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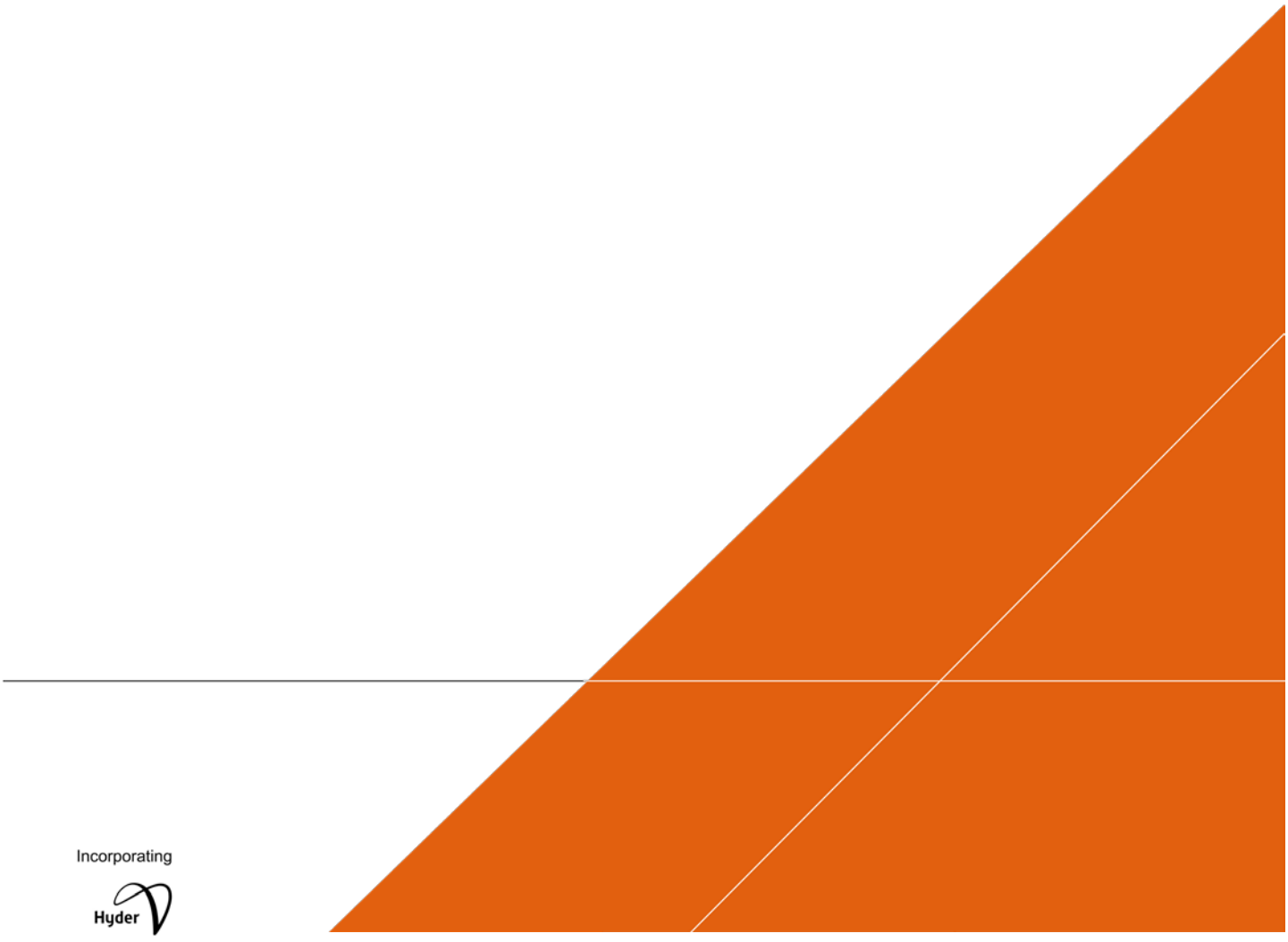
MOOREBANK PRECINCT INTERMODAL TERMINAL FACILITY – MPW STAGE 2

STORMWATER AND FLOODING ENVIRONMENTAL ASSESSMENT

01 AUGUST 2016



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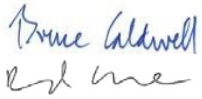
MOOREBANK PRECINCT
MOOREBANK INTERMODAL COMPANY – STAGE 2

Stormwater and Flooding Environmental Assessment

Author	Bruce Caldwell (Water Quantity) David Stone (Water Quality)	
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REVISIONS

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1	29 March 2016	First draft	Bruce Caldwell	Greg Ives
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4	1 August 2016	Final	Bruce Caldwell	Greg Ives

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1 INTRODUCTION

On the 3 June 2016 Concept Plan Approval (SSD 5066) was granted, under Part 4, Division 4.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), to develop the Moorebank Precinct West Project (MPW Project) on the western side of Moorebank Avenue, Moorebank, in south-western Sydney (the MPW site).

The MPW Project involves the development of intermodal freight terminal facilities (IMT), linked to Port Botany, the interstate and intrastate freight rail network. The MPW Project includes associated commercial infrastructure (i.e. warehousing), a rail link connecting the MPW site to the Southern Sydney Freight Line (SSFL), and a road entry and exit point from Moorebank Avenue.

Under the Concept Plan Approval, the MPW Project is to be developed in four phases, being:

- Early Works development phase, comprising:
    - The demolition of existing buildings and structures
    - Service utility terminations and diversion/relocation
    - Removal of existing hardstand/roads/pavements and infrastructure associated with existing buildings
    - Rehabilitation of the excavation/earthmoving training area (i.e. 'dust bowl')
    - Remediation of contaminated land and hotspots, including areas known to contain asbestos, and the removal of:
        - Underground storage tanks (USTs)
        - Unexploded ordnance (UXO) and explosive ordnance waste (EOW) if found
        - Asbestos contaminated buildings
    - Archaeological salvage of Aboriginal and European sites
    - Establishment of a conservation area along the Georges River
    - Establishment of construction facilities (which may include a construction laydown area, site offices, hygiene units, kitchen facilities, wheel wash and staff parking) and access, including site security
    - Vegetation removal, including the relocation of hollow-bearing trees, as required for remediation and demolition purposes
- Development of the intermodal terminal (IMT) facility and initial warehousing facilities
- 'Ramp up' of the IMT capacity and warehousing
- Development of further warehousing.

Approval for the Early Works phase (MPW Concept Plan Approval) was granted as the first stage of the MPW Project within the Concept Plan Approval. Works, approved as part of this stage are anticipated to commence in the third quarter of 2016.

Commonwealth Approval (No. 2011/6086), under the *Environmental Protection Biodiversity Conservation Act 1999* (EPBC Act), was also granted in mid 2016 (soon after the Concept Plan Approval) for the MPW Project. In addition to this, the Planning Proposal (PP_2012_LPOOL_004_00) which provided a rezoning of part of the MPW site, and surrounds, was gazetted on 24 June 2016 into the *Liverpool Local Environmental Plan 2008* (Amendment No. 62).

On 5 December 2014, Moorebank Intermodal Terminal Company (MIC) and SIMTA announced their in-principle agreement to develop the Moorebank IMT Precinct on a whole of precinct basis. This agreement is subject to satisfying several conditions which both parties are currently working towards. SIMTA is therefore seeking approval to build and operate the IMT facility and warehousing under the MPW Project Concept Approval, known as the MPW Stage 2 Proposal (the Proposal).

1.1 Report Purpose

This report has been prepared to support the Environmental Impact Statement (EIS) for approval of the Proposal. A summary of the works included in the Proposal is provided below.

This report has been prepared as part of a State Significant Development (SSD) Application for which approval is sought under Part 4, Division 4.1 of the EP&A Act. This report has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) (ref: SSD 16-

7709 and dated 14 July 2016) and revised environmental mitigation measures (REMMs) identified in the MPW Concept Plan Approval (SSD_5066). **Table 1-1** provides a summary of the SEARs and the REMMs from the MPW Concept Plan Approval, which are relevant to this report and the section where they have been addressed in this report.

Table 1-1: Assessment Requirements

Section / number	REMM	Where addressed in this report
9A	A soil and water management plan (or equivalent) would be developed before work begins in the conservation area. This plan would include erosion and sediment control plans (ESCPs) and procedures to manage and minimise potential environmental impacts associated with developing this area.	EW Design Dwg
9B	Site compounds, stockpiling areas and storage areas for sensitive plant, equipment and hazardous materials would be located above an appropriate design flood level, which would be determined based on the duration of the construction works.	EW Sections 5.3 & 5.4
9E	For all site works, provide temporary diversion channels around temporary work obstructions to allow low and normal flows to safely bypass the work areas.	C Design Drawing
9F	The potential effects of various flood events on construction phase works would be further investigated during detailed design and preparation of the Stage 2 SSD approval(s).	DD Section 5
9K	The following staging process would be considered to be implemented when constructing surface water drainage infrastructure: • Biofiltration and detention basins that form part of the proposed stormwater management strategy would be excavated at the first phase of development, with the intention that the excavated basins would be used as temporary construction phase sedimentation basins. Once these construction phases become operational, these temporary construction phase sedimentation basins could be developed into the permanent biofiltration and detention basins. • During the relevant phase of development, all major stormwater pipes and culverts (600 mm diameter and larger) and main channels and outlets would be installed. Minor drainage and upstream systems would then be progressively connected to the major drainage elements during each phase of construction as required.	C Design Drawing
9L	A soil and water management plan (or equivalent) would be developed before land was disturbed that would include erosion and sediment control plans (ESCPs) and procedures to manage and minimise potential environmental impacts associated with construction of the Project. The ESCP(s) for the Project would be prepared in accordance with Volume 1 of Managing Urban Stormwater: Soils and Construction ('the Blue Book') (Landcom 2004), Managing Urban Stormwater: Soils and Construction − Installation of Services, Volume 2A (OEH 2008) and Managing Urban Stormwater: Soils and Construction – Main Road Construction, Volume 2D (OEH 2008). The ESCP(s) would be established before the start of each construction phase and would be updated as relevant to the changing construction activities. Strategies to be considered as part of the plan include: • clean runoff from upstream undisturbed areas would be diverted around the Project site to minimise overland flow through the disturbed areas; • stabilised surfaces would be reinstated as quickly as practicable after construction; • all stockpiled materials would be stored in bunded areas and away from waterways to avoid sediment-laden runoff entering the waterways; • sediment would be prevented from moving offsite and sediment-laden water prevented from entering any watercourse, drainage line or drainage inlet;	C Design Drawings

	• erosion and sediment control measures would be regularly inspected (particularly following rainfall events) to monitor their effectiveness and stability; • erosion and sediment control measures would be left in place until the works are complete or areas are stabilised; • temporary erosion control and energy dissipation measures would be installed to protect receiving environments from erosion; and • vehicle movements would be managed during rainfall (or while the ground remains sodden) to minimise disturbance to the topsoil.	
9M	Procedures to maintain acceptable water quality and to manage chemicals and hazardous materials (including spill management procedures, use of spill kits and procedures for refuelling and maintaining construction vehicles/equipment) would be implemented during construction.	Design Drawings
9N	Vehicles and machinery would be properly maintained to minimise the risk of fuel/oil leaks.	C Design Drawings
9O	Routine inspections of all construction vehicles and equipment would be undertaken for evidence of fuel/oil leaks.	C Design Drawings
9P	All fuels, chemicals and hazardous liquids would be stored within an impervious bunded area in accordance with Australian Standards and NSW Environment Protection Authority guidelines.	C Design Drawings
9Q	Emergency spill kits would be kept onsite at all times. All staff would be made aware of the location of the spill kits and trained in their use.	C Design Drawings
9S	Construction plant, vehicles and equipment would be refuelled offsite, or in designated re-fuelling areas located at least 50 metres from drainage lines or waterways.	C Design Drawings
9U	A stormwater management plan (or equivalent) would be developed in accordance with the detailed design. This includes the requirement to control the rate of stormwater runoff so that it does not exceed the pre-developed rate of runoff.	DD Section 5
9V	The stormwater system would be designed such that flow from low order events (up to and including the 10% AEP event from the main part of the site, and up to and including the 2% AEP event for the rail access connection corridor) would be conveyed within the formal drainage systems. Flows from rarer events (up to the 1% AEP event) would be conveyed in controlled overland flow paths.	DD Section 5
9W	The onsite detention system proposed would detain flow and control discharge rates to the Georges River equal to predevelopment discharge rates.	DD Section 5
9X	A stormwater treatment system would be implemented, incorporating sedimentation and bio-filtration basins upstream of the stormwater detention basins.	DD,C Section 6 & Design Drawings
9Y	Use of onsite infiltration would be incorporated into the design through the distribution of swale drains and rain gardens across the Project site.	DD Section 6 & Design Drawings
9Z	A number of other stormwater management opportunities would be considered during development of the detailed design in accordance with Liverpool City Council's Development Control Plan Part 2.4 Development in Moorebank Defence Lands and other relevant policies, including: • polishing water runoff using dry creek gravel beds with macrophyte plants; • using drainage swales to slow down stormwater runoff and increase onsite infiltration; • collecting roof rainwater for re-use onsite; • installing gross pollutant traps (GPTs) at the outlets of the pipe system before discharge into the sedimentation basins; and • incorporating impervious surfaces and vegetated areas into the design to increase sub-surface water flow during rain events and to reduce the discharge of stormwater pollutants.	DD Section 6 & Design Drawings

Section / number	SEAR	Where addressed in this report
8	Soil and Water An assessment of soil and water impacts for the site. The assessment shall:	
8a	assess impacts on surface and groundwater flows, quality and quantity, with particular reference to any likely impacts on dragonfly species listed under the *Fisheries Management Act 1994*, the Georges River and Anzac Creek;	Sections 4 & 5: Quantity Section 6: Quality ('Groundwater' and 'impacts on dragonfly species' are not addressed in this report. Refer to biodiversity assessment regarding dragonfly)
8b	assess flooding impacts and characteristics, to and from the project, with an assessment of the potential changes to flooding behaviour (levels, velocities and direction) and impacts on bed and bank stability, through flood modelling, including:	Sections 4 & 5 (no bridge)
	i. hydraulic modelling for a range of flood events;	Sections 4 & 5
	ii description, justification and assessment of design objectives (including bridge, culvert and embankment design);	Sections 4 & 5
	iii. an assessment of afflux and flood duration (inundation period) on property;	Sections 4 & 5
	iv. consideration of the effects of climate change, including changes to rainfall frequency and/or intensity, including an assessment of the capacity of stormwater drainage structures; and	Section 5
	v. relevant provisions of the NSW Floodplain Development Manual 2005.	Sections 4 & 5
8c	assess effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas, water dependent fauna and flora (including Groundwater Dependent Ecosystems);	Section 6 (Groundwater is not addressed in this report)
8d	describe any mitigating effects of the proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options;	Section 6
8e	identification of proposed monitoring of hydrological attributes;	Section 6.
8f	address drainage issues associated with the development / site, including the incorporation of Water Sensitive Urban Design measures, stormwater and drainage infrastructure such as on-site detention systems to ensure peak discharges and flow velocities post development shall not exceed existing peak flows and velocities;	Section 5: Quantity Section 6: Quality
8g	undertake an assessment of surface water quality during construction (including reference to water quality objectives for the relevant catchment where objectives have been determined), including an identification of works that may impact water quality, and a summary of proposed monitoring and mitigation measures in accordance with Managing Urban Stormwater – Soils & Construction Volume 1 2004 (Landcom) and Volume 2 (DECC 2008);	Section 6
8h	consideration of stormwater quality and management (including monitoring) during operation of the site with the objective of maintaining or improving existing water quality taking into account the Water Quality Objectives	Section 6

8i	consider whether the existing sewerage system can cater for the proposal and whether environmental performance of the existing system will be impacted;	(sewerage is not addressed in this report)
8j	identify and assess the soil characteristics and properties that may impact or be impacted by the project, including acid sulfate soils, salinity, erodibility, unstable or unsuitable ground and unrippable rock; and	(soil characteristics are not addressed in this report)
8k	include a bulk earthworks strategy detailing the volume of spoil to be extracted from the site, planned reuse and amount of material to be imported.	(bulk earworks strategy is not addressed in this report)

1.2 MIC Stage 2 Proposal Overview

The MPW Stage 2 Proposal (the Proposal) involves the construction and operation of an Intermodal terminal (IMT) facility and associated warehousing, as shown in Figure 1-1.

The IMT facility would have the necessary infrastructure to support a container freight throughput volume of 500,000 twenty-foot equivalent units (TEUs) per annum. Specifically, the IMT facility within the Proposal site would include the following key components:

- Truck processing, holding and loading areas – with entrance and exit from Moorebank Avenue via an upgraded intersection and a round-about to distribute traffic between the warehousing precinct and the IMT
- Rail loading and container storage areas – installation of nine rail sidings, with an adjacent container storage area serviced by manual handling equipment
- Administration facility – office building with associated car parking and light vehicle access from Moorebank Avenue
- The Rail link connection – rail sidings within the IMT facility, which would be linked (to the south) to the Rail link (constructed as part of the MPE Project (SSD 14-6766)).

Also included within the Proposal are the following key components:

- Warehousing area – construction and operation of approximately 215,000 m^2 GFA of warehousing, with warehouses ranging in size from 4,000 m^2 to 71,000 m^2. Included within the warehousing area would be ancillary offices, truck and light vehicle parking, associated warehouse access roads.
- Freight village – construction and operation of approximately 800 m^2 of retail premises, with access from the internal road.
- Upgraded intersection on Moorebank Avenue and internal road – including works to Moorebank Avenue, Anzac Road to accommodate the proposed site entrance to Moorebank Avenue, and construction of an internal road.
- Ancillary works – including vegetation clearing, earth works, drainage and on-site detention, utilities installation/connection, signage and landscaping.

1.2.1 Proposal components and key terms

Table 1-2 provides a summary of the key terms, which are included within this EIS.

Table 1-2 Summary of Key Terms used Throughout this Document

Term	Definition
Moorebank Precinct West (MPW) Concept Plan Approval (Concept approval and Early Works)	MPW Concept Plan and Stage 1 Approval (SSD 5066) granted on 3 June 2016 for the development of the MPW Intermodal terminal facility at Moorebank and the undertaking of the Early Works. Granted under Part 4, Division 4.1 of the *Environmental Planning and Assessment Act 1979*. This reference also includes associated Conditions of Approval and Revised Environmental Management Measures, which form part of the documentation for the approval. N.B. Previously the MIC Concept Plan Approval

Moorebank Precinct West (MPW) EPBC Approval	Commonwealth Approval (No. 2011/6086), granted in mid-2016, for the impact of the MPW Project on listed threatened species and communities and impacts on the environment by a Commonwealth agency. Anticipated to be granted under the *Environmental Biodiversity Protection Conservation Act 1999*.
Moorebank Precinct West (MPW) Concept Plan EIS	The Environmental Impact Statement prepared to support the application for approval of the MPW Concept Plan and Early Works (Stage 1) under the *Environment Protection and Biodiversity Conservation Act 1999* and the *Environmental Planning and Assessment Act 1979*. N.B. Previously the MIC Concept Plan EIS
Revised Environmental Management Measures (REMMs)	The environmental management measures for the MPW Concept Plan Approval as presented within the MIC Supplementary Response to Submissions (SRtS) (PB, 2015) and approved under the MPW Concept Plan Approval.
Moorebank Precinct West (MPW) Planning Proposal	Planning Proposal (PP_2012_LPOOL_004_00) to rezone the MPW site from 'SP2-Defence to 'IN1- Light Industrial' and 'E3- Management', as part of an amendment to the *Liverpool Local Environmental Plan 2008* (as amended) gazetted on 24 June 2016.
Moorebank Precinct West (MPW) Project	The MPW Intermodal Terminal Facility as approved under the MPW Concept Plan Approval (5066) and the anticipated MPW EPBC Approval (2011/6086). N.B. Previously the MIC Project
Moorebank Precinct West (MPW) site	The site which is the subject of the MPW Concept Plan Approval, MPW EPBC Proposal and MPW Planning Proposal (comprising Lot 1 DP1197707 and Lots 100, 101 DP1049508 and Lot 2 DP 1197707). The MPW site does not include the rail link as referenced in the MPW Concept Plan Approval or MPE Concept Plan Approval. N.B. Previously the MIC site.
Early Works	Works approved under Stage 1 of the MPW Concept Plan Approval (SSD 5066), within the MPW site, including: establishment of construction compounds, building demolition, remediation, heritage impact mitigation works and establishment of the conservation area.
Early Works Approval	Approval for the Early Works (Stage 1) component of the MPW Project under the MPW Concept Plan Approval (SSD 5066) and the (yet to be granted) MPW EPBC Approval. Largely contained in Schedule 3 of the MPW Concept Plan Approval.
Early Works area	Includes the area of the MPW site subject to the Early works approved under the MPW Concept Plan Approval (SSD 5066).
Proposal	MPW Stage 2 Proposal (the subject of this EIS), namely Stage 2 of the MPW Concept Plan Approval (SSD 5066) including construction and operation of an IMT facility, warehouses, a Rail link connection and Moorebank Avenue/Anzac Road intersection works.
Proposal site	The subject of this EIS, the part of the MPW site which includes all areas to be disturbed by the MPW Stage 2 Proposal (including the operational area and construction area).
IMT facility	The Intermodal terminal facility on the Proposal site, including truck processing, holding and loading areas, rail loading and container storage areas, nine rail sidings, loco shifter and an administration facility and workshop.
internal road	Main internal road through the Proposal site which generally travels along the western perimeter of the site. Provides access between Moorebank Avenue and the IMT and warehouses.

Rail link connection	Rail connection located within the Proposal site which connects to the Rail link included in the MPE Stage 1 Proposal (SSD 14-6766).
Proposal operational rail line	The section of the Rail link connection and Rail link between the SSFL and the Rail link connection (included in the MPE Stage 1 Proposal) to be utilised for the operation of the Proposal.
construction area	Extent of construction works, namely areas to be disturbed during the construction of the Proposal.
operational area	Extent of operational activities for the operation of the Proposal.
Moorebank conservation area/conservation area	Vegetated area to remain to the west of the Georges River, to be subject to biodiversity offset, as part of the MPW Project.
Moorebank Precinct (MP)	Refers to the whole Moorebank intermodal precinct, i.e. the MPE site and the MPW site.
Moorebank Precinct East (MPE) Project	The Intermodal terminal facility on the MPE site as approved by the MPE Concept Plan Approval (MP 10_0913) and including the MPE Stage 1 Proposal (14-6766). N.B. Previously the SIMTA Concept Plan Approval
Moorebank Precinct East (MPE) site	The site which is the subject of the MPE Concept Plan Approval, and includes the site which is the subject of the MPE Stage 1 Approval. N.B. Previously the SIMTA site
Moorebank Precinct East (MPE) Stage 1 Proposal	MPE Stage 1 Proposal (14-6766) for the development of the Intermodal terminal facility at Moorebank. This reference also includes associated conditions of approval and environmental management measures which form part of the documentation for the approval. N.B. Previously the SIMTA Stage 1 Proposal
Rail link	Part of the MPE Stage 1 Proposal (14-6766), connecting the MPE site to the SSFL. The Rail link (as discussed above) is to be utilised for the operation of the Proposal.

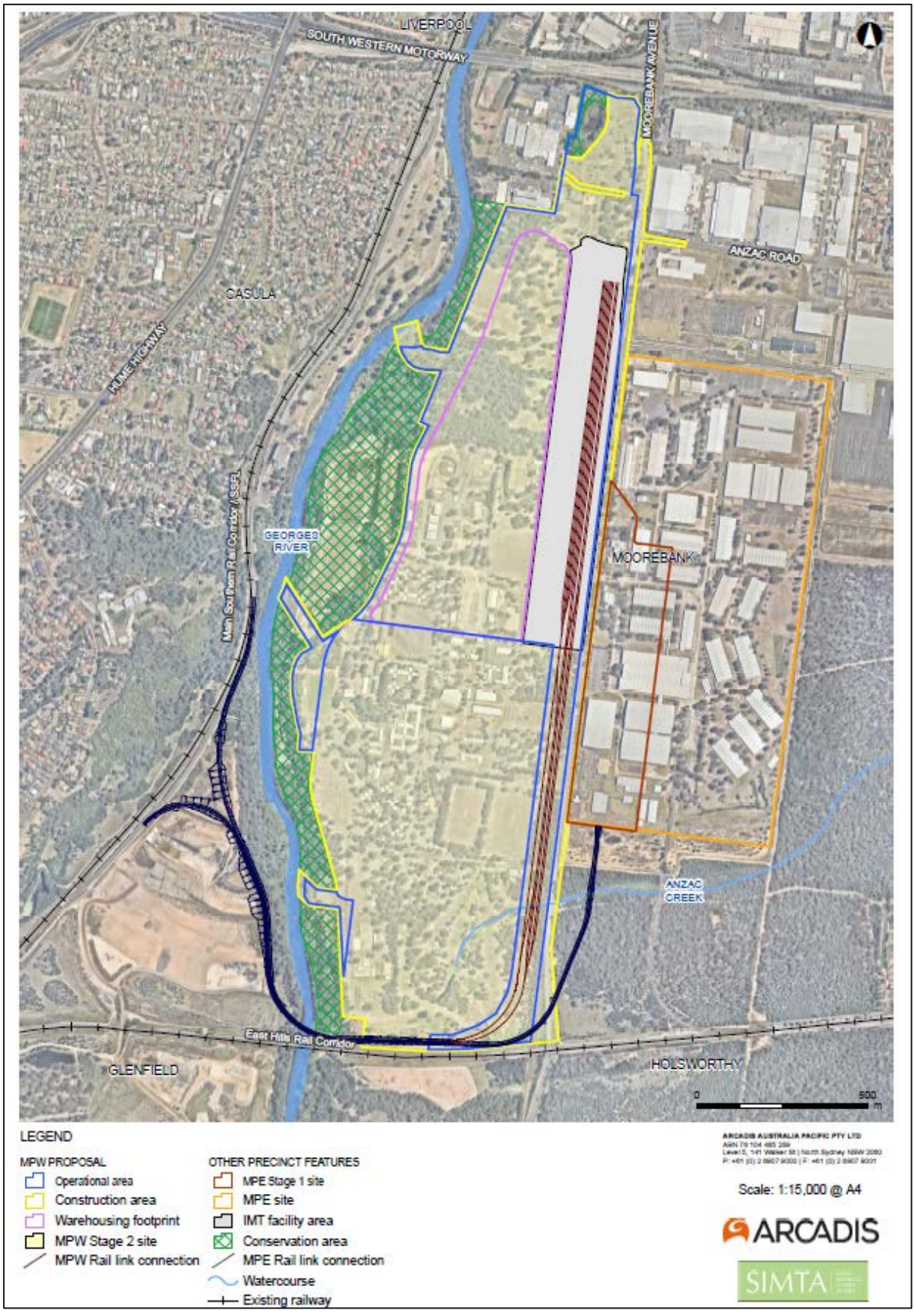


Figure 1-1: Proposal Overview

2 SITE DESCRIPTION

The Proposal site is generally bounded by the Georges River to the west, Moorebank Avenue to the east, the East Hills Railway Line to the south and the M5 Motorway to the north. It is located on Moorebank Avenue, Moorebank and forms Lot 1 in Deposited Plan (DP) 1197707[1]. The Proposal site also contains Lots 100 and 101 DP1049508, which are located north of Bapaume Road and west of Moorebank Avenue. The Proposal site is located wholly within Commonwealth Land.

The Proposal would also require works to upgrade the intersection of the MPW site with Moorebank Avenue and would therefore be undertaken on the following parcels of land:

- Moorebank Avenue, owned by the Commonwealth Government, south of Anzac Road Lot 2, DP 1197707 (formerly part of Lot 3001, DP 1125930).
- Moorebank Avenue, owned by Roads and Maritime Services, north of Anzac Road.
- A portion of Bapaume Road, a public road that is the responsibility of Liverpool City Council.
- A portion of Anzac Road, owned by Roads and Maritime Services, to the east of Moorebank Avenue.

The key existing features of the site are:

- Relatively flat topography, with the western edge flowing down towards the Georges River, which forms the western boundary to the MPW site.
- A number of linked ponds in the south-west corner of the Proposal site, within the existing golf course, that link to Anzac Creek, which is an ephemeral tributary of the Georges River.
- An existing stormwater system comprising pits, pipes and open channels.
- Direct frontage to Moorebank Avenue, which is a publicly used private road, south of Anzac Road and a publicly owned and used road north of Anzac Road.
- The majority of the site has been developed and comprises low-rise buildings (including warehouses, administrative offices, operative buildings and residential buildings), access roads, open areas and landscaped fields for the former School of Military Engineering (SME) and the Royal Australian Engineers (RAE) Golf Course and Club. Defence has since vacated and all buildings on the site are currently unoccupied and will be removed during the Early Works.
- Native and exotic vegetation is scattered across the Proposal site.
- The riparian area of the Georges River lies to the west of the Proposal site and contains a substantial corridor of native and introduced vegetation. The riparian vegetation corridor provides a wildlife corridor and a buffer for the protection of soil stability, water quality and aquatic habitats. This area has been defined as a conservation area as part of the MPW Concept Plan Approval.
- As stated above, the majority of the Proposal site has been developed, however heritage and biodiversity values still remain on the site.
- A strip of land (up to approximately 250 metres wide) along the western edge of the MPW site lies below the 1% annual exceedance probability (AEP) flood level.
- The site is privately owned by the Commonwealth and leased by SIMTA.

A number of residential suburbs are located in proximity to the Proposal site, including:

- Wattle Grove, located approximately 1,000 m from the Proposal site and 1,000 m from the Rail link connection to the east. The Rail link, which will be used during operation of the Proposal is 1,260 m to the west of Wattle Grove at its closest point.
- Moorebank, located approximately 630 m from the Proposal site and more than 1,400 m from the Rail link connection to the north. The Rail link is 2,500 m to the south of Moorebank at its closest point.
- Casula, located approximately 330 m from the Proposal site and 1,200 m from the Rail link connection to the west. The Rail link is approximately 290 m to the east of Casula at the closest point.
- Glenfield, located approximately 820 metres from the Proposal site and 1,100 metres from the Rail link connection to the south-west. The Rail link is approximately 750 m to the east of Glenfield at its closest point.

[1] Previously legally described as “Lot 3001, DP 1125930” in the MPW Concept Plan Approval (SSD 5066), however has since been subdivided.

3 REPORT STRUCTURE

This report addresses the flooding and stormwater management items for the MPW Stage 2 site (Proposal site) and includes:

(i) A flood impact assessment of the MPW Stage 2 Proposal on the Georges River (**Section 4**).

(ii) Assessment of the MPW Stage 2 Proposal in isolation from the overall Moorebank Intermodal freight precinct, with respect to;

- Water Quantity (**Section 5**).
- Water Quality (**Section 6**).

(iii) Overall conclusion with respect to flooding and stormwater management and potential flood impacts (**Section 7**).

In addition, this report provides a concept drainage strategy for an ultimate Moorebank Precinct masterplan concept (in **Appendix D**). The concept Moorebank Precinct drainage strategy has been developed so as to provide a framework within which the proposed flooding and stormwater management for the Proposal site can be assessed, and facilitate the interfacing of the Proposal site with future staging.

The location of each of these report elements is presented in **Figure 3-1**.

Flood estimation terminology in included in **Appendix E**.

3.1 Previous Surface Water Plans and Studies

This environmental flooding and stormwater assessment also draws upon the following previous surface water plans and studies.

- *'SIMTA Sydney Intermodal Terminal Alliance: Flood Study and Stormwater Management Part 3A Concept Plan Application'* (Concept Plan report) by Hyder Consulting (dated 12 August 2011), for the Sydney Intermodal Terminal Alliance (SIMTA).
- '*Moorebank Intermodal Terminal Surface Water Assessment*' by Parsons Brinkerhoff Australia Pty Ltd (dated 25 June 2014), for the Moorebank Intermodal Company.
- '*Moorebank Intermodal Terminal Facility* - Stage 1 Stormwater and Flooding Environmental Assessment' by Hyder Consulting (dated 10 April 2015), for SIMTA.
- *'Upper Georges River Flood Study'* by Department of Land & Water Conservation in conjunction with Liverpool City Council (December 2000).

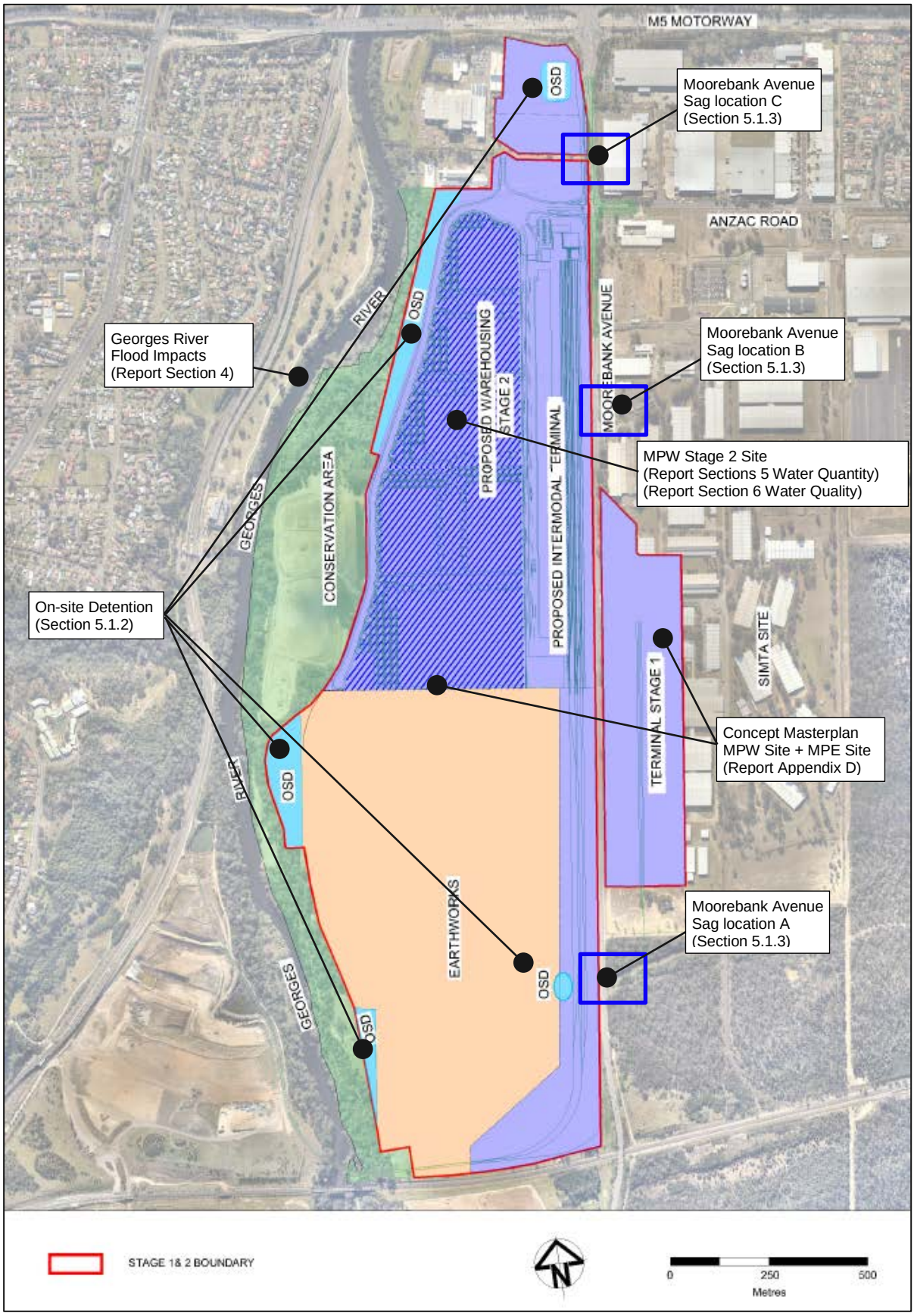


Figure 3-1: Flooding & Stormwater Report Structure

4 GEORGES RIVER

The Proposal site is located entirely within the catchment area of the Georges River. The Georges River enters the Liverpool LGA from the south on the western side of the Defence Lands at Holsworthy and flows to the north, meeting with Glenfield Creek at Casula. The river then 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 brackish and is subject to tidal influences.

As indicated in **Figure 4-1**, raising of the Proposal site (to facilitate site gradings and the proposed OSD basins) has the potential to impact on the Georges River flows and flood levels, although the site raising has essentially been limited to above the 100 year ARI flood extents, and the probable maximum flood (PMF) would only be impacted towards the northern end of the Proposal site.

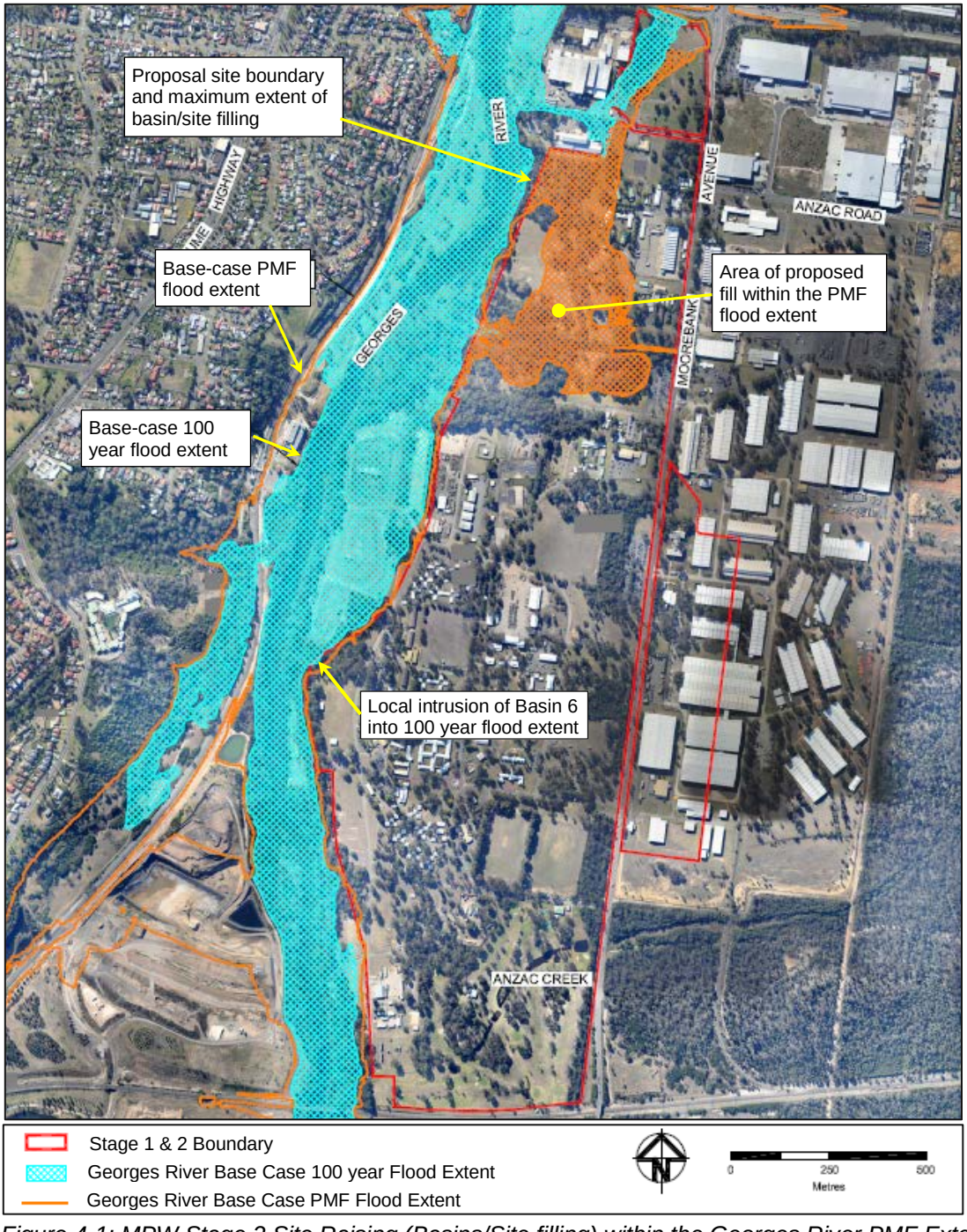


Figure 4-1: MPW Stage 2 Site Raising (Basins/Site filling) within the Georges River PMF Extents

That said, there is a very local intrusion of Basin 6 into the 100 year ARI flood extent. As such a flood impact assessment has been carried out, and is discussed in the following sections.

4.1 Flood Assessment Methodology

A flood assessment of the Georges River has previously been undertaken to analyse potential flooding impacts that may result from the proposed 'Sydney Intermodal Terminal Alliance (SIMTA) Stage 1 Project, which includes the Rail link and associated Georges River railway bridge. That assessment's analytical (HEC-RAS modelling) approach and findings are presented in the SIMTA Stage 1 Project approval documentation (*'SIMTA Intermodal Terminal Facility – Stage 1 Stormwater and Flooding Environmental Impact Assessment'* dated 10 April 2015, by Hyder Consulting).

To facilitate the Proposal site flood impact assessment, the April 2015 HEC-RAS model has been extended northward (adding River Stations 24 to 5) to beyond the northern extent of the Proposal site (as outlined in **Figure 4-2**). This extended model has served to determine 'Base-case' flood levels along the Georges River, with the 'Base-case' model approximating flood levels determined in the '*Upper Georges River Flood Study*' by Department of Land & Water Conservation in conjunction with Liverpool City Council, December 2000 (discussed more fully in the SIMTA Stage 1 Project approval documentation).

Subsequently, the Base-case (HEC-RAS) model has then been adjusted to represent raising of the Proposal site along the Georges River eastern overbank (outlined in **Figure 4-2**).

A summary of HEC-RAS modelling input data is included in **Appendix A**.

4.2 Flood Results

The 100 year and PMF flood estimates from the HEC-RAS 'Base-case' and 'Proposal site' modelling are summarised in **Table 4-1**. Additional HEC-RAS modelling output information is included in **Appendix A**.

The results indicate that the potential flood impacts of the proposed raising of the Proposal site would, up to a 100 year ARI event be negligible, and very limited (of the order of 0.01 metres (m)) for a PMF event.

4.3 Comments

Potential adverse flood impacts along the Georges River have been mitigated by limiting the Proposal site raising to areas above the 1% AEP.

Due to the minor intrusion of fill that is proposed on the Georges River floodplain, the HEC-RAS modelling approach is considered adequate for determining potential flood impacts.

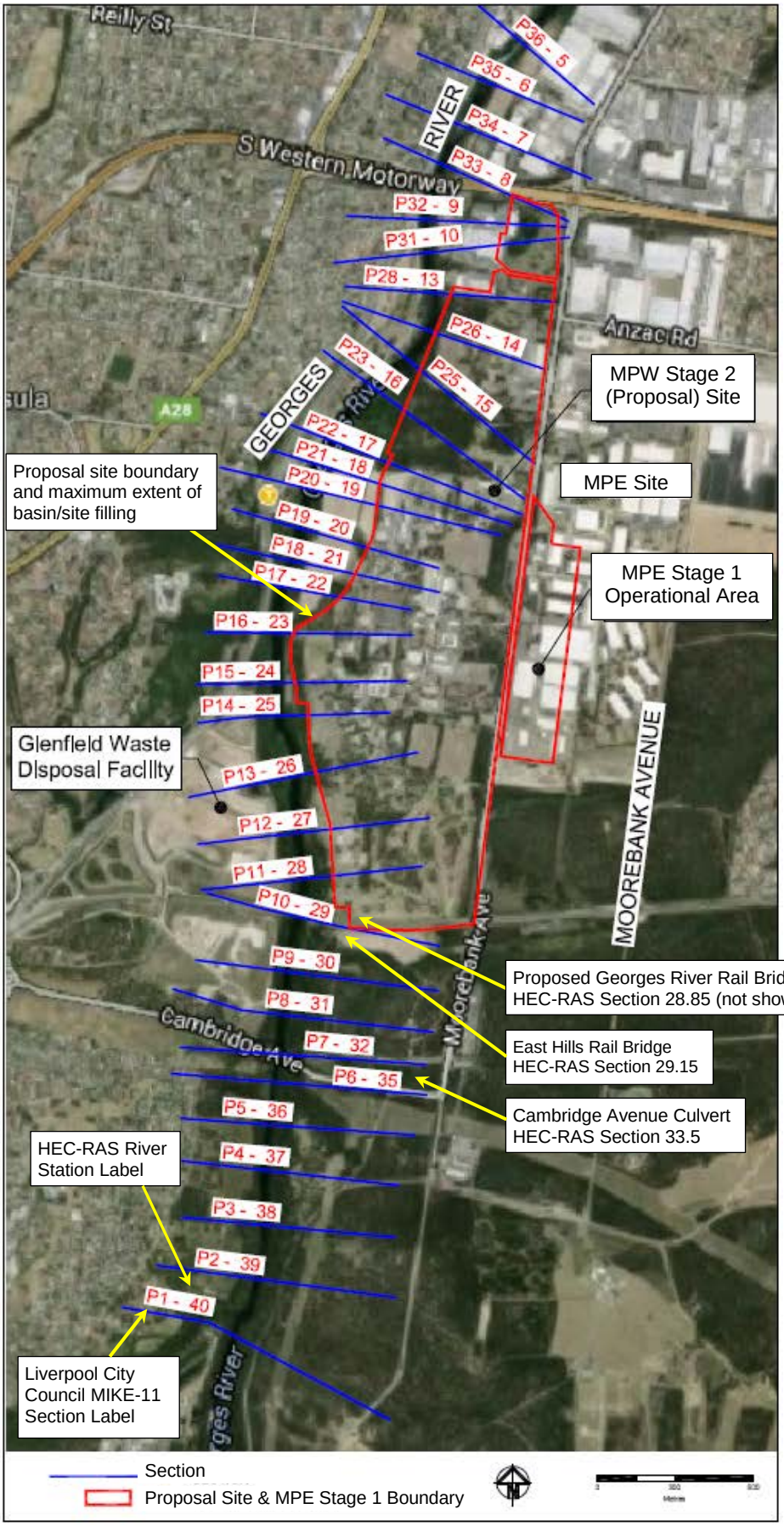


Figure 4-2: Location of HEC-RAS Model Sections

Table 4-1: Comparison of 'Base-Case' and 'MPW Stage 2 Proposed Development' Flood Levels

Location	100 year ARI			PMF		
	Flood Level (mAHD)		Flood Impact (mm)	Flood Level (mAHD)		Flood Impact (mm)
	Base-case Condition*	Proposed Condition		Base-case Condition*	Proposed Condition	
36	12.68	12.67	-0.01	16.24	16.24	0.00
35	12.68	12.67	-0.01	15.98	15.99	0.01
34	12.26	12.26	0.00	15.19	15.20	0.01
Cambridge Ave culvert	-	-	-	-	-	-
33	12.16	12.16	0.00	15.26	15.26	0.00
32	12.06	12.06	0.00	14.98	14.98	0.00
31	11.99	11.99	0.00	14.93	14.93	0.00
30	11.88	11.88	0.00	14.80	14.80	0.00
29.3	11.82	11.81	-0.01	14.72	14.72	0.00
29.2	11.76	11.75	-0.01	14.63	14.63	0.00
Existing. Rail Bridge	-	-	-	-	-	-
29.1	11.73	11.73	0.00	14.42	14.43	0.01
29	11.70	11.69	-0.01	14.43	14.43	0.00
28.9	11.72	11.72	0.00	14.43	14.43	0.00
Proposed MPE Stage 1 Rail Bridge	-	-	-	-	-	-
28.8	11.69	11.69	0.00	14.22	14.22	0.00
28.7	11.49	11.49	0.00	13.89	13.89	0.00
28	11.35	11.35	0.00	13.72	13.72	0.00
27	11.35	11.35	0.00	13.83	13.84	0.01
26	11.40	11.40	0.00	13.83	13.83	0.00
25	11.20	11.20	0.00	13.51	13.52	0.01
24	11.11	11.11	0.00	13.36	13.36	0.00
23	10.92	10.92	0.00	12.86	12.86	0.00
22	10.93	10.93	0.00	13.15	13.15	0.00
21	10.99	10.99	0.00	13.25	13.26	0.01
20	10.98	10.98	0.00	13.25	13.25	0.00
19	10.92	10.92	0.00	13.16	13.17	0.01
18	10.82	10.82	0.00	13.00	13.00	0.00
17	10.82	10.82	0.00	12.96	12.96	0.00
16	10.80	10.80	0.00	12.94	12.95	0.01
15	10.73	10.73	0.00	12.85	12.86	0.01
14	10.63	10.63	0.00	12.77	12.77	0.00

* i.e. with MPE Stage 1 Rail link potential flood impact (preliminary only, to be further assessed in MPE Stage 1 design)

5 WATER QUANTITY

The development of the Proposal site has the potential to impact upon the existing local area hydrology, Anzac Creek and the Georges River.

DRAINS software has been used to generate rainfall runoff models that represent both existing site conditions and post development site conditions to enable a comparison of discharges and quantify on-site detention (OSD) performance.

Initially, **Section 5.1** describes existing stormwater drainage conditions for the Moorebank Intermodal freight precinct site (i.e. inclusive of the MPE site and Proposal site), and DRAINS modelling of the Proposal site under existing conditions. The Proposal site stormwater analysis and design, potential flood impacts resulting from the Proposal site works, and associated flooding and stormwater mitigation measures, are summarised in **Section 5.2**. Subsequently, commentary is provided on the Proposal site regarding:

- Stormwater management and mitigation works during construction of the Proposal (**Section 5.3**).
- Flood emergency response planning (**Section 5.4**).
- Interfacing with future staging (**Section 5.5**).

5.1 Existing Conditions

As indicated in **Figure 5-1**, the Moorebank Intermodal freight precinct is bisected by Moorebank Avenue which runs in a north-south direction. The following sections describe the existing stormwater drainage conditions of the Moorebank Intermodal frieght precinct, which comprises:

- The MPE site.
- Moorebank Avenue.
- The MPW site.

MPE site

To the east of Moorebank Avenue is the MPE site which is itself bisected in a north-south direction by a catchment boundary. The general stormwater drainage conditions of the area to the east of Moorebank Avenue are described below:

- The eastern areas include two substantially developed catchment areas which discharge eastward via culverts (A and B) under Greenhills Road into open channels extending to Anzac Creek. However, the south-eastern corner (upstream of culvert B) has a significant flat area which provides considerable flood storage.
- The western areas are also significantly development and relatively flat, and include;
  - The MPE Stage 1 area which is to have mitigation features that are to limit site discharges (up to 100 year ARI events) to no greater than that of existing site conditions (as discussed in the 'SIMTA *Moorebank Intermodal Terminal Facility - Stage 1 Stormwater and Flooding Environmental Assessment'* by Hyder Consulting, 10 April 2015).
  - A number of small external areas discharge into the MPE site (as identified in the 'SIMTA *Moorebank Intermodal Terminal Facility - Stage 1 Stormwater and Flooding Environmental Assessment'* by Hyder Consulting, 10 April 2015).
  - A partially covered open channel which captures and conveys surface runoff to the north western corner of the site then westward, via a twin culvert C (2, 1.8m(h) x 2.0m(w)), under Moorebank Avenue, into an open channel and to the Georges River. However as shown in Photo 5-1, the upstream headwall entrance appears highly susceptible to blockage due to a combination of full height channel grating, walkway and fencing.

Photo 5-1: Moorebank Avenue, upstream of culvert, viewing west (downstream)

Moorebank Avenue

Moorebank Avenue itself has a crest located just to the south of the MPE site southern boundary. To the south of the road crest, runoff discharges to Anzac Creek. To the north of this (Georges river/Anzac Creek) road crest, overland flows generally discharge northward along the road corridor (towards culvert C). There are however a number of local pit and pipe systems on the western side of Moorebank Avenue including:

- A system which discharges from Moorebank Avenue westward under the MPW site then into the Georges River (shown in **Figure 5-1**).
- A conduit from the MPW carpark which discharges eastward under Moorebank Avenue into the MPE Stage 1 drainage system (which conveys flows northward to culvert C).
- Several other stormwater pits which may also discharge eastward into the MPE Stage 1 system, northward to culvert C or westward under the MPW site before discharging to the Georges River.

Approximately 200 m north of the culvert C crossing is a crest in Moorebank Avenue, followed by another sag in Moorebank Avenue some 400 m from the crest (just north of the Anzac Road intersection with Moorebank Avenue) where flows would again be relieved westward by a minor drainage system and overland via the road access to the ABB site. At location F of the ABB site is a twin culvert system (and overland flowpath), which continues westward towards the Georges River.

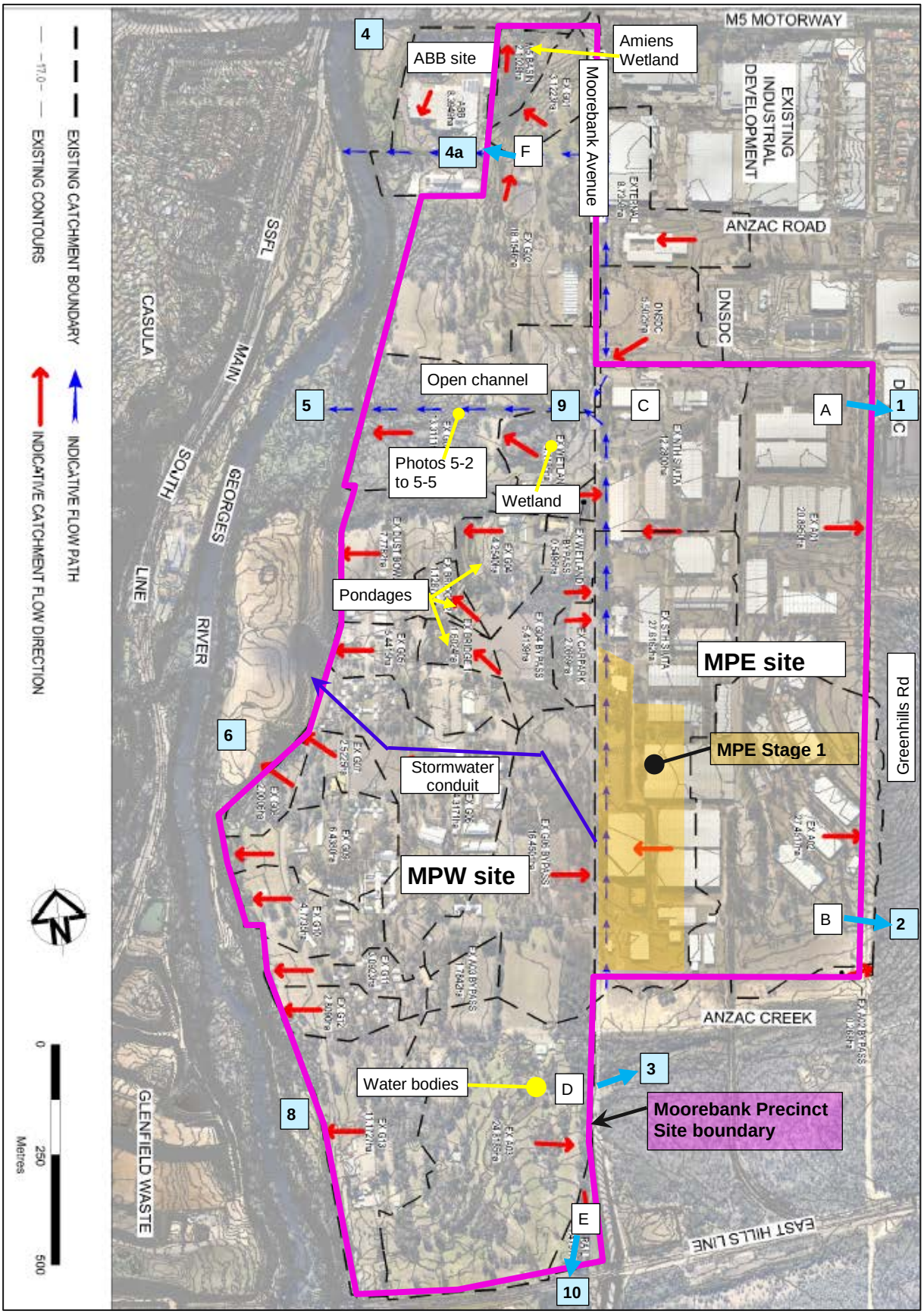


Figure 5-1: *Existing Site Conditions (refer also to **Appendix B** Existing Conditions catchment plan)*

MPW site (Proposal site)

To the west of Moorebank Avenue is the Proposal site. The south eastern portion of the Proposal site drains eastward, and is an upper catchment area of Anzac Creek. The remainder of the Proposal site discharges to the Georges River, either via Moorebank Avenue, or more directly from areas grading westward. As outlined in **Figure 5-1**:

- There are a number of existing buildings and infrastructure which are serviced by the local site drainage systems (not shown) that discharge to the Georges River.
- The southern portion of this area forms part of the Anzac Creek catchment and discharges eastward via culvert (D) under Moorebank Avenue. A very local area in the south, adjacent to Moorebank Avenue, discharges via a culvert (E) under the existing East Hills Rail Line and conveys in a south-westerly direction to the Georges River.
- This area includes a number of waterbodies:
  - Amiens wetland – located in the north-eastern corner of the site*, 'acts as an outlet controlled detention basin for the M5 Motorway and adjacent catchment, which means that if the water levels in the Georges River are elevated, the basin will not release water until its levels are below the outlet pipe levels. Waters are discharged from the Amiens wetland via piped connection to the Georges River'* (Parsons Brinkerhoff 2014).
  - Anzac Creek catchment water bodies – *'The densely vegetated and linked permanent waterbodies that form the headwaters of Anzac Creek provide some degree of detention and water quality treatment for stormwater flows from the local catchment draining to Anzac Creek. However, Anzac Creek is heavily degraded and is generally in poor condition'* (Parsons Brinkerhoff 2014).
  - Georges River catchment pondages – The site contains a number of small waterbodies that would provide some flow attenuation and/or water quality treatment. Two of the ponds serve as army training features and are without low flow outlets, a third pond to the north appears to be a more natural feature and has a channel outlet. Further north is a wetland which has no low flow outlet and appears to command only a local catchment area to the east of Moorebank Avenue.
- The open channel which conveys flows from the MPE site, through the MPW site, and into the Georges River, is initially a concrete lined trapezoidal shape. Approximately halfway between Moorebank Avenue and the Georges River, the concrete lined portion of the open channel is served by an energy dissipater which has catastrophically failed, resulting in major scouring (see Photos 5-2 to 5-5). Downstream is very inaccessible, and appears to be an incised and scoured unlined waterway, dropping away quite steeply down to the Georges River.

Photo 5-2: Channel failure and scouring viewing upstream (eastward)

Photo 5-3: Channel failure and scouring viewing downstream (westward)

Photo 5-4: Channel failure and scouring westward scouring

Photo 5-5: Channel failure and viewing viewing south-west

5.1.1 Assessment Methodology

Under existing conditions, the model catchments, impervious areas and drainage systems have been determined based on:

- Aerial photography.
- Aerial laser survey.
- Ground survey of the site where available.
- Site inspection carried out during the course of this assessment to clarify catchment features.
- Recent works associated with development of the north-eastern neighbouring property (based on the Australian Government Department of Defence project 'Defence Logistics Transformation Program DNSDC & JLU(V), Defence Project: JP0068P, Drawing Title: DNSDC – Civil Works Stormwatwer Management Plan, Dwg No. ACR-0367-0000-CI-SK-0050, issue: L for tender 22.10.12, prepared by Acor Consultants).

A catchment plan that represents the layout adopted for the existing conditions DRAINS model is included in **Appendix B**.

The DRAINS modelling parameters include:

- Paved area and Supplementary area depression storage = 1mm, and pervious area depression storage = 5mm.
- Soil type = 3.0.
- Antecedent moisture condition = 3.0 (rather wet).
- Initial and continuing losses of 20mm and 2.5mm/hr for pervious areas represented by the RAFTS module of DRAINS.
- RAFTS module 'Storage Coefficient Multiplication Factor' (Bx) = 1.0.

In addition:

- The Anzac Creek catchment area upstream (west) of Moorebank Avenue includes model parameters previously determined by Liverpool City Council (Council) in the process of conducting their Anzac Creek Floodplain Risk Management Study and Plan (by BMT WBM Pty Ltd, 30 May

2008), and the Georges River Floodplain Risk Management Study and Plan (by Bewsher Consulting, May 2004).

- Three pondages and a wetland located within the Georges River sub-catchments to the west of Moorebank Avenue have been modelled to include potential detention storage.
- The MPE Stage 1 Project works have been included (based on the configuration presented in the 'SIMTA *Moorebank Intermodal Terminal Facility* - Stage 1 Stormwater and Flooding Environmental Assessment' by Hyder Consulting (dated 10 April 2015), for MPE).

The DRAINS modelling has been run for storm durations of 5 minute to 36 hours for the 2 year, 5 year, 10 year, 20 year, and 100 year ARIs, and 15 minute to 6 hours probable maximum precipitation (PMP) events, and 30 hour and 36 hour extreme events (represented by 5x100year ARI).

A summary of the modelling input data is included in **Appendix B**.

5.1.2 Results

A summary of peak flows discharging from the Moorebank Intermodal terminal precinct is presented in **Table 5-1**. Summary of model outputs and sub-catchment flows leaving the Moorebank Intermodal terminal precinct are included in **Appendix B** for a range of storm durations.

5.2 Proposed Site Development Conditions

In demonstrating compliance with the SEARs itemised in **Table 1-1** of this report, analysis and design of the Proposal site under developed conditions has included:

- DRAINS modelling of indicative site areas with 10 year ARI minor drainage system capacity for the Proposal site (in accordance Liverpool City Council's *New South Wales Development Design Specification D5 Stormwater Drainage Design,* January 2003), and 50 year ARI capacity for rail areas.
- Indicative surface gradings and inlets that, in combination with stormwater conduit capacities would limit 100 year ARI surface ponding to no greater than 0.2m and depth x velocity limited to no greater than 0.4m^2/s within the Proposal site (excluding open waterways).
- 10 year ARI minor drainage system capacity and 100 year ARI major drainage system for the proposed (northern) Moorebank Avenue widening.
- Mitigation of potential adverse flood impacts that may otherwise result from the Proposal site development by the provision of:
  - On-site detention (OSD).
  - Drainage and flow relief from Moorebank Avenue westward through the Proposal site to the Georges River.

5.2.1 Assessment Methodology

To represent proposed development conditions, the existing conditions DRAINS modelling (discussed in **Sections 5.1.1** and **Section 5.1.2**) was adjusted to represent the post development site conditions as outlined **Figure 5-2** and in the accompanying design drawings. Model adjustments have included:

- Changes to sub-catchment boundaries. A sub-catchment plan that represents the layout adopted for the proposed conditions DRAINS model is included in the design drawings (noting that Basins 5 and 6 within the Proposal site have been sized to facilitate potential (minor) catchment area increases in future development stages).
- Increased imperviousness and reduced flow travel times representative of the proposed development.
- Introduction of detention storages 3a, 4, 5, 6 and 8. With respect to Basins 6 and 8, they have been assessed and sized to adequately mitigate the ultimate Moorebank Intermodal freight precinct development (and the Proposal site earthworks).

- A culvert that is to extend under the Proposal site Rail link connection and discharge westward into Anzac Creek. This culvert has also been assessed and sized to adequately convey ultimate Moorebank Intermodal terminal freight precinct development runoff (adopting 100% imperviousness and reduced flow travel times). Further discussion is provided in **Section 5.2.3** (Location B).
- An existing stormwater system which currently extends from Moorebank Avenue, through the Proposal site, to the Georges River. This system is to be realigned. Further discussion is provided in **Section 5.2.3** (The 'General' Western Moorebank Avenue Corridor Drainage).

An additional DRAINS model has also been created to represent stormwater systems for the largest site sub-catchment area which discharges into the southern end of Basin 5. This indicative system has been included as a separate DRAINS model to demonstrate typical system sizes, grades, cover and capacities – extending from the eastern rail corridor, westward through container handling areas, internal roads and parking areas, and via the western access road into the Basin(s). (For further discussion refer to **Section 5.2.4**.) A summary of the DRAINS modelling layout is included in **Appendix B**.

Specific elements of the Proposal site drainage analysis and design are discussed as follows.

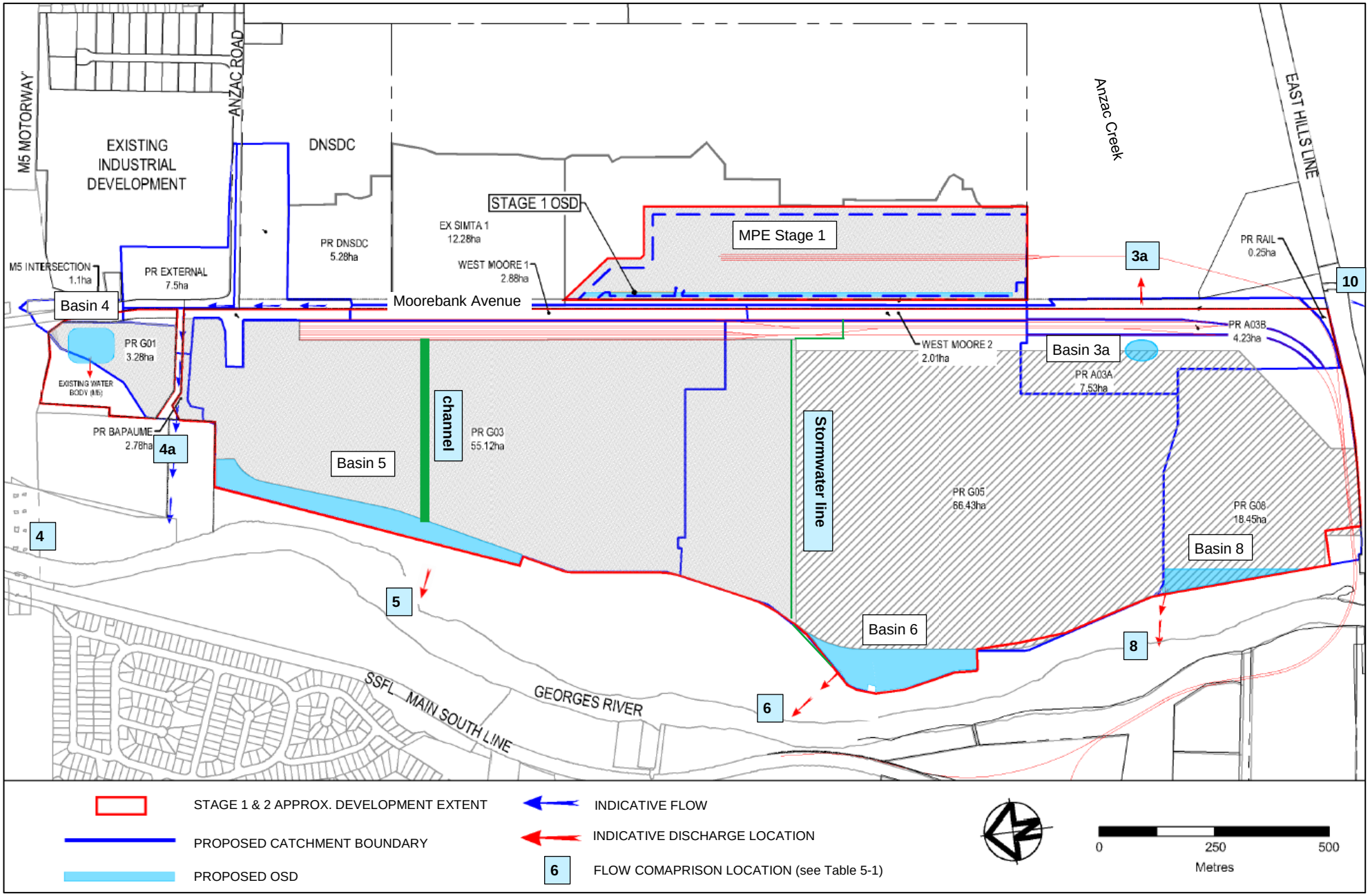


Figure 5-2: *Proposal site with inclusion of the (MPE) Stage 1 development*

5.2.2 On-Site Detention

A comparison of DRAINS model existing condition (**Section 5.1** modelling) and post-development condition flows at downstream locations of the Proposal site is included in **Table 5-1**, with a fuller comparison (being for a range of storm durations) provided in **Appendix B**. These results indicate that the proposed detention storages should adequately mitigate potential flow increases leaving the Proposal site.

A summary of the performance of the OSD storages is provided in **Table 5-2**, with concept OSD outlet designs provided in the accompanying design drawings. The low flow outlet configurations, and high level outlet weirs have been sized to control 100 year ARI flows for conditions entering basins with 'extended detention' (~3 month) water levels and low flow outlets fully blocked at the onset of the storm event.

Each of the four proposed Basins (4, 5, 6 and 8) discharging to the Georges River require outlet channels that are:

- To be configured with energy dissipaters and scour protection.
- In traversing the overbank areas of the Georges River, are to be no higher than existing ground surface levels (to avoid adverse flood impacts).
- Aligned with no less than a 45 degree entry angle into the Georges River channel.

It is likely that these outlet channels will include gabion and reno-mattress elements that accommodate grass and low vegetation as indicated in **Figure 5-3** and **Photo 5-6**.

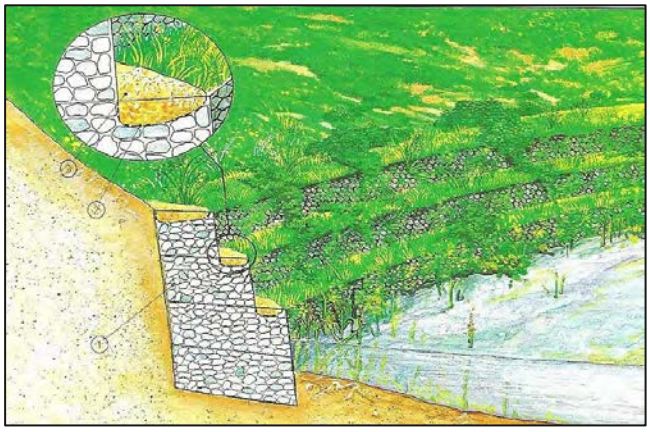


Figure 5-3: Vegetated Gabion Concept

Photo 5-6: Vegetated gabion structures

Table 5-1: Comparison of Existing Conditions and Proposed Development Peak Flow Estimates[#]

Discharge Location	Site Condition	Catchment Area (ha)	DRAINS Model Label	Flow (m^3/s)		
				5yr ARI	100yr ARI	PMF
8 Georges River MPW Site South	Existing	11.17	F Outlet 8	1.2	2.3	19
	Proposed	**18.45**	**F PR Outlet 8**	**0.5**	**0.9**	**27**
6 Georges River MPW Site (6+8)*	Existing	55.30	F Outlet 6	9.3	16.5	88
	Proposed	**85.24**	**F PR Outlet 6**	**2.3**	**5.3**	**110**
5 Georges River MPW Site (MPE + 5+6+8)*	Existing	155.53	F Outlet 5	16.0	29.1	168
	Proposed	**190.61**	**F PR Outlet 5**	**9.2**	**14.3**	**259**
4a MPW Site (at ABB Eastern Site boundary)	Existing	26.14	F EX G02	4.2	7.6	44
	Proposed	**10.65**	**F EX G02**	**3.0**	**4.6**	**21**
4 Georges River MPW Site North (4+4a+5+6+8)*	Existing	184.47	F EX Georges	19.4	34.8	199
	Proposed	**204.5**	**F PR Georges**	**11.7**	**18.5**	**277**
10 Georges River Rail MPW Site	Existing	1.48	C EX RAIL	0.0	0.1	0.6
	Proposed	**0.25**	**C PR RAIL**	**0.0**	**0.0**	**0.2**
3a Anzac Creek MPW Site South-east Site Boundary	Existing	24.82	F EX A3 Total	1.0	2.1	14
	Proposed	**11.77**	**F Anzac Cuvert**	**0.5**	**1.2**	**17**

* indicates cumulative discharge from Proposal site areas (see Figures 5-1 and 5-2 for flow locations)

[#] Refer to Appendix B for same storm duration comparisons

Table 5-2: Detention Storage Performance Summary

Storage [water quality extended detention level mAHD]	Catchment Area (ha)	Event	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)	Water Level (mAHD)	Volume (m^3)
Basin 4 MPW Site North [11.0]	3.3	100 year	1.9	0.3	11.48	3400*
		PMF	8.2	2.0	12.10	(7450)
Basin 5 Georges River MPW Site [11.3]	56.0	100 year	22.8	2.6	13.92	62800*
		PMF	105	80.0	14.70	(82600)
Basin 6 Georges River MPW Site [11.6]	66.8	100 year	27.2	4.3	13.92	58100*
		PMF	125	108	14.8	(79900)
Basin 8 Georges River MPW Site South [11.8]	18.5	100 year	8.2	0.9	14.49	20100*
		PMF	39	27.0	15.30	(26500)
Basin 3a Anzac Creek MPW Site South-east [15.0]	8.1	100 year	3.3	0.8	15.87	3500*
		PMF	17.5	15.1	16.40	(5500)

* Approximate 100 year active storage above water quality extended detention water level (see Figure 5-2 for Basin locations) Storage parameters and outlet configuration are included in Appendix B.
* Assumes OSD spills along approximate length of downstream wall.

5.2.3 Moorebank Avenue

The DRAINS modelling has also facilitated flow analysis and stormwater design along the Moorebank Avenue corridor. In particular, analysis of flow regimes has been carried out at the following locations that may potentially be impacted by the Proposal:

- **Location A (Figure 5-1 Culvert D)**: The southern culvert, which conveys flows from the Proposal site (existing golf course area), under Moorebank Avenue into Anzac Creek (Photo A1). No drainage works are proposed at this culvert crossing location, nor any changes to the existing swale drainage within the road corridor. That said:
  - The Proposal site catchment discharging westward to the Georges River is increased compared to existing conditions, hence reducing the Proposal site area discharging eastward to Moorebank Avenue (and its associated culvert).
  - To mitigate potential flow increases from the Proposal site, OSD is required (Basin 3a, as indicated in the accompanying design drawings).
  - While the Proposal site DRAINS modelling indicates a 100 year ARI flow of 0.8m^3/s draining from this area, the proposed Rail link connection requires a new culvert (indicated in the accompanying design drawings) to convey flows under the Rail link connection and into the existing culvert (under Moorebank Avenue). The new culvert has been sized to convey flows so as to accommodate the concept masterplan catchments and on-site detention location, and provide flexibility with respect to future staging.

Photo A1: Moorebank Ave 'Location A' southern culvert crossing, viewing south (Google street view)

- **Location B (Figure 5-1 Culvert C)**: This Moorebank Avenue culvert crossing (Photos B1 and B2) conveys flows from the MPE site (at its northern end) westward through the MPW Stage 2 site to the Georges River.

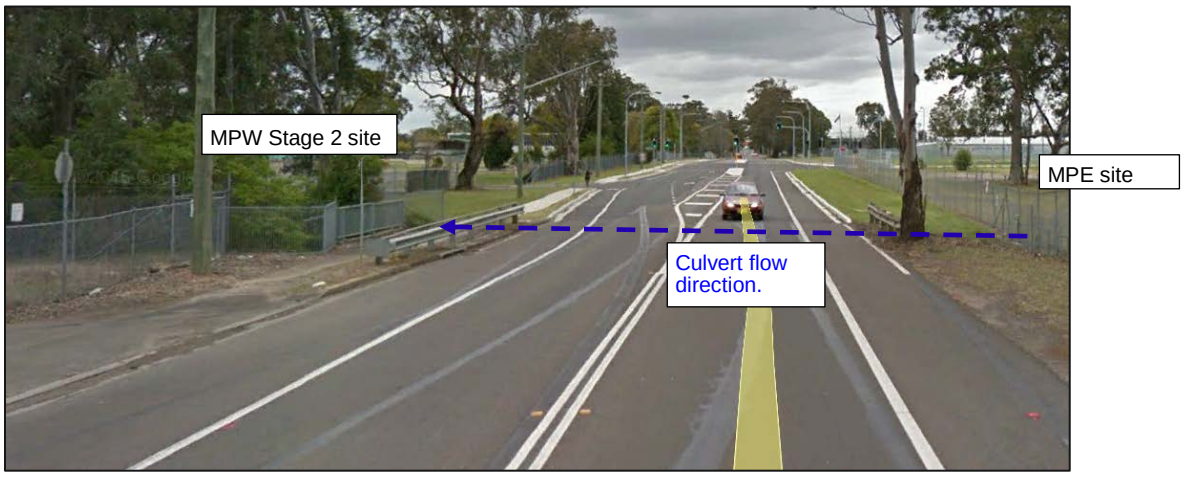


Photo B1: Moorebank Ave 'Location B' culvert crossing, viewing north (Google street view)

Photo B2: Moorebank Ave 'Location B', viewing upstream eastward (Google street view)

DRAINS modelling indicates that while the existing culvert could convey approximately 14m^3/s for unblocked conditions, full height grating at the culvert inlet (Photo B2, see also Photo 5-1 **Section 5.1**), may result in the culvert entrance becoming almost fully obstructed. As such, a weir analysis of water levels over Moorebank Avenue has been carried out with 100 year fully blocked culvert flows overtopping the Moorebank Avenue road corridor. (*Removal of the within channel grating would reduce the likelihood of blockage and flow obstruction. This may be a possible solution to reducing flows overtopping Moorebank Avenue, however the purpose(s) for the grating may include site security, requiring formal approval from the landholder(s) before removal of the grating.*)

Weir analysis of 100 year flows (of 14m^3/s) overtopping Moorebank Avenue has been based upon flows from the MPE site being no worse than under the pre-MPE Stage 1 Project (noting that the MPE Stage 1 OSD proposed in 'SIMTA *Moorebank Intermodal Terminal Facility* - Stage 1 Stormwater and Flooding Environmental Assessment' by Hyder Consulting, dated 10 April 2015, may reduce this peak flow).

The weir analysis indicates that such flows may extend along Moorebank Avenue for approximately 140m, with water up to 0.3m deep over the road centreline (at a water level of approximately 14.38mAHD) under existing conditions.

To mitigate the predicted impacts under the MPW Stage 2 development conditions, a drainage apron (approximately 155m long x 20m wide) is proposed. The proposed drainage apron (outlined in Photo B3) is to serve as an overland flow path grading from the western edge of the Moorebank Avenue pavement to a 15m(w) x 3.3m min.(h) partially covered channel (and associated lower level 2.4m(w) x 1.8m (h) culvert) to replace the existing open channel, and convey flows some 500m westward through the MPW Stage 2 site, then to the Georges River. This proposed system has been configured/sized to be resistant to blockage.

Weir analysis of this proposed development configuration (included in **Appendix B**) indicates that water levels over the Moorebank Avenue centreline (for an overland flow of 14m^3/s) would be of the order of 14.39mAHD (a 10mm increase compared to existing conditions), indicating that potential water level increases would be effectively mitigated.

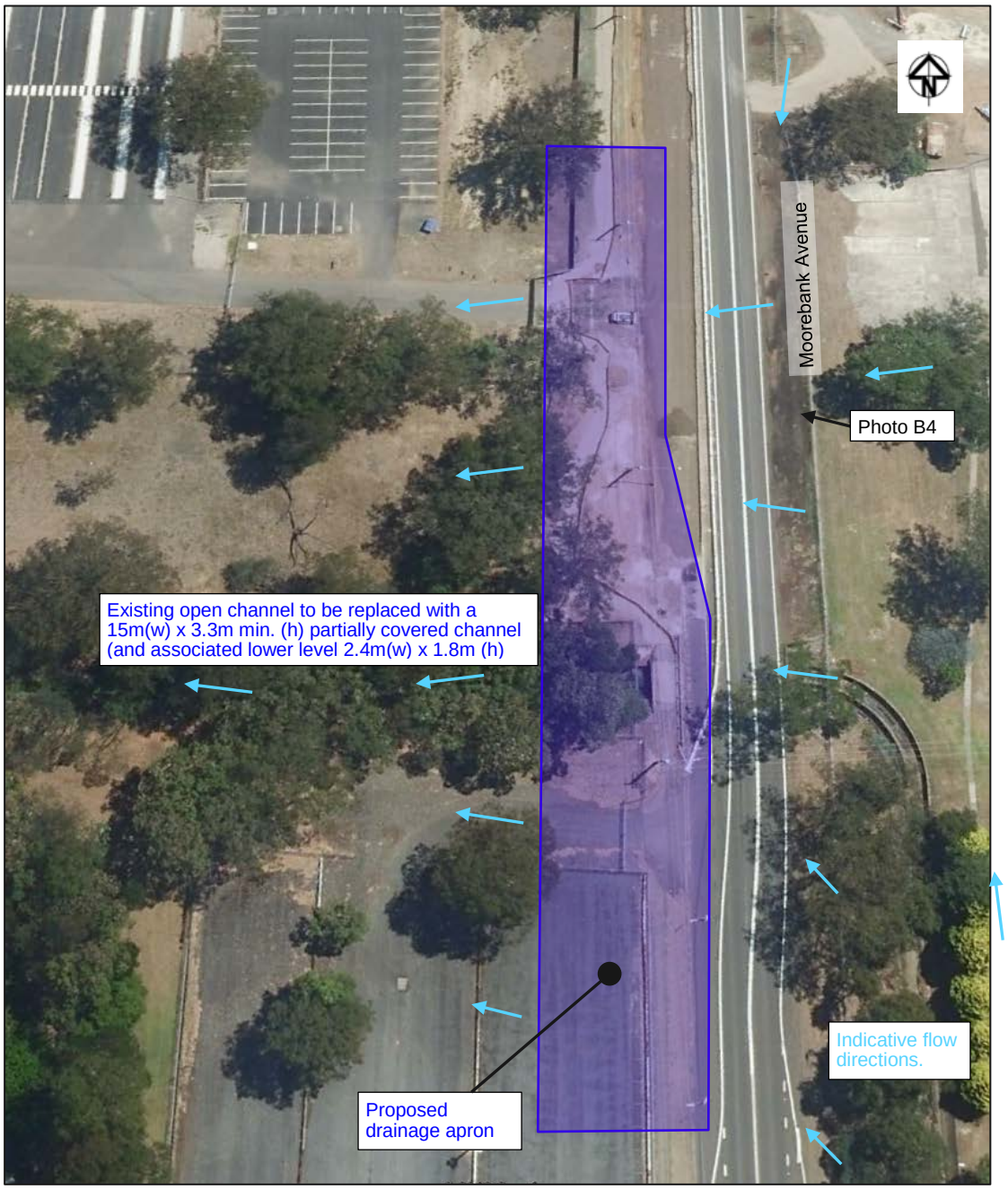


Photo B3: Moorebank Ave 'Location B' indicating proposed drainage apron (Google street view)

Photo B4: Moorebank Ave ‘Location B’ viewing north-west (Google street view)

In a PMF event, flows overtopping Moorebank Avenue at this location (under existing conditions) are estimated to be of the order of 68m^3/s, resulting in a depth of up to 0.5m over the road centreline (at a level of approximately 14.65AHD). Under the MPW Stage 2 development condition, the proposed drainage apron and associated conveyance system would limit inundation of Moorebank Avenue to approximately 14.72mAHD, an increase of approximately 0.07m (compared with existing conditions).

A summary of the Moorebank Avenue weir analyses is included in **Appendix B**. Further discussion on the proposed drainage apron and channel system is provided in **Section 5.2.6** and **5.6.2**.

The proposed drainage apron and channel system is outlined in the accompanying design drawings. To facilitate the conveyance of overland flows from Moorebank Avenue into the proposed partially covered channel, the apron is to include a concrete channel area (between the existing culvert headwall and the proposed channel) and otherwise be an open area of well-maintained grass with surface features otherwise limited to small to medium sized clean trunked trees (mature trunk diameters limited to 0.4m) at spacings no closer than 15m, and no closer than 10m either side of the proposed concrete channel.

With respect to emergency evacuation, analysis of the PMF conditions indicates that a 30 minute duration event generates peak PMF flows at this location. Due to the ‘flash flooding’ nature of this highly urbanised area, the resulting short inundation times are expected to have little if any impact on evacuation movements, and on-site refuge is to be provided (discussed in **Section 5.5**).

- **Location C (Figure 5-1 upstream of Culvert F)**: Bapaume Road is located approximately 200m south of the M5 Motorway (Photos C1 to C3), and relieves overland flows and ponding in Moorebank Avenue westward to the Georges River (via the ABB site).

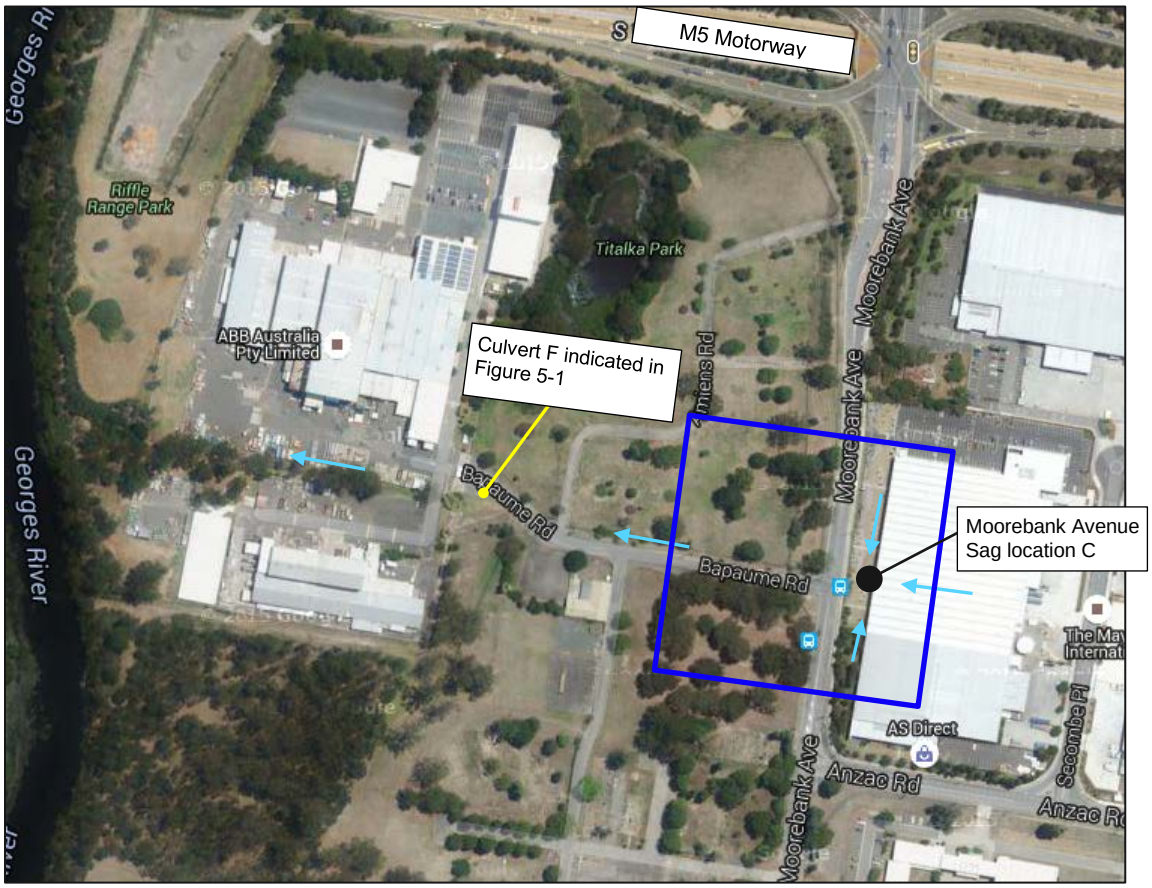


Photo C-1: Moorebank Ave 'Location C' indicating proposed drainage apron (Moorebank Avenue widening not shown) (Google street view)

Photo C2: Moorebank Ave 'Location C', Moorebank Ave/Bapaume Road intersection, viewing north (Google street view)

Photo C3: Moorebank Ave 'Location C', Moorebank Ave/Bapaume Road intersection, viewing west along Bapaume Road (Google street view)

This is an area where there is a potential for the Proposal site to impact on local stormwater and flood conditions due to Moorebank Avenue widening, regrading, and the proposed site filling. Analysis of the potential impacts and mitigation measures has included DRAINS modelling and weir assessment. DRAINS model and weir assessment information is included in **Appendix B**. These assessments and associated design issues are discussed as follows.

Existing conditions

- ***100 year ARI flows***
  Under these conditions, Moorebank Avenue overland flows have been determined to be approximately 1.3m^3/s at this intersection, with weir analysis indicating flows crossing Moorebank Avenue would be of the order of 0.22m deep over the road centreline (at a water level of approximately 13.96mAHD).
- ***Greater than 100 year ARI flows***
  In a PMF event, flows overtopping Moorebank Avenue at this location are estimated to be 19m^3/s, with flows over Moorebank Avenue having a depth of up to 0.38m over the road centreline (of 13.74mAHD) with a water level of approximately 14.12AHD.

MPW Stage 2 development conditions

- ***100 year ARI flows***
  Under these conditions, stormwater pit and conduit upgrading is proposed to reduce 100 year ARI overland flows and limit depths on Moorebank Avenue to no greater than 0.2m. With the proposed Moorebank Avenue widening, the proposed eastern street sag is to have a top of grate level of approximately 13.40mAHD, with a resulting water level of approximately 13.60mAHD, 0.36m lower than for existing conditions.
- ***Greater than 100 year ARI flows***
  In a PMF event, flows overtopping Moorebank Avenue at this location would be reduced to approximately 15m^3/s due to regrading of the MPW Stage 2 site and the proposed drainage inlet and conduit upgrades. However, if the road alignment design includes for a longitudinal grade of 0.5%, a 2.5% cross fall, and a road crest median (0.13m upstand, to limit traffic movements across the intersection), then water levels over Moorebank Avenue would increase by approximately 0.32m to a level of 14.44mAHD, with a depth over the proposed median (13.89mAHD at the Moorebank Avenue sag, adjacent to Bapaume Road) of 0.55m, and a depth of 1.04m over the gutter sag pit (being at approximately 13.40mAHD).

  In the process of considering how to further mitigate potential flood impacts for events greater than 100 year ARI, it is apparent that increasing the hydraulic capacity of Bapaume Road is necessary. Lowering of Bapaume Road (by the order of 0.5m) would be an option for achieving

the necessary hydraulic capacity. However, the capacity increase would be limited without also lowering of the Moorebank Avenue road crest.

While there is limited opportunity to lower Moorebank Avenue gutter sags (due to downnstream flow constraints at the western site boundary with ABB site), there is the opportunity to incorporate the following features in the Moorebank Avenue design (to lower its crest and hence flood levels):

- Replace the proposed Moorebank Avenue median with other traffic control devices that would not constrain overland flows, such as wire rope barrier.
- Lower the Moorebank Avenue centre-line (for a length of approximately 60m either side of the Bapaume Road intersection) by reducing the road cross-fall to say 2%, and the longitudinal grade to 0.3%. To avoid high maintence and trafficability issues resulting from such flat grades, consideration should be given to rigid pavement, dense/close graded asphalt, and continuous strip drainage.

With respect to emergency evacuation, analysis of the PMF conditions indicates that a 15 minute duration event generates peak PMF flows at this location. Hence, similar to 'Location B,' the 'flash flooding' nature of this highly urbanised area would result in short inundation times that are expected to have little if any impact on evacuation movements, and requiring on-site refuge is to be provided (discussed in **Section 5.5**).

It recommended that future Moorebank Avenue analysis and detailed design take into consideration the above-noted road alignment requirements and pavement design features to adequately mitigate potential adverse flood impacts.

- **The 'General' Western Moorebank Avenue Corridor Drainage**: As discussed in **Section 5.1** drainage of the western side of the Moorebank Avenue corridor includes several existing pit and conduit systems, some which discharge:
  - Westward under the Proposal site (in addition to the systems which connect into the location B [culvert] and location C [Bapaume Road drainage]).
  - To the east into the MPE site drainage system.

  The proposed stormwater management approach of these western Moorebank Avenue drainage systems is, where appropriate, to retain the existing systems/flow distribution connections. This approach is proposed to include:
  - Retaining of the southern system, yet realigning it through the Proposal site to avoid building over. In doing so, a drainage easement may potentially be necessary. Alternatively, this existing system could be realigned to drain northward (running along the western side of Moorebank Avenue) and discharging into the proposed channel/culvert system to be located immediately downstream of the existing culvert under Moorebank Avenue (at Location B).
  - Upgrading of the northern drainage systems discharging to Bapaume Road, so as to mitigate potential cross drainage flood impacts associated with the northern Moorebank Avenue pavement works, providing a minimum 10 year ARI minor system capacity and limiting 100 year ARI ponding depths to no greater than 0.2m.

  As part of the flood mitigation process, flows along the length of the Moorebank Avenue corridor are to be reduced by diverting Proposal site areas (that currently discharge into the corridor), westward (away from Moorebank Avenue) to the Georges River via proposed OSD storages.

5.2.4 Site Drainage System

DRAINS modelling of the indicative site drainage system (discussed in **Section 5.2.1**) indicates:

- Upstream 'IMT facility' areas are likely to be served by grated strip drainage discharging into minimum conduit sizes of 450mm diameter, achieving typical minimum grades of 0.5% to 1% with adequate pavement cover.
- The downstream system extending under the western access road and entering Basin 5, may be of the order of 3, 2.4m(w)x1.2m(h) with grades possibly limited to less than 0.5%, however achieving minimum self cleansing velocities of no less than 0.6m/s.

Open channels may also be appropriate as alternatives to some sections of stormwater conduits. However, the introduction of sections of covered over waterways would require consideration of blockage potential and associated design.

Based on the DRAINS model of the indicative site drainage system, a concept site trunk drainage layout is provided in the accompanying design drawings.

5.2.5 Sensitivity Assessment

OSD/Rainfall

A sensitivity assessment was also carried out with 100 year rainfall intensities increased by 10%. This resulted in an increase in 100 year ARI water levels of approximately 0.05m to 0.2m in the OSD storages. This sensitivity assessment is considered representative of potential climate change impacts, consistent with projected rainfall increases in accordance with the New South Wales Department of Environment and Climate Change (DECC) 'Floodplain Risk Management Guideline Practical Consideration of Climate Change' (October 2007) for Hawkesbury-Nepean catchment.

5.2.6 Comments and Conclusions

The DRAINS modelling results indicate that the proposed drainage systems and OSDs would provide adequate system capacities and mitigate potential adverse flood impacts that may otherwise result from the Proposal. However it should be noted that there are several design issues and potential refinements (itemised below) that should be taken into consideration during detailed design so as to be consistent with the stormwater management proposed in this report and the accompanying design drawings.

On-Site Detention (OSD) Configurations

Design of the OSDs also allows for alternative configurations with respect to landscaping and OSD form (than simply the vertical sided walls indicated on the accompanying design drawings). That said, it should be noted that:

1. Batter slopes of landscape storage systems that would comply with Liverpool City Council (LCC) requirements are 1(V):4(H) (OSD Stormwater Detention Technical Specification, LCC, January 2003), noting that basin side slopes should be 'preferably no steeper than 1 in 6 to allow easy egress' (Development Design Specification D5 Stormwater Drainage Design, LCC, January 2003)
2. Trees are not to be planted on basin embankments (Development Design Specification D5 Stormwater Drainage Design, LCC, January 2003), with trees to be located away from the toe of batters
3. A minimum freeboard of 0.3m above the 100 year water level is necessary.
4. Spillways to manage greater than 100 year ARI events should be located at the northern extents of the OSD discharging into the Georges River to minimise potential flood impacts.

There is also flexibility to alter catchment boundaries and areas. However such changes would require a similar process of pre and post development rainfall-runoff analysis (for multiple recurrence interval and rainfall durations) to demonstrate adequate mitigation of potential flow increases discharging to neighbouring and downstream areas. Furthermore, should such OSD and/or catchment area changes be considered, then all of the catchments and OSDs require assessing individually and in combination (with respect to mitigation performance).

Catchments and Development Flexibility

Catchment areas and site levels/gradings will be a crucial component of the development with respect to OSD sizes and locations, and interfacing the broader land-use and aims of the Proposal site.

In particular, since warehouse roof areas/buildings are the dominant feature of the Proposal site, development controls will be necessary, ensuring that individual building development discharge areas and locations are strictly adhered to in order to effectively utilise the stormwater conduits and OSDs, and hence comply with flooding and stormwater mitigation requirements. Flexibility for individual warehouse developments would still remain (following the installation of stormwater infrastructure). However such flexibility would require assessment of adequacy of the OSDs and associated stormwater systems to support the altered warehouse arrangements.

Moorebank Avenue

Future analysis and design refinements of the stormwater systems associated with:

- the Moorebank Avenue culvert crossing, drainage apron and channel at 'Locations B', and
- the Moorebank Avenue widening and realignment, and Bapaume Road drainage, at 'Location C'

should be based upon rigorous 2-dimensional modelling (using TUFLOW software or similar) so as to confirm performance and adequate mitigation of potential adverse flood impacts.

Pavement Grades

There are varying and alternative pavements and associated drainage configurations, particularly in the Intermodal terminal facility area, with a key consideration being the surface grading. To minimise local ponding and breakdown of pavement areas, minimum grades are necessary across the Proposal site. For concrete pavements, 1% minimum grading is recommended. For pavers and bitumen surfaces, 2% minimum grading, and if gravel surfacing (sometimes suitable in say container areas) horizontal grading may prove adequate.

While steeper than the minimum grades may further limit potential water damage to pavements, the above noted minimum grades limit the potential damage to container units in the handling and operation processes (UNCTAD Monographs on Port Management 5 Container Terminal Pavement Management, United Nations, 1996, p53).

Noise Barriers

Noise barriers that are proposed along the western length of the Proposal internal road are to be configured to accommodate:

- Overland flows from the eastern upstream areas of the Proposal site to continue westward into the proposed OSD storages and the Georges River. To do so, a continuous gap of 0.3m minimum height is required between finished ground surface levels and the underside of noise barriers.
- Maintenance of the OSD storages, vehicle access (between the internal road and the OSDs) will be necessary through the noise barriers.

5.3 Early Works

During Early Works for the MPW Project, regrading and stockpiling of fill is proposed within the central portion of the MPW site. A footprint of the stockpiling is outlined in **Appendix B** and provides indicative stormwater management, involving:

- Catch drains/drainage swales
- Sediment basins
- Indicative top of stockpile grading.

The existing stormwater conduit (which runs through the Proposal site (outlined in **Figure 5.1**)) conveys flows from Moorebank Avenue to the Georges River. This system will require assessment of its integrity and structural adequacy to withstand the Early Works loadings if it is to remain. Alternatively, it could be realigned, as discussed in **Section 5.2.3** (Moorebank Avenue, The 'General' Western Moorebank Avenue Corridor Drainage).

Furthermore, flood emergency response plans (FERPs) will be necessary for each of the Proposal areas as discussed in **Section 5.5**.

5.4 Construction Phase

During construction of the Proposal, to avoid potential adverse flood impacts on neighbouring property, flood mitigation measures necessary to maintain existing condition flow regimes and distributions leaving the construction area (so as to maintain runoff to no greater than for existing conditions) should include such alternatives as:

- Maintaining existing site catchment/sub-catchment boundaries.
- Limiting site imperviousness and grades to no greater than under existing development conditions.
- Provision of all the Proposal site OSDs (with associate catchment areas) in a completed operational state prior to the introduction of impervious areas (additional to existing conditions).
- Smaller detention storages that provide adequate rainfall runoff mitigation during partial construction/site development. If proposed, all such alternative/temporary detention storages will require analysis (as per **Section 5.2.6**) to determine the adequacy of their flood mitigation performance.
- The existing stormwater conduit (which runs through the Proposal site (outlined in **Figure 5.1**) conveys flows from Moorebank Avenue to the Georges River. This system will require assessment of its integrity and structural adequacy to withstand the construction works loadings if it is to remain. Alternatively, it could be realigned, as discussed in **Section 5.2.3** (Moorebank Avenue, The 'General' Western Moorebank Avenue Corridor Drainage).

Furthermore, FERPs will be necessary for each of the Proposal areas as discussed in **Section 5.5**.

5.5 Flood Emergency Response Plans

Part of the approach to the overall stormwater management for the Proposal is the consideration of evacuation and refuge. For this reason site conditions during a PMF are to be considered.

It will be necessary for the operator to develop FERPs for the construction and operational stages of the Proposal taking into consideration site flooding and broader flood emergency response plans for the Georges River and Anzac Creek floodplains, and Moorebank area.

For areas impacted by Georges River flooding, flood warning may be available, and FERPs could be quite different in terms of flood readiness, evacuation and recovery, than for say the areas of the Proposal site away from the Georges River flooding areas, e.g. works on Moorebank Avenue.

5.5.1 MPW Stage 2 Operational Area

While proposed filling will raise the operational area above the regional PMF levels, areas not impacted by regional flooding can still be affected by local PMF flow regimes.

The operational area is located within upper catchment areas and, as recognised in the NSW Floodplain Management Manual (April 2005, Section L6.2), there would be little if any available warning time for people to undertake action. As such, in developing an evacuation and refuge plan, it should include safe refuge within the Proposal site (above PMF flood levels) until hazardous flows have subsided and safe evacuation is possible.

5.6 Interfacing with Future Staging of the Moorebank Precinct

The proposed stormwater management for the Proposal has taken into consideration the approved and proposed development of the MPW Project and the adjacent MPE Project as part of the broader Moorebank Intermodal freight precinct. The following sections outline design consideration for integration of the Proposal within an overall strategy for stormwater management for the Moorebank Intermodal freight precinct.

5.6.1 On-Site Detention

The Proposal site sits within the context of a broader Moorebank Intermodal freight precinct which involves the development of the MPE site (inclusive of MPE Stage 1 Project) and the MPW site (inclusive of the Proposal site). A concept masterplan layout for the Moorebank Intermodal freight precinct is provided in **Appendix D**.

With respect to OSD (for rainfall-runoff mitigation), the Proposal site catchment areas and associated OSD storages form part of the OSD strategy for all future stages of the development as indicated in the Moorebank Intermodal freight precinct concept masterplan. In particular, Basins 5 and 6 have been sized to mitigate runoff from slightly larger catchment areas that may occur in future development stages, as identified in the accompanying design drawings and concept masterplan.

5.6.2 MPE Culvert and Channel

At Moorebank Avenue 'Location B' (see **Figure 5.2**), the proposed 15m(w) x 3.3m(h) partially covered channel and the associated 2.4m(w)x1.8m(h) culvert conveyance system that extends through the Proposal site (discussed in Section 5.2.3), is expected to accommode potential future stage Moorebank Road widening and re-alignment so as to convey external catchment runoff from Moorebank Avenue to the Georges River. Furthermore, the lower (culvert) section associated with the 15m wide channel is proposed to facilitate minimum grades (of 0.5%) for potential stormwater conduits servicing Moorebank Avenue in future stages of the Moorebank Intermodal freight precinct development.

That said, should the Proposal site levels (opposite the Georges River catchment areas of the MPE site) be lowered to no higher than the MPE site levels, then an option of – *raising Moorebank Avenue, to allow greater than 100 year ARI flows to sheet over (the raised) Moorebank Avenue and continue westward through the MPW Stage 2 site to the Georges River* – would remain available. Currently, the MPE Stage 1 Project has levels of 16.5mAHD along its western boundary, and the Proposal has top of rail levels along its eastern boundary of 17.2mAHD (0.6m higher than the MPE levels).

Lowering the Proposal levels provide opportunity for:

- Future raising of Moorebank Avenue that could result in:
  - relatively shallow sheet flows crossing Moorebank Avenue and extending through the MPW site;
  - a reduced concentration of flows at 'Location B'; and
  - a reduction in the partially covered channel sizing.
- Re-configuring a portion of the partially covered channel (in future design stages) to provide OSD, offsetting say some of the Basin 9 detention storage (shown in **Appendix D**, on the concept masterplan Figure A1-1).

To leave open the abovenoted opportunities, during future design stages of the Proposal site consideration ought be given to:

- Lowering the top of rail level within the Proposal site from 17.2mAHD to the 16.5mAHD.
- Setting these rails in concrete (rather than on ballast) to enable minimum stormwater grades (of 0.5%) to be achieved.
- Raising the alignment of the Moorebank Avenue and the MPE site (future warehouse) area north of the MPE Stage 1 Project, at a no later stage than the MPW Stage 2 works (if the benefit of reduced size of the partially covered channel, and flow concentration at 'Location B' is to achieved).

5.6.3 ANZAC Creek Catchment

With respect to the Anzac Creek catchment, the culvert proposed in the Proposal site works (under the Rail Link connection) has been sized and located to accommodate the concept masterplan layout (as shown in **Appendix D** Figure A1-1).

6 WATER QUALITY

6.1 Objectives and Performance Targets

The stormwater quality objectives and performance targets for the Proposal have been derived from the following key documents.

- ***Liverpool Development Control Plan 2008*** (Liverpool City Council, 12 November 2014) – provides general objectives and controls that apply to development within Liverpool LGA.
- ***Georges River Estuary Coastal Zone Management Plan*** (CZMP) (Georges River Combined Council's Committee, July 2013) – provides objectives and targets specifically for the Georges River Estuary and its catchment.
- ***SEARs for MPW Stage 2***.
- ***REMMs for MPW Stage 2***.

6.1.1 Objectives

The key objectives for stormwater quality management for the Proposal include:

- Maintain or improve existing water quality.
- To protect the aquatic environment of the downstream waterways including the Georges River.
- Prevent bed and bank erosion and instability of waterways.
- Provide sufficient flows to support aquatic environments and ecological processes.
- Incorporate a Water Sensitive Urban Design (WSUD) approach.

6.1.2 Performance Targets

Water quality performance targets for the Proposal have been derived from the key documents identified above and are summarised in **Table 6-1**.

Table 6-1: Water Quality Performance Targets

Item	Liverpool DCP 2008	Georges River Estuary CZMP 2013	SEARs
Total Suspended Solids (TSS)	80%	**85%**	**NorBE**
Total Phosphorus (TP)	45%	**60%**	**NorBE**
Total Nitrogen (TN)	45%	**45%**	**NorBE**
Gross Pollutants (GP)	90%	**90%**	**NorBE**

Table Key:
- *Percentage (%) values are the pollutant reduction targets relative to post development pollutant loads without any treatment*
- *NorBE = Neutral or Beneficial Effect (ie. 'maintain or improve existing water quality' as required by the SEARs)*
- **Bold** values are the adopted targets

While the percentage reduction targets contained in Georges River Estuary CZMP are more stringent than the targets contained in Liverpool DCP 2008, given that they have been developed specifically for the Georges River catchment it is considered appropriate to adopt these for the Proposal. In addition to these percentage reduction targets, the SEARs require existing water quality to be maintained or improved (ie. 'NorBE' / Neutral or Beneficial Effect). Whether NorBE is more stringent than the percentage reduction targets depends on the existing water quality conditions and it is considered

appropriate to check the performance of the proposed WSUD strategy against both targets. Therefore, both the Georges River Estuary CZMP percentage reduction and NorBE targets have been adopted for the site.

6.2 Proposed Water Quality Measures

To address potential impacts on stormwater quality, WSUD principles and a treatment train approach have been adopted. Two key treatment measures are proposed for the Proposal to meet the performance targets:

1. Gross Pollutant Traps (GPTs)
2. Rain gardens (Bioretention systems).

In addition, operational water quality monitoring is proposed as a mitigation measure. Details of this are to be included in the Operational Environment Management Plan (OEMP).

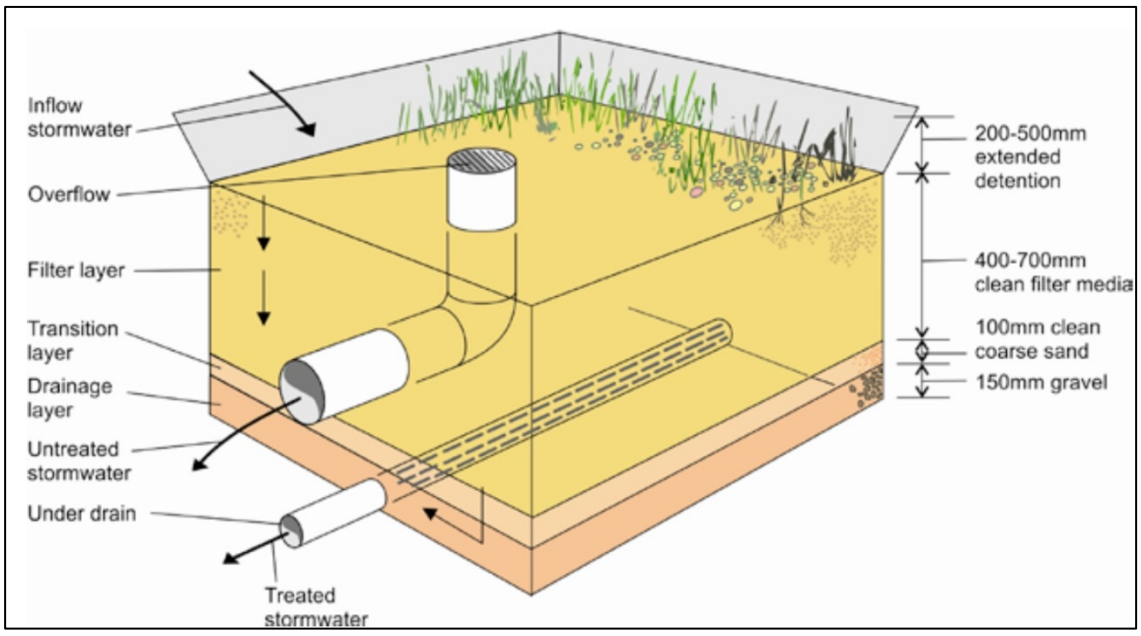
6.2.1 Gross Pollutant Traps

Gross pollutant traps (GPTs) are primary stormwater treatment measures, typically applied as the first measure in a stormwater treatment train. GPTs come in varying forms from simple trash racks through to more complex devices with continuous deflection screens and hydrodynamic separation.

The performance of GPTs varies according to the type of device selected. In this case, a device has been selected with continuous deflection screens and hydrodynamic separation to target the removal of a significant proportion of the Total Suspended Solid (TSS) load. Removal of TSS is important for protecting and minimising maintenance of downstream treatment devices such as rain gardens which are sensitive to high TSS loads.

6.2.2 Rain Gardens

Rain gardens are bioretention systems that comprise a combination of vegetation and filter substrate (refer **Figure 6-1**). They provide treatment of stormwater through the processes of settling, filtration and biological uptake and are very effective in the removal of fine sediments and nutrients. Rain gardens are proposed in the base of the stormwater basins (refer the accompanying design drawings).



Source: Using MUSIC in Sydney's Drinking Water Catchment (Sydney Catchment Authority, December 2012)

Figure 6-1: Typical Rain Garden Concept

In general, rain gardens are lined to protect adjacent structures or if there are known salinity hazards. The Proposal is located in an area of 'moderate salinity potential' as defined by the 'Salinity Potential in Western Sydney 2002' map distributed by the NSW Office of Environment and Heritage (OEH). This salinity classification in itself does not mean the proposed rain gardens need to be lined. However the site's soils are predominantly clays and sandy clays which are associated with shrinkage and differential settlement. Lining of the rain gardens will therefore be required when located adjacent to footings of structures such as retaining walls and buildings.

6.3 Assessment Methodology

Assessment of the performance of the proposed stormwater quality measures has been undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC V6.1).

A MUSIC model for the MPW Stage 2 site has been developed by applying the land uses and imperviousness values for existing and proposed conditions included in **Table 6-2**. The MUSIC model layout and other key modelling parameters are included in **Appendix C**.

Table 6-2: Stage 2 Land Use Areas and Imperviousness

Land use	Existing		Proposed**	
	Area (ha)	Imperviousness (%)	Area (ha)	Imperviousness (%)
Roof	30.0	100	54.3	100
Road***	45.0	90	93.3	90
Vegetated/ Landscaped	75.9	5	0.0*	N/A

** Landscaped areas will be provided as part of the proposed development, however for the purpose of water quality modelling they are likely to be insignificant and have been incorporated into the pervious area associated with roads.*
*** Proposed conditions reflect the ultimate development condition of the MPW Stage 2 Site.*
**** Includes all impervious areas other than roofs (ie. roads, terminal pavements, building aprons etc),*

6.4 Results and Comments

Based on the proposed stormwater quality measures the performance of the treatment measures included in the MPW Stage 2 site are presented in **Table 6-3** and **Table 6-4** relative to percentage reduction and NorBE targets respectively. **Table 6-5** provides details for each of the raingardens.

Table 6-3: Treatment Performance Relative to Percentage Reduction Targets

Scenario	Pollutant Loads (kg/year)			
	Gross pollutants	TSS	TP	TN
Proposed (no treatment)	29,600	235,000	450	2,520
Proposed (with treatment)	0	23,100	101	1,180
% Reduction Achieved	100	90	77	53
% Reduction Target	90	85	60	45

** Model: AA003760_Moorebank_MIC_Stage2_Dev_20160323*

Table 6-4: Treatment Performance Relative to NorBE Targets

Scenario	Pollutant Loads (kg/year)			
	Gross pollutants	TSS	TP	TN
Existing[#]	15,800	126,000	248	1,510
Proposed (with treatment)[+]	0	23,100	101	1,180
Reduction Achieved	100%	82%	59%	22%

[#] *Model: AA003760_Moorebank_MIC_Stage2_Exg_20160323*
[+] *Model: AA003760_Moorebank_MIC_Stage2_Dev_20160323*

Table 6-5: Raingarden details

Raingarden	Invert level (mAHD)	Filter area (m^2)	Extended Detention Volume (m^3)
Basin 3A	14.7	1,000	300
Basin 4	10.7	400	120
Basin 5	11.0	5,800	1,860
Basin 6	11.3	6,000	1,800
Basin 8	11.5	2,000	600

In summary, the water quality assessment has demonstrated that the performance of the proposed treatment measures (i.e. GPTs and rain gardens) complies with the catchment specific targets of the Georges River Estuary CZMP and also the site specific targets contained in the SEARs.

It should be noted that there are a range of alternative treatment measures that could also be used to meet the required pollution reduction targets. These alternatives could include proprietary filtration devices (e.g. Spelfilter cartridge system) or other emerging technologies (e.g. floating wetlands). These alternatives may be explored further and potentially substituted during the design development process to achieve the targets specified above.

6.5 Construction

The SEARs for the Proposal include a requirement to undertake an assessment of surface water quality during construction, identify works that may impact water quality and provide a summary of proposed mitigation measures.

This section should be read in conjunction with accompanying design drawings.

6.5.1 Proposed Works

Section 1 provides a summary of the construction works for the MPW Stage 2 Proposal. While all construction activities have the potential to impact on water quality, the key activities are:

- Vegetation clearing and demolition works.
- Bulk earthworks.
- Stormwater and drainage works.

6.5.2 Erosion and Sediment Controls

Without any mitigation measures and during typical construction activities, site runoff would be expected to convey a significant sediment load. A Soil and Water Management Plan (SWMP) and Erosion and Sediment Control Plan (ESCP), or equivalent, would be implemented for the construction of the Proposal. The SWMP and ESCPs would be developed in accordance with the principles and requirements of *Managing Urban Stormwater – Soils & Construction Volume 1 ('Blue Book')*(Landcom, 2004) and *Volume 2* (DECC 2008).

In accordance with the principles included in the Blue Book, a number of controls have been incorporated into a preliminary ESCP (refer to accompanying Drawings).

The sections below outline the proposed controls for management of erosion and sedimentation during construction of the Proposal.

Sediment Basins

Sediment basins have been sized and located to ensure sediment concentrations in site runoff are within acceptable limits. Preliminary basin sizes have been calculated in accordance with the *Blue Book* and are based on Berkshire Park Group soils ('Type F'). These soils are fine grained and require a relatively long residence time to allow settling.

As the majority of the MPW Stage 2 Site drains to the west, the sediment basins have been located generally along the western boundary of the site. An additional basin is proposed near the south eastern corner of the site to treat any flows that may discharge to Anzac Creek.

Sediment basins for 'Type F' soils are typically wet basins which are pumped out following a rainfall event when suspended solids concentrations of less than 50 mg/L have been achieved.

Sediment Fences

Sediment fences are located around the perimeter of the site to ensure no untreated runoff leaves the site. They have also been located around the existing and proposed drainage channels to minimise sediment migration into waterways and sediment basins.

Stabilised Site Access and Truck Washdown

For the MPW Stage 2 Site, stabilised site access and truck washdown areas are proposed at two locations on Moorebank Avenue, at the northern and southern ends of the site. This will limit the risk of sediment being transported onto Moorebank Avenue and other public roads.

Other Management Measures

Other management measures that will be employed are expected to include:

- Minimising the extent of disturbed areas across the site at any one time.
- Progressive stabilisation of disturbed areas once earthworks are complete.
- Regular monitoring and implementation of remedial works to maintain the efficiency of all controls.

It is noted that the controls included in the preliminary ESCP are expected to be reviewed and updated as the design, staging and construction methodology is further developed for the Proposal.

7 CONCLUSION

This Stormwater and Flooding Assessment has been prepared for approval of the MPW Stage 2 Proposal. This report has been prepared to support a State Significant Development (SSD) Application for which approval is sought under Part 4, Division 4.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and in accordance with the Secretary's Environmental Assessment Requirements (SEARs).

The following conclusions and recommendations have been made within this report:

- HEC-RAS model results affirm that potential adverse flood impacts along the Georges River have been mitigated by limiting the Proposal site raising to areas above the 1% AEP.
- The DRAINS modelling results indicate that:
  - The proposed drainage systems and OSDs would provide adequate system capacities and mitigate potential adverse flood impacts that may otherwise result from the Proposal site works.
  - The northern Moorebank Avenue widening (extending from the M5 Motorway to north of Anzac Road) can be aligned, and in conjunction with stormwater system upgrades, mitigate potential adverse flood impacts.
  - The introduction of a significant channel system downstream of the existing MPE site culvert crossing Moorebank Avenue, would adequately convey flows through the Proposal site to the Georges River.
- Hydraulic modelling of the OSD outlet channels (incorporating backwater analysis methodology of equivalent, e.g. HEC-RAS software) is required to facilitate the design of the channels and demonstrate their effectiveness with respect to energy dissipation and scour protection elements.
- Design considerations to optimise stormwater management along Moorebank Avenue have been identified. However:
  - The next stages of design and analysis should include 2-dimension rainfall-runoff modelling analysis of the Moorebank Avenue corridor (e.g. using TUFLOW software to more adequately quantify flow regimes for existing conditions and Proposal site development conditions) so as to facilitate design of the northern Moorebank Avenue widening and channel system (at the MPE culvert crossing location) and confirm hydraulic performance and stormwater/flood mitigation adequacy.
  - It is also recommended that consideration be given to the construction timing of future design stages with respect to management of greater than 100 year ARI flows.
- A preliminary ESCP has been developed to demonstrate how potential water quality impacts can be mitigated during construction of the Proposal.
- Stormwater quality modelling was undertaken for the Proposal, which demonstrated that implementation of the WSUD measures identified, including the use of gross pollutant traps and rain gardens, would result in a 'neutral or beneficial effect' on water quality as a result of the Proposal during operation.