Stormwater & Flooding Environmental Assessment

SIMTA SYDNEY INTERMODAL TERMINAL ALLIANCE

Part 3A Concept Plan Application

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SIMTA

SIMTA MOOREBANK INTERMODAL TERMINAL FACILITY

STORMWATER AND FLOODING ENVIRONMENTAL ASSESSMENT

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Executive Summary

The purpose of this report is to assess the potential impact of stormwater and floodwater on erosion and sediment mobilisation for the construction and operation phases of the Sydney Intermodal Terminal Alliance (SIMTA) proposal. This report has been prepared to inform the Concept Plan for the SIMTA proposal, which will be assessed under Part 3A of the *Environmental Planning and Assessment Act 1979*.

The assessment included a review of those guidelines that have been identified to apply to the proposed construction and operational activities:

- *Managing Urban Stormwater: Soils and Construction*, Vol. 1, 2A and 2D (DECC).
- *National Water Quality Management Strategy Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC Guidelines).
- *Fish Passage Requirements for Waterway Crossings and Guidelines for Fish Friendly Waterway Crossings* (DPI) under the *Water Management Act 2000* (WM Act).
- Liverpool Development Control Plan 2008.

The guidelines identify the soil and water management principles that should be applied during construction and operation phases of the SIMTA proposal in relation to characterisation and management of site soils and maintenance of water quantity and quality for receiving watercourses. The guidelines are equally relevant in the consideration of fish habitat management for the two identified receiving watercourses, Anzac Creek and the Georges River, which are located in close proximity to the SIMTA site within the rail corridor.

The assessment of potential impacts during the construction phase, and the controls available to reduce any such impacts, concluded that the implementation of appropriate management controls during the construction phase would minimise exposure of site soils, control surface water flows on site, and would enable “dirty” water to be retained and treated within the construction area. Progressive development of the SIMTA site, along with passive retention and treatment systems, would facilitate the maintenance of quality and quantity of surface water discharges from the site to adjacent vegetation and the Anzac Creek and Georges River watercourses.

An assessment of engineering design for water management on the SIMTA site during operational stages determined that water quality and quantity of discharge flows from the site would be maintained. The adoption of the identified design water structures for stormwater control and flood detention would match or improve pre-development flow rates for a range of storm occurrence intervals and durations. This would provide a nil nett effect on downstream flooding and associated stormwater issues such as scour and sedimentation of watercourses (Anzac Creek and the Georges River) and their channel and bank structures. A similar process for design of water structures for stormwater control and flood detention would be developed pending confirmation of design criteria for the proposed rail link.

Recommendations for management controls have been provided on the basis of site assessment and application of the relevant guidelines. Key recommendations include:

- Preparation of a Soil and Water Management Plan (SWMP) and Erosion and Sediment Control Plan (ESCP) for both the construction and operation phases.
- Implementation of management plan strategies prior to commencement of the staged construction phase.
- Monitoring and review performance of sediment and water control structures during construction and operation phases.

With respect to fish passage and fish habitat, all design associated with flood and stormwater management and mitigation of pollution and waterway crossings will be in accordance with the

requirements specified in Witheridge (2003) and Part 7 (Division 3) of the *Fisheries Management Act 1994* (FM Act).

1 INTRODUCTION

1.1 Background

The Sydney Intermodal Terminal Alliance (SIMTA) is a joint venture between Stockland, Qube Logistics and QR National. The SIMTA Moorebank Intermodal Terminal Facility (SIMTA proposal) is proposed to be located on the land parcel currently occupied by the Defence National Storage and Distribution Centre (DNSDC) on Moorebank Avenue, Moorebank, south-west of Sydney. SIMTA proposes to develop the DNSDC occupied site into an intermodal terminal facility and warehouse/distribution facility, which will offer container storage and warehousing solutions with direct rail access.

The SIMTA site is located in the Liverpool Local Government Area. It is 27 kilometres west of the Sydney CBD, 17 kilometres south of the Parramatta CBD, 5 kilometres east of the M5/M7 Interchange, 2 kilometres from the main north-south rail line and future Southern Sydney Freight Line, and 0.6 kilometres from the M5 motorway.

The SIMTA site, approximately 83 hectares in area, is currently operating as a Defence storage and distribution centre. The SIMTA site is legally identified as Lot 1 in DP1048263 and zoned as General Industrial under Liverpool City Council LEP 2008.

The parcels of land to the south and south-west that would be used for the proposed rail corridor are referred to as ‘the rail corridor’, these link to the existing East Hills Rail Line, and are part of Lot 3001 DP1125930 and Lot 1 DP1125930.. The proposed rail corridor covers approximately 65 hectares and adjoins the Main Southern Railway to the north. Existing land use on the rail corridor site includes vacant land, golf course, extractive industries, and a waste disposal depot.

Land bounding the SIMTA site and rail corridor site includes native vegetation (woodland, forest and wetland communities in varying condition) the Georges River and Anzac Creek (which have their confluence to the north of the proposed rail corridor). Located within the rail corridor site is the Glenfield Waste Disposal site, which comprises several lots that are currently all leased for the purposes of the waste facility.

The project will be undertaken as a staged development and it is intended that an overall Master Plan, for the entire site, be undertaken for the purpose of applying for Concept Plan approval under Part 3A of the *Environmental Planning and Assessment Act 1979*.

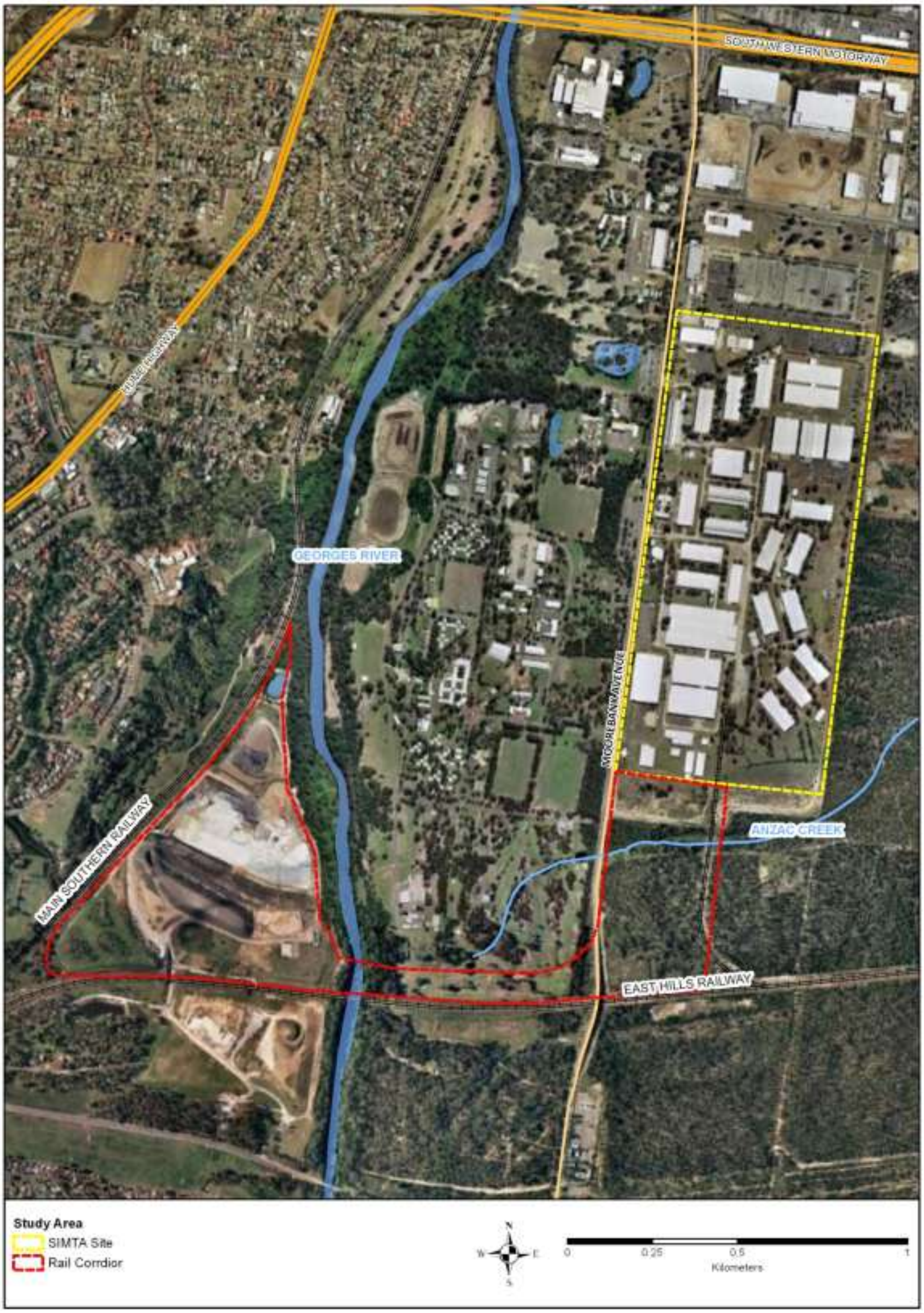

Figure 1: Proposed site for SIMTA Moorebank Intermodal Terminal

1.2 Purpose

This report has been prepared by Hyder Consulting (Hyder) for SIMTA to assess the potential environmental impacts associated with stormwater and flooding as a result of the SIMTA proposal. The intent is that this document will support the environmental assessment for

Concept Plan approval under Part 3A of the *Environmental Planning and Assessment Act 1979*. Mitigation strategies have been presented to minimise environmental impacts that may result from the construction and operational phases of the project.

The report addresses the Director's General's Requirements (DGRs) relating to stormwater and flooding issued on the 24 December 2010 (Table 1):

Table 1: Director's General's Requirements

Director's General's requirements	Section addressed
Surface water and stormwater quality, erosion and sedimentation impacts, on- and off-site.	Section 3
Taking into account: *Managing Urban Stormwater Soils and Construction*, Vol. 1, 2A and 2D (DECC) National Water Quality Management Strategy *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC) *Fish Passage Requirements for Waterway Crossings* and *Guidelines for Fish Friendly Waterway Crossings* (DPI)	Sections 3 and 4

1.3 Scope of this Assessment

This stormwater and flooding environmental assessment considers the management of potential surface water, stormwater, erosion and sedimentation impacts on water quantity, water quality and fish passage and habitat for the construction and operations of the SIMTA proposal. This report has considered the findings and information provided in the following SIMTA Moorebank Intermodal Terminal Facility reports:

- Stormwater and Flooding Study (Hyder Consulting 2011a).
- Flora and Fauna Assessment (Hyder Consulting 2011b).
- Civil Engineering Design (Hyder Consulting 2011c).
- Riparian Report (Hyder Consulting 2011d).
- Climate Risk Assessment (Hyder Consulting 2011e).

1.4 Legislation and Relevant Policies and Guidelines

Relevant local, state and federal legislation that may be triggered by the SIMTA proposal are presented in Table 2

Table 2: Legislative requirements that may be relevant to the SIMTA proposal

Legislation	Details	Agency responsible
Protection of the Environment and Operations Act 1997 (POEO Act)	Section 120 - prohibits water pollution, except in accordance with the provisions of an environment protection licence (EPL) issued under the Act.	NSW Office of Environment and Heritage
Fisheries Management Act 1994 (FM Act)	Part 2 and 7 (Division 3) - any works in a waterway may require approval to dredge and/or reclaim any material from the stream bed or riparian zones.	NSW Department of Primary Industry (Fisheries)
	Section 219 - a permit may be required for works which may result in the temporary or permanent blockage of fish passage within a waterway. Include silt fencing across waterways for sediment and erosion control and bunding and dewatering works during crossings construction.	
	Part 7 (Division 1) - waterway crossing design and construction must be consistent with gazetted Habitat Protection Plans (HPP), in particular, HPP No.1 which outlines the requirements for the management of 'snags' (large woody debris or boulders).	
Fisheries Management (General) Regulation 2002	Part 5 (clauses 112- 115) - permits may be required for any works which may involve the use of explosives, electrical devices or other dangerous substances within waters.	NSW Department of Primary Industry (Fisheries)
Threatened Species Conservation Act 1995	Part 6 of the TSC Act requires a licence to be held to pick or harm threatened species, populations or ecological communities or to damage habitat.	NSW Office of Environment and Heritage
Water Act 1912	Part 5A - a bore licence may be required prior to undertaking any excavations, including temporary dewatering for construction purposes. 'Bore' is any well, or excavation or other work, connected or proposed to be connected with sub-surface water sources to access it either by natural flows or by a pump or other artificial means (s. 105).	NSW Office of Water
Water Management Act 2000	Part 3 (Division 1, s.91) - a controlled activity approval is required to carry out a specified controlled activity at a specified location in, on or under waterfront land.*	NSW Office of Water
Liverpool Development Control Plan (DCP) 2008 Part 2.4 Moorebank Defence Lands	Section 3.8 - details the requirement to incorporate water efficient design principles within project design, including the collection/storage of rainwater within existing water bodies or on-site detention basins for re-use as on-site irrigation.	Liverpool City Council
Liverpool Development Control Plan (DCP) 2008 Part 1.1 General Controls for all Development	Section 6 - outlines requirements for water cycle management. Section 9 - outlines flooding risk for all development within the LGA.	Liverpool City Council

Legislation	Details	Agency responsible
	Section 7 - specifies the requirements for development near creeks and rivers.*	

* managing controlled activities on waterfront land is also covered in the *Riparian Report* (Hyder Consulting 2001d).

The following guidelines will be applied to the SIMTA proposal during the design, construction and operation phases as relevant:

1. Managing Urban Stormwater: Soils and Construction (Landcom 2004):
   - Volume 1: will be used to manage soil and water during the land disturbance phase. The purpose of these guidelines is to help mitigate the impacts of land disturbance activities on soils, landforms and receiving waters by focssing on erosion and sediment control
   - Volume 2A Installation of services: will be applied to manage erosion and sediment control during service installation.
   - Volume 2D Main road construction: will be applied to erosion and sediment control during the construction of works in the rail corridor.
2. Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000): these guidelines have been referenced in assessing in stream water quality objectives for the Georges River and Anzac Creek.
3. National Water Quality Management Strategy Australian Guidelines for Urban Stormwater Management (ARMCANZ/ANZECC 2000): these guidelines have been referenced for identification of stormwater management objectives (including protecting social, environmental and economic values).
4. Policy and Guidelines for Fish Friendly Waterway Crossings (DPI 2004): has been referenced to identify suitable management requirements where fish passage may be affected by structural crossings of Anzac Creek and Georges River.
5. Fish Passage Requirements for Waterway Crossings: the document *“Why do fish need to cross the road? Fish passage requirements for waterway crossings”* (Fairfull and Witheridge 2003) has also been referenced to identify suitable management requirements where fish passage may be affected by structural crossings of Anzac Creek and Georges River.

2 EXISTING ENVIRONMENT

2.1 Stormwater Conditions

The SIMTA site currently has a number of warehouse style facilities connected by internal roads and is interspersed with trees and grassed areas that provide a mix of pervious and impervious surfaces. The site is generally flat. The Moorebank Avenue frontage has a reduced level (RL) ranging from RL 14 to RL 16 metres. The Greenhills Road frontage rises from approximately RL 14 metres at each end to a localised peak of RL 22 metres approximately midway along the length of the SIMTA site (Hyder Consulting 2011a).

There are three existing stormwater discharge outlets from the SIMTA site, as shown in Figure 2.

> Outlet 1 & 2: Discharge eastward into Anzac Creek and cross under Greenhills Road via pipes and headwalls. Currently stormwater from the site flows through the site via constructed open grass lined channels to these discharge points. From Greenhills Road to Anzac Creek, the channels are less defined.
>
> Outlet 3: Discharges westward into the Georges River. Water from the site is collected in a formal concrete lined trapezoidal channel running within the site parallel to Moorebank Avenue. Water flows to a pipe crossing of Moorebank Avenue then into a concrete rectangular channel, which leads to Georges River.

The existing catchments on the site that drain to the above outlets are shown in Figure 3.

The rail corridor covers approximately 65 hectares and adjoins the East Hills Rail Line to the south and the Main Southern Railway to the west. Existing land use includes vacant land, golf course, extractive industries, and a waste disposal depot. A rail link of approximately 30m width would likely be constructed within the rail corridor area.

Sufficient design information to undertake this assessment was available for the SIMTA site only at the time of writing. Detail of this document is predominantly focussed upon the SIMTA site.

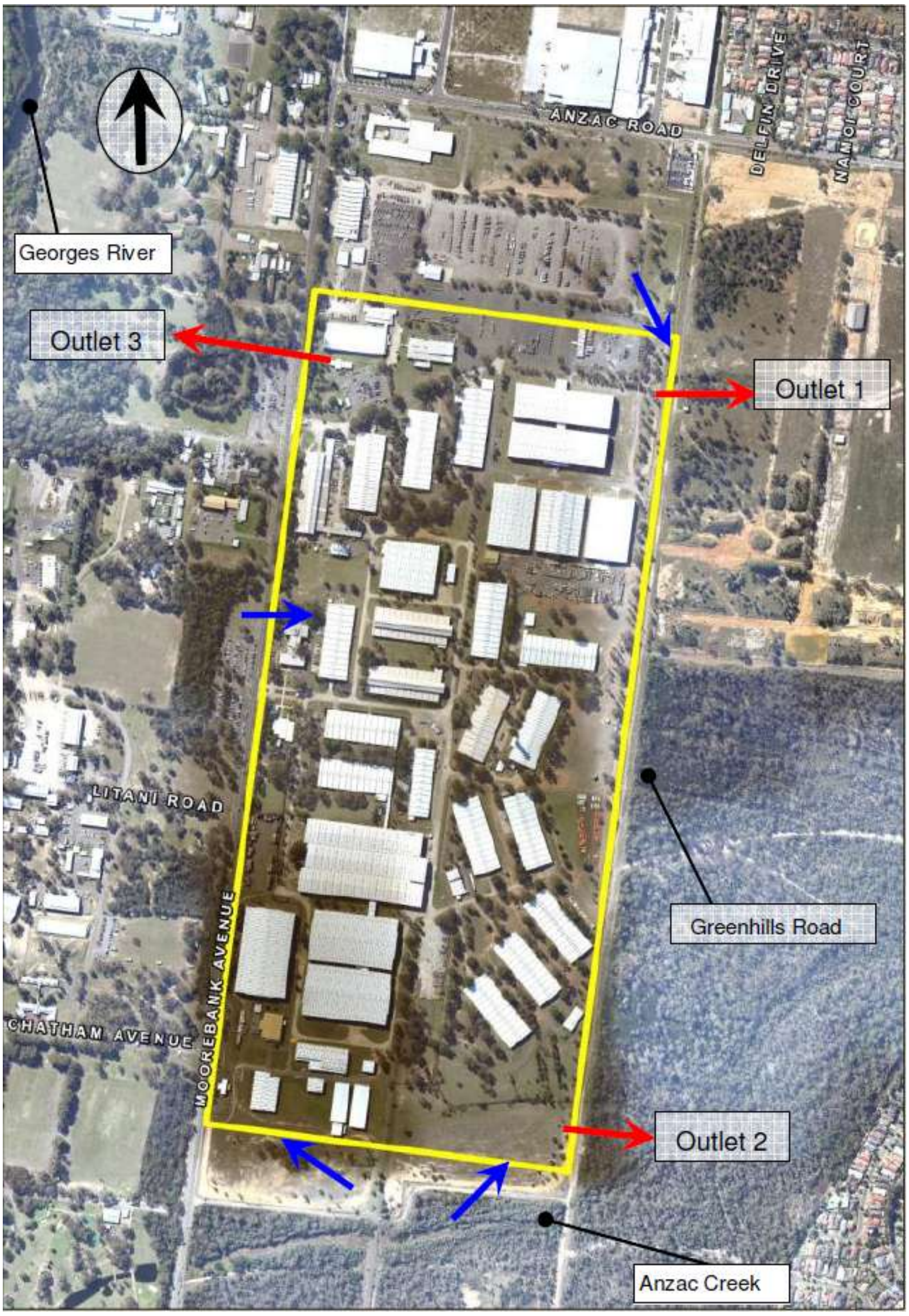

Figure 2: Existing site conditions (indicating external site flow locations)

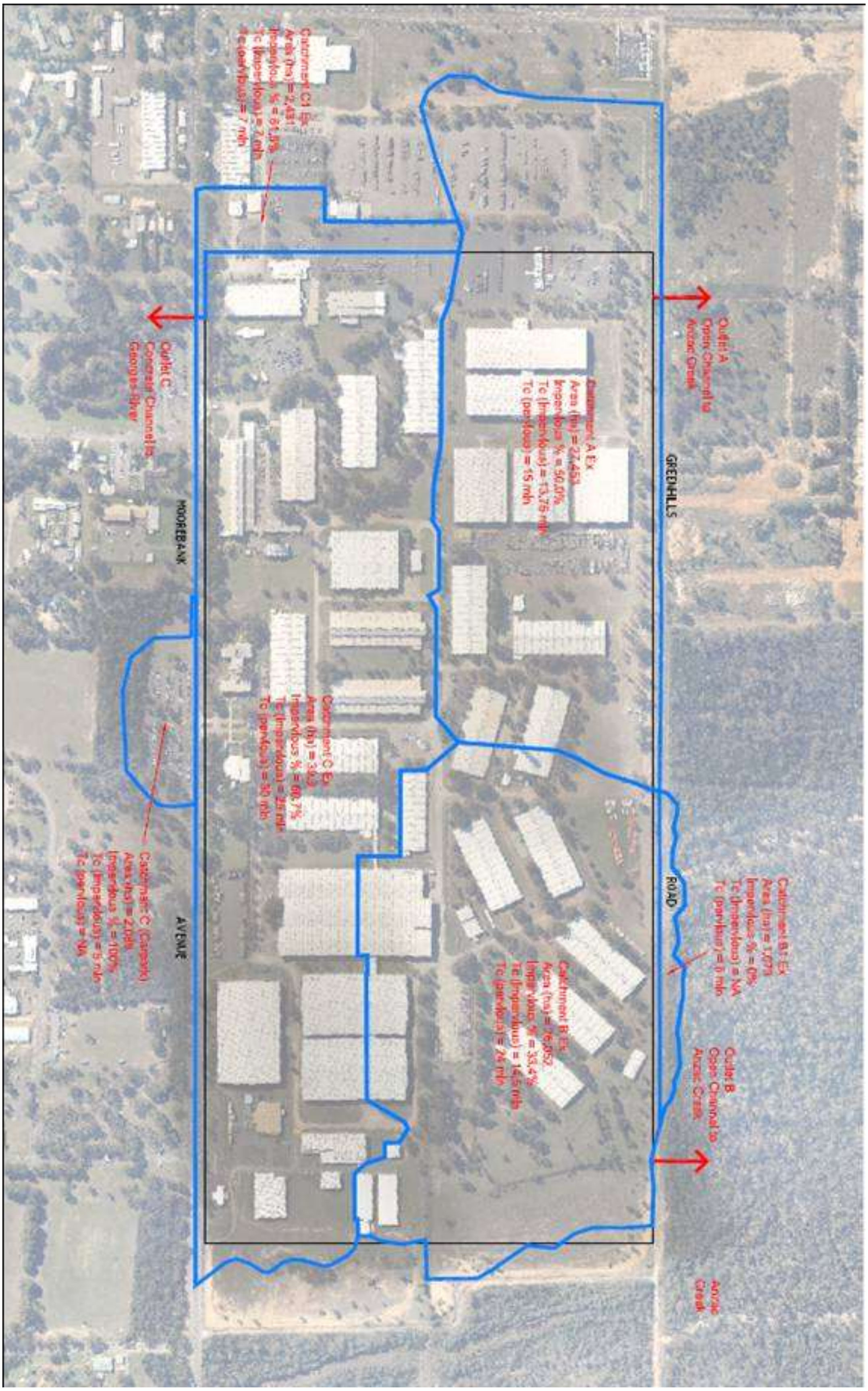

Figure 3: Existing site catchment boundaries including external catchments

2.2 Existing Ecological Conditions

Ecological information for Anzac Creek and the Georges River is based on the aquatic ecosystem assessment in the *Flora and Fauna Assessment* (Hyder Consulting 2011b) and the *Riparian Report* (Hyder Consulting 2011d). Information relating to the condition of bushland adjacent to the site and riparian vegetation is based on that presented within the *Flora and Fauna Assessment* (Hyder Consulting 2011b).

2.2.1 Anzac Creek

The SIMTA proposal is within the catchment of Anzac Creek, a small tributary of the Georges River. At the closest point, Anzac Creek is located some 50 metres to the south-west of the SIMTA site, and runs through the rail corridor. A flood study of the area (BMT WBM 2008) indicated that the Anzac Creek catchment covered an area of 10.6 square kilometres.

Anzac Creek is within the larger Georges River catchment, a sub-catchment of the Liverpool District catchment. Anzac Creek is 4 kilometres long and starts in the Department of Defence lands in Moorebank, flows north past the suburb of Wattle Grove and then underneath the M5 and Heathcote Road intersection. The creek then flows through Ernie Smith Recreation Reserve, flanked by the Moorebank Industrial Area to the west and the suburb of Moorebank to the east. It then flows under Newbridge Road, through McMillan Park and into Lake Moore at Chipping Norton. The Creek is heavily influenced by past development activities within the catchment and riparian zones. Anzac creek is heavily degraded and is generally in poor condition, it is predominantly in a low flow state with sluggish to minimal water movement dependent upon local rainfall see Figure 4 below.

Using the Strahler stream ordering method (Strahler 1957) and the Liverpool 9030-2S 1:25 000 topographic map, Anzac Creek from the headwaters in the Royal Australian Engineers Golf Course to just below Anzac Road is classified as a first order stream which has a defined channel where water flows intermittently.

The assessment undertaken as part of the *SIMTA Moorebank Intermodal Terminal Facility Flora and Fauna Assessment* indicates that Anzac Creek is likely to be classified as Class 3 fish habitat, as described in Table 3. This classification is supported by the results of fish surveys which identified only one species, introduced Gambusia (*Gambusia holbrooki*). Furthermore, the overall AUSRIVAS rating for macroinvertebrates was ‘Band B’ indicating that the macroinvertebrate community was ‘significantly impaired’ (Hyder Consulting 2011b).

At the time of the aquatic and riparian habitat assessment the portion of Anzac Creek in proximity to the site had limited aquatic habitat which included soft substrate pools and extensive macrophyte cover. There was no open or running water present at the site. The creek was obscured by dense growths of *Typha* sp. and *Salvinia molesta*. Water was mostly static and shallow (1 to 30 centimetres deep) with a small pool of approximately 1 metre depth immediately downstream of the culvert tunnels running underneath the disused rail line. Riparian vegetation was dominated by *Melaleuca* sp., *Eucalyptus* spp., and other native shrubs species.

Anzac Creek facing upstream of the railway culvert, displaying extensive growth of *Typha* sp. and *Salvania molesta*,

Table 3: Classification of fish habitat in NSW waterways (Fairfull and Witheridge 2003)

Class	Description
CLASS 1 **Major fish habitat**	Major permanently or intermittently flowing waterway (e.g. river or major creek), habitat of a threatened fish species.
CLASS 2 **Moderate fish habitat**	Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present. Known fish habitat and/or fish observed inhabiting the area.
CLASS 3 **Minimal fish habitat**	Named or unnamed waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or recognised aquatic habitats.
CLASS 4 **Unlikely fish habitat**	Named or unnamed waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free standing water or pools after rain events (e.g. dry gullies or shallow floodplain depressions with no permanent aquatic flora present).

Water quality sampling undertaken as part of the aquatic survey found that the majority of water quality parameters were within ANZECC (2000) guidelines for lowland aquatic ecosystems of south-eastern Australia, with the exception of pH and percentage dissolved oxygen (DO%). The pH recording in Anzac Creek of 5.62 was below the lower guideline value of 6.5. The DO% of Anzac Creek, 11.6%, was considerably below the lower guideline value of 60%. Alkalinity was 70 mg/l $CaCO_3$, however, there is currently no ANZECC guideline value for this parameter (Hyder Consulting 2011b).

Existing flooding

A floodplain risk management study and plan commissioned by Liverpool City Council for Anzac Creek (BTM WBM 2008) identified that upstream of the M5 Motorway flooding is generally confined to the main channel of Anzac Creek. Effective conveyance of flood discharges in the main channel for events up to the 100-year ARI in size results in very little floodplain inundation and no inundation of residential properties within the Wattle Grove development (located adjacent to Anzac Creek). The existing culverts through the M5 Motorway embankment adequately convey flood waters to the downstream reaches of the catchment without significant retention and/or backwater accumulation.

Downstream of the M5 Motorway there is extensive floodplain inundation for events in excess of the 5-year ARI, with flooding highly influenced by conditions in the Georges River. The backwater influence of Georges River flooding extends as far upstream as the M5 Motorway which can result in extensive, albeit low velocity, inundation.

2.2.2 Georges River

The Georges River lies some 750 metres to the west of the SIMTA site, and at the proposed rail corridor is located within the Mid-Georges River catchment and the Liverpool District sub-catchment. It enters the Liverpool LGA from the south on the western side of the Defence Lands at Holsworthy and flows north, meeting with Glenfield Creek at Casula. From here the Georges River continues to flow north past the Liverpool City Centre, under Newbridge Road, past Lighthorse Park and over the Liverpool Weir. Downstream of the Liverpool Weir, the Georges River becomes slightly salty (estuarine) and is subject to tidal influences.

The NSW Department of Primary Industries (2006) classified the Georges River as Class 1 fish habitat (a major permanently flowing waterway). The aquatic survey conducted in the likely area of the proposed rail line crossing identified two species of fish, including one specimen of the native Flathead Gudgeon (*Philypnodon grandiceps*) and the introduced Gambusia (*Gambusia holbrooki*) (Hyder Consulting 2011b). The AUSRIVAS macroinvertebrates results for the Georges River rated the sampling site as 'B and C', suggesting that it is 'severely impaired' with fewer macroinvertebrate families observed than expected (Hyder Consulting 2011b).

At the survey site, within the identified rail corridor, the Georges River was 40 to 60 metres wide, and the bank dropped rapidly to a depth of 1.2 metres before falling away at a steadier grade. Aquatic habitats present included soft substrate pool habitat, large woody debris and extensive macrophyte cover. Riparian vegetation was dominated by a dense growth of Lantana, with occasional tall *Eucalyptus* spp. Access was only possible to the eastern side of the river because the western bank was almost vertical. Overhanging vegetation, fallen logs, mats of sticks, submerged (*Elodea canadiensis*) and floating aquatic plants (*Azola* sp., *Salvinia molesta*) were present throughout the study reach along the bank.

The water quality sampling undertaken as part of the aquatic survey found that the majority of water quality parameters were within ANCECC (2000) guidelines for lowland aquatic ecosystems of south-eastern Australia, with the exception of pH and DO%. In the Georges River the pH 6.06 was below the lower guideline value of 6.5. DO% was also below the lower guideline value of 60% (Hyder Consulting 2011b).

2.2.3 Bushland and Riparian Vegetation

NSW National Parks and Wildlife Service mapping – Native vegetation of the Cumberland Plain 1:25 000 map series (NSW NPWS 2002) identifies *Cooks River/Castlereagh Iron bark Forest* as occurring on the SIMTA site with a minor presence of *Shale Gravel Transition Forest* (Figure 4). This vegetation type is listed as Endangered Ecological Communities (EEC) under Schedule 1 of the NSW *Threatened Species Conservation Act 1995* (TSC Act).

The condition class is reported to vary between poor and moderate to good with the majority being poor (poor is less than 10 percent and moderate to good greater than 10 percent). The ecological field investigation verified the presence of a number of canopy species indicative of *Cooks River/Castlereagh Iron bark Forest* and *Shale Gravel Transition Forest,* as well as a number of non-conforming canopy species including: Spotted Gum *(Corymbia maculata);* Narrow Leaved Ironbark *(Eucalyptus crebra);* and Kurrajong *(Brachychiton populneus)* (Hyder Consulting 2011b). These signature species are indicative of *Moist Shale Woodland in the Sydney Basin Bioregion* which is listed as an EEC under Schedule 1 of the Threatened Species Conservation Act (1995)

The bushland to the east and south of the SIMTA site, and within the rail corridor, is mapped as *Castlereagh Scribbly Gum Woodland* and *Castlereagh Swamp Woodland* (NSW NPWS 2002) with a condition class as moderate to good. *Castlereagh Swamp Woodland* is characterised by dense stands of Paperbark trees (*Melaluca decora)* along with other canopy trees, such as Drooping Red Gum (*E. parramattensis* ssp *parramattensis)* (DECC 2005). Field investigation verified the presence of *M. decora* and *E. parramattensis ssp parramattensis* and confirmed the condition rating as moderate to good (Hyder Consulting 2011b). *Castlereagh Swamp Woodland* is listed as an EEC under the TSC Act. Although *Castlereagh Scribbly Gum Woodland* is not listed as endangered, it may intergrade with adjacent *Castlereagh Swamp Woodland*, and intergrade areas should be considered part of the *Castlereagh Swamp Woodland community* (NSW Scientific Community 2000). A Preliminary Determination has been made to support the listing of *Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion*, as a Vulnerable Ecological Community in Part 2 of Schedule 2 of the TSC Act.

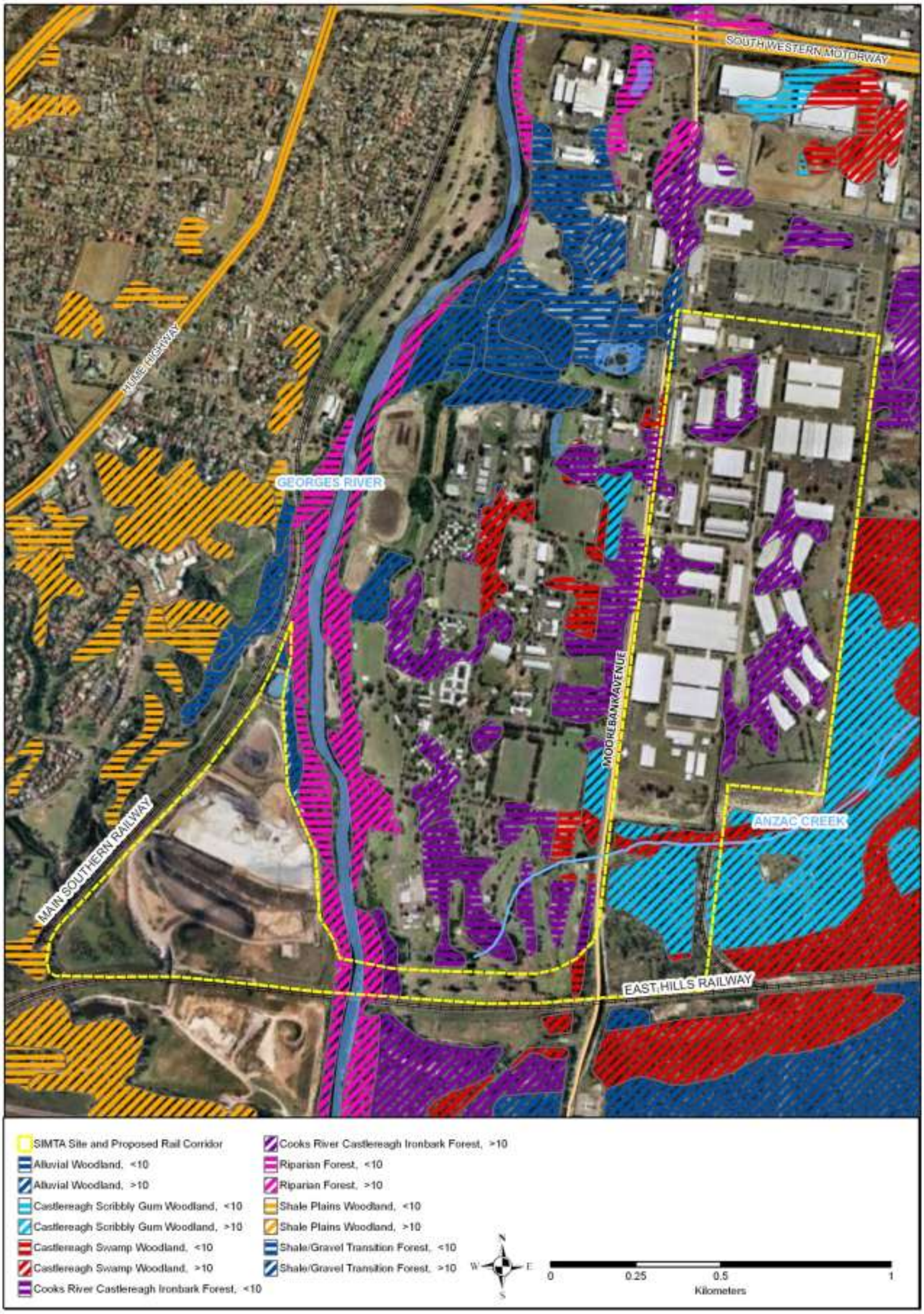

Figure 4: Vegetation Communities (Source: NSW National Parks and Wildlife Service 2002)

2.3 Geology and Soils

The geology of the Penrith 1:100 000 sheet (Clark and Jones, 1991 mapped the study area east of the Georges River as Tertiary alluvium (map unit Ta), described as clayey quartzose sand and clay. The study area to the west of the Georges River was mapped as mainly Quaternary deposits of medium-grained sand, clay and silt (map unit Qpn), with some Tertiary alluvium in the centre.

The soil landscapes of the Penrith 1:100 000 sheet (Bannerman and Hazelton 1990) mapped five different soil landscapes within the study area: the fluvial soil landscapes Berkshire Park, Richmond and Freemans Reach, the erosional soil landscape Luddenham and the residual soil landscape Blacktown. The features and location in the study area of the mapped soil landscapes are detailed in Appendix A (Table A1).

The SIMTA site has been subject to substantial development over time, and considerable changes have been made to the natural landscape. Consequently the SIMTA site is a mixture of residual soils and filled materials, with undisturbed areas retaining some residual topsoil. The residual soil material generally consists of stiff to very stiff clayey soils grading rock. Areas of dense silty and clayey sands to depths of approximately 3 metres, possibly associated with an old stream bed, were also encountered through the central area (Hyder Consulting 2011c).

Rock across the SIMTA site appears to be a siltstone or shale. This lithic material varies in depth from approximately 1 metre around a localised peak along the eastern portion of the SIMTA site, through to 10 to 12 metres around other areas.

Much of the SIMTA site has already been subject to filling operations. Where filling is already present, it is generally up to 1 metre in depth, however, there are some locations where the depth reaches up to 2.5 metres. Some areas of fill have been identified (Hyder 2011b) to have been poorly compacted and not complying with requirements for engineered fill under structures.

Details of the Revised Universal Soil Loss Equation (RUSLE) to estimate soil loss from a particular site per year are presented in Appendix A. The key outputs for the SIMTA site are as follows:

- Rainfall erosivity factor (R Factor) is 2,500 based on the location of the site.
- Soil erodibility factor (K Factor) of the site is 0.048.
- Conservation practises (P Factor) is given a default value of 1.3.
- Cover factor (C Factor) is 1.

The Computed Soil Loss (A) is 185.64 tonnes per hectare/year which falls within a soil loss class of 2 (151 - 225 tonnes per hectare/year). Therefore the SIMTA site is considered to have a Low Erosion Hazard with no restrictions on soil exposure, as opposed to a higher class (>4 where restrictions on soil exposure at times of year would be imposed (see Table 4.3 of 'Blue Book' (Landcom, 2004)) likely to be required with regard to land disturbance activities. The RUSLE for the rail corridor will be determined at the Concept Design stage prior to any construction works and associated clearing.

There have been no contamination issues identified on site to date that would affect stormwater, flooding or any ancillary effects upon receiving water quality or quantity. The geology and soils in the rail corridor lands between the Georges River and Moorebank Avenue would be further investigated and assessed during the project application stage.

2.4 Climatic Conditions

Details of the historical climatic data based on the Bankstown Airport AWS (site number: 066137; Latitude: 33.92 S, Longitude: 150.99 E) are presented in the report *Climate Risk Assessment* (Hyder Consulting 2011e). The average annual rainfall for the 43 years on record is 867.5 millimetres, with the highest annual rainfall of 1,397.8 millimetres occurring in 1988.

Average rainfall intensity data and rainfall intensity frequency data are presented in Appendix B.

3 POTENTIAL ENVIRONMENTAL IMPACTS

This section identifies potential environmental impacts associated with stormwater and flooding in relation to water quantity, water quality and fish passage and habitat during the construction and operational phases.

3.1 Construction

3.1.1 Water Quantity

The progressive demolition and removal of existing structures on the site, such as warehouses, roads and footpaths, is likely to result in a temporary increase in surface permeability and as a consequence, a decrease in surface flows from the site. As the construction progresses surface flows from the site are likely to increase as a result of increasing areas of impermeable surfaces being established.

It is also possible that the removal of existing stormwater management structures, such as pipes and open grass lined channels, may result in an increase of surface flows volume and velocity across the site and the associated mobilisation of debris and soils. This increase in surface flow has the potential to contribute to increased erosion, surface scouring and scouring of water channels, as well as the transportation of sand silt and clay off-site into adjacent vegetation and waterways. Increased flows to waterways may also increase the severity and impacts of flood events, particularly in relation to Anzac Creek and its riparian communities (Hyder Consulting 2011e).

Surface flow volumes and velocities would be dependent upon the location and staging of the works across the construction phase. Retained or constructed hardstand areas and drainage structures will naturally accelerate surface flows across the site. Disturbed natural and constructed areas provide a rougher surface that assists in slowing surface water runoff and encourages infiltration of water into the soil profile.

In order to minimise the potential for adverse environmental impacts during construction of the proposed SIMTA proposal, appropriate stormwater controls would be implemented (See Section 4).

3.1.2 Water Quality

During the land disturbance phase of development, there is potential for soil to be eroded from the construction site and deposited onto nearby lands or into downstream waterways. This situation could be exacerbated by the removal of stabilising vegetation on the site in advance of construction requirements. Construction activities on the site that have the potential to impact water quality include:

- Alteration of the topography and associated water catchment areas of the site.
- Changing of the soil profile on site to expose potentially more reactive soils.
- Removal of vegetation.
- Removal or modification of existing drainage, retention or diversion structures.
- Transportation of noxious weeds.
- Modification or removal of drainage pathways across the SIMTA site.
- Concentration of surface water flows.

Sedimentation impacts to riparian vegetation communities can include changes to physical properties of the soil profile through increased deposition of fine or clayey materials around trunk bases and in root zones that may result in reduction in oxygen availability.

Sedimentation impacts to water courses can result in increased turbidity, which in turn can result in a lowering of the temperature of the water body and a consequential lowering of dissolved oxygen. Each of these factors can have deleterious consequences for the viability of fish habitat within Anzac Creek or Georges River.

In order to minimise the potential for adverse environmental impacts during construction of the proposed SIMTA proposal, appropriate erosion and sediment control measures would be implemented, and these are detailed in section 4 of this report.

3.1.3 Fish Passage and Habitat

Likely impacts upon fish passage and habitat are those impacts that may arise as a result of unmitigated activities associated with the construction and operation of the SIMTA proposal. Likely impacts may result in the degradation of aquatic habitats and obstruction to fish passage and may include:

- Diversion of flows and/or alteration to the natural flow conditions within the waterway.
- Bed and bank erosion resulting from changes to stormwater flows.
- Reduced water quality and light penetration due to erosion and run-off from the construction area.
- The removal of shade trees.
- The release of sediment into the stream resulting in damage to, or the removal of, bank vegetation, particularly vegetation that shades the low-flow channel.
- Obstruction to fish passage as a result of inappropriate design and/or construction of watercourse crossings over Anzac Creek and Georges River.

Left unmitigated, these impacts may adversely affect breeding movements, restrict access to breeding sites, provide habitat for predatory and introduced fish species and may ultimately result in localised extinctions of fish populations.

In order to minimise the potential for adverse environmental impacts during construction of the proposed SIMTA proposal, appropriate fish passage and habitat protection controls would be implemented, and these are detailed in section 4 of this report.

3.2 Operation and maintenance

3.2.1 Water Quantity

The civil engineering report addressing stormwater and flooding (Hyder Consulting 2011a) provides estimates of peak flows downstream of the site for a range of recurrence intervals. This data is presented in Table 4 below. Table 4 illustrates the balance between the modelled existing and post development peak flow estimates for surface water outflow

Viewed in conjunction with the proposed mitigation measures including installation of flood detention rain gardens, modelling for the site indicates that the volume and velocity of surface flows from the site would be static or less than current outflows. This includes flows from Outlet 1 (to Anzac Creek), Outlet 2 (to Anzac Creek) and Outlet 3 (to Georges River).

Table 4 Comparison of Peak Flow Estimates (m³/s)

Discharge Location	Site Condition	Catchment Area (ha)	DRAINS Model Label	Flow at Downstream of Greenhills Rd / Moorebank Ave			
				2yr	20yr	100yr	PMF
Outlet 1 NE Corner of Site Greenhills Road)	Existing	27.45	OF17	2.42	6.24	8.33	50
(	Developed	38.08	OF64	1.72	2.93	3.54	56
Outlet 2 SE Corner of Site(Greenhills Road)	Existing	27.13	OF9	0.40	1.11	2.63	31
	Developed	18.64	OF51	0.39	0.86	2.01	27
Outlet 3 NW Corner of Site	Existing	42.33	OF30	5.74	10.20	12.70	62
	Developed	40.22	OF102	3.43	8.35	7.82	104

Potential flooding impacts downstream of the site are as follows:

- Without the provision of appropriate design/management measures the increased intensity of local flooding would be limited to less than 5mm in the100 year ARI 9-hour event (Hyder 2011a).
- For the PMF 1-hour event, the proposed site raising would result in flood level increases of up to 0.25 metres in the largely undeveloped areas to the south of the site. Further downstream, to the north of the southern site boundary, flood level increases due to site development are predicted to be limited to no more than 5mm.

In summary the proposed flood impacts of the operation would be negligible for local developments in anything up to a 100 year ARI, at which point it would be part of a larger systemic issue where the sites' surface water flow is not the primary contributing factor to flood heights.

3.2.2 Water Quality

During the operation phase of the SIMTA proposal surface waters would report to designated drainage and retention structures that provide for sediment and particulate deposition and detention and retention of surface flows. These structures would control the release of stormwater from site to minimise the likelihood of any downstream channel or bank scour effects.

Within the SIMTA site boundary there would be minimal exposed soil material to contribute to sediment loads leaving the site. There is likely to be deposition of particulates on the SIMTA site associated with road and rail transport movements. Surface migration of particulates during wet weather events would be captured within the designed stormwater control structures. The control structures reduce the velocity and carrying capacity of stormwater flows to enable particulates to fall out of suspension. Discharge of particulates from site during typical flow conditions is considered to be negligible.

There is the potential for spills of fuels, oils, lubricants or site goods to occur on- or off-site with the potential to affect water quality. Vehicle refuelling and maintenance would generally be performed within designated bunded areas where any spills would report to a sump for collection and appropriate disposal.

Spills that occur on site would report to the designed stormwater drainage system where spill response procedures can be applied. Similarly, spill response and emergency response procedures would apply to spills occurring off-site.

Potential impacts to water quality resulting from the operational phase of the SIMTA proposal would be negligible due to the surface water detention structures and implementation of spill and emergency response procedures.

3.2.3 Fish Passage and Habitat

Fish passage barriers during the operation and maintenance phase may result from:

- Debris blocking a culvert.
- Blockage as a result of an alteration to the natural flow conditions within the waterway caused by the construction of a waterway crossing.

Fairfull and Witheridge (2003) identify the range of possible impacts associated with different types of waterway crossing. For example, possible impacts from bridges include alterations to flood flow velocities and blockage of fish passage along floodplains caused by elevated approach roads. Potential impacts associated with causeways include excessive flow velocities through the low flow pipe and debris blockage of the pipe.

The design of any watercourse crossings has not, as yet, been prepared for the SIMTA proposal. A detailed consideration of fish passage impacts resulting from crossing structures for Anzac Creek and Georges River has not been undertaken. The impacts will be assessed based on the final design for the crossings across the Georges River and Anzac Creek.

The potential impacts documented in Sections 3.1 and 3.2 will be suitably mitigated by the design principles and strategies identified in section 4 management and mitigation measures.

4 MANAGEMENT AND CONTROL/MITIGATION MEASURES

4.1 Construction

4.1.1 Water Quantity

The overall stormwater design of the SIMTA proposal will seek to:

- Adopt national best practice stormwater standards for the proposed intermodal terminal facility.
- Comply with recognised Australian Standards and Liverpool City Council Guidelines.
- Provide site levels which are above localised flood levels but do not impact upon capacity of existing floodplains.
- Providing adequate grades for surface drainage which do not impact on the operational requirements for the facility.
- Provide drainage facilities which minimise requirements for in-ground pipework and provide facilities for stormwater detention and Water Sensitive Urban Design (WSUD).

The primary mitigation measure would be the progressive development of the site allowing for better management and reduced sediment mobilisation through a reduction in the total surface area of exposed material at any one time. Additionally, the works would be scheduled to undertake the bulk of the early earthworks in the driest period of July, August and September (Hyder Consulting 2011e), where practicable to do so.

Through the construction period sedimentation basins would be used across the site to capture all site surface waters for a 1 in 10 year storm event. This water would then be used on site or treated for sediment and particulate removal and discharged. Each of these sedimentation basins would be located and sized to provide sufficient capacity for each site sub-catchment. The management objective to retain capacity within these basins to achieve water quality objectives would require treatment and discharge of surface water flows retained on site. This treatment to retain stormwater capacity would result in site surface waters being discharged at the current discharge points to maintain site discharges to Anzac Creek and minimise any impact on water volumes received by Anzac Creek.

4.1.2 Water Quality

Erosion and water quality issues are commonly encountered on construction projects of the scale of the SIMTA proposal. These issues are usually adequately and appropriately managed through the development of a project specific construction environmental management plan (CEMP), operational environmental management plan (OEMP) and consideration of appropriate controls during the detailed design process. The following measures would adequately address erosion and water quality risks for the SIMTA proposal, and would be considered when developing the CEMP.

Best practice measures would be implemented in the construction phase of the SIMTA proposal to manage erosion and sedimentation control in accordance with Managing Urban Stormwater: Soils and Construction, Volume 1 (Blue Book 1 – Landcom, 2004). All works involving construction across waterways will be undertaken with reference to “Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterways Crossings” (NSW Fisheries 2003).

The objective of erosion and sediment control strategies is to minimise the pollution of ground and surface waters resulting from construction activities. This includes the incorporation of specific structures and measures to minimise erosion and sedimentation associated with the SIMTA proposal.

The following principles will apply to all areas and stages of the construction program:

- **Minimise extent of ground disturbance**. The initial clearing of the SIMTA site of vegetation and existing structures is to be progressively staged to minimise surface exposure of the disturbed area of the SIMTA site at any one time.
- **Control clean water onto and through the site**. Temporary surface water controls would be installed to divert off-site and on-site clean waters away from areas exposed and disturbed by construction and into existing drainage structures for conveyance through the site. This strategy reduces the volume of surface waters that need to be managed as "dirty" waters from surface water contact with exposed soils, and maintains flows within local watercourses (Anzac Creek and Georges River).
- **Implement erosion and sediment control strategies**. Construction activities are to be undertaken so as to minimise the amount of disturbed area, reduce length and steepness of slopes, implement erosion control measures and rehabilitate or stabilise disturbed areas quickly. Erosion control is a proactive strategy which would minimise the degree of sediment transport from the site and thereby reduced the chance of reduction in off-site water quality.

  Sediment control involves the use of sediment basins and sediment traps to enable deposition or filtration of sediments to occur.
- **Monitoring and evaluation.** Generic water quality guidelines (ANZECC 2000) would be adapted to reflect the existing water quality present within Anzac Creek and Georges River.

Measures to be used would include a variety of construction practices, structural controls and vegetative measures aimed at managing runoff at a non-erosive velocity, and the protection of disturbed soil surfaces. Erosion control measures are to be implemented to reduce potential soil loss from the SIMTA proposal by:

- Protection of soil surface.
- Reducing the length and steepness of slopes.
- Increasing the time of concentration of overland flow.
- Directing overland flow to a stable outlet point.
- Progressive stabilisation following completion.
- Monitoring of controls & strategies.

Emphasis would be placed on scheduling land disturbance and rehabilitation progressively to minimise the likelihood of erosion occurring as opposed to solely relying on temporary works to control erosion and sedimentation.

The aim for erosion and sediment control is to firstly minimise erosion and then to capture sediment from disturbed areas, with an emphasis on pollution prevention rather than pollution control. Additionally, a focus for the SIMTA proposal would be on runoff separation, i.e. diverting "clean" stormwater runoff around the site or away from construction areas, as well as the management and maintenance of long-term controls required during the construction phase.

Runoff resulting from the construction area would be managed to deliver water quality that satisfies the water quality objectives for the SIMTA proposal prior to its exit from the site. Although essential, it is important to note that sediment basins are considered secondary to erosion control in minimising ground and surface water pollution resulting from construction activities. The main aim is to prevent surface waters from non-disturbed areas entering the site thereby reducing potential for erosion and sediment mobilisation within exposed surface areas, rather than sole reliance on a basin at the end of the 'treatment train'.

Sediment traps would be used in addition to basins to provide additional filtering and interception of runoff from the site. These sediment traps may include a variety of measures including rock socks, native hardwood mulch, rock checks, sand bags, sediment fence and inlet filters. The use of mulch is not to be used where there is a risk of mulch tannins entering adjacent watercourses.

The derivation of a site specific understanding of water quality trends would require the confirmation of a suite of baseline water quality indicators that reflects seasonal variability.

The baseline monitoring program would commence as soon as possible and extend up until the commencement of the SIMTA proposal. The monitoring program would capture seasonality in water quality conditions. Due to the nature of water courses and drainage conditions of the project area, a mixture of ambient and event based monitoring would be considered for the following physico-chemical and biological indicators:

• pH	• Temperature	• Turbidity	• Dissolved oxygen
• Surface films and debris	• Chemical contaminants (metals and hydrocarbons)	• Total suspended solids	• Visual clarity and colour

The stormwater runoff quality objectives and treatment targets for the proposed development will be established according to the *Liverpool Development Control Plan 2008* (general controls and controls applicable to Moorebank Defence Lands).

The installation and maintenance of all soil and water management works on the site would be continually monitored to ensure correct implementation and modification of erosion and sediment control plans (ESCPs) if and when necessary. Daily monitoring of measures would be undertaken by internal environment and construction staff. Regular inspections, monitoring and updating of ESCPs would be undertaken by a qualified erosion control expert.

The ESCPs are to detail the specific measures, locations and methods of construction based on the final construction specification.

Chemical containment, spills and leaks will be managed through construction phase emergency response and spill response procedures included within the CEMP. This section of the CEMP will include reference to a site MSDS register for all chemicals (i.e. fuels and lubricants) held on the SIMTA site. All handling and storage of chemicals (including fuels) would be within designated and separately bunded areas. Spill control kits would be included in site vehicles and positioned at key locations in order to facilitate rapid response and control for the clean up of any spills on site.

Site characteristics and constraints will be investigated and evaluated in the development of erosion and sediment control strategies. Options to minimise water quality impacts, erosion, and pollutant and sedimentation impacts during the construction phase on the Georges River, Anzac Creek and adjacent areas of vegetation, including riparian vegetation are identified in Table 5.

Erosion and sediment controls will be implemented across the site in accordance with the principles and examples identified in *Managing Urban Stormwater: Soils and Construction* Volume 1 and Volumes 2 E and 2D (refer to Section 1.4).

Table 5: Construction phase water quality options

Focus/Issue	Mitigation options
General	Water quality will be primarily managed through the design strategies in accordance with the best practice documents identified in Section 3.
	Measures would be implemented to prevent soil erosion and discharge of sediments and pollutants from the site during construction of the SIMTA proposal, in accordance with Managing Urban Stormwater and Managing Urban Stormwater Guidelines.
	Any environment protection licence or other key environmental requirements will be highlighted in signage at each discharge point.
	Disturbed areas will be limited to only those areas which need to be worked on at that point in time, and areas would be rehabilitated, stabilised or sealed as soon as possible following construction.
	Construction of sediment basins as early as practical in the construction process.
	Sediment basins will be flocculated with appropriate, approved flocculants to enhance the settling of dispersible and small sediment particles where required to meet discharge objectives.
	The sediment basins will be operated to remove sediment when the sediment storage zone has reached 80% of capacity.
	Clean run on water would be diverted around all works using diversion drains or other physical devices.
Erosion	Best practice soil and water management techniques will be implemented. This will include the use of sediment fences, check dams, level spreaders and other devices to mitigate the export of soil from the site.
	Any harvestable topsoil would be stockpiled and reused during landscaping of the site. Stockpile heights would be minimised to limit wind erosion or denaturing of the soil.
	Temporary sterile grass covers would be used to seal areas whenever practical.
	In the longer term soil erosion would be managed by providing vegetation cover to exposed soils.
	Trees would be mulched on site and the mulch used in the revegetation and stabilisation of the site.
Hazardous materials	All storages of fuel and chemicals would be bunded and stored in approved storage containers with MSDS sheets available for response reference.
	Procedures for the recovery of spilt materials will be established.
	If soils are disposed off-site, then routine testing will be undertaken to assess the appropriate waste classification of the soils according to the OEH guidelines.
Waterways	The use of floating booms shall be made where major crossings and permanent pools are put at risk from construction activities.
	Use of working platforms for works across Georges River would be considered.
	Temporary crossings would use material that would not result in sediment material entering waterways.
	Temporary crossings must be removed with minimal disturbance to the drainage

Focus/Issue	Mitigation options
	system they cross.
	Where feasible, bank vegetation would be retained and integrated into scour protection on current banks to minimise impacts.
	Scour protection would be implemented on both upstream and downstream ends of all structures where increased velocities have the potential to cause scour.
	Drainage structures would be designed to facilitate fish passage in accordance with DPI Fisheries guidelines (Fairfull and Witheridge, 2003).
Vegetation	Wherever possible, vegetation will be retained in drainage lines until subsequent works are about to commence in order to reduce erosion risks and retain filtering capacity on the SIMTA proposal.
	Top soil dressing and revegetation would take place as soon as practicable, following completion of construction activities.
	Any areas to be vegetated which do not have a topsoil cover would be topsoiled first.
	Riparian vegetation would be reinstated for the watercourses affected by the proposal.
	Revegetation would only use endemic native species.

4.1.3 Fish Passage and Habitat

All design associated with flood and stormwater management and mitigation of pollution will be in accordance with the requirements specified in Fairfull and Witheridge (2003) and Part 7 (Division 3) of the *Fisheries Management Act 1994* (FM Act).

As Class 1 fish habitat (major permanently flowing waterway) the preferred type of watercourse crossing for the Georges River is a bridge or arch (Fairfull and Witheridge 2003). This would be in-line with the existing rail bridge over this section of the Georges River. Bridges and arches generally have the least impact on fish passage as they normally involve limited disturbance to the flow or the aquatic habitat of a waterway.

The following principles would be considered in the design of any bridge/arch crossing Georges River:

- Siting of a bridge would avoid crossing Georges River at, or near, sharp bends, sections of unstable channel, or major "riffle" systems (shallow areas where water flows swiftly over rocks, gravel or timber).
- Removal of essential shade trees would be avoided.
- Locating of bridge piers or foundations within the main waterway channel would be avoided as far as possible.
- Bridge piers would be designed and orientated to avoid the formation of large-scale turbulence or the erosion of the bed and banks of the waterway.
- Light penetration under bridges to encourage fish passage would be maximised.
- Use and extent of those bed and bank erosion control measures that may reduce aquatic habitat values or inhibit the regrowth of natural in-stream and bank vegetation would be minimised.
- Where practical, construction works across the bed of the Georges River should be staged to minimise the total disturbance at any given time and to allow the full bypassing of stream flows around the works to maintain fish passage.

As Class 3 fish habitat the preferred type of watercourse crossing for Anzac Creek is a culvert (Fairfull and Witheridge 2003). The following principles would be considered in the culvert crossing design for Anzac Creek:

- Fish passage requirements would be considered when selecting the type of culvert box or pipe, concrete or corrugated metal, single cell or multi-cell).
- Where practical, the culvert would be aligned with the downstream channel to minimise bank erosion.
- A multi-cell culvert design would be considered with a combination of elevated "dry" cells to encourage terrestrial movement, and recessed "wet" cells to facilitate fish passage.
- Altering the channel's natural flow, width, roughness and base-flow water depth through the culvert's wet cells would be avoided where possible. Wet cells would aim to have a minimum water depth of 0.2-0.5 metres to facilitate fish passage.
- The culvert would be designed to maximise the geometric similarities of the natural channel profile from the bed of the culvert up to a flow depth of 0.5 metres ("Low Flow Design") as a minimum.
- Where conditions allow, the construction of pools would be considered at both the inlet and outlet of the culvert to assist in the dissipation of flow energy and to act as resting areas for migrating fish.
- If a low-flow channel is constructed within the base slab of the culvert, the channel would extend across the inlet and outlet aprons.
- Debris deflector walls may be used to reduce the impact of debris blockages on fish passage.
- Rock protection and/or the formation of a stabilised energy dissipation pool at the outlet would be considered if necessary to assist in minimising erosion to avoid the formation of a perched culvert and damage to the stream bed and banks.

The design of the crossing would refer to the detailed engineering guidelines provided in Fairfull and Witheridge (2003).

During the construction phase:

- All reasonable efforts would be taken to program construction activities during those periods when flood flows and fish passage is not likely to occur. As a minimum requirement, fish migrations and breeding periods, as advised by NSW DPI, would be avoided.
- Temporary sidetrack crossings would be constructed from clean fill (free of fines) using pipe or box culvert cells to carry flows, or a temporary bridge structure.
- All temporary works, flow diversion barriers and in-stream sediment control barriers would be removed as soon as practicable and in a manner that does not promote future channel erosion.
- The construction site would be left in a condition that promotes native revegetation and shading of habitat pools.

4.2 Operation and Maintenance

4.2.1 Water Quantity

To mitigate the impacts of the operation of the SIMTA proposal, stormwater detention facilities will be designed to limit peak discharges, for a range of storm durations, to no greater than under existing conditions (Hyder Consulting 2011a).

A series of large channels and swales are proposed, to capture and provide storage. These channels will span the SIMTA site in a north-south direction. They will be designed to receive surface flows from open pavements graded in an east-west direction thus negating the need for surface inlets with grates. Underground pipe work will generally only be used to capture and convey stormwater from building downpipes to the large channels.

In addition, rainwater tanks will be used on the site, as identified within the water conservation controls set by Liverpool Council's Liverpool Development Control Plan (2008) for development in Moorebank Defence Lands, and also to satisfy built environment sustainability objectives. Rainwater tanks will collect roof water from warehouses to be used for non-potable water demands for toilet flushing and for outdoor use. All rainwater tanks would have a first-flush device to capture gross pollutants and sediments accumulating on the roof. Rainwater tanks also provide stormwater treatment through settling and harvesting in addition to their main purpose of providing alternative source of water for non-potable water uses.

The stormwater flows across the site under a modelled 1 in 10 storm event are able to be mitigated through the detention of much of the flows on site in the rain gardens and water transport structures. The detention of the stormwater in these structures is intended to eliminate any increase in peak flow discharges by volume through stormwater detention resulting in the same peak discharge volumes continuing over an extended period. This detention will reduce the risk of scouring of water ways and associated sedimentation downstream, and reduce the likelihood of localised flooding and downstream afflux. The aim of these works will be to match post-development flows from the site with pre-development flow rates for a range of storm occurrence intervals and durations.

4.2.2 Water Quality

Water quality management for the operation phase of the SIMTA proposal is focused on prevention of sediment, particulates and pollutants from entering natural watercourses. These objectives are primarily achieved by early stabilisation of disturbed and exposed soils, interception of surface flows and separation or deposition of suspended materials prior to stormwater flows entering the natural watercourse.

The options identified in Table 6 will be considered during detailed design to mitigate the impacts of the development on the quality of water leaving the site and entering Georges River and Anzac Creek.

Table 6: Operation phase water quality options

Proposed treatment option	Objective	Description
Buffer strips	Pre-treatment Source control measure used to pre-treat stormwater runoff before it reaches the main	Buffer strips are vegetated areas adjacent to drainage lines that intercept diffused stormwater runoff from impervious areas before it reaches the treatment measures, thus remove coarse to medium sized

Proposed treatment option	Objective	Description
	treatment measures such as rain gardens and bio-swales.	suspended solids and associated nutrients.
Gross pollutant traps (GTPs)	Pre-treatment Capture coarse sediment, trash and vegetation matter carried in the stormwater. No removal of suspended solids and nutrients.	A GPT is a physical structure or device that prohibit large pollutants from entering water sources.
Rain gardens	Bio-retention system Remove pollutants from stormwater, especially when associated with a submerged zone, which provide a permanent pool of water at the bottom of the system that helps to maintain a healthy plant community.	Rain gardens comprise a combination of vegetation and filter substrate, which provide treatment of stormwater through filtration, extended detention and some biological uptake. Rain gardens are proposed to treat runoff from the majority of the site in an integrated structure that provides for on-site detention (OSD) storage in addition to water quality treatment.
Bio-swales	Bio-retention system Provide runoff conveyance in addition to the water quality treatment through filtration, extended detention and biological uptake.	Bio-swales perform similarly to rain gardens but are generally associated with a longitudinal gradient. The proposed bio-swales for the Moorebank site have fairly flat gradient, thus they provide extended detention during their normal operation, with excess runoff discharging to overflow pits. No OSD storage would be provided as part of the proposed bio-swales.
Lining	Bio-retention system In general, bio-retention systems are lined either to protect structures if they are located next to some or if the site has known salinity hazards.	There are no known risk associated with salinity on the Moorebank site as indicated by the salinity hazard risk map of NSW produced by the OEH. However, as the site's soils are predominantly clays and sandy clays associated with shrinkage and differential settlement, the bio-retention systems would be lined when they are located next to footings of structures such as retaining walls and buildings.

Details of the areas for the proposed stormwater quality treatment measures for the site are presented in the Stormwater and Flooding Study (Hyder Consulting 2011a).

Management of water quality impacts during operation will focus on the maintenance of sediment basins and the landscape treatments within the SIMTA site and rail corridor land. Adaptive management measures would be developed to maintain performance of the water quality treatment measures in the event that future rainfall events increase in either frequency or intensity. Regular maintenance inspections would be conducted (where practical), with appropriate recording to identify and rectify general performance risks, including:

- Areas of erosion, sediment deposition and/or poor vegetative cover.
- Blocked drains and GPTs.

- Slumped batters.
- Sediment basins or other stormwater treatment measures requiring maintenance or repair.

It is anticipated that each operational section and building would have its own spill management system that will prevent ingress into the surface water drainage system.

4.2.3 Fish Passage and Habitat

Many of the impacts arising during the operation will be addressed through the application of appropriate water crossing design principles, as detailed in the section 4.1.3.

Wherever possible, in-stream maintenance activities on the Georges River crossing would be programmed for times of the year that minimise overall environmental harm, giving appropriate consideration to anticipated critical periods of fish passage and seasonal high flows.

Wherever possible, in-stream maintenance activities would be programmed for those times of the year that minimise overall environmental harm, giving appropriate consideration to anticipated critical periods of fish passage and seasonal high flows.

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APPENDIX A

SOIL DATA

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Soil Landscapes

Table A1: Soil landscapes mapped in the study area by Hazelton et al. (1989)

Soil Landscape	Features (Bannerman and Hazelton 1990)	Location in study area
Berkshire Park (Fluvial)	Orange heavy clays and clayey sands, often mottled; ironstone nodules common. On dissected, gently undulating rises on the Tertiary terraces of the Hawkesbury/Nepean river system.	SIMTA site and rail corridor lands east of Georges River.
Richmond (Fluvial)	Poorly structured orange to red clay loams, clays and sands; ironstone nodules may be present. Landscape is Quaternary terraces of the Nepean and Georges Rivers, mainly flat.	100 m wide strip adjoining western bank of Georges River.
Freemans Reach (Fluvial)	Deep brown sands and loams, apedal to moderately structured, usually friable. Landscape: present active floodplain of the Nepean River; level with minor relief to meander scrolls, levees and back swamps.	Small area in south-eastern corner of the study area west of the Georges River.
Luddenham (Erosional)	Shallow dark podzolic soils or massive earthy clays on crests; moderately deep red podzolic soils on upper slopes; moderately deep yellow podzolic soils and prairie soils on lower slopes and drainage lines. Landscape is undulating to rolling low hills on Wianamatta Group shales, often associated with Minchinbury Sandstone.	Across most of study area west of Georges River.
Blacktown (Residual)	Shallow to moderately deep hardsetting mottled texture contrast soils; red and brown podzolic soils on crests, draining to yellow podzolic soils on lower slopes and drainage lines. On gently undulating rises on Wianamatta Group Shales.	Small area in south of waste disposal site, west of Georges River.

Revised Universal Soil Loss Equation

The Revised Universal Soil Loss Equation (RUSLE) as detailed within *Soils and Construction Volume 1* (2004) (the Blue Book) is a conservation planning tool formulated to estimate soil loss from a particular site per year. The equation uses set variables (e.g. site location and landscape, slope length, amount of previous disturbance) to calculate an estimate. This can be used to formulate measures to manage erosion and sedimentation both on and off the site and provide an indication of some basic design parameters for construction. The RUSLE also helps provide information on likely requirements of sediment basins based upon likely volumes of soil loss for various ARIs. The RUSLE was applied to the SIMTA site to ascertain the requirements for erosion and sediment control throughout the construction period and to provide a basis for calculating sediment basin sizing. The results are as follows:

- The rainfall erosivity factor (R Factor) was determined to be 2,500 based on the location of the site (Appendix B Blue Book - Map 10, Sydney). This is a measure of the ability of rainfall to cause erosion.
- The soil erodibility of the site (K Factor) is a measure of the susceptibility of soil particles to detachment and transport by rainfall and runoff. The site is situated within the Berkshire Park soil landscape and contains soil consistent with Type F soil texture, indicating that the soils are composed of mainly clay and silt (more than one third). The

site is classified as within the hydrologic group C and a slope range of 0-5%. The K factor for the site is listed as 0.048.

- The length of slope (LS) or gradient is 0-5% as per point above within Berkshire Park soil landscape. The length of slopes on site is assumed to be 80 metres given that more than 1000 square metres will be disturbed. The LS was calculated to be 1.19 using Table A1 (Appendix A-9 Blue Book).
- Erosion control practice factor (P Factor) refers to the condition of the site in terms of the roughness of the soil to establish vegetation and to slow the velocity of water runoff. As the site is currently developed a P Factors default value of 1.3 indicating that the site is compacted and smooth.
- The cover (C Factor) is the ratio of soil loss from land under specified crop conditions from continuously tilled, bare soil. Given that the land has been disturbed the C factor is taken to be 1.

Computed Soil Loss (A) = R x K x LS x P x C tonnes per hectare/year

= 2500 x 0.048 x 1.19 x 1.3 = 185.64 tonnes per hectare/year.

The calculated soil loss class is 2 (151 - 225 tonnes per hectare/year), therefore the site was considered to have a Low Erosion Hazard with no timing restrictions likely to be required with regard to land disturbance activities. The required sediment basin sizing for the site needs to be determined once more detailed construction staging and site design detail is available.

APPENDIX B

RAINFALL INTENSITY DATA

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Table B1: Average rainfall intensity (ARI) data

DURATION	1 Year	2 years	5 years	10 years	20 years	50 years	100 years
5 mins	87.7	112	142	159	182	212	234
6 mins	82.1	105	133	149	171	199	220
10 mins	67.2	86.2	109	123	140	164	181
20 mins	49.1	63.0	80.3	90.2	103	121	134
30 mins	40.0	51.3	65.5	73.7	84.6	98.7	109
1 hr	27.1	34.9	44.7	50.3	57.8	67.6	75.0
2 hrs	17.7	22.8	29.3	33.1	38.0	44.5	49.5
3 hrs	13.7	17.6	22.7	25.6	29.4	34.5	38.3
6 hrs	8.77	11.3	14.6	16.4	18.9	22.2	24.6
12 hrs	5.68	7.33	9.47	10.7	12.4	14.5	16.1
24 hrs	3.74	4.84	6.29	7.14	8.26	9.72	10.8
48 hrs	2.44	3.17	4.15	4.74	5.50	6.50	7.28
72 hrs	1.84	2.39	3.15	3.60	4.19	4.96	5.57

Table B2: Rainfall intensity frequency data for SIMTA site