PART B

STAKEHOLDER ENGAGEMENT

Chapter 5 > Stakeholder engagement

B

5 Stakeholder engagement

5.1 Overview

To enable the identification and engagement of relevant stakeholders and to ensure issues raised were effectively addressed in the project planning phase and this EA, a stakeholder engagement strategy was prepared for the T4 Project. The objectives of the stakeholder engagement strategy included:

- to identify all relevant stakeholders who have an interest in the T4 Project and the ongoing operations of PWCS, including relevant government agencies and community groups;
- to provide stakeholders with accurate and timely information on the T4 Project;
- to identify and understand the aspects of the T4 Project which are of most interest to stakeholders;
- to seek feedback on the design of the T4 Project and the proposed approaches to minimising impacts, and identify opportunities to accommodate feedback into the project design; and
- to establish relationships with the community which can be utilised in the future to the benefit of the community and PWCS, such as partnering in long-term community development projects.

Stakeholder engagement has been undertaken in accordance with the stakeholder engagement strategy and to satisfy the consultation requirements in the DGRs.

5.2 Formal consultation requirements

The DGRs identify specific requirements for consultation and stakeholder engagement. This includes consultation with:

- local government, including Newcastle City Council (NCC) and Port Stephens Council;
- state government agencies, including NPC, HDC, Hunter-Central Rivers CMA, OEH, NOW, Fishing and Aquaculture, RMS and Transport for NSW;
- Commonwealth government agencies, specifically the DSEWPC and Department of Infrastructure and Transport;
- service and infrastructure providers, including ARTC, RailCorp, Hunter Water, Ausgrid, Telstra and Jemena;
- the public, including special interest groups and affected landowners; and
- Aboriginal stakeholders.

The stakeholder engagement process, activities undertaken to date and key outcomes are described in this chapter.

5.3 Stakeholder engagement process

The key components of the stakeholder engagement strategy are initial stakeholder identification, stakeholder assessment and stakeholder engagement. Each of these components is described below.

5.3.1 Stakeholder identification

The stakeholder identification process involved compiling a list of all stakeholders likely to be relevant to the T4 Project. It largely drew on PWCS's existing information and understanding of the community in which it operates.

The broad stakeholder groups identified include Commonwealth and state government agencies, members and ministers; NCC and Port Stephens Council; the local community and nearest residential neighbours; special interest groups; Aboriginal groups; neighbouring industry; industry representative groups; PWCS employees; and the media.

5.3.2 Stakeholder assessment

Following the stakeholder identification process, an assessment of the stakeholders was undertaken to further understand the extent to which the various parties were likely to be impacted by and/or have an interest in the T4 Project. The purpose of this exercise was to inform the development of appropriately tailored stakeholder engagement strategies and schedule.

5.3.3 Stakeholder engagement

The initial round of stakeholder engagement commenced in early 2010, with the T4 Project introduced to a number of stakeholders.

The stakeholder groups identified and the engagement activities undertaken are presented in Table 5.1. A range of formal and informal stakeholder engagement tools have been used, including phone calls, meetings and briefing sessions, community information sessions and information sheets. In addition, a T4 Project webpage has been developed which provides information about the T4 Project and points of contact for people to raise concerns or request further information.

Table 5.1 Stakeholders and engagement activities

Stakeholder	Engagement activities
Neighbours (industrial, commercial and residential)	• Telephone survey • Key stakeholder interviews • Community information sheets • Community information sessions
Commonwealth and state government agencies	• Planning focus meeting • Face to face meetings • Letter, email and phone correspondence
Local government, including NCC and Port Stephens Council, mayors and individual councillors	• Planning focus meeting • Face to face meetings • Project briefing sessions • Letter, email and phone correspondence

Table 5.1 Stakeholders and engagement activities *(Cont'd)*

Stakeholder	Engagement activities
Federal and state political members	• Key stakeholder interviews
Local business and business chambers/groups	• Key stakeholder interviews
Industry groups (tourism, commercial fishers, other industry groups operating in the port area)	• Key stakeholder interviews • Community information sheets
Sports/recreation groups (recreational fishing groups, sailing and boating clubs, sports clubs operating in the port area)	• Key stakeholder interviews • Community information sheets
Environmental groups (interest, advocate and research groups associated with the area)	• Key stakeholder interviews • Community information sheets
Community groups and organisations (groups from surrounding suburbs and locations)	• Key stakeholder interviews • Community information sheets
Cultural and heritage groups associated with the area	• Face to face meetings • Letter, email and phone correspondence
Service providers (education, health, emergency services, employment and training)	• Face to face meetings • Letter, email and phone correspondence
Media groups and outlets	• Media statements and releases
Other relevant non-government organisations and not for profit organisations	• Face to face meetings • Key stakeholder interviews • Community information sheets

5.4 Government consultation

All levels of government have been consulted and engaged during the preparation of this EA to identify key issues for consideration and seek clarification and guidance on assessment approaches and a number of government policies applicable to the T4 Project. Engagement has been both formal and informal, by face-to-face and telephone briefings and meetings. In particular, engagement has been undertaken with DSEWPC, Department of Infrastructure and Transport and ARTC at the Commonwealth level, NCC and Port Stephens Council at the local level, and the following agencies at the state level:

- DP&I;
- NSW Department of Premier and Cabinet, including OEH;
- Transport for NSW, including RMS and NPC;
- Department of Primary Industries, including NOW, Fishing and Aquaculture and Hunter-Central Rivers CMA; and
- HDC.

5.4.1 Multi-government

i Planning focus meeting

The PFM was held on 9 December 2010 in Newcastle. It was attended by representatives of two Commonwealth government agencies (DSEWPC and Department of Transport and Infrastructure), the aforementioned state government agencies (Section 5.2) and NCC.

The PFM facilitated information exchange between government and the proponent about the project and the matters to be addressed in the EA.

Prior to the PFM, PWCS met with a number of government agencies individually to provide them with an overview of the T4 Project and its timing and facilitate discussion of assessment expectations and key matters of interest early in the planning process.

A PEA was prepared and distributed to all participants two weeks prior to the PFM. The PEA, which is essentially a briefing document, provided details on:

- background to the T4 Project;
- the project description as it was at the time;
- statutory requirements;
- planned stakeholder engagement; and
- an initial assessment of environmental impacts and how those impacts will be assessed in an EA.

The PFM included presentations on the T4 Project need, description and potential impacts, followed by an inspection of the T4 project area and its surrounds. The meeting was concluded with an open discussion about key matters for consideration in the EA.

At the PFM, DP&I requested that all agencies provide comment on draft DGRs that were to be prepared by DP&I. Draft DGRs were issued to all government agencies. DGRs were provided on 14 March 2011 incorporating feedback from government agencies, with letter clarification provided on 17 May 2011 and supplementary DGRs which included requirements from DSEWPC issued on 21 September 2011 following declaration of the T4 Project as a controlled action under the EPBC Act.

The DGRs and supplementary DGRs describe the matters that government agencies wanted addressed in this EA (refer Appendix A). Following receipt of the DGRs and supplementary DGRs, meetings/briefings were held with government to seek clarification on the assessment requirements and to discuss assessment methodologies and results.

ii Project Control Group

Through DP&I's Project Delivery Unit, a governmental Project Control Group (PCG) was formed to provide a forum for addressing key aspects of the T4 Project. The PCG met with representatives from PWCS and the EA study team on 7 June, 14 September, 26 September and 25 October 2011. Participants included:

- DP&I;
- Department of Premiers and Cabinet, including OEH;

- Transport for NSW, including RMS and NPC; and
- DSEWPC.

5.4.2 Local government

NCC and Port Stephens Council have been engaged. Eight meetings/briefings have taken place with NCC officials and office bearers and four meetings have occurred between PWCS and representatives of Port Stephens Council. These meeting were mostly to discuss general project matters, including updates on the project design and schedule.

5.4.3 State government

A number of briefings and meetings have been held with state government agencies to brief them on the T4 Project and discuss specific matters and policies relating to their jurisdiction. A summary of these briefings and meetings is provided below.

i Department of Planning and Infrastructure

In addition to numerous phone calls and written correspondence, four face-to-face meetings were held with DP&I prior to the formation of the PCG. Subsequent formal consultation with DP&I has been via the PCG meetings.

Meetings/briefings with DP&I were mostly to discuss general project matters, including updates on the project design and schedule. A meeting was held with DP&I on 20 April 2011 to discuss the department's rail assessment requirements. This meeting led to DP&I's clarification letter dated 17 May 2011 (Appendix A). EMM and PWCS met with DP&I on 21 December 2011 to discuss adequacy review comments on the draft EA from DP&I and other agencies.

ii Office of Environment and Heritage

In addition to numerous phone calls and written correspondence, there have been 12 face-to-face briefings and meetings with OEH in relation to various aspects of the T4 Project, including ecology, contamination, groundwater, air quality, noise and surface water. OEH were also involved in a compensatory habitat workshop (refer to ecology assessment in Appendix K for details) and the PCG meetings.

A further ten meetings have occurred with the National Parks and Wildlife Service (NPWS), who also participated in the compensatory habitat workshop.

Key meetings with OEH included:

- Meeting on 18 May 2011 regarding the groundwater and contamination assessments, where the assessment methodology and preliminary results were presented to OEH. OEH representatives stated that they were satisfied the investigations met its requirements and had no need to meet again until draft assessment results were ready.
- Meeting on 25 May 2011 regarding the air quality and noise assessments where the proposed assessment and modelling methodologies were presented and discussed. OEH representatives stated that they were satisfied with the study approaches and had no need to meet again.

- Meeting on 27 June 2011 to clarify the stormwater discharge criteria for the T4 Project. In particular, the meeting sought to clarify the DGR which states 'the EA must reflect a goal of no discharge of water to the Hunter River, other than natural surface run-off in extreme weather events, during operation of the project….'. At this meeting it was agreed that discharge from the T4 Project is permissible under certain conditions, particularly when the Hunter River is in flood, and that the surface water assessment is to define an 'extreme weather event' and show how the T4 Project will achieve the requirement.

- Meeting on 5 August 2011 to discuss the draft groundwater and contamination assessment results and approach to presenting remediation options. At the meeting it was agreed that a remediation action plan (RAP) was not required prior to project approval, and that instead, a remediation options report be prepared. This was subsequently confirmed by OEH in writing. Despite this, based on adequacy review feedback from DP&I, an Outline RAP has been prepared and is provided as Appendix G.

iii Roads and Maritime Services

A number of meetings have been held with RMS to discuss road transport and maritime-related aspects of the T4 Project, including nine meetings with the roads branch and two meetings with the maritime branch. Formal consultation with RMS has also been undertaken via the PCG meetings. RMS also receives regular briefings on the T4 Project via the Hunter River Remediation Taskforce, which met approximately four times in the last 12 months.

Key meetings included:

- Meeting with the former RTA on 24 May 2011 to discuss the proposed traffic assessment methodology. At the meeting the RTA stated that the main issue was likely to centre on traffic impacts during construction. Concurrence on the assessment methodology was obtained.

- Meeting with RMS on 11 January 2012 to discuss its adequacy review comments on the draft traffic assessment.

iv Transport for NSW

A meeting was held with Transport for NSW on 10 August 2011 to discuss road and rail transport-related aspects of the T4 Project. In relation to road transport, PWCS confirmed that the T4 Project did not include any road transport of coal. In relation to rail transport, representatives from Transport for NSW stated that documenting the ARTC's process for identifying future rail transport needs and bringing on new capacity would meet its rail assessment requirements. The need to consult with RMS was also emphasised.

v Fishing and Aquaculture

Meetings were held with Fishing and Aquaculture in June 2010 and May 2011 to discuss marine aspects of the T4 Project (including dredging and wharf construction). A representative of Fishing and Aquaculture also attended a compensatory habitat workshop.

vi NSW Office of Water

A meeting was held with NOW on 26 July 2011 to discuss the groundwater and surface water assessments. At this meeting, the scopes and assessment approaches and scopes were presented. Based on these presentations, NOW representatives stated that they were comfortable with the assessment approaches and did not have any other specific requirements.

Separate meetings have been held regarding bore licences.

vii Newcastle Ports Corporation

PWCS has been engaged in regular consultation with NPC regarding the T4 Project since November 2009.

viii Hunter – Central Rivers Catchment Management Authority

Since January 2010 seven meetings have occurred with representatives of the Hunter-Central Rivers CMA in relation to the T4 Project. Representatives of the CMA also attended a compensatory habitat workshop.

5.4.4 Commonwealth government

i Department of Sustainability, Environment, Water, Population and Communities

In addition to phone calls and written correspondence, face-to-face meetings and briefings with DSEWPC regarding the T4 Project were held on 1 June 2010, 6 October 2010, 1 December 2010, 18 March 2011, 1 June 2011, 7 June 2011 and 13 September 2011. This included an inspection of the T4 project area with DSEWPC representatives on 13 September 2011. Consultation with DSEWPC focused on the T4 Project's potential impact on MNES and measures proposed to mitigate and offset impacts. Consultation with DSWEPC has also occurred through its participation in the PCG and the PFM.

ii Department of Infrastructure and Transport

One meeting has occurred with the Commonwealth Department of Infrastructure and Transport in October 2010. This meeting was in relation to the Major Project Facilitation status subsequently granted to the T4 Project.

5.5 Service and infrastructure providers

A number of meetings have been held with service and infrastructure providers, including:

- ARTC;
- Aus-Grid;
- Rail Corp;
- Hunter Water;
- Jemena; and
- Telstra.

5.6 Community and special interest groups

Comprehensive consultation has been undertaken with the local community, including special interest groups, during preparation of this EA, in particular for the heritage and social impact assessments. Key consultation activities undertaken include:

- interviews with key stakeholder groups, including a participatory values mapping exercise;
- telephone survey of more than 400 residents proximate to the T4 project area;
- distribution of community information sheets on the T4 Project;
- community information sessions; and
- themed dialogues.

A summary of these consultation activities is provided in the following sections and more detail is provided in Chapter 18 and Appendix S.

5.6.1 Interviews with key stakeholders

A list of all identified stakeholders is provided in Appendix S. Face-to-face interviews were undertaken with key stakeholder groups including resident, sporting, recreational and environmental groups, local businesses and industry, to discuss the T4 Project and identify:

- areas around the T4 project area of particular use and value to stakeholders – this was assessed through a participatory values mapping exercise during the interviews (refer to Appendix S for further detail);
- issues/impacts perceived by participants as being associated with the T4 Project;
- opportunities for enhancement; and
- general community needs/aspirations.

Responses from all stakeholders were analysed, collated and, for the mapping exercises spatially referenced, to produce values/impacts/opportunities data and maps highlighting areas of community value, areas of perceived impact and areas where PWCS could make improvements as part of the T4 Project.

The most frequently perceived negative impacts of the T4 Project were associated with air quality, roads/transport, port development/activity, climate change and the environment. The most frequently perceived positive impacts were increased community engagement by PWCS as a result of the T4 Project and economic flow-on effects of the T4 Project.

5.6.2 Telephone survey

Residents in suburbs near the T4 project area were contacted randomly by telephone and asked to participate in a household survey. Survey areas comprised:

- Area 1 (Fern Bay): Fern Bay (total of 60 participants);
- Area 2 (Mayfield): Mayfield, Mayfield East and Mayfield West (total of 161 participants);
- Area 3 (Stockton): Stockton (total of 79 participants); and
- Area 4 (Tighes Hill): Carrington, Tighes Hill, Warabrook (total of 102 participants).

A total of 402 households participated in the survey, which assisted in providing an insight into community opinion on the T4 Project and its impacts and the operations of PWCS more generally.

When asked to respond yes or no to the question ‘Do you or your family have any concerns in relation to Port Waratah Coal Services’ proposed T4 Project? 58% of respondents answered ‘yes’ (ranging from 54% in Tighes Hill to 67% of respondents in Stockton). These respondents were then asked to specify what potential impacts were of particular concern to them. The majority of perceived impacts identified as of concern related to increased dust, traffic congestion and general environmental impacts. Of the 71% of respondents that indicated they were aware of the T4 Project, approximately 61% were supportive (moderate to highly supportive) of it going ahead. Detailed survey results are provided in Appendix S.

Table 5.2 summarises matters raised during stakeholder consultation by stakeholder group.

Table 5.2 Summary of matters raised by key stakeholders

Item raised	Business	Commercial fishing	Community groups	Community residents	NCC	Education	Environmental groups	Government	NGOs	Recreation/sporting
Air quality										
Existing coal dust impacts			•	•	•				•	•
Poor existing dust complaints handling			•							
Perceived dust impacts from the project			•			•				
Perceived dust impacts from the project stockpiles	•		•	•	•			•	•	•
Need improved dust management for the project			•	•						
Need improved dust monitoring for the project	•		•	•	•					
Existing exhaust pollution	•									
Roads										
Beautification of Cormorant Road corridor	•		•	•						
Increased traffic on Cormorant Road corridor	•	•	•	•	•		•	•	•	•
Port industry										
Cumulative impacts from other port development	•		•	•	•			•		•

Table 5.2 Summary of matters raised by key stakeholders

Item raised	Business	Commercial fishing	Community groups	Community residents	NCC	Education	Environmental groups	Government	NGOs	Recreation/sporting
Supportive of development location	•		•							
Need to maximise port resources	•		•							•
Poor reputation of industry	•						•			
Strategic planning required			•					•		
Ensuring ownership/leadership/responsibility			•	•						
Inadequate approvals process	•									
Local investment needed			•		•					
Climate change										
Investing in 'green' initiatives				•		•				
Relocation of wind turbine	•		•				•			•
Contributing to climate change			•	•		•	•			•
Environment										
Impacts on birds	•	•		•			•			
EA process is rigorous/positive						•	•			
Existing environmental management				•		•				
Impacts on green and golden bell frog	•			•	•	•	•			•
Project improves understanding of ecology						•				
Need to protect/respect local environment				•						
Rail										
Perceived increase in dust and noise from trains		•	•	•	•			•		
Perceived increase in rail through residential areas			•	•						
Shipping and waterways										
Opposed to dredging in the harbour	•	•	•	•	•					•
Enhanced access to fishing areas as a result of the project		•								
Existing boat movements managed well	•									•
Increased ships limiting access to harbour	•	•								•
Supportive of location of turning circle	•		•							
Shipping queue is too long	•									•
Coal chain										
Increased dependency on coal/coal chain	•	•			•					
Need to better manage impacts of coal chain		•		•			•			
Contamination										
Supportive of capping project on Kooragang Island				•			•			
Concern about contamination from shipping		•								
Concern about contamination of waterways		•	•	•	•		•			•
Noise										
Existing noise management				•						

Table 5.2 Summary of matters raised by key stakeholders

Item raised	Business	Commercial fishing	Community groups	Community residents	NCC	Education	Environmental groups	Government	NGOs	Recreation/sporting
Visual										
Visual impact of the project	•		•	•			•			•
Social services/support										
Increased demand for social services/support						•			•	
Economic										
Economic growth for the region (positive)	•	•	•	•		•		•		
Potential to positively and negatively impact other industries		•	•			•			•	
Will create employment (positive)	•		•	•			•	•	•	
May impact land values negatively			•	•						
Community engagement										
Awareness of existing complaints process				•						
Community funding is positive	•		•	•	•		•		•	
PWCS generally demonstrate Corporate Social Responsibility		•		•			•			
PWCS generally has a good reputation	•	•	•	•	•		•	•	•	
PWCS generally have good relationships with the community			•	•						
Need for increased communication and consultation	•	•	•	•	•	•			•	•

5.6.3 Community information sheets

A community information sheet was distributed in May 2011 to approximately 12,400 households and businesses in Wickham, Carrington, Fern Bay, Stockton, Tighes Hill, Mayfield, Mayfield East, Mayfield West and Warabrook. The sheet included an introduction and overview of the T4 Project and a summary of investigations being undertaken as part of the EA, including community consultation proposed. The information sheet included a number of contact methods for interested parties to obtain further information on the T4 Project.

A second community information sheet was distributed in October 2011 to approximately 14,200 households and businesses in the same areas as the first sheet, plus the suburbs of Islington and Maryville. The second sheet provided a T4 Project update and an overview of preliminary EA findings.

A third community information sheet is planned for distribution at a similar time to public exhibition of this EA. It would provide an overview of EA findings.

5.6.4 Community information sessions

Community information sessions for the T4 Project were held at the Stockton Bowling Club on Saturday 22 October 2011 (10.00 am to 5.00 pm) and the Mayfield East Public School on Saturday 29 October 2011 (10.00 am to 5.00 pm). The purpose of the information sessions was to provide information on the T4 Project, including the preliminary results of the technical assessments.

5.6.5 Themed dialogues

In October 2011, themed dialogues were held with a range of different stakeholders to brief them on the preliminary results of the technical assessments. Stakeholders were grouped into common interest areas including harbour user, ecology, commercial fishers, community, industry and government land manager groups.

5.7 Aboriginal stakeholder consultation

Consultation with Aboriginal stakeholders was undertaken in accordance with the DECCW (now OEH) (2010) *Aboriginal cultural heritage consultation requirements for proponents 2010* and DEC (now OEH) (2005) *Guidelines for Aboriginal cultural heritage impact assessment and community consultation* (draft), as part of the heritage assessment of the T4 Project. This consultation is discussed in Chapter 16 and Appendix Q.

PART C

ENVIRONMENTAL ASSESSMENT

C

6 Environmental risk identification

6.1 Introduction

The DGRs require the inclusion of an environmental risk analysis to identify potential environmental impacts associated with the T4 Project. They also require consideration of proposed mitigation measures and potentially significant residual environmental impacts after the application of proposed mitigation measures. They state:

> *'where additional key environmental impacts are identified through this environmental risk analysis, an appropriately detailed impact assessment of this additional key environmental impact must be included in the Environmental Assessment*.'

A qualitative preliminary environmental risk assessment of the T4 Project was undertaken in September 2010 prior to preparation of the PEA. This was primarily to assist in identifying key environmental attributes for consideration in the T4 Project planning and assessment process and facilitate an assessment process which focuses on the key issues. The risk assessment was based on knowledge of the existing environment, environmental interactions, operations at KCT and the proposed T4 Project footprint and activities at the time.

The risk assessment identified potential impacts and ranked them according to their possible likelihood of occurrence and the consequences of the impact if it occurred. The preliminary risk assessment did not include any measures to mitigate or ameliorate impacts and as such was presented as an unmitigated scenario (ie no environmental safeguards will be in place). Three classes of environmental risk were established, low, medium and high.

This risk identification process together with consultation with government agencies and other stakeholders enabled key aspects to be identified for further assessment. An assessment of each attribute has been undertaken as part of this EA, commensurate with its risk. Appropriate measures have subsequently been nominated for each attribute to address potential risks.

6.2 Qualitative preliminary risk assessment

The results of preliminary qualitative risk assessment undertaken in September 2010 are presented in Table 6.1. Once again, it should be noted that the assessment was based on knowledge of the existing environment, environmental interactions, operations at KCT and the proposed T4 project footprint and activities at the time, and was for the unmitigated scenario.

Table 6.1 Unmitigated environmental risk rating

Issue	Preliminary rating
Ecology	
Impact upon survival of a migratory or threatened species	High
Impact on local population of green and golden bell frog	High
Impact on EEC/Hunter Wetlands National Park/Hunter Estuary Wetlands Ramsar site	Medium
Contamination	
Exacerbation of existing contamination/new areas of contamination identified	High
New contamination from the T4 Project	Low

Table 6.1 Unmitigated environmental risk rating *(Cont'd)*

Issue	Preliminary rating
Erosion and sedimentation	High
Interception of hazardous materials	Medium
Acid leachate	Medium
Groundwater	
Impact on groundwater quality	High
Impact on groundwater dependent ecosystems	High
Contaminated groundwater brought to surface	High
Impact on groundwater levels or flow regimes	Medium
Impact on groundwater users	Low
Air quality	
Operational air quality impacts	High
Odour impacts	Medium
Construction air quality impacts	Low
Noise and vibration	
Operational noise impacts	High
Noise or vibration impacts during construction	Medium
Road traffic noise impacts	Low
Rail noise impacts	Low
Social	
Amenity impacts on residents	High
Perceived impacts to the community	High
Traffic and transportation	
Increases in traffic during construction	High
Increases in traffic during operation	Low
Increases in rail movements	Medium
Increase in shipping movements	Medium
Surface water	
Impacts on Hunter River – water quality	Medium
Impact on drainage patterns	Medium
Impacts on Hunter River – environmental flows/flooding	Low
Visual	
Impact on visual amenity	Medium
Lighting impacts	Medium
Impact on visual character of the area	Medium
Energy use and greenhouse gas	
Energy consumption/greenhouse gas emissions	Medium
Contribution to global warming	Medium
Heritage	
Impact on Aboriginal heritage	Low
Impact on non-Aboriginal heritage	Low

Based on the risk assessment results in Table 6.1, the following broad qualitative risk ratings were assigned to each environmental attribute:

- High – air quality, contamination, ecology, groundwater, noise and vibration, social, traffic and transportation;
- Medium – energy use and greenhouse gas, surface water, visual; and
- Low – heritage.

Whilst not all of these environmental attributes were specifically identified in the DGRs as requiring assessment, assessments for each of these attributes have been undertaken as part of this EA, commensurate with risk. The risk assessment process only considered adverse impacts, however the T4 Project will have a number of benefits, including economic benefits and it was necessary to consider both costs and benefits in the evaluation of whether the T4 Project will be of net benefit. Accordingly an economic assessment was also undertaken.

Assessments were initially undertaken for the T4 Project without application of mitigation measures. Based on the results of these initial assessments, mitigation measures, if required, were applied, and the assessments finalised based on application of these measures. Accordingly, all of the technical studies, which are presented in Part C of this EA and in full in Volumes 2 to 6 consider and assess any residual impacts following application of mitigation measures.

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7 Contamination and soils

This chapter summarises the contamination and soil-related components of the following suite of reports prepared by Douglas Partners and independently reviewed by Dr Bill Ryall:

- contamination assessment;
- groundwater assessment;
- summary of contamination issues - Site F (part of OneSteel site); and
- assessment of remediation options.

Consideration is also given to an outline remediation action plan (ORAP) prepared for the T4 Project to address a DGR. These reports are included as Appendices C to G.

The contamination and groundwater assessments (including the OneSteel assessment) were used to determine remediation requirements and options to effectively manage site contamination during and following development. The assessment of remediation options report and ORAP are outcomes of the assessment reports.

Contamination is discussed in this chapter predominately as it relates to soils. Groundwater and surface water contamination is addressed separately in Chapters 8 and 9.

7.1 Existing environment

7.1.1 Geology

Site geology comprises the Permian-age Tomago Coal Measures overlain by Quaternary alluvium and fill material. These geological features are characterised as follows:

- the Tomago Coal Measures comprise shale, siltstone, sandstone, conglomerate and coal;
- the alluvium comprises fine to medium grained estuarine sediments, with some zones of gravel, overlain by fluvial sands; and
- the fill material on top of the natural profile comprises fine grained estuarine sediments (dredged material) and waste, including contaminated materials.

There are no recorded geological faults beneath the T4 project area.

Subsurface investigations indicate that the T4 project area typically comprises fill material (waste and dredged material) overlying silty clay, silt, sand, silty sand, sandy clay, clay and siltstone. The main stratigraphic units vary in depth and thickness. Not all units are present at all locations and the silt, sand and silty sand are interbedded in many areas. Stratigraphy is characterised in Table 7.1. Hydrogeology is described in Chapter 8.

Table 7.1 T4 project area - generalised stratigraphy

Main Unit	Sub-Unit	Depth (m) From	To	Description	Elevation at base of layer (m NHTG)
1	1.1	Ground Level	0.0 / 11.7	Waste fill including coal washery reject, slag, coal fines, oil/tarry sludge, clayey silt filter cake, kiln wastes, cell scale (gypsum and manganese dioxide), asbestos, basic oxygen steel-making (BOS) flue dust and lime sludge.	4.4 / -4.3
	1.2	0.2 / 3.4	2.2 / 7.3	Fill (dredged fines at FDF) comprising clayey silt from deposition of dredged material.	3.6 / -0.1
2	-	0.0 / 18.0	2.6 / 23.0	Silty clay/silt with some clayey peat layers - generally soft to firm.	4.8 / -13.0
3	3.1	2.6 / 21.6	16.3 / 30.1	Sand/silty sand - loose to medium dense.	-15.0 / -32.4
	3.2	16.3 / 30.1	23.4 / 37.7	Sand - medium dense to dense.	-6.7 / -36.6
	3.3	16.3 / 31.0	25.3 / 46.5	Sand - very dense, some gravel.	-10.2 / -36.6
4	4.1	12.3 / 37.7	29.2 / 50.6	Silty clay - stiff to very stiff.	-10.2 / -41.3
	4.2	12.3 / 21.6	14.6 / 78.8	Sandy clay and clay - stiff to hard.	-15.4 / -71.1
5	-	14.6 / 78.8	-	Siltstone - very low to low strength to termination.	-

7.1.2 Acid sulphate soils

Acid sulphate soils (ASS) are sediments and soils that contain iron sulphides. Exposure to oxygen, eg by drainage or excavation, can cause the sulphides to oxidise and generate sulphuric acid. ASS can be either actual ASS (AASS) or potential ASS (PASS). AASS contain iron sulphides which have oxidised and PASS contain iron sulphides which have not oxidised.

The ASS risk maps for the area prepared by the former Department of Land and Water Conservation (now OEH) indicate the following:

- there is a high probability of occurrence of ASS materials within sediments of the Hunter Estuary;
- there is a high probability of occurrence of ASS materials within 1 m of the surface in some parts of the T4 project area, in proximity to the existing Kooragang Island main rail line;
- the majority of the T4 project area comprises 'disturbed terrain' due to previous filling and land reclamation. The ASS potential of these areas can be determined by soil investigations.

ASS screening tests and detailed analytical testing of soil samples done as part of this EA found that the natural soils and sediments within the T4 project area are PASS. They may however have some buffering capacity (presence of acidity-neutralising materials), which would neutralise acid generation to an extent and reduce the net acidity value if oxidation were to occur.

Previous tests of Hunter River sediments have indicated the possible presence of ASS, though past experience with dredging from the Hunter River has shown that the buffering capacity of saline water entrained with dredged material would neutralise acid generation and specific management measures would not be required.

Testing of coal washery reject material at the KIWEF undertaken as part of this EA found that this material has some potential for acid generation upon oxidation, however, due to the material's buffering capacity, any acid generated would likely be neutralised. The potential for acid generation from coal washery reject material is therefore considered to be low. This is generally consistent with the results of previous investigations of coal reject material at the KIWEF.

7.1.3 Soil contamination

Soils in the T4 project area have elevated concentrations of a range of contaminants, reflective of past waste emplacement, reclamation and filling. Fill includes material dredged from the Hunter River and waste from the former BHPB steelworks and BHPB subsidiaries, including coal washery reject, slag, coal fines, oil/tarry sludge, clayey silt filter cake, kiln wastes, cell scale (gypsum and manganese dioxide), asbestos, basic oxygen steel-making (BOS) flue dust and lime sludge. Historic waste emplacement locations are shown in Figure 2.6. Licensed waste emplacement facilities that have operated in the T4 project area (refer Section 2.5.3 i) comprise the:

- KIWEF, 1972 – 1999: waste disposal cells (Ponds 1 to 39) that have been filled with waste from the former BHPB steelworks and BHPB subsidiaries, along with general refuse dumps surrounding the ponds;
- Delta EMD site, 1989 – 2009: four landfill cells overlying the former KIWEF Ponds 33 to 36 that have been filled with waste from an EMD plant; and
- FDF, 1993 – present: Cells 1 to 5, that are periodically used to receive and store dredged material trucked from the Hunter River associated with expansion works at KCT. Cells 4 and 5 were formerly KIWEF Ponds 37 to 39. Emplacement activities at the FDF are likely to be completed before construction of the T4 Project starts.

In its contamination investigations Douglas Partners focussed on six general areas of the T4 project area, referred to as Sites A, B, C, D, E and F. Figure 7.1 shows the locations and naming/numbering system for these sites, as well as the former KIWEF disposal cells. The existing environment and potential impacts are generally described separately for Sites A to F due to their different waste emplacement histories and associated differences in contamination. The waste emplacement histories for Sites A, B, C, D and F are summarised in Table 7.2. Site E has not been subject to waste emplacement activities and is therefore not included in this table.

Table 7.2 Waste emplacement history

Site	Former waste emplacement areas	Waste
A	KIWEF waste disposal cells (Ponds 1 to 12), asbestos disposal cell and general refuse dumps.	Waste from the former BHPB steelworks and BHPB subsidiaries, including slag, coal washery reject, oil and tar sludge, asbestos and general refuse.
B	KIWEF waste disposal cells (part Ponds 13 to 19, 21, 23 and 25).	Waste from the former BHPB steelworks and BHPB subsidiaries, including slag and coal washery reject. Only minor fill has been undertaken on the southern side of Cormorant Road.
C	KIWEF waste disposal cells (Ponds 33 to 36).	Waste from the former BHPB steelworks and BHPB subsidiaries, including slag and coal washery reject.
	Delta EMD waste emplacement facility (four landfill cells overlying former KIWEF Ponds 33 to 36).	Waste from an EMD plant.
D	KIWEF waste disposal cells (Ponds 37 to 39).	Waste from the former BHPB steelworks and BHPB subsidiaries, including slag and coal washery reject.

Table 7.2 Waste emplacement history

Site	Former waste emplacement areas	Waste
	PWCS FDF (Cells 1 to 5).	Dredged material from Hunter River South Arm including cement modified dredged sediment from BHPB's Hunter River Remediation Project.
F	Filling with industrial waste.	Brecketts, blast furnace slag, brick, refractory, iron ore, coal washery reject and other steel making wastes.

Soil contamination has been characterised based on a review of historic filling and waste disposal records, EPA notices and several geotechnical and contamination studies previously undertaken at and around the T4 project area, augmented by field investigations at Sites A to D undertaken for this EA. Soil testing locations are shown on Figure 7.2.

A summary of existing soil contamination is provided below for Sites A to F respectively and localised zones of contamination are shown on Figure 7.3. Groundwater and surface water contamination is described separately in Chapters 8 and 9.

i Site A

Site A comprises the western part of the former KIWEF. Ground surface levels range from 3 to 12 m AHD, being lowest in the western parts of Site A and highest around the asbestos disposal cell in the north-east.

Elevated pH and concentrations of metals, in particular manganese, copper and zinc, associated with coal washery reject and slag waste have been recorded across Site A. There are also localised zones where contaminants are concentrated, including the following (refer Figure 7.3):

- Localised zones of elevated polycyclic aromatic hydrocarbon (PAH) and total petroleum hydrocarbon (TPH) concentrations.
- Asbestos burial pits at Area K7 near the northern boundary of the T4 project area where there are plastic bags of leaded steel dust co-disposed with asbestos. This area is currently contained by a surface capping layer.
- Ponds 5 and 7 where there is non-aqueous phase liquid (NAPL) hydrocarbon contamination (tar waste) to depths of approximately 8 m, with associated elevated concentrations of hydrocarbons in the soil, namely BTEX (benzene, toluene, ethylbenzene, total xylenes), PAHs and TRHs. These ponds have permeable walls and no side or base lining and so while the hydrocarbon contamination originated at Pond 5, it has migrated to part of Pond 7. The likely extent of hydrocarbon impacted soil, determined by the investigations for this EA, is shown on Figure 7.3. There is an existing geo-synthetic clay liner (GCL) cap over part of Pond 5, however, it does not extend over the full extent of identified tar impact.
- Area K3, which contains a localised area of lead contamination associated with BOS flue dust.

ii Site B

Site B comprises land to the north and south of Cormorant Road (Figure 7.1). The ground surface in the northern portion ranges from approximately 9 m AHD to 10.6 m AHD east to west. The waterfront land is mostly low-lying mudflats with a ground surface of 0.5 to 3.5 m AHD.

Soil contamination within Site B includes:

- localised areas of PAH contamination within waste disposal ponds 13 to 19, 21, 23 and 25;
- localised area of lead contamination at Pond 25 associated with BOS flue dust (only a small portion of Pond 25 is within the T4 project area); and
- localised area of light non-aqueous phase liquid (LNAPL) hydrocarbon (lubricating oil with trace amounts of diesel) contamination at the northern boundary of Site B, around monitoring Well B-01 (Figure 7.3).

The portion of Site B south of Cormorant Road comprises only minor fill and is considered to have low potential for contamination.

iii Site C

Site C, comprising the former Delta EMD waste disposal facility, is located centrally within the T4 project area (Figure 7.1). Ground surface levels range from 2.5 to 5 m AHD. Soil contaminants within Site C include:

- heavy metals including iron, manganese and zinc derived from the dredged Hunter River sediments placed over the area during reclamation activities in the 1960s and 1970s, as well as waste from the BHPB steelworks and EMD plant;
- elevated pH and concentrations of PAHs (including benzo(a)pyrene), TPHs and BTEX associated with the KIWEF waste; and
- elevated concentrations of sulphur and potassium associated with EMD waste.

iv Site D

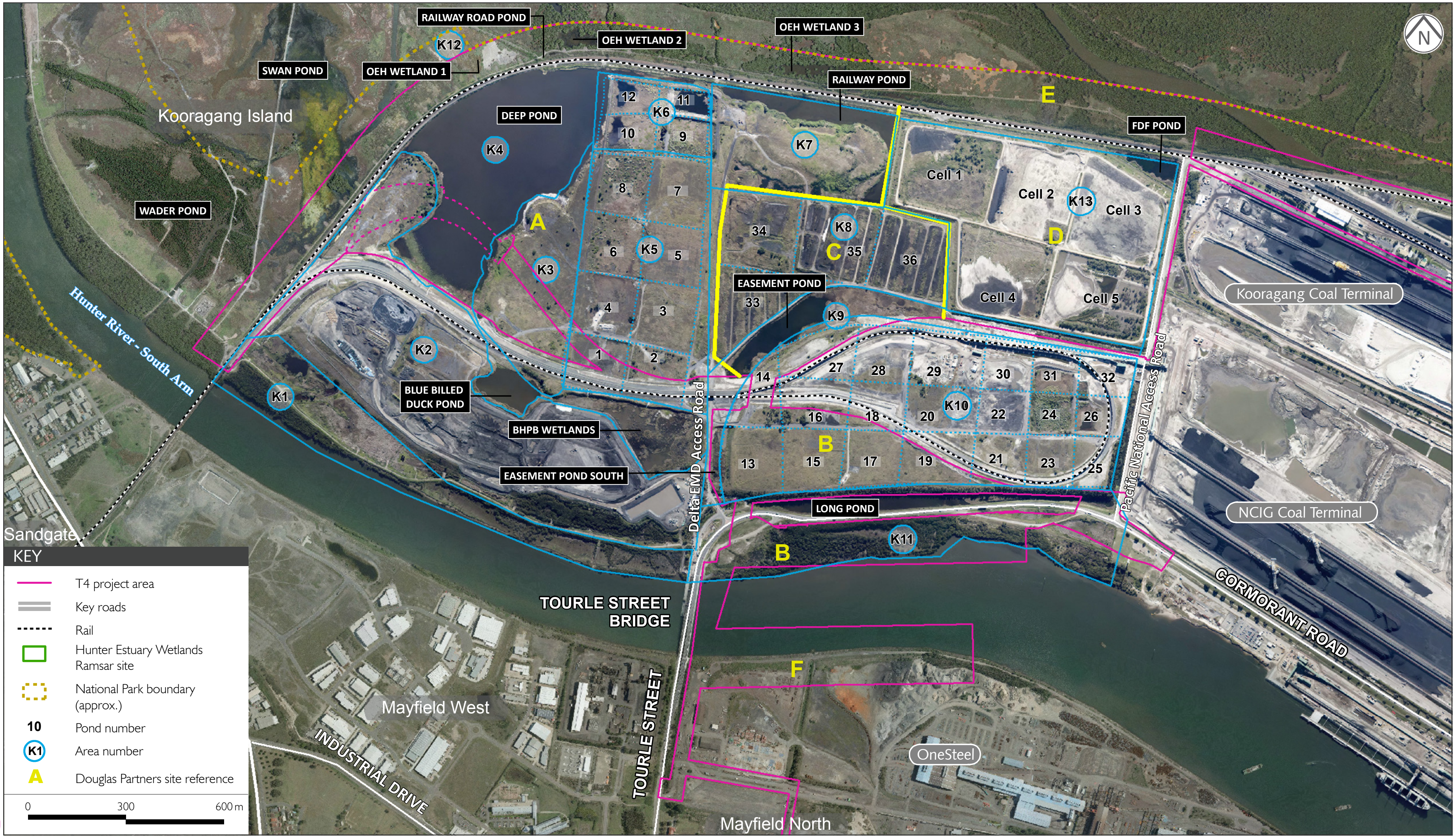
Site D, comprising the FDF, is located in the north-eastern portion of the T4 project area (Figure 7.1). The cell walls of the FDF are generally at 7.5 to 7.8 m AHD, while the ground surface within the cells varies from 3.5 to 6.5 m AHD, depending on the level of fill.

Contamination is variable and dispersed. While most soil testing results for the area complied with the relevant criteria, the following soil contaminants have been recorded at elevated levels:

- hydrocarbons, including PAHs (total PAHs and benzo(a)pyrene), BTEX and TRHs; and
- pH and heavy metals (chromium, copper, lead, manganese, mercury and zinc), associated with dredged sediments from the Hunter River.

v Site E

Site E comprises a low lying corridor of land approximately 100 m wide, located immediately west and north of the existing Kooragang Island main rail line, within the Special Activities zone (SP1) (Figure 7.1). This area contains remnant vegetation and has a low likelihood of soil contamination. Accordingly it has not been subject to detailed contamination assessment.



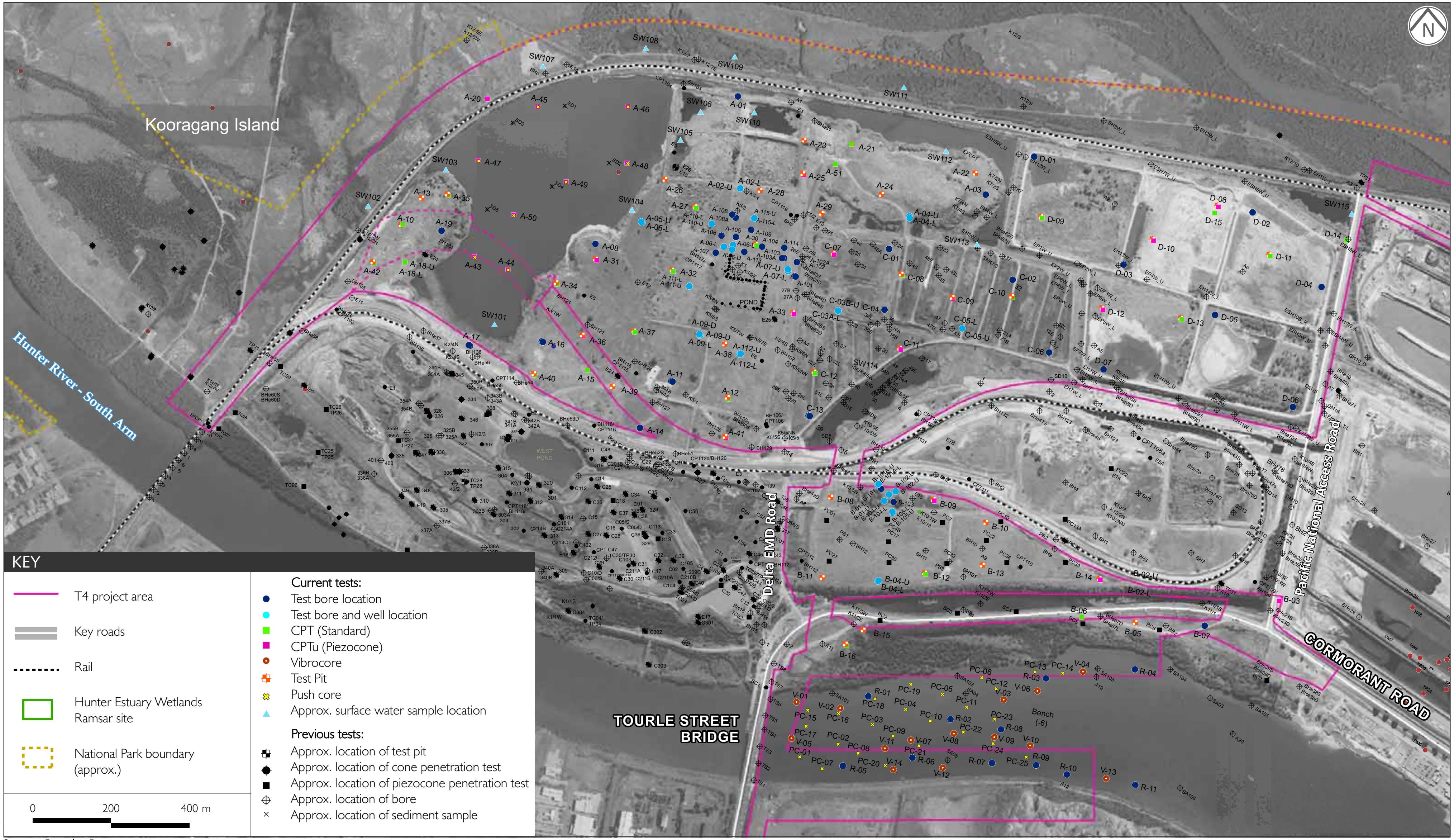
Source: Douglas Partners
Aerial photo source: 2011 Sinclair Knight Merz Pty Ltd.

Locations of Sites A,B,C,D,E and F and waste disposal cells

T4 Project - Environmental Assessment

FIGURE 7.1

EMM PWCS



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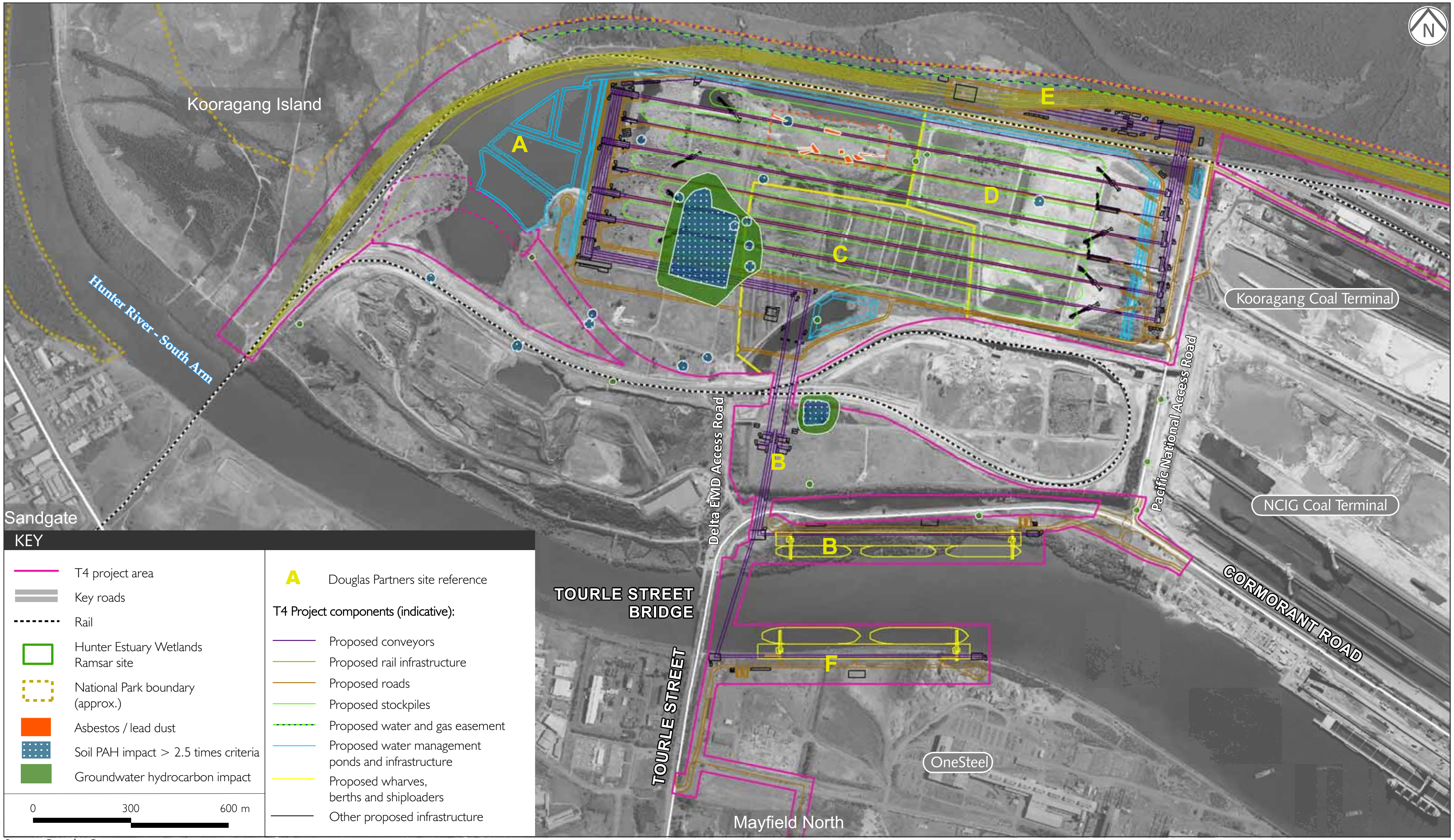
Source: Douglas Partners
Aerial photo source: 2011 Sinclair Knight Merz Pty Ltd.

Soil and Water Test Locations

T4 Project - Environmental Assessment

FIGURE 7.2



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Source: Douglas Partners
Aerial photo source: 2011 Sinclair Knight Merz Pty Ltd.

EMM

PWCS

Contamination zones

T4 Project - Environmental Assessment

FIGURE 7.3

vi Site F

Site F is on OneSteel's land on the south bank of the Hunter River South Arm (Figure 7.1). Parts of the OneSteel site to be developed by the T4 Project are mostly relatively flat reclaimed industrial land that have been extensively filled.

The OneSteel site is included on the 'List of NSW Contaminated Sites Notified to OEH'. Information on historic filling and industrial activity, EPA notices issued for the site (15008, 16003 and 19033) and environmental investigations between 2002 and 2009 indicate that the principal contaminants within Site F are benzene, PAHs (including naphthalene), petroleum, phenols, metals, cyanide and ammonia. Based on knowledge of past filling and industrial activity and known contamination at adjacent sites where similar land use has occurred, the possibility of additional organic and inorganic contaminants within Site F cannot be discounted.

7.1.4 Capping strategies

In December 2010, OEH approved the surrender of EPL 6437, which related to Site A and the northern part of Site B. The approval included conditions relating to final capping (to be implemented by 28 March 2013), materials management, environmental monitoring and reporting. The main features of the approved capping are as follows:

- 0.5 m cap comprising coal washery reject, compacted to achieve a permeability of $1x10^{-7}$ m/s;
- surface grades of not less than 1%;
- Pond 5 – maintain existing GCL cap, minor re-contouring, extend the cap nominally 20 m past the boundary of Pond 5 and compact it to achieve a permeability of $1x10^{-8}$ m/s;
- minimise disturbance to the asbestos disposal area (the existing cap over this area is considered to be sufficient); and
- in relation to general earthworks (cut/fill) for regrading, capping and final landform preparation, any cut material that is significantly contaminated, as defined in a materials management plan, will be disposed off-site or relocated to a nominated containment cell.

These capping works do not form part of the approval sought for the T4 Project. While currently subject to negotiations, it is understood that HDC will implement these works in areas not developed during Stage 1 of the T4 Project. Construction of the low permeability stockyard and sealed surfaces during Stage 1 will form the cap over areas not covered by HDC's capping. Subsequent stages of the T4 Project will effectively create a new cap and render the underlying HDC capping redundant.

Site C operates under EPL 7675. The licence was revised in 2009 to reflect the following capping strategy:

- seal bearing surface – regrading of in situ materials;
- sealing layer – low permeability ($3\ x10^{-11}$ m/s) GCL cap; and
- hardstand surface (pavement material).

These capping works do not form part of the T4 Project, however a low permeability base is proposed to be installed before dredge material emplacement starts (refer Section 8.3.2 iv). Ultimately, the constructed stockyard will form the final cap in Site C, as elsewhere. This will form part of a revised closure plan for Site C.

Site D operates under EPL 5022. PWCS proposes to submit a closure plan for this site that is consistent with the T4 Project.

7.2 Impact assessment

7.2.1 Purpose and objectives

The purpose of the contamination assessment was to:

- characterise soil and groundwater contamination so that the potential effects of the T4 Project could be assessed; and
- determine appropriate mitigation measures to effectively manage site contamination.

The objectives of the contamination assessment were to ensure that the T4 Project could be constructed and operated in a manner that would protect the environment and human health. Environmental values that require protection are the:

- wetlands in the Hunter Wetlands National Park;
- Hunter Estuary Wetlands Ramsar site; and
- north and south arms of the Hunter River.

The potential risk to these areas is associated with the potential for contaminant migration through groundwater.

7.2.2 Methodology

Soil contamination has been characterised by collating and reviewing historic filling and waste disposal records, EPA notices and data from several geotechnical and contamination studies previously undertaken at and around the T4 project area. This includes numerous environmental investigations at Site F and other areas of the OneSteel site between 2000 and 2009, and sediment sampling results from the Hunter River South Arm, where dredging is proposed. This sampling in the Hunter River was done as part of an approved Sampling Analysis Plan to support an application for a sea dumping permit to DSEWPC and characterise the sand to be used as fill for the T4 Project.

To provide more information on the presence, extent and level of contamination, and identify requirements for remediation and management, field-based investigations were undertaken at Sites A to D as part of this EA. The field investigations were designed to complement existing information. Additional field work for the T4 Project investigations included:

- A total of 44 new test bores, 47 cone penetration tests (22 standard and 25 piezocone), 46 test pits excavated by backhoe, eight push cores (in Deep Pond) and 24 monitoring wells and 15 standpipes, at the locations indicated on Figure 7.2.
- Soil sampling and testing at National Association of Testing Authorities (NATA) registered laboratories, as follows:

- Testing of soil contaminant concentrations in 105 soil samples. Soil samples were analysed for metals, ammonia, hydrocarbons (TRHs and PAHs), BTEX, total phenols, total cyanide, total organic carbon (TOC), asbestos and pH.

- Sulphate and chloride testing to enable preliminary assessment of soil aggressivity to concrete and steel structures.

- Waste classification of soils in accordance with OEH's *Waste Classification Guideline* (DECCW 2009), including leachability testing to assess the potential for soils to release chemical contaminants into the environment through contact with liquids and subsequent production of leachates.

- Soil screening tests and detailed analytical testing for ASS, undertaken in accordance with the Acid Sulphate Soils Management Advisory Committee (1998) *Acid Sulphate Soils Manual* and Ahern et al. (2004) *Acid Sulphate Soils Laboratory Methods Guidelines*.

The soil sampling and testing programme was in accordance with a Sampling Analysis and Quality Plan (SAQP) (Section 7.2 in Appendix C) prepared by Douglas Partners and independently reviewed by Dr Bill Ryall. The sampling procedures generally concur with OEH guidelines and current industry practice. Testing was done in conjunction with surface water and groundwater testing. Detailed methodology is provided in Appendix C.

To assess soil contamination, test results were compared against the following OEH guidelines and criteria:

- DEC (2006) *Guidelines for the NSW Site Auditor Scheme, 2nd edition*. These guidelines contain health-based contaminant criteria for different land uses set by the Commonwealth National Environmental Health Forum (NEHF). The relevant criteria for the T4 project area are the commercial/industrial land use criteria (NEHF criteria F).

- EPA (1994) *Guidelines for Assessing Service Station-site*s. The sensitive land use criteria in these guidelines were used to assess BTEX and TRH.

- DECC (2009) *Waste Classification Guidelines, Part 1: Classifying Waste*. These guidelines were used to assess waste classification of soils.

A total of 1,309 soil samples were collected during the investigations. Of these, 105 soil samples were tested for total contaminant concentrations. Sample selection for testing included consideration of the likely presence of contamination based on material type, visual or olfactory evidence of possible contamination (ie odour or staining), proximity to a known source of contamination, and whether generally representative of soil/fill conditions, in order to characterise site contamination. The soil sampling and testing complemented historical data.

The results have been incorporated into the existing environment descriptions in Sections 7.1 and 7.2.3 and are provided in detail in Appendix C.

7.2.3 Soil testing results

i Contaminant concentrations

Laboratory soil testing results for the T4 Project investigation were generally within the DEC (2006) health-based criteria for commercial/industrial land use (NEHF criteria F) and EPA (1994) criteria for sensitive land use (BTEX and TRH). Contaminant concentrations which exceeded land use criteria included:

- metals, total PAH, TRHs, BTEX and/or benzo(a)pyrene at 58 sampling locations across Sites A to D; and
- total PAH, TRHs, benzene, toluene and/or benzo(a)pyrene at 25 sampling locations across Sites A to D.

Contaminants with concentrations exceeding the DEC (2006) NEHF criteria F by 2.5 times were recorded at 36 sampling locations, and included metals, TRHs, BTEX, total PAH and benzo(a)pyrene (refer Figure 7.3 and Drawing 2.15 in Appendix C). The soil testing results have been incorporated into the existing environment description in Section 7.1 and are presented in detail in Appendix C.

ii Aggressivity

Soil aggressivity is not an environmental risk but may affect the stability and integrity of structures that come into contact with these soils. Preliminary testing for soil aggressivity to concrete and steel structures generally indicated 'non-aggressive' or 'mild' conditions. This is a design consideration only. Further assessment is recommended in areas containing elevated soil or groundwater contamination, where permanent contact with steel or concrete structures could occur, to determine design specifications for adequate protection of these structures.

iii Waste classification and leachability

Classification of soils in accordance with the DECCW (2009) *Waste Classification Guidelines* identified that, based on total chemical contaminant concentrations, the soil samples were classified as 'General Solid Waste', Restricted Solid Waste' and 'Hazardous Waste'. Leachability testing showed that some samples had a lower potential for leaching, which would reduce the waste classification.

7.2.4 Acid sulphate soils

The T4 Project has been designed to minimise disturbance of subsurface materials. However, some excavation will be undertaken, including for construction of the dump stations and conveyor tunnels and relocation of gas and water mains, and may disturb materials containing PASS. If not managed appropriately, disturbance of PASS and exposure to air can cause the iron sulphides to oxidise, producing sulphuric acid, and heavy metals can be mobilised, both of which can lead to environmental impacts. The soils may have some buffering capacity, which would reduce the net acidity value. Notwithstanding, in the event that PASS are to disturbed (excavated or dewatered) during T4 Project construction activities, suitable measures are readily available to manage the potential risks associated with acid generation (refer Section 7.3.1) and have been effectively implemented at other locations on Kooragang Island, including by PWCS.

As described in Section 7.1.2, past experience has been that Hunter River sediments to be dredged may include ASS, however, the buffering capacity of saline water would neutralise acid generation and specific management measures are not likely to be required. However, as a precaution, monitoring and contingency measures are proposed during dredge material emplacement.

As described in Section 7.1.2, testing to assess the acid generating potential of coal washery reject material determined that the potential for acid generation was low, when considering the buffering (neutralising) capacity of this material. However, as a precaution, monitoring and contingency measures are proposed during any disturbance of coal reject materials.

7.2.5 Soil contamination

The key risks associated with soil contamination in the T4 project area are:

- Potential for excavation to disturb/expose contaminants which may pose a human health and/or environmental risk.
- Potential for increased leaching of existing soil contaminants to groundwater and mobilisation through groundwater, with associated impacts to receiving water bodies without mitigation. This could occur due to a temporary rise in groundwater levels during dredge material emplacement, potentially bringing contaminants in contact with the groundwater, and soil 'squeezing' under the weight of T4 Project fill and infrastructure, forcing pore water out of the soil profile (refer Section 8.2).
- Potential for dredged material placed across the site to contain contaminants.

In addition to low-level industrial contamination across Sites A, B, C, D and F, specific areas of soil contamination requiring management are:

- Site A – Ponds 5 and 7, where further leaching and migration of hydrocarbon contamination (tar waste) could occur. The existing GCL cap is not large enough to adequately manage the existing tar contamination or additional effects of T4 Project loading and its integrity could be compromised by ground settlement under the T4 Project load.
- Site A – asbestos burial pits, where there is a risk of mobilising contaminants (particularly lead) through groundwater if the lead dust comes into contact with groundwater. It is noted that the existing capping over this area is considered adequate to minimise infiltration of surface water. Excavation in this area would be limited to the overlying refuse with limited penetration of the cap.
- Site B – near Well B-01, where further migration of LNAPL hydrocarbon contamination could occur. The area of lead contamination at Pond 25 is not likely to be disturbed by the T4 Project.
- Site C – Delta EMD site, where if unmitigated, further migration of heavy metals (particularly manganese) and hydrocarbons could occur.
- Site D – FDF, where further leaching and migration of existing contaminants (principally PAHs, TRHs and heavy metals) could occur, particularly if the existing leachate collection system fails (refer Section 8.2.3 v).
- Site F – OneSteel site, where excavation may expose contaminated soils, including a benzene impacted area. If unmitigated exposed contaminants could pose an environmental and health risk, particularly to the adjacent Hunter River South Arm.

The above risks are predominately groundwater-related and have been assessed by detailed groundwater and contaminant transport modelling. The outcomes are presented in Chapter 8 and Appendix E. Contaminant management and remediation strategies are proposed, as identified in Sections 7.3 and 8.3, and will minimise the potential for adverse impacts associated with contamination.

Initial sampling results for sediments to be dredged from the Hunter River South Arm indicate that they contain uniformly low concentrations of all contaminants, well below even the highly conservative guideline values for ocean disposal. Accordingly, the contamination status of sandy material should pose no impediment to placement of this material on the T4 project area. Further testing is being undertaken in support of the sea dumping permit process.

7.2.6 Human health

A qualitative human health exposure assessment was prepared by Banksia EOHS Pty Limited (Appendix F in Appendix C). The potential for disturbing contaminated material during construction and remediation activities and associated exposure of workers to contaminants was the main health risk identified. This risk is minimised by the project design, which restricts disturbance to in situ contaminated materials, however, the assessment conservatively assumed the highest contaminant concentrations recorded in the T4 project area would be encountered.

Banksia EOHS Pty Limited found the health risk to workers and the surrounding community can be effectively managed during construction by site-specific procedures, personal protective equipment (PPE) and conventional earthwork controls. The proposed contamination remediation and management measures, including capping (refer Section 7.3), will prevent human access/contact with contaminants during operations. Subject to implementing these measures, health of the T4 Project's construction workers and the surrounding community will be protected during the T4 Project's construction and operation.

Douglas Partners supported this conclusion, noting that with mitigation, off-site contaminant levels will be similar to or less than relevant Australian and New Zealand Environment Conservation Council (ANZECC) (2000) trigger values or background levels (as applicable) and so human health risks will be effectively managed during and after construction of the T4 Project.

7.3 Management and monitoring

7.3.1 PASS management

Dredged material brought to site and any disturbance (dewatering or excavation) of PASS and coal reject materials will be managed in accordance with a site-specific acid sulphate soil management plan (ASSMP) to reduce and manage the potential risks associated with acid generation. The ASSMP will be prepared prior to any soil disturbance and will include routine pH monitoring of dredged materials and dredge return water, contingencies for treatment if required, and lime treatment of PASS during earthworks, to neutralise any acid generation. Such measures have been effectively implemented at other locations on Kooragang Island, including by PWCS.

7.3.2 Contamination

The proposed development of the T4 project area presents an opportunity to improve its environmental condition by implementing strategies that minimise exacerbation of existing contamination and long-term risks associated with this contamination.

A review of available contamination management and remediation strategies was undertaken for the higher risk areas of contamination identified within the T4 project area (Appendix F). Preferred options were selected and are outlined in the ORAP (Appendix G). The strategies are mostly to minimise the risk of contaminant mobilisation and migration through groundwater and so are described in Section 8.3. Once the management and remediation measures have been finalised and agreed with relevant stakeholders, they will be fully detailed in a remediation action plan (RAP), to be approved by OEH prior to implementation.

Construction activities for the T4 Project will include some excavation of contaminated fill. Excavated material will be managed through a Materials Management Plan (MMP), which will be part of the CEMP. The MMP will include re-use and disposal specifications for excavated material. Excavated materials will be classified dependent on the level of contamination and geotechnical characteristics, likely as either:

- suitable for unrestricted re-use within the T4 project area;
- suitable for restricted re-use within the T4 project area; and
- not suitable for re-use (for example NAPLs and asbestos).

Depending on its classification, the excavated material may then be re-used as general fill or placed in purpose-built containment cell(s) within the T4 project area. This is consistent with requirements of the OEH approved capping strategy for Sites A and the northern portion of Site B, under EPL 6437.

A preliminary assessment of suitable locations for a containment cell(s) within the T4 project area was undertaken. Key design and siting considerations include the following:

- cell(s) should be as far as practical from sensitive receptors;
- base level should be at least 1.5 m above highest expected groundwater level;
- if under the proposed stockyard area, the cell(s) should be designed to withstand preloading and T4 Project loads, and geotechnically unsuitable material will have to be improved/stabilised or separated and placed in non-loaded areas;
- the location and design should allow for the cell size to be increased if necessary, given that the final volume of material not suitable for re-use is currently unknown; and
- the cell(s) cannot be located where piles will be installed, for example within the footprint of a transfer house, buffer bin, conveyor or other piled structure.

Douglas Partners identified that there are a number of suitable locations for an on-site containment cell within the T4 project area, eg within the Delta EMD site or at Site B North. A detailed site selection and design process will be undertaken before construction starts. This process will include mapping the areas and depths of excavation, assessment of the likely composition of the materials to be excavated, sizing of the cell, design of the lining system and preparation of construction procedures.

The OEH approved capping strategies for the KIWEF and Delta EMD site under EPLs 6437 and 7675 include a seal-bearing surface and low permeability sealing layer. The T4 Project would provide equivalent or superior capping to that already approved. This will include low permeability capping, by way of the surface paving, liners at the water management ponds, low permeability cement-stabilised sand over the yard machinery berms and a basal layer of low permeability sand-cement-bentonite mix or equivalent at the stockpile pads. The T4 Project construction is likely to effectively provide a sealing layer with hydraulic performance equivalent to a 0.5 m capping layer with permeability less than $1x10^{-8}$ m/s. The T4 Project's construction will also provide capping at areas other than the KIWEF and Delta EMD site, including at the OneSteel site, which will contribute to managing contamination there.

7.3.3 Aggressivity

For detailed design purposes, further assessment of soil aggressivity to concrete and steel structures is recommended in areas containing elevated soil or groundwater contamination where permanent contact with steel or concrete structures could occur. The testing results will be used to determine appropriate specifications for concrete and steel corrosion protection. As most areas will be filled with dredged sand (non-aggressive) this will only be relevant to piles and certain pipelines.

7.3.4 Human health

Health protection requirements for workers, to minimise their exposure to contaminants, will vary across the T4 project area depending on the nature of construction activity and contamination in particular areas. The requirements will be included in the CEMP and may include:

- use of specific PPE and procedures in areas where contaminants may exceed the safe threshold values; and

- use of exclusion zones where appropriate.

The management and remediation measures described in Sections 7.3.2 and 8.3, including capping, will be adequate to prevent access to contaminants during operations and protect human health.

7.4 Conclusions

The purpose of the contamination assessment was to characterise contamination at the T4 project area and identify appropriate management and remediation measures to effectively manage site contamination.

Soils within the T4 project area have elevated concentrations of a range of contaminants including metals, hydrocarbons, BTEX and pH, reflective of past filling and waste emplacement. There is general low level industrial contamination across the T4 project area, as well as localised areas where contaminants are more concentrated. The key areas of contamination requiring management are:

- Site A – soil contamination associated with tar waste in Ponds 5 and 7 and lead dust co-disposed with asbestos at burial pits near the northern boundary of the T4 project area;

- Site B – localised area of LNAPL phase hydrocarbon contamination;

- Site C – heavy metals (particularly manganese), hydrocarbons and other contaminants at the Delta EMD site;

- Site D – hydrocarbons and metals at the FDF; and

- Site F – benzene, PAHs (including naphthalene), petroleum, phenols, metals, cyanide and ammonia at the OneSteel site.

The T4 Project provides an opportunity to reduce the existing contamination risks, including risks to the adjacent wetlands and the Hunter River, and contribute to the responsible development of an area that is contaminated. The proposed remediation and management measures for the T4 Project have been designed to meet regulatory guidelines and requirements and ensure protection of human health and the environment.

Natural soils and sediments underlying fill materials within the T4 project area are PASS. There are also ASS risks associated with material to be dredged from the Hunter River. The potential for acid generation from fill materials comprising coal washery reject is low. Dredged material brought to site and any disturbance of coal washery reject material and natural soils and sediments will be managed in accordance with a site-specific management plan to reduce the potential risks associated with acid generation. Such measures have been effectively implemented at other locations on Kooragang Island, including by PWCS.

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8 Groundwater

This chapter summarises the groundwater assessment report and groundwater components of the summary of contamination issues - Site F (part of OneSteel site), remediation options report and ORAP. These reports were all prepared by Douglas Partners and are included as Appendices D to G. The groundwater assessment report was independently reviewed by Dr Noel Merrick.

8.1 Existing environment

8.1.1 Aquifers

Groundwater beneath the T4 project area is contained in an upper unconfined aquifer in the fill material ('Fill Aquifer'), and a generally confined aquifer within the underlying estuarine sediments ('Estuarine Aquifer'). These are separated by a clay aquitard. The depth to bedrock varies from about -5 m to -62 m NHTG.

Contours of groundwater head for the Fill and Estuarine Aquifers, based on water level gauging at 150 wells and several surface water features on 25 November 2010, are included in Figures 8.1 and 8.2.

i Fill Aquifer

The Fill Aquifer is contained within the layer of waste and dredged fill, which typically has low to moderate permeability. It is unconfined, which means it can freely drain to and be recharged from the surface, and the water table fluctuates accordingly. The Fill Aquifer is predominately recharged by rainfall, with sub-horizontal flows towards surface water features, though some leakage occurs through the clay aquitard down to the Estuarine Aquifer.

The groundwater contours in Figure 8.1 show that there are several groundwater mounds within the water table, up to around 6.5 m NHTG. These mounds represent areas of groundwater recharge. They are generally at areas of higher topography and are bounded by surface water bodies where groundwater intercepts/drains to the surface. There is no significant groundwater mounding below the FDF (Site D); groundwater levels at this location are likely to be controlled by an existing leachate collection system.

ii Aquitard

The Fill and Estuarine Aquifers are separated by a natural clay aquitard, which typically ranges from less than 1 m to around 5.5 m thick, though is over 15 m thick in places. The aquitard has low permeability, though sufficient to allow some downward flow to the Estuarine Aquifer. The aquitard is possibly absent at some locations, allowing localised connectivity between the Fill and Estuarine Aquifers, however, no specific evidence of this was observed in the investigations for this EA.

iii Estuarine Aquifer

The Estuarine Aquifer consists of a sand layer of moderate to high permeability that varies from several metres to approximately 30 m thick, and also includes interbeds of sand at varying depths within the underlying clay layers. The Estuarine Aquifer is generally confined between low permeability clay layers and the water is stored under pressure. The phreatic surface (the height at which a water table would form in a bore connected only to the Estuarine Aquifer) is however below the water table in the Fill Aquifer, thereby allowing some vertical infiltration from the Fill Aquifer.

The contours in Figure 8.2 show that groundwater heads in the Estuarine Aquifer form a north-south ridge line below the western parts of the Delta EMD site (Site C) and a smaller east-west ridge line across Site C. Groundwater flows are generally sub-horizontal from the ridge lines to the north, west and south, toward the north and south arms of the Hunter River. Seepage rates in the Estuarine Aquifer towards the Hunter River are estimated to be in the order of 15 m to 20 m per year. There is groundwater mounding below Site C, likely to be mostly due to its relatively central location between the northern, western and southern flow boundaries, however, potentially also due to the aquitard being thinner and more permeable there, compared to others parts of the T4 project area.

iv Summary of groundwater flow patterns

The T4 project area groundwater flow patterns are generally summarised as follows:

- rainfall infiltrates to the Fill Aquifer;
- mounding of the water table occurs within the Fill Aquifer with sub-horizontal flow toward surface drainage features;
- vertical percolation occurs through the clay aquitard to the underlying Estuarine Aquifer; and
- sub-horizontal flow occurs within the Estuarine Aquifer, toward the Hunter River North Arm, tidal wetlands to the north and west (to a minor extent) and the Hunter River South Arm.

8.1.2 Surface water interactions

Groundwater, primarily within the Fill Aquifer, interfaces with surface water bodies in and around the T4 project area. The surface water bodies mentioned in the following sections are described in Chapter 9 and shown on Figure 9.1.

Ponds in the T4 project area that discharge to the Fill Aquifer and receive recharge from it include Deep Pond, Ponds 9 to 12, Railway Pond, FDF Pond and Long Pond.

Some seepage occurs from ponds in the T4 project area to surrounding water bodies mostly via the Fill Aquifer. This includes from Deep Pond, FDF Pond and Railway Pond, through the rail embankment to OEH Wetlands 2 and 3, and potentially to a limited extent from Deep Pond toward OEH Wetland 1, Railway Road Pond and Swan Pond. The artificially modified BHPB Wetlands and Blue Billed Duck Pond, to the south of the NCIG rail loop, are also expected to receive groundwater flows from beneath the T4 project area.

The Fill Aquifer discharge boundaries are expected to be Swan Pond to the west, the Hunter River South Arm to the south and the Hunter River North Arm to the north. Groundwater does not flow east, beyond the boundary of the proposed stockyard area.

The Estuarine Aquifer has its primary discharge boundaries at the north and south arms of the Hunter River. The Estuarine Aquifer receives vertical leakage through the clay aquitard, particularly in areas where the clay is thinner and/or more permeable, such as the Delta EMD site and Easement Pond. Some minor upward flow periodically occurs from the Estuarine Aquifer to surface water bodies in and around the T4 project area however such flows do not control the water levels in these water bodies.

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Source: Douglas Partners
Aerial photo source: 2011 Sinclair Knight Merz Pty Ltd.

EMM

PWCS

Groundwater level contours - Fill Aquifer (25 November 2010)

T4 Project - Environmental Assessment

FIGURE 8.1

Source: Douglas Partners
Aerial photo source: 2011 Sinclair Knight Merz Pty Ltd.

Groundwater level contours - Estuarine aquifer (25 November 2010)

T4 Project - Environmental Assessment

FIGURE 8.2

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Based on ecological considerations and proximity to the T4 project area, the key surrounding features considered in the groundwater assessment are:

- surrounding wetlands, including BHPB Wetlands, Blue Billed Duck Pond, Railway Road Pond and OEH Wetlands 1, 2 and 3;
- Hunter Estuary Wetlands Ramsar site; and
- north and south arms of the Hunter River.

8.1.3 Groundwater quality

Groundwater quality has been characterised based on data in several groundwater, geotechnical and contamination studies undertaken at and around the T4 project area, including approximately 20 years of groundwater and surface water monitoring data. The monitoring locations are shown on Figure 7.2 and detailed results are provided in Appendix E.

Groundwater beneath the T4 project area has elevated concentrations of a range of contaminants, reflective of past waste emplacement, and closely linked to the soil contamination. Groundwater pH and concentrations of metals (primarily manganese) and PAHs exceeding ANZECC (2000) trigger levels for protection of slightly to moderately disturbed aquatic ecosystems have been recorded across most of the T4 project area. This includes localised contaminant zones, which are indicated on Figure 7.3. The groundwater assessment pays particular attention to the following specific areas of contamination:

- Ponds 5 and 7 (in Site A) where there is NAPL hydrocarbon (tar waste) contamination in the Fill Aquifer. Elevated concentrations of PAHs and ammonia and elevated pH have been recorded in the Fill Aquifer. These ponds have permeable walls and no side or base lining and so while the hydrocarbon contamination originated at Pond 5, it has migrated laterally to part of Pond 7 and to a lesser extent, down to the Estuarine Aquifer. Concentrations of PAHs in the Estuarine Aquifer are lower than for the Fill Aquifer, with only mean concentrations of phenanthrene and anthracene exceeding the relevant ANZECC (2000) trigger values. Metal concentrations in the Estuarine Aquifer are generally higher than in the Fill Aquifer, with mean cadmium, cobalt, copper, manganese and nickel concentrations above ANZECC (2000) trigger values. There is an existing GCL cap over part of Pond 5, however, it does not extend over the full extent of identified tar impact.
- Asbestos burial pits at Area K7 (in Site A), where there are plastic bags of lead dust co-disposed with asbestos, mostly located above the water table.
- Site B, near Well B-01 (Figure 7.3), where there is localised LNAPL hydrocarbon (degraded lubrication oil) contamination in the Fill Aquifer, and to a minor extent in the underlying Estuarine Aquifer.
- Delta EMD site (Site C), where pH and concentrations of metals, PAHs, BTEX, ammonia, sulphate and cyanide have been recorded above ANZECC (2000) trigger levels.
- FDF (Site D), where exceedances of the ANZECC (2000) trigger levels have been recorded for ammonia, cyanide and metals (aluminium, cadmium, copper, mercury, molybdenum and zinc) in both aquifers. Mean contaminant concentrations are generally similar in both aquifers, though some metal concentrations are higher in the Estuarine Aquifer and PAHs are higher in the Fill Aquifer.

- OneSteel site (Site F), where groundwater contamination includes benzene, ammonia, metals, TRHs and some PAHs. In particular there is an area of benzene contamination, regulated under EPL 11149, with reported impact in both the Fill and Estuarine Aquifers. Historic seeps of groundwater contamination from the OneSteel site to the Hunter River have been reported.

It is noted that higher recorded metal concentrations in the Estuarine Aquifer than the Fill Aquifer could reflect natural background concentrations, rather than waste emplacement, with the exception of manganese.

There are also areas of contamination at industrial land adjacent to the T4 project area. Concentrations of PAHs more than 10 times the ANZECC (2000) trigger values have been recorded at some bores near the T4 project area.

8.1.4 Water supply bores

An online search for NOW licensed groundwater bores identified three on Kooragang Island, GW053226, GW200456 and GW200485. Well GW200456 is licensed for industrial irrigation and wells GW053226 and GW200485 are licensed for industrial purposes. These wells are located between 1.5 and 2.3 km east of the proposed stockyard area, within Kooragang Island's industrial area.

8.1.5 Groundwater dependent ecosystems

Groundwater dependent ecosystems in and around the T4 project area are saltmarsh and mangrove forest communities. These are located along the Hunter River South Arm and the northern and western edges of the T4 project area (Figure 10.4). Potential impacts to these communities, including groundwater-related impacts are addressed in Chapter 10 and Appendix K.

8.2 Impact assessment

8.2.1 Purpose and objectives

The groundwater and contamination assessments were undertaken jointly. Their purpose and objectives were the same and are described in Section 7.2.1.

8.2.2 Methodology

The groundwater assessment included field investigations and data collection, and quantitative modelling to simulate groundwater conditions with and without the T4 Project and evaluate the effectiveness of potential mitigations. Groundwater interaction with water bodies outside the T4 project area, including BHPB Wetlands, Blue Billed Duck Pond, Hunter River, Hunter Estuary Wetlands Ramsar site, Railway Road Pond and OEH Wetlands 1, 2 and 3, was a key consideration.

i Field investigations and data collection

Data from numerous past groundwater, geotechnical and contamination studies at and around the T4 project area was reviewed and collated. This included approximately 20 years of groundwater and surface water monitoring data, including from more than 150 wells and piezometers in the Fill and Estuarine Aquifers.

Additional field work for the T4 Project investigations included:

- Site visits in 2010 and 2011 to characterise surface water features, including field measurements of pH and electrical conductivity (EC).
- Measurement of water levels at 150 groundwater wells and piezometers and selected surface water bodies within an eight-hour period on 25 November 2010, to provide a 'snapshot' of water levels across the T4 project area. Contours of groundwater head, based on these measurements, are provided in Figures 8.1 and 8.2.
- Monitoring of groundwater levels between 26 November 2010 and 1 November 2011 by loggers installed at three pairs of Fill/ Estuarine Aquifer wells, and surface water levels at eight water bodies between 7 December 2010 and 1 November 2011, to provide information on how surface water and groundwater interact and respond to rainfall and tidal variations.
- A total of 44 new test bores, 47 cone penetration tests (22 standard and 25 piezocone), 46 test pits, eight push cores (in Deep Pond) and 24 monitoring wells and 15 standpipes, at the locations indicated on Figure 7.2.
- Sampling and laboratory testing of groundwater chemical properties.
- Soil testing for TOC to determine coefficients for contaminant transport modelling.

ii Numerical flow modelling

Steady-state and transient groundwater flow modelling was undertaken using the data described in Section 8.2.2 i; groundwater flow patterns, as established in Section 8.1.1 iv; and the following software:

- MODFLOW with Groundwater Vistas, Version 6.04 Build 17;
- MODFLOW-SURFACT, Version 4.0 numerical engine using PCG5 solver; and
- PEST for preliminary parameter estimation.

The flow models were set up for the T4 project area, extending to the identified flow boundaries (Hunter River South Arm, Hunter River North Arm, western side of Swan Pond and a point near the eastern boundary of the proposed stockyard area). Three layers were created to represent the Fill Aquifer, aquitard and Estuarine Aquifer. The steady state model was calibrated using the 'snapshot' November 2010 groundwater level data and climate data from Bureau of Meteorology (BoM) weather stations at Newcastle Nobbys (station 61055) and Williamtown (station 61078). The transient flow model was calibrated using local rainfall, evaporation and tide data and the four months of logged groundwater and surface water level data available at the time modelling commenced in March 2011. Calibration results are provided in Appendix E.

The flow models were used to simulate existing and future groundwater flows and predict any potential T4 Project-related alterations to water levels, hydraulic gradients and flow rates (which may affect contaminant transport rates) and salinity levels (associated with the dredge material emplacement). Predictions were made for groundwater and surface water bodies in and around the T4 project area, with and without mitigations. The following scenarios were modelled:

- continuation of the existing condition, that is no T4 Project; and
- three phases of T4 Project development:

i. initial construction (Stage 1), including filling with dredged material and preloading for Stage 1 development;

ii. construction of Stages 2 and 3, including progressive preload, construction and capping; and

iii. post construction, that is the scenario where the T4 Project has been fully constructed and capping is complete.

iii Contaminant transport modelling

The numerical flow modelling described above was used to identify potential changes to the groundwater regime which may impact the flux of contaminants from the T4 project area to surrounding surface water bodies, and therefore require mitigation.

Contaminant transport modelling was then undertaken using the modelling software ConSim. The modelling was used to predict the probable range of contaminant concentrations at selected surface water bodies outside of the T4 project area for a probable range of conditions, including continuation of the existing condition, and various T4 Project development options, for example various mitigations. A probabilistic approach was necessary due to factors including the variability in contaminant distribution and potential future flow rates and water levels.

iv Cumulative impacts and interaction with other developments

Groundwater modelling incorporated existing and proposed developments on and adjacent to the T4 project area. This includes the capping proposed by HDC, KCT (and its expansion), NCIG (and its expansion) and the BHPB emplacement area. Details of these developments and how they have been addressed in the model are provided in the groundwater assessment (Appendix E).

8.2.3 Modelling results

The following potential effects of the T4 Project were assessed:

- saline dredge water infiltration;
- soil ‘squeezing’ and contaminant mobilisation under the weight of T4 Project fill and infrastructure;
- excavations and aquitard penetration;
- changes to permeabilities from filling and capping; and
- impacts to the existing FDF leachate collection system.

Effects considered included changes to water levels, flow regimes and quality. The results are discussed in the following sections. Detailed numerical modelling results are provided in Appendix E.

i Dredge water

Dredged material placed across the T4 project area will be transported with saline water from the Hunter River. This water is proposed to be directed to Deep Pond and then back to the Hunter River South Arm following settling treatment, as described in Chapter 3. However, some would infiltrate to groundwater, temporarily increasing the head of water and promoting the flow of saline water toward receiving surface water bodies. In particular, if unmitigated, Deep Pond, where saline water will be stored, presents a risk to water bodies it has groundwater connection with, and the relatively thin aquitard beneath the Delta EMD site could allow saline water infiltration to the Estuarine Aquifer.

The modelling results indicate that without mitigation, temporary net increases in salinity of over 10,000 mg/L would be expected at all ponds in the T4 project area during dredge material emplacement, and at wetlands along the northern T4 project area boundary, including OEH Wetlands 2 and 3 and Railway Road Pond. A net increase in salinity of 1,000 to 5,000 mg/L was conservatively predicted at OEH Wetland 1, and it was considered possible that saline water could reach BHPB Wetlands and Blue Billed Duck Pond. A net increase in salinity levels of over 5,000 mg/L could also occur at Swan Pond, however, this pond is already saline; salinity levels between approximately 17,850 and 53,340 mg/L were measured during the monitoring events in 2011. The salinity would dissipate over a period of around two years following dredge material emplacement.

With mitigation, including liners at Deep Pond and Site C (refer Section 8.3), there would be no significant impact on salinity of assessed ponds and wetlands surrounding the T4 project area. The net increase in salinity levels would be less than 1,000 mg/L (equivalent to the salinity of fresh water) at Blue Billed Duck Pond, BHPB Wetlands, Easement Pond, OEH Wetland 1 and Railway Road Pond, which is less than the existing background salinity concentrations. Field measurements indicate that salinity of the water bodies in and around the T4 project area ranges from about 1,500 mg/L to over 10,000 mg/L due to natural cycles of rainfall and evaporation; these natural fluctuations could continue to occur with the T4 Project. Tidal flats to the north, including OEH Wetlands 2 and 3 could receive some saline inflows, however, these water bodies are already saline and so no significant net impacts are expected.

Dredge water infiltration is predicted to lead to temporary groundwater mounding and increased flow rates. In particular, if unmitigated, leakage to the Estuarine Aquifer could increase groundwater head and flow rates by more than three times, mostly due to leakage through the relatively permeable area under Site C. With mitigation, including a liner at Site C, predicted peak heads in the Estuarine Aquifer were substantially reduced to around 3.0 m NHTG, which is within 0.9 m of their current levels.

No significant changes to water levels at surface water bodies outside the T4 project area are anticipated as a result of dredge material emplacement.

Modelling predicted that there would be no changes to water levels at the tidal flats to the north, including OEH Wetlands 2 and 3 and Ramsar wetlands, as these levels are mostly controlled by rainfall, evaporation and tidal inundation, not groundwater. Similarly, it was predicted that, subject to implementation of the proposed mitigations, water levels at OEH Wetland 1 and Railway Road Pond would continue to fluctuate naturally, within about 0.1 m of levels without the T4 Project. Water levels at these ponds are mostly influenced by rainfall and evaporation, not groundwater.

The proposed capping by HDC will reduce groundwater levels in the Fill and Estuarine Aquifers, which is predicted to lead to a reduction in the typical water levels in the BHPB Wetlands and Blue Billed Duck Pond by about 0.15 m. When the impacts of dredge material emplacement and preloading for the T4 Project are superimposed, there is a temporary increase in water levels of about 0.15 m, followed by a decrease due to the effects of the capping. The temporary impacts during dredge material emplacement can be reduced by the measures described in Section 8.3, for example diverting the dredge water to the north of Ponds 5 and 7 and/or capping higher permeability sections of bund walls. The net long-term difference in water levels at BHPB Wetlands and Blue Billed Duck Pond with and without the T4 Project (assuming the HDC capping would be implemented for the no T4 Project scenario) is predicted to be less than 0.05 m.

The potential effects of increased groundwater levels and flow rates on contaminant transport are described in the following section.

ii Loading, squeezing and contaminant transport

Filling and preloading will lead to consolidation (squeezing) of the underlying soil profile, and force water out of the pore spaces of compressible fine grained silt/clay soils and into the Fill and Estuarine Aquifers. The clay aquitard is the major stratum that would be subject to the squeezing effect. The clay aquitard is generally not a source of contamination, however, the water squeezed from it would temporarily increase flow rates (horizontal and vertical) in the Fill and Estuarine Aquifers. The increased flow rates may affect the flux of contamination already present in the Fill and Estuarine Aquifers. Also a rise in the water table could bring contaminated materials which are currently unsaturated into contact with groundwater, with subsequent contaminant leaching into the groundwater. If unmitigated, there is potential for associated impacts on water quality at receiving surface water bodies.

The volumes of water expelled by the filling and preloading process are predicted to typically range from about 0.55 m^3/m^2 to 0.70 m^3/m^2. Recharge rates on site, other than at existing capped areas such as Pond 5 and the FDF (the latter having a partial informal 'cap' of cement-modified sediment), are estimated to typically range from about 20% to 50% of annual rainfall (about 0.22 m to 0.33 m/year). Consequently, the preloading represents about two to three years' annual recharge rates, which is generally distributed about one-third to the Estuarine Aquifer and two-thirds to the Fill Aquifer.

The above would result in overall increases in flow distances in the Estuarine Aquifer equivalent to about one year's flow for the preloading as a whole. The travel time for groundwater in the Estuarine Aquifer to the Hunter River is estimated to be about 50 years, and therefore any short-term increase in mobility of existing contamination due to increased flow rates from preloading is considered to be insignificant.

The groundwater modelling results indicate that without mitigation, dredge material emplacement and the 'squeezing' effect of T4 Project loading would temporarily increase the rate of contaminant transport through the Fill Aquifer towards Blue Billed Duck Pond, Deep Pond, Easement Pond and OEH Wetland 2. transport of contamination is limited by the leachability of the source contaminants into the expelled water

Travel distances during a two year period of dredge material emplacement and preloading would be roughly equivalent to those which would occur over an eight year period with continuation of the existing condition. At the completion of dredge material emplacement and preloading, PAH concentrations at Blue Billed Duck Pond, Deep Pond, Easement Pond and OEH Wetland 2 would typically be slightly higher than for the no development scenario, though up to twice as high for naphthalene. Although contaminant transport modelling indicated that this could occur in the long term without the T4 Project, the risks are higher during dredge material emplacement and preloading. These risks can be appropriately mitigated by the measures in Section 8.3 and would be offset by a net decrease in the contaminant flux in the longer term, once the site is capped.

It is noted that the proposed capping by HDC would decrease groundwater levels and therefore flow rates and flux of existing contamination from the site. Overall the final capping of the T4 Project is more extensive than the proposed HDC capping. Therefore, the long-term water levels and flow rates, and the ongoing flux of existing contaminants, is predicted to be similar to or less than the case with the proposed HDC capping and no T4 Project.

In addition to general industrial contamination and localised zones of concentrated contamination, specific areas of contamination requiring specialised management are as follows:

- Ponds 5 and 7, where further leaching and migration of tar waste could occur, both horizontally and vertically to the Estuarine Aquifer. The existing GCL cap is not large enough to adequately manage the existing tar contamination or additional effects of T4 Project loading. Further, there is potential for ground settlement under the T4 Project load to compromise the cap integrity. If unmitigated, Blue Billed Duck Pond and OEH Wetland 2 are potential receptors from the Fill Aquifer beneath these ponds, and the Hunter River North Arm is a potential receptor from the Estuarine Aquifer.

- Asbestos burial pits near the northern boundary of the T4 project area, where bags of lead dust co-disposed with asbestos could come into contact with groundwater. These bags are expected to settle below the water table with the T4 Project. If they were to rupture, or have already ruptured, lead could leach into the groundwater and, if unmitigated, migrate toward wetlands to the north. This may or may not occur, however, as a precaution, mitigation and monitoring measures will be in place to address this risk.

- Site B, near Well B-01, where if unmitigated, further migration of free phase hydrocarbon (oil) contamination could occur.

- Delta EMD site, where if unmitigated, further migration of contaminants could occur horizontally and vertically to the Estuarine Aquifer.

- FDF, where further leaching and migration of existing contamination could occur, particularly if the existing leachate collection system fails (refer Section 8.2.3 v). If unmitigated, groundwater with elevated PAH and metal concentrations would move through the Fill Aquifer toward OEH Wetland 3, potentially at concentrations exceeding relevant ANZECC (2000) criteria. Modelling results indicated the following:

  - With early capping of the FDF, PAH and metal concentrations reaching OEH Wetland 3 at 10 years from commencement of dredge material emplacement would be similar or less than existing (background) groundwater concentrations, with the exception of aluminium. Concentrations would be significantly higher if the FDF is not fully capped until Stage 3.

  - Without mitigation, concentrations of PAHs and metals reaching OEH Wetland 3 would increase with time to above background concentrations; 50th and 95th percentile concentrations of all metals are predicted to be above ANZECC criteria at OEH Wetland 3 within 100 years and PAHs within 1000 years.

  - If the leachate collection system does not fail these impacts would be reduced, as much of the fill would be kept dry and any leachate would be intercepted before reaching OEH Wetland 3. Notwithstanding, precautionary mitigations are proposed to protect the portion of OEH Wetland 3 to be retained by the T4 Project (Section 8.3).

  Minimal impact on the Estuarine Aquifer and receiving Hunter River North Arm is predicted as the 95th percentile concentrations of metals (other than aluminium) leaching to the base of the aquitard are predicted to generally be less than the background concentrations in the Estuarine Aquifer. The 95th percentile concentration of aluminium at the Hunter River North Arm after 1,000 years is predicted to be similar to the background maximum concentration. Therefore, no adverse impact on existing concentrations is expected. The 50th and 95th percentile concentrations of PAHs reaching the base of the clay and the Hunter River North Arm are predicted to be less than ANZECC criteria, except for anthracene, which is controlled by background concentrations. Therefore no significant impact is expected.

- The proposed wharf area on the south bank of the Hunter River South Arm, where if unmitigated, excavation may expose and accelerate the release of contaminated groundwater into the river.

The management, remediation and monitoring measures proposed to address each of these areas are described in Section 8.3, and will ensure appropriate protection of environmental values. These measures will minimise the risks of off-site contaminant migration during and following construction of the T4 Project to acceptable levels.

There is potential for contamination from outside of the T4 project area to enter the T4 project area. This risk can be addressed through the monitoring described in Section 8.3.

iii Excavation, dewatering and interaction with the clay aquitard

The T4 Project has been designed to minimise penetration of the clay aquitard, and associated risk of increased hydraulic connectivity, contaminant transfer between the Fill and Estuarine Aquifers, and changes to groundwater levels and flow rates. Some localised excavations would be undertaken below the water table, most notably for construction of the dump stations and conveyor tunnels and relocations of the gas and water mains. If not managed appropriately dewatering of excavations could lead to short-term localised drawdown of surrounding groundwater levels. Potential impacts are discussed below.

Some piles are proposed to be founded in the Estuarine Aquifer, however, this is not expected to lead to any significant hydraulic connection between the aquifers as the piles are low permeability structural elements, and the pile-clay interface will generally smear upon installation.

Deep soil mixing may be used to improve foundation conditions at some areas, however, the impact on vertical permeability of the aquitard would be minimal as the technique retains the clay in situ.

Excavation for the dump stations and conveyor tunnels will extend through the clay aquitard and into the Estuarine Aquifer. Conventional methods of construction would involve installing dewatering wells and abstracting significant volumes of groundwater. Based on previous experience, flow rates for conventional dewatering of a dump station could range up to about 20,000 m^3/day. This would lead to significant drawdown of surrounding groundwater levels. For the T4 Project, diaphragm walls with either jet grout floors or walls keyed into the deep clay are proposed to be used, as is done at KCT. This would seal off the excavation and only require removal of water contained inside the sealed structure (eg from direct rainfall), thereby significantly reducing the volume of water removed and minimising impacts on groundwater levels outside of the sealed dump station and conveyor tunnel excavations. Based on previous experience, flow rates for dewatering following jet grouting could be up to about 10 m^3/day). The diaphragm walls and jet grout floors or walls keyed into the deep clay would also prevent hydraulic connection between the aquifers.

The Jemena gas main relocation is proposed to be constructed using horizontal directional drilling, with only localised excavations at entry and exit points (subject to geotechnical conditions being suitable). The water main is proposed to be constructed using open trench techniques. The excavations for pipeline relocation will be short-term and into clay soils which will limit groundwater inflows. The limited groundwater inflows will generally be able to be managed using sheet pile walls and sump and pump dewatering, with minimal associated impacts on groundwater levels over this short period.

For other excavations, in the more permeable fill material, groundwater inflow rates would potentially be higher and spear point dewatering may be required. Based on conventional dewatering with spears installed at 2 m intervals, flow rates of up to about 50 m^3 per day per metre of open trench, and estimated typical open trench lengths of 50 m or less, flow rates would be around 2,500 m^3 per day. Flow rates and associated dewatering-related impacts on surrounding groundwater levels can be reduced by using sheet pile walls driven to the depth of the underlying clay aquitard and/or re-injection of the abstracted water. In this instance the dewatering could be by sump and pump methods and flow rates may be reduced to about 10% of those for conventional dewatering. Drawdowns would be localised, with the majority of drawdown occurring within the sheet pile walls and with only minor drawdown immediately adjacent to the walls.

Excavation at the OneSteel site may expose contaminated groundwater, in particular the existing benzene plume, which could accelerate the migration of contaminants towards the Hunter River and result in adverse impacts. Based on current staging scenarios, development of the OneSteel site is not proposed for several years. Further investigations are proposed at this site to characterise the extent of contamination and inform development of appropriate management measures. As indicated in Section 8.3, suitable measures are available to manage groundwater contamination at this site.

iv Filling and capping

Filling with relatively high permeability sand would temporarily increase rainfall infiltration to groundwater, and increase groundwater flow rates and levels in the short term (estimated to be for about two years). This has the potential to temporarily increase leaching of existing contaminants from the soil and the flux of contaminants through groundwater toward sensitive receptors, as discussed in Section 8.2.3 ii. These short-term impacts are proposed to be mitigated as set out in Section 8.3.

Any potential short-term impacts during filling and preloading would be offset by the subsequent construction of the low permeability coal stockyard and berms and sealed surfaces, which would effectively create a low permeability cap. This will reduce rainfall infiltration and groundwater flow rates and levels and slow the flux of contaminants. With the T4 Project, average water levels in both aquifers and the associated flux of contaminants would be lower than for existing conditions. This is a beneficial outcome and will minimise long-term risks posed by contaminants in the T4 project area. It is also consistent with the existing approved remediation strategy for the KIWEF (capping).

v Interaction with the FDF leachate collection system

Groundwater levels at the FDF are artificially low (generally about 1.8 m to 2.0 m NHTG) due to an existing leachate collection system, which has a drainage level set at approximately 1.6 m NHTG. As such, dredged materials in the FDF (containing contaminants) have generally remained above the water table to date, and there is no firm evidence that any off-site contaminant migration has occurred from this area.

It is estimated that, under the T4 Project load, the base of the dredge spoil would settle to around 1.5 m to 2.0 m NHTG and differential settlement could impact the leachate collection system. With capping and assuming failure of the existing leachate collection system, a typical long-term water table level of approximately 3.0 m NHTG is predicted. This will mean that, without mitigation, the lower 1.5 to 2.0 m of dredge spoil within the FDF would be below the water table and potential contaminant mobility would be increased (refer Section 8.2.3 ii for discussion of contaminant transport). Section 8.3 provides details on appropriate mitigations to address this risk.

8.2.4 Water supply bores

The T4 Project will not impact the three bores on Kooragang Island that are licensed for irrigation and industrial use, as groundwater beneath the T4 project area does not interact with groundwater to the east of the proposed stockyard area, where these bores are located. There are no current plans for beneficial use of groundwater by the T4 Project.

8.3 Management and monitoring

8.3.1 Objectives

The proposed groundwater management, remediation and monitoring measures have been developed with the following objectives:

- to ensure protection of environmental values, including the Hunter River, Hunter Estuary Wetlands Ramsar site and wetlands outside of the T4 project area;
- to ensure protection of human health; and
- to enable beneficial use of the T4 project area and improve its environmental condition by minimising exacerbation of existing contamination and long-term risks associated with this contamination.

8.3.2 Management

The T4 Project presents an opportunity to reduce the environmental liabilities of the T4 project area by implementing strategies that manage and mitigate risks associated with the existing contamination. It will contribute to the responsible development of an area that is contaminated.

The proposed measures are based on EPL requirements and OEH approved management strategies that apply to parts of the T4 project area, supplemented by additional measures required for specific areas where capping would be insufficient to meet environmental objectives.

The existing OEH approved management strategy for the KIWEF, prepared by GHD (2009), includes a 0.5 m thick low permeability (permeability less than or equal to 1×10^{-7} m/s) cap, to reduce surface infiltration, and annual monitoring of groundwater and surface water. This is appropriate for most of the T4 project area, including localised contamination zones, and the proposed T4 Project design is compatible with this strategy. However, additional measures are required to address specific contaminant sources identified in Section 8.2.3.

An assessment of available management and remediation options was undertaken for the higher risk areas identified in the T4 project area and documented in the assessment of remediation options report (Appendix F). Management and remediation options were identified and ranked, considering attributes such as consistency with relevant guidelines, regulation and policy, effectiveness, proven track record in Australia, availability, ease of implementation, stakeholder acceptance, cost and time to implement. Only well-established proven strategies and technologies which comply with relevant OEH guidelines and policies were considered. The assessment of remediation options report (Appendix F) details the management and remediation options considered, including physical/chemical, biological, thermal and containment options. The method of assessing and ranking the management and remediation options is described in Section 5.2 of Appendix F.

The preferred management and remediation options, based on current information, are summarised in Table 8.1, though could be refined following further investigations. These are the preferred options from Section 5.3 of the assessment of remediation options report (Appendix F). The measures will require detailed assessment, trials, design and cost estimation prior to implementation. Once finalised and agreed with OEH, these measures, including validation testing and contingency measures, will be fully detailed in a RAP, which will be approved by OEH prior to implementation. Groundwater management and monitoring measures, including measures for monitoring and maintaining remediation structures to ensure their ongoing effectiveness will also be incorporated into the CEMP and the EMS.

Table 8.1 Summary of preferred management and remediation options

Aspect	Preferred option	Second ranked option	Third ranked option
Pond 5/7 tar waste	Soil-bentonite barrier wall	Permeable reactive barrier[1]	Extend cap and monitor
Lead dust / asbestos	Permeable reactive barrier[1]	Soil-bentonite barrier wall	-
Site B LNAPL	Dual phase extraction	Pump and treat[2]	Soil-bentonite barrier wall
Delta EMD site (dredge material emplacement phase)	Liner/ cap prior to dredge material emplacement, to reduce vertical infiltration	Soil-bentonite barrier wall	Interception drain and monitor
FDF	Permeable reactive barrier[1]	Cap and monitor	Interception drain and monitor
Deep Pond (dredge material emplacement phase)	Low permeability liner prior to dredging	-	-

Notes *1. Includes possible variants such as 'funnel and gate' arrangements*

2. Includes combinations with related technologies, such as air sparging

Implementation of the proposed remediation and management measures will protect environmental values including the Hunter River, Hunter Estuary Wetlands Ramsar site and wetlands outside of the T4 project area, and will improve the long-term environmental condition of the site and immediate surrounds. The proposed capping will also ensure protection of human health, by preventing access to the contaminants.

i Ponds 5 and 7

The management strategy currently approved by the OEH for Pond 5 is to extend the existing the cap a further 20 m beyond the Pond 5 footprint, and compact it to achieve permeability less than or equal to 1 x 10^{-8} m/s. However, the investigations for this EA found that NAPL contamination extends beyond this, into Pond 7, and any cap would need to extend much further than 20 m.

The preferred mitigation option is containment by installing a soil-bentonite barrier wall. The barrier wall would typically be constructed in a slurry supported trench around Pond 5 and part of Pond 7 to around 10 m deep, subject to detailed design. This would intercept the Fill Aquifer containing the raw tar materials. The detailed design would consider requirements for internal drainage to relieve water pressure and collect any leachate, which could be re-infiltrated within the confines of the barrier wall or collected for treatment and disposal.

The DEC (now OEH) (2007) *Guidelines for the Assessment and Management of Groundwater Contamination* recognise that containment may be the most appropriate mitigation, and in this instance this is the case. Intrusive remediation options would likely increase the risk of environmental harm due to tar exposure, and would be prohibitively expensive.

During dredge material emplacement it is also proposed to implement one or more of the following measures:

- divert dredge water around Ponds 5 to 8 and place only dry sand over these areas;
- divert dredge water across Ponds 5 to 8 in lined channels and place only dry sand over these areas; and/or
- selectively cap higher permeability sections of bund walls around Ponds 5 to 8 to prevent infiltration of dredge water and subsequent flow towards Blue Billed Duck Pond.

ii Lead dust/asbestos

While it is not confirmed that there would be any impact from the lead dust in the asbestos burial pits, the ‘precautionary principle’ has been applied in development of mitigations. It is proposed to install a permeable reactive barrier (PRB) along the northern side of Area K7 founded within the clay aquitard, subject to detailed design. This barrier would be designed to maintain northerly groundwater flows while ‘treating’ any lead leachate (in the event that lead dust comes into contact with the groundwater).

There are several design options for a PRB, however, it is likely that a ‘funnel and gate’ arrangement would be used for the T4 Project. This would comprise low permeability barrier wall panels that ‘funnel’ the groundwater toward intervening permeable zones (‘gates’) of reactive treatment medium. Treatment medium may include zero-valent iron, chelators, sorbents and/or microbes, as required to treat lead contamination. The contaminants would be concentrated and either degraded or retained in the barrier material, which may need to be replenished periodically.

The groundwater monitoring network for the T4 Project would include monitoring of water quality at wells on both sides of the PRB. Regular monitoring of the reactive media would be undertaken and it would be replenished as required.

iii Site B LNAPL

The DEC (now OEH) (2007) guidelines and OEH policy dictate that free-phase floating product, as present at Site B in the vicinity of Well B-01, should be removed or treated to the extent practicable. The preferred remediation technique at this location is to use a dual phase extraction system to pump out the contaminated groundwater, free-phase hydrocarbon and hydrocarbon soil vapour. The extracted liquids and vapour would be treated and collected for disposal, or re-injected to the subsurface (where permissible).

iv Delta EMD site

The current OEH approved management strategy for the Delta EMD site is to install a low permeability (3 $\times 10^{-11}$ m/s) GCL cap. Douglas Partners found that this cap (or equivalent), installed prior to dredge material emplacement, would be suitable to manage the risk of saline water infiltrating to groundwater and subsequently to Easement Pond and other water bodies during dredge material emplacement. Alternatively, a low permeability liner could be installed over the existing landform, nominally 0.5 m thick, with a permeability less than or equal to 1 $\times 10^{-8}$ m/s, with the same effect. Surface water and groundwater monitoring would be undertaken during dredge material emplacement to confirm the effectiveness of the cap.

Following filling, the approved capping strategy or equivalent is considered adequate to manage contamination at this site. The cap installed prior to dredge material emplacement would be sacrificial as the construction of T4 Project infrastructure at a higher level will form a new cap.

v Fines Disposal Facility

Groundwater modelling indicates there is potential for leaching of groundwater with elevated hydrocarbon and metal concentrations towards OEH Wetland 3. The preferred mitigation option is to install a PRB along the northern side of the FDF founded within the clay aquitard (subject to detailed design). This barrier would be designed to maintain northerly groundwater flows while ‘treating’ any leachate potentially generated by the FDF sediments coming into contact with groundwater. The primary leachable contaminants at the FDF that would be treated by the PRB are PAHs, TPHs and metals (aluminium, chromium, copper, lead, mercury and zinc). The most likely design option for the PRB would be the 'funnel and gate' arrangement described for the lead dust/asbestos at Area K7. As the FDF will be capped, leachate generation during operations should be minimal.

The groundwater monitoring network for the T4 Project would include monitoring of water quality at wells on both sides of the PRB. Regular monitoring of the reactive media would be undertaken and it would be replenished as required.

vi Deep Pond

It is proposed to install a liner in Deep Pond, to prevent saline dredge waters from seeping through the rail embankment into wetlands to the west and north-west, including OEH Wetland 1 and Railway Road Pond. The water management ponds for the T4 Project operations would also be lined.

The new rail embankment will be constructed with relatively permeable material to minimise effects on groundwater flows through the embankment to OEH Wetland 1 and Railway Road Pond, and minimise any loss of recharge to these water bodies.

vii OneSteel

Management measures to address contamination at the OneSteel site are anticipated to involve the following:

- where possible, avoid or minimise disturbance of areas of known contamination;
- manage potential vapour intrusion risks through engineering design and monitoring for the benzene plume area;
- appropriate management of all materials disturbed/excavated during construction;
- capping by construction of the facility; and
- on-going monitoring.

Further investigations are proposed at this site to characterise the extent of contamination and refine the management and remediation strategy. These investigations will be undertaken before the OneSteel site is developed, which based on current staging scenarios, is not proposed for several years. The management strategies will be fully documented in the RAP.

viii Excavations below the water table

The following mitigations will be in place to minimise the risk of aquifer connectivity through aquitard penetration, dewatering requirements and the associated potential for temporary localised groundwater drawdown:

- diaphragm walls and jet grouted floors or walls keyed into the deep clay, for dump station and conveyor tunnel excavations;
- horizontal directional drilling for installation of the gas pipeline, with only localised excavations at entry and exit points (subject to geotechnical conditions being suitable); and
- sheet pile walls founded in the clay aquitard material to limit groundwater ingress to excavations below the water table.

8.3.3 Monitoring

Groundwater and surface water monitoring plans will be developed and implemented for T4 Project construction and longer term operations, respectively. These plans will include water quality monitoring to assess the effectiveness of the controls and identify any requirements for additional mitigations. This will include monitoring of groundwater salinity upstream of sensitive receptors (BHPB Wetlands, Blue Billed Duck Pond, OEH Wetland 1 and Railway Road Pond) during construction; water levels at OEH Wetland 1 and Railway Road Pond during construction; groundwater quality on both sides of the PRBs and potentially around the containment cell(s) described in Section 7.3.2; and monitoring to assess if contaminants are entering the T4 project area from adjacent areas.

8.4 Conclusions

Groundwater beneath the T4 project area has elevated concentrations of a range of contaminants including metals, PAHs and pH, reflective of past waste emplacement, and closely linked to the soil contamination. This includes localised zones of contamination.

The ‘loading’ with fill material and infrastructure and the associated ‘squeezing’ of the soil profile is likely to lead to short-term increases in groundwater flows (horizontal and vertical) which could temporarily increase leaching of existing contaminants from the soil and the rate of contaminant transport through groundwater toward surrounding surface water bodies. The groundwater modelling results indicate that suitable mitigation measures are available to minimise the short-term risks of off-site contaminant migration to acceptable levels and ensure appropriate protection of environmental values. Any short-term impacts would be offset by the subsequent capping which will reduce rainfall infiltration and groundwater flow rates and levels and result in a net decrease in the flux of contaminants in the longer term. This is a beneficial outcome and will minimise long-term risks posed by contaminants in the T4 project area.

The existing OEH approved management strategy for the KIWEF, being a low permeability cap and annual monitoring of groundwater and surface water is appropriate for the majority of the T4 project area. The T4 Project is compatible with this strategy. Additional measures are proposed to address specific contaminant sources.

A range of remediation options are available for these sources and following detailed design, the final strategy will be fully described in a RAP. At this stage the preferred options include:

- construct a soil-bentonite barrier wall to contain tar waste at Ponds 5 and 7;
- install permeable reactive barriers to treat any leachate from the lead dust/asbestos area and FDF, while maintaining northerly groundwater flows;
- pump out the LNAPL hydrocarbon contamination at Site B by ‘dual phase extraction’ and treat and dispose of it;
- cover the Delta EMD site with a low permeability liner or cap before emplacing dredge material, to reduce vertical infiltration of saline dredge water; and
- install a low permeability liner in Deep Pond before dredge material emplacement to prevent saline dredge waters from seeping through the rail embankment into wetlands to the west and north-west.

In addition a comprehensive groundwater and surface water monitoring program will be implemented during T4 Project construction and operations to assess the effectiveness of the controls and identify any requirements for additional mitigations.

If the project is approved, the above measures will be refined and presented for subsequent approval as part of a RAP. This will include further investigations at the OneSteel site before construction starts there, to characterise contamination in more detail and refine the management and remediation strategy.

Some saline water from the Hunter River will infiltrate to groundwater when dredged material is placed across the T4 project area. With the proposed mitigations in place, the net impact on salinity at ponds and wetlands outside the footprint of T4 Project infrastructure will be insignificant. These water bodies experience natural fluctuations in salinity that will continue to occur with the T4 Project. There will be some saline inflows to tidal flats to the north, including OEH Wetlands 2 and 3, however these are naturally saline due to tidal influence.

No significant changes to water levels at surface water bodies surrounding the T4 project area are anticipated. The levels are primarily controlled by rainfall, evaporation and tidal inundation, not by groundwater.

The T4 Project will not impact the three bores on Kooragang Island that are licensed for irrigation and industrial use and no beneficial use of groundwater is currently proposed.

The groundwater assessment and numerical modelling results indicate that implementation of the proposed contamination remediation and management measures will ensure protection of human health and environmental values from potential groundwater-related impacts, including the Hunter River, Hunter Estuary Wetlands Ramsar site and wetlands outside of the T4 project area. These measures will improve the long-term environmental condition of the T4 project area and surrounds by addressing risks associated with the existing contamination.

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9 Surface water

This chapter summarises the flooding and surface water assessments prepared by WorleyParsons and SMEC, which are presented in Appendices H and J.

9.1 Existing environment

The T4 project area is within the Lower Hunter Estuary of the Hunter River catchment. The Hunter River is classed as a 'waterway affected by urban development'. At the T4 project area location Kooragang Island divides the Hunter River into two arms, referred to as the north and south arms. The T4 Project's wharf and berth facilities are proposed to be developed on the north and south banks of the Hunter River South Arm. At this location the Hunter River South Arm has a channel width of between 230 and 350 m and channel depth of approximately -2 to -4 m AHD.

The channel is proposed to be deepened to approximately -16.2 m AHD to create navigable shipping channels, and -17.8 m AHD for berth pockets adjacent to the foreshore. The dredging works will be undertaken by PWCS under an existing development consent (DA-134-3-2003-i) held by NSW Maritime which will be modified. The channel and flow regime of the Hunter River South Arm have previously been modified by revetment structures, reclamation and upstream flood gates and by dredging downstream of the proposed T4 Project berth locations.

Surface drainage within the T4 project area is mostly highly modified. There are engineered drainage structures including culverts, drains and levees, and artificially formed drainage depressions and ponds. The ponds have formed due to rail embankments, levees and past landfill activities, for example ponding within cells which were constructed for waste emplacement and not filled. The main ponds in the T4 project area (Figure 9.1) are known as:

- Deep Pond (approximate 23 ha surface area);
- Ponds 9 to 12 (approximate 6.8 ha combined surface area);
- Railway Pond (approximate 4.5 ha surface area);
- Railway Road Pond (approximate 0.5 ha surface area);
- Easement Pond (approximate 2.6 ha surface area);
- Easement Pond South (approximate 1 ha surface area); and
- FDF Pond (approximate 1.9 ha surface area).

These ponds are recharged by rainfall and localised runoff and surface flow occurs between some of them (Figure 9.1). Deep Pond also has connectivity with surface water bodies outside the T4 project area; it is recharged by inflow from Blue Billed Duck Pond, located to the south-east, and discharges to tidal wetlands at the edge of the Hunter River South Arm, via culverts under the NCIG rail loop. The only other ponds in the T4 project area which have direct surface connection to external water bodies are Easement Pond South, which discharges to the BHPB Wetlands, and Easement Pond, which may discharge to Long Pond during prolonged wet weather. Habitat values of surface water bodies in and around the T4 project area are addressed in Chapter 10 and Appendix K.

Ponds in the T4 project area also interact with groundwater. In particular, substantial downward leakage is likely to occur through the base of Easement Pond, and Ponds 9 to 12 are essentially 'windows' to the groundwater system. Groundwater seepage also occurs from Deep and Railway Ponds, through the rail embankment toward OEH Wetlands 2 and 3 to the north and potentially, to a very limited extent, from Deep Pond toward OEH Wetland 1 and Swan Pond to the west. Groundwater interaction is described in more detail in Chapter 8 and Appendix E.

There are also some waterbodies that are only partly within the T4 project area. The main ones are Long Pond, just north of Cormorant Road, and creeks and wetlands north and west of the T4 project area that extend into the proposed rail and utility corridor, known as Swan Pond, OEH Wetlands 1, 2 and 3, Mosquito Creek, Mosquito Creek Tributary, Eastern Watercourse and Eastern Freshwater Wetland. These waterbodies are shown on Figures 9.1 and 9.2 and described as follows:

- **OEH Wetlands 1, 2 and 3 -** these wetlands total approximately 21 ha and are located near the northern boundary of the T4 project area, where the proposed rail and utility corridor will be (Figure 9.1). OEH Wetlands 2 and 3 are inundated at high tide. OEH Wetland 1 is primarily recharged by surface runoff and shows minimal response to tidal fluctuations. If the wetlands overtop, surface flow occurs toward Swan Pond and eventually the Hunter River South Arm (OEH Wetland 1) and toward tributaries of the Hunter River North Arm (OEH Wetlands 2 and 3). OEH Wetlands 2 and 3 interact with groundwater, including minor seepage from Deep and Railway Ponds in the T4 project area.

- **Swan Pond** - a saline pond west of the T4 project area, a small area of which is in the proposed rail and utility corridor. It has tidal connection to the Hunter River South Arm and is likely to receive limited groundwater recharge from the T4 project area.

- **Long Pond** - an artificial pond of approximately 3.4 ha, located just north of Cormorant Road. It is recharged by surface water runoff and groundwater. Long Pond has limited surface connection with the Hunter River South Arm; it can overtop the road and discharge to the river following prolonged heavy rainfall.

- **Mosquito Creek** – a tidal creek approximately 60 m wide and over 2.5 m deep (measured 13 January 2012) that conveys Hunter River North Arm flows to adjoining wetlands in the national park. Mosquito Creek previously connected the Hunter River North and South Arms, however, was partly filled by construction of the Kooragang Island main rail line in 1966; flows south of the rail embankment were blocked at this time. Continuous water level monitoring from 13 to 20 January 2012 found negligible attenuation of the tidal prism between the upstream and downstream ends of Mosquito Creek (Section 8.2.1 of Appendix J).

- **Mosquito Creek Tributary** – a tidal tributary of Mosquito Creek, approximately 50 m north of the existing rail embankment, that conveys flows north-east to wetlands there. At the proposed rail embankment location it is 8 to 10 m wide and 1.5 to 2 m deep (measured 13 January 2012).

- **Eastern Watercourse** - an estuarine watercourse approximately 850 m east of Mosquito Creek. Its southern extent comprises a lagoon about 200 m long and 20 to 30 m wide, that is a remnant of Mosquito Creek, previously isolated by filling. Similarly, the northern portion is a former tributary of Mosquito Creek (Figure 9.2). A levee has been constructed across it around 150 m north of the lagoon, which appears to block flows to/from the north. The levee and filling to the east and west likely prevent lower level tidal exchange, as evidenced by higher salinity measurements north of the levee on 13 January 2012 (40 mS/cm compared to 18 mS/cm in the lagoon). Water level monitoring south of the levee from 18 to 23 January 2012 showed limited tidal response (2 to 3 cm) indicating water level is predominantly groundwater-influenced and the lagoon does not receive daily tidal exchange. However, some tidal exchange may occur between the wetlands to the west and the lagoon during high spring and king tides. The highest tide during monitoring was 1.9 m (in Newcastle Harbour); further monitoring is needed to see whether tidal exchange occurs at higher tides (Newcastle Harbour's highest astronomical tide is 2.1 m).

- **Eastern Freshwater Wetland** – a freshwater wetland complex east of the Eastern Watercourse. Its hydrologic regime is likely to be controlled by direct rainfall and evapotranspiration, though minor runoff recharge could occur from its periphery. Groundwater is likely to keep the open water bodies permanently full, with some seasonal variability.

The main surface water features surrounding the T4 project area are (Figure 9.1):

- **Blue Billed Duck Pond** - an artificial pond of approximately 2 ha, located on the BHPB emplacement land, to the south of the NCIG rail loop. It receives surface runoff, including overflows from the adjacent BHPB Wetlands, and discharges to Deep Pond via piped culverts under the NCIG rail line. Groundwater interaction is likely.

- **BHPB Wetlands** - an artificial pond approximately 5.8 ha in area, located on the BHPB Billiton emplacement land, to the south of the NCIG rail loop. It receives surface water runoff, including overflows from Easement Pond South and discharges to Blue Billed Duck Pond. Groundwater interaction is likely.

- Intertidal and freshwater wetlands within the Hunter Wetlands National Park and Hunter Estuary Wetlands Ramsar site, to the north and west of the T4 project area.

Water quality of the ponds in and around the T4 project area has been characterised by monitoring undertaken by various parties since 1981. This has included monitoring at 14 locations within the T4 project area since 2000, under the requirements of EPLs 5022, 6437 and 7675. Douglas Partners also monitored at 15 locations as part of this EA, the results of which are in Appendix E. The monitoring locations are shown on Figure 7.2.

Monitoring results indicate that mean pH and mean concentrations of several metals (aluminium, cadmium, chromium, copper, lead, mercury, nickel and zinc), as well as ammonia, cyanide, total phosphorus and TSS exceed the ANZECC (2000) trigger values at the Hunter River and/or other water bodies in and around the T4 project area. All water quality results have been conservatively compared against the guidelines for slightly to moderately disturbed ecosystems. Water quality monitoring results are summarised in Table 9.1.

Table 9.1 Summary of surface water monitoring results – mean values

Analyte[1]	ANZECC default trigger values		Freshwater wetlands			Estuarine wetlands/estuary			
	Freshwater	Estuarine	Blue Billed Duck Pond	Easement Pond	Railway Pond	Deep Pond	Long Pond	OEH Wetlands	Hunter River
pH	6.5 - 8	7 - 8.5	8.8	8.3	8.3	8.8	8.6	7.7	7.9
EC (µS/cm)	125 - 2,200	-	1,236	2,925	3,419	13,238	15,980	17,340	45,110
TSS	~ 15.6 – 130 (6-50 NTU)	~ 1.3-26 (0.5-10 NTU)	46.5	-	-	16.5	39.1	15.7	24.9

Table 9.1 Summary of surface water monitoring results – mean values

Analyte[1]	ANZECC default trigger values		Freshwater wetlands			Estuarine wetlands/estuary			
	Freshwater	Estuarine	Blue Billed Duck Pond	Easement Pond	Railway Pond	Deep Pond	Long Pond	OEH Wetlands	Hunter River
TP	0.05	0.03	0.34	-	-	0.30	-	0.24	0.08
Ammonia	0.90	0.91	0.21	-	-	0.45	1.01	0.93	0.17
Cyanide	0.007	0.004	0.004	0.005	-	0.012	0.021	0.039	0.004
Phenol	0.32	0.40	0.035	-	-	0.017	0.028	0.058	0.058
Aluminium	0.055	-	0.42	0.07	0.08	0.32	-	0.07	0.60
Cadmium	0.0002	0.0007	0.034	0.042	0.036	0.018	0.010	0.011	0.002
Chromium	0.001	0.0044	0.010	0.072	0.075	0.011	0.010	0.012	0.008
Copper	0.0014	0.0013	0.009	0.013	0.016	0.018	0.017	0.054	0.015
Iron	-	-	0.63	0.08	0.09	1.05	0.52	3.08	0.87
Lead	0.034	0.044	0.034	0.084	0.100	0.026	0.031	0.011	0.008
Manganese	1.9	0.08	0.41	0.10	0.13	0.09	0.03	0.03	0.01
Mercury (µg/L)	0.06	0.1	0.27	0.58	0.73	0.14	0.08	0.07	0.13
Nickel	0.011	-	0.013	0.013	0.015	0.066	0.058	0.010	0.013
Potassium	-	-	29.5	58.2	105	230	-	515	360
Sodium	-	-	385	446	477	3463	-	13900	9075
Zinc	0.008	0.015	0.169	0.018	0.017	0.091	0.107	0.098	0.056

Notes: ANZECC trigger value exceedances are in blue font.

1. All values are in mg/L except pH, EC and mercury

9.2 Impact assessment

The T4 Project's construction and operation is expected to alter existing flow regimes, water quality and water quantity. The primary objective of water management will be to prevent adverse surface and ground water quality impacts, especially at off-site water bodies.

9.2.1 Alteration to existing flow regimes

i Construction

The T4 Project will alter the existing (albeit highly modified) surface flow regime within the T4 project area. The proposed surface drainage systems during dredge material emplacement and operations are described in Chapter 3 and illustrated schematically in Figures 3.8 and 3.11.

Most existing ponds in the T4 project area, including Railway and FDF Ponds, Ponds 9, 10, 11 and 12, and parts of Easement Pond will be filled as part of the T4 Project. The north-eastern corner of Easement Pond will be modified to act as a settling pond, referred to as Transfer Pond 1 (Figure 3.11). Easement Pond South and Railway Road Pond will be retained. The ponds that will be filled are all artificial and do not have direct surface connection to surface water bodies outside the T4 project area, other than potential sporadic overflows from Easement Pond to Long Pond. Accordingly, filling these ponds is not expected to significantly affect surface water flow regimes external to the T4 project area.

The proposed rail embankment will cross the southern ends of Mosquito Creek, Mosquito Creek Tributary, Eastern Watercourse and Eastern Freshwater Wetland, where they abut the existing rail embankment. SMEC assessed the potential impacts on the tidal regime of wetlands to the north, that receive tidal flows from these waterways. The assessment found that the proposed disturbance to the southern 350 m of Mosquito Creek is not likely to affect tidal flows to wetlands to the north. Similarly, the southern 100 m of the Eastern Watercourse that will be disturbed, including the lagoon, does not influence the tidal regime of wetlands outside the proposed disturbance footprint and so they are not likely to be impacted. Without mitigation the following hydrodynamic impacts could occur:

- The proposed rail embankment could obstruct or restrict tidal flows in the southern section of Mosquito Creek Tributary, which may alter the tidal regime in receiving wetlands. PWCS proposes to maintain the wetlands' existing tidal flow regime by realigning the tributary channel north of the new rail embankment (Figure 9.2).

- The rail embankment will disturb the mangrove area west of the Eastern Watercourse, which may restrict tidal exchange with the wetland complex to the east (Figure 9.2). Mitigation measures to maintain tidal flows are provided in Section 9.3.1 iv.

- A small net increase in the amount of freshwater runoff entering the Eastern Freshwater Wetland may occur due to vegetation removal for embankment construction and reduced evapotranspiration. However, given the relatively small disturbance footprint compared to the size of the Eastern Freshwater Wetland, any impact is likely to be negligible.

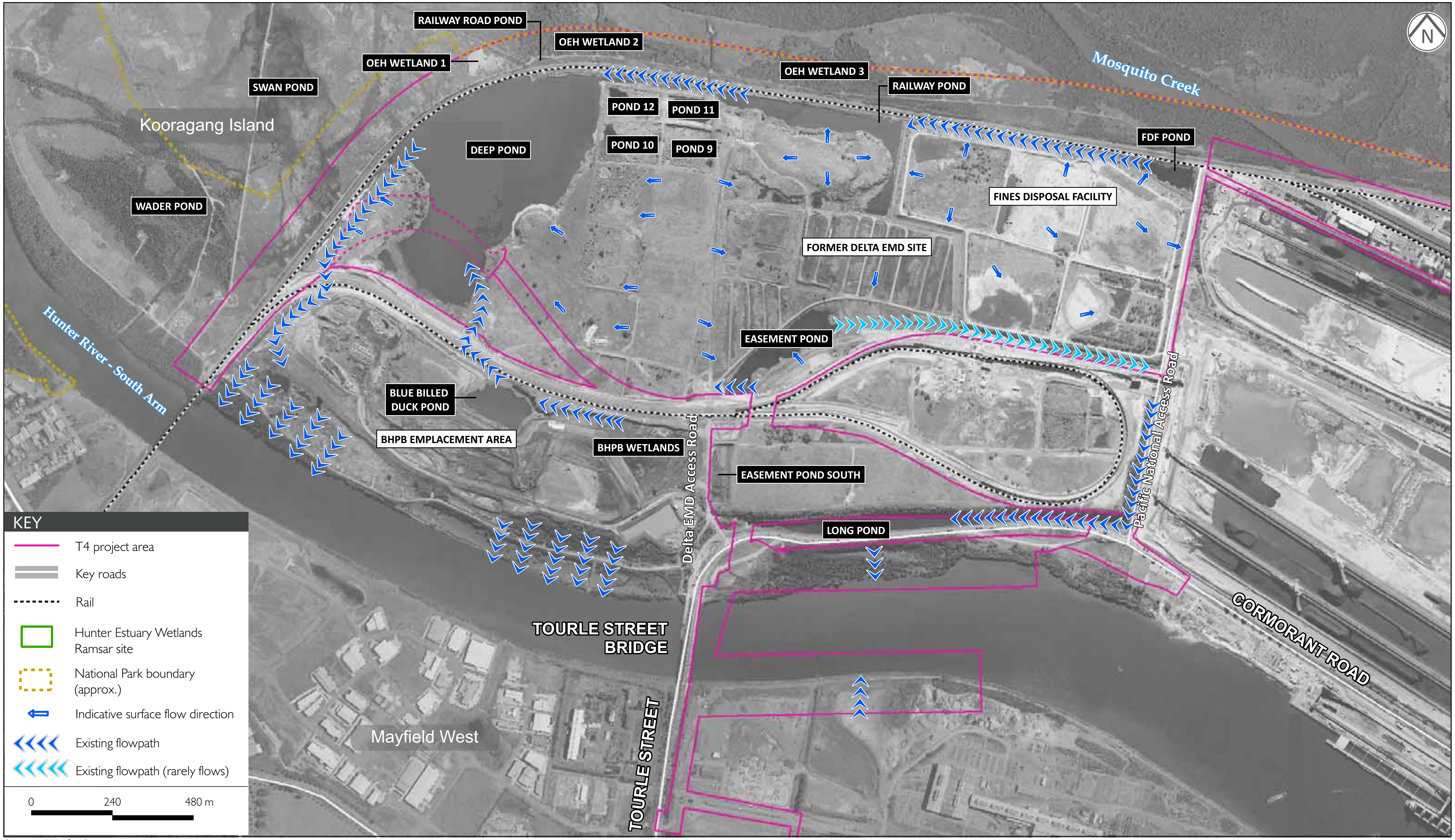
- The new rail embankment may block or divert surface flows to the Eastern Freshwater Wetland from the south, ie from the existing rail line. Drainage will be provided within the rail embankment (eg drainage from rail ballast to jump-up pits) to maintain flows into the wetland from the rail area and avoid adverse impacts.

During construction, runoff from the T4 project area will be treated in settling ponds and then ultimately drain to the Hunter River South Arm, along existing flow paths which will be modified as required for water quality management. Most surface flows (apart from rainfall runoff) will be dredge return water. This water will be directed to the northern portion of Deep Pond for settling treatment, prior to discharging back into the Hunter River South Arm (under licence), by the route indicated on Figure 3.8. This will incorporate part of an existing drainage line, which will be temporarily lined and modified to avoid the wetland area at the river's edge. Once dredge material emplacement is completed, the lined drainage channel will be removed and the existing downstream flow regime re-established.

The southern portion of Deep Pond will be retained by the T4 Project. Measures will be in place to prevent entry of dredge water to this area of Deep Pond during construction. A rail flyover is proposed to be constructed over Deep Pond as part of NCIG's development. This could be built before the T4 Project starts. If this happens, the rail flyover embankment would serve as the bund to the southern portion of Deep Pond (although culverts may need to be temporarily blocked). The hydraulic connection of the southern portion of Deep Pond with Blue Billed Duck Pond will be unchanged and flows will continue to discharge to the Hunter River South Arm at the existing discharge point via a drainage channel that will be constructed linking the southern sections of Deep Pond to the existing culverts under the NCIG rail line.

A chain of habitat ponds is proposed to be developed across the T4 project area, incorporating the southern and western portions of Deep Pond (refer Chapter 10 for discussion).

The surface flow regime for water bodies downstream of Deep Pond will not be affected by the T4 Project.



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Source: WorleyParsons
Aerial photo source: 2011 Sinclair Knight Merz Pty Ltd.

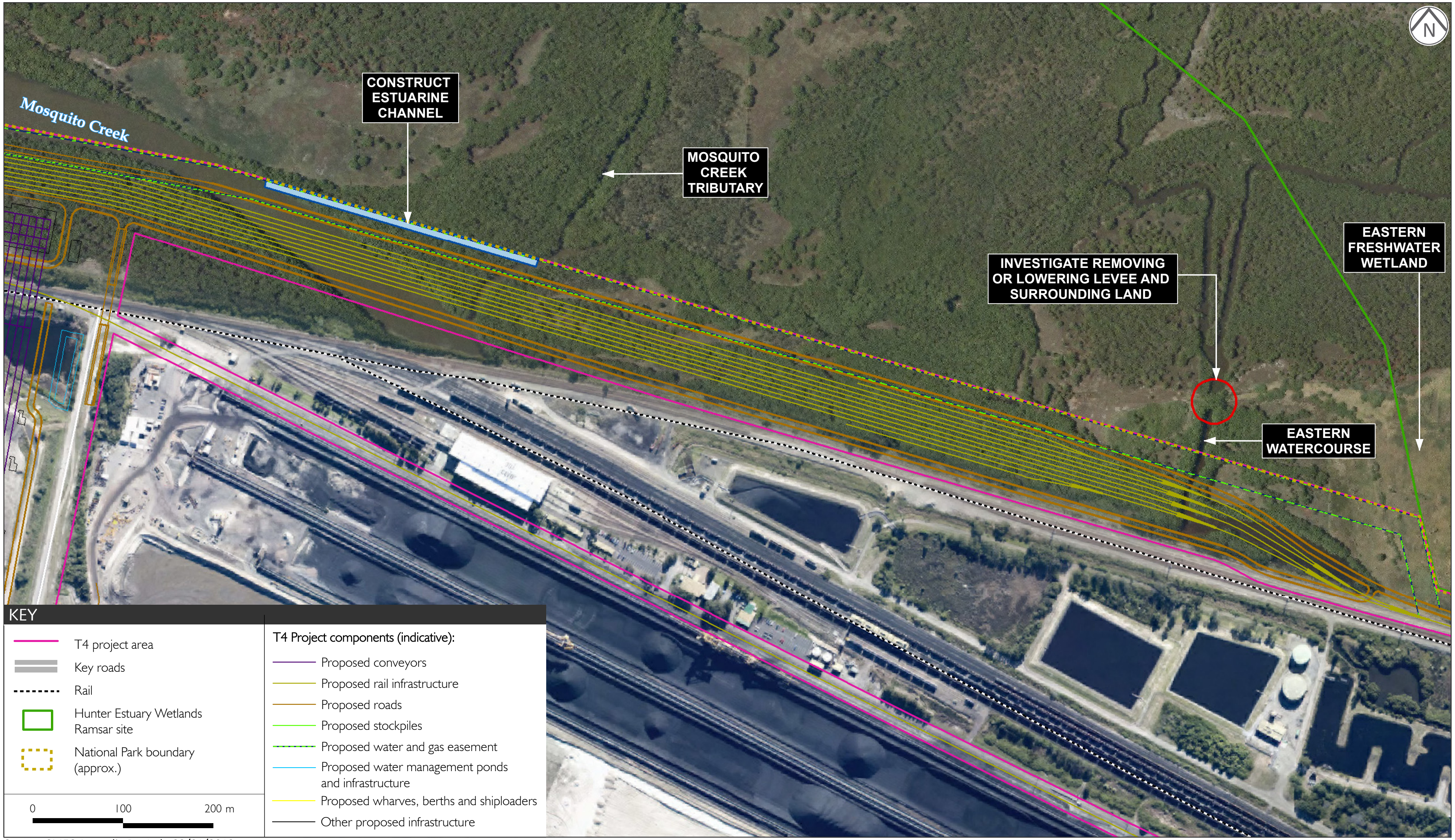
EMM

PWCS

Existing surface drainage

T4 Project - Environmental Assessment

FIGURE 9.1



Integrated Design Solutions | 030418 EA Rev A - 13 February 2012

Source: SMEC Australia Pty Ltd - 23/01/2012
Aerial photo source: 2011 Sinclair Knight Merz Pty Ltd.

EMM

PWCS

Proposed mitigation measures

T4 Project - Environmental Assessment

FIGURE 9.2

ii Operation

During operations, runoff from the northern and western rail embankments will be directed to local sediment swales for treatment prior to returning to the existing drainage regime. Runoff from operational areas of the T4 project area will be retained on-site and directed to the settling ponds, which will be constructed in the northern portion of Deep Pond (Primary Settling Ponds 1 and 2, Secondary Settling Pond and the Clearwater Pond). These settling ponds will allow for desilting and subsequent re-use of surface water runoff from the site. During prolonged rainfall, treated surface water from the Clearwater Pond will overflow to the southern portion of Deep Pond and to the Hunter River South Arm, which is the existing receiving body for overflows from Deep Pond.

Surface water and groundwater in the T4 project area has limited influence on ponds and wetlands in the Hunter Wetlands National Park and Hunter Estuary Wetlands Ramsar site to the north and west and consequently, their flow regimes will not be significantly affected by the T4 Project. With implementation of proposed mitigations the T4 Project will not affect the BHPB Wetlands, Blue Billed Duck Pond or Long Pond. Further detail on groundwater interactions is provided in Chapter 8 and Appendix E. The T4 Project has been specifically designed to avoid OEH Wetland 1 and Railway Road Pond, in order to preserve their habitat values. There will be some reduction in the area of OEH Wetlands 2 and 3 due to the proposed railway embankment, however their existing flow regimes will not be significantly affected. It is estimated that approximately 4 ha of the existing 21 ha surface area of the OEH Wetlands will be reclaimed, predominantly by the railway embankment widening. The ecological implications of this are assessed in Chapter 10 and Appendix K.

The groundwater and surface water assessments (Appendices E and J) concluded that, subject to implementation of the mitigation measures proposed, there will be no significant impact to existing flow regimes outside the T4 project area as a result of the T4 Project.

Habitat considerations associated with the proposed removal and modification of surface water bodies in the T4 project area are addressed in Chapter 10 and Appendix K. A comprehensive mitigation and offset package is proposed, including a chain of habitat ponds across non-operational parts of the T4 project area.

9.2.2 Water quality

i Construction

Water quality impacts during construction may include:

- the potential for hydrocarbon spills from construction equipment, for example diesel spills, to affect receiving water quality;
- the potential for surface runoff and dredge water to erode and entrain soil/sediment from exposed surfaces or stockpiles, and elevate suspended solid concentrations and turbidity in receiving waters; and
- the potential for any contaminants in dredged material to impact water quality of dredge return water. As discussed in Section 7.2.5, sediment sampling has shown that the material to be dredged from the Hunter River South Arm contains uniformly low concentrations of all contaminants and so this is not likely to pose a risk to quality of dredge return water.

A suite of erosion, sediment, spill and leak controls are proposed to be implemented as part of a CEMP, to minimise the potential for off-site surface water impacts. These controls are described in Section 9.3 and include capture of suspended solids and surface water monitoring to assess the effectiveness of the controls.

As part of the ground improvement works, sand will be pumped from the dredging operations to the proposed stockyard area. Dredge water will be generated, as well as surface runoff from the site. These waters will be contained within a bunded area in the stockyard area, and directed to Deep Pond for settling treatment, prior to discharging back into the Hunter River South Arm (under licence). The proposed return of sediment-treated dredge water to the Hunter River is consistent with practices for other dredging campaigns in the Hunter River South Arm, including at NCIG and KCT.

The capture efficiency of the proposed sedimentation basin (Deep Pond) during Stage 1 of construction (when dredge material emplacement will be occurring) was assessed using the basin sizing methods outlined in Landcom (2004) *Managing Urban Stormwater: Soils and Construction* (referred to as the Blue Book) and guidance in the DECC (2008) *Managing Urban Stormwater: Soils and Construction Volume 2E Mines and Quarries*. Based on these guidelines and the size of the proposed stockyard (approximately 160 ha), the preliminary calculations indicate that, during dredging operations, a minimum settling volume of approximately 26,000 m^3 will be required to meet the requirements of Landcom (2004). The volume of Deep Pond is estimated to be over 100,000 m^3 and as such will meet settlement requirements during dredge material emplacement.

Following filling of the site, settling ponds will be constructed to contain sediment movement within the site. Preliminary calculations indicate that a minimum settling volume of approximately 61,000 m^3 will be required to meet the requirements of the Landcom (2004) Blue Book. The settling volume offered by the two primary ponds and the secondary pond is approximately 94,000 m^3 and so will meet settling requirements.

A surface water quality monitoring program will be developed and implemented to monitor water quality within the on-site settlement ponds and ensure the water quality objectives (to be defined in the CEMP) are met.

The potential for groundwater and ASS related impacts is addressed in Chapters 7 and 8 and Appendices C and E.

ii Operation

There is potential for runoff from operational parts of the T4 project area to entrain contaminants such as suspended solids, dissolved inorganic salts and heavy metals. This includes aluminium, copper, iron and nickel, particularly from the coal storage area. Minor concentrations of contaminants could also arise from the corrosion of structures and plant, particulate loads from vehicles, atmospheric deposition and minor leaks and spills from vehicles and plant. Due to the strong association between suspended solids and many other contaminants, including hydrocarbons and heavy metals that adhere to suspended solids (Duncan 1999; DLC 1998), a system that is efficient in removing suspended solids is proposed, which will also be effective for reducing other contaminants.

All runoff from operational areas will be captured in sedimentation basins and directed to the settling pond system (Primary Settling Ponds 1 and 2, Secondary Settling Pond and Clearwater Pond) prior to re-use on-site. During periods of prolonged wet weather, the storage capacity of the Clearwater Pond may be exceeded, resulting in discharge to the Hunter River. An assessment of the sediment removal efficiency of the settling pond system was undertaken to assess the water quality of discharges. Table 9.2 shows the sediment removal efficiency at the outlet of Clearwater Pond during a 90th, 95th and 99th percentile peak daily discharge flow. The sediment removal efficiency objective is 90% removal of TSS (defined as having an average particle size of 20 µm).

Table 9.2 Clearwater Pond sediment removal efficiency

Discharge event (percentile)	Peak daily flow (m^3/s)[1]	Capture efficiency (%)
90th	0.97	98.7
95th	1.4	97.7
99th	2.1	96.0

Notes: 1. The peak daily flow is the peak predicted during a discharge event, which may occur for a number of days. The reported peak flow is the average flow over the day.

The results in Table 9.2 indicate that the sediment removal efficiency objective of 90% is predicted to be exceeded by the Clearwater Pond, with a capture efficiency of 96% for a 99th percentile discharge event. This level of capture efficiency will also substantially reduce the concentration of other contaminants in the water column such as hydrocarbons and heavy metals that adhere to suspended solids.

The quality of runoff and off-site discharge during operations is likely to be similar to that at KCT, which has a similar operation, catchment characteristics and surface water management system to that proposed for the T4 Project. Monitoring results at KCT's two main water management ponds, known as Settling Pond 1 and Clarified Pond 1, are provided in Table 9.3. Settling Pond 1 receives surface runoff and return process water from most of KCT. Clarified Pond 1 receives water pumped from Settling Pond 1, for re-use on-site.

Table 9.3 KCT water quality data – mean values

Analyte	ANZECC Default Trigger Values - Freshwater	Settling Pond 1	Clarified Pond 1
pH	6.5 - 8	8.2	8.0
TSS (mg/L)	15.6 - 130	19.1	-
TP (mg/L)	0.05	0.10	-
Aluminium (mg/L)	0.055	0.59	0.39
Ammonia (mg/L)	0.90	0.03	0.03
Cadmium (mg/L)	0.0002	0.0005	0.0005
Chromium (mg/L)	0.001	0.001	0.001
Copper (mg/L)	0.0014	0.002	0.001
Cyanide (mg/L)	0.007	0.005	0.001
Iron (mg/L)	-	0.370	0.250
Lead (mg/L)	0.034	0.001	0.001
Mercury (µg/L)	0.06	<0.0001	<0.0001
Manganese (mg/L)	1.9	0.055	0.050
Nickel (mg/L)	0.011	0.002	0.001
Phenol (mg/L)	0.32	<1.0	<1.0
Zinc (mg/L)	0.008	0.035	0.028

Notes: ANZECC trigger value exceedances are in blue font.

Comparison of the KCT water quality results in Table 9.3 with those for existing water bodies in and around the T4 project area (Table 9.1) shows that:

- mean TSS concentrations are generally lower at KCT's water management ponds than the surrounding water bodies considered, including the Hunter River;
- mean nutrient concentrations (TP and ammonia) at KCT's water management ponds are generally similar to or lower than the surrounding water bodies, including the Hunter River; and
- mean metal concentrations at KCT's water management ponds are generally similar to or lower than the surrounding water bodies, except for aluminium. Mean aluminium concentrations were similar at KCT's Settling Pond 1 and the Hunter River but higher than at most other surrounding water bodies considered.

Monitoring results indicate that a number of analytes have exceeded the default ANZECC (2000) trigger values for slightly to moderately disturbed freshwater ecosystems at one or both of the KCT water management ponds. Other than aluminium, exceedances at KCT were similar to or less than the exceedances at the surrounding water bodies, including the Hunter River. Therefore it is expected that if site discharges were to occur, the quality of receiving waters would not be significantly affected.

9.2.3 Site water balance

i Water balance modelling

Anticipated water supply and use during construction and operations are described in Section 3.9.2.

Water demand during construction will be limited, including for amenities, dust suppression and moisture conditioning of earthworks. The water will be sourced from a temporary connection to the HWC main. Water captured in sediment ponds will also be used where practicable.

A water balance model was prepared to assess the effectiveness of the proposed site water management system during T4 Project operations at the nominal maximum capacity of 120 Mtpa. The model included anticipated water demands, rainfall and evaporation data and catchment characteristics including catchment areas, proportion of impervious surfaces and estimated runoff volumes. A total of 110 years of continuous rainfall data were used. This data covers a wide range of climatic conditions including droughts, major flood events and other average, wet and dry periods. The water balance model was calculated for dry (10th percentile), average (50th percentile) and wet (90th percentile) rainfall years. The results are presented in Table 9.4.

Table 9.4 Typical water balance for dry, average and wet years

Aspect	Units	Dry Year[4]	Average Year[4]	Wet Year[4]
Rainfall [7]	(mm/year)	795	1134	1543
Water sources				
Surface water runoff	ML/year	1,110	1,640	2,359
Potable water supply	ML/year	848	443	441
Total	**ML/year**	**1,958**	**2,083**	**2,800**
Water demands				
Stockpile dust suppression	ML/year	1,151	1,107	1,085
Chute dust suppression	ML/year	247	247	247
Belt cleaning	ML/year	228	228	228
Wash down	ML/year	10	10	10

Table 9.4 Typical water balance for dry, average and wet years

Aspect	Units	Dry Year[4]	Average Year[4]	Wet Year[4]
Ship supply	ML/year	136	136	136
Total net demands	**ML/year**	**1,771[5]**	**1,728**	**1,706**
Water harvesting efficiency[3]	(by Calc)	**60%**	**85%**	**85%**
Evaporation Losses	(ML/Year)	85	102	103
Total water loss	**ML/year**	**1,856**	**1,830**	**1,809**
Site discharge				
Average discharge volume	ML/year	102	253	991
Discharge frequency[1]	Typical number of annual discharge events	1 to 3	2 to 6	3 to 10
Site discharge coefficient [2]	Discharge/ total runoff	0.09	0.15	0.42

Notes: *1. A discharge event is defined as a period of continuous discharge. The discharge event is counted following a 72-hour period of no discharge.*

2. Discharge coefficient is the total discharge volume/total surface water runoff.

3. Average water harvesting efficiency is the percentage of potential process water demand that is met by surface water re-use. Potable water demands are not included in this calculation.

4. Results for dry, average and wet years are representative of 10th percentile, average and 90th percentile rainfall years respectively. Reported results from each category have been determined based on the average results from five representative rainfall years.

5. Total not exact due to rounding.

The water balance results in Table 9.4 indicate that surface runoff will vary from 1,110 ML/year in dry years to 2,359 ML/ year in wet years. Water demand (potable and runoff captured on-site) is relatively constant, with a 65 ML/year variation between dry and wet years predicted due to variations in the number of days stockpile dust suppression is required. However there is a greater variation in water supply, in the order of 601 ML, between average and dry years. The variation between wet and average years is much less (43 ML).

Modelling indicates that water demand and evaporative losses exceed the estimated surface water runoff in dry years by 746 ML/year. Average water demand therefore exceeds supply in dry years and discharges will be limited to wet weather periods during the year when total runoff exceeds the available storage. Surface runoff in an average year (1,640 ML/year) is predicted to be slightly less than total surface water loss (1,830 ML/year), indicating that discharge events will mostly be due to storage constraints. In wet years, the estimated surface runoff volume exceeds demand by 550 ML/year and discharge events will therefore occur due to both storage and demand constraints.

These results of the water balance presented in Table 9.4 were used to predict likely average discharges (averaged over the 110-year rainfall record) to the Hunter River South Arm. The water management system has been designed to retain runoff from the equivalent of a 100 year average recurrence interval (ARI) 2-hour duration storm event. Two performance criteria have been established for assessing average discharges:

- the average frequency of site discharge is to be no more than 1 in 3 months; and
- the average annual volumetric discharge from the site is to be less than 25% of total surface water runoff (ie 75% of average volumetric runoff is re-used on-site).

Predicted discharges from the site are shown in Table 9.5. The average discharge coefficient represents the portion of total site runoff that is discharged from site over the 110-year rainfall record. The surface water re-use efficiency is the percentage of potential site water demand that is met by re-use of surface water (it excludes potable water demands).

Table 9.5 Water balance model results – 110-year record

	Model results	**Objective**
Discharge frequency	1 in 3 months (95 days)	1 in 3 months (90 days)
Discharge coefficient[1]	0.24	0.25
Surface water re-use efficiency[2]	73 %	N/A

Notes: 1. The total discharge volume/total surface water runoff over the 110 year record.

2. Surface water re-use efficiency is the percentage of potential process water demand that is met by surface water re-use. Potable water demands are not included in this calculation.

The results in Table 9.5 indicate the water management system would achieve both of the discharge objectives listed above. Discharges from the site to the Hunter River would occur at an average frequency of once every 95 days which marginally exceeds the objective of once every 90 days. The predicted discharge coefficient of 0.24 indicates that 24% of runoff would discharge from site, with 76% captured and re-used on-site. This exceeds the objective of no less than 75% re-use. The model predicted that 73% of the T4 Project's process water demands could be met by re-use of surface water captured on-site.

Additionally, Section 9.2.2 ii demonstrated that the site water management system could exceed the objective of 90% removal efficiency of TSS during a 99th percentile discharge event (refer Table 9.2).

ii Potential climate change impacts

To assess the potential impacts of climate change on water management, OEH's estimates of projected climate change impacts in the Hunter Valley, '*NSW Climate Impact Profile: The Impacts of Climate Change on the Biophysical Environment of New South Wales*' (DECCW 2010) was adopted. The report projects that climate change impacts in the Hunter Valley to occur by 2050 will include increased evaporation rates in all seasons, and increased rainfall during spring, summer and autumn and a decrease in winter.

The site water balance model was updated to include adjustments to seasonal rainfall and evaporation rates as well as stockpile dust suppression water use, as this is likely to increase with evaporation rates. A comparison of the water balance modelling results for the existing climate scenario (refer Table 9.5) and the projected 2050 climate scenario is presented in Table 9.6.

Table 9.6 Results for existing and project 2050 climate change scenarios

	Existing climate conditions	**Projected 2050 climate conditions**	**Objective**
Discharge frequency	1 in 3 month (95 days)	1 in 3 month (88 days)	1 in 3 month (90 days)
Discharge coefficient	0.24	0.25	0.25
Surface water re-use efficiency	73 %	71 %	N/A

The results in Table 9.6 indicate that a minor increase in the frequency and magnitude of discharge events will occur as well as a minor reduction in the average surface water re-use efficiency, however overall the projected 2050 climate change scenario will not significantly alter the performance of the surface water management system.

9.2.4 Flooding

A flooding assessment was undertaken by WorleyParsons (Appendix H) to assess the areas of the T4 Project at risk of inundation from flooding. This included an assessment of the impacts of sea level rise on flooding of the T4 project area in its existing state (ie prior to development) and post-development of the T4 Project. Two scenarios were considered for both the existing and post-development cases:

- sea level rise only scenario - the impact of sea level rise under normal river discharge conditions; and
- sea level rise plus 1% annual exceedance probability (AEP) peak flood discharge event scenario - the combined impact of sea level rise plus increased peak flood discharge (with a 1% annual AEP peak flood discharge event).

The year 2100 ARI design still water levels published in the DECCW (2010) *NSW Coastal Risk Management Guide: Incorporating Sea Level Rise Benchmarks in Coastal Risk Assessments* were used as the still water level incorporating climate change for all modelled scenarios.

i Existing case (prior to T4 Project development)

Sea level rise only scenario – under the existing case prior to development of the T4 Project, the model results predict that most of Kooragang Island is inundated under extreme elevated water levels including sea-level rise. However, the only noticeable flooding of the T4 project area will occur to the west of the Pacific National Access Road, as a result of the overtopping of Long Pond, and along the foreshore between the Tourle Street Bridge and the rail crossing of the Hunter River South Arm. Accordingly, sea-level rise over the first few decades of development are not a concern for the T4 project area.

Sea level rise plus 1% AEP peak flood discharge event scenario – under the existing case (ie prior to T4 Project development), widespread flooding is predicted across the entire T4 project area. Overtopping of the Kooragang Island main rail line is predicted, with flood levels exceeding the railway line by up to 0.6 m at the lowest elevations. This overtopping results in higher water levels across lower lying parts of the T4 project area, including Deep Pond, Railway Pond and Easement Pond, with localised flooding around the Delta EMD site. Isolated flooding is also predicted west of the Pacific National Access Road and along the foreshore adjacent to the South Arm between the Tourle Street Bridge and the rail crossing of the Hunter River South Arm.

ii Post-development of the T4 project area

Sea level rise only scenario – the results of the sea-level rise only scenario for the post-development case illustrate similar flooding extents to the existing case before development of the T4 Project. The only noticeable change will be an approximate 100 m reduction in the southern extent of flood waters near some parts of the T4 Project's northern boundary during a 100 year ARI flood. This is due to obstruction by the T4 Project's rail embankment, which is expected to be up to 6 m high.

Sea level rise plus 1% AEP peak flood discharge event scenario – under the post-development case, modelling results indicate a significant reduction in the level of flooding across the developed portion of Kooragang Island, compared to the existing case (prior to the T4 Project). This is a result of the increased fill levels associated with the proposed development. The level of overtopping of the existing Kooragang Island main rail line is similar to that under existing case, however only Deep Pond receives the flood waters, with flooding to the east obstructed by the fill. The flood extent on the foreshore adjacent to the Hunter River South Arm under the post-development case is similar to the base case.

iii Summary

The flood modelling for the existing and post-development scenarios (incorporating climate change) indicates that changes to site elevations as a result of filling during development of the T4 Project will reduce inundation of floodwaters (compared to existing conditions) during extreme flood events (1% AEP) on most parts of the T4 project area. Therefore flooding is unlikely to significantly impact operation of the T4 Project.

Further, based on the modelling results in Appendix H and given the proximity of the T4 Project to the river mouth, it is unlikely that the T4 Project will impact upon flooding or effects of sea level rise at any downstream localities.

9.3 Management and monitoring

9.3.1 Construction

i Objectives

The principal objective of surface water management during the T4 Project's construction will be to prevent contamination of surface and ground waters.

ii Erosion and sediment control

As part of the CEMP, an erosion and sediment control plan (ESCP) will be implemented in accordance with the Landcom (2004) Blue Book. Implementation of the ESCP will ensure that there are no significant adverse impacts on receiving water quality during construction. The ESCP will include the following measures:

- construct site drainage works to contain and convey stormwater and dredge water;
- where possible, the site will be divided into smaller, more manageable catchments and runoff from non-operational areas will be separated from runoff from operational areas. The runoff from operational areas will be directed to sediment settling basins;
- existing ponds to be retained near construction areas will be marked as 'no go' areas;
- the portion of Deep Pond to be used as a settling basin will be separated from the southern portion of Deep Pond, with the remaining pond area to be used as a settling basin;
- construction plant and materials will be stored and maintained away from temporary and permanent drainage features;
- refuelling of plant/machinery will take place within bunded areas. Where this is not possible refuelling will be undertaken by trained staff supplied with appropriate spill clean-up kits;
- monitor captured runoff prior to discharging to the Hunter River South Arm during/after prolonged or significant rainfall events;
- install silt curtains (skirt with floats and ballast) in the Hunter River South Arm during construction of the wharf facilities and at the dredge water return point;

- where necessary, water any stockpiles and exposed areas to reduce the likelihood of sediment entrainment through wind driven processes;
- where appropriate, undertake early re-vegetation or sealing of completed elements of the development to reduce sediment laden run off;
- regularly inspect construction areas and surface water controls;
- regularly inspect and maintain all plant and machinery to reduce the likelihood of oil/grease leaks; and
- provide spill kits to facilitate the rapid remediation of any accidental spill of potential contaminants.

iii Water quality monitoring

A surface water quality monitoring program will be developed and implemented to monitor water quality within the site settlement basins and at locations upstream and downstream from the dredge return water release point in the Hunter River South Arm. Monitoring parameters will include but not be limited to turbidity, electrical conductivity and pH. Monitoring will be undertaken during discharge events and monthly at other times. During dredging operations, weekly monitoring of existing water bodies external to the T4 Project will be undertaken to ensure surface water management controls are working appropriately. Target quality levels will be documented in the CEMP.

iv Acid sulphate soils management

Proposed ASS management is described in Section 7.3.1.

v Hydrologic mitigations

Mosquito Creek Tributary

A realigned channel will be constructed north of the new rail embankment, to maintain the existing tidal flow regime to nearby wetlands potentially affected by disturbance to the southern end of Mosquito Creek Tributary (Figure 9.2). The realigned channel will be designed and constructed with similar hydraulic characteristics to the existing channel. Its final design will be based on detailed investigations at Mosquito Creek Tributary, including:

- additional water level monitoring to characterise the tidal regime and hydraulics;
- bathymetric survey; and
- hydraulic analysis to inform detailed design of the constructed channel.

The potential to realign the rail embankment at the Mosquito Creek crossing south of its currently proposed location, to abut the existing rail embankment, will also be investigated. This would reduce the disturbance footprint and the length of the diversion channel, and allow room for a mangrove buffer to be established between the rail embankment and the constructed channel.

Wetlands near the Eastern Watercourse

Works will be undertaken to avoid impacting the tidal regime of the wetland complex near the Eastern Watercourse. The mitigation design will be finalised prior to construction, in consultation with an ecologist. It will be based on detailed investigations including water level monitoring in the lagoon and north of the levee, to characterise the existing tidal regime, and surveying topography of the levee and surrounding land. It is likely that mitigation will involve modifying or removing the existing levee at the Eastern Watercourse to maintain tidal flows to the wetland complex by this route.

There is potential to recreate saltmarsh by regrading some of the previously filled wetland area to a level that would create favourable conditions for saltmarsh.

Eastern Freshwater Wetland

Drainage will be provided within the rail embankment (eg drainage from rail ballast to jump-up pits) to maintain flows into the Eastern Freshwater Wetland from the rail area.

9.3.2 Operation

i Objectives

The proposed operational water management system has been designed to prevent contamination of ground and surface waters during the operation of the T4 Project and has the following objectives:

- design the site water management system so the average discharge frequency to the Hunter River does not exceed one in three months;
- where practical, separate management of runoff generated from non-operational ('clean') and operational (potentially 'dirty') areas;
- maximise stormwater re-use; and
- minimise impacts to off-site water bodies.

The effectiveness of surface water management measures will be monitored during operations to ensure these objectives are being met and identify any aspects for improvement, as described in the following section.

ii Monitoring

The proposed surface water treatment system will be designed to provide adequate and efficient treatment and management of surface runoff by containing, collecting/treating, reusing and, when required, disposing of runoff.

To ensure operational surface water controls achieve the specified treatment targets, a surface water quality monitoring program will be implemented during operations, as part of the EMS. Recommended monitoring locations and frequencies are provided in Appendix J. Water quality trigger levels will be included in the EMS. All monitoring results will be documented in an annual report and will be retained in an appropriate database that will be available to relevant agencies on request. In addition to water quality sampling, the monitoring program will indicatively require:

- monitoring of water levels in settling ponds to assess pond freeboard capacity;
- annual monitoring of sediment levels in settling ponds;
- weekly inspection of sediment sumps, oil traps and transfer ponds, to ensure the capture of any oil spills;

- annual internal audit to ensure monitoring and recording of data is being undertaken in accordance with the EMS; and
- annual (and as needed) review of the monitoring program to reflect regulatory or operational changes.

If monitoring results exceed relevant trigger values, the following contingency measures will be implemented:

- undertake data validation, for example review database for false entries and/or repeat sampling;
- consider increasing monitoring frequency and sampling points to identify and confirm the source of any suspected adverse water quality input;
- identify contaminant source and rectify any operational procedure, storage, delivery and/or bunding systems as required;
- review the EMS to identify opportunities to improve or rectify any identified problem; and
- if any component of the surface water management framework is identified as creating an unacceptable environmental impact, establish remedial actions in consultation with the relevant agencies.

9.4 Conclusions

The surface water assessment determined that while the T4 Project will alter the existing (albeit highly modified) surface flow regime within the T4 project area, the proposed water management systems and controls will ensure there will be no significant adverse impacts to water quality or flow regimes of surrounding wetlands or the Hunter River. This includes ponds and wetlands in the Hunter Wetlands National Park and Hunter Estuary Wetlands Ramsar site.

The proposed controls include containing and treating surface runoff; erosion, sediment, spill and leak controls; and surface water monitoring to confirm the effectiveness of surface water management measures and identify any aspects for improvement. Key elements of the operational surface water management strategy for the T4 Project include:

- design the site water management system so the average discharge frequency to the Hunter River does not exceed one in three months;
- where practical, separate management of runoff generated from non-operational and operational areas;
- maximise stormwater re-use; and
- minimise impacts to off-site water bodies.

Modelling determined that the proposed settling ponds will large enough to meet Landcom (2004) requirements for sediment retention and DECC (2008) requirements for sediment and erosion control. The proposed water management system was predicted to typically meet or exceed the level of treatment required.

During operations, runoff from operational areas will be captured, directed to settling ponds and re-used. Water balance modelling indicates that 76% of site runoff will be captured and re-used to meet 73% of the T4 Project's process water demands. During prolonged wet weather, when the design capacity of the water storages is exceeded, surplus water will flow to the Hunter River South Arm (under licence). Modelling indicates that this would occur at an average frequency of once every 95 days months which meets the relevant discharge objective.

Flood modelling showed that the T4 Project is unlikely to be significantly impacted by flooding or impact flooding or effects of sea level rise at any downstream areas.

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