9.0 Topography, Geology, Soils and Sediments

9.1 Existing Environment

9.1.1 Topography

The Illawarra Region is characterised by a pronounced coastal escarpment, rising 400 m to 700 m above sea level within 12 km of the coast. Port Kembla is located approximately 7 km east of the escarpment, on flat low lying topography of the narrow coastal plain. It is estimated that elevation within the study area is between 3 m and 5 m PKHD.

9.1.2 Geology

The study area is underlain by Quaternary alluvium, described as being gravel, swamp deposits and sand dunes (Wollongong 1:50,000 Geological Sheet, 1974). Weathered geology of the area is conducive to sandy soil formation.

Quaternary materials are likely to be underlain by low to medium strength Permian siltstone, shale and sandstone of the Berry Formation, Shoalhaven Group to the centre, west and north of the site; and by melanocratic, coarse grained to porphyritic latite, Dapto latite, of the Shoalhaven Group to the south (Wollongong 1:50 000 Geological Sheet, 1974).

The depth of basement bedrock varies between -11 m to -16 m PKHD across the site.

9.1.3 Soils

Soils in the landside portion of the proposed development are categorised as 'Disturbed Terrain' on the Wollongong 1:100 000 soil landscape series sheet 9029-9129. Disturbed soils are those areas of varied topography, cleared of vegetation, with the top 100 cm of soil disturbed and/or removed. Previous subsurface investigations (cited in CH2MHill, 1999) indicate the landside portion of the proposed development is underlain by imported fill of up to 3.6 m depth.

Soils investigations undertaken as part of the investigations for the proposed development encountered natural sands, likely aeolian, marine or dune sands, and estuarine sediments below the fill layer (refer to **Appendix C**). Fill materials across the site include:

- Dark brown gravelly sand with minor clay.
- Shallow sandy fill.
- Coal wash fill.
- Highly plastic clays.
- Building material.
- Road base.

Subsurface investigations were undertaken on the southern shores of Port Kembla in 1994 (CMPS&F Environment, 1994). Elevated levels of heavy metals (arsenic, lead, copper, chromium and zinc), total petroleum hydrocarbons (TPHs) and polycyclic aromatic hydrocarbons (PAHs) were detected in fill material.

The relatively high permeability of naturally sandy soil is conducive to groundwater flows, which have been found to be moving into the harbour (north-eastward) at approximately 5 m below the surface. Groundwater investigations (URS, June 2004) detected levels of copper, nickel, zinc and lead above ANZECC (2000) guidelines. Groundwater contaminants were likely sourced from contaminated fill materials and industrial runoff across the aquifer catchment.

9.1.4 Acid Sulfate Soils

Potential acid sulfate soils (ASS) are potentially acidic, waterlogged soil layers rich in iron sulphide; primarily pyrite. The presence of Actual ASS is generally limited to coastal/estuarine areas, where ground levels are below + 6 m PKHD. Elevations of the site are considered to be less than 6 m PKHD. When excavation or drainage brings these soils into contact with oxygen, the pyrite is oxidised to form sulphuric acid. If the amount of acid exceeds the neutralising capacity of the soil, and the pH falls below 4, the soils are known as actual ASS. Acid can run off these soils during rainfall, scalding vegetation and killing aquatic fauna. Actual ASS may also react with concrete and steel infrastructure.

The *NSW Acid Sulfate Soil Risk Maps* (DNR, 2002) for Wollongong show the following categories:

- High risk of occurrence of ASS in estuarine bottom sediments of the Inner Harbour (extrapolated to be present in the Outer Harbour which is categorised as ocean and therefore not tested).
- Disturbed terrain for all landward soil.

The maps do not distinguish between Potential ASS and Actual ASS.

Dredged material from the Inner Harbour has, on occasion, been deposited in the Outer Harbour. The presence of the relocated Potential ASS in the Outer Harbour is not identified on the *NSW Acid Sulfate Soil Risk Maps*.

9.1.5 Sediments

Sediments of the Outer Harbour are affected by both natural processes, such as tidal flushing and longshore drift, and, to a lesser extent, mechanical mixing from deep draft vessels as well as wake produced by boats.

In the 1990's a reclamation program commenced in the Outer Harbour involving the placement of dredged material predominantly from the Inner Harbour, and partly from the Outer Harbour, in an area along and out from the south western foreshore. Materials were derived from:

- the casting basin (Inner Harbour) and No. 4 Bulk Liquids Berth (Outer Harbour) in the 1990's;
- the multi-purpose berth extension (Inner Harbour) in early 2000's; and
- development of Berths 107 and 103 (Inner Harbour) in 2007-2008.

Results of sampling within the disposal area (AECOM, 2009) indicate that sediments are comprised of very soft dark grey to black silty clay.

Results of Inner Harbour and Outer Harbour sediment sampling and analysis (Douglas Partners, 2002) reveal that a grain size gradient exists from the coarse sand and fine gravel sediments around the break wall and mid reaches of the Outer Harbour to the fine silty-clays towards the Cut and Inner Harbour. Following disturbance, coarse grains of sands and gravels tend to settle out of suspension considerably faster than fine sediments of silty-clay.

Site geotechnical characteristics comprise sandy silty clay, sandy clay and minor gravelly clay, and dredged fill shallowly underlain by very hard bedrock. Anthropogenic inclusions within sediments include coal, timber and aluminium fragments.

9.2 Methodology

9.2.1 Geotechnical Considerations

The Outer Harbour has been investigated for its geotechnical characteristics, which has included hydrographic and seismic surveying, borehole sampling and soil testing. Specifically, intensive sampling and testing has been undertaken for contamination assessment (**Section 10** and **11**).

9.2.2 Soils

Previous studies were reviewed (cited where appropriate) to inform soil characterisation and potential for mobilisation during construction and operation. Soil and sediment assessments conducted by AECOM for this EA were examined to determine appropriate mitigation measures and requirements for management plans to be incorporated into the CEMP.

9.2.3 Sediments

Hydrometer tests conducted as part of a harbour sediment sampling and analysis report (Douglas Partners, 2002) undertaken for the Outer Harbour, revealed the fine sediments, from dredged material of the Inner Harbour, settled out of suspension in sea water within two hours. Potential for dispersion of sediments to a water column outside of the Outer Harbour as a result of dredging/reclamation activities is considered to be limited, assuming tidal and current conditions are adequately assessed as dredging and reclamation activities proceed.

9.2.4 Acid Sulfate Soils

ASS investigations have been undertaken as a component of the Sediment Investigation for this EA (**Appendix B**). The ASS assessment was carried out in accordance with the guidelines in the *Acid Sulfate Soil Manual* (ASSMAC, 1998). The analytical results indicated the presence of acid sulfate material between 0 and 3.3 m (oxidic and anoxic layers) at the sample locations tested. Potential ASS dredged and relocated from the Inner Harbour will need to be considered during mobilisation of Outer Harbour sediments. Potential impacts and mitigation measures associated with disturbance of Potential ASS and Actual ASS are discussed in **Section 10.**

9.2.5 Potential for Dinoflagellate Cysts in Sediments

Impacts of dredging and reclamation activities associated with the disturbance and mobilisation of contaminated sediments, and the potential for toxic bloom from dinoflagellate cysts is discussed in **Sections 10, 12** and **16**.

9.3 Impact Assessment

9.3.1 Concept Plan

Proposed Activities

Concept Plan activities considered likely to impact on Topography, Geology, Soils, and Sediments include:

- Demolition of No. 3, 4 and 6 Jetties.
- Dredging for all basins, all multi-purpose and container berth boxes, and for extension of the swing basin.
- Construction of a multi-purpose terminal and container terminal with reclaimed material including emplacement of sediment into contained areas within the reclamation footprint.
- Operation of all terminals.
- Installation of utilities to service the multi-purpose terminal and container terminal (e.g. water, power 240V and 415V, telecommunications, sewer and sulphuric acid pipeline).
- New access roads from Christy Drive to the multi-purpose terminal, from Foreshore Road to the container terminal and from Darcy Road to the board harbour.
- Provision for extension of rail sidings.
- Construction of pavement material between the extent of reclamation area and the landside boundary to the west and south.
- Extension of the rail siding in the South Yard and extension of a rail link to the container terminal, including a bridge over Foreshore Road.

During Construction

Construction activities associated with the proposed development have the potential to impact on soils and sediments in the manner described below.

- Exposure and/or mobilisation of soils creating dust which may extend beyond the Port Kembla Outer Harbour development area.
- Movement of machinery exposing and mobilising soils and sediments.
- Sediment accumulation from earthworks in stormwater drains, drainage lines and natural surface depressions.
- Sedimentation and increased turbidity of water bodies including Salty Creek, Darcy Road Drain, and the Outer Harbour.
- Exposure of dredged Potential ASS to oxygen during movement and/or disposal of sediments.
- Exposure of ASS during land based construction activities such as construction of access roads, utility services and hardstand areas, albeit that these activities involve excavation to a limited depth.
- Importation of potentially contaminated soils (fill) for the reclamation area.
- Leaching of contaminants from dredged sediment after placement in reclamation areas.
- Mobilisation of contaminated soils from excavation and construction activities resulting in the potential creation of new 'hot spots'.
- Mobilisation of contaminated soils within surface water runoff potentially degrading quality of receiving waters, i.e. Salty Creek, Darcy Road Drain and the Outer Harbour.
- Mobilisation of contaminated sediments during dredging.

The impacts above will be prevented or controlled by adopting the mitigation measures proposed in **Section 9.4.**

The greatest potential for soil exposure and mobilisation would occur during excavation and construction activities associated with construction of the road and rail links, construction of the hardstand area from reclamation to the site boundary, construction of utility services and from stockpiles of spoil and fill material to be used for reclamation.

Excavation and land based construction activities would be appropriately managed to prevent sediment accumulation including sedimentation of stormwater drains, and turbidity of the water column with ensuing impacts on the Outer Harbour, Salty Creek, Darcy Road Drain, and surface water on site.

During Operation

The reclamation footprint of the multi-purpose terminal, container terminal, and roads and rail infrastructure, would consist of a final hardstand of pavement material above a consolidated layer of spoil/slag materials.

Potential exists for the groundwater flow regime to be altered should reclamation material be of a lower hydraulic conductivity to the naturally permeable soils of the shoreline. This issue is discussed in more detail in **Section 11.**

Detailed design would incorporate surface water flow modelling to inform civil infrastructure design. The 1:100 ARI would be modelled to cater for appropriate management of stormwater drainage (quantity and quality), thereby minimising potential for soil and sediment mobilisation.

The final hardstand and stormwater drainage systems would ameliorate potential for disturbance to soils and sediments during operation of Port facilities.

9.3.2 Major Project

Proposed Activities

Major Project activities considered likely to impact on Topography, Geology, Soils, and Sediments include:

- Demolition of No. 3 and No. 4 Jetties.
- Dredging for all basins, all multi-purpose boxes, all container terminal boxes.
- Reclamation of the majority of the multi-purpose terminals footprint (except for a small area adjacent to No. 6 Jetty) and all of the container terminals footprint.
- Construction and operation of part of the multi-purpose terminal (one berth) and construction of one berth for the container terminal.
- Installation of utilities to service part of the multi-purpose terminal (e.g. water, power 240V and 415V, telecommunications, sewer and sulphuric acid pipeline).
- New access road from Christy Drive to the multi-purpose terminal and temporary access road from Foreshore Road to the container terminal.
- Extension of No. 13 rail siding in the South Yard.

During Construction

Construction activities associated with the proposed development have the potential to impact on soils and sediments in the manner described below..

- Exposure and/or mobilisation of soils creating dust which may extend beyond the Port Kembla Outer Harbour development area.
- Movement of machinery exposing and mobilising soils and sediments.
- Sediment accumulation from earthworks in stormwater drains, drainage lines and natural surface depressions.
- Sedimentation and increased turbidity of water bodies including Salty Creek, Darcy Road Drain, and the Outer Harbour.
- Exposure of dredged Potential ASS to oxygen during movement and/or disposal of sediments.
- Exposure of ASS during land based construction activities such as construction of access roads and utility services, albeit that these activities involve excavation to a limited depth.
- Importation of potentially contaminated soils for the reclamation area.
- Leaching of contaminants from dredged sediment after placement in reclamation areas.
- Mobilisation of contaminated soils from excavation activities and construction vehicles resulting in the potential creation of new ‘hot spots’.
- Mobilisation of contaminated soils within surface water runoff potentially degrading quality of receiving waters, i.e. Salty Creek, Darcy Road Drain and the Outer Harbour.
- Mobilisation of contaminated sediments during dredging.

The impacts would be minimised or managed by adopting the mitigation measures proposed in **Section 9.4.**

The greatest potential for soil exposure and mobilisation would occur during excavation and construction activities associated with construction of the road links, construction of utility services, extension of the rail siding and from stockpiles of spoil and fill material to be used for reclamation.

Excavation and land based construction activities could give rise to sediment accumulation including sedimentation of stormwater drains, and turbidity of the water column with ensuing impacts on the Outer Harbour, Salty Creek, Darcy Road Drain, and surface water on site.

During Operation

The reclamation footprint would consist of a final hardstand of pavement material (for part of the multi-purpose terminal), and a construction hardstand of consolidated spoil/slag materials. During operation of the Major Project, the reclaimed surfaces of the southern portion of the multi-purpose terminals and eastern and western container terminals would remain unpaved. The surface of these areas would be comprised of compacted gravels or other suitable materials that will minimise air-borne fugitive dust and mobilisation of sediments in surface water runoff.

Potential exists for the groundwater flow regime to be altered should reclamation material be of a lower hydraulic conductivity to the naturally permeable soils of the shoreline. This issue is discussed in more detail in **Section 11**.

Detailed design would incorporate surface water flow modelling to inform civil infrastructure design. The 1:100 ARI would be modelled to cater for appropriate stormwater drainage (quantity and quality), minimising potential for soil and sediment mobilisation.

The final hardstand and stormwater drainage systems would ameliorate potential for disturbance to soils and sediments during operation of Port facilities.

9.4 Mitigation Measures

9.4.1 Concept Plan

CEMPs would include a *Soil and Water Management Plan* (SWMP) and *Acid Sulfate Soil Management Plan* (ASSMP), taking into account the *Managing Urban Stormwater: Soils and Construction* guidelines (Landcom, 2004) and the *Acid Sulfate Soil Manual* (ASSMAC) respectively.

Mitigation measures presented below would ensure the environmental impact of construction and operational activities on soils and sediments is minimised. Erosion and sediment control measures for construction and operation of the Concept Plan would include:

- Implementing a practical and logical staging program for the erosion and sediment control measures.
- Dust management in accordance with an Air Quality Management Plan prepared for each project stage
- Where applicable, mobilisation of disturbed soils confirmed to be Actual ASS, would be handled in accordance with the *Acid Sulfate Soil Management Plan.*
- Preference would be given to disposal/placement of Potential ASS in locations beneath the water to avoid exposure to oxygen.
- Detailed design of operational roads and terminal hardstand would apply appropriate stormwater drainage controls.
- CEMPs and OEMPs would include a requirement to cover all unsecured loads leaving the Port.
- Only environmentally suitable fill materials would be used for reclamation.

These measures form part of the draft Statement of Commitments (**Section 29**) of this EA.

Detailed mitigation measures would be outlined in CEMPs and OEMPs prepared prior to construction and operation of each discrete stage of works, subject to subsequent planning approvals.

9.4.2 Major Project

Mitigation measures recommended for the Concept Plan above (**Section 9.4.1**) would be incorporated into relevant CEMPs and OEMPs for the Major Project. In addition, specific mitigation measures applicable to construction and operation activities associated with potential impacts of the Major Project include:

- Minimising the erosion of soil from disturbed areas on the site by:
  - Installing water diversion structures to ensure surface water runoff does not enter zones of exposed soils during construction.
  - Limiting the area of disturbance to those locations necessary to construct the new roads, and reclamation area.
  - Implementation of site management procedures including watering of unsecured stockpiles of reclamation material (if stockpiles contain fines) anticipated to be exposed and unused for a period longer than two continuous weeks.
- Installing sediment traps around areas of exposed soils to protect downstream water quality.

- Installing buffers to the riparian zone, for example sediment fences, to prevent sediment laden water from entering Salty Creek, Darcy Road Drain, and the Outer Harbour.
- Installing of filter rolls at stormwater drain locations to minimise potential for sedimentation of drains and subsequent flooding during heavy rainfall.
- Dust mitigation activities such as watering of unsealed roads and covering of truck loads.
- Sediments within the dredging area would require removal and incorporation into the reclamation. As these sediments are soft and susceptible to slumping, consolidation to acceptable levels for hardstand construction may require soil enhancement procedures and treatments as required.
- Reclamation edge structures (temporary and permanent) would incorporate geotextile material to, mitigate effects of wave action and avoid material slumping back into the harbour.
- An ecologically sustainable system of pollution control would be established for implementation during construction activities (including dredging, reclamation and landside activities). For example, for stockpiles of spoil found to contain fine particles, the use of geomesh or seeding would be initiated on stockpiles anticipated to remain unused for construction purposes and exposed for a period of 2 weeks or more.
- A temporary top layer of permeable materials would be placed atop reclaimed areas not programmed for pavement material during the Major Project. Any fine particles deposited within this layer would be watered during construction.
- The temporary top layer of permeable materials would be designed to slightly slope to the centre of the reclaimed area creating temporary sediment ponds. Stormwater would pond and progressively re-enter the Outer Harbour after being filtered of sediments through the consolidation material.
- Measures to minimise excess materials being deposited offsite during loading and transportation of bulk materials from the material handling area. Controls such as vehicle shaker pads, use of vacuum road sweepers, covering loads during transport and dust suppression.

Detailed mitigation measures, including those outlined above would be included in a CEMP prepared prior to construction and an OEMP prior to operation. The CEMP would address the potential for soil and sediment mobilisation, including a description of soil and sediment particle characteristics including ASS, contamination and salinity. The CEMP would include a *Soil and Water Management Plan* (SWMP) and *Acid Sulfate Soil Management Plan* (ASSMP), taking into account the *Managing Urban Stormwater: Soils and Construction* guidelines (Landcom, 2004) and the *Acid Sulfate Soil Manual* (ASSMAC) respectively.

9.5 Summary

Potential for impacts to soils and sediments of the Outer Harbour would be temporary in nature and duration, related primarily to construction and reclamation activities. A number of measures would be implemented to control soil erosion and prevent sedimentation of the Outer Harbour, Salty Creek and Darcy Road Drain.

PKPC would prepare a SWMP and ASSMP to be incorporated into the overall CEMPs and OEMPs. The SWMP and ASSMP would address all areas where significant disturbance of land or stockpiling of soils is likely to occur complying with the NSW government guidelines *Managing Urban Stormwater: Soils and Construction* guidelines (Landcom, 2004) and the *Acid Sulfate Soil Manual* (ASSMAC). Recommendations of these guidelines would be applied during all programs of work to manage and mitigate potential for impact from soil and sediment disturbance, mobilisation and accumulation, resulting from construction and operational activities of the Outer Harbour development.

Elutriate results indicated that there is a potential for copper, arsenic, vanadium and zinc to be released into the water column during dredging at concentrations which could exceed their respective ANZECC (2000) 95% Marine trigger values.

The vanadium and zinc elutriate exceedances were isolated (one out of 51 samples) and related to samples taken from sediments beneath the proposed multi purpose terminal that will not be subject to dredging.

The copper elutriate exceedances were also relatively isolated (seven out of 51 samples), but were more widely distributed throughout the dredge footprint. The concentrations of copper in the elutriate samples exceeding the trigger value (1.3 µg/L) typically ranged between 2 µg/L and 5 µg/L (between two and four times the trigger value), with one result of 11 µg/L.

The arsenic elutriate exceedances were wide spread (39 out of 51 elutriate samples) and corresponded with sediment samples with total concentrations which also exceeded the ISQG-High trigger values. As such, the arsenic elutriate exceedances are likely to represent the worst case scenario in terms of arsenic being mobilised to the water column during the proposed reclamation works. The concentrations of arsenic in the elutriate samples exceeding the trigger value (4.5 µg/L) were typically less than 20 µg/L (that is approximately four times the trigger value) with only seven results greater than 20 µg/L. As noted in NADG (2009), the initial dilution ratio of 1:4 incorporated as part of the elutriate analysis is likely to 'greatly overestimate water quality impacts given that, within the four-hour period, dilutions of the order of a hundred times or more (and often much more) would normally be expected'. Water quality impacts can be estimated as a function of the dredge footprint, water column depth, and dredging and reclamation methodology, including the capacity of the barge and the mass of sediment (and contaminant contained within it) placed at any one time. Therefore, a more detailed quantification of the actual water quality impacts is not possible until the dredging methodology is confirmed.

Notwithstanding, and in consideration of the likely dilution effects of dredging and reclamation, it is considered unlikely that the elutriate results for both arsenic and copper, which were typically three to four times the ANZECC (2000) 95% marine trigger value, indicate that the dredging and reclamation works will have a significant impact on the receiving environment.

10.0 Contamination: Sediment Quality

10.1 Existing Environment

A review of previous investigation reports considering sediment quality within the location of proposed reclamation and dredging included the Douglas Partners (2002) sediment sampling of the harbour for proposed maintenance dredging. Of the 74 sampling locations assessed, most were located across the Inner Harbour and only one was located within the Outer Harbour. The results of the sample (identified as 'Sample 3.2') collected from approximately 11 metres depth, south east of No. 6 Jetty, within the Outer Harbour were as follows:

- Antimony, cadmium, cyanide, selenium, silver, TBT, vanadium, TPH, BTEX, OCPs, PCBs and Total phenolics concentrations were all reported at concentrations below the laboratory LOR.
- A zinc concentration of 81 mg/kg and an iron concentration of 9,100 mg/kg was reported in the analysed sample.
- Copper, lead, mercury, molybdenum and Total PAHs concentrations in 'Sample 3.2' were reported to exceed the ISQG-Low while none of these concentrations exceeded the ISQG-High.

Patterson Britton (2005a and b) undertook two sediment sampling programs focussed on the south west part of the Outer Harbour, to assess contaminant concentrations prior to the creation of a spoil emplacement area containing sediments dredged from the Inner Harbour. The investigation found that the 95% Upper Confidence Limit (UCL) for all analytes was generally above the *ANZECC Interim Sediment Quality Guideline* (ISQG)-Low trigger values and that the 95% UCLs for copper lead, mercury, silver, zinc and naphthalene were all above the ANZECC ISQG-High trigger values.

The investigation undertaken by AECOM (2009) revealed that sediment within and around the study area predominantly comprises of sandy silty clay, sandy clay and minor gravelly clay. Anthropogenic inclusions within sediments include coal, timber and aluminium fragments. Hydrocarbon, tar-like and chemical odours are present in sediments located within the middle of the spoil emplacement area, near the outlet of Salty Creek and at the southern end of the proposed eastern dredge footprint near the eastern breakwater (adjacent to No. 4 Jetty). A sheen can also be observed within sediments collected between 0.3 and 0.5 m below ground surface (bgs) from a location (PC22) near No. 4 Jetty.

10.2 Methodology

The key objective of the Sediment Investigation (**Appendix B**) for the proposed Outer Harbour development is to address the specific contamination management requirements specified by the DGRs, including:

- Characterise the lateral and vertical distribution of contaminated sediments in the area of proposed dredging operations.
- Assess harbour water quality at high and low tide.
- Collect data required to undertake a qualitative human health and ecological risk assessment of in-situ sediments and groundwater (refer **Section 12**).
- Inform construction and operational environmental management plans for the proposed development.
- Inform an evaluation of the practicability and suitability of re-use of the dredged material within the proposed reclamation.

Limited sediment investigations have previously been undertaken within the Outer Harbour to characterise the nature of potentially contaminated sediments in conjunction with development activities in the Inner Harbour. These investigations have been reviewed as a component of the Sediment Investigation prepared by AECOM (2009).

The scope of work undertaken as part of the Sediment Investigation included:

- Collection of 30 grab samples using a modified Smith McIntyre grab sample from the surface of the harbour bed (oxidic layer) at 30 locations across the proposed dredge footprint.
- Collection of sediment samples from between 0.5 m and 4.8 m below the harbour bed (anoxic layer) using a combination of piston coring and vibro-coring techniques at 90 locations across the proposed dredge footprint and existing underwater emplacement area.
- Collection of paired low and high tide harbour water samples from three locations (mirroring Sydney Water's historic monitoring program) totalling 12 samples.
- Laboratory analysis of selected samples for potential contaminants of concern selected based on historic site activities and previous investigation results.

The results of the sediment sample analysis program were compared against the ANZECC/ARMCANZ (2000) *Interim Sediment Quality Guidelines* (ISQGs) Low and High Trigger Values for the purpose of assessing potential environmental impacts. The results were also compared against the National Environment Protection Council (NEPC), 1999 *National Environment Protection (Assessment of Site Contamination) Measure (NEPM)* guidelines for commercial and industrial land use to assess suitability for use in reclamation of the land that will comprise the future berths.

Harbour water samples (and sediment sample elutriate results) were compared to the ANZECC/ARMCANZ (2000) *Guidelines for Fresh and Marine Water Quality* 95% protection trigger value for marine water. This assessment criterion was selected in consideration of the disturbed nature of the location of the proposed reclamation and dredging in the Outer Harbour.

10.3 Impact Assessment

10.3.1 Concept Plan

It should be noted that the areas investigated as part of this Sediment Investigation relate specifically to Stage 1 (Major Project). As such the proposed dredging, including the area north of the Port Kembla Gateway Jetty (currently leased until 2022) and the swing basin area south of the northern breakwater were not sampled. Dredging works would be required in both of these areas in the future as part of Stage 3 of the Concept Plan (refer to **Figure 5-7**).

Although the Sediment Investigation did not include those areas requiring dredging as part of Stage 3, and therefore these areas cannot be fully assessed as part of this EA, potential issues relating to contaminated sediments as a result of dredging activities are considered likely to be similar to those areas assessed for the Major Project (Stage 1) which include:

- The potential release of contaminants from sediment during the dredging and/or placement of materials within the reclaimed areas due to physical processes or chemical changes;
- Mobilisation of bioavailable contaminants within sediments into the water column and subsequent incidental ingestion and/or dermal absorption into the food chain;
- Disturbance of potential acid sulfate soil (PASS) and the risk of them becoming actual ASS when brought to the surface as part of the dredging and reclamation activities.

A further Sediment Investigation would be conducted in the area north of the Port Kembla Gateway Jetty and south of the northern breakwater as part of subsequent project applications for these Stage 3 works.

10.3.2 Major Project

The analytical results obtained from the Sediment Investigation were generally consistent with the findings of previous investigations on the contamination of sediments within the Outer Harbour. The extent and nature of contamination identified within the sediments is summarised below:

- Heavy metals contamination (concentrations exceeding their respective ANZECC Interim Sediment Quality Guideline [ISQG] trigger values) was identified across the majority of the dredge footprint within the shallow sediments (approximately 0-0.3 m bgs).
- The highest concentrations of heavy metals (with concentrations greater than their respective ANZECC ISQG-High) were identified predominantly within the top 1.0 m of the existing underwater emplacement area.
- Copper and lead concentrations (and to a lesser degree arsenic) exceeded the NEPC (1999) National Environment Protection (Assessment of Site Contamination) Measure Health-Based Soil Investigation Levels (SILs) for a commercial/industrial land use in localised areas at the southern end of the eastern dredge footprint (current location of No.4 Jetty) and also in the vicinity of the Darcy Road Drain.
- PAH contamination was identified across the majority of the dredge footprint within the shallow sediments (approximately 0-0.3 m bgs). The highest PAHs concentrations (greater than their respective ANZECC ISQG-High) were identified within the spoil emplacement area.
- TBT contamination (exceeding the ANZECC ISQG-High) appeared to be confined to the southern end of the eastern dredge footprint adjacent to the eastern breakwater (in the vicinity of No.4 Jetty).
- Heavy metals concentrations in the harbour water samples were less than the adopted assessment criteria (ANZECC [2000] 95% Marine Water), with the exception of the following:
  - Cadmium - concentrations in two harbour water samples (10 400 µg/L and 65 400 µg/L respectively) (both collected at high tide) exceeded the adopted assessment criteria (5.5 µg/L). These very high cadmium concentrations are considered to be erroneous and require additional investigation/monitoring; and
  - Copper - concentrations in one harbour water sample (2 µg/L) (collected at high tide) exceeded the adopted assessment criteria (1.3 µg/L).

Potential impacts associated with contaminated sediments as a result of construction activities include:

- The potential release of contaminants from sediment during the dredging and/or placement of materials within the reclaimed areas due to physical processes or chemical changes;
- Mobilisation of bioavailable contaminants within sediments into the water column and subsequent incidental ingestion and/or dermal absorption into the food chain;
- Disturbance of potential acid sulfate soil (PASS) and the risk of them becoming actual ASS when brought to the surface as part of the dredging and reclamation activities.

Dredging works would be undertaken within an area protected by silt curtains and using a dredging methodology aimed at minimising the dispersal of sediments within the water column. Dredged sediment would be placed within a bunded containment area at depth to form the base for the reclamation and covered with suitable materials to encapsulate the sediments. Silt curtains would also be used at the emplacement area to control turbidity in the water column (refer **Figure 6-8**).

The risk to human health and the environment associated with the contaminated sediment (in particular the potential sediment contamination hotspots) would be evaluated by a further qualitative risk assessment. If the risk assessment concludes that the contamination hotspots present an unacceptable risk to the environment, a Remedial Action Plan would be prepared to appropriately manage the identified materials of concern. Remedial actions could include placing more contaminated materials at greater depths, encapsulation/stabilisation works or removal offsite.

10.3.3 Acid Sulfate Soils

AECOM conducted a review of the *Acid Sulfate Soil Risk Map* (Edition 2) for Wollongong, published by the Department of Natural Resources (DNR, 2002). The ASS Risk Map indicated that:

- There is a 'High Probability' of potential acid sulfate soil (PASS) being present within the 'Estuarine Bottom Sediments' of the Inner Harbour (extrapolated to the PKOH which is categorised as Ocean by the Map and therefore not classified).
- There is a potential for 'severe environmental risk' if bottom sediments are disturbed by activities such as dredging.
- The analytical results for SPOCAS (suspension peroxide oxidation combined acidity and sulfate) indicated that there is a potential for acid sulfate material between 0 and 3.3 m (oxidic and anoxic layers) at the site.

PASS investigations were undertaken as a component of the sediment investigation (AECOM 2009). The PASS assessment was carried out in accordance with the guidelines in the *Acid Sulfate Soil Manual* (ASSMAC, 1998). These guidelines provide action criteria for differing sediment types which, if exceeded, trigger the need to prepare an *Acid Sulfate Soil Management Plan* (ASSMP). The analytical results confirmed the presence of acid sulfate material between 0 and 3.3 m (oxidic and anoxic layers) at the sampled locations.

When PASS are brought to the surface, from dredging and reclamation activities, the buffering capacity of the soil becomes diminished as a result of oxygen exposure, and the soils become actual ASS. Potential surface water run-off could mobilise these soils during rainfall potentially detrimentally impacting on vegetation, aquatic flora and concrete and steel infrastructure.

These potential impacts will be readily managed during the dredging and reclamation activities simply by avoiding or minimising PASS coming into contact with oxygen. This will be achieved by continuously transporting wet sediments within the water column from the point of dredging for immediate disposal at the emplacement (reclamation) site.

10.3.4 Elutriate Testing

The elutriate test is designed to simulate the potential release of contaminants from a sediment during the dredging and/or placement of materials as part of a reclamation due to physical processes or chemical changes. Elutriate water concentrations were compared to ANZECC (2000) *Marine Water Quality Guidelines*.

The elutriate results (not allowing for dilution effects – see discussion below) indicated that there is a potential for copper, arsenic, vanadium and zinc to be released into the water column during dredging at concentrations which could exceed their respective ANZECC (2000) 95% Marine trigger values.

A dilution rate of 1:4 has been applied to the reported elutriate results to simulate the likely dilution and dispersion of contaminants of potential concern (CoPC). This approach is consistent with the NADG (2009) which provides for consideration of initial dilution when considering elutriate test results.

Both arsenic and copper concentrations, the key CoPCs in relation to the elutriate results, were typically three to four times the ANZECC (2000) 95% marine trigger value. However, since a dilution ratio of 1:4 is taken into account, it is considered that the elutriate results indicate that the dredging and reclamation works are unlikely to have a significant impact on the receiving environment.

10.4 Mitigation Measures

10.4.1 Concept Plan

A sediment investigation would be conducted in the area north of the Port Kembla Gateway jetty and south of the northern breakwater as dredging works will be required in these areas in the future as part of Stage 3 of the Concept Plan.

Based on the findings of the Sediment Investigation undertaken for the Major Project (Stage 1) and the expected similar sediment characteristics in the areas mentioned above, it is likely that the proposed dredging and reclamation mitigation measures outlined for the Major Project below, can be applied to the Stage 3 dredging works in the future. This would include:

- Preparation of a DEMP.
- Suitable containment of dredged sediments within the reclamation area.
- Preparation of an ASSMP.
- Preparation of a SWMP.
- Water quality monitoring (refer **Section 14**).

10.4.2 Major Project

In order to ensure that the identified potential impacts associated with the dredging and placement of contaminated sediments are appropriately mitigated, the following measures have been proposed:

- A Dredging Environmental Management Plan (DEMP) would be prepared as a sub-plan of the CEMP for the dredging and reclamation works. The DEMP would be prepared (as a precursor to the redevelopment works) once the detailed design for the dredging works is finalised and the further qualitative risk assessment has been undertaken.
- Ensure that the recommended mitigation measures incorporated into the DEMP are appropriate and specific to the proposed dredging works, therefore minimising potential impacts to the environment;
- Dredged sediments would be transported while wet and immediately placed in the reclamation area to avoid the need for land storage and wastewater management (none will be guaranteed), and to prevent the oxidation of potential acid sulfate soils;
- The initial dredging works would involve the construction of underwater bunds to contain the contaminated sediments on the sea floor. Slag and other suitable materials would be used to overly and encapsulate these sediments. This approach would appropriately manage the potential issues of wave action and mitigate any significant hydraulic gradient between the sediments and the Outer Harbour which could result in leaching of contaminants;
- Sloping rock revetment walls (reclamation edge structures) would incorporate geotextile fabric to mitigate the effects of wave action and avoid material slumping back in the harbour.
- The risk to human health and the environment associated with the contaminated sediment (in particular the identified sediment contamination hotspots) would be evaluated by a further qualitative risk assessment. If the risk assessment concludes that the contamination hotspots present an unacceptable risk to the environment, a Remedial Action Plan would be prepared to appropriately manage the identified materials of concern. Remedial actions could include placing more contaminated materials at greater depths, encapsulation/stabilisation works or removal offsite;
- A Soil and Water Management Plan would be prepared to appropriately manage the accumulation of surface water from rainfall until the reclamation areas are finally paved. In the preparation of this plan, consideration would be given to contingency measures such as sediment basins being constructed. During the operational phase, contingency measures such as a first flush stormwater capture system would also be implemented;
- In considering the elutriate analysis results, the following mitigation measures would be detailed in the DEMP to minimise impact on the receiving environment of the Outer Harbour:
  - Dredged sediments deposited as part of the proposed reclamation will be contained in an engineered containment structure which would be constructed of higher quality and less impacted material;
  - The sediment would effectively be encapsulated and confined within the engineered structure;

  - Dredged sediments would be placed at depth, likely below the depth of wave action at the base of the reclamation fill to maximise the opportunity for future consolidation and reduce the potential for further disturbance;
  - Dredging and emplacement of sediments in the reclamation area would be undertaken within the protection of parallel silt curtains encompassing the dredging and placement areas;
  - Dredging technologies would be selected in consideration of their ability to minimise the generation of turbidity;
  - Turbidity measurements and toxicant monitoring would be employed in conjunction with observations by personnel undertaking the dredging and reclamation activities to assist in early identification of problems and proactive implementation of mitigation measures;
  - Regular (e.g. monthly) flyovers would be conducted to assess the presence of potential sediment plumes and algal blooms from the dredging or placement areas;
  - Contingency measures that can be implemented immediately in the event visible turbidity and harbour water quality impacts are identified during routine monitoring;
  - Based on AECOM's experience on similar projects and involving similar contaminants (including the Hunter River remediation project), it is considered that the above mitigation measures would be suitable in minimising adverse affects to the receiving environment during the proposed dredging and placement works;
- The DEMP would include monitoring such as, daily visual inspections of sediment control devices to determine the condition and effectiveness of control measures in protecting the receiving aquatic ecosystem;
- An acid sulfate soil management plan would be prepared as a precursor to the dredging and reclamation works to ensure that these works either avoid exposing potential acid sulfate soils to oxygen or provide for appropriate management of the PASS;
- As part of Soil and Water Management sub-plans of relevant CEMPs, water quality monitoring programs would be developed in consultation with DECCW and Port Kembla Harbour Environment Group. Water quality monitoring would establish existing baseline conditions, monitoring frequencies, testing locations and procedures, and define appropriate water quality parameters (refer **Section 14**);
- Cadmium sampling would be included as part of the water quality monitoring program to be undertaken prior to the commencement of dredging works, to confirm baseline cadmium concentrations within the Outer Harbour.

10.5 Conclusions

The following conclusions can be drawn from the Sediment Investigation:

- Contamination was identified within the sediments of the Major Project area (Stage 1) of the Outer Harbour, which could be disturbed and mobilised during construction (dredging) works associated with the development. These potential impacts can be appropriately managed by adopting suitable dredging methodologies and environmental safeguards such as parallel silt curtains, during the dredging works.
- There is the potential for acid sulfate soils (PASS) to be present within the harbour sediments and the PASS can present a significant environmental risk if disturbed and exposed to oxygen. These potential impacts would be appropriately managed during the dredging and reclamation works by ensuring that the dredged material is transported while wet and immediately placed in the reclamation area, thus preventing exposure to the atmosphere.
- Heavy metal concentrations in the harbour water samples were less than the adopted ANZECC assessment criteria with the exception of cadmium concentrations in two samples (likely to be erroneous) and copper concentrations in one water sample.
- The elutriate test results indicate that, after allowing for a dilution ratio of 1:4, the dredging and reclamation works are unlikely to have a significant impact on the receiving environment.
- Based on AECOM's experience on similar projects and involving similar contaminants (including the Hunter River Remediation Project), it is considered that the above mitigation measures would be suitable in minimising adverse affects to the receiving environment during the proposed dredging and placement works. Consequently, AECOM considers that modelling/field trials to assess the potential mobilisation and/or dispersion of contaminants would not be required. Due to the large mobilisation costs associated with such field trials, these works are also likely to be impracticable and cost prohibitive.

- The proposed sediment emplacement and encapsulation structures are considered to be appropriate to manage the potential issues of wave action and mitigate any significant hydraulic gradient between the sediment and the Outer Harbour which could result in leaching of contaminants from the sediments.
- Based on the findings of the Sediment Investigation the expected similar sediment characteristics in the area north of the Port Kembla Gateway Jetty and south of the northern breakwater, the proposed dredging and emplacement mitigation measures outlined for the Major Project above, are also considered to be applicable to the Stage 3 works in the future.
- Sediment Investigation should be conducted in the area north of the Port Kembla Gateway Jetty and south of the northern breakwater as part of subsequent project applications.

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11.0 Contamination – Soil and Ground Water

11.1 Introduction

A land based investigation was undertaken with a focus on the Major Project (Stage 1) area and in particular, the road link from Christy Drive to the multi-purpose terminals. The objective of the investigation was to:

- Delineate soil and groundwater contamination in the proposed land based excavation area. (specifically the materials that it is anticipated would be disturbed by the proposed new road link).
- Delineate contaminants in groundwater.

An extension of the railway sidings at the Pacific National South Yard and the construction of a temporary access road for the container terminals reclamation, also fall within the scope of the Major Project. Soil sampling was not undertaken for these areas as part of this investigation as the focus of the contaminated land investigation was on areas of high risk i.e. potentially contaminated soil in vicinity of the new road link off Christy Drive, which was identified by considering past land uses.

An in-situ investigation in the vicinity of the proposed extension of the railway sidings was deemed to be unnecessary given the historical use of the site, and a low potential of identifying contaminants other than those typically found within rail corridors. Such contaminants can be easily managed during construction and are unlikely to result in any significant environmental risks.

Sampling was not undertaken in the vicinity of the proposed temporary road link to the container terminals (for construction traffic) as the construction methods for the temporary access road are likely to require minor regrading works and minimal soil disturbance.

As part of Stage 2 of the Concept Plan the following new road links are proposed:

- A new road link to the container terminals off Foreshore Road.
- Extension of a road link adjacent to the multi-purpose terminals off Foreshore Road.
- A potential new road link along a disused rail corridor between Darcy Road and the boat harbour carpark.

Soil sampling was not undertaken for these areas as part of this investigation but should be required as part of project applications for construction and operation of Stages 2 and 3 of the Concept Plan that are made at a later date.

Soil and groundwater investigations have previously been undertaken to assess potential contamination issues both within the location of the new road corridor off Christy Drive and within properties adjacent to the proposed new road corridor. These investigations have been reviewed as a component of the Land Based Investigation prepared by AECOM (2009) (refer to **Appendix C**) and are summarised in the following section.

The scope of work undertaken as part of the Land Based Investigation included:

- Review of site history including historical environmental investigation reports relating to the location for the proposed new road corridor.
- Advancing of a total of 11 boreholes (BH01 to BH11) across the location of the proposed road corridor to a maximum depth of 1.5 m bgs corresponding with the maximum anticipated excavation depth required by the road development and collection of soil samples from each location (refer **Figures 11-1** and **11-2**) .
- Laboratory analysis of samples for contaminants of potential concern (CoPC) based on historic site activities and previous investigation results.
- No groundwater sampling was undertaken as part of this investigation as previous studies recorded groundwater in the vicinity of the proposed road corridor to the multi-purpose terminals to be between 4.2m and 4.3m below ground surface (bgs) and at approximately 2.6m bgs in the vicinity of the proposed link road to the container terminals. Excavation works for the proposed link road to the multi-purpose terminals would be limited to a depth of around 1.5 m bgs. Therefore, it is unlikely that groundwater would be encountered during excavation works associated with the construction of this link road.

Figure 11-1: Location of land based investigation

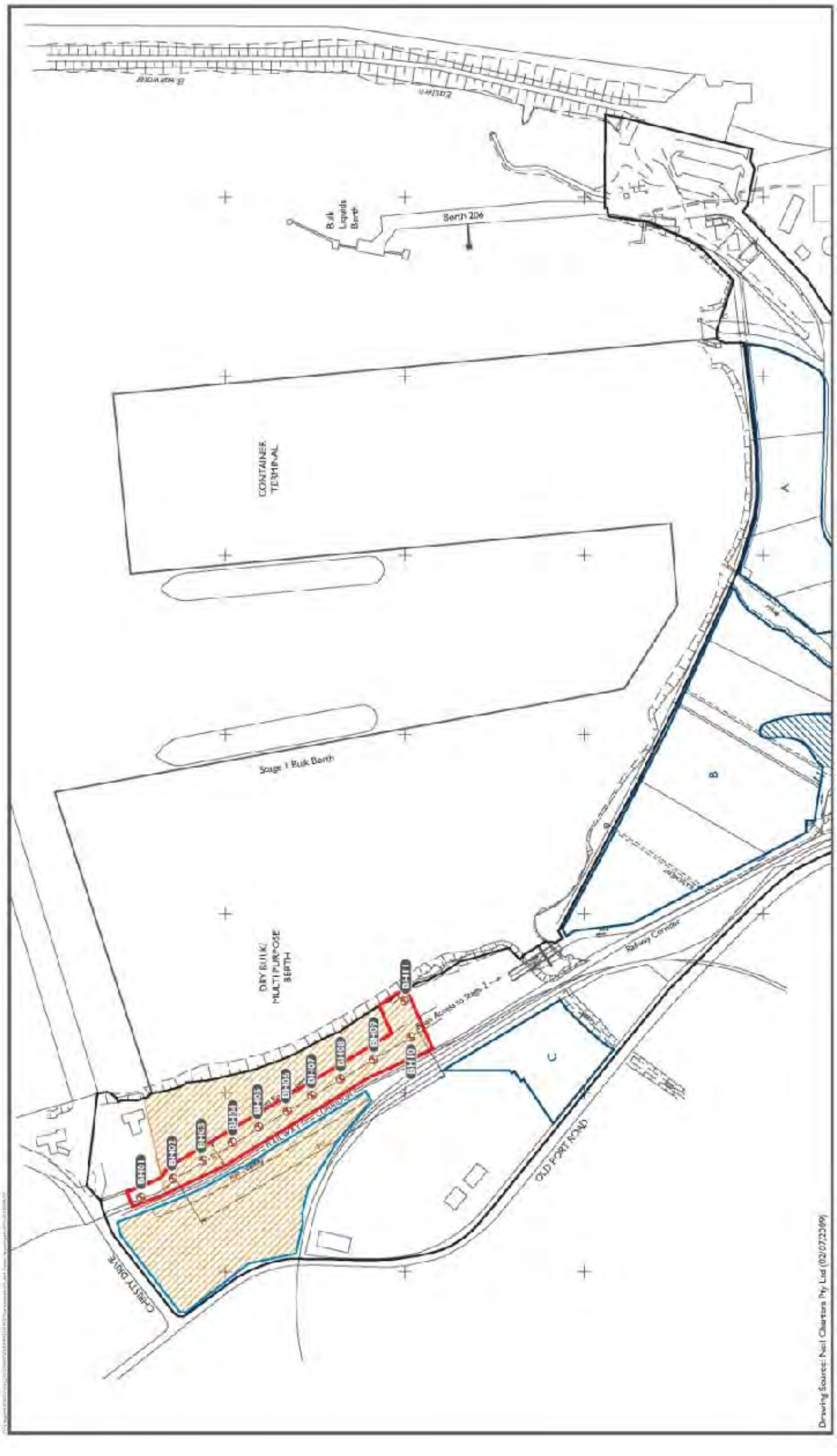
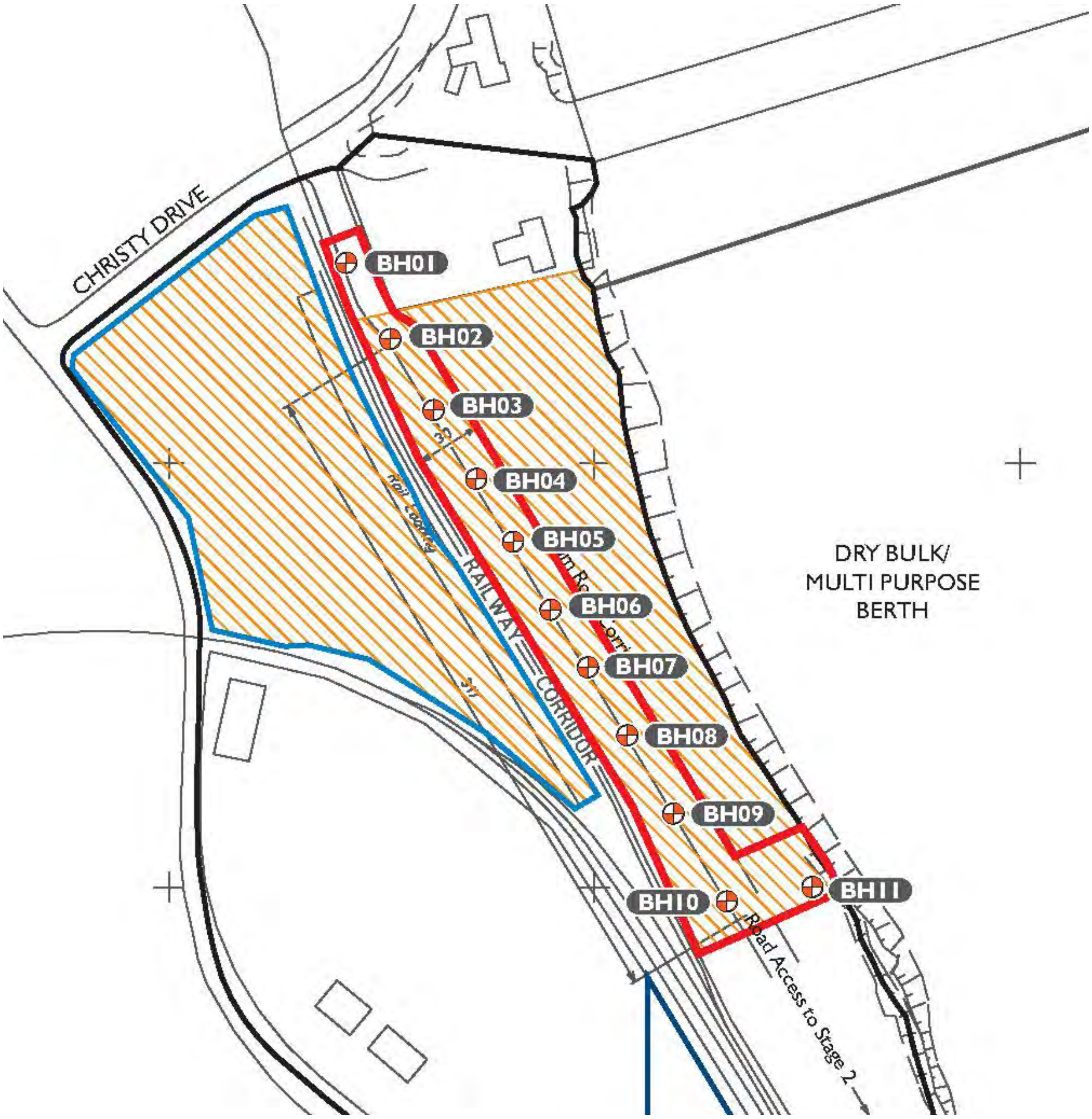


Figure 11-2: Sampling locations for land based investigation



Based on the proposed future industrial land use (namely a link road within an industrial precinct used for access to the multi-purpose terminals), the soil and historical groundwater analytical results were compared to the following soil assessment criteria (SAC):

- NSW EPA, 1994. Guidelines for Assessing Service Station Sites.
- NSW DEC, 2006. Guidelines for the NSW Site Auditor Scheme (2^{nd} Edition).
- NEPC, 1999. NEPM National Environment Protection (Assessment of Site Contamination) Measure (Site Investigation Level [SIL_4] for a commercial/industrial land use).
- WA Department of Health (DoH) (2009) Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia (asbestos in soils only).
- ANZECC (2000) Guidelines for Fresh and Marine Water Quality (95% protection level).

11.2 Existing Environment

Based on a review of previous environmental investigations and available anecdotal information, the location of the proposed new road corridor has been historically used since 1 September 1900 when it was resumed by the Public Works Department. An electricity power station was constructed immediately west of the proposed road corridor and the land was transferred to the Electricity Commission of NSW when it was formed in 1950 under an Act of Parliament which brought all power stations under one jurisdiction.

The power station was subsequently decommissioned and demolished and the location of the proposed road corridor was acquired by the Maritime Services Board on 18 November 1986. The location of the proposed road corridor is currently owned by NSW Maritime and occupies one portion of a 3.5 hectare parcel of foreshore land located immediately east of a State Rail Authority rail corridor. The rail corridor is currently active and used for the transport of bulk goods via rail.

A review of previous environmental soil and groundwater investigations undertaken in the vicinity of the proposed road corridor between 1993 and 2009, together with consideration of anecdotal evidence associated with fill materials in adjacent industrial precincts, indicated that contaminated fill from land reclamation works in the area were likely to be present at the location. A Camp Scott and Furphy (CMPS&F) Environmental (1994) investigation report concluded that the southern foreshore of the Outer Harbour could generally be characterised by three fill types:

- Fill Type 1: sand and clay fill containing significant amounts of slag, rubble and building waste that was generally contaminated with heavy metals and localised areas of TPH contamination.
- Fill Type 2: black coal wash fill which generally contained contaminant concentrations below the adopted guidelines.
- Fill Type 3: fill containing slag nodules which contained isolated heavy metals and PAH contamination.

11.3 Impact Assessment

11.3.1 Concept Plan

The focus of the land based investigation was on land disturbance during Stage 1 of the Concept Plan. Although this Investigation did not include the proposed new link roads proposed as part of Stages 2 and 3 of the Concept Plan, potential issues relating to soil and groundwater contamination as a result of road construction and other activities requiring land based excavations have been considered. The extent of disturbance of potentially contaminated soil is quite small relative to the footprint of the Concept Plan development. Further investigations would be undertaken as part of the project applications for Stage 2 and 3 made at a later date.

Notwithstanding, potential issues relating to soil and groundwater contamination are considered likely to include:

- Mobilisation of contaminated soils from excavation works and construction vehicles resulting in new exposure pathways and potential human health risk.
- Mobilisation of contaminated soils within surface water runoff potentially impacting the receiving waters of Darcy Drain, Salty Creek and the Outer Harbour.
- The greatest potential for contaminated soil mobilisation would likely occur during excavation and construction activities associated with the new road links from Foreshore Road to the container terminals, from Christy Road to the multi-purpose terminals and from Darcy Road to the boat harbour carpark.

- Historical groundwater results indicate heavy metal contamination within the foreshore surrounding the Outer Harbour, which has the potential to be intercepted during the land based earthworks. A Douglas Partners investigation concluded that the depth to groundwater in the area of the proposed eastern road corridor extending from Foreshore Road to the container terminals was approximately 2.6m bgs. Therefore, given the limited depth of excavation works associated with the new road construction (maximum around 1.5 m bgs) it is unlikely that groundwater would be encountered.
- The proposed reclamation area has the potential to impact on the groundwater flow regime in this area of the Outer Harbour, particularly if the reclamation area was of a significantly different hydraulic conductivity to the naturally permeable soil profile of the Outer Harbour shoreline (refer **Section 11.3.2** for further discussion).
- Additional fill reclamation material (the source of which is currently unknown), that needs to be imported for use in the proposed reclamation works, would need to meet the NEPM Health Based Investigation Levels (HIL F) for commercial/industrial land use and be confirmed to have leachable properties which are protective of receiving water bodies. Alternatively an additional Specific Resource Recovery Exemption would be required and the relevant conditions of the Exemption complied with.

11.3.2 Major Project

Soil

CoPC in all samples analysed during this investigation were less than the site assessment criteria with the exception of:

- An elevated copper concentration (12 900 mg/kg relative to the SAC of 5 000 mg/kg) reported in one sample at 0.2-0.3 m bgs (collected from dark brown and black sand and coarse gravel fill with some ash).
- Chrysotile asbestos fibres were identified in one sample from 0.5 -0.6 m bgs (collected from dark brown and black sand and coarse gravel fill with some ash).

Together with the results of the previous environmental investigations these results suggest that there is a high risk of isolated ‘hotspots’ of contamination being identified during the course of excavation activities within fill material across the location of the proposed road corridor.

Potential impacts associated with these identified hotspots include:

- Mobilisation of contaminated soils from excavation works and construction vehicles resulting in new exposure pathways and potential human health risk.
- Mobilisation of contaminated soils within surface water runoff potentially impacting the receiving waters of Darcy Drain, Salty Creek and the Outer Harbour.

The greatest potential for contaminated soil mobilisation would likely occur during excavation and construction activities associated with the new road link from Christy Drive to the multi-purpose terminals and also during the extension of rail sidings.

The fill materials encountered by the investigation are generally considered suitable for re-use as part of the proposed new road link development (i.e. commercial / industrial land use) with the exception of:

- A hotspot of copper contamination located at 0.2 to 0.3 m bgs in borehole BH08;
- A hotspot of asbestos fibres detected at 0.5-0.6 m bgs at BH10; and
- Other contamination ‘hotspots’ that might be encountered during the development works.

Disturbance of fill materials would be controlled by a Site Management Plan (SMP) as part of relevant CEMPs for the project. The SMP would establish a suitable management framework for excavation works, which would include identifying contamination hotspots based on visual and odour observations and through detailed soil sampling analysis, if required. Appropriate management of contamination ‘hotspots’ could include selective excavation, stockpiling, characterisation and disposal (either within the reclamation area or to an offsite soil remediation facility).

Construction workers who may come into contact with material that is suspected of being contaminated would employ appropriate hygiene procedures and wear proper personal protective equipment to minimise the risk of human health impact through accidental ingestion, inhalation and dermal exposure pathways.

Due to the proposed likely depth of excavations (approximately 1.5 m bgs), acid sulfate soils are not likely to be excavated during the proposed road construction works and, consequently, these materials would not require management.

Groundwater

The Douglas Partners investigation concluded that the depth to groundwater in the area of the proposed western road corridor extending from Christy Drive ranged between 4.2m bgs and 4.3m bgs.

Historical groundwater results indicate heavy metal (specifically arsenic, copper, zinc, lead, cadmium and nickel) contamination exceeding the adopted SAC has been reported within the vicinity of the location of the proposed road corridor and the foreshore surrounding the Outer Harbour. The highest historical groundwater contamination concentrations have been reported between the Darcy Road Drain and the No. 3 Jetty.

PAH, PCB and OCP groundwater contamination exceeding the adopted groundwater assessment criteria have not been historically identified within groundwater, although there is potential for PAH and PCB impact due to contamination identified within the fill and natural soils.

TPH and BTEX contamination has not been historically identified in groundwater but there is potential for groundwater impact due to several known TPH impacted fill and natural soils identified in historical investigations.

Groundwater contamination in the vicinity of the proposed road corridor is a regional issue that is not specific to the site. Groundwater is not expected to be encountered during excavation works associated with the construction of the proposed new road corridor given the limited depth of such excavation works (maximum around 1.5 m bgs) and the recorded depth of groundwater (between 4.2 and 4.3m bgs). Therefore, management of groundwater is not expected to be required as part of the land based construction works.

The proposed reclamation area has the potential to impact on the groundwater flow regime in this area of the Outer Harbour, particularly if the hydraulic conductivity of the reclamation area was significantly different to that of the natural soil profile of the Outer Harbour shoreline. It is likely that the majority of groundwater discharge is along the current shoreline, with a small density driven flow component at the bottom of the harbour. The rate limiting factor would be the hydraulic conductivity of the shore-side material.

The hydraulic conductivity of the compacted dredged sediments or blast furnace slag fill (or other similar material) that would be placed as part of the reclamation is likely to be similar or greater than the existing foreshore, therefore the change in the flow regime is likely to be insignificant. The density driven base flow, if occurring, would likely be reduced given the additional material that would be placed during the reclamation.

The rate limiting factor of the groundwater discharge will be the hydraulic conductivity of the shore-side material. From a contamination standpoint the flux of contamination migrating into the harbour will not change due to the placement of material in the reclamation area, in that the hydraulic conductivity of the existing foreshore material will not change significantly. In the unlikely case the hydraulic conductivity of the placed material is significantly less than the existing material, the groundwater flux and hence the contaminant flux will be reduced in the reclamation area.

It would be important to ensure that the reclamation would be designed to ensure the existing groundwater flow regimes are not significantly altered and that there is no increased risk of harm associated with the groundwater contamination.

Waste Classification

The current criteria used in NSW to characterise waste materials for off-site disposal is the NSW DECC (2008) *Waste Classification Guidelines*. Consideration of toxicity characteristics leaching procedure (TCLP) analysis of selected soil samples from the location of the proposed road corridor, together with total concentration analytical results, in accordance with the waste guidelines, indicated that the fill materials (including hotspots) encountered during the Land Based Investigation (excepting those containing asbestos) would be classified as '*General Solid Waste'*, if disposal to an off-site NSW DECCW licensed landfill was required.

Imported Fill

As part of the reclamation works for the multi-purpose terminals and the container terminals it is proposed to import substantial quantities of fill to the site primarily from available sources in the local and regional area.

In normal circumstances imported fill would be required to be of an appropriate quality to meet the NEPM Health Based Investigation Levels for commercial and industrial land use. PKPC has made application to DECCW for a Specific Resource Recovery Exemption under the POE (Waste) Regulations 2005 to utilise blast furnace slag and coal wash. Blast furnace slag would be sourced from the 'Mount Prosser' stockpile area in Port Kembla. This stockpile area contains approximately 1.5 Mt and is located in relative close proximity to the Outer Harbour. The coal wash resource would be also be sourced locally.

At this stage a draft Specific Resource Recovery Exemption for blast furnace slag has been received and a coal wash exemption is currently under consideration by DECCW. PKPC would be required to address specific requirements contained in the approvals, which are likely to include undertaking sampling of the material prior to its use to ensure it meets government standards. PKPC has proposed a number of Quality Assurance controls to ensure that the fill material would be suitable for reclamation purposes including visual screening and waste tracking measures.

Additional fill reclamation material (the source of which is currently unknown, but is likely to come from major construction projects in the Sydney metropolitan region), that needs to be imported to the site would also need to meet the NEPM Health Based Investigation Levels (HIL F) for commercial/industrial land use and be confirmed to have leachable properties which are protective of receiving water bodies. Alternatively additional Specific Resource Recovery Exemptions would be required and the relevant conditions complied with.

11.4 Mitigation Measures

11.4.1 Concept Plan

The results of previous investigations undertaken in the area of the proposed new link roads to the container terminals and to the multi-purpose terminals (both off Foreshore Road) indicates that similar soil contamination issues are likely to be present in these areas as those encountered at the site during this investigation (which focused on the Major Project (Stage 1).

Additional site specific investigations would be undertaken as part of the project application for Stages 2 and 3, in order to identify if any contamination 'hotspots' exist so that these areas can be appropriately managed in line with the suggested mitigation measures for the Major Project as detailed below.

11.4.2 Major Project

Disturbance of fill materials within the location of the proposed road corridor would be controlled by a CEMP to manage excavation works and to facilitate:

- Identification of contamination 'hotspots' based on visual and odour observations and through detailed soil sample analysis if required. Consequently, excavation works should be supervised by an appropriately experienced environmental scientist.
- Appropriate management of contamination including selective excavation (to minimise quantities), stockpiling, characterisation and disposal (likely to an off-site soil remediation facility) assuming that the material is not suitable for inclusion within the reclamation area.

It is also recommended that prior to commencing works in this area, a Limited Phase Two Environmental Site Investigation be undertaken at the proposed site for the extension of the railway siding at the South Yard, to assess potential contamination issues in this area. It is expected that these investigations would reveal contamination results typical to rail corridors and could easily be managed in line with the mitigation measures detailed above.

It is recommended the reclamation area be designed to ensure the existing groundwater flow regimes are not significantly altered and that there is no increased risk of harm associated with the groundwater contamination.

Background groundwater monitoring should be conducted at the site prior to the commencement of the works and annually thereafter, to assess whether exposure pathways created by the proposed development of the site causes the regional groundwater contamination to migrate toward the foreshore and allowing appropriate management measures to be implemented to address this issue.

11.5 Conclusion

11.5.1 Soil Contamination

Historic environmental assessment results, together with anecdotal evidence associated with fill materials in industrial precincts including at Port Kembla, suggest that there is a high risk of isolated 'hotspots' of contamination being encountered during the course of excavation activities within fill material across the proposed road corridor site. This issue can be addressed by implementing suitable measures contained within a CEMP.

The results of previous investigations undertaken in the area of the new link roads to the container terminals and to the multi-purpose terminals indicates that similar soil contamination issues are likely to be present in these areas as those encountered at the site during this investigation. It is recommended that prior to commencing work for Stage 2 and 3 works that a Limited Phase Two Environmental Site Investigation be undertaken to assess potential contamination issues in these areas.

It is also recommended that prior to commencing works in this area, a Limited Phase Two Environmental Site Investigation be undertaken at the proposed site for the extension of the railway siding at the Pacific National South Yard as well as for the construction of the temporary access road for the Container Terminal reclamation.

Groundwater Contamination

Groundwater contamination in the vicinity of the proposed Outer Harbour development is a regional issue that is not specific to the location of the development. The excavation works associated with the proposed new road corridor to the central portion of the multi-purpose terminals are unlikely to intercept groundwater. As such, management of groundwater is not expected to be required as part of the land based works.

Despite this, it is recommended that the existing groundwater monitoring program undertaken for the Outer Harbour continues to identify trends and any impact on the regional groundwater arising from the Outer Harbour development.

The proposed reclamation area has the potential to impact on the groundwater flow regime in this area of the Outer Harbour, particularly if the hydraulic conductivity of the reclamation area was significantly different to that of the natural soil profile of the Outer Harbour shoreline. It will be important that the reclamation would be designed to ensure that the existing groundwater flow regimes are not significantly altered and that there is no increased risk of harm associated with groundwater contamination.

12.0 Qualitative Human Health and Ecological Risk Assessment

12.1 Introduction

A Qualitative Human Health and Ecological Risk Assessment was undertaken to consider risk associated with contamination of in-situ sediments and groundwater. The aim of the assessment was to identify significant risk to human health and environmental receptors that may result from impacts associated with the construction and operation of the Concept Plan and Major Project.

A copy of this qualitative assessment is found at **Appendix D** of this EA. The following is a summary of the main conclusions and recommendations contained in that assessment.

12.2 Methodology for Environmental Assessment

AECOM has undertaken a qualitative assessment of the nature and extent of reported sediment and groundwater contamination within the Outer Harbour and foreshore area, and developed a conceptual model describing contaminant transport and exposure pathways by which human and ecological receptors may be exposed to reported sediment and groundwater contaminants.

12.3 Existing Environment

The overall aquatic ecological environment within the Outer Harbour is highly modified due to:

- Physical modifications of the harbour (e.g. construction of breakwaters and jetties and dredging and reclamation activities) associated with the development of the port.
- The industrial nature of the surrounding area.
- Reported presence of pest species due to ballast discharge within the Outer Harbour.
- The high level of boat/shipping activity within the Outer Harbour.

The ecological value of the Outer Harbour area is therefore considered generally low.

Previous investigations have found that the bed sediments of the Outer Harbour contain elevated concentrations of CoPC.

12.4 Impact Assessment

12.4.1 Concept Plan

Potential Human Health Risks

Risks to human health receptors would primarily occur during dredging works proposed to take place in Stages 1 and 3 of the Concept Plan development as well as intrusive road and rail construction works in Stages 1 and 2. Risks would occur as a result of disturbance or mobilisation of sediments within the Outer Harbour that contain elevated concentrations of CoPC. This is likely to be a relatively short term impact confined to the construction periods.

Potential risks to human receptors have been assessed as low or moderate for most receptor/exposure pathway combinations. Potentially ‘high’ or ‘moderate’ human health risks, if uncontrolled by appropriate design and environmental management measures, include:

- Direct contact with surface/harbour water by recreational users or dredging workers;
- Direct contact with groundwater by intrusive workers; and
- Ingestion of fish tissue with elevated CoPC concentrations.

Potential Ecological Risks

Notwithstanding the low ecological value of the Outer Harbour, potential risks to ecological receptors may occur during dredging and intrusive construction works as part of Concept Plan development, including:

- Direct contact with surface water by all ecological receptors;
- Direct contact of invertebrates, macroalgae, fish and pelagic organisms with sediment and/or pore water; and
- Ingestion of edible flora, invertebrates or fish by ecological receptors.

12.4.2 Major Project

Potential Human Health Risks

Risks to human health receptors would primarily occur during dredging works to be undertaken as part of the Major Project (Stage 1) or during intrusive construction works for road and rail infrastructure.

Potential risks to human receptors have been assessed as low or moderate for most receptor/exposure pathway combinations. Potential human health risks assessed as potentially 'moderate' if uncontrolled by appropriate design and environmental management measures include the following:

- Direct contact with surface water by recreational users or dredging workers. The moderate risk rating for these exposures is due to significantly elevated cadmium concentrations reported in two isolated harbour surface water samples. It appears that the cadmium analytical results may be erroneous based on other harbour surface water, sediment and elutriate analytical results as part of this investigation and historical water quality data in the Outer Harbour.
- Direct contact with groundwater by intrusive workers. While risks were assessed as moderate for these receptors, the extent of exposure for individual receptors is considered likely to be very low given the limited nature of the proposed earthworks (primarily construction of roads, rail lines and service infrastructure) and the depth to groundwater. The potential risks can be managed with the use of appropriate personal protective equipment/clothing and hygiene procedures.

Human health risks assessed as potentially 'high' (on a qualitative basis) if uncontrolled by appropriate design and environmental management measures included the following:

- Ingestion of edible fish tissue with elevated CoPC concentrations due to foraging/exposure in the Outer Harbour.

The potentially high risk rating for this exposure has been based on elevated concentrations of CoPC reported in sediments.

It is considered that potential risks associated with this exposure pathway warrants further qualitative assessment prior to the commencement of dredging works. This further assessment would be based on detailed design of the dredging works and specific environmental management techniques which aim to minimise and control the dispersal of contaminated sediment.

Potential Ecological Risks

Potential risks to ecological receptors may primarily occur during the proposed dredging works as a result of disturbance or mobilisation of sediments within the Outer Harbour that contain elevated concentrations of CoPC. This is likely to be a relatively short term impact confined to the construction period of the project.

Potential risks to a number of ecological receptors have been assessed as potentially high if uncontrolled by appropriate dredging design and environmental management measures based on reported elevated concentrations of CoPC in harbour sediments and the presence of ecological receptors within surface water and sediment.

However it should be noted that the overall aquatic ecological environment within the Outer Harbour is already highly modified due to:

- Physical modifications of the harbour (e.g., construction of breakwaters and jetties and dredging and reclamation activities) associated with development of the Port.
- The industrial nature of the surrounding area.
- Reported presence of pest species due to ballast discharge with the Outer Harbour.
- The high level of boat/shipping activity within the Outer Harbour.

The ecological value of the Outer Harbour area itself is therefore considered to be generally low.

Further qualitative assessment of potential ecological risks should consider higher value receptors/areas which may be indirectly affected by sediment contamination within the Outer Harbour e.g:

- Potential indirect risks to human health due to toxic dinoflagellate blooms or bioaccumulation of contaminants into edible fish or shellfish; and
- Potential indirect adverse effects or risks to the broader marine aquatic ecosystem or communities (i.e. outside the modified and heavily impacted PKOH area).

It is noted that dredging works have been successfully undertaken by PKPC in the Inner and Outer Harbours over an extended number of years without creation of such toxic dinoflagellate blooms.

12.5 Mitigation Measures

12.5.1 Concept Plan

Potential risks identified to human receptors would be managed by consideration of the nominated exposure pathways and through suitable design of construction methodologies. Risks to ecological receptors, notwithstanding the low ecological value of the harbour, would be managed through careful consideration of the nominated pathways and suitable design of construction methodologies and environmental mitigation measures, for each stage of Concept Plan development.

The following environmental management framework is considered appropriate for each discrete stage of works as part of the Concept Plan:

- Preparation of the Dredging Environmental Management Plan to minimise impacts associated with the dispersal of sediments during dredging.
- Undertaking regular water quality monitoring before and during dredging works.
- Preparation of a Site Management Plan to manage handling of potential contaminated soil.

Measures used to mitigate potential risks under the Major Project would be applied, where applicable, to future stages of the Concept Plan.

The preliminary assessment carried out for the Concept Plan concluded that the majority of the risk to human receptors would occur during dredging and reclamation works. The majority of dredging and reclamation works occur during Stage 1 of the Concept Plan. However, dredging and reclamation of additional areas proximal to the Port Kembla Gateway Jetty and swing basin is programmed to occur during Stage 3. Further detailed assessments would be undertaken for these activities as part of subsequent project applications.

12.5.2 Major Project

Measures to mitigate the potential risks to workers, the public and to ecological communities during dredging works for the Major Project (Sage 1) would include the following:

- Use of parallel silt curtains around dredging and emplacement areas during dredging works;
- Wet emplacement of dredged materials;
- Appropriate personal protective equipment and hygiene practices for construction workers;
- Employ dredging technologies or other environmental mitigation measures to minimise the dispersal of contaminated sediments during dredging;
- Dredging would occur progressively within defined areas, so that disturbance areas are restricted to a limited area of the wider harbour at any one time;
- Sediment piping or barging to the emplacement area; and
- Ensure that dredged sediment which is to be reclaimed would be placed in a suitably designed containment area to minimise interaction (slumping or leaching) with the surrounding harbour waters.
- Sloping rock revetment walls (reclamation edge structures) would incorporate geotextile fabric to mitigate the effects of wave action and any potential slumping of material back into the harbour.

PKPC would undertake water quality monitoring in the Outer Harbour prior to and during the proposed dredging works. Results of water quality monitoring would be used to clarify the reported elevated cadmium concentrations in PKOH surface waters.

Following detailed design of the dredging works and associated environmental management measures, a further qualitative assessment would be undertaken, with respect to potential risks to ecological receptors, to consider:

- Potential indirect effects or risks to marine ecosystem or communities outside the heavily impacted PKOH area;
- Potential indirect risks to human health due to toxic dinoflagellate blooms or bioaccumulation of contaminants into edible fish or shellfish; and
- The extent to which protected or recreationally important species are present within the PKOH.

12.6 Summary

A qualitative risk assessment of the nature and extent of reported sediment and groundwater contamination on human and ecological receptors has been undertaken, to determine the risks to human and ecological health posed by the Concept Plan and Major Project. A conceptual model of contaminant transport and exposure pathways was also developed to determine the exposure of human and ecological receptors to sediment and groundwater contaminants.

Potential risks to human receptors are low to moderate for most receptor/exposure pathways. Moderate or high human health risks would be managed through suitable design of construction methodologies and the use of personal protective equipment.

Potential ecological risks are high for a number of ecological receptors due to the risk associated with the disturbance or mobilisation of contaminated sediments within the Outer Harbour. The ecological value of the Outer Harbour is considered to be low owing to the highly developed and disturbed nature of the harbour. Risks to ecological receptors would be managed by measures implemented during dredging and intrusive works in order to limit the disturbance and dispersion of contaminated sediments and groundwater.

A range of mitigation measures are proposed to mitigate potential risks associated with the mobilisation of sediments during the dredging and reclamation activities. Following detailed design of the dredging works and associated environmental management measures for the Major Project (Stage 1) a further qualitative assessment would be undertaken in respect to potential risk to ecological receptors.

13.0 Preliminary Hazard Analysis

13.1 Existing Environment

Land use in the vicinity of the Outer Harbour is zoned industrial and includes heavy industries such as BlueScope Steel, Orica and building material manufacturing companies. The closest residential area is located approximately 600 metres to the south west of the proposed development area across Five Islands Road.

The proposed Outer Harbour development would provide berths for containers handling, bulk trades and general cargo. General cargo may include Dangerous Goods (DGs) that enter the port in containers or bulk products in portable tanks or Intermediate Bulk Containers (IBCs).

The detailed Preliminary Hazard Analysis is presented in **Appendix E** to this EA. The following is a summary of the main conclusions and recommendations contained in the detailed assessment.

13.2 Methodology for Environmental Assessment

The objective of the Preliminary Hazard Analysis (PHA) is to demonstrate that the proposed development would not result in creating a hazardous facility and that the proposed safeguards and operations would ensure the facility is only potentially hazardous. The objective arises as a result of the potential to exceed the DGs threshold levels listed in State Environmental Planning Policy No.33, Hazardous and Offensive Developments (SEPP33). SEPP33 requires the proponent to assess the hazards associated with the storage of DGs and whether these hazards have the potential to impact offsite land uses. The policy is supported by a number of Hazardous Industry Planning Advisory Papers (HIPAPs) that provide guidance on the assessment of hazards and risks and provide acceptable hazard and risk criteria.

The methodology used for the assessment has been based on HIPAP No.6, Hazard Analysis Guidelines. Each DG Class and representative product, selected for assessment, was subjected to a detailed hazard analysis and consequence assessment. The results of this component of the study were used to make recommendations that should be considered during development of the detailed design of the proposed development, including separation distances and DG storage design areas.

Dry bulk and general cargo transferred between ships and the multi-purpose terminals area in Stage 1 would not comprise DGs. Berth 206 that is currently used to import sulphuric acid would be demolished as part of Stage 1 and facilities for the sulphuric acid imports, including a new pipeline, would be relocated to the first multi-purpose berth. Sulphuric acid would be the only DG to be handled as part of Stage 1 (Major Project). The risk of impact beyond the site boundary associated with the transfer and transport of the sulphuric acid within the Outer Harbour would be low as relevant pipeline and ship collision safeguards would be implemented.

Accordingly, the risks to offsite facilities from dry bulk and general cargo would be negligible for Stage 1 (Major Project). As a result, the focus of the hazard analysis is on operations for the Concept Plan as a greater number and range of DGs are likely to present risks to offsite facilities in Stage 2 and 3 when the container terminal facilities are operational.

13.3 Impact Assessment

13.3.1 Concept Plan

The Concept Plan would consist of multi-purpose terminals, container terminals and associated ship berthing facilities. The Concept Plan would be undertaken in a staged manner over a 25-30 year timeframe and is scheduled to be completed by 2037.

The Concept Plan would include dredging, reclamation works, and general construction works associated with the terminals, new access roads and rail upgrades as well as the relocation of facilities for the import of sulphuric acid. Once completed, seven berths would be operational for ships arriving and departing with goods that would be loaded and unloaded at the various wharves (4 container berths and 3 multi-purpose berths).

As part of the Concept Plan, ships would arrive and depart with dry bulk, general cargo and containers that would be lifted from or to the ships using ship or wharf mounted cranes. The containers would be transferred to and from the ships by cranes and wharf vehicles and may be stored on site prior to loading or after unloading. Fumigation for quarantine purposes would be required for some of the containers arriving from overseas.

There is potential for ship collisions between ships that are manoeuvring around the Port. There is also potential for fuel leaks and discharge during bunkering activities.

The containers delivered to the Port may hold DGs and, hence, during the storage period there is a potential for incident that could impact offsite areas. In addition, there is the potential for incidents associated with the transfer of sulphuric acid between the intake area and the Orica storage facility located to the south of the Outer Harbour development.

13.3.2 Hazard Analysis

As Stages 2 and 3 of the development when DGs would be most prevalent (i.e. associated with the container terminals) are in the early stages of planning, it was not possible to identify the exact list and quantities of DGs that would pass through the Port. Separate project applications will be lodged in the future for the container terminal operations and a robust hazard analysis would be undertaken as part of these applications.

For the purposes of this assessment, the types of DGs that generally pass through Ports were reviewed and a representative list developed. Based on this list a detailed hazard analysis was conducted for the proposed operations and temporary DG storages at the site. A hazard identification table was developed the results of which indicated what DGs required review and assessment. The following hazards were assessed:

- **Flammable Gas Cylinders (Class 2.1)** – gas release, delayed ignition and explosion in the shipping container.
- **Toxic Gas Cylinders/Drums (Class 2.3)** – gas release and dispersion downwind resulting in the potential for toxic impact to people offsite.
- **Flammable/Combustible Liquids (Class 3)** – release of flammable/combustible liquid, ignition and pool fire.
- **Flammable Solids (Class 4.1)** – ignition of flammable solid and localised fire.
- **Solids that Emit Flammable/Toxic Gas when Wet (Class 4.3) –** potential for goods to become wet releasing flammable or toxic gas.
- **Oxidising Agents (Class 5.1) –** the storage of (for example) ammonium nitrate that could be impacted from external events causing explosion.
- **Toxic Substances (Class 6) –** release of toxic solids or liquids with potential impact to the environment and people.
- **Corrosive Substances -** release of corrosive solids or liquids (such as sulphuric acid) with potential impact to the environment and people.
- **Environmentally Active Substances –** release of environmentally active material with the potential to impact the biophysical environment (e.g. harbour).

The hazard analysis identified a number of hazards that have the potential to impact offsite and these hazards were carried forward for consequence analysis. As a result of the hazard analysis a number of recommendations were made to ensure the risks would be maintained in the As Low As Reasonably Practicable (ALARP) range. These are detailed in the mitigation section of this summary.

13.3.3 Consequence Assessment

The hazards identified to have a potential to impact offsite include the following:

- Flammable gas leak into a container from a gas cylinder, delayed ignition and explosion.
- Flammable liquids release, ignition and pool fire.
- Toxic gas release and dispersion downwind towards sensitive land uses (off-site).
- Fire in the Ammonium Nitrate (AN) storage area leading to explosion with the potential to impact adjacent sites.

Each hazard was subjected to a consequence analysis to determine the severity of impact at the boundary of the development. The results of the analysis are presented below:

a) **Flammable Gas Leak and Explosion**

In the event of a release of gas within a container, the gas would form a flammable mixture and, if ignited, explode. The distance to an overpressure level of 7kPa (the maximum permissible level at the development boundary above which further risk assessment is required) is 78m. Hence, there is sufficient space at the location of the proposed container terminals to store the containers holding flammable gas well clear of the site boundary.

b) **Flammable Liquid Release, Ignition and Pool Fire**

In the event of a flammable liquid release, the liquid would be contained within a bund that should be constructed around the storage facility. Ignition of the liquid could result in a bund fire, radiating heat to the surrounding area. The heat radiation impact at 4.7kW/m2 (the maximum permissible level at the site boundary above which further risk assessment is required) is 30.1m. Hence, there is sufficient space at the location of the proposed development to store the containers holding flammable gas well clear of the site boundary.

In the event of a fuel release during bunkering operations, the tanker driver and ship operator can deploy the emergency shut down and spill containment systems. The fuel transferred to ships would be combustible liquid and not flammable liquid and therefore the probability of ignition is very low.

c) **Toxic Gas Release and Downwind Impact**

In the event of release of a toxic gas (e.g. ammonia or chlorine), the gas would disperse downwind until it reached a concentration which was not harmful. The study identified that in the worst case a release of chlorine from a storage drum could result in a fatality impact to a distance of 558m. Hence, if the containers holding the drums were stored at the north east corner of the container terminal, there would be no fatality impact offsite. However, it was identified that the concentration beyond the site boundary may reach levels that would result in injuries and, hence, it would be necessary to review the final design safeguards and conduct a detailed risk assessment as part of the environmental assessment for the container terminals operation (Stages 2 and 3), which would be subject to a separate project application process. Design criteria would need to be set that meet relevant legislative requirements.

d) **Explosion of Stored Ammonium Nitrate**

In the event of a fire that may impact on AN storage, the fire could initiate an explosion within the stored AN. The maximum quantity stored in each stack would not exceed 300 tonnes, as specified by the relevant Australian Standard. The impact distance to 7kPa (the maximum permissible level at the site boundary above which further risk assessment is required) is 584m. There is adequate area available within the container terminal to meet this siting requirement so that there would be no impact above acceptable levels beyond the site boundary (i.e. at Foreshore Road and Boat Harbour).

13.3.4 Major Project

One berth at the multi-purpose terminals would be operational as part of (Major Project) Stage 1.

Bulk goods would be unloaded or loaded using ship mounted equipment and/or wharf mounted equipment. PKPC has advised that the bulk goods transferred between the ships and the Port as part of the Major Project would include products such as woodchips, gypsum, sand, coke, fertiliser, clinker, slag, steel making materials, construction materials, timber, steel, and newsprint but would not contain DG. Accordingly, risks to offsite facilities from operation in this area for Stage 1 would be negligible.

Existing No. 4 Jetty (Berth 206) which is currently used for the transfer of sulphuric acid would be demolished as part of the Major Project and a new pipeline would be constructed to connect the first multi-purpose berth with the existing aboveground storage tanks at the Orica site. There would be no bulk storage of acid at the multi-purpose terminal. Acid transfers, from bulk tanker ships to the existing acid tanks, would be performed via the new pipeline.

The potential for undetected leaks from the sulphuric acid pipeline would be low if relevant pipeline safeguards were implemented. In addition, the potential for impacts from external sources would also be low as the pipeline would be located wholly within the area of the proposed development. Accordingly, the risk of impact beyond the site boundary would be negligible.

Sulphuric acid transfers at the first multi-purpose berth would be conducted using flexible lines. It is assumed that the principles of ISGOTT (International Safety Guide for Oil Tankers and Terminals), the IMDG (International Maritime Dangerous Goods) and the Australian Dangerous Goods Code would be employed by the operator of the pipeline (Orica). These standards require the implementation of significant safeguards in relation to the transfer of DG from ship to shore and vice versa. Based on adoption of these safeguards (summarised in **Section 13.4**), the risks associated with the proposed transfer operation are considered to be low. However, as the final details of acid transfer are not currently complete, the transfer risks would need to be reviewed in the final hazard analysis when the transfer operation design is confirmed.

There is potential for ship collisions in the Outer Harbour during day to day shipping operations. A review of potential impacts as a result of collisions indicates that the consequences of a release of Dangerous goods would be negligible, due to the safeguards used at the Port. This is supported by the existing incident report for the Port showing no collisions between ships in the past 10 years. Based on this assessment, no further analysis has been conducted.

Fuel bunkering operations proposed for the Outer Harbour development would be the same as existing bunkering operations at the Port. The current history of incidents during transport of the fuel at the Port indicates that there have been no serious spills or fires that have resulted in impacts beyond the immediate area of an incident (i.e. large spill to the environment or major fire on the way to or at the wharf). The current and proposed safeguards meet the requirements of the regulations and standards. Based on the history and safe operations using the existing safeguards, the risks associated with the transport of fuel to the Port are considered low as the same operations and safeguards will be used.

13.4 Mitigation Measures

13.4.1 Concept Plan

Based on the analysis outlined above, it is considered that the proposed development can be designed to meet the requirements of SEPP33. Hence, the facility would be classified as ‘potentially hazardous’ only and therefore would be permissible in the proposed location provided that the mitigation measures, outlined below, are implemented.

A number of recommendations for mitigation have been made to ensure the risks are maintained within the permissible levels of SEPP33 and also within the ALARP range. These are outlined below:

- It was identified that Methyl Bromide was likely to be used as a fumigation product for a percentage of the containers at the container terminal. As Methyl Bromide is a HCFC gas, there is a potential for this gas to impact the environment and, to some extent, operators close to the fumigation process. It is therefore recommended that the container terminal be designed and operated with Methyl Bromide dosing and capture systems to minimise the risk of harmful gas release to the atmosphere. This issue can be assessed in further detail as part of the container terminal project application in the future to determine the hazard and risk impact and the need for mitigation measures.

- Flammable (Class 3), corrosive (Class 8), toxic (Class 6) and environmentally active (Class 9) liquids may be delivered to site in 20,000 L isotainers. Leaks from tanks may impact the environment and, in the case of flammable liquids, ignite causing fires that may spread to other container storage areas. It is therefore recommended that containers holding flammable, corrosive, toxic or environmentally active materials be located within a spill containment area with a capacity of 20,000 L.
- Safeguards that would be implemented for the transfer of DGs from ship to shore and vice versa, under the relevant standards, include:
  - Annual testing of transfer hoses (including pressure tests).
  - Full documented inspection of the flexible connections prior to commencement of transfer and after transfer commences.
  - Fully attended transfer operations.
  - Emergency Response Plans available and ready for implementation in the event of an incident.
  - Spill response equipment available and ready for implementation (both ship and wharf).
  - Isolation of the wharf in the transfer area (preventing access to the transfer points) using barricades.
  - Safety Management Plans compliant with the standards requirements.
- In the event of a fire (e.g. in the flammable liquids container storage area) the fire may impact the flammable solids containers, initiating combustion in this area. The analysis identified that the heat radiation from a flammable liquids storage fire at distances below 35m may initiate combustion in the flammable solids area. Hence, the detailed design of the area would ensure that the flammable solids storage area be separated from the flammable liquids storage area by a minimum of 35m.
- It was identified that the relevant Australian Standard for the storage of AN, a product that may be delivered to the Port in containers, limits storage quantities to a maximum of 300 tonnes. It was identified as part of this study that an explosion of 300 tonnes of AN would result in an overpressure of 7kPa at a distance of 584m from the explosion. There is sufficient site area available at the container terminals to accommodate this separation distance. Hence, AN storages at the container terminals would be sited and designed to comply with the relevant Australian Standard in respect to both storage quantities and siting (distance separation). This issue would be assessed in more detail as part of a Project applications for operation of the container terminals (Stages 2 and 3).
- It was identified that in the event chlorine is delivered to the site in drums, a drum leak could result in injury impacts to people beyond the boundary of the proposed development. The current status of the project design is preliminary and detailed operations with respect to storage and handling of chemicals (i.e. deliveries, detailed safeguards, etc.) are not available. Hence, it is difficult to assess the risks associated with an injurious level of chlorine at the site boundary. Therefore the risks associated with the storage of toxic gases would be further investigated as part of a separate approval for operation of the container terminal (Stages 2 and 3) and risk reduction measures determined as a result of the assessment would be included in the terminal design and operation for those stages.
- It was identified that DGs would be transported to and from the Port as part of the operation of the container terminals during Stages 2 and 3. At this stage of the project details about the likely transport routes, number and type of vehicles, etc. are not available for DGs transport and therefore it is difficult to conduct a transport risk assessment. An assessment of the transport requirements and risks associated with the transport of DGs should be undertaken in accordance with relevant guidelines (The Australian Dangerous Goods Code) as part of a separate project applications for Stages 2 and 3.
- An Emergency Response Plan (ERP) would be prepared for the multi-purpose terminals and container terminals. The ERP would be prepared in accordance with the HIPAP No.1 Emergency Planning Guidelines.
- A review of the potential impacts as a result of ship collisions indicates that the consequences of a release of Dangerous Goods would be negligible, due to the safeguards used at the Port. This is supported by the existing incident record for the Port showing no collisions between ships in the past 10 years. Based on this assessment, no further analysis has been conducted.
- Fuel transfer operations for the Outer Harbour development would be the same as existing bunkering operations within the Port. Based on the analysis conducted above, and the safeguards installed and used, the risk of incidents as a result of bunkering operations is considered low and therefore no further analysis is conducted.

Further hazard assessments would be undertaken as part of project applications for development and operation of the terminal facilities proposed for Stages 2 and 3 of the Concept Plan.

13.4.2 Major Project

This assessment has been based on an assumption that the multi-purpose terminals would not contain stored DGs. The risks posed by the operation of the sulphuric acid pipeline, including ship to shore transfers, are considered to be as low as reasonably practicable (ALARP) as appropriate safeguards and response plans would be put in place to reduce the risk to on and off site receivers.

Sulphuric Acid (Class 8) corrosive would be unloaded from ships at the first multi-purpose berth and transferred to the offsite Orica storage facility. Leaks from the pipeline may impact the environment and could result in serious injury should personnel come into contact with the leaked materials. Safeguards during construction and operation of the sulphuric acid pipeline would be implemented to ensure risks are minimised and maintained within the ALARP range.

A range of safeguards may include:

- Locating the pipeline within the dedicated services corridor.
- Use of underground marker tape to highlight the presence of the pipeline as well as above-ground service indicator sign posts.
- Construction from corrosion-resistant materials.
- Maintenance of inventory records and pipeline inspections
- An Emergency Response Plan (ERP) would be prepared for the central portion of the multi-purpose terminals which will be operational as part of the Major Project. The ERP would be prepared in accordance with the HIPAP No.1 Emergency Planning Guidelines.

13.5 Summary

The proposed Outer Harbour development is located in an established port and industrial setting and approximately 600m from the closest residential areas to the south west across Five Islands Road.

The Outer Harbour development would consist of multi-purpose (dry bulk and general cargo) terminals and container terminals with associated ship berthing facilities.

Operation of a sulphuric acid pipeline and transfer facilities at the multi-purpose terminals would not pose significant risks as appropriate safeguards and mitigation measures would be in place to minimise the risks and impacts arising from leaks and spills. The central portion of the multi-purpose terminals, to be developed and operated as part of Stage 1 of (Major Project), would not comprise import or export of other DGs.

The type of DGs that are likely to be stored and handled at the container terminals (Stage 2 and 3 of Concept Plan) are not known in detail at this stage, however, it can reasonably be assumed that the DGs would be representative of those typically found at similar terminal facilities across a range of ports in NSW and Australia. For the container terminal, this can be assessed in more detail when project applications are being sought to develop and operate the terminals.

Based on the impact assessment carried out, the proposed Outer Harbour development would not exceed the requirements of SEPP33, Hazardous and Offensive Developments. Hence, the facility would be classified as 'potentially hazardous' only and therefore would be permissible in the proposed location with the range of relevant mitigation measures and further assessments noted above.

14.0 Hydrology and Water Quality

14.1 Introduction

The DGRs included specific hydrology and water quality management requirements (among others) in respect of the Outer Harbour development as prepared by DECCW (formerly DECC). The key hydrology and water quality issues that were required to be addressed were:

- Erosion of drainage lines.
- Waste and disturbance of contaminants.
- Surface water and stormwater management.
- Acid sulfate soils management.
- Dredging and spoil management.
- Dinoflagellate cysts disturbance.

14.2 Existing Environment

14.2.1 Catchment Description

Port Kembla Outer Harbour receives flows from two main industrial catchments, Salty Creek and Darcy Road Drain (refer **Figure 14-1**). The Outer Harbour also receives water from other sources such as stormwater runoff, and licensed industrial discharges.

Land uses adjacent to the proposed area to be developed are predominantly heavy industrial with some commercial and residential properties south west of the Outer Harbour, along Wentworth Road and west of Five Islands Road.

The Salty Creek and Darcy Road Drain catchments have relatively high levels of impervious hard surfaces, estimated to be greater than 60 percent based on aerial photography interpretation. The majority of this impervious runoff is captured in a formal drainage system of kerbs and gutters adjacent to the roads, railways and industrial sites, which then flows into Salty Creek or Darcy Road Drain and discharges to the Outer Harbour.

14.2.2 Existing Catchment Hydrology

Salty Creek Catchment

Salty Creek is an estuarine creek system located in Port Kembla between Five Islands Road and the Outer Harbour (**Figure 14-2**). Salty Creek is approximately 1.4 kilometres in length and is open intermittently to the Outer Harbour at Red Beach. The creek has been anthropogenically modified, with sections of the creek being straightened, channelized and rock lined to maximise land use, drainage, through flow, and, flood protection of surrounding assets (**Plate 14-1**). The majority of the creek banks are steep to vertical (70 to 85%) and are approximately 1.5m in height.

The catchment is bounded by Harry Morton Park to the south and the Port Kembla Steelworks to the north (Forbes Rigby, 2000). The catchment drainage flows eastward towards the Outer Harbour from an approximate maximum height of 51m PKHD near Flagstaff Park, to less than 5m PKHD close to the outlet to the Outer Harbour, east of Old Port Road (Forbes Rigby 2000).

The majority of land use within the Salty Creek catchment is industrial, which is estimated to be greater than 80% of the catchment. The remaining catchment land use is commercial and residential.

Figure 14-1: Salty Creek and Darcy Road Drain

Figure 14-2: Salty Creek Catchment

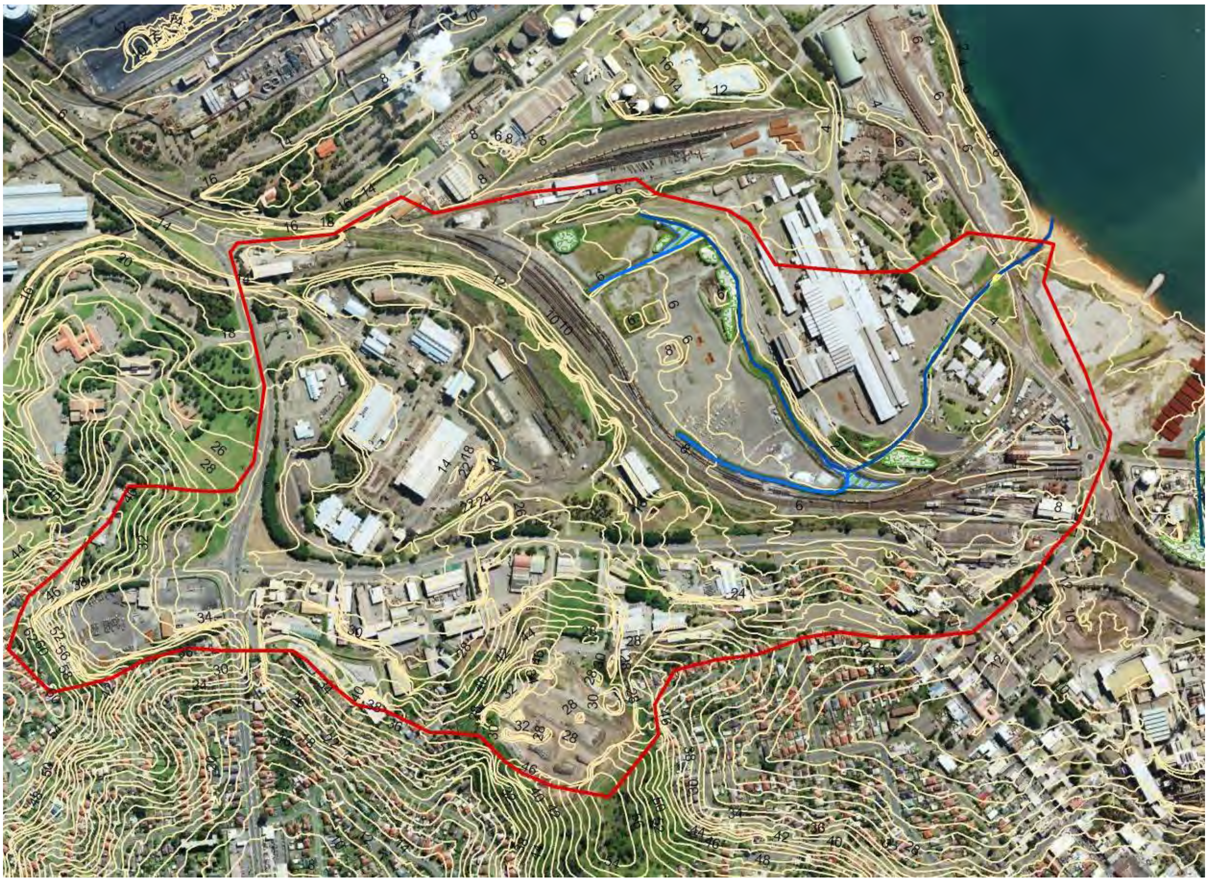


Plate 14-1: Salty Creek between Old Port Road and Foreshore Rail Line Illustrating Channel Modifications

Source: AECOM 2009

A flood study carried out by Forbes Rigby in 2000 estimated the catchment size to be approximately 125 hectares based on drainage plans obtained from BHP. It is assumed that overbank flows and cross-catchment flows occur during major rainfall and flow events, due to the relatively flat topography of the catchments and high levels of landscape disturbance from historical industrial development. These overbank flows could be exacerbated by tidal influences as well as by intermittent closure of the creek mouth.

Aerial photography interpretation and field investigation identified numerous constructed drains throughout the catchment. The Outer Harbour Railway Loop embankment at approximately RL 7m PKHD, forms a significant obstruction to overland flows emerging from the low-lying building and paved surfaces (approximately 5m PKHD) to the south of Old Port Road (Forbes Rigby, 2000). This embankment acts as a dam wall in major flood events resulting in water passing through it at the Salty Creek culvert only, or, beneath the railway at the Old Port Road railway underpass, some 400m north of the Salty Creek culvert. Significant flows are suspected to be lost from the north of the catchment along Old Port Road (Forbes Rigby, 2000).

Forbes Rigby (2000) calculated peak flows for a range of Average Recurrence Intervals (ARI) for Salty Creek using the probabilistic rational method as described in the Australian Rainfall and Runoff flood estimation guidelines. These calculated peak flows are presented in **Table 14-1** below. The time of concentration (tc) for the 125 hectares catchment was determined to be 50 minutes (Forbes Rigby 2000).

The peak flows in **Table 14-1** are unlikely to be based on the Salty Creek railway culvert capacity and the undersized culvert at Old Port Road. As such, the maximum flow within Salty Creek downstream of the railway culvert is conservatively estimated to be 20m^3/s for events up to the 100 year ARI design storm (Forbes Rigby, 2000).

The Salty Creek catchment contains minimal existing water sensitive urban design (WSUD) or stormwater control devices. A porous wall barrier and detention pond, north of Red Beach, assists with surface water runoff infiltration and sediment and gross pollutant detention along with a sediment erosion fence near the south of Red Beach. However, the majority of stormwater and other surface runoff is not treated prior to entering the creek system and ultimately the harbour.

Table 14-1: Salty Creek Calculated Peak Flows (Forbes Rigby, 2000)

ARI (yrs)	Intensity (mm/hr)	Flow (m3/s)
1	39.8	8.6
2	51.1	13.1
5	65.0	19.8
10	72.9	25.3
20	83.5	32.5
50	97.2	39.3
100	107.7	46.5

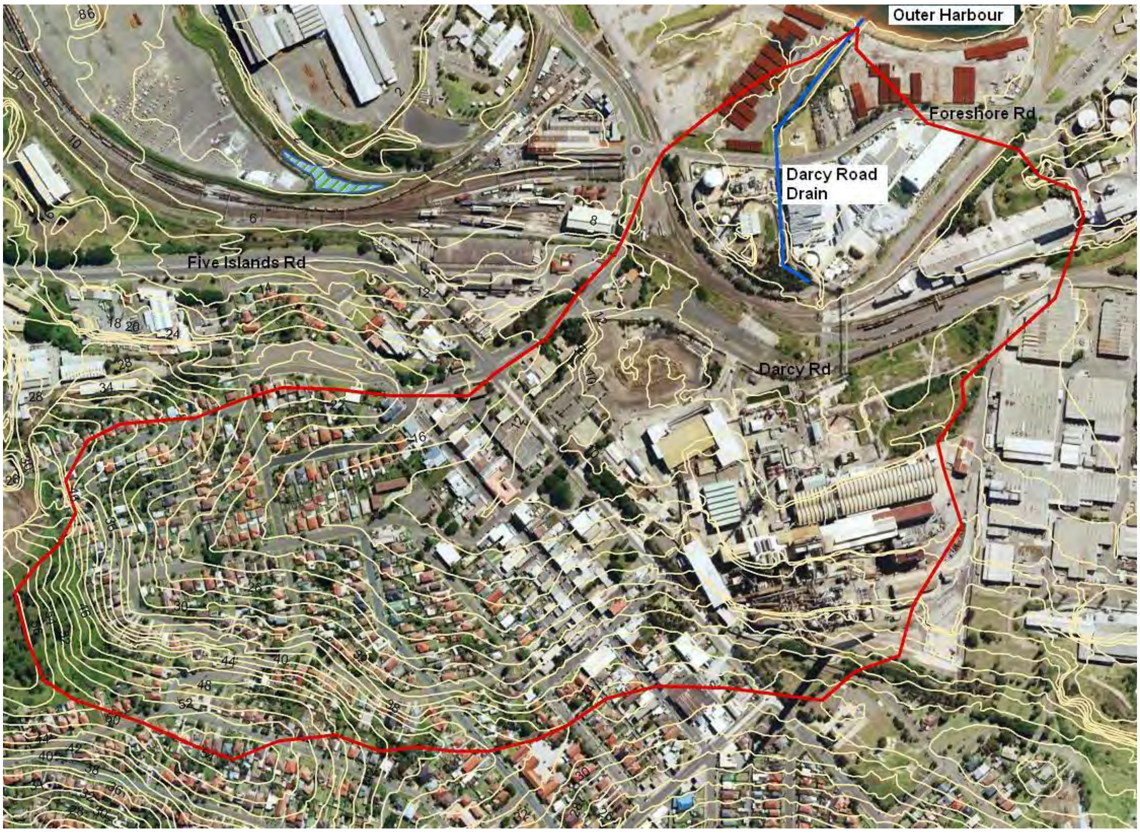
Darcy Road Drain Catchment

Some 400m south of the Salty Creek mouth, Darcy Road Drain enters the Outer Harbour west of No. 3 Jetty. The Darcy Road Drain catchment is the main source of stormwater and effluent from a number of adjacent commercial and industrial premises including Orica and the former Port Kembla Copper site.

The Darcy Road Drain catchment (**Figure 14-3**) is estimated to be approximately 80 hectares based on aerial photography and the NSW Department of Lands 2m contour GIS layer. The catchment is bounded by Harry Morton Park to the west, Port Kembla train station and Foreshore Road to the north west, and St. Patricks Catholic Primary School and Electrolytic Street to the south.

The majority (approximately 60%) of the catchment land use consists of industrial activities located within the north eastern portion of the catchment adjacent to the Outer Harbour. Land use within the remaining catchment to the south west is commercial (approximately 10%) along Wentworth Street and residential (approximately 30%) to the west of Wentworth Street.

Figure 14-3: Darcy Road Drain Catchment



14.2.3 Existing Water Quality

Surface Water

Water quality in the Outer Harbour and associated waterways is affected by urban and industrial runoff which has in the past led to the contamination of the soils/sediments, ground water and receiving harbour waters.

A review of water quality sampling results from a harbour water quality monitoring program that has been ongoing in the Port since 2002 was undertaken to identify trends in water quality over time. The main objectives of the ongoing harbour water quality monitoring program are to meet the following environmental values:

- Aquatic ecosystems.
- Recreational water quality and aesthetics.
- Industrial water quality.

The harbour water quality monitoring program also aims to establish trends in harbour water quality whilst assessing whether concentrations of contaminants of concern are moving towards meeting the environmental values detailed above. For the purpose of this review the results specific to aquatic ecosystems were reviewed only to maintain consistency with the harbour water sampling conducted by AECOM at high and low tide as part of this EA.

Seven sites within the Outer Harbour were sampled between 2002 and 2008 as listed in **Table 14-2.**

Table 14-2: Historical Water Quality Sampling Sites Within the Outer Harbour

Site Identification*	Sample site description	Sample type
7	Entrance to the Inner Harbour (“The Cut”)	Surface water sample
8	Entrance to the Inner Harbour (“The Cut”)	10 metre depth
9	No. 6 Jetty	Surface water sample
10	No. 6 Jetty	10 metre depth
11	Darcy Road Drain	Surface water sample
12	Darcy Road Drain	10 metre depth
13	Harbour entrance (Outer Harbour)	Surface water sample

*As specified in the program

The historical water quality data was assessed against the ANZECC (2000) 95% marine water trigger values to ensure consistency with the investigation undertaken by AECOM as part of this EA. As all analytes were reported at concentrations less than their respective assessment criteria, with the exception of metals, metal concentrations only have been assessed as part of this review (refer to **Appendix B** for a more detailed discussion). A summary of raw data is presented in **Table 14-3**.

Trends associated with the water quality data include the following:

Sites 7 and 8 (The Cut)

- In general, the concentrations of aluminium reported for both surface and deep samples (10m) tend to fluctuate and generally decrease between April 2003 and July 2004 until October 2004 where the concentrations peak before steadily decreasing until March 2008 where a similar peak is observed.
- Copper concentrations remained fairly constant between 2002 and 2008.
- No specific trends were observed for zinc, cadmium, or tin.

Sites 9 and 10 (No. 6 Jetty)

- Aluminium concentrations fluctuated between 2002 and 2008.
- Copper concentrations remained fairly constant between 2002 and 2008.
- No specific trends were observed for zinc, cadmium, or tin.

Sites 11 and 12 (Darcy Road Drain)

- In general, concentrations of aluminium reported for both surface and deep samples (10 m) generally increased between April 2003 and March 2008 where the concentrations peak before steadily decreasing in October 2008.
- In general copper concentrations remain fairly constant throughout the data set with no specific trends noted.
- No specific trends were observed for zinc, cadmium.
- No specific trends in the data were observed for tin, however it is noted that the limits of reporting (LOR) vary significantly throughout the data set. The summary tables provided no justification for the variability of LORs which for certain surface water sampling events (January 2003 and October 2004) are between <24 and <25µg/l.

Site 13 (Entrance to the Outer Harbour)

- Concentrations of aluminium were greatest during autumn and winter when rainfall is likely to have been highest.
- In general copper concentrations remain fairly constant throughout the data set with the highest concentrations reported in autumn and winter when rainfall is likely to have been highest.
- No specific trends were observed for zinc, cadmium, or tin.

Overall it was noted that the data was generally inconsistent and no significant trends were observed.

It was noted that the LORs (i.e. the minimum level able to be detected by the laboratory) vary significantly throughout the data set and in many instances were greater than the adopted assessment criteria.

The analytical results for water quality monitoring undertaken by AECOM as part of this EA revealed that heavy metals concentrations in the harbour water samples were less than the adopted assessment criteria (ANZECC [2000] 95% Marine Water), with the exception of the following:

- Cadmium - concentrations in two harbour water samples (10 400 µg/L and 65 400 µg/L respectively) (both collected at high tide) exceeded the adopted assessment criteria (5.5 µg/L). These extremely high cadmium concentrations in two of the water samples are likely to be erroneous based on other harbour surface water, sediment and elutriate analytical results as part of this investigation and historical water quality data for the Outer Harbour.
- Copper – concentrations in one harbour water sample (2 µg/L) (collected at high tide) exceeded the adopted assessment criteria (1.3 µg/L).

Table 14-3: Summary of Historical Water Quality Data

Analyte	ANZECC 2000 Criteria (95% level of species protection) – Marine Environments		Range of Concentration	
		Sites	Surface water samples	Deep water samples
Aluminium	0.5 µg/L	7 and 8 9 and 10 11 and 12 13	<2 -13 µg/l <0.8 -14 µg/l <0.6 -14 µg/l <0.3 -11 µg/l	<0.8 -7 µg/l <0.3 -6.2 µg/l <0.6 -9 µg/l -
Chromium	4.4 µg/L	7 and 8 9 and 10 11 and 12 13	<1 -< 4 µg/l 0.4 - <4.0 µg/l 0.5 - <4.0 µg/l <0.3 -<4 µg/l	<1 -< 4 µg/l 0.4 - <4.0 µg/l 0.5 - <4.0 µg/l -

Analyte	ANZECC 2000 Criteria (95% level of species protection) – Marine Environments		Range of Concentration	
		Sites	Surface water samples	Deep water samples
Manganese	80 µg/L	7 and 8 9 and 10 11 and 12 13	<1 – 19 µg/l 0.8-14 µg/l <0.5-8.4 µg/l <0.8 -4 µg/l	<1 – 19 µg/l 0.8-14 µg/l <0.5-8.4 µg/l -
Iron	300 µg/L	7 and 8 9 and 10 11 and 12 13	<1 – 17.5 µg/l <1.0 - <5.0 µg/l <1.0 - <5.0 µg/l <0.6 -<3 µg/l	<1 – 17.5 µg/l <1.0 - <5.0 µg/l <1.0 - <5.0 µg/l -
Nickel	70 µg/L	7 and 8 9 and 10 11 and 12 13	<2 – <5 µg/l <0.2 - <0.5 µg/l <0.2 - <0.5 µg/l <2 -<5 µg/l	<2 – <5 µg/l <0.2 - <0.5 µg/l <0.2 - <0.5 µg/l -
Copper	1.3 µg/L	7 and 8 9 and 10 11 and 12 13	<1.0 -2.5 µg/l <1.0 -3.0 µg/l <1.0 -4.0 µg/l <1 - 2 µg/l	<1.0 - <2.0 µg/l 0.9 – 2.0 µg/l - -
Zinc	15 µg/L	7 and 8 9 and 10 11 and 12 13	<1.0 -20.0 µg/l <1.0 – 16.0 µg/l <0.5 – 14.0 µg/l <0.8 - 7 µg/l	<1.0 – 10. 5 µg/l <0.5- 7.0 µg/l <0.5 – 14.0 µg/l -
Cadmium	5.5 µg/L	7 and 8 9 and 10 11 and 12 13	<0.4 – 18.6 µg/l 0.5 and 10.7 µg/l 0.4 and 7 µg/l <0.7 - 6 µg/l	<0.7 -4.4 µg/l <1 – 5 µg/l <0.7 – <2 µg/l -
Tin	35 µg/L	7 and 8 9 and 10 11 and 12 13	<0.4 - <25 µg/l <0.6 - <24.0 µg/l <0.2 - <25.0 µg/l <0.2 - <25 µg/l	<0.4 - <25 µg/l <0.6 - <24.0 µg/l <0.2 - <25.0 µg/l <0.2 - <25 µg/l
Lead	4.4 µg/L	7 and 8 9 and 10 11 and 12 13	<0.3- <20 µg/l <1.0 - <20 µg/l - <0.3 -20 µg/l	<0.3- <20 µg/l <0.3 - <12.0 µg/l <0.8 - <8.2 µg/l -
Arsenic	4.5 µg/L	7 and 8 9 and 10 11 and 12 13	<0.3- <20 µg/l 1.2 -1.7 µg/l 1.2 -1.7 µg/l <1 - 3 µg/l	<0.3- <20 µg/l 1.2 -1.7 µg/l 1.2 -1.7 µg/l <1 - 3 µg/l

Analyte	ANZECC 2000 Criteria (95% level of species protection) – Marine Environments		Range of Concentration	
		Sites	Surface water samples	Deep water samples
Selenium	3 µg/L	7 and 8 9 and 10 11 and 12 13	0.06-0.28 µg/l 0.07 – 0.31 µg/l <0.1 – 0.4 µg/l 0.04 – 0.22 µg/l	0.06-0.28 µg/l 0.07 – 0.31 µg/l <0.1 – 0.4 µg/l 0.04 – 0.22 µg/l

Groundwater

Existing groundwater conditions are described in detail in **Section 11**.

Based on the review of previous contamination studies undertaken for the Outer Harbour foreshore area, the depth to groundwater in the area of the proposed western road corridor (that extends from Christy Drive to the multi-purpose terminals) ranges between 4.2 and 4.3m below ground surface (bgs). In contrast, the groundwater in the area of the proposed eastern road corridor extending from Foreshore Road to the container terminals is approximately 2.6m bgs.

Historical groundwater results indicate that heavy metal (specifically arsenic, copper, zinc, lead, cadmium and nickel) contamination has been reported within the vicinity of Port Kembla Outer Harbour. This groundwater contamination is a regional issue and is not specific to the area to be developed. The highest historical groundwater contamination concentrations have been reported between the Darcy Road Drain and the No. 3 Jetty. PAH, polychlorinated biphenyl (PCB) and organochlorine pesticides (OCP) were not detected in groundwater during the historical investigations.

14.3 Methodology for Environmental Assessment

The hydrological and water quality assessments were based on a literature review of previous hydrological, groundwater, surface water, soil, sediment investigations, aerial photography interpretation and site visits, to determine the potential for hydrological impacts and degradation of water quality, as a result of the proposed Outer Harbour development.

The following documents have been considered in the environmental assessment of hydrology and water quality:

- NSW Water Quality and River Flow Objectives – (DECCW, 2009);
- Using the ANZECC Guidelines and Water Quality Objectives in NSW (DEC, 2006); and
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000).

14.4 Impact Assessment

14.4.1 Concept Plan

Construction

The most likely impacts on hydrology and water quality as a result of the Concept Plan construction works are associated with dredging and reclamation activities, general land based construction works and alterations to existing watercourses and drainage lines.

Dredging of rock and soft sediments would be undertaken between the multi-purpose terminals and container terminals as well as to the east of the container terminal. Dredging would also be undertaken for all container berth boxes, approach channels and to expand the existing ship turning circle located to the south of the northern breakwater. The majority of the required dredging is programmed to occur within Stage 1 of the Concept Plan, with the remaining dredging to be undertaken in Stage 3.

Dredging activities have the potential to create turbid plumes, disturb acid sulfate soils, mobilise contaminated sediments and disturb dinoflagellate cysts present in the Outer Harbour, with resulting water quality impacts. It is important to note that existing shipping activities affect turbidity within the Outer Harbour on a daily basis as does less regular rainfall events. Further detailed discussion of the potential impacts on turbidity is presented in **Section 14.5** as part of the impact assessment for Major Project (Stage 1).

Following reclamation the surfaces for the proposed multi-purpose and container terminals would remain unpaved and pervious for some time until pavement is constructed to facilitate operational activity. In addition there would be stockpiles of imported fill (for reclamation), construction roads and general construction work areas (for storage of plant and equipment, amenities, offices). These areas of loose material would be susceptible to erosion (particularly during inclement weather) and fine material may become mobile and airborne, increase sediment loads of surface water and ultimately degrade water quality in the adjacent drainage lines and harbour.

Local hydrology would be altered by the Concept Plan to allow flow from Salty Creek and Darcy Road Drain through the reclamation footprint into the Outer Harbour.

Measures are proposed as part of the CEMP, DEMP and SWMP to control potential impacts associated with dredging activities, turbidity, reclamation surfaces, stockpile areas and surface water runoff. Control measures to mitigate potential impacts during construction are described in **Section 14.6**.

Operation

Once the multi-purpose and container terminals are operational, the main impacts on water quality would arise from shipping transport and operation activities, including fuel and oils spills and leaks, ballast water discharge, cargo losses and general wear and tear on facilities and infrastructure.

The Concept Plan would result in an increase in the area of hardstand impervious surface as a result of reclamation activities. This would increase the volume of stormwater runoff and the potential for increased pollutant loads (such as total suspended solids and hydrocarbons) to the Outer Harbour. Appropriately designed pollution control devices would be included in all stormwater drainage to capture pollution before it reaches the harbour.

Control measures to mitigate potential impacts arising during operation are described in **Section 14.6**.

14.5 Impact Assessment

14.5.1 Major Project

Construction

Dredging

As part of the Major Project, dredging of rock and soft sediments would be undertaken for:

- All multi-purpose berth boxes and approach channels apart from an area adjacent to No. 6 Jetty (Port Kembla Gateway) and the swing basin;
- All container berth boxes and approach channels.
- Basins between the multi-purpose terminals and container terminals.
- The basin east of the container terminals.

It is anticipated that a combination of dredging methodologies, techniques and equipment would be employed during dredging campaigns. Soft materials would be dredged using either 'excavator and grab' or 'cutter suction' dredge methods. Hard rock material would be drilled, blasted and excavated using a grab or backhoe dredger.

Dredging works would have the potential to impact directly on the water quality of the Outer Harbour as well as indirectly on aquatic flora and fauna as a result of reduced water quality. Dredging would generate turbid plumes by mobilising sediment into the water column. These plumes could impact on sensitive receptors such as macroalgal communities and aquatic fauna as a result of reduced light availability and increased suspended sediment concentration. Dredging also has the potential to expose acid sulfate soil and disturb dinoflagellate cysts that may be within the estuarine bottom sediments of the harbour, leading to a reduction in water quality and/or potential for toxic bloom.

Silt curtains with suitable length drops determined for each dredging campaign, would be deployed around each dredge and emplacement area. Silt curtains would reduce turbidity and contain dispersion of turbid plumes thereby minimising impacts on aquatic flora and fauna. Dredging and emplacement of sediment within the reclamation area would be undertaken within the water column and therefore no wastewater would be generated from the dredged sediments. Aquatic macroalgal taxa of hard substrate communities in the Outer Harbour have been shown to be tolerant to low light conditions, therefore temporarily reduced light availability resulting from potential increased turbidity associated with dredging works would be unlikely to have significant impact on these communities in the long term. Mobile fauna could avoid turbid areas of poorer water quality within the construction footprint by moving to more favourable locations and there is sufficient area in the Outer Harbour for this to occur.

Mobilisation of contaminated sediments into the water column could have significant impacts on water quality and in turn effects on aquatic flora and fauna. These issues are discussed in more detail in **Sections 10** and **16**.

Salty Creek and Darcy Road Drain

Local hydrology would be altered to allow existing creeks/drains to flow through the reclamation footprint into the Outer Harbour. Darcy Road Drain would be extended through the reclamation area. Initially (during Stage 1) the drainage line would remain an open, u-shaped channel with wing walls and an energy dissipater at the discharge point to the harbour. The energy dissipater would reduce the potential for localised impacts on bed morphology. In order to allow operational movement for the container terminals, the drain would be enclosed under hardstand in Stage 2 of the Concept Plan.

Darcy Road Drain currently conveys flow from a predominantly industrial catchment, including stormwater and effluent from the now closed Port Kembla Copper site and the Orica plant and other adjacent commercial and industrial facilities. Although there would be a change in hydrology of the drain, there would be no change to the water quality of the drain as it is dependent on land use in the catchment (which would not change as a result of the Concept Plan. The extension would be designed to ensure sufficient capacity to convey current and future flows from the Darcy Road Drain catchment to ensure there is no increase in flood risk.

The proposed reclamation has the potential to impact on Salty Creek. The existing Salty Creek estuary is an intermittently closed or open lake or lagoon (ICOLL). The estuary entrance crosses Red Beach which, from time to time and in the absence of heavy rainfall, builds up in height under persistent low swell wave action such that the flood tide can become constricted or prevented from entering the estuary. This also has the effect of hindering the outflow discharge of freshes caused by rainfall, which can exacerbate flooding upstream. The characteristics of such ICOLLS are that they experience far greater ranges in fluctuations of water levels and salinity than do those estuaries that are open permanently to the sea.

During times when the creek is closed, large rainfall events can cause localised upstream flooding. Earth moving contractors have been engaged when this occurs to open the creek to the harbour to alleviate flooding, which in turn reduces the periods of low salinity in the creek.

Salty Creek would be redirected through the reclamation area to discharge to the harbour. Initially the creek would be redirected and remain an open channel but would be permanently enclosed in Stage 2 to allow operational movement for the multi-purpose terminals.

When the seabed fronting the Salty Creek entrance is reclaimed, the culvert that would be constructed would ensure that the tidal and flood discharge conveyances would be maintained for Salty Creek.

As a result of the redirection, Salty Creek would become permanently open to the sea and, hence, to tidal flushing. This could provide a benefit to water quality within the creek and Outer Harbour by reducing the build-up of pollutants that would currently occur when the mouth is closed for a period, and thereby reducing the load discharged to the Outer Harbour when reopened. It will also reduce localised upstream flooding that occurs during rainfall events when the creek mouth is closed.

The change to a permanently open system would also result in a reduction in the variations of salinity and water levels within Salty Creek, with potential impacts on the diversity and abundance of aquatic flora and fauna. Changing the entrance conditions of Salty Creek would also affect the passage of fish in and out of the estuary. Fish are habitually deterred by long dark tunnels, as such, the fish passage to and from Salty Creek and the Outer Harbour is likely to be disconnected. The impacts on aquatic ecology resulting from the changed hydrological regime of Darcy Road Drain and Salty Creek are discussed in **Section 16**.

General Construction

Construction material stockpiles and general construction work areas may be subject to erosion and result in impacts on water quality by increasing sediment loads of surface water runoff entering the Outer Harbour. Measures to control erosion and sediment transport, as outlined in **Section 9** would be implemented as part of a CEMP prepared for the construction works and this would include preparation of a SWMP. These preventative measures are relatively standard on construction projects and would manage any potential for erosion and sedimentation, thus ameliorating any impact on water quality.

Although unlikely, fuel and oil leaks and spills could occur during construction. In addition, litter, fine particles from eroding soils and associated heavy metal and organic contaminants could be generated and mobilised during the construction activities resulting in degradation of water quality in the surrounding environment. Control measures outlined in the CEMP(s) prepared for each package of construction works would minimise the potential for spills to occur, and mitigation measures including the use of spill kits on site, would minimise the impacts on surface and/or ground water quality should they occur.

Groundwater

Based on a review of historical groundwater studies undertaken within the foreshore area of the Outer Harbour, groundwater has been recorded at between 2.6 and 4.2m bgs in the vicinity of the proposed new road off Christy Drive. The excavation works associated with the proposed new access road and service infrastructure would be a maximum of 1.5m bgs. Therefore groundwater should not be encountered during the construction of the new road.

The proposed reclamation area has the potential to impact on the groundwater flow regime in this area of the Outer Harbour, particularly if the hydraulic conductivity of the reclamation area is significantly different to that of the natural soil profile of the Outer Harbour shoreline. This issue is discussed in more detail in **Section 11**.

The proposed reclamation area should have no impact on groundwater quality. However, to ensure that the reclamation activities do not adversely impact upon local groundwater, the results of an existing groundwater monitoring program that is undertaken within the Outer Harbour would be reviewed throughout the reclamation activities to monitor the affect of the development on the existing groundwater (refer **Section 11**).

14.5.2 Operation

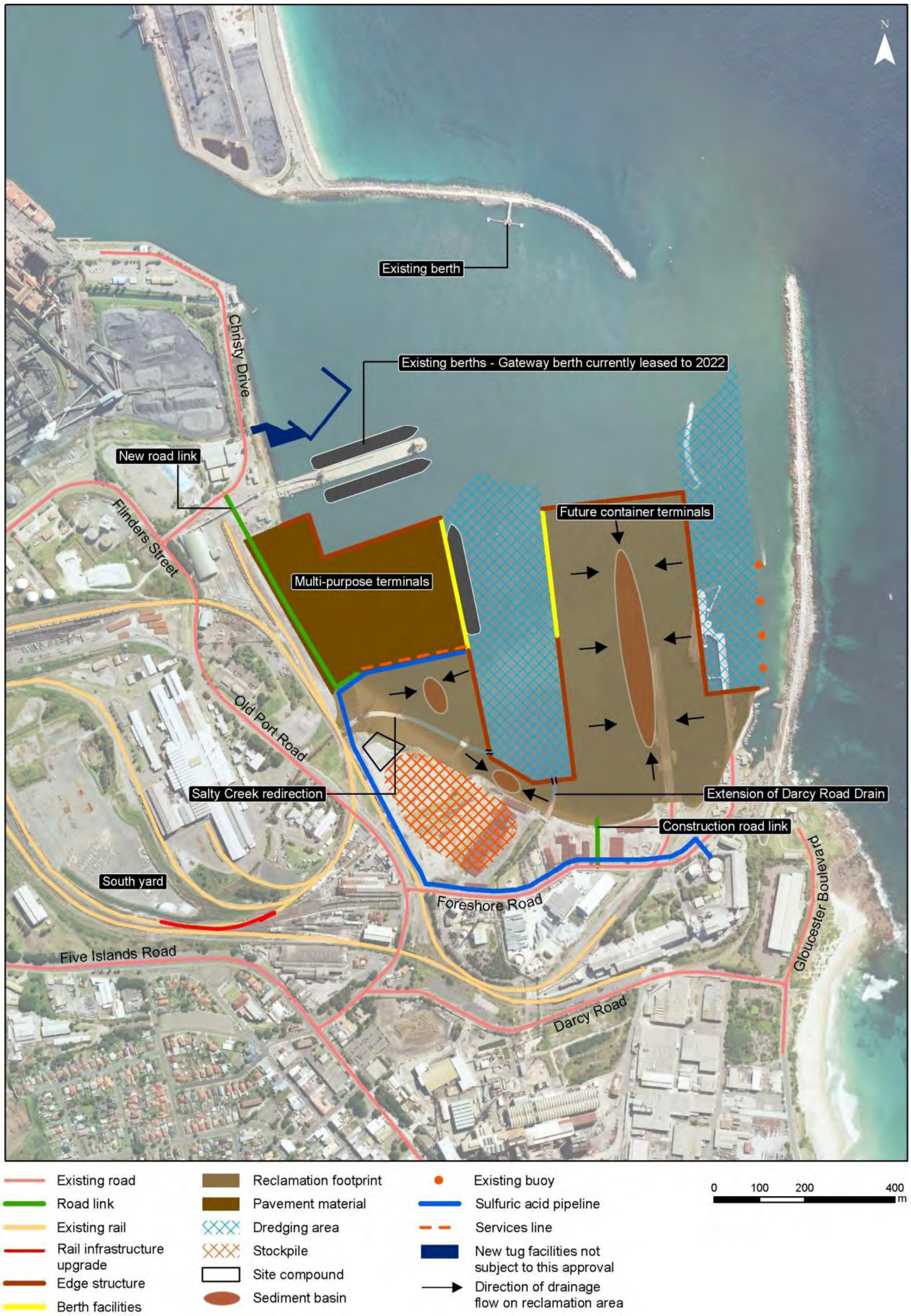
Surface water runoff from impervious surfaces and unpaved reclamation areas within the proposed development site has the potential to mobilise sediments and contaminants (such as litter and hydrocarbons from oil and fuel spills and leaks) and organic matter which would degrade receiving water quality. A formal and permanent drainage system would be installed for the area of paved hardstand for the central portion of the multi-purpose terminals.

With the exception of the central portion of the multi-purpose terminals, the reclaimed surfaces of the southern portion of the multi-purpose terminals and eastern and western container terminals would remain unpaved. The surface of these areas would be comprised of compacted gravels or other suitable material. Although the finished surface material would be chosen to minimise air-borne fugitive dust it is likely that the unpaved surface would provide a source of sediment which could be mobilised and discharge to the Outer Harbour.

To limit the input of sediment-laden runoff to the Outer Harbour, the surface of the reclamation area would be profiled to direct runoff away from the harbour to temporary sediment retention basins (**Figure 14-5**). These basins would be designed to capture and filter sediment runoff from unpaved reclamation areas which would percolate into the reclamation material. The rock revetment walls surrounding the reclamation area would be lined with geotextile fabric which would prevent any fine-grained material that may be transported via preferential pathway from discharging to the harbour and degrading harbour water quality.

During operation of the central portion of the multi-purpose terminals there could be impacts on water quality from transport and operation activities, including fuel and oils spills and leaks, ballast water discharge, cargo losses and general wear and tear on facilities and infrastructure. Control measures contained in the site OEMP and emergency response plans would minimise the potential of these occurring and mitigate the impacts on water quality should they occur.

Figure 14-5: Stage 1 Construction - Sediment Retention Basins



14.6 Mitigation Measures

14.6.1 Concept Plan

Construction impacts on water quality would be managed according to a CEMP that would be prepared for each stage of Concept Plan development. The CEMP would set out appropriate controls to manage and mitigate potential impacts on water quality associated with dredging and reclamation activities and construction of terminals and associated infrastructure, and would outline appropriate response procedures for dealing with emergencies such as spills and leaks during construction activities.

These controls would be detailed in a series of sub-plans including:

- Dredging Environment Management Plan
- Soil and Water Management Plan
- Site Management Plan
- Emergency Response Plan
- Acid Sulfate Soil Management Plan

Potential impacts on hydrology and water quality, resulting from the operation of the Concept Plan would be managed by a number of OEMPs (prepared for each discrete port activity). The OEMPs would outline specific measures to ensure impacts to water quality and hydrology during operation of the port are minimised.

As part of the OEMP, monitoring programs for water quality and biology would be developed, in consultation with DECCW and the Port Kembla Harbour Environment Group, and implemented for each stage of the Concept Plan. These monitoring programs would establish existing baseline conditions and would outline monitoring frequencies and testing procedures. Results would be used to identify emerging trends or problems, provide data for measuring the impact of operational activities, determine whether pollution controls are working and provide a basis for efficient response to emergencies such as floods and spills.

Further hydrological and water quality assessments would be undertaken as part of project applications for development and operation of the terminal facilities proposed for Stages 2 and 3 of the Concept Plan.

14.6.2 Major Project

Construction

SWMP would be prepared as part of the CEMP(s) for each package of works to be constructed for the Major Project to minimise the amount of sediment and polluted water entering the Outer Harbour. The SWMPs would contain emergency procedures for high rainfall events and other extreme weather conditions that have potential to increase soil erosion and sedimentation during construction.

SWMPs would include installation and maintenance of erosion and sediment control devices, minimisation of the area to be disturbed, daily visual inspection of devices and avoidance of earthworks during wet weather where possible.

The design and implementation of channel structures or culverts is required to convey flows from Salty Creek and Darcy Road Drain through the reclamation area. The structures would be designed and sized to mitigate adverse flood impacts upstream of the site for flood events up to the 100 year ARI design storm event. The design of these structures would consider:

- Potential climate change impacts due to increasing sea levels and rainfall intensities.
- Investigation into the inclusion of devices to improve water quality.
- Possible hydraulic impacts due to flows greater than the 100 year ARI storm and up to the Probable Maximum Flood and/or due to blockage of the structure.
- Fish passage.

Specific measures to address the handling of oils and fuels and the washing of all equipment, including all concreting equipment, would be undertaken within bunded areas or containers and pollutants trapped in bunded areas would be disposed of in accordance with the waste management section of the CEMP. Any fuel spillage would be reported, documented and immediately remediated. Collected contaminated material would be disposed of as per management section of the CEMP and in accordance with the NSW Waste Classification Guidelines 2008. The CEMP would include an Acid Sulfate Soil Management Plan and a Spoil Management Plan.

A Dredging Environmental Management Plan would be prepared and implemented, incorporating:

- Description of extraction methodology and machinery to be employed;
- Identification of dredge areas;
- Identification of disposal areas;
- Turbidity control devices;
- Erosion and sediment control measures; and
- Water quality monitoring locations.

A Demolition Management Plan would be prepared prior to demolition or rock blasting activities within the harbour and include the implementation of environmental control devices, such as floatation booms and silt curtains to reduce impacts on the surrounding water quality.

Water quality and biological monitoring programs would be developed, in consultation with the Port Kembla Harbour Environmental Group, and implemented during construction, to ensure that water quality objectives in the Port Kembla Outer Harbour are not compromised. The water quality and biological monitoring programs would form part of the CEMP and would:

- Establish existing baseline conditions;
- Identify monitoring parameters;
- Identify representative sampling locations and frequency of sampling;
- Identify testing procedures (ensuring chemical testing is undertaken by NATA accredited laboratory);
- Outline the framework and format for reporting monitoring results.

A framework for the water quality monitoring program is provided below. A framework for a biological monitoring plan is provided in **Section 16**.

Introduction

A Water Quality Monitoring Program (WQMP) will be developed prior to the commencement of dredging activities in conjunction with the appointed dredging contractor.

Objectives

The primary objective of the WQMP is to minimise water pollution from turbidity and mobility of contaminants when sediments are dredged. This will be achieved by monitoring water quality prior to and during dredging activities to ensure mitigation and control measures, such as silt and turbidity curtains, are adequate and effective. The WQMP would be prepared in accordance with the Project Conditions of Approval and an Environment Protection Licence for a water-based extractive activity under *Protection of the Environment Operations Act 1997*.

Proposed works

As part of the Port Kembla Outer Harbour development, both sediment and rock would be dredged from the Outer Harbour and deposited within the reclamation area. Approximately 383,575m^3 of rock and 833,675m^3 of sediment would be dredged within Stage 1 of the development. The WQMP would include details on the locations of the proposed dredging works, dredging methodology, staging and volumes of material. Refer to **Section 6** for further details pertaining to the construction program and staging for Stage 1.

Monitoring regime

Water quality would be monitored by a combination of visual inspection, physico-chemical and toxicant monitoring measures.

Baseline monitoring

The WQMP should commence a few months prior to the commencement of dredging works to establish a water quality baseline and identify variability of background physico-chemical levels in relation to shipping movements, tides, winds and storm events.

Visual Inspection

During dredging activities, a silt curtain containment system would be used around the dredging equipment, active dredging area and spoil placement area to contain turbidity and allow sediments to settle within a confined area. The silt curtains would be anchored on the seafloor.

Daily visual monitoring would be undertaken to ensure mitigation controls and measures, such as silt curtains, are working properly and turbid plumes that are generated by the works are appropriately contained. Visual inspections would also identify sheens (i.e. oils and fuel on the water surface) that may result from plant and equipment that has not been properly maintained.

Monthly flyovers would be undertaken to assess the presence of potential turbidity plumes.

Physico-chemical monitoring

Manual measurements would be taken twice daily to record TSS, pH, dissolved oxygen and temperature. Measurements would be taken at four locations; two locations adjacent to the active work zone (area of impact e.g. immediately outside the silt curtains surrounding the dredge) and two locations that would be remote from the dredging activity. Measurements taken at the remote location would act as reference points and be used for comparison with measurements taken adjacent to the active work zone.

The trigger value for TSS would be confirmed once variation in existing turbidity is identified during baseline monitoring. Turbidity measurements should be taken from at least two different depths to examine any stratification effects.

Toxicant monitoring

Chemical contaminants such as metals and PAHs that have potential to impact upon ecosystems are grouped together under the term toxicants. Sampling points for toxicant monitoring would be similar to the locations for manual measurements for physico-chemical monitoring.

Toxicant monitoring would be undertaken by the use of diffusive gradients in thin-films (DGTs). DGTs provide a relatively new method of measuring bioavailability (or toxicity) of metals in aquatic systems. The DGT device measures concentration of metals in solution in-situ and the theory of the system is based on the diffusional characteristics of metals in a hydrogel. Four DGT water sampler units would be suspended in situ within the Outer Harbour. Locations and method of suspension would be confirmed with the dredging contractor once the dredging contract is awarded.

The toxicant concentrations would be compared against 95% protection levels for estuarine environments outlined within the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000). Concentrations would be measured for toxicants listed in **Table 14-4**.

Table 14-4: Toxicants that would be measured during Port Kembla Outer Harbour dredging activities

Toxicant	
Metals	Antimony Cadmium Chromium (VI) Copper Cobalt Lead Mercury (inorganic) Nickel Silver Selenium Vanadium Zinc
Polycyclic Aromatic Hydrocarbons	Anthracene Benzo(a)pyrene Fluoranthene Napthalene Phenanthrene
Metalloids	Arsenic

Record keeping

Records would be kept to document measurement times, dates, location, and name of the measurement collector for physico-chemical monitoring. Reports should be prepared to document results of the toxicant monitoring. Additional records should be kept to collect data on visual inspection of plumes, wind speed and direction and rainfall.

Contingency Measures

Contingency measures should be included in the WQMP to manage exceedences of concentration limits. Measures should include the following, where appropriate:

- Additional monitoring.
- Install additional silt curtains.
- Isolate dredging activities.
- Modify or suspend activities.

Operation

An OEMP would be prepared and implemented for operation of the central portion of the multi-purpose terminals. It would include the following controls, as a minimum, to manage impacts on hydrology and water quality:

- Design of a stormwater management system for the terminal areas.
- A control system to ensure that bulk material stockpiles and materials within handling areas are contained onsite, through the use of containment walls, bunding, stormwater and dust controls. Any excess sediment laden runoff will either be contained within the bunded storage areas or directed to a land based treatment area. A program of regular monitoring and maintenance of the storage and handling of bulk materials will be implemented.

- Measures to minimise excess materials being deposited offsite during loading and transportation of bulk materials from the material handling area. Controls such as vehicle brush shaker pads, use of vacuum road sweepers, covering loads during transport and dust suppression will be implemented to reduce any potential impacts on water quality.
- Emergency spill response procedures.

Programs for monitoring water quality within the Outer Harbour and Salty Creek would be undertaken during operation of the Major Project. These monitoring programs would outline monitoring frequencies and testing procedures and results would be used to identify emerging trends or problems, provide data for measuring the impact of operational activities, determine whether pollution controls are working and provide a basis for efficient response to emergencies such as floods and spills.

14.7 Summary

The assessment of the hydrology and water quality aspect of the proposed Outer Harbour development concluded that works associated with the construction and operation of the proposal could potentially impact on the water quality of the Outer Harbour and its associated waterways if not managed appropriately.

PKPC would develop a suite of management plans and monitoring programs as part of the CEMP and OEMP which would address all stages of the construction and operation of the proposed development to minimise the impact on water quality and hydrology of the Outer Harbour.

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15.0 Coastal Hydrodynamic Processes

15.1 Existing Environment

The coastal hydrodynamic processes pertinent to the development of the Outer Harbour have been studied extensively and a summary of this study has been presented here and in more detail in **Appendix F**. These hydrodynamic process studies include both infragravity (long) wave and gravity (swell) wave transformation into the Harbour, tidal discharge and sea level fluctuations.

Major hydrodynamic processes affecting operations in the Outer Harbour include the entry of long waves past the breakwaters. Long waves have very low wave height (the amplitude can be in order of decimetres) but long wave lengths which cycle over periods of minutes in contrast to short waves, which cycle in seconds. These waves can resonate within the harbour and cause ships to range dangerously at their berths. The existing Outer Harbour experiences long wave resonance (seiching) some 12 times each year, on average, which puts a significant constraint on shipping operations. On occasions, dangerous ranging causes the tugs to leave their existing berths (on No. 3 Jetty) to take shelter in the Inner Harbour.

Swell waves enter the Outer Harbour and dissipate along the foreshore between the No. 6 Jetty (Port Kembla Gateway) and the existing tug berths. During severe storms, swell waves some 2 m high can shoal onto this spending (or dissipative) beach. Some swell wave energy enters the Outer Harbour also by overtopping the eastern breakwater during severe storms (refer **Plate 15-1**) although the amount of wave energy entering the harbour this way is relatively low.

The tidal current streams within Port Kembla Harbour have very low velocities.

Water level fluctuations within the Outer Harbour result from the regular rise and fall of the tide, which has a range of 2.0 m at Port Kembla. However, at times elevated water levels are experienced during storms. Further, there is an identified risk of future sea level rise as a result of climate change.

Plate 15-1: Swell Wave Overtopping the Eastern Breakwater 22nd October 1992 (Photo courtesy of the NSW Manly Hydraulics Laboratory)

15.2 Methodology for Environmental Assessment

The most critical of the coastal processes relevant to the development of the Outer Harbour for the shipping trade is the presence of long waves. The resonance characteristics of the Outer Harbour can be de-tuned by changing the outline configuration of the Outer Harbour. The proposed reclamation has been designed with this as an important objective.

Swell wave penetration studies have been undertaken using computer numerical wave transformation modelling validated with field data measurements. The existing harbour was schematised to simulate the long wave characteristics and the model was changed with a number of proposed reclamation schemes (refer to Master Plan) to test their efficacy in ameliorating harbour seiching.

Numerical modelling has previously been used to assess impact of proposed reclamation schemes on tidal discharge, particularly for the Inner Harbour.

Future projections of sea level rise have been adopted from the NSW Government Policy on Sea Level Rise, which allows for 0.4 m increase in sea levels by 2050 and 0.9 m by 2100 relative to 1990 levels.

15.3 Impact Assessment

15.3.1 Concept Plan

The long wave modelling has demonstrated that the Outer Harbour can be designed and developed progressively as a functional port. The modelling indicated that the adverse impacts of the long wave activity were ameliorated with each stage of the reclamation having been completed. However, fine tuning of the shape of the seaward (northern) end of the proposed container terminals was required to eliminate the formation of a long wave in that location. The seaward edge of the container terminals will be a platform located on concrete piles and is programmed under Stage 3 of the Concept Plan.

Moored ship modelling under seiching conditions for tugs, cargo and container ships at their respective berths has confirmed that the Concept Plan would be suited for these types of proposed shipping operations. The predicted ship movements in the Outer Harbour were found, generally, to be well within guideline standards for the 1% design event (100 year storm).

The Concept Plan would not significantly affect the long wave processes or the tidal discharge of the Inner Harbour, nor would it have significant impact on tidal velocities. The impact of the reclamation on tidal exchange would not affect the saltwater cooling water system for BlueScope Steel's operations. The proposed development would have virtually no impact on the tidal discharge of the Inner Harbour and, if anything, would marginally improve tidal exchange there.

The reclamation would obviate swell wave dissipation onto the existing beach on the western foreshore of the Outer Harbour. This would have the effect of eliminating one of the long wave generating processes within the Outer Harbour. The computed swell wave height coefficients at the proposed berths of the Concept Plan are small and swell wave heights would be within those allowable under the PIANC (Permanent International Association Navigation Congress) Guidelines for the shipping that is proposed.

There would be no swell wave impact on erosion of unconsolidated foreshores of the Outer Harbour as finalisation of the Concept Plan would result in all foreshores being either vertical edge structures for berths or sloping rock revetments. Bank erosion would therefore not be an issue as no natural unconsolidated foreshore would remain in the Outer Harbour.

Reclamation and finished terminal levels have been designed to ensure future sea level rise can be accommodated for the economic lifetime of the development with a sufficient margin to ensure sustainability beyond that time into the future. The proposed reclamation level has been set to RL 4.0m and the finished pavement level of the terminal has been set to RL 5.2m. These levels comfortably meet sea level rise predictions contained in the NSW DECC Draft Sea Level Rise Policy for both the years 2050 and 2100 and allow for a freeboard of 0.5m and 1.3m, respectively (refer **Section 26** for additional detail).

15.3.2 Major Project

The seiching within the Outer Harbour could be sensitive to the staging of the reclamation. Maunsell │ AECOM (2009a) presented the results of seiche modelling within the Outer Harbour for each of the staged development milestones, indicating there would be no adverse impacts from long wave activity resulting from the reclamation footprint under Stage 1 (Major Project).

Due to a late change in project scope, long wave modelling has not been undertaken for the penultimate stage of reclamation, which comprises a relatively narrow strip of reclamation around the existing No. 6 Jetty (Port Kembla Gateway). The difference in the reclamation footprint between the Major Project and that modelled for the Concept Plan is small and it is considered that the long wave properties of the would not differ significantly. Further assessment of the impacts associated with the narrow strip of reclamation around the existing No. 6 Jetty (Port Kembla Gateway) would be undertaken as part of a future project application for this stage of work.

15.4 Mitigation Measures

15.4.1 Concept Plan

The proposed reclamation level of 4.0 m PKHD has been set to be sustainable for predicted extreme sea level rises for the design life of the facilities. A final level of 5.2 m PKHD for all terminals is suitable to cater for predicted sea level rise at 2100 and beyond.

15.4.2 Major Project

Comprehensive and detailed studies of the coastal hydrodynamic processes have been undertaken for each stage of the proposed Outer Harbour development. These studies have led to a reclamation design that would ameliorate the adverse impacts of harbour seiching, which, at present, puts a significant constraint on shipping operations within the Outer Harbour. In this regard, there are no further mitigation measures required.

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16.0 Aquatic Ecology

16.1 Introduction

The PEA for the proposed Outer Harbour development (Maunsell AECOM, 2008) identified that the main interaction between the project and aquatic biota would occur in the soft and hard substrate habitats. A review of existing information followed by a comprehensive survey of aquatic species and marine vegetation in those habitats was undertaken for the proposed development by the Subtidal Ecology and Ecotoxicology Laboratory at the University of New South Wales (UNSW). The results have been interpreted and utilised to inform the following section. The full survey report is presented in **Appendix G**.

16.2 Existing Environment

16.2.1 Soft Substrate Habitat

Flora

The conditions in Port Kembla Harbour have not favoured the establishment of seagrass or mangrove communities (Maunsell AECOM, 2008). Previous surveys in the harbour have found no significant macroalgal flora (marine vegetation) was associated with the soft substrate habitat. Pollard and Pethebridge (2002) recorded only one species of Red algae (*Acrosorium venulosum*) in an area containing previously dredged material that has been deposited in the Outer Harbour, which is within the footprint of the proposed development. This area of deposited material (from Inner Harbour dredging) has subsequently been further modified by the construction of a new berth and extension of an existing berth at the Cargo Handling Facility in the Inner Harbour (SKM, 2004).

Presence of dinoflagellate cysts has been recorded in Port Kembla Harbour. Pollard and Pethebridge (2002) collected sediment cores in Port Kembla Harbour for assessment of dinoflagellate cyst presence. Cysts of at least 16 different dinoflagellate species were identified in these sediment cores. *Alexandrium "catenella type*" cysts were reported in relatively low numbers from sediments collected in the Outer Harbour sites.

A recent sediment survey, to assess the presence of dinoflagellate cysts in the area to be dredged and reclaimed as part of the Outer Harbour development , was undertaken by UNSW (2009) at four locations in the Outer Harbour and one location in Salty Creek. A total of 14 sites were sampled and potentially toxic dinoflagellate cysts (Alexandrium sp.) were identified at two sites from location L2 (outside the development footprint) and one site at Salty Creek. Abundances of Alexandrium sp. were low (< 5/ml) and the toxic dinoflagellate *Gymnodinium catenatum* was not identified in any of the samples.

The presence of Alexandrium cysts in the sediments raises the possibility of occurrence of potentially toxic algal blooms. During dredging cysts can be disturbed and their dispersal through the photic layer of the water column is thus enhanced, leading to potential occurrence of toxic blooms. Blooms of *A. catenella* in southern Australian waters usually occur for about two to four weeks in the warmer months between December and April (Pollard and Pethebridge, 2002). However, to date there is no evidence of any toxic blooms occurring in Port Kembla (Pollard and Pethebridge, 2002), despite dredging and spoil movement taking place in recent works in Port Kembla Harbour.

Fauna

Fish sampling using seine and gill nets was undertaken on the soft substrate habitat in the Outer Harbour as part of early environmental investigations for port expansion planning (AWT, 1999). In this study, seine nets were hauled by hand though the shallow sandy beach habit off Red Beach. Gill net sampling was undertaken in the deeper subtidal soft substrate habitat off Red Beach. All the surveyed sites, except for one gill net sampling site, were within the footprint of the proposed Concept Plan for either reclamation or dredging.

A total of 221 specimens belonging to 13 taxa were recorded with more that 60% being juveniles. The most abundant taxa were juvenile Yellowfin Bream (*Acanthopagrus australis*) and adult Sandy Sprats (*Hyperlophus vittatus*) accounting for 44% and 19% of the total fish catch respectively (AWT, 1999). The Red Morwong (*Cheilodactylus fuscus*) was the only species collected in the gill nets surveys of the deeper soft substrate habitat. These results suggest that the soft substrate beach habitat off Red Beach potentially provides a nursery area for juvenile fish.

Sediment infauna and grain size were sampled by UNSW (2009) at four locations in the Outer Harbour and one location in Salty Creek. At each harbour location, two replicate Van veen grab samples were collected at four sites in 5m depth and spaced 100-300m apart. Replicates samples were also collected by corer at four shallow water subtidal sites in Salty Creek at 20 m intervals. The Outer Harbour sediment samples were found to be comprised of silty sand while Salty Creek sites were largely sand with a smaller proportion of silt present in the samples.

Harbour Locations L1 and L2 were outside the direct footprint of the proposed development while Locations L3 and L4 were within the areas that would be subject to reclamation.

Significant differences in sediment infauna were found between locations, where locations L1, L2 and L3 were similar to each other but different to L4 (UNSW, 2009). Thirty-two sediment infauna taxa were identified from the Outer Harbour sediment samples while 11 taxa occurred in the Salty Creek samples. The Outer Harbour taxa were dominated by Polychaete families Cirratulidae, Spionidae and Sabellidae, particularly at locations L2 (Cirratulidae and Sabellidae), L3 (Cirratulidae and Spionidae) and L4 (Cirratulidae). The Salty Creek sites were characterized by the presence of Bivalves, Polychaete family Nereididae and Oligochaetes.

The intertidal macroinvertebrate fauna associated with the sandy beach was not sampled in the recent study by UNSW (2009). Johnson (1995) surveyed macroinvertebrate fauna of Red Beach in Port Kembla Outer Harbour as well as two other non-industrial harbours in the area of Port Kembla. The study found an impoverished fauna in the Red Beach location with only six species recorded. Very little similarity was found to previous sandy beach studies in NSW.

16.2.2 Hard Substrate Habitat

Flora

Pollard and Pethebridge (2002) surveyed macroalgae in Port Kembla Harbour as part of a harbour wide assessment of introduced species. In the Outer Harbour sites, macroalgae were largely restricted to Red (Rhodophyta) and Brown (Phaeophyta) species with the greatest diversity associated with No. 3 and No. 4 Jetties. A total of 12 species of Red algae were recorded (ten species were associated with No. 3 and No. 4 Jetties, only one species occurred on the eastern breakwater and one species occurred on the spoil ground). A total of eight species of Brown algae were recorded (four associated with the jetties, three on the eastern breakwater and one species at the recreational boat ramp). A curious occurrence of a seagrass species (*Halophila ovalis*) was noted on the No. 6 Jetty pile scrapings along with one species of Green (Chlorophyta) algae. No introduced macroalgal species were recorded in the harbour during the 2002 survey.

Surveys of subtidal epibiota by UNSW (2009) were undertaken along four transects in the Outer Harbour:

- two transects on the eastern breakwater.
- one transect along the wooden wharf piles of No. 6 Jetty.
- one transect along No. 4 Jetty (Berth 206)

The survey found Red and Brown algae were the predominant macroalgae with turfing taxa occurred on the Jetties and crustose algae occurring on the breakwater. This is consistent with the pattern of algal occurrence recorded by Pollard and Pethebridge (2002).

The absence of Green algal taxa and the predominance of Red and Brown macroalgal species reported by Pollard and Pethebridge (2002) and UNSW (2009) suggest that light availability, among other factors, is important in structuring macroalgal communities in the subtidal hard substrate habitat in the Outer Harbour. Seasonal variability in algal community structure was not sampled by either survey. Pollard and Pethebridge (2002) sampled macroalgal cover (marine vegetation) in autumn (May) and UNSW (2009) sampled in winter (June). The recorded absence of green macroalgal cover between the two studies is unlikely to be affected by the timing of the surveys as seasonal variability would affect the presence of individual species and the taxa would still be represented if favourable conditions were present in the Outer Harbour.

Fauna

Fish fauna associated with the hard substrate habitat in the Outer Harbour was sampled using visual diver surveys by AWT (1999) and UNSW (2009).

Relatively diverse fauna was recorded by both studies with abundance dominated by few species. UNSW (2009) study recorded a total of 19 species associated with the eastern breakwater locations with Mado (*Atypichthys strigatus),* Yellowtail (*Trachurus novaezelandiae)* and Moon wrasse (*Thalassoma lunare*) being the most abundant at these locations. Twelve species were associated with the No. 6 Jetty and No. 4 Jetty locations with Yellowtail, Mado, Silver Sweep (*Scorpis lineolatus*), Eastern Hulafish (*Trachinops taeniatus*) and Yellowfin Bream (*Acanthropagrus australis*) being the most abundant. Similarly AWT (1999) recorded high abundance of Yellowtail, Mado and Silver Sweep at the eastern breakwater locations. Only Yellowtail and Red Morwong (*Cheilodactylus fuscus*) were recorded at all the surveyed locations (UNSW, 2009).

Hard substrate sub-tidal epifaunal cover was sampled using photo quadrat techniques (UNSW, 2009). Four transects at 3m depth were surveyed in June 2009; two at eastern breakwater locations, and one transect at No. 4 Jetty and No. 6 Jetty respectively. Results showed that barnacles were the predominant faunal cover on the eastern breakwater while No. 4 Jetty and No. 6 Jetty locations supported a more diverse cover comprised of bivalves, porifera and ascidians.

16.2.3 Threatened Species, Populations and Communities

The NSW *Fisheries Management Act 1994* (FMA) establishes provisions for the identification, conservation and recovery of threatened fish, aquatic invertebrates and marine vegetation. Species listed as being protected under the FMA provides for another level of conservation of aquatic biodiversity. All Sygnathids (seahorse, weedy seadragon, pipefish) are listed as being protected. These protected species can be found in a variety of habitats including shallow estuaries and deep offshore reefs. Sygnathids were not recorded during the fish surveys undertaken and it is considered that the harbour is unlikely to provide suitable Sygnathid shelter due to the absence of canopy forming macroalgal species.

Preliminary assessment undertaken for the Project identified that the hard substrate of the existing breakwaters may provide potential habitat for juveniles of one threatened fish species, the black cod (*Epinephelus daemelii).* However, the species has not been previously recorded in the Harbour (Maunsell AECOM, 2008). Habitat requirements for this species were summarised from Pogonski (2000) and DPI (2007) and the threatened species assessment was carried out according to the *Draft Guidelines for Threatened Species Assessment* (DECC & DPI 2005).

As the proposed development does not involve modification of the existing breakwater, which may provide suitable habitat, specific field surveys for the presence/ absence of black cod were not considered warranted. However, the impact assessment focussed on the potential indirect impacts of the development on the known habitat requirements.

Black cod

Black cod, also known as black rockcod or black-saddled rockcod, are a large, reef-dwelling grouper species. They are found in warm temperate and subtropical parts of the south-western Pacific, and occur along the entire NSW coast including Lord Howe Island. They occur in coastal and estuarine rocky reefs from relatively shallow shorelines areas to deeper offshore waters. They are rarely seen due to their secretive nature and are usually found hiding in caves and under ledges. Juveniles settle in coastal rock pools and larger juveniles occur around rocky shores in estuaries. An investigation into potential habitat for black cod was carried out as part of this assessment. Results are discussed in **Section 16.3.2**.

16.3 Impact Assessment

16.3.1 Concept Plan

Construction

Key construction activities that would be undertaken for the Concept Plan that would impact on aquatic ecology include:

- Dredging of sediments (Stages 1 and 3).
- Underwater blasting (Stage 1). Underwater blasting creates shockwaves which can have adverse effects on aquatic fauna particularly fish and marine mammals.
- Spoil placement and reclamation (Stages 1, 2 and 3).
- Redirection of Salty Creek and extension of Darcy Road Drain (Stage 1).

Broadly speaking, potential impacts to aquatic ecology associated with these activities would include:

- Smothering of sediment infauna in the dredged and the spoil emplacement (reclamation) areas.
- Generation of turbid plumes and the mobilisation of contaminants into the water column.
- Water quality changes.
- Physical changes.
- Disturbance and suspension of dinoflagellate cysts and increased likelihood of toxic algal bloom occurrence.
- Blasting which creates a generation of shockwaves.
- Loss of approximately 30% of existing soft substrate habitat, including loss of sandy beach habitat (Red Beach).
- Creation of approximately 1.77km of hard substrate habitat.

Operation

Once operational, potential impacts to aquatic ecology would include:

- Polluted stormwater runoff from hardstand.
- Alteration of hydrological regime of Salty Creek.

These construction and operation impacts would occur as part of activities to be undertaken as part of the Concept Plan (Stages 1 to 3). Although the areas of development are different for each stage, the type, extent, magnitude and duration of impacts occurring as part of the Major Project (Stage 1) would be similar to those occurring as part of Stages 2 and 3 and it is considered, therefore, that the results of the assessment undertaken for the Major Project would be similar to results for the other stages. Notwithstanding, additional studies assessing the impact on aquatic ecology associated with Stages 2 and 3 would be prepared as part of separate applications for approval made at a later date.

A detailed discussion of impacts associated with construction and operation of Stage 1 is presented in **Section** below.

16.3.2 Major Project

The Major Project comprises construction and operation of Stage 1 of the Concept Plan. Activities that would be undertaken as part of Stage 1 that would impact on aquatic ecology include:

- Reclamation for the entire footprint of the development with the exception of an area in the vicinity of Port Kembla Gateway (refer **Figure 6-1**).
- Dredging for the entire footprint of the development with the exception of an area in the vicinity of Port Kembla Gateway and extension of the swing basin that is located to the south of the northern breakwater (refer **Figure 6-1**).
- Redirection of Salty Creek and extension of Darcy Road Drain.

A detailed description of impacts on aquatic ecology resulting from activities that would be undertaken as part of Stage 1 is provided below.

Construction

16.3.3 Smothering of Sediment Infauna

Smothering of sediment infauna in the dredged and the spoil emplacement (reclamation) areas would result in loss of infauna with permanent loss occurring in the emplacement areas due to removal of habitat and temporary disturbance occurring in the dredged areas.

Assessing change at the locations potentially disturbed by construction related activities depends on how well the pre-disturbance condition is measured. Where sampling does not occur over an appropriate time scale, any unusual result from the 'before disturbance' sampling period is likely to unduly influence conclusions about recovery in the future. Morrisey and Underwood et al., (1992) reported variability in benthic fauna over a range of timescales from days to several months. Similarly Morissey and Howitt *et al.*, (1992) have provided indication of spatial scales of variation which may be important.

Impacts of dredging on benthic fauna have been investigated (e.g. Newell et al., 1998; Wilson 1998). Rates of recovery in benthic fauna following dredging were found to increase along a gradient of environmental stability. In highly disturbed environments fewer organisms are capable of survival and such environments are colonized by fewer resistant species. They can reproduce to high densities creating a low diversity high abundance benthic community structure. High abundance of polychaetes such as Capitellids and Spionids are characteristic of sites that have been disturbed or are impacted by organic pollution. As the stability of the environment increases these opportunistic species are replaced by a greater variety of species.

Wilson (1998) studied the recovery of sediment infauna communities in Botany Bay following the dredging for the construction of the parallel runway. The dredged areas monitored by Wilson (1998) were in deeper habitat (>10m) similar to the depth proposed to be dredged in Outer Harbour. Monitoring showed that dredging in Botany Bay did not have long term effects on sediment infauna. Recolonisation of the dredged areas occurred within a period of months; however recovery to the pre-dredging community structure had not occurred by the end of the two-year study period.

Following the completion of the reclamation, there would be sufficient sediment habitat remaining in the Outer Harbour to provide species for recruitment to the dredged areas. Based on previous investigations of impacts of dredging on sediment infauna it can be concluded that recovery of dredged areas in Port Kembla would occur, however it may take some time to recover to the pre-dredging community structure.

16.3.4 Generation of Turbid Plumes

Construction activities, involving dredging and reclamation, result in suspension of sediments in the water column generating sediment plumes (turbidity) which, unless controlled, can be dispersed some distances away from the disturbed area. While the presence of a visible sediment plume impacts on the aesthetics of an area and can create community concern about poor environmental controls, it does not necessarily translate to adverse environmental impacts.

Turbidity changes induced by dredging would result in adverse environmental effects when the turbidity generated is significantly larger than the natural variation of turbidity and sedimentation rates in the area (Stern & Strickle, 1978 & Optin et al., 2004 in Erftmemeijer & Robin Lewis III, 2006; in SPC 2007). Ecosystems that experience large variations in turbidity levels due to natural processes would have evolved greater tolerance to turbidity changes which could arise from activities such as dredging (Nieuwaal, 2001). Increased turbidity levels are common in the harbour as a result of both port operations and climatic events. Higher turbidity occurs when deep draft ships enter or leave the port, while the harbour also suffers excessive turbidity following significant rainfall events. The proposed reclamation and operations associated with the Outer Harbour are therefore not considered to result in a significant increase in the turbidity already experienced in the harbour, especially if the proposed mitigation measures are implemented.

However the main issues with turbidity resulting from the dredging and reclamation activities proposed in the Outer Harbour that require consideration, relate to:

- Changes to water quality by reduction in light availability and the potential for suspension of contaminated sediments.
- Physical changes due to excessive sediment deposition leading to smothering of sediment infauna outside the development footprint.

The sensitive ecological receptors in the areas that would be directly and indirectly impacted include:

- Hard substrate macroalgae, epifauna and mobile fauna on the eastern and northern breakwaters may be sensitive to changes in water quality.
- Soft substrate infauna in Outer Harbour areas outside the development footprint may be sensitive to physical changes due to excessive sediment deposition.

16.3.5 Water Quality Changes

Generation of turbid plumes can impact on sensitive receptors through reduced water quality. Prolonged reduction in light availability could lead to a shift in the predominant macroalgal taxa occupying the shallower habitats, thus affecting the community structure. However these changes in community structure are not likely to alter the values provided by this habitat, as the changes are reversible when structuring conditions change. Macroalgal communities tend to be structured according to availability of light, nutrients and space (Denley and Dayton, 1985). These factors are limiting for plants and lead to competitive interactions between species. Shallow reef flora is generally dominated by Green and Brown algae with Red algae predominating in deeper water (with lower light availability). Prolonged reduction in light availability could lead to a shift in the predominant algal taxa occupying the shallower habitats, thus affecting the community structure.

The hard substrate floral community structure in the Outer Harbour has been shown to be dominated by macroalgal taxa tolerant to low light conditions suggesting that the ambient water quality conditions provide relatively prolonged periods of high turbidity. Therefore any reduction in light availability due to increased turbidity levels is likely to not have significant impacts on the macroalgal community over the long term. Furthermore, dispersion of turbid plumes outside the footprint of the proposed development would be contained by controls including silt curtains, and sediment in the reclamation area would be contained by an engineered structure (refer **Figure 6-8**).

Mobile aquatic fauna, such as fish, within the area of the proposed development can avoid turbid areas by moving to more favourable locations. This occurs under natural conditions as turbidity and other physico-chemical water quality parameters vary naturally and many aquatic organisms have wide tolerance and adaptive capacities (ANZECC 2000). Turbidity within the construction area would be variable depending on ambient conditions and the location of the dredging and reclamation activities. There is sufficient area available in Outer Harbour for mobile fauna to avoid the turbid areas within the construction footprint. Therefore specific mitigation for impacts of turbidity on mobile fauna is not required.

It is the mobilisation of contaminants into the water column which could have the greatest impact on sensitive ecological receptors. Results of sediment sampling in Port Kembla Harbour indicated contamination of the sediments within the areas to be dredged by a range of heavy metals, PAHs and other contaminants (refer to **Section 10**).

The bioavailability of heavy metals is considered to be limited due to low solubility in seawater. For metals to become detached from the sediments and transported away from the dredge area there would need to be a marked change in the pH, which is unlikely given the buffering capacity of the seawater. It is known that the solubility of most metals increases at a pH of more than about 10 or less than about 4. Hence bioavailability of metals would be limited primarily to ingestion pathways. Any fauna likely to ingest contaminated sediment would already be occasionally subject to such processes due to the ambient conditions harbour-wide. Therefore activities to be undertaken for Stage 1 are not creating new pathways of exposure or exposing new ecological receptors to potential heavy metal contamination. However, activities associated with Stage 1 may be increasing the duration of such exposure.

The mobilisation of contaminants into the water column could have the greatest impact on the hard substrate community structure through potential to disrupt recruitment and settlement processes. Studies in Port Kembla Harbour (Knott *et al*., 2009) found that dredging activities resulted in large-scale suspension of contaminated sediments. During these dredging activities the recruitment of the dominant filter-feeders (e.g. barnacles and polychaete worms) was disrupted and ceased for a period of four months, despite being abundant prior to dredging. Therefore mitigation measure would be needed to limit the dispersion of sediment plumes towards the sensitive ecological receptors found on the hard substrate habitat in the Outer Harbour.

16.3.6 Physical Changes

Smothering of sediment infauna could occur outside the Stage 1 footprint due to dispersion of sediment laden waters and excessive sediment deposition. Benthic fauna can tolerate some sediment deposition as it is part of the natural structuring process. As the process is likely to be gradual, infaunal communities adapt by migrating through the sediment layer. The effect of high sediment loads, on benthic animals, near areas of sediment deposition has been found to be generally small (EPA Victoria, 2001). A SWMP would be prepared to control sediment deposition during construction and operation.

16.3.7 Disturbance and Suspension of Dinoflagellate Cysts

The presence of *Alexandrium "catenella type*" cysts in the sediments of the Port raises the possibility of future potentially toxic blooms. *Alexandrium* cysts were reported in relatively low numbers from sediments collected in the Outer Harbour sites. Disturbance and suspension of any cysts present in the sediments cannot be avoided. However the dispersion of any suspended material can be managed by installing silt curtains to trap any suspended material within the area of disturbance. Monitoring and avoiding dredging during conditions known to be associated with bloom formation in other similar environments would form part of an Algal Bloom Contingency Plan for the construction phase of the project.

16.3.8 Blasting

Underwater blasting can impact on aquatic biota due to the generation of underwater shockwaves. An underwater explosion produces a pressure waveform with rapid oscillations from positive pressure to negative pressure which results in rapid volume changes in gas-containing organs leading to internal damage and mortality (Keevin and Hamden, 1997).

The extent of the underwater shock wave generation depends on whether the explosion occurs in open water or is confined. Confined explosions, such as that proposed as part of Stage 1, generate much less potential environmental impact as some of the pressure waves would be radiated into the surrounding stiff medium such as rock (US FWS, 2006).

The potential for impacts is largely confined to fish and mammals for whom injury and mortality resulting from underwater blasts has been well documented (Keevin and Hamden, 1997). The swim bladder in fish is the most frequently damaged organ and in mammals, gas containing organs such as lungs and the intestinal tract are most affected by underwater blasting. Impacts such as these depend on the size of the pressure change that is generated. Significance thresholds for fish and setback requirements for marine mammals have been established (Wright and Hopky, 1998).

In NSW, guidelines for assessment of blasting impacts apply primarily to the built environment and human amenity. Guidelines to manage impacts of underwater blasting developed by the US Army Corp of Engineers (Keevin and Hamden 1997), Canadian Department of Fisheries (Wright and Hopky, 1998) and the British Joint Nature Conservation Committee (JNCC, 2009) were reviewed for an assessment of potential mitigation measures which may be applied to the Port. Various measures to mitigate against potential impacts on marine fauna as a result of blasting are discussed in **Section 16.4**).

16.3.9 Creation and Removal of Soft Substrate Habitat

The footprint of the proposed development would result in a loss of Red Beach shallow sandy habitat and approximately 30 percent of the deeper soft substrate habitat in Outer Harbour which would be replaced by 2.74 km of new hard substrate habitat following the completion of the reclamation and the implementation of the Concept Plan.

Based on the results of surveys undertaken for the proposed development, the habitat values provided by the soft and hard substrates in the Outer Harbour differ.

Historical sampling of the Red Beach shallow sandy habitat showed it had impoverished macroinvertebrate infauna with only six species recorded. However, fish surveys showed that the shallow sandy bottom off Red Beach may function as a nursery area by providing a suitable habitat for juvenile fish of commercial or recreational value. The surveys of deeper soft substrate habitat showed that it provides an infaunal community structure dominated by Polychaetes and limited fish fauna.

The loss of the shallow sandy beach habitat is significant because it is the only such area in the Outer Harbour. Although the quality of the Outer Harbour aquatic environment has been degraded over the decades of industrial activity in its catchment, the shallow sandy beach may provide an important nursery habitat for fish.

While it is not possible to directly compare the importance of the soft substrate habitat that would be lost against that which is gained by its replacement with hard substrates, the studies carried out to date suggest that unique values may be provided by the shallow soft substrate areas that would be lost and would need to be mitigated and/or compensated for.

Although the loss of approximately 40 hectares of deeper soft substrate habitat is a significant reduction in area, there would be sufficient surface area of deeper soft substrate habitat remaining in the Outer Harbour to continue to provide those habitat values. Therefore compensatory measures for the loss of the deeper soft substrate are considered unnecessary.

16.3.10 Creation and Removal of Hard Substrate Habitat

Differences in hard substrate community structure showed that the rocky embankment of the eastern breakwater provides a low diversity habitat dominated by barnacles and crustose algae while the jetty locations supported a more diverse cover comprised of tufting algae, bivalves, porifera and ascidians with a relatively diverse fish fauna utilising the habitats provided by these structures. While a whole range of factors may be involved in structuring these communities including surface type, orientation and access to light, hydrodynamic processes and frequency of disturbance, it is apparent that providing a hard surface with features that have some structural complexity would provide habitat values to aquatic biota.

In Port Kembla, it is possible that the Outer Harbour rock breakwaters, particularly at the entrance to the harbour, provide suitable habitat for black cod. The development would not result in the removal or modification of the existing rocky reef that is formed by the harbour breakwaters, or result in changes to coastal rock pools. Additional hard substrate habitat would be created as a result of the multi-purpose and container terminals. Rock revetment walls would be constructed along the southern edge of the reclamation area between the multi-purpose terminals and container terminals, as well as along the northern end of the container terminal, providing long term habitat. However, the newly created hard substrate of the wharf face is unlikely to be suitable long term habitat for adults of this species as it would not provide suitable niches for shelter. Turbidity associated with dredging activities, unless controlled, may temporarily affect this species through water quality changes. Controlling dispersion of turbid plumes by installing silt curtains around the dredging and dredge emplacement areas would reduce the risk of water quality impacts on rocky reef dwelling biota.

No endangered populations of the black cod species have been recorded in Port Kembla Harbour. The proposed development would result in the creation of new hard substrate habitat of the newly created wharf face and revetment walls which would replace the existing soft substrate in sections of the Outer Harbour. As soft substrate habitat is not favoured by this species it is considered unlikely that the proposed action is likely to have an adverse effect on the life cycle of black cod.

No listed endangered or critically endangered ecological communities, which may be characterised by the presence of this species, occur in the Outer Harbour area. No critical habitat for this species would be affected by Stage 1 activities.

The new hard substrate surfaces would be constructed incorporating measures described in *Environmentally Friendly Seawalls: A Guide to Improving the Environmental Values of Seawalls and Seawall-lined Foreshores in Estuaries* (Sydney Metro CMA and DECC, 2009), where possible, to enhance the aquatic ecosystem values provided by the newly constructed hard substrate. The berths and revetments may incorporate features including:

- Boulder sized rocks placed without cement to form revetments to provide crevices in the intertidal and sub-tidal areas;
- Artificial rock pools in the revetments;
- Textured finish on vertical walls by placement of objects such as concrete knobs.

16.3.11 Draft Guidelines for Threatened Species Assessment (DECC & DPI 2005)

The assessment of impact of Stage 1 on the desired environmental outcomes for protection of threatened species, outlined in the *Draft Guidelines for Threatened Species Assessment* (DECC & DPI 2005), is summarised in **Table 16-1** below:

Table 16-1: Draft Guidelines for Threatened Species Assessment

TSA Guideline	Assessment	Net Impact
Maintain or improve biodiversity values (i.e. there is no net impact on threatened species or native vegetation).	Stage 1 would have no net impact on the black cod as there would be no direct impact on its potential key habitat and any indirect impacts through water quality changes can be mitigated through the installation of appropriate controls (such as silt curtains around the work areas).	No net impact
Conserve biological diversity and promote ecologically sustainable development.	Stage 1 would have no net impact on the biological diversity of Port Kembla Outer Harbour as characterised by threatened species. The temporary impacts associated with water quality changes would be controlled though the use of measures such as silt curtains around the work areas. Therefore principles of ecologically sustainable development as applied to threatened species would not be compromised by Stage 1 of the development.	No net impact
Protect areas of high conservation value (including areas of critical habitat).	The rocky reef habitat associated with the harbour breakwaters would not be modified by Stage 1. Port Kembla Outer Harbour is not likely to provide habitat of conservation value for black cod.	No net impact
Prevent the extinction of threatened species.	Reduction in numbers of this species along the NSW coastline has been associated with over-harvesting by line and spear fishing. Stage 1 of the development would not affect this existing threat to the species. As there is no direct impact on the black cod habitat and any indirect impact can be readily controlled, Stage 1 is considered highly unlikely to lead to a local extinction of the black cod.	No net impact
Protect the long term viability of local populations of a species, population or ecological community.	As the existing rocky reef habitat formed by the harbour breakwaters is not altered by Stage 1 it is considered unlikely that the life cycle of the black cod would be affected such that a viable local population of it is likely to be placed at risk of extinction	No net impact
Protect aspects of the environment that are matters of national environmental significance.	Investigations undertaken indicate that Stage 1 would not have an impact on the matters of national environmental significance.	No net impact

Based on the results of the Threatened Species Assessment the project is considered unlikely to have an adverse impact on the long term survival of the threatened species.

Operation

The existing Salty Creek estuary can be termed an intermittently closed or open lake or lagoon (ICOLL). The estuary entrance crosses a beach (Red Beach) that, from time to time and in the absence of heavy rainfall, builds up in height under persistent low swell wave action such that the flood tide can become constricted or prevented from entering the estuary. This also has the effect of hindering the outflow discharge of freshwater caused by rainfall, which can exacerbate flooding upstream. The characteristics of such ICOLLS are that they experience far greater ranges in fluctuations of water levels and salinity than do those estuaries that are open permanently to the sea.

When the seabed fronting the Salty Creek entrance is reclaimed, a culvert would be constructed within the reclamation to ensure that the tidal and flood discharge conveyances would be maintained; that is, Salty Creek would no longer be an ICOLL as the entrance would become open permanently to the sea and, hence, to tidal flushing. This would result in a reduction in the variations of salinity and water levels within Salty Creek, which has the potential to change the species composition of fauna and flora that currently inhabit this system. This change in species composition is likely to be from a smaller assemblage of species adapted to greater fluctuations in water level and salinity to a larger assemblage of species typically found in the surrounding marine environment.

The changing of Salty Creek to a permanently open system could provide a benefit of increased flushing of the creek, which would reduce the build-up of pollutants that would currently occur when the mouth is closed for a period thereby reducing the load discharged to the Outer Harbour when reopened.

A further change to the entrance conditions of Salty Creek, which is relevant only to the Concept Plan, is the closing over of the Salty Creek drainage culvert to facilitate unimpeded movement across and between the operational terminals. The enclosure of the drain would create a long dark tunnel which is likely to adversely impact on the passage of fish from the sea to the estuary and *vice versa*.

16.4 Mitigation Measures

Key activities associated with the Concept Plan that would impact on aquatic ecology would be undertaken throughout the three stages of development. Furthermore, as the majority of reclamation and dredging for the development footprint would be undertaken as part of the Major Project, the mitigation measures developed for construction of Stage 1 would be relevant for Stages 2 and 3 also.

Similarly, the operational activities that would be undertaken in each stage of the Concept Plan, such as operation of berths, truck and train movements, stockpiling of dry bulk and containers, would be similar throughout each of the stages and result in similar impacts to stormwater quality. Therefore the measures and controls proposed to mitigate potential impacts on aquatic ecology for all stages of the Concept Plan have been presented together below.

16.4.1 Construction

Turbidity

Turbidity from dredging and reclamation can be managed as part of a DEMP using a number of techniques including:

- Selection of appropriate work methods.
- Use of silt curtains with floating booms.
- Use of diffuser heads on outlet pipes.
- Preventing the overflow of barges or bunds.
- Sediment in the reclamation area could be contained by quay walls, armoured revetments or similar structures.

The effectiveness of the mitigation measures to limit the dispersion of sediment plumes would be reviewed by water quality monitoring. A framework for a water quality monitoring program is outlined in **Section 14**. Biological monitoring of the effects of dredging on larval settlement on the existing and newly created hard substrate would also be undertaken to validate the predictions made in the impact assessment. The implementation of these measures would be developed during the design phase of the construction program and documented in the CEMP. A framework for a Biological Monitoring Program is provided below.

Biological Monitoring Program

Introduction

A sessile invertebrate recruitment study would be undertaken following construction of new hard substrate to monitor the effects of dredging and reclamation on larval settlement. A framework for the biological monitoring is outlined below.

Objectives

The primary objective of the biological monitoring would be to monitor the effects of dredging and spoil emplacement on marine ecosystem health within the Outer Harbour. This would be achieved by undertaking a sessile marine invertebrate recruitment study during dredging activities and documenting recruitment and assemblage development of both native and invasive species. The biological monitoring would be undertaken in accordance with the Project Conditions of Approval and an Environment Protection Licence for a water-based extractive activity under *Protection of the Environment Operations Act 1997*. The biological monitoring results from this study should be compared against a baseline data set of sessile invertebrate recruitment collected by UNSW in 2009/10. Sessile invertebrates form a significant component of the biological diversity of the Harbour. They are sessile filter feeders and hence are likely to be exposed, and sensitive, to water-borne contaminants possibly created by dredging.

Proposed works

As part of the Port Kembla Outer Harbour development, both sediment and rock would be dredged from the Outer Harbour and used to create new land dedicated to port activities. The full development would require approximately 5,300,000m^3 of fill material. Approximately 383,575m^3 of rock and 833,675m^3 of sediment would be dredged within Stage 1 of the development and used as fill for the reclamation.

The first round of biological monitoring would be undertaken during dredging works for the first multi-purpose berth.

Monitoring locations

As part of Stage 1a dredging works, recruitment of sessile invertebrates would be monitored by deploying settlement plates at similar sites to those used for the UNSW baseline study, including:

1. Eastern breakwater
2. Northern breakwater
3. Northern side of Number 6 Jetty
4. Number 4 Jetty
5. A site approximately 50 m north of the Stage 1a dredging area

Reference sites would also be established in appropriately located estuaries on the NSW coast. Additional monitoring would be undertaken for later stages of dredging at appropriate locations.

Sampling method

Settlement panels (PVC plates) would be erected at each site to emulate hard substrate surface. The panels would be removed after a period of approximately 8 weeks and examined to determine the number of taxa present and the percentage cover of each taxon on the plates.

Frequency of sampling

It is recommended that a sessile invertebrate study is undertaken in stages throughout the completion of Stage 1 of the development (during and after dredging) to assess the impact of dredging works on water quality and aquatic ecology.

Blasting

Blasting impacts on fish and marine mammals can be managed through a range of measures:

- One of the key mitigation measures would be to incorporate the pressure thresholds for physical trauma to fish and marine mammals, such as those published by Wright and Hopky (1998), into the design criteria for blasting activities in the harbour. Physical modelling of pressure changes in the water column and further mitigation through the installation of physical barriers would also be considered if necessary.
- Developing a marine observer program whereby blasting is halted if whales are sighted within specified distances from the development area.
- Develop a Marine Mammal Management Plan for Construction by Blasting based on available and relevant guidelines.

Dinoflagellate Cysts

The potential for dispersion of any suspended dinoflagellate cysts would be mitigated by installing silt curtains around the work areas and this would form part of a DEMP. A program to monitor conditions known to be associated with toxic bloom formation in other similar environments would form part of an Algal Bloom Contingency Plan for the construction phase of the project.

Loss of Soft Substrate Including Red Beach

The design of the wharf face and rock revetments would take into account the need to provide surface treatment with features that have some structural complexity to facilitate recruitment and settlement of epibiota on the new structures.

Opportunities to compensate for the loss of soft substrate have been identified in Tom Thumb Lagoon and Garungaty Waterway (**Appendix G**). Both the Lagoon and Waterway are tidal water bodies, which offer soft sediment habitat for fish and other aquatic fauna within the catchment of Port Kembla Harbour. PKPC has initiated discussions with Wollongong City Council and Conservation Volunteers Australia (CVA) regarding potential habitat improvement projects at Tom Thumb Lagoon and Garungaty Waterway. The measures proposed are consistent with Councils (2007) *Estuary Management Plan and the Plan of Management* prepared for CVA in 2006 (Brown, 2009). Council and CVA have jointly managed volunteers undertaking restoration works at Tom Thumb Lagoon for several years.

PKPC intends to seek a long term partnership arrangement with Council and CVA to fund the improvement works plus ongoing monitoring and maintenance to ensure that effective habitat outcomes are achieved and sustained on the site (See letter of intent from PKPC to the Department of Industry and Investment dated 18 December 2009, **Appendix G**). A description of some of the proposed compensation measures are detailed in Attachment A to PKPC's Letter titled Indicative Compensatory Measures for Aquatic Habitat (**Appendix G**).

16.4.2 Operation

An OEMP would be developed by the terminal operator to cover stormwater management, and emergency planning which would need to be consistent with the existing environmental management plans and policies covering the Port Kembla port operations (refer to **Section 14** for further discussion on proposed mitigation measures pertaining to stormwater management).

The design of the box culverts for conveying Salty Creek flows would consider incorporating a V-shaped recess in the floor of the culvert to facilitate movement of fish and other mobile aquatic species during periods of low flow.

Further mitigation measures relevant to Stage 2 of the Concept Plan only, could be to introduce light into the Salty Creek Drainage Tunnel, by means of various possible design options, in order to create more natural daylight conditions, to encourage the passage of fish from the sea to Salty Creek and *vice versa*.

16.5 Summary and Conclusions

Construction and operation of the Concept Plan (including Stage 1) is not likely to have significant impacts on the aquatic ecology of the Outer Harbour.

A range of control measures can be readily implemented to manage potential turbidity impacts during construction. Impact of blasting during construction would be managed through the design and construction process and would be documented in a Marine Mammal Management Plan for Construction by Blasting. An Algal Bloom Contingency Plan would be prepared for the construction phase to address the process for managing a potential algal bloom.

The loss of the deeper soft substrate habitat associated with the reclamation, although significant in surface area, is not considered likely to have a significant impact. The surveys of deeper soft substrate habitat showed that it is a low diversity faunal habitat and sufficient area of deeper soft substrate would remain in the Outer Harbour. New hard substrate habitat, in the form of wharf face, pile supported decks and rock revetments would be designed with enhanced features to provide expanded aquatic habitat values to those that already exist in the Outer Harbour.

The loss of the shallow soft substrate habitat off Red Beach is considered to be of some significance. Aquatic habitat offsets/compensatory measures are proposed for the loss of potential juvenile fish habitat currently provided by this shallow sandy substrate.

Changes to the dynamics of Salty Creek are likely to impact on the species composition of this system. However, these changes have the potential to improve water quality by permanently opening the entrance to the sea and allowing tidal flushing. Mitigation measures proposed would assist in the movement of fish and other mobile aquatic species through the ultimately closed Salty Creek drainage culvert.

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17.0 Terrestrial Ecology

17.1 Introduction

An ecological field investigation and desktop study was conducted to determine the likely impact of the proposed Outer Harbour development on terrestrial flora and fauna. The ecological assessment is presented below and supplementary data, including a threatened species list, and an outline of a Green and Golden Bell Frog Management Plan, are presented in **Appendix H**.

17.2 Methodology

Searches of the NPWS Atlas of NSW Wildlife and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool were undertaken to determine if any flora or fauna species listed under the *Threatened Species Conservation Act 1995* (TSC Act) or EPBC Act have been recorded or predicted to occur within a 10km radius of the study area.

The assessment of likely impacts on threatened flora and fauna is based on the distribution of threatened species records and habitat requirements as described in the relevant Department of Environment, Climate Change and Water (DECCW) threatened species profiles. A targeted search for *Litoria aurea* (Green and Golden Bell Frog) (GGBF) was undertaken in August 2009 and included a review of previous surveys and an assessment of the proposed Outer Harbour development area as potential habitat for the species.

Extensive ecological survey efforts have been undertaken by Gaia Research in 2007 and 2008 to gather accurate and relevant database information relating to populations of GGBF in the proposed development area. Hence, the database information for this species is considered to be reliable, recent and reflective of the current ecological context of the study area. For the purposes of this assessment, 'study area' was defined as the footprint of the development and any additional areas directly, or indirectly, affected by activities associated with the Concept Plan and Major Project (Stage 1), including the locations of new road links and rail infrastructure upgrades.

Field surveys were limited to a targeted search of GGBF and did not include any other formal fauna surveys. This is a direct result of the industrialised nature of the surrounding environment and the limited extent of available habitat. A conservative approach was taken in the assessment of likelihood of occurrence of threatened fauna species in order to account for the limited extent of field survey undertaken.

Ecological communities and flora and fauna species considered potentially sensitive to the impacts of the Concept Plan were assessed in terms of the potential to have a significant impact on the survival of the species or community at the local scale. Assessments of significance were undertaken in accordance with the draft *Guidelines for Threatened Species Assessment* (DECCW and DPI, 2005).

17.3 Existing Environment

17.3.1 Overview

The Outer Harbour foreshore area has been entirely cleared of its original vegetation and extensively modified. Much of the site consists of hard paved areas. There are limited trees (native or introduced) on the site. Along the foreshore of the Outer Harbour, a small sandy beach (Red Beach) at the mouth of Salty Creek is highly disturbed with a road constructed over the foredune and lagoon area. Narrow strips of grass and shrubs line Salty Creek, Darcy Road Drain and the shoreline between Salty Creek and the Inner Harbour.

The Port Kembla Heritage Park is approximately 1 ha in size and is located at the south eastern extremity of the Outer Harbour. The park is mostly grassland and a small area has been dedicated for a constructed wetland to provide breeding habitat for *Litoria aurea* (GGBF).

There is a narrow rocky coastline east of Heritage Park that is continuous with a small rocky platform approximately 1.5 ha in area just to the south and with the eastern breakwater, which extends approximately 1 km to the north. *Five Islands Nature Reserve* is located approximately 2.5 km east of the Outer Harbour and is important as a breeding habitat for migratory birds. The rocky habitats of Five Islands Nature Reserve are outside the area to be developed.

17.3.2 Fauna Habitat

Highly Modified Areas

The landside area to be developed provides little habitat for native flora and fauna due to historical land clearance activities and the industrial context. The area is considered to be of low habitat value due to a lack of floral species diversity. Species diversity in the area is low due to the highly disturbed nature of the site and relatively little native remnant vegetation available for viable fauna habitat.

Marginal habitat areas exist in Salty Creek for marine and aquatic fauna. These habitat areas are in the reach between Old Port Road and the foreshore railway line, and, upstream within the wetland depression area, adjacent to the Pacific National South Yard (**Figure 17-1**). The small stands of native shrubs (*Acacia longifolia var. sophorae*) that occur along the drainage channels would also provide some limited habitat value, although these stands are fragmented and isolated.

The proposed works would involve reclamation of land up to the mouth of Salty Creek and Darcy Road Drain outlets. Much of the surrounding industrial land use confines the existing creek channels to their current positions. These drainage channels are unlikely to provide potential foraging habitat for the GGBF due to the tidal influence and saline environment. Furthermore, the areas are separated from other potential GGBF habitat by cleared hard stand areas within the industrialised area and roadways.

The vegetation on the landside area to be developed is limited as extensive historical development has resulted in high levels of vegetation clearance. There are few native trees present. Some isolated established tree plantings (*Melaleuca, Acacia, Eucalyptus* species as well as introduced species) are located between the Salty Creek channel and BlueScope Steel car park (**Figure 17-1**). However, this fragmented stand is located outside of the Outer Harbour development area and contains minimal to no native understorey or native ground cover species. Several small stands of trees (*Melaleuca, Acacia, Eucalyptus* species as well as introduced species) are located further upstream adjacent to the Pacific National South Yard and at the top (southern end) of Darcy Road Drain. These areas would also not be directly impacted by the proposed Outer Harbour development.

Native and exotic fauna species that are able to utilise highly modified habitat are likely to exist in the proposed Outer Harbour development area. Some native and small mammal and bird species may persist in the areas dominated by *Chrysanthemoides monilifera* (Bitou Bush) and *Lantana camara* (Lantana) in the understorey layers. These areas are chiefly found along the foredunes north of Foreshore Road. However, fauna species that require a diverse understorey and disturbance sensitive species are unlikely to exist in these environments.

Aquatic Habitats

Two small wetland areas dominated by *Typha* spp. exist at the top (south western end) of Salty Creek. There are narrow strips of grass and shrubs, including areas containing species characteristic of coastal saltmarsh communities, lining Salty Creek, Darcy Road Drain and the shoreline between Salty Creek and the Outer Harbour. The vegetation along Salty Creek is dominated by exotic vegetation such as *Lantana camara* (Lantana), *Chrysanthemoides monilifera* (Bitou Bush) and exotic grasses such as *Pennisetum clandestinum* (Kikuyu) and *Cynodon dactylon* (Couch Grass). A mixture of native and exotic sedges line the edges of Salty Creek and the dominant native shrub species, *Acacia longifolia var. sophorae*, occurs along the edges. Darcy Road Drain is dominated by *Acacia longifolia var. sophorae* with an understorey consisting of exotic grasses such as Couch Grass and Kikuyu.

The present condition of Salty Creek and Darcy Road Drain is highly modified and the limited emergent vegetation is likely to be as a result of high water velocity during heavy rainfall and competition of introduced species. The water quality of Salty Creek and Darcy Road Drain is relatively poor due to the concentration of stormwater flows, weed invasion and the influx of pollutants from hard stand surfaces in the surrounding industrial areas. Along with the low abundance of emergent aquatic vegetation along these waterway areas, little habitat for aquatic fauna species exists here.

The dunes along the foreshore area of the Outer Harbour are dominated by Bitou Bush, a declared noxious weed within the Wollongong LGA. PKPC currently controls Bitou Bush through the use of herbicides.

17.3.3 Vegetation Communities

There are no threatened ecological communities as listed under the EPBC Act occurring in the Outer Harbour area.

During the site survey, small fragmented patches of vegetation containing Coastal Saltmarsh species were observed along Salty Creek between Old Port Road and the foreshore railway line adjacent to the shoreline (refer **Figure 17-1)**. This community is listed as an Endangered Ecological Community (EEC) under the TSC Act. The Saltmarsh is present on both sides of the creek and varies in patch size and condition, with the majority of patches exhibiting a high level of weed encroachment. The overall extent of the fragmented Coastal Saltmarsh is quite limited and estimated to be approximately 30 square metres.

The dominant native species within this patch include *Sarcocornia quinqueflora*, *Paspalum vaginatum* (Saltwater Couch), *Juncus kraussii* (Sea Rush), *Suaeda australis* (Austral Seablite) and *Cyperus laevigatus*. There are a number of exotic species that are encroaching into the Saltmarsh Community including *Cynodon dactylon* (Couch Grass) and *Acacia longifolia var.sophorae*. *Lantana camara* (Lantana) and *Chrysanthemoides monolifera (*Bitou Bush), both noxious weeds, are scattered along the edge of the Coastal Saltmarsh.

17.3.4 Threatened Flora

A search of the *EPBC Act Protected Matters Tool* revealed five threatened flora species of national significance with potential to occur in the Port Kembla locality. This includes two vulnerable and three endangered species.

A search of the *DECC Wildlife Atlas* revealed nine flora species listed as threatened under the TSC Act which have potential to occur in the locality. This includes three vulnerable and six endangered species.

The likelihood of occurrence of these species is presented in **Appendix H**. In summary, the likelihood of occurrence of the threatened flora species listed under the TSC Act and EPBC Act is low due to a lack of suitable habitat present within the Outer Harbour development area.

17.3.5 Threatened Fauna

A search of the *EPBC Act Protected Matters Tool* revealed 33 threatened fauna species of national significance which have potential to occur in the Port Kembla area. This includes 21 vulnerable, 11 endangered and one critically endangered species.

A search of the *DECCW Wildlife Atlas* revealed 77 fauna species listed as threatened under the *TSC Act 1995* which have potential to occur in the Port Kembla area. This includes 65 vulnerable, 11 endangered and one critically endangered species.

The likelihood of occurrence of these species is presented in **Appendix H**. The threatened fauna species with a moderate to high likelihood of occurrence include *Litoria aurea* (GGBF), *Pteropus poliocephalus* (Grey-headed Flying-fox) and *Sterna albifrons* (Little Tern).

Grey-headed Flying-fox

Pteropus poliocephalus (Grey-headed Flying-fox) is listed as Vulnerable under the EPBC and TSC Act. The Grey-headed Flying-fox is likely to forage in the urban areas surrounding the proposed Outer Harbour development in flowering and fruiting specimens of both native and introduced tree species. Roost sites are typically located near water, such as lakes, rivers or the coast and vegetation often consists of patches of paperbark forest, mangroves and riparian vegetation though colonies also use highly modified vegetation in urban areas (DEWHA, 2009). No known camp sites occur near the proposed Outer Harbour development area.

Due to its wide-ranging foraging behaviour, foraging habitat for this species is considered to be present wherever fleshy-fruited and nectar-producing trees are present within 15 km of roost sites. This includes both native and introduced trees within urban landscapes. No roosting or forgaing habitat for this species is found in the Outer Harbour development area.

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Figure 17-1: Riparian vegetation surrounding proposed Outer Harbour development.

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Green and Golden Bell Frog

The Green and Golden Bell Frog (GGBF) *Litoria aurea* is listed as Endangered under the TSC Act and Vulnerable under the EPBC Act. The GGBF is known to occur in the Port Kembla area and to breed in areas near the proposed areas to be developed as part of the Outer Harbour development.

The GGBF inhabits unshaded permanent, open-water swamps or ponds that have a variable water level and dense vegetation (AMO, 2008), marshes, dams and stream sides with a grassy area and rocks and/or vegetation nearby for sheltering (NPWS 1999). Adults are usually found close to, or in water or very wet areas in forests, woodlands, shrublands and open or disturbed areas. The eggs and tadpoles can be found in permanent lakes, swamps and dams with still water.

There are 43 remaining populations of the GGBF known to exist in NSW and only 12 of these are within conservation reserves (DECC, 2005). A sub-population of the species is found at North Port Kembla (adjacent to the Outer Harbour) (AECOM, 2008). This is the most well known and considered the most significant population in the Illawarra region (DEC, 2005).

Threats identified for the GGBF include:

- Natural predators such as wading birds, snakes and eels.
- Foxes and cats.
- Exotic fish, i.e. the Plague Minnow, eat the larvae.
- Fungal pathogens.
- Changes to water quality and drainage patterns.
- Herbicides.

It is thought that the artificial drainage lines along the Wollongong – Port Kembla railway line are functioning as refuge or dispersal areas for the GGBF (Gaia Research, 2008). Gaia Research assessed potential and existing GGBF habitat in the vicinity of the proposed Outer Harbour development. Locations identified as Sites 6, 7, 8, 15, 17 and 18 are proximate to the proposed development as shown in **Figure 17-2**. An excerpt from the Gaia Research report that describes each of the sites is reproduced below.

<u>Site 6 Rail Corridor</u>: *RailCorp land halfway between Port Kembla North and Port Kembla Railway Stations contains drainage ditches that contain Typha orientalis* (Broad-leaved Cumbungi) *that are potential foraging and shelter habitat. There is scope to construct additional ponds to provide potential breeding habitat for GGBF.*

<u>Site 7 Rail Corridor</u>*: A concrete drainage line running perpendicular to rail line between Port Kembla North and Port Kembla Railway Stations. There is scope to eradicate weeds and remove concrete edging and replace it with large rocks to provide refuge habitat for frogs. This area was not surveyed but potential habitat exists.*

<u>Site 8 Rail Corridor</u>*: Northern side of rail lines between Port Kembla North and Port Kembla Railway Stations. There is an opportunity to place a small earthen wall across the most eastern arm of the reed beds to create a shallow pond. There is a pipe that discharges water into this area that would fill the pond. No GGBF observed at this location however potential habitat exists.*

<u>Site 15 Brick and Block</u>*: This site is the prime breeding site for the Port Kembla sub-population. There are three fenced ponds, which are managed and the population is monitored regularly.*

<u>Site 17, Rail Corridor:</u> *GGBF have been observed to move from Site 15 to Site 17 at the end of the breeding season. Currently the area does not contain habitat. Construction of additional breeding habitat or a vegetated movement corridor is a high priority in this area.*

<u>Site 18 Orica Land:</u> *This site is significant because it is a few hundred metres from Site 15 and a GGBF has been recorded here. The site is currently not used. Construction of habitat ponds is a high priority in this area.*

Figure 17-2: Location of Known or Potential GGBF Habitat Sites in Close Proximity to the Proposed Outer Harbour Development

A number of initiatives have been undertaken in the Outer Harbour area to rehabilitate GGBF breeding habitat. A number of businesses surrounding the development footprint, such as BlueScope Steel and PKPC, have committed to constructing breeding ponds to enhance and connect existing habitat. A number of these ponds have been constructed and form part of a habitat network in the Port Kembla area.

PKPC recently constructed a breeding pond at the Heritage Park site, near to and to the east of Site 18. The plastic-lined pond is 600 mm deep and has been vegetated with native terrestrial and aquatic plants. Boulder piles have been placed adjacent to the pond to provide shelter / over-wintering habitat. Further creation of GGBF breeding habitat is proposed in this location and would increase dispersal avenues between foraging habitat areas.

A framework of a management plan for the protection of the GGBF and its habitat on the subject site has been prepared and is presented as part of supporting information to this section that is presented in **Appendix H**. The GGBF Management Plan framework is for guidance only and would form the basis for a final *Green and Golden Frog Management Plan* that would be prepared by the proponent in consultation with a suitably qualified ecologist prior to works commencing on the site. The GGBF framework has been prepared with consideration of recommendations made by DECCW following the EA adequacy review (draft letter dated 26 November 2009).

The *Green and Golden Frog Management Plan* outline contains 23 actions in four time frames (prior to construction, during construction, after construction and ongoing).

These actions address the following issues:

- Habitat protection, enhancement, creation and maintenance.
- Predator deterrence and control.
- Frog population monitoring.
- Environmental monitoring.
- Workplace education.
- Liaison and cooperation with local and regional land holders and managers.

Where action items are not the sole responsibility of PKPC (e.g. during operation), the appropriate stakeholder(s) for implementing the actions would be identified during preparation of the final *Green and Golden Frog Management Plan.*

Seabird and Shorebird Habitat

The shoreline habitats (including the rocky coast, the eastern breakwater and Red Beach at the mouth of Salty Creek represent potential habitat for ten species of seabirds and shorebirds (all listed as vulnerable) and the endangered Little Tern (*Sterna albifrons*).

Port Kembla was used regularly by Little Terns during the 1950's, however nesting sites were destroyed in the early 1960's during the development of Port Kembla Inner Harbour complex (NPWS, 2003). Red Beach and the Outer Harbour are now considered unsuitable habitat as a result of exotic vegetation encroachment and industrial use. There have been no subsequent nesting records since 1977 (NPWS, 2003). Sightings of the Little Tern may increase in summer months however these may be due to the presence of numerous migrants from populations that breed in eastern Asia (NPWS, 1999).

Red Beach and the small amount of associated sand dune vegetation broadly fits the habitat type used for nesting by the Little Tern and other seabird and shorebird species. However, these areas were highly modified during the original development of the foreshore in this location and do not resemble natural habitat.

The available habitat for sea-birds and shorebirds is marginal with a narrow band of *Spinifex sericeus* occurring along the foredunes however the remaining dune area is dominated by Bitou Bush and introduced grasses. These areas may harbour predators such as foxes and rats and is unlikely to be used as nesting grounds by the Little Tern.

17.4 Impact Assessment

17.4.1 Concept Plan

Construction

a) Vegetation Communities

There are no threatened ecological communities as listed under the EPBC Act occurring in the Port Kembla Outer Harbour area.

Salty Creek would be redirected through the multi-purpose terminal during Stage 1 of the Concept Plan and would remain an open channel through the reclamation area. The open channel would be enclosed under hardstand to allow operational movement across the multi-purpose terminal during Stage 2 of the Concept Plan.

A small patch of vegetation containing species characteristic of Coastal Saltmarsh (listed under the TSC Act) would be removed during Stage 1 of Concept Plan. It is unlikely that additional vegetation communities or habitat would be removed or modified during Stages 2 and 3.

b) Threatened Flora

An assessment of the likelihood of occurrence of each species based on previous records and habitat attributes present concluded that no flora species listed as threatened under the EPBC Act or TSC Act are likely to occur within the Outer Harbour development area (refer **Appendix H**).

Vegetation removal would be required surrounding Salty Creek and Darcy Road Drain during Stage 1 of the Concept Plan.

As part of Stage 2 of the Concept Plan, there is potential to construct an access road approximately 300 m in length that would provide a direct public link from Darcy Road to the boat harbour. The road would be constructed within a disused railway corridor. Construction of the road would require some vegetation removal. However, given the disturbed nature of the area, and the limited species diversity, it is considered unlikely that suitable habitat for threatened flora species occurs in this area. A detailed survey of this area would be undertaken as part of a separate project application made for Stage 2.

c) Threatened Fauna and Habitat

Searches revealed that a number of threatened fauna species were recorded within a 10 km radius of the study area. The likelihood of occurrence of these species based on their habitat preferences, previous records, and the vegetation condition observed during field investigations is provided in **Appendix H**.

Given that the majority of vegetation to be removed consists of shrub species, the area to be affected is unlikely to be used as roosting or foraging habitat by threatened fauna species such as Pteropus poliocephalus (Grey-headed Flying-fox).

d) Seabird and Shorebird Habitat

Reclamation of Red Beach would occur during Stage 1 of the Concept Plan. It is considered unlikely that any threatened species of seabirds or shorebirds would nest around the margins of the Outer Harbour or be dependent on these areas as regular roosting or feeding areas.

There is not likely to be any further impact on shorebird habitats as a result of Stages 2 and 3 of the Concept Plan.

e) Green and Golden Bell Frog

One threatened species, the GGBF, is known to occur in the Port Kembla area and to breed in areas near the proposed areas to be affected by the Concept Plan.

The potential construction of an access road during Stage 2 of the Concept Plan from Darcy Road to the boat harbour would occur within a disused railway corridor. This corridor is significant because it is a few hundred metres from Site 15 (GGBF prime breeding site) and is known habitat for the GGBF as demonstrated through a series of documented sightings in 2007 and 2008 (Site 18). The area likely to be disturbed as result of construction activities for the road link is unlikely to remove any significant breeding habitat of the GGBF. Where feasible, revegetation (e.g. tussock forming vegetation) along the new road alignment at this location would improve links to the GGBF population at Site 15 by providing suitable refuge and foraging habitat.

The GGBF is known to travel considerable distances and is capable of significant migratory movements (Pyke and White, 2001). Potential impacts on GGBF may include collisions from vehicles during construction activities associated with the extension of a new road and rail links to connect with the new container terminals during Stage 2 of the Concept Plan. These locations are in close proximity to known foraging habitat such as the old rail corridor at the southern end of the eastern breakwater and the rail corridor close to Sites 15 and 17. Mitigation measures such as the installation of frog exclusion fencing surrounding construction areas and education promoting awareness of the GGBF would minimise potential threats to this species during the construction period.

Reclamation activities that would impact on Salty Creek and Darcy Road Drain would occur during Stage 1 of the proposed Concept Plan. Salty Creek and Darcy Road Drain do not contain emergent aquatic vegetation, and the vegetation aligning the edges is highly modified due to previous land-use disturbances. Decking would enclose this outlet during Stage 3 to allow operational access across the container terminals. There would be no further modifications to habitat surrounding Salty Creek and Darcy Road Drain.

As part of the Concept Plan, land reclamation would be completed and pavements would be constructed between the landward extent of reclamation and the western and southern boundary of development. It is unlikely that the proposed activities at these locations would significantly impede the recovery of the GGBF species given that this area is unlikely to provide habitat for the species.

Operation

Nocturnal birds (such as Owls) and mammals (such as bats) may be affected by the increase in night-time lighting. Nocturnal species are adapted to low light conditions to forage for food and could therefore be deterred from foraging areas as a result of excessive light spill. Fauna species are also likely to be disturbed by artificial light as they are at an increased risk from predators. Where possible and deemed reasonable, lighting for terminals and other operational areas, including the new road link, would be carefully selected to minimise light spill on surrounding areas and to minimise any potential impacts to opportunistic fauna species that may be present within the proposed development area.

Noise and vibration impacts have the potential to dissuade fauna species from roosting or foraging habitat. However, given the highly industrialised nature of the surrounding area, disturbance sensitive species are unlikely to persist in these areas. This impact is not likely to affect threatened fauna species that may potentially occur within the Outer Harbour development area.

Operational activities along roadways may potentially lead to an increased risk of fauna (such as GGBF) being killed or injured by traffic. The implementation of the mitigation measures proposed, such as frog exclusion fencing and education campaigns would minimise potential threats to this fauna species.

Increased stormwater flows from the larger area of impervious road surface and pollutants from vehicles may affect waterways and associated ecosystems. Stormwater runoff is already impacted by industrial activities undertaken in the catchment area. With the implementation of appropriate stormwater control measures, the likelihood of waterways and associated aquatic ecosystems being affected by the proposal is considered to be low.

Overall, it is unlikely that any adverse impacts to flora and fauna would occur during operation of the Outer Harbour development, particularly if suitable mitigation measures are adopted.

17.4.2 Major Project

Construction

a) Vegetation Communities

During reclamation of the multi-purpose terminals Salty Creek would be redirected through the reclamation area to the waters of the Outer Harbour. Salty Creek channel would be left open however works associated with reclamation would intersect the small patch of vegetation containing Coastal Saltmarsh species north of Old Port Road. Direct impacts on this small area of Coastal Saltmarsh species would include removal of a few square metres of this vegetation type and modifications to the habitat of the remaining areas during the associated construction works.

The limited in-channel bench width, vertical banks and surrounding industrial land-use, limits possible landward migration of the Saltmarsh. The medium to long-term viability of this community within this particular location is thus severely limited.

This small area of Saltmarsh has low species diversity, is weed infested, fragmented and isolated from other areas of Saltmarsh such as Tom Thumb Lagoon in the Inner Harbour. Therefore, impacts associated with the reclamation of this area are not significant due to the limited conservation value of the Coastal Saltmarsh occurrence within the area. A more detailed assessment of impacts to Coastal Saltmarsh is provided with the supplementary information to this section that is presented in **Appendix H**.

b) Threatened Flora

An assessment of the likelihood that each species or potential habitat for the species occurs within the area to be developed concluded that no flora species listed as threatened under the EPBC Act 1999 or TSC Act 1995 are likely to occur within the area of the Major Project (refer to **Appendix H**).

Flora species identified from database searches, and the likelihood of their occurrence (based on previous records and habitat attributes), are summarised in **Appendix H.** In summary, none of the threatened flora species listed in the database search are likely to occur within the area. This area is largely comprised of waters of the Outer Harbour which would become reclaimed land and some highly modified land side areas of Red Beach that have been planted with a limited number of native plant species.

c) Threatened Fauna and Habitat

Given that the majority of vegetation to be removed consists of shrub species, the area to be affected by the Major Project is unlikely to be used as roosting or foraging habitat by threatened fauna species such as *Pteropus poliocephalus* (Grey-headed Flying-fox).

Vegetation removal around Salty Creek and Darcy Road Drain and Red Beach may provide some value as fauna habitat however they do not contain important habitat features such as tree hollows or large mature heavily-flowering trees and have low structural diversity. These areas are considered to provide marginal habitat for the threatened fauna species.

d) Seabird and Shorebird Habitat

Land reclamation for the multi-purpose terminals would result in the reclamation of Red Beach during Stage 1.

The eastern breakwater of the harbour and nearby rocky headland at Heritage Park, which are close to but outside the area that would be directly affected by the Stage 1 development, also have some potential feeding and roosting habitat for seabird and shorebird species.

The areas of potential habitat are considered to be marginal due to the following:

- Their small extent.
- Likely impacts of feral predators such as the Black Rat (*Rattus rattus*) and European Red Fox (*Vulpes vulpes*).
- Disturbance from adjacent industrial land uses.
- Isolation from larger more natural areas of potential habitat.
- Their relatively simple structure when compared to natural habitats.
- Dominance of Bitou Bush and introduced grasses in the dune vegetation.

The seabird and shorebird species likely to occur are highly mobile and are unlikely to be significantly affected during the construction work. They do not rely on the affected areas for their survival within the locality. Therefore, no mitigation measures are considered necessary to protect the marginal potential habitat present for seabird and shorebird species.

e) Green and Golden Bell Frog

Construction activities have the potential to lead to a range of impacts such as destruction of foraging habitat, pollution of waterways and increased mortality due to collision with construction machinery and vehicles. Construction activities associated with Stage 1 which have the potential to impact on GGBF habitat are described below.

A small portion of potential foraging habitat may be disturbed amongst the foreshore area adjacent to Old Port Road. This area consists largely of exotic grasses and Bitou Bush. This area is not a suitable movement corridor or preferred foraging and shelter habitat for the GGBF due to disruptions in the landscape from hard stand areas and roads. There has been no recorded sighting of GGBF in or near this area.

The use of herbicides to control Bitou Bush along the foreshore also means it is likely to be unsuitable for GGBF. Dispersal avenues from the foreshore to other areas of potential foraging habitat are interrupted by roads, rail lines and large industrial sites consisting of paved areas.

Drainage lines along railway lines within the vicinity of the Outer Harbour have the potential to function as refuge and/or dispersal areas for GGBF (Gaia Research, 2008). The proposed Major Project works would involve reclamation of land up to the mouth of Salty Creek. The vegetation along Salty Creek is dominated by exotic vegetation such as Lantana, Bitou Bush and exotic grasses such as Kikuyu and Couch. Native sedges occur and native shrubs of *Acacia longifolia var. sophorae* align the edges.

Reclamation of land up to the mouth of Darcy Road Drain outlet would also occur during Stage 1. The vegetation of Darcy Road Drain is dominated by Acacia trees with an understorey consisting of exotic grasses such as Couch and Kikuyu. Darcy Road Drain and the Salty Creek channel would be extended through the reclamation area. These drainage channels are unlikely to contain potential foraging habitat for the GGBF due to the tidal influence and saline environment. Furthermore, they are separated from other potential habitat areas by cleared areas of Foreshore Road and the railway line.

Extension of Darcy Road Drain and Salty Creek as a result of the reclamation may affect potential habitat downstream through potential impacts on water quality as a result of silt-laden water reaching the adjacent drainage channel. This potential impact would not have a significant adverse impact on any GGBF population that may be present in these locations. Surface water management measures are proposed during construction to prevent any substantial alteration to current surface water quality.

The proposed rail infrastructure upgrade of the South Yard during Stage 1 would require the removal of potential foraging habitat surrounding an artificial concrete-lined drain to allow for the extension of a rail siding (No. 13) by approximately 120 m in length. The vast majority of the area that would be occupied by this siding is currently covered by gravel with minimal vegetation. A few metres at the eastern end of the siding only would affect potential GGBF habitat. The vegetation within this area consists of scattered native shrubs of *Acacia longifolia var. sophorae* with a weedy understorey. Exotic understorey species include Blackberry, Crofton Weed and grasses such as Kikuyu. *Typha* spp. and *Phragmites* sp. occur where the drainage line enters the area.

A new access road from Christy Drive to the multi-purpose terminals, a temporary construction access road from Foreshore Road to the container terminals and erection of site compound areas 100 m south east of Salty Creek would also occur as part of Stage 1 works. These areas are unlikely to be preferred habitat for the GGBF as they are isolated from other habitat areas and do not provide adequate dispersal avenues.

f) Operation

Nocturnal species are adapted to low light conditions to forage for food and could therefore be deterred from foraging areas as a result of excessive light spill. Fauna species are also likely to be disturbed by artificial light as they are at an increased risk from predators. Lighting for the central portion of the multi-purpose terminals and other operational areas, including the new road link, would, if deemed appropriate, be carefully selected to minimise light spill on surrounding areas and to minimise any potential impacts to opportunistic fauna species that may be present within the proposed development area.

Noise and vibration impacts have the potential to dissuade fauna species from roosting or foraging habitat however given the highly industrialised nature of the surrounding area, disturbance sensitive species are unlikely to persist in these areas. This impact is not likely to affect threatened fauna species that may potentially occur within the Outer Harbour development area.

Increased stormwater flows from the impervious road surface areas and terminal and pollutants from vehicles may affect waterways. However, with the implementation of appropriate stormwater control measures, the likelihood of waterways and associated aquatic ecosystems being affected by the proposal is considered to be low.

Therefore it is unlikely that any adverse impacts to flora and fauna would occur during operation of Stage 1 of the Outer Harbour development, particularly if suitable mitigation measures are adopted.

17.5 Mitigation Measures

17.5.1 Concept Plan

The potential impacts on the GGBF at each stage of construction for the Concept Plan should be managed in accordance with a Green and Golden Frog Management Plan (GGBFMP). The GGBFMP would include the following:

- Program of works and timeline for all key components of the project.
- Undertake a conservation assessment ranking for any known or likely GGBF habitats in the study area, including but not limited to, identification and assessment of breeding, shelter, foraging, and movement habitat components.
- Identify any actual or potential threats from construction and operations.
- Identify appropriate actions to prevent or minimise actual or potential threats.
- Include details of how the proponent will monitor and report on the ongoing effectiveness of the GGBFMP.
- A program of works and timeline for planting and landscaping in appropriate areas with vegetation suitable for GGBF foraging and shelter as well as installing structures (such as logs and concrete pieces) to facilitate movement and over wintering habitat.
- A feasibility assessment of retaining and/or enhancing shelter, foraging and movement habitat or potential breeding habitat along the proposed road corridor off Darcy Road.

The need for the creation of additional breeding ponds to offset any potential impacts to potential foraging habitat for populations of GGBF (Site 18) would be assessed during Stages 2 and 3 of the Concept Plan.

The GGBFMP should be reviewed and updated as necessary in Stages 2 and 3 of the Concept Plan.

Ecological impacts of the Concept Plan will be reviewed as part of project applications for Stages 2 and 3 including impacts on threatened species, populations and ecological communities, and riparian and stream ecology (Salty Creek).

17.5.2 Major Project

Mitigation measures (outlined above for the Concept Plan) would also be relevant for Stage 1 and should be considered in parallel with the measures proposed below.

Potential impacts on the GGBF during construction of the Major Project (Stage 1) would be managed in accordance with a GGBFMP as detailed below:

- The GGBFMP to be prepared would be informed by an outline GGBFMP presented in **Appendix H** and be consistent with the following Management Plans:
  - Draft Recovery Plan: Green and Golden Bell Frog (Lesson 1829) Recovery Plan (DECCW, 2005)
  - Best Practice Guidelines: Green and Golden Bell Frog Habitat (DECCW, 2008)
- The GGBFMP would be consistent with actions presented in The Green and Golden Bell Frog Key Population at Port Kembla Management Plan (DECCW, 2007) and the Assessment of Habitat, Dispersal Corridors and Management Actions to Conserve the Port Kembla Key Population of Green and Golden Bell Frog 2007-2008 (Gaia Research, 2008).

Prior to any works which involve the clearing of vegetation and debris within the Major Project (Stage 1) area, a suitable and targeted survey would be undertaken by an ecologist in order to allow for the detection of any GGBF. If GGBF are detected, no clearing works would commence until the GGBF response provisions have been implemented.

The following mitigation measures aim to minimise the spread of deadly pathogens and disease to the GGBF:

- Frog exclusion fencing would be installed around construction sites in close proximity to known or potential GGBF breeding or foraging habitats to minimise the likelihood of GGBF entering construction sites during reclamation activities associated with Stage 1
- The construction works site and any open trenches within the development area should be checked each morning during construction for the presence of any frogs which should be released into nearby ground cover. Handling the species should be minimised. Frog Hygiene Protocol (NPWS, 2001) should be followed to avoid the spread of chytrid spores or other pathogens between aquatic habitats and frog sites.
- The importation of water should avoid known areas of breeding or foraging habitat in close proximity to construction activities (such as Site 18).
- The use of imported mulch or compost should be avoided in any rehabilitation works in the vicinity of known breeding areas and associated dispersal avenues.

The potential impacts on threatened flora, fauna and ecological communities for all stages of the Concept Plan would be mitigated as follows:

- All potential chemical pollutants (e.g. fuels, oils, lubricants, paints, etc.) would be stored in appropriate containers within bunded areas within construction compounds to minimise the risk of pollution of aquatic environments.
- Weed management as required in areas affected by construction throughout the extent and duration of the project.
- Construction compound lighting would be directed towards the ground so that the angle between the beam and the vertical is kept as small as possible. Glare would be kept to a minimum by keeping the main beam angle less than 70^{o} wherever practicable.

17.6 Conclusion

The patch of Coastal Saltmarsh community that would be affected in Salty Creek north of Old Port Road is of relatively low quality and conservation significance due to its small size, weed invasion and low species diversity. The small size, linear shape and low species diversity of this patch would limit its potential habitat value for fauna such as wading birds.

The area of potential terrestrial habitat for seabirds and shorebirds is of poor quality and small in comparison to the size and quality of shorebird habitat further north, south and east. The Little Tern is almost exclusively coastal and prefers sheltered environments which are not provided at the Outer Harbour. Suitable breeding habitat no longer exists due to feral predators and land use disturbances. No seabird or shorebird species are likely to be significantly affected by the proposed development.

The area of potential foraging habitat likely to be modified by the proposed works is unlikely to be preferred habitat for the GGBF, as the lack of existing shelter and foraging habitat do not provide suitable movement corridors to other potential habitat areas. Mitigation of potential impacts on the GGBF would be proposed in a dedicated GGBF Management Plan.

The proposed Outer Harbour development is unlikely to have a significant impact on other flora and fauna species, populations or ecological communities listed under the TSC Act or EPBC Act.