		A line connecting those parts of a water mass having the same salinity, ie, a contour of equal salinity levels.
Littoral Zone		An area of the coastline in which sediment movement by wave, current and wind action is prevalent.
Littoral Drift Processes		Wave, current and wind processes that facilitate the transport of water and sediments along a shoreline.
Mangroves		An intertidal plant community dominated by trees.
Marine Sediments		Sediments in sea and estuarine areas that have a marine origin.

Mathematical/ Computer Models		The mathematical representation of the physical processes involved in runoff, stream flow and estuarine/sea flows. These models are often run on computers due to the complexity of the mathematical relationships. In this report, the models referred to are mainly involved with wave and current processes.
MHL		Manly Hydraulics Laboratory
MSL		Mean Sea Level
Neap Tides		Tides with the smallest range in a monthly cycle. Neap tides occur when the sun and moon lie at right angles relative to the earth (the gravitational effects of the moon and sun act in opposition on the ocean).
NSW		New South Wales
NTU		Nephelometric Turbidity Units
Numerical Model		A mathematical representation of a physical, chemical or biological process of interest. Computers are often required to solve the underlying equations.
Phase Lag		Difference in time of the occurrence between high (or low water) and maximum flood (or ebb) velocity at some point in an estuary or sea area.
Salinity		The total mass of dissolved salts per unit mass of water. Seawater has a salinity of about 35g/kg or 35 parts per thousand.
Saltation		The movement of sediment particles along the bed of a water body in a series of 'hops' or 'jumps'. Turbulent fluctuations near the bed lift sediment particles off the bed and into the flow where they are carried a short distance before falling back to the bed.
Sediment Load		The quantity of sediment moved past a particular cross-section in a specified time by estuarine flow.
Semi-diurnal		A twice-daily variation, eg. two high waters per day.
Shear Strength		The capacity of the bed sediments to resist shear stresses caused by flowing water without the movement of bed sediments. The shear strength of the bed depends upon bed material, degree of compaction, armouring,
Shear Stress		The stress exerted on the bed of an estuary by flowing water. The faster the velocity of flow the greater the shear stress.
Shoals		Shallow areas in an estuary created by the deposition and build-up of sediments.

Slack Water		The period of still water before the flood tide begins to ebb (high water slack) or the ebb tide begins to flood (low water slack).
Spring Tides		Tides with the greatest range in a monthly cycle, which occur when the sun, moon and earth are in alignment (the gravitational effects of the moon and sun act in concert on the ocean)
SS		Suspended Solids
Storm Surge		The increase in coastal water levels caused by the barometric and wind set-up effects of storms. Barometric set-up refers to the increase in coastal water levels associated with the lower atmospheric pressures characteristic of storms. Wind set-up refers to the increase in coastal water levels caused by an onshore wind driving water shorewards and piling it up against the coast.
Suspended Sediment Load		That portion of the total sediment load held in suspension by turbulent velocity fluctuations and transported by flowing water.
Tidal Amplification		The increase in the tidal range at upstream locations caused by the tidal resonance of the estuarine water body, or by a narrowing of the estuary channel.
Tidal Exchange		The proportion of the tidal prism that is flushed away and replaced with 'fresh' coastal water each tide cycle.
Tidal Excursion		The distance travelled by a water particle from low water slack to high water slack and vice versa.
Tidal Lag		The delay between the state of the tide at the estuary mouth (eg. high water slack) and the same state of tide at an upstream location.
Tidal Limit		The most upstream location where a tidal rise and fall of water levels is discernible. The location of the tidal limit changes with freshwater inflows and tidal range.
Tidal Planes		A series of water levels that define standard tides, eg. 'Mean High Water Spring' (MHWS) refers to the average high water level of Spring Tides.
Tidal Prism		The total volume of water moving past a fixed point in an estuary during each flood tide or ebb tide.
Tidal Propagation		The movement of the tidal wave into and out of an estuary.

Tidal Range		The difference between successive high water and low water levels. Tidal range is maximum during Spring Tides and minimum during Neap Tides.
Tidally Varying Models		Numerical models that predict estuarine behaviour within a tidal cycle, ie, the temporal resolution is of the order of minutes or hours.
Tides		The regular rise and fall in sea level in response to the gravitational attraction of the Sun, Moon and Earth.
Tributary		Catchment, stream or river which flows into a larger river, lake or water body
Training Walls		Walls constructed at the entrances of estuaries to improve navigability by providing a persistently open entrance.
Turbidity		A measure of the ability of water to absorb light.
T_z (Zero Crossing Period)		The average period of waves in a train of waves observed at a location.
Velocity Shear		The differential movement of neighbouring parcels of water brought about by frictional resistance within the flow, or at a boundary. Velocity shear causes dispersive mixing, the greater the shear (velocity gradient), the greater the mixing.
Wind Shear		The stress exerted on the water's surface by wind blowing over the water. Wind shear causes the water to pile up against downwind shores and generates secondary currents.

* A number of definitions have been derived from the Estuary Management Manual (1992).

Appendix G

Wind-Speed and Direction Joint Occurrence at Mascot

Table G1: Joint Occurrence of Wind Speed and Direction at Mascot
Percentage Calms - 17.4

	Wind Speed (m/s)										
Dirn	0.0-2.5	2.5-5.0	5.0-7.5	7.5-10.0	10.0-12.5	12.5-15.0	15.0-17.5	17.5-20.0	20.0-22.5	22.5-25.0	**TOTAL**
N	0.48	1.73	0.98	0.33	0.07	0.01	0.00	0.00	0.00	0.00	3.60
NNE	0.25	1.36	1.39	0.88	0.37	0.08	0.01	0.00	0.00	0.00	4.34
NE	0.34	1.94	2.51	1.72	0.74	0.15	0.01	0.00	0.00	0.00	7.41
ENE	0.22	1.10	1.18	0.48	0.08	0.01	0.00	0.00	0.00	0.00	3.07
E	0.33	1.66	1.32	0.28	0.03	0.01	0.00	0.00	0.00	0.00	3.63
ESE	0.21	1.09	0.82	0.21	0.04	0.01	0.00	0.00	0.00	0.00	2.38
SE	0.31	1.82	1.95	0.79	0.19	0.05	0.02	0.00	0.00	0.00	5.13
SSE	0.19	1.61	2.28	1.31	0.56	0.18	0.05	0.01	0.00	0.00	6.19
S	0.31	1.84	3.13	2.86	1.62	0.67	0.18	0.03	0.01	0.00	10.66
SSW	0.16	0.84	1.05	1.01	0.54	0.23	0.06	0.02	0.00	0.00	3.92
SW	0.37	1.25	0.98	0.55	0.18	0.06	0.02	0.01	0.00	0.00	3.41
WSW	0.29	1.32	1.13	0.64	0.24	0.07	0.02	0.00	0.00	0.00	3.71
W	0.86	3.03	2.00	1.03	0.52	0.20	0.06	0.01	0.00	0.00	7.70
WNW	1.08	2.87	0.98	0.45	0.26	0.12	0.04	0.00	0.00	0.00	5.79
NW	1.78	4.34	1.19	0.44	0.22	0.07	0.02	0.00	0.00	0.00	8.07
NNW	0.59	1.90	0.69	0.26	0.10	0.02	0.01	0.00	0.00	0.00	3.56
TOTAL (%)	7.78	29.71	23.56	13.23	5.77	1.92	0.49	0.08	0.02	0.01	82.58
P of E (%)	82.58	74.79	45.08	21.52	8.29	2.52	0.60	0.11	0.03	0.01	

Appendix H

Wave Model Results

Swell Wave Parameters Pre-Dredging				
Loc#	H_{50} (m)	σ	H_e (m)	ϕ_m (°TN)
1	0.0367	0.7920	0.0687	339.62
2	0.0538	0.7763	0.0983	343.66
3	0.0649	0.7901	0.1212	333.02
4	0.0665	0.8418	0.1351	336.54
5	0.0641	0.9238	0.1505	342.74
6	0.0756	0.9534	0.1876	6.27
7	0.0939	0.9564	0.2344	54.38
8	0.0858	0.8947	0.1910	10.58
9	0.0721	0.8594	0.1509	20.24
10	0.0745	0.8943	0.1658	24.24
11	0.0663	0.9009	0.1493	23.86
12	0.0784	0.9121	0.1801	30.79
13	0.0591	0.8844	0.1292	35.78
14	0.0813	0.9210	0.1899	34.12
15	0.0596	0.9216	0.1394	36.28
16	0.0687	0.9172	0.1593	38.56
17	0.0698	0.9022	0.1575	35.10
18	0.0744	0.8876	0.1636	28.32
19	0.0669	0.8916	0.1481	26.69
20	0.0557	0.9248	0.1310	27.24
21	0.0448	0.9194	0.1043	36.65
22	0.0432	0.9269	0.1020	42.93
23	0.0477	0.9353	0.1144	39.76
24	0.0506	0.8772	0.1092	37.06
25	0.0633	0.8762	0.1364	30.89
26	0.0665	0.9435	0.1620	38.33
27	0.0594	0.9307	0.1413	39.24
28	0.0641	0.9124	0.1474	32.71
29	0.0517	0.9577	0.1294	35.85
30	0.0514	0.9918	0.1375	40.68
31	0.0665	0.8927	0.1475	65.77
32	0.0414	0.9979	0.1121	55.38
33	0.0808	0.8857	0.1770	66.55
34	0.0491	0.9776	0.1277	47.71
35	0.0737	0.8820	0.1604	58.13
36	0.0827	0.8637	0.1744	50.45
37	0.0884	0.8529	0.1830	56.28
38	0.0880	0.8261	0.1741	57.49
39	0.0608	0.8292	0.1209	44.11
40	0.0540	0.8375	0.1089	42.62
41	0.0521	0.8318	0.1041	42.99
42	0.0775	0.8293	0.1542	44.06
43	0.0811	0.8359	0.1631	47.82
44	0.0759	0.7895	0.1416	51.78
45	0.0886	0.7766	0.1619	45.17
46	0.0926	0.7836	0.1711	41.56
47	0.0705	0.8099	0.1358	43.12
48	0.0657	0.7923	0.1231	35.57

Swell Wave Parameters Post-Dredging				
Loc#	H_{50} (m)	σ	H_e (m)	ϕ_m (°TN)
1	0.0368	0.7937	0.0691	339.45
2	0.0540	0.7781	0.0989	343.42
3	0.0653	0.7912	0.1221	333.02
4	0.0671	0.8421	0.1364	336.22
5	0.0655	0.9270	0.1547	342.79
6	0.0774	0.9562	0.1931	5.81
7	0.0990	0.9605	0.2491	50.60
8	0.0884	0.9006	0.1989	9.77
9	0.0726	0.8613	0.1525	19.96
10	0.0756	0.8949	0.1684	24.37
11	0.0630	0.8919	0.1396	24.55
12	0.0749	0.9062	0.1703	31.27
13	0.0581	0.8805	0.1262	36.11
14	0.0787	0.9170	0.1825	34.26
15	0.0568	0.9167	0.1316	36.35
16	0.0671	0.9150	0.1550	38.54
17	0.0668	0.9011	0.1505	35.07
18	0.0706	0.8861	0.1548	27.87
19	0.0641	0.8938	0.1425	26.75
20	0.0532	0.9218	0.1244	27.18
21	0.0430	0.9199	0.1002	36.50
22	0.0420	0.9270	0.0992	43.01
23	0.0462	0.9348	0.1107	39.70
24	0.0493	0.8792	0.1068	36.82
25	0.0618	0.8742	0.1327	30.39
26	0.0649	0.9422	0.1577	38.03
27	0.0585	0.9313	0.1393	38.98
28	0.0638	0.9125	0.1467	32.50
29	0.0516	0.9595	0.1296	35.67
30	0.0516	0.9916	0.1379	40.59
31	0.0668	0.8952	0.1489	65.74
32	0.0416	0.9996	0.1130	55.33
33	0.0813	0.8865	0.1784	66.55
34	0.0493	0.9796	0.1287	47.77
35	0.0742	0.8832	0.1619	58.14
36	0.0832	0.8654	0.1759	50.54
37	0.0887	0.8535	0.1838	56.34
38	0.0883	0.8268	0.1749	57.56
39	0.0610	0.8287	0.1212	44.16
40	0.0541	0.8394	0.1094	42.67
41	0.0523	0.8311	0.1044	43.02
42	0.0776	0.8300	0.1546	44.08
43	0.0814	0.8363	0.1638	47.84
44	0.0761	0.7895	0.1419	51.82
45	0.0889	0.7767	0.1625	45.25
46	0.0929	0.7843	0.1719	41.63
47	0.0707	0.8111	0.1365	43.21
48	0.0657	0.7927	0.1232	35.64

Swell Wave Parameters Pre-Dredging				
Loc#	H_{50} (m)	σ	H_e (m)	ϕ_m (°TN)
49	0.0863	0.7915	0.1615	31.43
50	0.1007	0.7283	0.1711	31.16
51	0.1059	0.7897	0.1976	43.50
52	0.0715	0.7961	0.1348	356.40
53	0.1175	0.7842	0.2173	44.55
54	0.1028	0.8300	0.2047	70.14
55	0.0968	0.8442	0.1974	66.58
56	0.1179	0.8970	0.2636	76.20
57	0.1237	0.9671	0.3152	82.67
58	0.1439	0.9817	0.3772	86.85
59	0.0543	0.7935	0.1019	102.54
60	0.0692	0.8032	0.1319	96.61
61	0.1112	0.7712	0.2016	81.41
62	0.1200	0.7711	0.2175	71.58
63	0.1022	0.7654	0.1836	68.35
64	0.0747	0.7725	0.1357	85.58
65	0.0613	0.7745	0.1117	80.82
66	0.0740	0.7670	0.1333	97.73
67	0.0929	0.7922	0.1740	99.82
68	0.0965	0.8009	0.1833	110.34
69	0.1341	0.7579	0.2382	102.33
70	0.1332	0.7554	0.2357	96.04
71	0.1273	0.7905	0.2378	97.41
72	0.1249	0.7986	0.2363	99.49
73	0.1090	0.8248	0.2152	113.51
74	0.1329	0.8395	0.2689	119.64
75	0.0962	0.8403	0.1949	119.47
76	0.0927	0.8158	0.1804	118.13
77	0.0620	0.8746	0.1332	112.56
78	0.0633	0.9106	0.1451	108.30
79	0.0531	1.0194	0.1501	114.97
80	0.0402	1.1247	0.1424	120.10
81	0.0275	1.1023	0.0927	124.83
82	0.0223	0.9468	0.0547	131.14
83	0.0167	0.9410	0.0405	136.27
84	0.0078	0.9846	0.0206	147.43
85	0.0052	1.0275	0.0149	154.97
86	0.0026	1.0566	0.0079	165.25
87	0.0030	0.9174	0.0070	183.77
88	0.0055	0.9227	0.0129	195.90
89	0.0468	1.0575	0.1432	130.31
90	0.0765	0.9405	0.1853	116.17
91	0.0557	0.9622	0.1406	115.60
92	0.1393	0.9539	0.3460	116.42
93	0.1147	0.8754	0.2468	135.67
94	0.0971	1.4394	0.7710	140.20
95	0.0125	1.2943	0.0667	161.58
96	0.0092	1.4134	0.0678	182.43

Swell Wave Parameters Post-Dredging				
Loc#	H_{50} (m)	σ	H_e (m)	ϕ_m (°TN)
49	0.0863	0.7916	0.1615	31.48
50	0.1008	0.7287	0.1714	31.23
51	0.1059	0.7897	0.1976	43.49
52	0.0715	0.7964	0.1348	356.63
53	0.1177	0.7848	0.2179	44.65
54	0.1028	0.8305	0.2049	70.07
55	0.0965	0.8445	0.1969	66.57
56	0.1188	0.8974	0.2658	76.32
57	0.1261	0.9673	0.3214	83.01
58	0.1439	0.9817	0.3772	86.85
59	0.0544	0.7944	0.1022	102.55
60	0.0692	0.8038	0.1320	96.64
61	0.1112	0.7713	0.2016	81.41
62	0.1200	0.7711	0.2175	71.57
63	0.1022	0.7657	0.1837	68.34
64	0.0748	0.7728	0.1359	85.56
65	0.0614	0.7750	0.1120	80.82
66	0.0740	0.7672	0.1333	97.73
67	0.0929	0.7913	0.1738	99.82
68	0.0967	0.8016	0.1839	110.35
69	0.1343	0.7583	0.2387	102.33
70	0.1333	0.7557	0.2360	96.05
71	0.1276	0.7904	0.2383	97.42
72	0.1251	0.7984	0.2366	99.49
73	0.1092	0.8242	0.2154	113.51
74	0.1332	0.8403	0.2699	119.67
75	0.0963	0.8395	0.1948	119.50
76	0.0927	0.8158	0.1804	118.16
77	0.0621	0.8748	0.1335	112.59
78	0.0633	0.9108	0.1451	108.31
79	0.0531	1.0194	0.1501	114.98
80	0.0402	1.1247	0.1424	120.11
81	0.0275	1.1023	0.0927	124.84
82	0.0223	0.9468	0.0547	131.15
83	0.0167	0.9410	0.0405	136.28
84	0.0078	0.9846	0.0206	147.44
85	0.0052	1.0275	0.0149	154.97
86	0.0026	1.0566	0.0079	165.25
87	0.0030	0.9174	0.0070	183.77
88	0.0055	0.9227	0.0129	195.89
89	0.0469	1.0575	0.1435	130.32
90	0.0765	0.9404	0.1852	116.16
91	0.0557	0.9618	0.1405	115.56
92	0.1391	0.9546	0.3460	116.39
93	0.1147	0.8754	0.2468	135.67
94	0.0971	1.4335	0.7579	140.20
95	0.0125	1.2943	0.0667	161.58
96	0.0092	1.4134	0.0678	182.43

Swell Wave Parameters Pre-Dredging				
Loc#	H_{50} (m)	σ	H_e (m)	ϕ_m (°TN)
97	0.2429	1.0596	0.7465	131.88
98	0.1792	0.9122	0.4118	117.43
99	0.1922	0.8739	0.4125	116.74
100	0.2615	0.7765	0.4779	115.03
101	0.2958	0.8437	0.6028	111.39
102	0.0143	0.9274	0.0338	143.06
103	0.2395	0.8710	0.5115	106.42
104	0.3160	0.7942	0.5937	110.24
105	0.2614	0.8334	0.5236	145.84
106	0.1283	0.9635	0.3246	76.69
107	0.0870	0.9670	0.2216	60.97
108	n/a	n/a	n/a	n/a
109	n/a	n/a	n/a	n/a
110	0.2607	0.7989	0.4935	112.82
111	0.2528	0.7971	0.4772	109.55

Swell Wave Parameters Post-Dredging				
Loc#	H_{50} (m)	σ	H_e (m)	ϕ_m (°TN)
97	0.2429	1.0596	0.7465	131.88
98	0.1791	0.9120	0.4114	117.43
99	0.1920	0.8745	0.4125	116.72
100	0.2617	0.7768	0.4784	115.03
101	0.2944	0.8437	0.5999	111.44
102	0.0143	0.9274	0.0338	143.06
103	0.2407	0.8707	0.5137	106.31
104	0.3160	0.7942	0.5937	110.24
105	0.2614	0.8334	0.5236	145.84
106	0.1237	0.9634	0.3129	77.10
107	0.0815	0.9691	0.2085	62.02
108	n/a	n/a	n/a	n/a
109	n/a	n/a	n/a	n/a
110	0.2589	0.7976	0.4891	112.91
111	0.2503	0.7964	0.4720	109.52

Appendix D

SAP Report

See separate Volume 2 Appendix D1

See separate Volume 2 Appendix D2

Appendix D3 - Methodology for Calculating TBT

URS

Memorandum

Date: 4 October 2012

To: Chris Fay

From: Travis Hurley

Subject: Methodology for Calculating TBT Concentrations in Deposited Sediments

This memorandum is provided to detail the methodology applied to calculate the potential Tributyltin (TBT) concentrations in sediment dispersed and deposited within Botany Bay as a consequence of the dredging program proposed by Caltex. The loading of TBT concentrations in sediment has been calculated to determine the chronic impacts of TBT on marine benthic organisms.

Settlement densities for calculations were assumed to correspond to the fine fractions from each area resulting in densities of 750 kg/m^3, 800 kg/m^3, 1500 kg/m^3 and 1017 kg/m^3 to represent the approach channel/turning circle, the sub-berth, fixed berths and across all areas, respectively. The thickness and extent of the sediment predicted to settle as a result of the entire dredging program has been modelled by Cardno in Appendix C. These results are extrapolated to predict the concentration of TBT in sediments in Botany Bay at the end of the dredging program. Calculations applied the 95% UCL of TBT concentrations measured in sediments from each area and across all areas within the dredge footprint recorded in sampling undertaken by Worley Parsons. The results from these investigations can be found in Technical Appendices D1 and D2.

1. Step 1: Convert the density into smaller scale for sample sizes

The Handbook for Sediment Quality Assessment (Simpson et al. 2005) describes that generally most epifaunal and infaunal organisms are found in the upper 10 cm of sediments. Sediment sampling conducted post-dredging would therefore aim to collect surface sediments within the top 10 cm to determine the potential toxicity of TBT concentrations. For these calculations, it is therefore assumed that a sample size of 10 cm^3 will be required to test for TBT contamination in sediments surrounding the project area post dredging.

The density of the sediments, as described above has been determined by the concentration of fines for each area and all areas. The first step required was to convert the known density of kg/m^3 into kg/cm^3. The conversion for this is provided below:

$$1\ kg/m^3 = 1.0 \times 10^{-6}\ kg/cm^3$$

The densities (in kg/m^3) for each area and all areas with the converted densities (in kg/cm^3) are provided in the table below.

Density	Approach/Turning Circle	Sub-Berths	Fixed Berths	All Areas
kg/m^3	750	800	1500	1017
kg/cm^3	0.00075	0.0008	0.0015	0.001017

2. Step 2: Use the predicted sediment thickness to calculate the mass of sediment and TBT contaminated sediment within samples

A volume of 10 cm^3 was used to identify the mass of the entire sample. The thickness of the sediment deposition provided in the modelling of the dredging program conducted by Cardno is predicted to range between 0.01 mm and 35 mm (Appendix C). Assorted thicknesses between this range were selected to represent the volume of TBT contaminated sediment within representative samples. This was conducted using the following equation:

Mass (kg) = Volume (cm^3) x Density (kg/cm^3)

The results of the above equation calculations are provided in the Table below.

Volume (cm^3)	Density (kg/cm^3)			
	Approach/Turning Circle (kg)	Sub-Berths (kg)	Fixed Berths (kg)	All Areas (kg)
10	0.0075	0.008	0.015	0.010166667
0.35	0.0002625	0.00028	0.000525	0.000355833
0.2	0.00015	0.00016	0.0003	0.000203333
0.15	0.0001125	0.00012	0.000225	0.0001525
0.1	0.000075	0.00008	0.00015	0.000101667
0.05	0.0000375	0.00004	0.000075	5.08333E-05
0.01	0.0000075	0.000008	0.000015	1.01667E-05

3. Step 3: Calculate the proportion of contaminated sediment in each sample

The proportion of contaminated TBT sediment was calculated by dividing the mass of contaminated sediment by the mass of sediment from 10cm^3 samples. The results are presented below.

Sediment Thickness (cm)	Proportion of sample
0.35	3.5%
0.2	2%
0.15	1.5%
0.1	1%

0.05	0.5%
0.01	0.1%

4. Use the predicted proportion of the sample and TBT concentrations in sediments to calculate the predicted TBT loading in surrounding areas

The 95% UCL for each area and for all areas from the sampling undertaken by Worley Parsons are provided below.

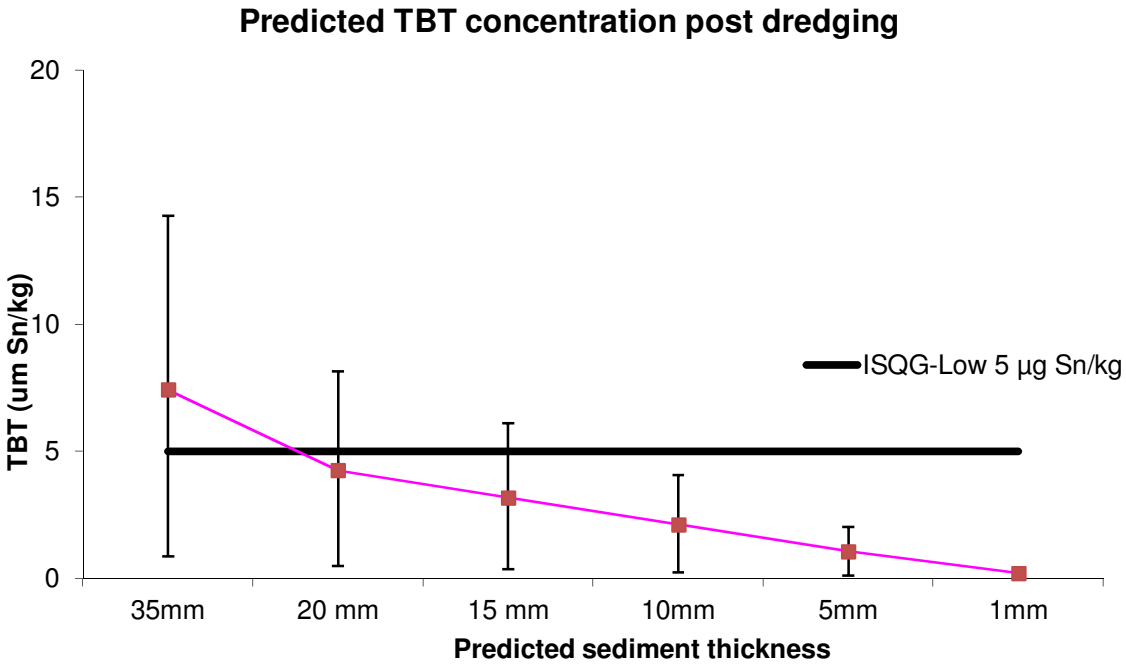
Area	95% UCL of TBT in Sediment (µg Sn/kg)
Approach Channel/ Turning Circle	408
Sub-Berth	311
Fixed Berths	25
All Areas	212.5

The 95% UCL of TBT concentrations in sediments were multiplied by the proportion of the post-dredge sediment sample containing contaminated sediments to calculate the predicted loading or residual TBT concentrations in the areas surrounding the dredge footprint. The residual TBT concentrations are presented in the Table and Figure below. The values exceeding the ISQG-low value of 5 µg Sn/kg are highlighted. The Figure shows the TBT value for all areas and the range in TBT concentrations in sediments across each area (i.e. assuming different settlement densities and source sediment concentrations).

Sediment Thickness	Approach/Turning Circle (µg Sn/kg)	Sub-Berths (µg Sn/kg)	Fixed Berths (µg Sn/kg)	All Areas (µg Sn/kg)
35mm	14.28	10.885	0.875	7.4375
20mm	8.16	6.22	0.5	4.25
15mm	6.12	4.665	0.375	3.1875
10mm	4.08	3.11	0.25	2.125
5mm	2.04	1.555	0.125	1.0625
1mm	0.408	0.311	0.025	0.2125

The Table and the Figure below clearly show that only where the sediment deposition thickness exceeds approximately 10 mm, the TBT concentration associated with the sediments are predicted to remain above the threshold limit of 5 µg Sn/kg^{-1} in the ANZECC/ARMCANZ

Guidelines (2000). These results should be compared to the model of sediment deposition produced by Cardno to observe the extent of sediment deposition predicted to exceed 10 mm.



5. References

ANZECC/ARMCANZ 2000. National Water Quality Management Strategy, Paper No. 4, Australian and New Zealand Guidelines for fresh and marine water quality, Volume 1, The Guidelines. Australian and New Zealand Environment and Conservation Council/ Agricultural and Resourse Management Council of Australia and New Zealand.

Simpson, S.L., Batley, G.E., Charlton, A.A., Stauber, J.L., King, C.K., Chapman, J.C., Hyne, R.V., Gale, S.A., Roach, A.C. and Maher, W.A. 2005. Handbook for Sediment Quality Assessment. CSIRO; Bangor NSW.