Appendix B

HECRAS results

1% AEP FLOOD LEVELS AND AFFLUX								
		Existing	Northern Option		Southern Option		Central Option	
MIKE 11 Cross Section	HEC RAS Cross section	Flood Level	Flood Level	Afflux	Flood Level	Afflux	Flood Level	Afflux
		(m)	(m)	(m)	(m)	(m)	(m)	(m)
100000	41	13.46	13.5	0.04	13.46	0	13.55	0.09
100225	40	12.96	13.01	0.05	12.96	0	13.06	0.1
100450	39	12.97	13.02	0.05	12.98	0.01	13.07	0.1
100630	38	12.74	12.79	0.05	12.75	0.01	12.85	0.11
100835	37	11.96	12.03	0.07	11.97	0.01	12.1	0.14
101005	36	12.28	12.34	0.06	12.29	0.01	12.41	0.13
101057	35	12.2	12.27	0.07	12.21	0.01	12.34	0.14
-	34.5	Culvert	Culvert		Culvert		Culvert	
101072	34	12.09	12.17	0.08	12.11	0.02	12.23	0.14
101120	33	12.01	12.09	0.08	12.03	0.02	12.16	0.15
101270	32	11.98	12.06	0.08	12.01	0.03	12.13	0.15
101440	31	11.94	12.02	0.08	11.97	0.03	12.09	0.15
-	30.2	Bridge	Bridge		Bridge		Bridge	
-	30.15	11.78	11.87	0.09	11.81	0.03	11.94	0.16
	30.1				Bridge			
101650	30	11.75	11.84	0.09	11.75	0	11.92	0.17
101795	29	11.4	11.51	0.11	11.4	0	11.6	0.2
101990	28	11.42	11.52	0.1	11.42	0	11.61	0.19
102185	27	11.49	11.59	0.1	11.49	0	11.68	0.19
102390	26	11.27	11.38	0.11	11.27	0	11.47	0.2
102535	25	11.15	11.26	0.11	11.15	0	11.33	0.18
102730	24	10.97	11.09	0.12	10.97	0	11.19	0.22
	23.5						Bridge	
102930	23	11.03	11.16	0.13	11.03	0	11.13	0.1
	22.5						Bridge	
103125	22	11.08	11.19	0.11	11.08	0	11.08	0
103230	21	11.09	11.21	0.12	11.09	0	11.09	0
103390	20	11.01	11.13	0.12	11.01	0	11.01	0
103555	19	10.92	11.05	0.13	10.92	0	10.92	0
103700	18	10.91	11.04	0.13	10.91	0	10.91	0
103860	17	10.89	11.02	0.13	10.89	0	10.89	0
104000	16	10.81	10.94	0.13	10.81	0	10.81	0
104095	15	10.69	10.84	0.15	10.69	0	10.69	0
104185	14	10.69	10.84	0.15	10.69	0	10.69	0
	13.5		Bridge					
104355	13	10.52	10.6	0.08	10.52	0	10.52	0
	12.5		Bridge					
104535	12	10.42	10.42	0	10.42	0	10.42	0
104785	11	10.31	10.31	0	10.31	0	10.31	0
104960	10	10.19	10.19	0	10.19	0	10.19	0
105160	9	10.11	10.11	0	10.11	0	10.11	0
105355	8	9.6	9.6	0	9.6	0	9.6	0
105560	7	9.75	9.75	0	9.75	0	9.75	0
105720	6	9.57	9.57	0	9.57	0	9.57	0
105960	5	9.42	9.42	0	9.42	0	9.42	0
106160	4	9.38	9.38	0	9.38	0	9.38	0
106330	3	9.47	9.47	0	9.47	0	9.47	0
106530	2	9.2	9.2	0	9.2	0	9.2	0
106540	1	9.2	9.2	0	9.2	0	9.2	0

EXTREME EVENT FLOOD LEVELS AND AFFLUX

		Existing	Northern Option		Southern Option		Central Option	
MIKE 11 Cross Section	HEC RAS Cross section	Flood Level	Flood Level	Afflux	Flood Level	Afflux	Flood Level	Afflux
		(m)	(m)	(m)	(m)	(m)	(m)	(m)
100000	41	19.35	19.81	0.46	19.75	0.4	19.84	0.49
100225	40	18.42	19.15	0.73	19.06	0.64	19.2	0.78
100450	39	18.16	18.84	0.68	18.74	0.58	18.9	0.74
100630	38	17.63	18.07	0.44	17.95	0.32	18.17	0.54
100835	37	17.87	18.52	0.65	18.41	0.54	18.6	0.73
101005	36	17.83	18.35	0.52	18.19	0.36	18.46	0.63
101057	35	17.34	17.95	0.61	17.84	0.5	18.03	0.69
-	34.5	Culvert	Culvert		Culvert		Culvert	
101072	34	17.17	17.8	0.63	17.69	0.52	17.87	0.7
101120	33	16.93	17.46	0.53	17.31	0.38	17.59	0.66
101270	32	16.99	17.62	0.63	17.49	0.5	17.74	0.75
101440	31	16.9	17.54	0.64	17.42	0.52	17.65	0.75
-	30.2	Bridge	Bridge		Bridge		Bridge	
-	30.15	15.98	16.58	0.6	16.46	0.48	16.72	0.74
	30.1				Bridge			
101650	30	15.91	16.51	0.6	15.91	0	16.65	0.74
101795	29	15.16	15.94	0.78	15.16	0	16.12	0.96
101990	28	15.69	16.45	0.76	15.69	0	16.63	0.94
102185	27	15.6	16.39	0.79	15.6	0	16.56	0.96
102390	26	15.03	15.67	0.64	15.03	0	15.88	0.85
102535	25	14.88	15.59	0.71	14.88	0	15.81	0.93
102730	24	14.09	15.2	1.11	14.09	0	15.53	1.44
	24.5						Bridge	
102930	23	14.69	15.62	0.93	14.69	0	15.04	0.35
	23.5						Bridge	
103125	22	14.71	15.67	0.96	14.71	0	14.71	0
103230	21	14.76	15.72	0.96	14.76	0	14.76	0
103390	20	14.57	15.6	1.03	14.57	0	14.57	0
103555	19	14.32	15.32	1	14.32	0	14.32	0
103700	18	14.28	15.33	1.05	14.28	0	14.28	0
103860	17	14.26	15.32	1.06	14.26	0	14.26	0
104000	16	14.16	15.3	1.14	14.16	0	14.16	0
104095	15	14.03	15.24	1.21	14.03	0	14.03	0
104185	14	14.02	15.22	1.2	14.02	0	14.02	0
	13.5		Bridge					
104355	13	13.77	14.85	1.08	13.77	0	13.77	0
	12.5		Bridge					
104535	12	13.7	14.13	0.43	13.7	0	13.7	0
104785	11	13.2	13.2	0	13.2	0	13.2	0
104960	10	13.3	13.3	0	13.3	0	13.3	0
105160	9	13.33	13.33	0	13.33	0	13.33	0
105355	8	13.22	13.22	0	13.22	0	13.22	0
105560	7	13.21	13.21	0	13.21	0	13.21	0
105720	6	13.2	13.2	0	13.2	0	13.2	0
105960	5	13.18	13.18	0	13.18	0	13.18	0
106160	4	13.13	13.13	0	13.13	0	13.13	0
106330	3	12.85	12.85	0	12.85	0	12.85	0
106530	2	11.82	11.82	0	11.82	0	11.82	0
106540	1	11.8	11.8	0	11.8	0	11.8	0

Appendix B

Stormwater Management Plan

Moorebank Intermodal Company

Moorebank Intermodal Terminal

Stormwater Management Plan

26 June 2014

PARSONS BRINCKERHOFF
A BALFOUR BEATTY COMPANY

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Abbreviations

AEP	Annual Exceedance Probability
ARI	ARI – Average Recurrence Interval
CERAT	Coastal Eutrophication Risk Assessment Tool
DNSDC	Defence National Storage and Distribution Centre
DoD	Department of Defence
EC	Electrical Conductivity
ESA	Environmental Site Assessment
EV	Environmental values
GRCCC	Georges River Combined Council Committee
Ha	Hectares
LCC	Liverpool City Council
OEH	NSW Office of Environment and Heritage
OSD	On-Site Detention
m AHD	Metres Australian Height Datum
MIMT	Moorebank Intermodal Terminal
MIC	Moorebank Intermodal Company
NOW	New South Wales Office of Water
RCP	Reinforced concrete pipe
SSFL	Southern Sydney Freight Line
TN	Total nitrogen
WQOs	Water Quality Objectives

1. Introduction

This report outlines drainage strategies for the three conceptual layouts proposed for the development of the Moorebank defence lands into the Moorebank Intermodal Terminal (MIMT). The three concepts layouts relate to the location of the railway crossing of the Georges River and subsequent connection to the Southern Sydney Freight Line (SSFL) on the western side of the Georges River, these concepts are referred to as follows and are included in Appendix A:

- Northern rail connection concept layout (northern) (Figure 1.1)
- Central rail connection concept layout (central) (Figure 1.2)
- Southern rail connection concept layout (southern). (Figure 1.3).

The drainage strategies provide stormwater management recommendations based on investigations into the existing site, catchment, design criteria, opportunities/constraints and the proposed site layouts at the time of the assessment. The intent of this drainage strategy is to show how stormwater quality and quantity will be managed for the Project to ensure negligible impact beyond the Project site boundary. Much of the detail was developed for a previous northern layout configuration and has been used as the basis of the assessment for this current assessment.

It is noted that there is little difference in the hardstand areas proposed for each layout so many of the measures proposed are applicable to all layouts. Further design of the stormwater management system will be required when an adopted layout is finalised.

1.1 Site description

The MIMT Project site (Project site) is situated on land in the Sydney suburb of Moorebank, NSW and is referred to as the 'defence lands site' in this document. The Project site is approximately 220 hectares (ha) in area, and is located within a locality that includes the residential suburbs of Casula, Wattle Grove and North Glenfield, as well as industrial, commercial and Department of Defence (DoD) land (refer Appendix A). The proposed Project would provide connectivity to Port Botany by rail, and would connect to major regional and interstate roads and highways via the M5 and M7 Motorways.

To the north of the Project site, the local area is generally characterised by industrial and commercial land uses, including the adjacent ABB Australia's Medium Voltage Production Facility.

To the east of the Project site, land use is predominately industrial and commercial, with extensive DoD land further east (including the Holsworthy military area).

To the west of the Project site is the Georges River, with a generally well established riparian area, that is heavily vegetated in parts. The Leacock Recreation Park and Casula Powerhouse Arts Centre, recreational areas used by members of the community, are located on the west bank of the Georges River. The areas west and north-west of the Georges River mark a transition to low-density residential development and associated commercial developments and community facilities within the suburbs of Casula and Liverpool. The area to the south west includes the Glenfield Landfill site. This area is highly disturbed and manages its own stormwater runoff and leachate runoff systems to prevent pollutants entering the Georges River.

To the south of the Project site is the East Hills Railway Line. Further south are large areas of bushland and the DoD's Holsworthy Barracks.

Stormwater management at the Project site is governed by the Liverpool City Council (LCC) Liverpool District Stormwater Management Plan and the LCC Development Control Plan no.49.

2. Existing site

2.1 Upstream stormwater catchments

The Project site is bordered by the Defence National Storage and Distribution Centre (DNSDC) to the east, the Moorebank Business Park to the north-east, the M5 South Western Motorway to the north, the ABB site to the north-west, the Georges River to the west and the Eastern Hills Railway line to the south.

Stormwater runoff from the DNSDC, the Moorebank Business Park, the M5 South Western Motorway and the ABB site interact with the Project site. The interactions of these upstream catchments are detailed in the following sections.

2.1.1 Defence National Storage and Distribution Centre (DNSDC)

The DNSDC currently discharges stormwater via drainage infrastructure into the Project site at two locations. The first discharge location is through the box culverts underneath Moorebank Avenue that connect to the open channel flowing west across the defence lands site. The second discharge location is a 600 RCP that connects to grated pits on either sides of the Moorebank Avenue road reserve located approximately 210 m north of Chatham Avenue.

Existing topography within the DNSDC site shows that the western side of the DNSDC produces overland stormwater flows towards Moorebank Avenue and is either intercepted by open channels on the Eastern side of Moorebank Ave or flows over Moorebank Avenue into the defence lands site. The drainage channel on the Eastern side of Moorebank Ave connecting to the open channel through the defence land site has a shallow grade (<0.5%) and is assumed that it does not have capacity to contain the 1% Annual Exceedance Probability (AEP) flood event and likely overflows and crosses Moorebank Ave into the existing defence land site during large flood events.

The Eastern side of the DNSDC produces overland flows away from the defence land site and into Anzac Creek.

The current road grading along Moorebank Avenue has very little fall (<0.5%) and it is assumed that very little flow travels along Moorebank Ave and instead large storm events overflow from the DNSDC directly into the defence land site.

2.1.2 M5 South-West Motorway stormwater runoff

The stormwater drainage from the M5 South-West Motorway intersection with Moorebank Avenue (M5 intersection) to the north of the Moorebank IMT site has been designed to discharge into the defence land site in events greater than or equal to the 1% AEP event. In events less than the 1% AEP the M5 intersection drainage system has been designed to discharge to Georges River via dedicated 1,500 mm and 2,100 mm diameter pipes fitted with non-return outlet floodgates. Flows exceeding the capacity of the drainage system have been designed to discharge from a surcharge pit at 9.1 m AHD within the road reserve and spill into the existing Amiens wetland/detention basin in the north of the defence lands site. The design plans for the M5 intersection stormwater system indicate that the 1% AEP discharge from the surcharge pit is 0.4 m^3/s. However, it is not known if the system was designed including the tail water effect due to the Georges River, as flood events within the Georges River will close the floodgates on the outlet pipes from the M5 intersection drainage and may cause flows to discharge from the surcharge pit in events more frequent than the 100 year event and at flows larger than that of 0.4 m^3/s mentioned above.

2.1.3 Moorebank Business Park

Based on available topography information, the south-western corner of the Moorebank Business Park (approximately ¼ of the site) will contribute overland flows onto Moorebank Avenue and Anzac Avenue which will flow along the road alignments to the primary sag point along Moorebank Avenue.

2.1.4 ABB site

A vegetated swale abutting the southern boundary of the ABB site runs beneath an overhead power line that crosses the Georges River. Based on the existing contours, this channel appears to convey surface flows from the surrounding site and may also collect surface runoff from the ABB site.

2.2 Existing site drainage infrastructure

2.2.1 Overland flows and fall across site

The defence land site is generally flat or gently undulating, with the elevation over the majority of the site ranging from approximately 12.5 to 16.0 mAHD with a high point of approximately 18.0 m AHD corresponding to the intersection of Chathman Avenue and Ripon Road. A terrace abuts the Georges River on the western boundary at a much lower elevation than the rest of the site. The terrace is well defined by a sharp change in evaluation of approximately 6 m. Site survey details are shown in Figure 2.1 Existing drainage and overland flow path in Appendix A.

Based on the existing topography of the site the contours indicate that the majority of the surface water runoff within the site will drain in a general North West direction towards the Georges River. The remaining runoff will either drain towards the Anzac creek or will drain to the East towards Moorebank Avenue (Appendix A).

For the GWS site it is understood that the Georges River top of bank levels are no lower than 11.8 mAHD (Hyder Consulting, June 2013). However the LCC flood risk map indicates that most of the GWS site is high flood risk which means it is susceptible to inundation in the 1% AEP flood event. The GWS site is still operational but it is assumed that the long term topography of the site will have a fall of land towards the Georges River and ensure there is no loss of floodplain storage.

2.2.2 Existing pipework and culverts

Existing drainage within the defence lands site consists of pipes and open channels which generally flow north-west across the site and discharge into the Georges River. This stormwater pipe network primarily services the existing buildings and infrastructure located near the centre of the site. Trunk mains are shown in Figure 2.1 and range from 600 to 1,300 millimetre (mm) diameter Reinforced Concrete Pipes (RCP). These trunk mains all discharge into Georges River with the exception of the one 600 diameter RCP in the south of the site which discharges into Anzac Creek.

Two open channels are noted on site; an informal vegetated open channel in the north of the site abutting the southern property boundary of the ABB site and an open concrete-lined trapezoidal channel that flows westward through the site from the sag point in Moorebank Avenue to Georges River (refer to Appendix A).

The existing drainage network through the GWS site is unknown but it is assumed that all runoff from buildings and roads is collected in a pipe and/or open channel network that directs flows to a treatment point before being released into the Georges River.

2.2.3 Existing discharge locations

The existing defence land site currently discharges stormwater to both the Georges River to the west and Anzac Creek to the south east of the site.

The primary discharge of stormwater into Georges River is by:

- a DN750 pipe outlet from the Amiens wetland on the lower banks of the Georges River at 4.50 m AHD and fitted with a non-return floodgate
- a grassed open channel along the western boundary of the ABB site which runs alongside an existing overhead power line crossing Georges River
- a trapezoidal, concrete-lined, open channel flowing west across the defence lands site with an invert level of approximately 10.0 m AHD at the top of a drop structure into Georges River
- approximately six main outlet headwalls along the western site boundary from the piped underground stormwater drainage network within the defence land site.

From a site visit conducted by Parsons Brinckerhoff on 4 November 2010, this drainage infrastructure was observed to be in poor condition. The open channel was blocked and/or covered by thick vegetation, erosion around the drop structure has placed its structural integrity at risk and the downstream gulley has been significantly eroded.

Discharges into Anzac Creek occur from drainage in the area surrounding the Royal Australian Engineers Golf Course in the south-east corner of the site. This catchment drains to road culverts underneath Moorebank Avenue before discharging into Anzac Creek.

2.3 Existing waterways

The existing waterways and water bodies adjacent to and within the existing site are the Georges River, Anzac Creek, Amiens wetland and the Defence Land ponds as described above. Surface water flow within the Project site and surrounding local catchment predominately drains to one of the on-site water bodies before discharge to the Georges River.

Currently, there is very limited stormwater treatment on the site. The Amiens wetland and Defence Land ponds may serve to provide some retention of nutrients, sediment and other pollutants; however discharge of stormwater from the Project site to the Georges River and Anzac Creek is largely unmanaged.

2.3.1 ANZAC Creek

Anzac Creek is an ephemeral tributary of the Georges River and flows in a north-westerly direction and ultimately drains to Lake Moore on the Georges River. In the south-west corner of the site a number of linked permanent water bodies form the headwaters of Anzac Creek within the existing Royal Australian Engineers Golf Course. Culverts underneath Moorebank Avenue discharge water from the site into Anzac Creek. The position of these culverts corresponds to a sag in the profile of Moorebank Avenue (road at 14.85 m AHD).

It is assumed that the linked permanent water bodies currently provide some degree of on-site detention and water quality treatment for stormwater flows within the local catchment area within the site.

2.3.2 Georges River

At the regional level the Georges River is the main receiving waterway for discharge from the Project site.

Water quality in the Georges River middle reach is heavily influenced by stormwater runoff from urban development.

A review of available land use and catchment maps shows that land use in the middle to lower catchment predominately comprises of urban developed land incorporating residential, business, industrial and mixed use land zones. The Georges River catchment is highly urbanised and significantly modified (HRC 2001). Rural and open space land use zones are also located downstream of the Project where surface flow from these areas drains directly to the Georges River.

Urban development and activities contribute to degraded water quality and ecosystems. Wastewater (in the form of stormwater and sewage) has the potential to convey physical and chemical stressors to the river environment that can reduce the water quality and have detrimental impacts. Increased nutrient load, sedimentation, reduction in areas of riparian vegetation and altered environmental flow regimes are all stressors associated with urban development (www.environment.nsw.gov.au).

A review of available existing water quality data for the Georges River is provided in following sections of this report.

2.3.2.1 Georges River Flood levels

The Georges River borders the western boundary of the site; hence, the flows conveyed along this river system will interact with the drainage within the defence lands and developed Moorebank IMT. The results of a computer-based (MIKE 11) flood model for the Georges River as referenced in the Georges River Model Study, Draft Report May 1999, prepared by Bewsher Consulting Pty Ltd. detail the flood levels during design rainfall events. The 1% AEP flood level due to flows from Georges River along the western boundary of the site range from 11.7 to 10.4 mAHD at the East Hills Railway to the M5 South-West Motorway respectively. Appendix B shows the estimated extents of the flood risk area during 5% AEP and 1% AEP design rainfall events.

2.4 Existing stormwater quality treatment

This section reviews the existing on-site water bodies and water quality treatment systems before identifying the sensitive receptors within these water bodies that could potentially be impacted by this project in the following section.

2.4.1 Amiens wetland

The Amiens site is located in the north eastern corner of the Defence Lands site and is bounded by the M5 South Western Motorway to the North, Moorebank Avenue to the west, Bapaume road to the south and the ABB site to the west.

The Amiens site has an approximate local catchment area of 5.9 ha consisting of an open grassland area containing scatted trees and shrubs which drains north towards a water body.

The Amiens wetland is approximately 5 m deep and has an approximate volume of 17 ML and acts at an outlet controlled detention basin. Stormwater from the M5 South Western Motorway drainage to the north in addition to flows from the local catchment are detained by the Amiens wetland before it is discharged via a piped connection to Georges River.

Based upon preliminary investigations, the key drainage features of the Amiens wetland and its interface with the M5 South Western Motorway drainage system are described below:

- Amiens wetland weir outlet at R.L 7.791 m AHD
- inlet pit within the M5 South Western Motorway road reserve with a grate level of 7.591 m AHD. The inlet pit outlets to a DN 750 steel pipe which is connected downstream to an outlet headwall
- DN750 steel pipe south of the M5 South Western Motorway connecting upstream to the inlet pit and discharges downstream at an IL of 4.50 m AHD from an outlet headwall. The outlet headwall is situated on the lower banks of the Georges River and is fitted with a non-return floodgate
- 1,500 RCP dedicated to the M5 South Western Motorway drainage on the north side of the motorway discharging from an outlet headwall at an IL of 5.07 m AHD. The outlet headwall is situated on the lower banks of the Georges River and is fitted with a non-return floodgate
- 2100 RCP dedicated to the M5 South Western Motorway drainage on the south side of the motorway discharging from an outlet headwall adjacent to the DN 750 outlet headwall at an IL of 4.50 m AHD. This outlet headwall is situated on the lower banks of the Georges River and is fitted with a non-return floodgate
- M5 South Western Motorway drainage surcharge pit at 9.10 m AHD on the southern side of the motorway. Stormwater surcharging this pit flows south towards the inlet pit and into Amiens wetland
- drainage from the south-west side of the M5 South Western Motorway, Moorebank Avenue intersection flows via open swale drains towards the inlet pit.

As noted above the invert levels for the three outlets to Georges River are below the 1% AEP peak flood level. Hence, during flood events the rising water level in Georges River will close the non-return floodgates and prevent return flows from Georges River entering the Amiens site. Conversely, the non-return floodgates will also prevent stormwater discharging from the Amiens site and hence stormwater will be stored until the Georges River subsides, the non-return floodgates open and water is able to drain out. The Amiens site is required to store stormwater from the following sites:

- flows that exceed the capacity of the M5 South Western Motorway drainage and discharge from the surcharge pit. The estimated 1% AEP peak flow which is estimated to surcharge flow from the M5 South Western Motorway drainage network is 0.4 m^3/s
- drainage from the south-west side of the M5 South Western Motorway, Moorebank Avenue intersection
- the local catchment area of the Amiens Site.

2.4.2 Defence land ponds

The Defence land site contains four small water bodies that are most likely currently used for attenuation and/or water quality treatment.

The Defence lands water body (refer Appendix A) is located south of the concrete-lined, trapezoidal open channel running through the site and west of the car-park area off Moorebank Avenue. This large water body contains a number of constructed vegetated islands and is surrounded by thick vegetation. The exact function of this large water body is not currently known, but it is assumed that it is used for attenuation and water quality treatment of flows from the surrounding car-parks, local catchment and overflows from the adjacent trapezoidal concrete channel. Discharge from this water body is assumed to be to the concrete-lined, trapezoidal open channel to the north.

In the centre of the defence lands site, approximately south-west of the Defence Lands water body, three smaller water bodies are located. The function of these water bodies is also not known, however, it is assumed that they provide some degree of attenuation, storage and/or on-site non-potable re-use.

As well as the above water bodies, two small dams are noted on site to the North of Long Hai Road and north-west of the intersection of Bircross Road and Long Hai Road.

2.4.3 Glenfield landfill site

It is understood that the Glenfield landfill site has two main water bodies that are used for treating water from the site. The function and operation of these water bodies is not understood but it is assumed that their operation and treatment processes would be focused on the range of pollutants that are generated on the Glenfield landfill site. It would therefore be best to avoid these water bodies so as not to interrupt their function and operation.

2.5 Existing stormwater quality

2.5.1 Amiens wetland

Water quality in the Amiens wetland is influenced by surface runoff from adjacent open grassland and roadways including Moorebank Avenue and the M5 South Western Motorway. Flows from the local catchment of approximately 7 ha are detained by the Amiens wetland before being discharged via a piped connection to Georges River.

2.5.2 Defence land ponds

Water quality in these ponds is influenced by nearby surface flows and stormwater from developed areas of the Project site, DNSDC and runoff from Moorebank Avenue. These ponds would provide some function for attenuation and water quality treatment of flows from the surrounding car-parks, local catchment and overflows from the adjacent trapezoidal concrete channel. Discharge from these ponds overtops the pond outlets and flows through informal overland channels into the Georges River.

2.5.2.1 Review of existing water quality data

An environmental site assessment (ESA) was conducted in January 2011 by Parsons Brinckerhoff to assess and characterise the nature and likely extent of contamination at the site based on the areas of potential environmental concern (Parsons Brinckerhoff 2011). The following field parameters were collected at each surface water sampling location using a water quality meter:

- pH ranged between 6.47 to 9.37 indicating a wide range of values from slightly acidic to alkaline conditions
- electrical conductivity ranged from 65.4 to 528 µs/cm indicating fresh water
- temperature ranged from 20.3 to 30.4ºC
- dissolved oxygen ranged between 4.02 to 8.44 indicating that surface waters are well oxygenated

The following analytes were also assessed as part of the surface water assessment:

- total petroleum hydrocarbons (TPH)
- BTEX compounds (benzene, toluene, ethylbenzene and xylene)
- polycyclic aromatic hydrocarbons (PAHs)
- polychlorinated biphenyls (PCBs)
- heavy metals (including arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc)
- semi-volatile organic compounds

- volatile organic compounds.

While the majority of samples returned results below the laboratory quantitation limit, concentrations of copper, nickel and zinc were above the default trigger values provided in the ANZECC guidelines for these metals.

Based on the findings of the ESA, the soil and groundwater contamination identified at the site is unlikely to contribute significant additional impacts to the water quality within the Georges River. Impacts due to potential migration of contaminated groundwater and surface water from the site to the Georges River are considered to be low.

2.5.3 Anzac Creek

Water quality in the Anzac Creek headwater sub-catchment within the Project site (approx.28 ha) is influenced by overland flows and golf course activities. As a result of the golf course development, the headwaters of Anzac Creek are highly modified. Some degree of retention exists among the Anzac Creek water bodies particularly upstream of the culvert crossing Moorebank Avenue. It is expected that some degree of water quality treatment of stormwater flows would be provided by the densely vegetated channel.

Anzac Creek is heavily degraded and is generally in poor condition. It is predominately in a low flow state with sluggish to minimal water movement dependent upon local rainfall (Hyder Consulting 2011). Water quality sampling at Anzac Creek was undertaken as part of the aquatic survey for the SIMTA environmental assessment (Hyder Consulting 2011). The sampling included water temperature, pH, electrical conductivity, dissolved oxygen, turbidity and alkalinity at a single point in time to coincide with the aquatic survey. The sampling results indicated that pH and dissolved oxygen were outside the ANZECC guideline values for 95% species protection of lowland aquatic ecosystems in south eastern Australia. All other values were within the guidelines.

2.5.4 Georges River

The existing water quality of the Georges River has been assessed by:

- establishing water quality objectives (WQOs) as provided by New South Wales Office of Water (NOW)
- reviewing and analysing available water quality data
- comparing water quality data to relevant guidelines and river health objectives
- monthly monitoring of water quality (as part of an ongoing 2 year programme that commenced in July 2013).

Existing water quality data for the Georges River have been assessed by obtaining available data through a number of external sources including:

- NOW
- NSW Office of Environment and Heritage (OEH)
- Georges River Combined Council Committee (GRCCC).
- monthly sampling program

A summary of the results of WQO indicators relevant in determining baseline water quality of the Georges River are provided in Table 2.1 with the sites located on Figure 2.1. Limitations exist in these data sets as they are discrete sampling events. Variability in these data and recorded values and concentrations outside of desired WQOs can be influenced by climatic environmental conditions (section 2.5.4.1 at the time of sampling or errors in the sampling methodology.

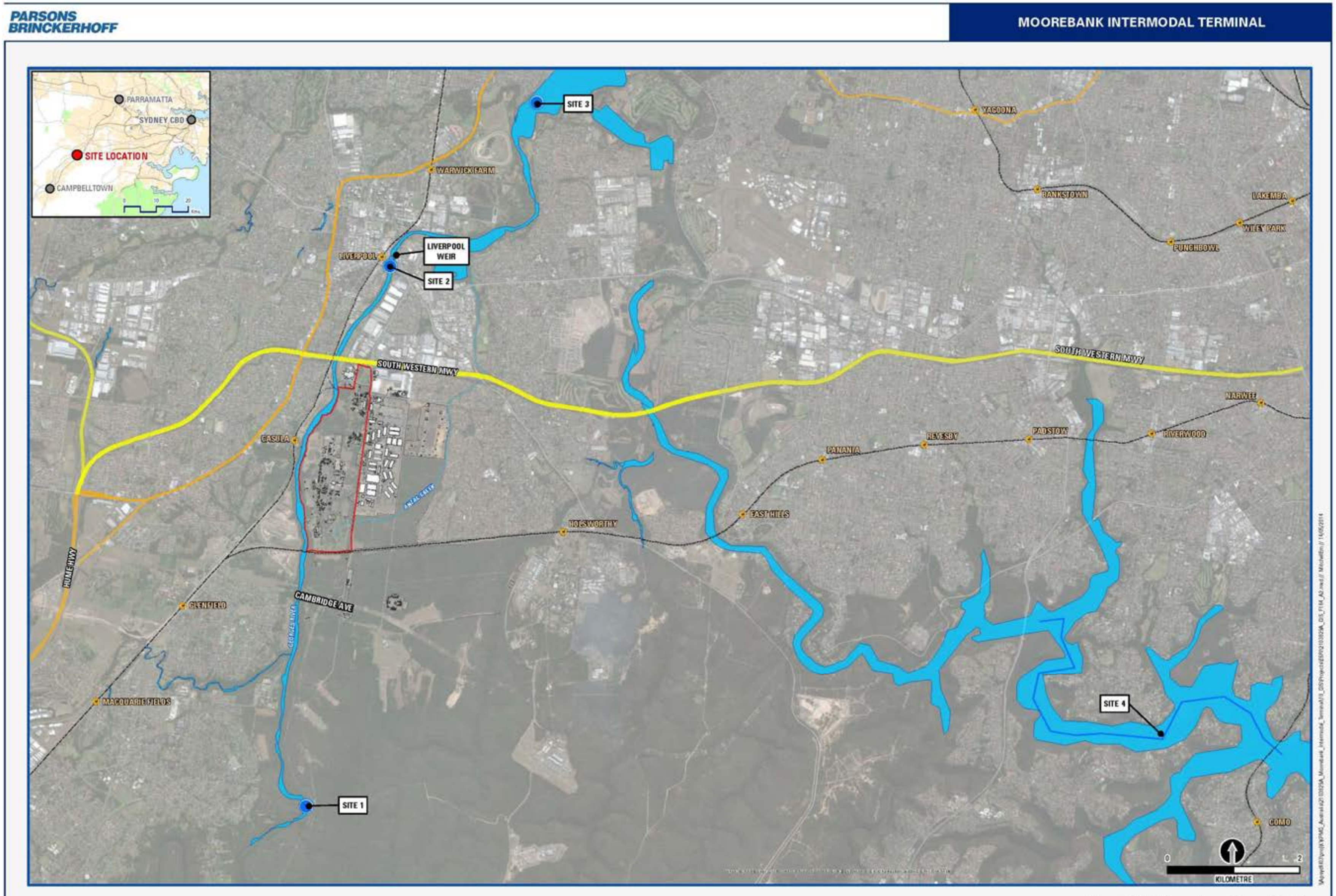


Figure 2.1: Existing water quality sampling sites

Figure 2.1 Existing Water Quality Sampling Sites

Table 2.1 Existing data used in the Georges River baseline water quality assessment

Data owner	Data source	Location	Latitude	Longitude	Date range of data	Available water quality variables						
						Chl*a*	pH	TN	TP	NTU	EC	DO
NOW3	Site 1	Simmos Beach	33°59'57.41"S	150°54'42.98"E	Jan-2004–Apr 2004	N	N	Y	Y	Y	Y	N
NSW OEH1	Site 2	Upstream of Liverpool Weir (G8)	33°55'36.05"S	150°55'41.16"E	Feb 2007–Oct 2007	Y	Y	Y	Y	Y	N	N
NSW OEH1	Site 3	Downstream of Liverpool Weir (G7)	33°54'17.06"S	150°57'9.54"E	Feb 2007–Oct 2007	Y	Y	Y	Y	Y	N	N
NSW OEH2	Site 4	Georges River estuarine	Transect		Jan 2010–Apr 2011	Y	N	N	N	Y	N	N

1 - Data obtained from the OEH CERAT online database

2 - Data obtained directly from NSW OEH Coastal Catchments Unit

3 - Data obtained directly from NSW Office of Water Data request.

Existing data to assess WQO biological indicators for primary and secondary contact (such as bacterial content and algae counts) are not available and therefore are not considered as part of this water quality assessment.

Existing data from the receptors was reviewed against these guidelines in order to assess the current watercourse condition in relation to the designated environmental values.

Table 2.2 Existing water quality data

	Site 1			Site 2			WQOs (lowland rivers)	
Freshwater (lowland rivers)	Min	Max	Mean	Min	Max	Mean	Min	Max
pH	3.12	8.65	7.42	6.95	7.96	-	6.5	8.5
TN (µg/l)	210	650	360	530	1060	720		350
TP (µg/l)	10	20	10	15	78	35		25
Turbidity (NTU)	<1	14	3	1.7	63.1	24.1	6	50
EC (25°C)	86	323	244	-	-	-	125	2200
Chl *a* (µg/l)	-	-	-	<1	31.5	7.6		5
Estuarine	Site 3			Site 4			WQOs (estuaries)	
pH	4.84	8.1	-	-	-	-	7.0	8.5
TN (µg/l)	360	1670	940	-	-	-		300
TP (µg/l)	25	161	79	-	-	-		30
Turbidity (NTU)	3.2	68.5	23.7	2.2	24.9	7.75	0.5	10
EC (25°C)	-	-	-	-	-	-	-	-
Chl *a* (µg/l)	<1	17.6	5.3	2.5	4.6	5.7		4

Notes: TN=Total Nitrogen, TP = Total Phosphorus, NTU = Nephelometric Turbidity Units, EC = Electrical Conductivity, Chl*a* = Chlorophyll *a*

2.5.4.1 Water quality sampling rainfall and weather

The Liverpool (Michael Wenden) BoM station (station # 067020) is the closest monitoring station to the Project with long-term rainfall summary statistics.

When rainfall is compared to the dates when existing water quality data was collected at sites 1–3 (refer Figure 2.1) the monthly rainfall is generally close to the longer term median (refer Figure 2.2 and Figure 2.3). Exceptions are noted in April 2004, February 2007 and June 2007 when rainfall was considerably higher than the longer term median. Existing datasets do not contain sufficient frequency to allow the impact of rainfall intensity to be compared to water quality in the receiving watercourses.

Major rainfall events can have a considerable impact on water quality indicators where exceedences in water quality indicators above recommended guidelines are likely. These rainfall data do not indicate any consistent major rainfall events that are likely to have had a considerable impact on water quality during the date range of monitoring events. It is reasonable to consider that the available water quality data is representative of the existing conditions at the Project site during months of average rainfall.

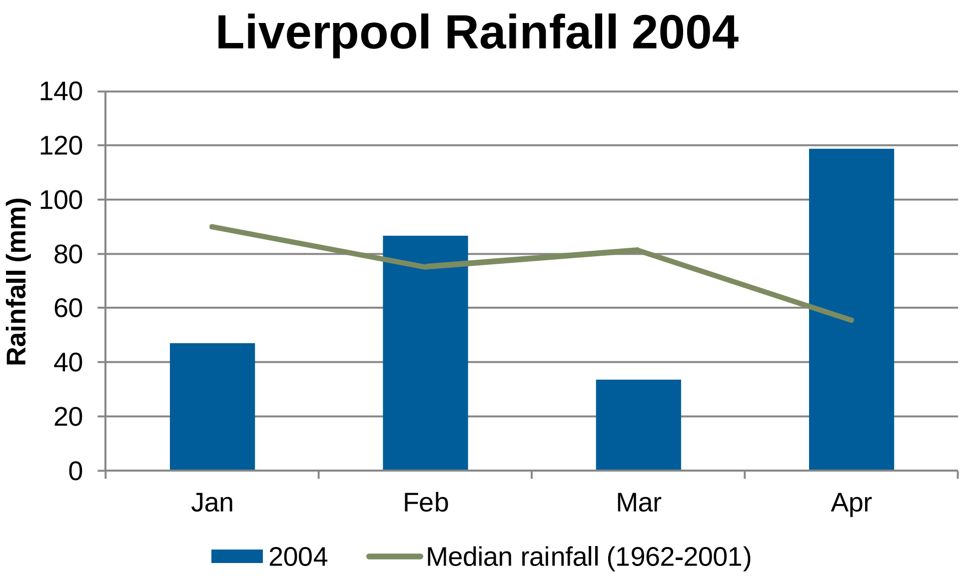


Figure 2.2 **2004 Temporal variations in rainfall during water quality sampling**

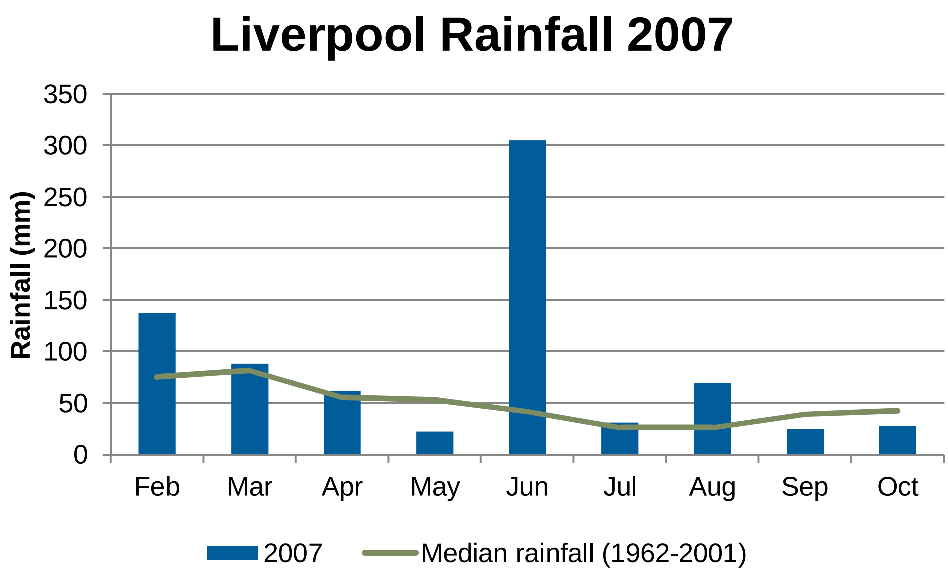


Figure 2.3 **2007 Temporal variations in rainfall during water quality sampling**

2.5.4.2 NSW Office of Water – Site 1

The NOW sampling location closest to the Project site is located at Simmos Beach upstream of Liverpool weir in the freshwater reach of the Georges River. This location is indicated as Site 1 on Figure 2.1. Simmos Beach is located approximately 3.7 km upstream from the southern boundary of the site and provides a representative indication of water quality of the freshwater reach of the Georges River adjacent to the Project.

The water quality data from NOW are summarised below:

- minimum pH values are recorded below WQOs in 2 samples. Maximum pH values are recorded above WQOs in 1 sample. The mean value of data recorded is within the desired range of WQOs (n=36)
- maximum Total Nitorgen concentration exceeds the desired WQO in 10 samples. Mean TN concentration exceeds the desired range of WQOs (n=19)
- Total Phosphorus concentrations (maximum and mean) are within desired range of WQOs (n=19)
- turbidity values are within the desired range of WQOs (n=26)
- electrical conductivity (EC) values below desired WQOs were recorded in one sample (n=19). The average EC value is within the desired WQO range.

2.5.4.3 Coastal Eutrophication Risk Assessment Tool (CERAT) – Site 2 and 3

Water quality data have been reviewed for two sites located on the Georges River; 1 site upstream of the Liverpool Weir (in close proximity to the weir) in the freshwater reach of the Georges River, and; one site located at Chipping Norton Lake downstream of the weir in the estuarine tidal reach of the Georges River. These sites are indicated as site 2 and 3 respectively in the water quality data are summarised below.

- the observed minimum and maximum pH levels are within the WQOs (n=2) at site 2 and below WQOs in two samples at site 3
- all samples (n=14) are above the maximum WQOs for TN at site 2 and site 3
- the maximum concentration of TP exceeded maximum WQOs for TP in 8 sampling events (n=14) at site 2 and 13 sampling events at site 3. The mean concentration of TP during the sampling period exceeds WQOs at both sites
- the turbidity maximum exceeds WQOs in one sample (n=6) at site 2 and three samples (n=6) at site 3
- chlorophyll a concentrations exceed maximum WQOs in three samples (n=12) at site 2 and three samples (n=13) at site 3. The average concentration of Chla exceeds WQOs at both sites.

2.5.4.4 NSW Office of Environment and Heritage – Site 4

OEH data were obtained during six discrete monitoring events between December 2010 and April 2011. The sampling was undertaken along a transect downstream of the Liverpool Weir in the estuarine reach of the Georges River. The results from the OEH sampling program represent indicative water quality parameters downstream of the Project along the estuarine reach. The results are summarised below:

- the maximum recorded chlorophyll a concentration was above the desired WQOs during all six sampling events. The average concentration recorded during all six sampling events exceeded the desired WQO
- the maximum turbidity exceeded the WQO for turbidity in four out of six sampling events. The average turbidity exceeded the WQO in two out of six sampling events.

2.5.4.5 GRCCC data

Three sampling sites of the GRCCC River Health Monitoring Program are located within close proximity to the Project site and have been chosen as representative sites for water quality. Two freshwater sites, Simmos Beach and Cambridge Avenue, are located 3.7 km and 0.5 km, respectively, upstream from the southern boundary of the Project. These locations are representative of water quality in the freshwater reach adjacent to the Project. The Lt. Cantello Reserve site is located approximately 13 km downstream from the northern boundary of the Project site and is representative of water quality in the estuarine reach of the Georges River in close proximity to the Project.

The GRCCC River Health Monitoring Program reports that water quality was ‘Fair’ on nine occasions and ‘Good’ on the remaining three occasions. No breakdown of water quality conditions by parameters was provided for these GRCCC sites.

2.5.4.6 Project specific water quality monitoring programme

A monthly water quality monitoring programme for the Georges River has been established for the Project, which commenced in July 2013 and will continue for 2 years (24 sampling events). Routine basic water quality indicators will be analysed for all events with an additional comprehensive suite collected on alternating (reduced) monitoring events. Water quality indicators will be analysed as indicated in Table 2.3.

Table 2.3 Water quality sampling programme indicators and analytes

<table>
<tr><th>Water quality indicators to be analysed</th><th colspan="2">Event</th></tr>
<tr><td>Field parameters (dissolved oxygen [concentration and % saturation], electrical conductivity, pH, temperature, total dissolved solids)</td><td rowspan="5">Basic suite</td><td rowspan="8">Comprehensive suite</td></tr>
<tr><td>Physical parameters (total suspended solids, turbidity)</td></tr>
<tr><td>Major ions (Na, K, Ca, Mg, Cl, SO4, CO3, HCO3, SiO2) and alkalinity/hardness</td></tr>
<tr><td>Metals suite (including dissolved Ag, Al, As, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb, V, Zn)</td></tr>
<tr><td>Nutrients suite (total nitrogen and total phosphorus)</td></tr>
<tr><td>Microbiology (enterococci, faecal coliforms)</td><td rowspan="3"></td></tr>
<tr><td>Oil and grease screen</td></tr>
<tr><td>TPH and BTEX</td></tr>
</table>

Five sampling locations have been selected for the monitoring programme. Suitable locations were selected on the basis of being upstream and downstream of the proposed development, providing spatial representation along the Georges River, and ease of access to the river. Following a walkover assessment during the first sampling run, all proposed locations have been deemed suitable and retained for the water quality monitoring programme. Access to the surface water monitoring sites is described in Table 2.4 and locations are shown in Figure 2.4.

Table 2.4 Water quality monitoring locations and access description

Site	Site location	Access description	Grid ref (56H UTM)
SW01	Georges River at Cambridge Avenue	This location is accessible from Cambridge Avenue. Water quality samples were taken from the river using a kayak. The most appropriate location to launch the kayak is upstream of the road bridge on the left bank. There is adequate parking behind the crash barrier, providing a safe place to work.	0307109 6239186
SW02	Georges River above Liverpool Weir	Access is available through Bill Morrison Park via Newbridge Road (using the west bound underpass). The park provides access to both upstream and downstream locations of Liverpool Weir (i.e. SW02 & SW03). Water quality samples were taken from the river using a kayak. Access to the upstream location is provided from the concrete weir platform on the bank of the river.	0308526 6244179
SW03	Georges River below Liverpool Weir	Access is available from Bill Morrison Park (as above). An informal track along the gabion baskets on the right bank can be used to reach a suitable kayak launching area at similar height with the baseflow water level. Alternative safe access during high flow events will need to be reviewed when out on site. Water quality samples were taken from the river using a kayak.	0308571 6244264
SW04	Georges River Estuarine	River access at Quota Park (towards the west) was used to launch the kayak. Public thoroughfare is available from Whelan Ave at Bainbridge Avenue intersection for access to the park pathway followed by 120 m walk upstream to launch site (before bridge over Lake Moore. Water quality samples were taken from the river using a kayak. Alternative access is also available from Haigh Park however; this would result in a greater walking distance to the kayak launch location and sampling location. Following the walkover, a kayak trolley has been purchased to assist with safe carrying of the kayak from the car to the launch location.	0309666 6244226
SW05	Anzac Creek at Royal Australian Engineers Golf Course	Access to the golf course is available from Chatham Avenue (main access gates to the Golf Course and School of Military Engineering). Defence clearance and identification is required at this point. Barry Dodd (Golf Course Manager) is aware of the work and has given permission to access the course without any prior notification. A footbridge over the creek is located between two holes on the golf course providing a safe location for sampling without interrupting the golfers. Water quality samples were taken using a telescopic pole for a grab sample.	0307811 6240166

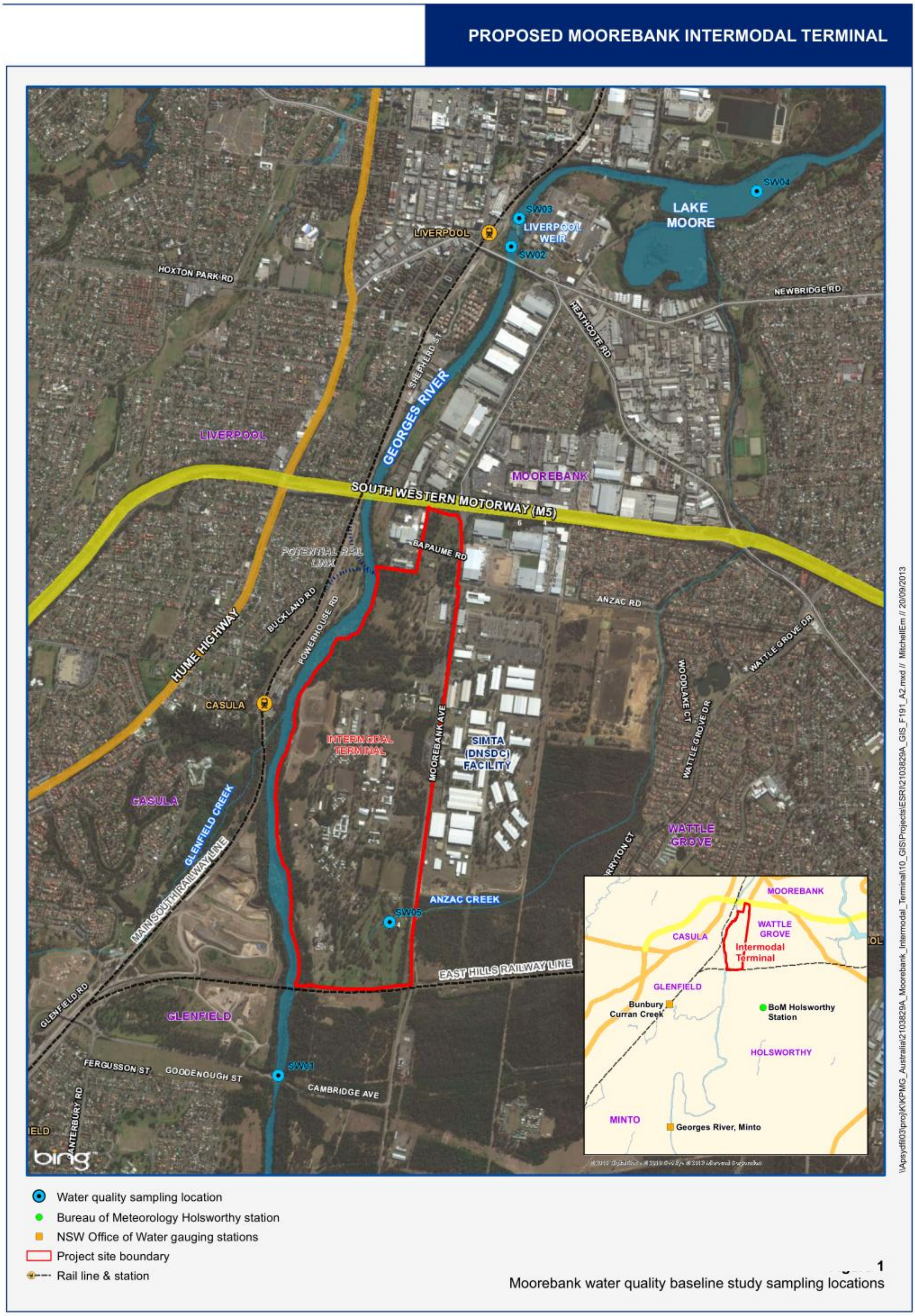


Figure 2.4 **Water quality monitoring locations**

The monthly sampling programme also involves analysis of weather observations at Bureau of Meteorology Holsworthy station 067117 and Liverpool (Whitlam Centre) BoM station 067035. The Liverpool station is used for comparison of prevailing weather conditions prior to and during a sampling event against long term averages which are not available for the Holsworthy station. Water level and flow records prior to sampling are also reviewed at the following locations:

- Bunbury Curran Creek – NSW Office of Water gauging station (Station No. 213012)
- Georges River, Minto Heights – NSW Office of Water gauging station (Station No. 213018)
- Liverpool Weir – Manly Hydraulics Lab (Station No. 213400).

The gauging station at Liverpool Weir provides automatic monitoring of water levels at 15 minute intervals upstream of Liverpool Weir, with the weir acting as the control point for flows.

The main purpose of these comparisons and data reviews is to determine antecedent flow conditions in the river for the sampling events.

The monthly monitoring reports summarise the prevailing weather and river flow conditions and the results of the laboratory analysis and comparison to ANZECC guidelines for the monitored parameters. A typical example of the monthly monitoring summary results is provided in Table 2.5.

Table 2.5 Typical water quality monitoring results (from January 2014 sampling round)

Ecosystem type	Chl *a* (µg/L)	TP (µg/L)	TN (µg/L)	DO (% saturation)	pH (pH units)	Turbidity (NTU)	Salinity (EC µS/cm)
Lowland River	3	25	350	85–110	6.5–8.0	6–50	125–2,200
SW01	<1	<10	400	73.5	7.52	1.7	390
SW02	<1	<10	400	86.1	8.06	1.8	367
SW05	9	170	1,800	57.0	7.54	27.6	360
Estuary	4	30	300	80–100	7.0–8.5	0.5–10	N/A
SW03	5	50	600	74.8	7.49	5.8	5,053
SW04	3	50	600	79.8	7.51	8.7	9,210

ANZECC guideline default trigger values

Values within ANZECC guideline trigger values

Values exceeding ANZECC guideline trigger values

TP = Total phosphorous; TN = Total nitrogen; DO = Dissolved oxygen; EC = electrical conductivity

The findings to date of the Project specific water quality monitoring programme are as follows:

- Weather conditions since commencement of the programme in July 2013 have been relatively dry with below average rainfall. The sampling events to date have therefore not captured a high flow event, and results to date reflect water quality for the lower range of flow conditions.
- Exceedances for TN and TP have been recorded for all monitoring locations.
- SW05 most commonly exceeds TN and TP trigger values, likely to be due to fertilisers used at the Golf Course.
- No major exceedances for metals have been recorded.
- Other exceedances have been recorded but none indicating unusual or long term trends of concern.
- In general the results to date reflect the prevailing low flow conditions.
- As the programme is approximately 50% complete and has been operating during predominantly low flow conditions, it is recommended that summary statistics from the programme be prepared at a more advanced stage of the programme when a longer term record is available that captures more variability in flow conditions.

3. Design objectives

Drainage design for the proposed MIMT will be required to comply with and consider the criteria outlined in the following guidelines and regulatory requirements:

- Engineers Australia, Australian Rainfall and Runoff 1999
- Liverpool City Council, NSW Development Design Specification D5: Stormwater Drainage Design
- Liverpool City Council, NSW Development Design Specification D7: Erosion Control and Stormwater Management
- Liverpool City Council development control plan no. 49 for Amiens, Yulong and DNSDC sites Moorebank international technology park Moorebank avenue, Moorebank
- Liverpool City Council On-Ste Stormwater Detention Technical Specification
- Regional Environmental Planning Policy (REP) No.2 – Georges River catchment
- as a major portion of the developed Project site will contain significant rail corridors, considerations for design to Australian Rail Design Standards or RailCorp standards should be made. The design requirements within this report have therefore incorporated the RailCorp TMC 421 drainage design standard
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000)
- NSW Water Quality and River Flow Objectives for the Georges River.

3.1 Drainage design objectives

The relevant design criteria from the above guidelines and regulatory requirements have been summarised in Table 3.1 to Table 3.5 below.

Table 3.1 Stormwater drainage design criteria

Design	Criteria	Reference
Piped stormwater design rainfall event	▪ 10 year Average Recurrence Interval (ARI) # for commercial/industrial area ‘minor’ systems	Section D5.04
Surface roughness coefficients	▪ flow across parks = 0.35 ▪ flow across industrial = 0.04 ▪ flow across commercial = 0.04 ▪ flow across paved areas = 0.01 ▪ flow across asphalt roads = 0.013 ▪ flow across gravel areas = 0.02	Section D5.06
Minimum conduit sizes	▪ pipes = 375 mm diameter ▪ box culverts = 600 mm wide x 300 mm high	
Velocity of flow in stormwater pipelines.	▪ minimum = 0.6 m/sec ▪ maximum = 6.0 m/sec	Section D5.09
Pipe gradient	▪ minimum = 1% ▪ maximum = 10%	Section D5.09

Design	Criteria	Reference
Overland flow of water (1% AEP)	▪ maximum allowable depth =0.2 m ▪ maximum velocity x depth product = 0.4 m^2/s	Section D5.12
100 year flood level freeboard	▪ floor levels = 0.5 m ▪ entrances to underground car parks = 0.1 m	
Maximum side slopes	▪ grassed lined open channels = 1 in 6	Section D5.13
Gross Pollutant Traps	▪ gross Pollutant Traps are to be provided on all pipe outlets prior to discharging to watercourses	Section D5.13
Bridges and culverts	▪ shall be designed for the 1% AEP storm event without afflux	Section D5.14
Minimum cover	▪ under Roads = 600 mm ▪ overland = 400 mm	Section D5.18
Drainage design specifications	▪ development Construction Specification C221 pipe drainage	
	▪ NSW specification 220 stormwater drainage general	

Table 3.2 Liverpool City Council wet sedimentation basin design criteria

Design	Criteria	Reference
Volume/capacity	▪ minimum = 250 m^3/ha of disturbed site including the building areas. ▪ an allowance of 50 m^3/ha is required if diversion controls are not used to direct clean upstream water from outside the site away from construction areas	Section D7.11
Capacity Measurement	▪ the capacity shall be measured below the invert of the lowest incoming flow	Section D7.11
Spillway	▪ a secondary or emergency stabilised spillway must be provided to prevent overtopping of the structure. This shall be directed to a safe overland flow path	Section D7.11
Spillway freeboard	▪ minimum = 0.5 m freeboard above the level of the spillway	Section D7.11
Access	▪ man proof fence with lockable gates to surround basin	Section D7.11
Maintenance Access	▪ an all-weather access must be provided to the basin for maintenance	Section D7.11 and Section D7.19
Plan dimensions	▪ arbitrary length to width ratio of between 2 and 3:1	Section D7.11
Layout	▪ the entry and exit points should be located at the opposite ends of the basin. ▪ otherwise some form of approved baffles shall be installed to minimise short circuiting of the flow	Section D7.11 and Section D7.19
Discharge from basin	▪ dry basin - perforated riser encapsulated by a filter device ▪ wet basin - flocculated by dosing with gypsum and pumped	Section D7.11
Batters	▪ internal – Maximum = 3:1 ▪ external – Maximum = 2:1	Section D7.11

Design	Criteria	Reference
Disturbed Areas	▪ all disturbed areas including batters shall be topsoiled and seeded	Section D7.11
Depth	▪ minimum depth = 1.5 m ▪ average depth = 2.5 m	Section D7.19
Side Slopes	▪ approximately = 1 in 8	Section D7.19
Velocity	▪ maximum = 0.3 m/s at 2.5 m depth based on the 1 in 1 year ARI storm	Section D7.19
Weir overflow	▪ overtops on average three times per year	Section D7.19
Weir freeboard	▪ minimum = 0.3 m between a restricted discharge outlet for the pond and a storm overflow weir	Section D7.19
Construction	▪ prior to the commencement of any site clearing or construction works	Section D7.19
De-Silted	▪ when average water depth ≤ 1.5 m due to sediment build-up	Section D7.19
Buffer Zones	▪ minimum = 20 m of grassed foreshores	Section D7.19
Dam Safety	▪ meet the requirements of the Dams Safety Act, 1978 and the NSW Dams Safety Committee	Section D7.19

Table 3.3 Liverpool City Council dry detention basin design criteria

Design	Criteria	Reference
Volume requirement	▪ the rate of stormwater runoff (both piped and overland) from the post-developed site is not to exceed the rate of runoff from the pre-developed site	OSD Tech. Spec. Section 1.2.1
Design rainfall events	▪ 5, 10, 20, 50 and 100 year ARI	OSD Tech. Spec. Section 1.2.1
Outlets	▪ basin high level outlet = basin 1% AEP flood level	Section D5.15
Freeboard	▪ minimum floor level = 0.5 m	OSD Tech. Spec. Section 1.2.7
Batter slopes	▪ maximum = 1:4	OSD Tech. Spec. Section 1.2.7
Depth	▪ 20 year ARI depths < 1.2 m	OSD Tech. Spec. Section 1.2.7
Water ponding	▪ maximum = 300 mm	OSD Tech. Spec. Section 1.2.7
Design contingency	▪ 20% additional storage for vegetation growth and construction inaccuracies	OSD Tech. Spec. Section 1.2.7
Basin design	▪ the hazard category should be determined by reference to ANCOLD[1]	Section D5.15

[1] The Australian National Committee on Large Dams Incorporated

Table 3.4 Georges River Discharge design criteria

Design	Criteria	Reference
Flood control works	▪ New South Wales Government's Floodplain Development Manual: the management of flood liable land	REPP Georges River Section 6
Hazardous or offensive, or potentially hazardous or offensive industries	▪ development consent required unless located on either flood liable land or land within 40 m of any watercourse within the Catchment, in which case it is prohibited	REPP Georges River Section 7
Construction management	▪ managing Urban Stormwater: Soil and Construction Handbook (1998) – [BLUE BOOK]	REPP Georges River Section 9
Stormwater management system or works	▪ must follow Liverpool City Council: D7 - Erosion control and stormwater management	REPP Georges River Section 20
Development in vegetated buffer areas	▪ developments must also comply with: ‣ Planning for Bush Fire Protection ‣ NSW State Rivers and Estuaries Policy ‣ NSW Wetlands Management Policy	REPP Georges River Section 21
Stormwater best practice treatment guidelines	▪ 90% removal of gross pollutants ▪ 80% removal of TSS ▪ 55% removal of TP ▪ 40% removal of TN	Sydney Catchment Management Authority

Table 3.5 Rail corridor design criteria

Design	Criteria	Reference
Piped stormwater design rainfall event	▪ 20% AEP	C4-2.1
Open channel slope	▪ minimum = 1:200	
Overland flows	▪ the formation level shall be designed so that it is not overtopped in a 1 in 100 year flood ▪ water from one track shall not cross another track to get away. Drainage shall be provided by sumps and pipes in the 'six-foot' as required	C4-2.3.1 C4-2.3.1
Parallel pipe depth	▪ minimum = 600 mm	C4-2.3.2
Under track pipe depth	▪ minimum = 1,600 mm (top of rail to top of pipe) (may be 1,200 mm in specific cases)	C4-2.3.2
Pipe slope	▪ minimum = 1:200	C4-2.3.2
Pipe diameter	▪ minimum = 225 mm	C4-2.3.2
Pipe strength	▪ minimum = class 4	C4-2.3.2, Table 1

3.2 Water quality design objectives

3.2.1.1 Water Quality downstream receptors

This section identified key downstream receptors of water quality. The Project site is located in the middle reach of the Georges River sub-catchment and runoff will also flow to the lower reaches (Anzac Creek). There are a number of different stakeholders and landowners downstream of the Project including:

- local councils
- government agencies
- State and Commonwealth departments (including Department of Defence)
- Aboriginal land councils
- environmental and community groups.

A number of parks and reserves are also located along the river providing recreational facilities and leisure activities for the general public. The Department of Defence land at Holsworthy has water frontage and the river has historically been used for military exercises.

Towra Point Nature Reserve is a Ramsar wetland located downstream of the Project at the mouth of the Georges River in Botany Bay.

3.2.1.2 Environmental values

Environmental values are those values or uses of water that the community believes are important for a healthy ecosystem for public benefit, welfare, safety or health (DEC 2006). The guiding principles of the environmental values are classified according to the land use characteristics applicable to sub-catchments within the wider catchment. For example, the environmental values and associated water quality objectives for the Georges River have been established for the following areas:

- mainly forested areas
- waterways affected by urban development
- uncontrolled streams
- estuaries.

The Project site is located on a section of river that is classified as an ‘uncontrolled streams’ and ‘waterways affected by urban development’. Water quality objectives for ‘estuaries’ is a potential downstream receptor of water quality. The mainly forested areas objectives refer to the upper reaches of the Georges River and therefore are not applicable for this project. Table 3.6 outlines the environmental values applicable to the Project for waterways affected by urban development within the Georges River catchment.

The environmental values for waterways affected by urban development are applicable to the Project and have been applied when assessing the water quality of the Georges River. As such, the environmental values for uncontrolled streams have not been considered in the water quality assessment.

Table 3.6 Environmental values for waterways affected by urban development

Environmental value	Objective*
Aquatic ecosystems	Maintaining or improving the ecological condition of water bodies and their riparian zones over the long term.
Visual amenity	Protect and improve aesthetic qualities of waters.
Secondary contact recreation	Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed.
Primary contact recreation	Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed.

Source: NSW Water Quality and River Flow Objectives, NSW Office of Water (http://www.environment.nsw.gov.au/ieo/GeorgesRiver/report-02.htm)

*Aquatic foods is also listed for achievement in 5–10 years

3.2.1.3 Water quality objectives

There are two kinds of water quality objectives (WQOs) that are applicable to the site – catchment specific objectives based on maintenance of environmental values identified in section 3.2.1.1 and default trigger values included in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000) which provide a threshold or a range of desired values to achieve WQOs.

For each environmental value, the catchment-specific water quality guidelines identify particular water quality characteristics or indicators that are used to measure whether the desired environmental values are at risk. Water quality and river flow objectives for the Georges River have been endorsed by the NSW Office of Water (NOW) and are based on measurable environmental values.

WQOs derived to maintain existing conditions or improve conditions for waterways at a national level are provided in the ANZECC water quality guidelines.

The Georges River catchment lies between the altitudes of 440 m AHD and sea level. The Project site is located at an approximate ground level height of 15 m AHD. The Project is located upstream of the Liverpool Weir adjacent to a freshwater reach of the Georges River and in close proximity to the estuarine tidal reach. As discussed in section 2.2.1, discharge from the Project is directly to the Georges River from the Project site and indirectly to the Georges River via Anzac Creek. As such the lowland rivers and estuary WQOs provided in the water quality guidelines are applicable to the Project.

Indicators to achieve aquatic ecosystem WQOs for waterways affected by urban development for the Georges River have been obtained from NSW Office of Water (NOW) and are provided below in Table 3.7.

Table 3.7 WQOs for protection of Aquatic Ecosystems in lowland rivers and estuaries of the Georges River

	Lowland River	Estuaries
Total Phosphorus (µg/L)	25	30
Total Nitrogen (µg/L)	350	300
Chlorophyll-*a* (µg/L)	5	4
Turbidity (NTU)	6-50	0.5–10
Electrical Conductivity (µS/cm)	125–2200	-
Dissolved oxygen (% saturation)	85–110	80–110
pH	6.5–8.5	7.0–8.5
Temperature	Default trigger values are provided in ANZECC 2000 guidelines. An unnatural change in temperature (>80%ile, <20%ile) is the default trigger value.	
Chemical contaminants or toxicants	Default trigger values are provided in table 3.4.1 in the ANZECC 2000 guidelines.	
Biological assessment indicators	This form of assessment directly evaluates whether management goals for ecosystem protection are being achieved. Many potential indicators exist.	

Source: NSW Water Quality and River Flow Objectives for the Georges River (http://www.environment.nsw.gov.au/ieo/GeorgesRiver/report-03.htm#P405_33547)

NOW also provides indicators to achieve WQOs for visual amenity and primary and secondary contact recreation environmental values of the Georges River. These indicators are summarised in Table 5.2.2 of the water quality guidelines (ANZECC 2000) and included in Appendix B.

4. Drainage strategy development

4.1 Design opportunities and constraints

Based on an understanding of the current site conditions, the proposed site layouts and the design criteria as outlined above, the following opportunities and constraints have been identified. These constraints and opportunities have been used to identify requirements for a general drainage strategy and a concept design at later stages of design.

4.1.1 Drainage constraints

4.1.1.1 Fall across site

As the hard stand areas within the Project site will be heavily utilised, it is assumed that preference would be given to a drainage design that avoided overland flow paths across the site. Initial site investigations have shown that there is likely to be very little fall (<0.5%) across the site for piping large storm events under the Project site facilities. With the minimum design requirement of 1.2 m depth and 1/200 slope for piped drainage crossing rail lines, a piped 1% AEP drainage line and 2 m deep detention basins could result in an outlet approximately 3 m below the Georges River 1% AEP flood level. A submerged outlet would cause river water to backflow into the drainage network during the 1% AEP event and increase the size requirement of the detention basins.

As piped drainage of the 1% AEP event is constrained by a lack of fall across the site and involves higher construction costs, a combination of drainage mechanisms for different areas and rainfall events shown in Table 4.1 should also be considered in concept designs.

Table 4.1 Combined site drainage

Area	Rainfall event	Drainage mechanism
Warehousing, buildings, hardstand areas	Up to 10%AEP	Piped
	10%–1% AEP	Overland
Rail corridors, container transfer and storage areas	Up to 2% AEP	Piped
	2%–1% AEP	Overland

Providing a combination of piped drainage and overland flows will allow rainfall events below the 2% AEP to drain freely into the Georges River. During 1% AEP rainfall events, the drainage network will be required to surcharge into onsite detention or be detained within the drainage network.

4.1.1.2 Amiens wetland

The ‘Amiens wetland’ refers to a wetland/detention basin situated in the northern end of the Project site. This water body is currently utilised for water treatment and detention of runoff surcharging from the M5 stormwater drainage during heavy rainfall. Developing over this area will require the treatment and detention function of the Amiens wetland to be reinstated elsewhere. The option for piping the M5 surcharge to a detention basin on the Project site should be included in concept designs. Discussion with NSW Roads and Maritime Services (RMS) will be required regarding the construction over the Amiens wetland and diversion of this runoff.

4.1.1.3 Moorebank Business Park and Moorebank Avenue runoff

The current drainage from the DNSDC flows towards Moorebank Avenue and crosses the site through an existing open channel drain. Available drainage drawings do not show any on site detention within the Moorebank Business Park and it is therefore assumed that runoff flows directly from the DNSDC and enters the existing open channel drain or crosses Moorebank Avenue into the Project site. Developing the Project facilities over the existing channel will therefore require runoff from the DNSDC to be directed though newly constructed box culverts under the Project facilities or diverted elsewhere. Diversion of this flow would require considerable works within the already heavily developed DNSDC area and is therefore not considered feasible. A box culvert should therefore be installed to replace the existing open channel drain. This box culvert drainage line must be suitable for heavy traffic loading and have capacity to transfer the 1% AEP event runoff from the DNSDC.

Overland flows and runoff from the DNSDC and Moorebank Avenue that are not captured by the open channel on the eastern side of Moorebank Avenue will cross Moorebank Avenue. These flows will therefore require directing into new collection points along the western side of Moorebank Avenue and connect to the new drainage system within the Project site discharging to Georges River.

4.1.1.4 Anzac Creek environmental flows

Anzac Creek begins at Moorebank Avenue and not within the southern section of the Project site. However, the Project site and Golf Course currently contribute runoff to the creek. Although further investigations and discussions are required with Council, it has been assumed that there will be some environmental flow requirements and contributions from the existing Project site that should be maintained following development of the MIMT. A southern portion of the developed Project site should therefore drain to Anzac creek through the existing culverts under Moorebank Avenue.

4.1.1.5 Glenfield Landfill Site

The Glenfield landfill site is assumed to have its own stormwater and surface water runoff system. This system would treat both stormwater runoff from hardstand areas and from waste fill sites. It is likely that the landfill site also has a leachate management system that treats the leachate generated from the landfill. Therefore any proposed works, such as the rail embankment should avoid these current treatment systems. Stormwater runoff from the proposed rail embankment and associated construction works should be managed separately to any landfill operations.

4.1.1.6 Stormwater pollutant sources

The Georges River is currently considered ‘under stress’ it terms of water quality and anthropogenic contributions to pollution levels in the river. As stormwater runoff from the site can contain significant pollution constituents, a strong emphasis on stormwater quality treatment should be provided in concept and detailed designs. Table 4.2 details expected pollution and sources that should be addressed.

Table 4.2 Stormwater pollution and possible sources

Pollutant	Source
Gross Pollutants/Trash and litter	▪ all hard stand areas
Sediment/Suspended Solids	▪ all hard stand areas ▪ bulk storage areas ▪ vehicle/train wash-down areas
Heavy metals, Oils, Grease, hydrocarbons	▪ car/truck parks ▪ access roads ▪ container transfer areas
Bulk hydrocarbons	▪ hazardous materials storage ▪ fuel storage ▪ substations ▪ vehicle/train wash-down areas ▪ maintenance facilities
Phosphorus	▪ all hard stand areas
Nitrogen	▪ all hard stand areas
Other toxic materials	▪ hazardous materials storage ▪ maintenance facilities

Each of these pollution constituents and sources should be considered for prevention and treatment through either proprietary or water sensitive urban design (WSUD) systems in the concept and detailed designs. Further recommendations for onsite treatment are provided in section 4.6.

4.1.2 Drainage opportunities

4.1.2.1 Existing drainage networks onsite

Drainage across the current site consists of a pipe drainage network with main stormwater pipelines from 600 mm to 1200 mm diameter. Depending on the site layout, location of new services and the interference with construction methods, it may be possible to utilise some of this existing drainage network. Concept designs should be made to utilise this existing drainage and decisions on feasibility assessed at the detailed design stage when more information on the final site design and construction methods are available.

4.2 Proposed Project layouts

The Project will consist of intermodal transport facilities to allow the transfer of containers between road and rail associated with the import/export container handling operation. Appendix A presents the layouts for the three options proposed. Key facilities to be included in the Project include:

- rail layout and connections both internal and to the Southern Sydney Freight Line (SSFL)
- container storage yard
- warehousing
- internal road network
- administration and ancillary terminal facilities
- utilities and stormwater management infrastructure
- vehicle access to external road network
- conservation zone along edge of Georges River.

For the purposes of the drainage strategy these areas have been divided into runoff response categories and summarised in the following table for each proposed layout. This breakdown is based on the layout at the time of the assessment and has been done to demonstrate how stormwater runoff could be managed on the project site. These runoff response categories relate to how rainfall runoff will be generated from each surface. The hardstand areas will have a fast response time while the intermodal (IMT) areas will have a slower response time due to the presence of ballast covered rail line areas. The conservation area will generate little runoff until the ground has reached saturation.

Table 4.3 Proposed layout surface breakdown#

Proposed layout	Hardstand (Ha)	IMT (Ha)	Conservation (Ha)
Northern rail connection option	53.4	66.7	47.7
Central rail connection option	66.9	59.0	42.0
Southern rail connection option	67.1	67.1	41.3

Note: # The Project site area is 220 ha. The remaining areas not accounted for in this table include drainage features, landscaping and buffer zones.

4.3 Drainage design

The proposed strategies provided below have been developed such that they can be applied to each of the proposed layouts, northern, central and southern. It is assumed that the overall breakdown of stormwater runoff generating areas (intermodal areas and warehousing etc.) does not significantly change between the three options. In light of the key design constraints and based on the Project site characteristics the following three options for drainage across the site were considered.

Option 1: 10% AEP piped conveyance and 1%AEP overland flows to detention basins.

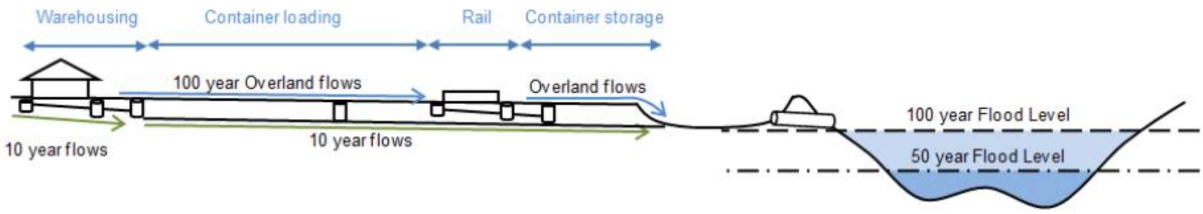


Figure 4.1 Drainage and detention option 1

Option 2: 1% AEP piped conveyance with surcharge to detention basins

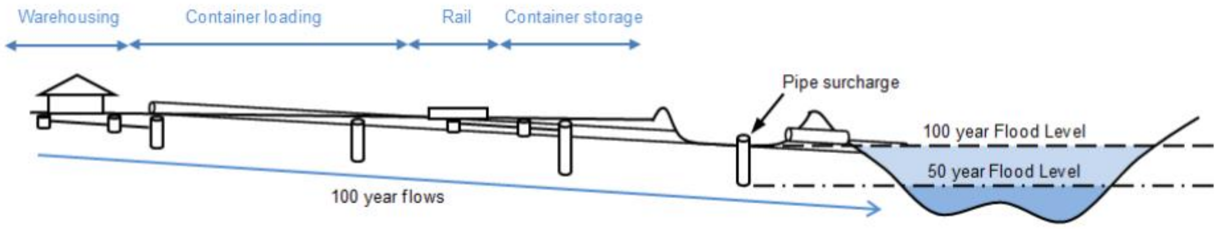


Figure 4.2 Drainage and detention option 2

Option 3: 10% AEP piped conveyance with onsite detention and 1%AEP overland flows to detention basins

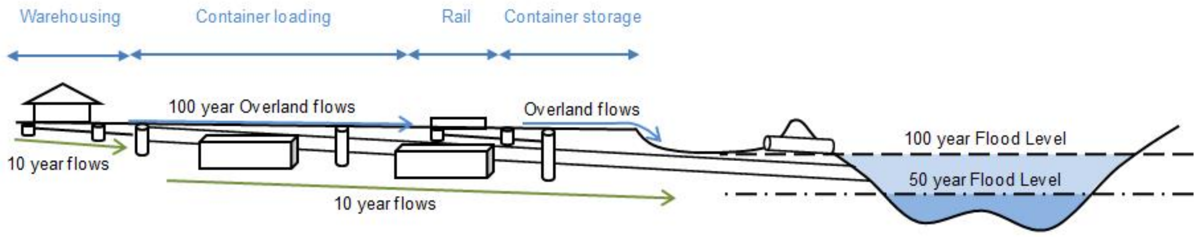


Figure 4.3 Drainage and detention option 3

4.3.1 Rail corridors

As a requirement of the rail corridor design, 1%AEP overland flows should not cross the tracks. As the rail tracks cross through the centre of the site, either 1% AEP drainage under the tracks or ponding upstream of the rail tracks is required.

Section C-2.3.5 (TMC 421), of RailCorps' drainage design standard requires drainage pits with ballast cages at 50 m (maximum) spacing to allow 2% AEP overland flows to enter the drainage network. These pits should connect to stormwater pipes running parallel to the rail tracks. A trunk main drainage pipe can then convey stormwater across the rail corridors. Further design and modelling will be required to determine optimum pit and pipe sizes.

If 1% AEP flows are not conveyed in underground drainage, then overland flow paths will be required along and across the rail tracks. To allow overland flow across the rail tracks shallow culverts should be installed at 50 m centres under rail tracks. These culverts should be at least 1 m in length and 300 mm in depth. Considerations for maintenance of these culverts will be required prior to finalising designs.

4.3.2 Container transfer and container storage areas

The container transfer station areas have been assumed to be 100% impervious with a 1% slope towards Georges River. As this area is under high use for the unloading and loading of containers, it has been assumed that preference will be given to minimising disruptions to operations by overland stormwater flows across this area. Although further design considerations around this assumption are required it has been assumed that overland flow less than 100 mm at low velocities (< 1 m/s) will not disrupt operations. It is therefore proposed that piping all flows up to the 10% AEP rainfall event be considered for the design. Further investigations into volumes, depths and velocities of overland flows are required in further stages of design.

Similar to the container transfer areas, it has been assumed that overland flows less than 100 mm and velocities less than 1 m/s will not disrupt operations around the container storage areas. Further assumptions have been made that containers are stored above ground level on railway sleepers or tracks that allows overland flows to travel under containers. Consideration of a freeboard above overland flows should be allowed for in the detailed design of the container storage areas to prevent water entering the containers. Should over land flows be undesirable through the container transfer and storage areas, considerations for grated channels across can be made as shown in Figure 4.4.

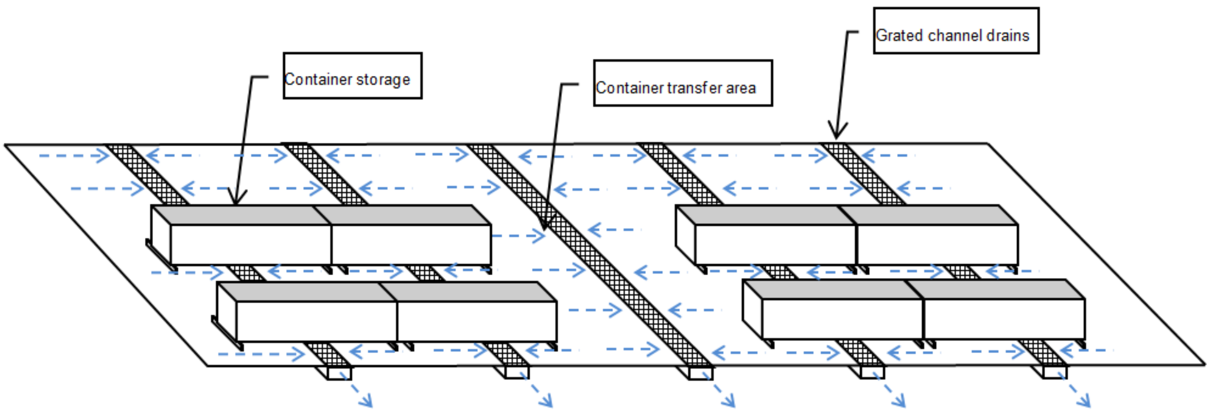


Figure 4.4 Grated channel flow diversions across container transfer and storage areas

As required by the Liverpool City Council, NSW Development Design Specification D5: Stormwater Drainage Design, all access roads, footpaths and car park areas on site will have 10% AEP piped drainage capacity. Overland flows will follow road or footpath alignments and discharge to appropriate overland drainage conveyance points.

Car parks will be graded with a 1% slope towards catchpits spaced at approximately 50 m centres. When a rainfall event exceeds the 10% AEP event capacity of the drainage network, the catchpits will surcharge into the car park. The car park should then be designed to allow a detention volume above the surface level of the car park which will drain down through the drainage network at the end of a rainfall event. During large storm events when the detention capacity of the car park is exceeded, stormwater water should overtop the car park kerbing and flow along overland flow paths to the detention basins.

4.3.3 Roof areas

All roof downspouts will require connection to the underground drainage network. The drainage network must therefore provide capacity for the runoff generated during 10% AEP rainfall events from roof areas. Although stormwater collection tanks may be implemented on some or all roof areas, drainage must still allow capacity for runoff from the 10% AEP rainfall event from roof areas.

4.4 Stormwater outlets

Stormwater outlets will be required along Georges River and Anzac Creek at points directly downstream from detention basins. In some instances existing outlet headwalls may be utilised following a condition assessment of these outlets. Where new outlets are to be constructed, considerations for construction within the river embankment will be required in the construction erosion and sedimentation control plan. Further considerations in line with the Georges River Strategic Bank Stabilisation Plan may also be required depending on the extent of works required.

The general design for outlet headwalls will follow standard details for outlets in the Liverpool Council standards and guidelines. These details will include scour and erosion protection and may also include gross pollutant traps (GPTs) depending on the onsite GPT options employed.

4.5 Stormwater quantity treatment

4.5.1 On-site detention requirements

Onsite detention is required to detain 1% AEP flowrates to predeveloped flowrates as outlined in section 6.1 of the ‘Liverpool Development Control Plan 2008, Part 1.1, General Controls for all Development’ and the Liverpool City Council ‘On-site stormwater detention policy’.

Preliminary investigations of each layout identified sub-catchments that have sufficient fall towards available areas for locating detention basins. Each sub-catchments detention volume requirements were sized based on the peak flow estimates for each sub-catchment in the following tables.

Table 4.4 Northern rail connection stormwater runoff estimation

		10% AEP		2% AEP		1% AEP	
	Area (m^2)	Existing	Developed	Existing	Developed	Existing	Developed
Catchment 1	24,000	0.19	0.76	0.30	1.20	0.36	1.43
Catchment 2	140,000	0.82	3.27	1.30	5.19	1.55	6.20
Catchment 3	230,000	1.21	4.82	1.91	7.65	2.29	9.15
Catchment 4	277,000	1.42	5.70	2.26	9.04	2.70	10.81
Catchment 5	257,000	1.32	5.28	2.10	8.39	2.51	10.03
Catchment 6	192,000	1.05	4.19	1.66	6.66	1.99	7.96

Table 4.5 Central rail connection option stormwater runoff estimation

		10% AEP		2% AEP		1% AEP	
	Area (m^2)	Existing	Developed	Existing	Developed	Existing	Developed
Catchment 1	24,000	0.19	0.76	0.30	1.20	0.36	1.43
Catchment 2	140,000	0.82	3.27	1.30	5.19	1.55	6.20
Catchment 3	230,000	1.21	4.82	1.91	7.65	2.29	9.15
Catchment 4	277,000	1.42	5.70	2.26	9.04	2.70	10.81
Catchment 5	257,000	1.32	5.28	2.10	8.39	2.51	10.03

Table 4.6 Southern rail connection stormwater runoff estimation

		10% AEP		2% AEP		1% AEP	
	Area (m^2)	Existing	Developed	Existing	Developed	Existing	Developed
Catchment 1	24,000	0.19	0.76	0.30	1.20	0.36	1.43
Catchment 2	140,000	0.82	3.27	1.30	5.19	1.55	6.20
Catchment 3	230,000	1.21	4.82	1.91	7.65	2.29	9.15
Catchment 4	277,000	1.42	5.70	2.26	9.04	2.70	10.81
Catchment 5	257,000	1.32	5.28	2.10	8.39	2.51	10.03
Catchment 6	192,000	1.05	4.19	1.66	6.66	1.99	7.96

Where area is available detention ponds were located and the area required calculated based on a detention depth of 1.5 m. Detention pond layouts for the northern, central and southern rail connection layout options are show in Appendix A. The following tables provide a summary of the estimated detention basin areas for each layout.

Table 4.7 Northern rail connection option detention requirement estimation

Drainage area reference	Catchment area (m^2)	Detention requirement (m^2)
Catchment 1	24,000	610
Catchment 2	140,000	5,161
Catchment 3	230,000	9,194
Catchment 4	277,000	11,655
Catchment 5	25,7000	10,510
Catchment 6	192,000	7,464
Total	**1,120,000**	**44,593**

Table 4.8 Central rail connection option detention requirement estimation

Drainage area reference	Catchment area (m^2)	Detention requirement (m^2)
Catchment 1	24,000	610
Catchment 2	173,000	6,605
Catchment 3	560,000	26,447
Catchment 4	292,000	12,300
Catchment 5	234,000	9,415
Total	**1,283,000**	**55,377**

Table 4.9 Southern rail connection development detention requirement estimation

Drainage area reference	Catchment area (m^2)	Detention requirement (m^2)
Catchment 1	24,000	610
Catchment 2	190,000	7,357
Catchment 3	190,000	7,357
Catchment 4	440,000	19,866
Catchment 5	223,000	8,989
Catchment 6	288,000	12,069
Total	**1,355,000**	**56,247**

Detention basin sizes vary between each layout options as each sub-catchment and drainage alignment is different depending on the layout of infrastructure on site. The location and size of these basins will be considered further during concept and detailed design.

4.6 Stormwater quality treatment

To address treatment requirements in section 3.2 and specifically in Table 3.5 the following treatment best management practices are recommended:

- subsurface drainage
- swales drainage
- raingardens
- sedimentation basins (within the detention basin inlets)
- biofiltration basins and permanent ponds (within the detention basin inlets).

Preliminary calculations have been undertaken to estimate the area of water quality treatment required to meet best management objectives. In NSW these objectives are generally accepted as 90% removal of gross pollutants, 80% removal of Total Suspended Solids (TSS), 55% removal of Total Nitrogen (TN) and 40% removal of Total Phosphorus (TP). The following table summarises the area of treatment required for each layout.

Table 4.10 Northern rail connection option treatment area requirement estimation

Drainage sub-catchment area reference	Catchment area (m^2)	Approx. treatment area requirement (m^2)
Catchment 1	24,000	60
Catchment 2	140,000	350
Catchment 3	230,000	575
Catchment 4	277,000	692.5
Catchment 5	257,000	642.5
Catchment 6	192,000	480
Total	**1,120,000**	**2,800**

Table 4.11 Central rail connection option treatment area requirement estimation

Drainage sub-catchment area reference	Catchment area (m^2)	Approx. treatment area requirement (m^2)
Catchment 1	24,000	60
Catchment 2	173,000	432.5
Catchment 3	560,000	1,400
Catchment 4	292,000	730
Catchment 5	234,000	585
Total	**1,283,000**	**3,208**

Table 4.12 Southern rail connection option treatment area requirement estimation

Drainage sub-catchment area reference	Catchment area (m^2)	Approx. treatment area requirement (m^2)
Catchment 1	24,000	60
Catchment 2	190,000	475
Catchment 3	190,000	475
Catchment 4	440,000	1,100
Catchment 5	223,000	557.5
Catchment 6	288,000	720
Total	**1,355,000**	**3,388**

4.6.1 Runoff mitigation

Runoff mitigation attempts to reduce the volume of water leaving a site during a storm event, by slowing the stormwater flow path or redirecting stormwater into the subsoil or vegetation. The ‘Liverpool Development Control Plan 2008, Part 2.4, Development in Moorebank Defence Lands’ provides the following suggestions for runoff mitigation within the site:

- use porous paving materials to minimise runoff
- polish water from on-site runoff by directing runoff into on-site dry creek gravel beds with macrophyte plants
- use drainage swales adjacent to entry roads instead of kerbs to slow down stormwater runoff and increase on-site infiltration.

Due to the industrial land use and heavy trafficking of hardstand areas on site, it is expected that porous paving on site will quickly become fouled and require regular maintenance. It is expected that this maintenance will be costly and disruptive to operations on site and porous pavement is therefore not recommended for use on site.

It is recommended that swale drains and rain gardens be incorporated into the design of the preferred layout to meet the DCP objectives.

5. Summary of recommended design considerations

5.1 Stormwater and flood flow management

The final drainage design is required to provide piped 10% AEP drainage capacity from all hard stand areas, piped 2% AEP drainage capacity from all rail corridors and 1% AEP overland flows from the site. It is assumed that overland flows will be allowed to pond on site to below the rail levels to prevent overtopping of the rail corridors. This assumption is necessary to ensure pipe grades can be maintained and to prevent Georges River floodwaters from impacting the local stormwater system. This design is represented in Figure 5.1 below.

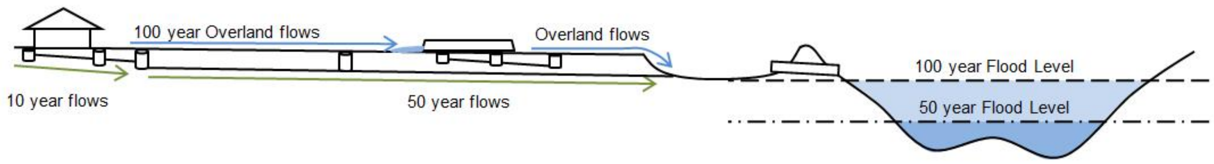


Figure 5.1 Recommended drainage strategy

In order to prevent 1% AEP floodwaters affecting the stormwater system, consideration of low pipe grades (such as 0.33%) and alternate pipe/culvert sizes (box culverts instead of circular) should be considered as part of the detailed design. The use of open and roofed channel drains could also be considered for along Moorebank Ave and within the warehouses to reduce the overall fall through the drainage section.

Low grade pipes reduce low flow velocities which create situations where the pipes are susceptible to siltation. This design issue should be addressed at the detailed design stage by providing high velocity sections within pipes and culverts, easy maintenance access, silt traps within minor drainage sections and regular cleaning programmes.

Further detailed designs will also need to consider more suitable minor drainage alignments and pit locations based on more detailed site layouts and details.

5.2 Stormwater quantity treatment

Conceptually, it is proposed that stormwater quantity be addressed by providing detention basins prior to stormwater discharges into the Georges River. As the grade of the drainage network will be low there is likely to be a greater volume of water retained in the pipe network and therefore the required detention basin volumes are likely to be lower than those determined previously.

The major constraint on the site (apart from available area) is fall across the site. Any detention ponds are required to be above the 1% AEP levels to avoid submerged outlets. Similarly to prevent backing up of water within the pipe the inlet to any detention basins should be above 11.7 m AHD. With a finished surface level of 14.5 m AHD, this gives a 2.3 m pipe fall limitation (with minimum 500 mm pipe cover) across the site. Based on a minimum pipe grade of 0.33% the maximum allowable pipe lengths are around 700 m.

This maximum drainage length limitation is encountered on all site layout options and specifically the Northern rail connection option - Area 6, Central rail connection option – Area 5 and Southern rail connection option – Area 3 and 5. In the previous concept design, allowances for swales and oversized drainage pipes were made to provide some detention function and discharge to Anzac Creek from these areas. Compensational detention was then provided in other areas to reduce the sites overall detained peak flow to design requirements.

For the southern end of the site, within the Anzac Creek catchment, the detailed design should consider the inclusion of detention basins to capture the four exceedences per year storm event. The outlet of the basins in this area should maintain a low flow similarly to what is currently occurring from the Golf course ponds.

If there are no opportunities for detention basins for the Anzac Creek catchment area then, stormwater runoff will have to be controlled and restricted to current flow conditions through the pipe network. Design and analysis of the system will need to consider pit surcharging and maximum ponding depth within hardstand areas. Further designs for the stormwater ponding for detention purposes on site with finished surface levels, slopes and kerbing will be required at further stages of design.

Final designs of detention basins will require outlet flow restrictions to be designed within the drainage outlet manholes that restrict peak flows to the pre-developed peak flows shown in Table 3.1, Table 3.2 or Table 3.3.

5.3 Stormwater quality treatment

Stormwater quality treatment objectives have been addressed for discharges to Georges River by providing sediment and biofiltration basins prior to the stormwater detention basins. It is proposed that these treatment systems been designed to operate offline from peak storm events and treat the stormwater quality flows.

Sediment basins should be designed to minimise the maintenance requirements of the downstream biofiltration basins and also prevent the blocking of the biofiltration basin sub soil. It is intended that these sediment basins will require maintenance every 6–12 months. Maintenance will involve the removal of sediment by a suction truck or mechanical digger. Detailed designs should therefore allow for maintenance access and develop feasible solutions for the maintenance of these basins.

No formal treatment systems have been designed for discharges that cannot flow to detention basins (i.e. to Anzac Creek) and it is intended that a combination of onsite raingardens and swales will be designed in the detailed design stages to address water quality from these catchments. Due to the limited site layout information available at this stage of design, the layout of raingardens and swales has been omitted from this stage of design. Should there be insufficient room for treatment for the Anzac Creek catchment; compensative treatment can be achieved with the other sub-catchments treatments to meet the site's overall treatment objectives.

5.4 Constructability and construction phasing

Bulk earthworks for the entire site will be carried out primarily during Project Phases A, and B and will build up the finished surface level across the entire site. As part of the bulk earthworks the construction of temporary sediment basins will be required and it is therefore proposed that the biofiltration and detention basins are excavated so that spoil can be used for fill across the site and the basins used for temporary sediment basins. On completion of the bulk earthworks, the temporary sediment basins can then be developed into the finished biofiltration and detention basins as required.

Also during the bulk earthworks it is proposed that all major stormwater pipelines are installed across the entire site to reduce soil handling. Incorporated in this major drainage will be the culvert diversion of flows from the DNSDC site. Minor drainage can then be connected to the major drainage during each stage of construction.

For works through the Glenfield landfill site, the construction program needs to ensure it manages soil and erosion separate to the landfill facilities. Soil and erosion measures should be included separate to the current landfill operations and ensure no sediment is released to the Georges River.

For bridge works across the Georges River and Anzac Creek, consideration would be given to undertaking these works during a low flow and low rainfall period where possible. According to the rainfall statistics for Liverpool (station 067035, Bureau of Meteorology, accessed 8/04/2014 2.00 pm) the lower rainfall months are July, August and September. The section of the Georges River adjacent to the site is not subject to tidal influence so this will not be an issue during construction.

5.5 Further design elements required

As noted in individual sections above, the following design elements require further investigation in the detailed design stages:

- verification of drainage alignments, sizes and slopes with detailed site designs
- verification of pit types, locations and capacities with detailed site designs
- raingarden and swale treatment design for discharges to Anzac Creek
- onsite detention for discharges to Anzac Creek
- GPTs locations and specifications for each individual warehouse areas
- Investigation of the interaction between all underground services.

It is expected that most of these elements will be addressed in due course through the detailed design stage.

6. References

Hyder Consulting, August 3013, Transitional Part 3A Concept Application, SIMTA Moorebank Intermodal Terminal Facility – Flood Study and Stormwater Management.

Golder Associates, April 2013, Phase 1 Environmental Site Assessment, Rail Corridor Land for SIMTA Moorebank Intermodal Terminal Facility, Part 3A Concept Plan Application.

Engineers Australia, Australian Rainfall and Runoff 1999.

Liverpool City Council, NSW Development Design Specification D5: Stormwater Drainage Design.

Liverpool City Council, NSW Development Design Specification D7: Erosion Control and Stormwater Management.

Liverpool City Council development control plan no. 49 for Amiens, Yulong and DNSDC sites Moorebank international technology park Moorebank Avenue, Moorebank.

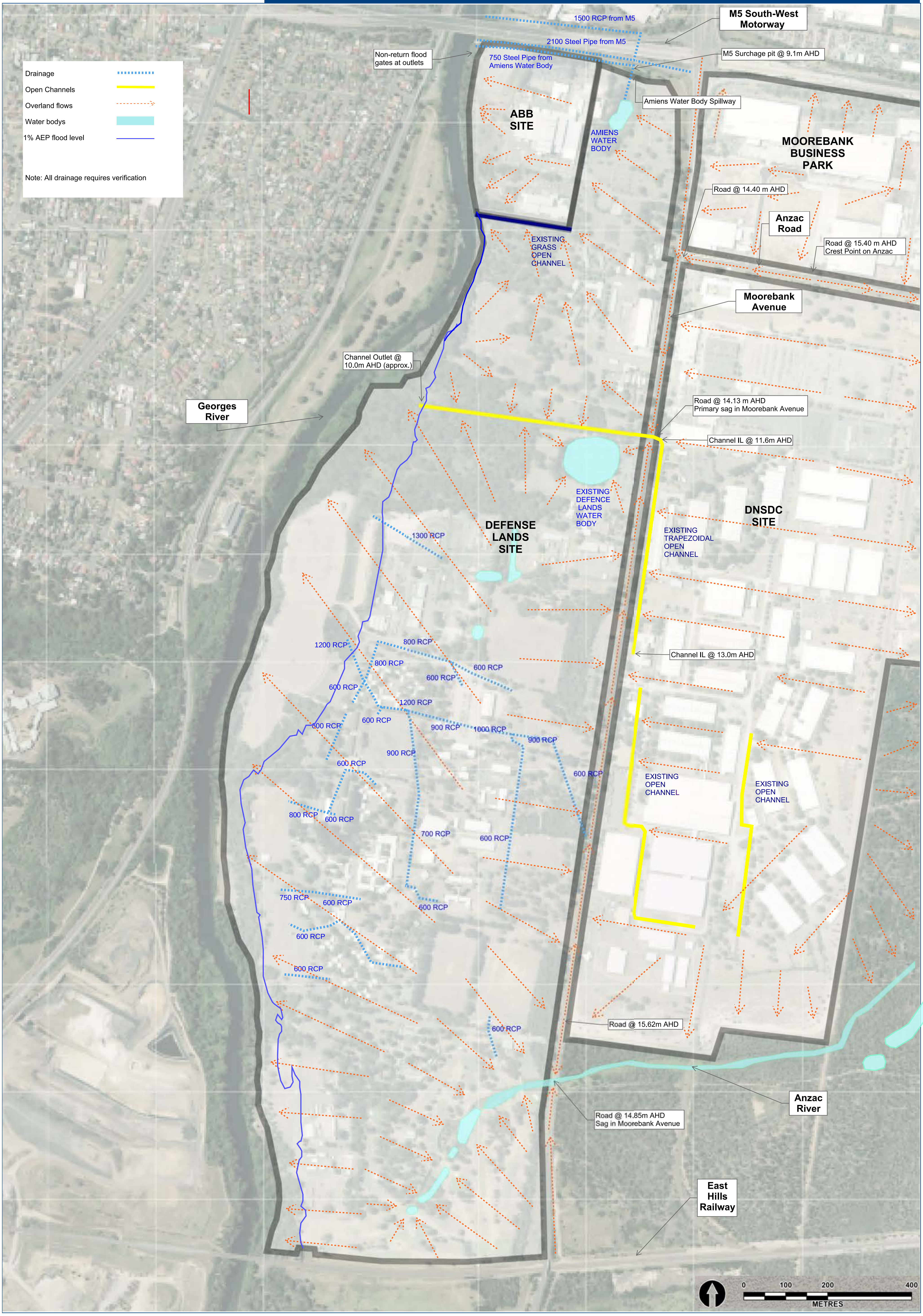
Liverpool City Council On-Ste Stormwater Detention Technical Specification.

Regional Environmental Planning Policy (REP) No.2 – Georges River catchment.

Appendix A

Drawings

EXISTING DRAINAGE AND OVERLAND FLOW PATHS



INDICATIVE SOUTHERN RAIL CONNECTION CONCEPT LAYOUT
MOOREBANK INTERMODAL TERMINAL

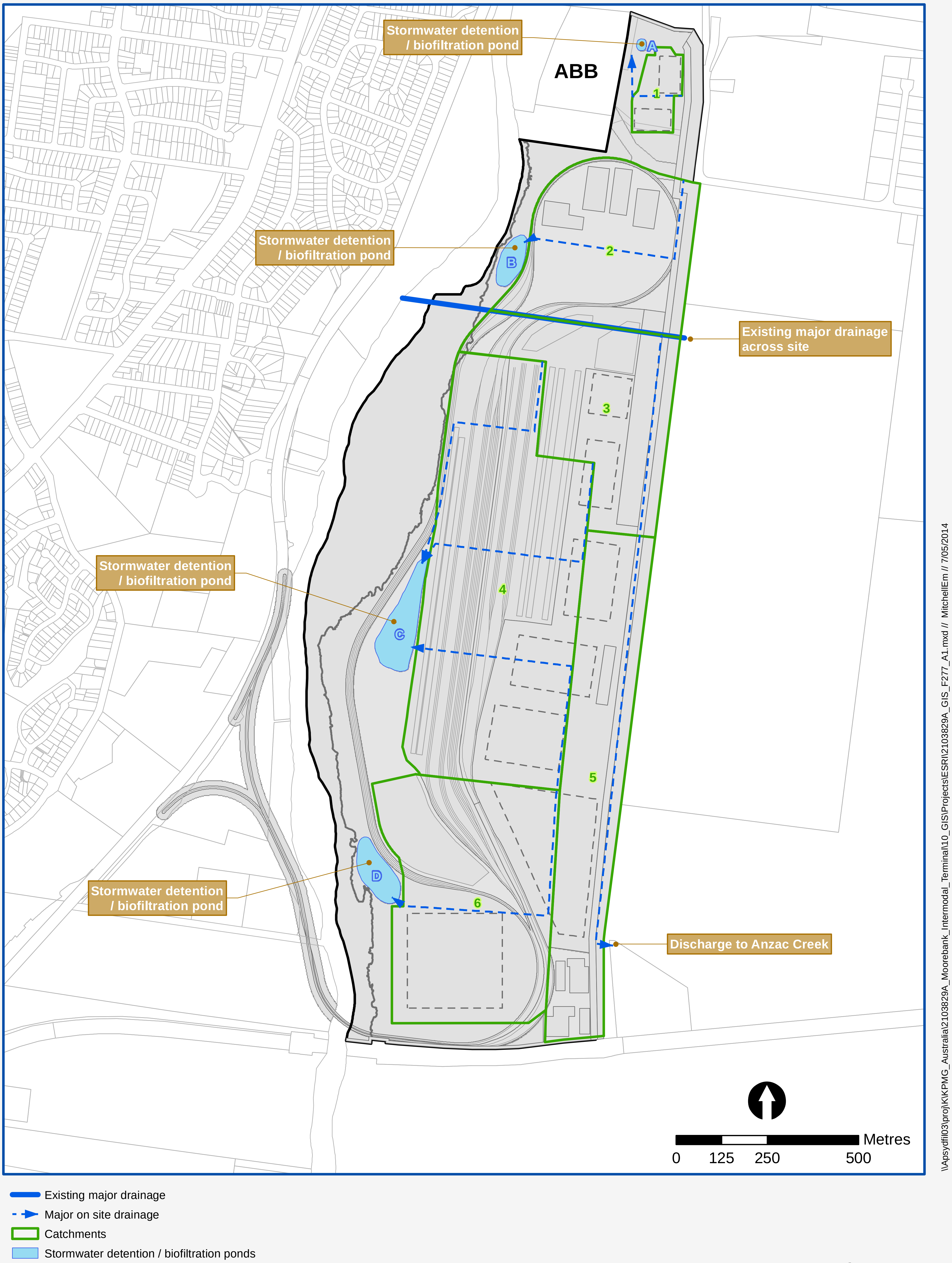


Figure X.X:
Indicative southern rail access option drainage strategy

INDICATIVE NORTHERN RAIL CONNECTION CONCEPT LAYOUT
MOOREBANK INTERMODAL TERMINAL

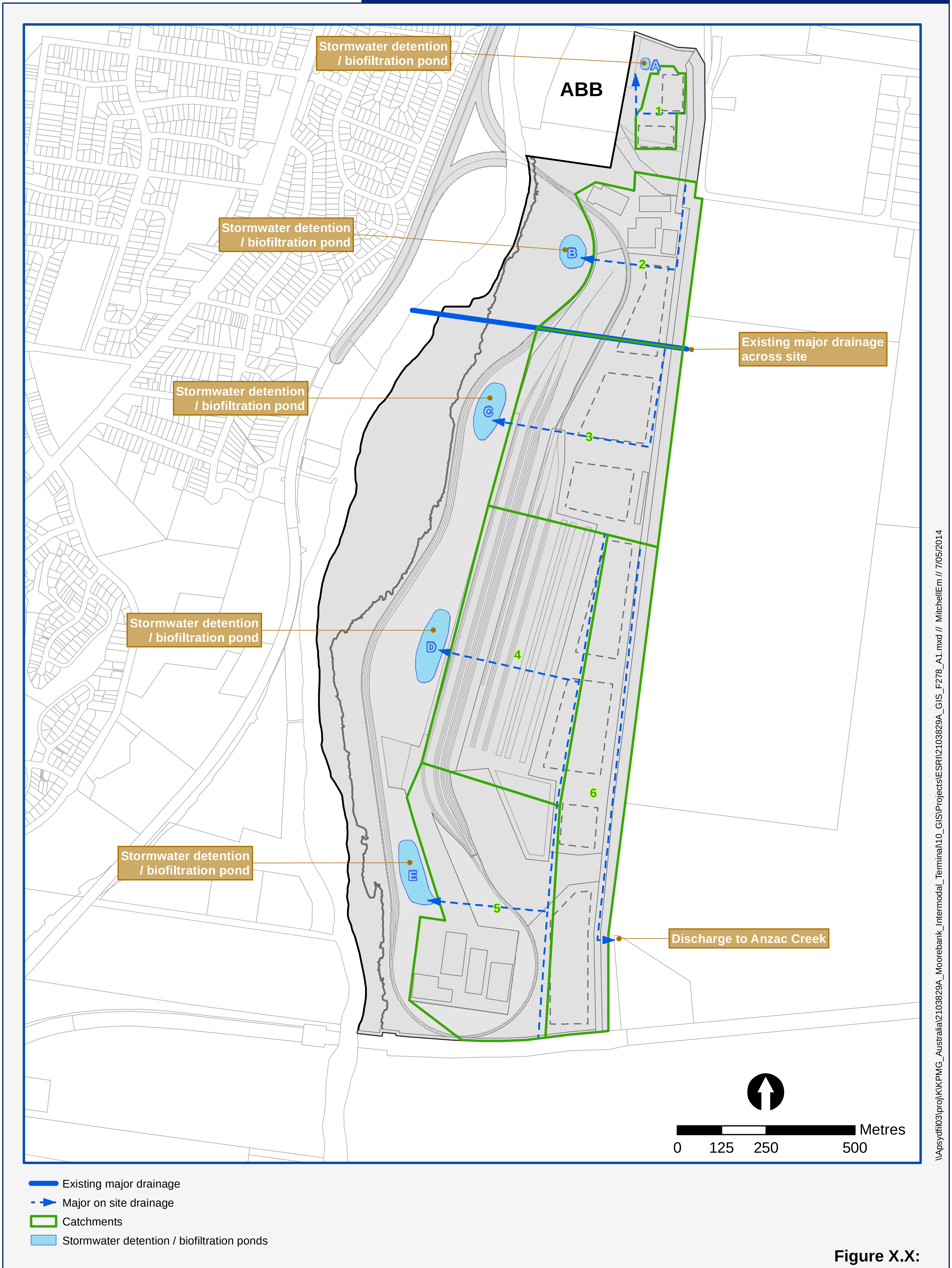


Figure X.X:
Indicative northern rail access option drainage strategy

INDICATIVE CENTRAL RAIL CONNECTION CONCEPT LAYOUT
MOOREBANK INTERMODAL TERMINAL

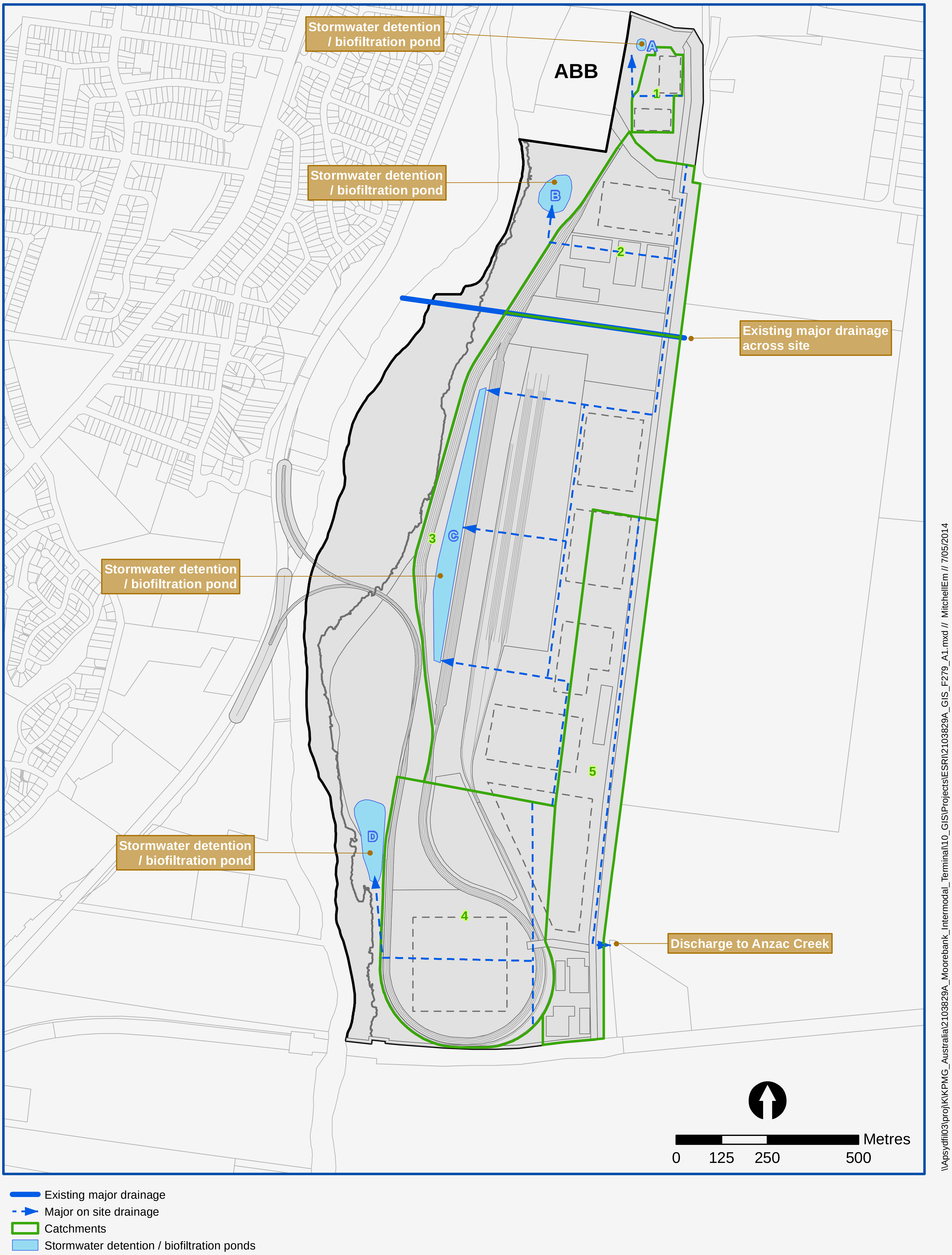


Figure X.X:
Indicative central rail access option drainage strategy

Appendix B

Water Quality Guide Indicators (ANZECC)

B1. ANZECC 2000 Water Quality Guidelines

Parameter	Guideline
Microbiological	
Primary Contact	▪ the median bacterial content in fresh and marine waters taken over the bathing season should not exceed 150 faecal coliform organisms/100 mL or 35 enterococci organisms/100 mL. Pathogenic free-living protozoans should be absent from bodies of fresh water.
Secondary Contact	▪ the median value in fresh and marine waters should not exceed 1,000 faecal coliform organisms/100 mL or 230 enterococci organisms/100 mL
Nuisance organisms	▪ macrophytes, phytoplankton scums, filamentous algal mats, sewage fungus, leeches, etc., should not be present in excessive amounts ▪ direct contact activities should be discouraged if algal levels of 15,000–20,000 cells/mL are present, depending on the algal species ▪ large numbers of midges and aquatic worms should also be avoided.
Physical and chemical	
Visual clarity and colour	▪ to protect the aesthetic quality of a waterbody: ▸ the natural visual clarity should not be reduced by more than 20% ▸ the natural hue of the water should not be changed by more than 10 points on the Munsell Scale ▸ the natural reflectance of the water should not be changed by more than 50% ▪ to protect the visual clarity of waters used for swimming, the horizontal sighting of a 200 mm diameter black disc should exceed 1.6 m.
pH	▪ the pH of the water should be within the range 5.0–9.0, assuming that the buffering capacity of the water is low near the extremes of the pH limits.
Temperature	▪ for prolonged exposure, temperatures should be in the range 15–35°C.
Toxic chemicals	▪ waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreation. Toxic substances should not exceed values in tables 5.2.3 and 5.2.4 in the water quality guidelines.
Surface films	▪ oil and petrochemicals should not be noticeable as a visible film on the water nor should they be detectable by odour.

Source: ANZECC water quality guidelines 2000 (Table 5.2.2 of the water quality guidelines).

Appendix C

Figures

INDICATIVE CENTRAL RAIL CONNECTION CONCEPT LAYOUT
MOOREBANK INTERMODAL TERMINAL

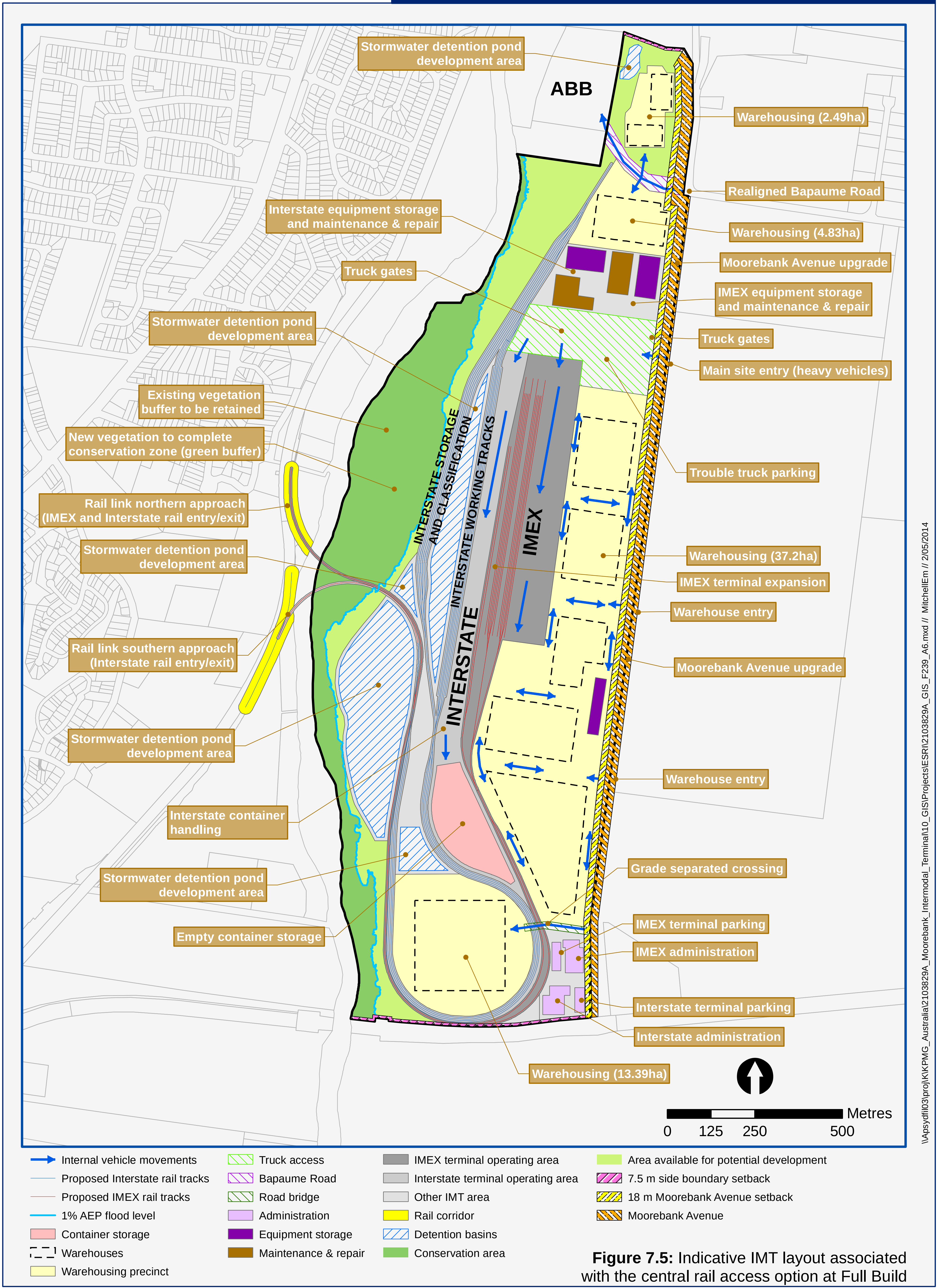


Figure 7.5: Indicative IMT layout associated with the central rail access option at Full Build

INDICATIVE SOUTHERN RAIL CONNECTION CONCEPT LAYOUT
MOOREBANK INTERMODAL TERMINAL

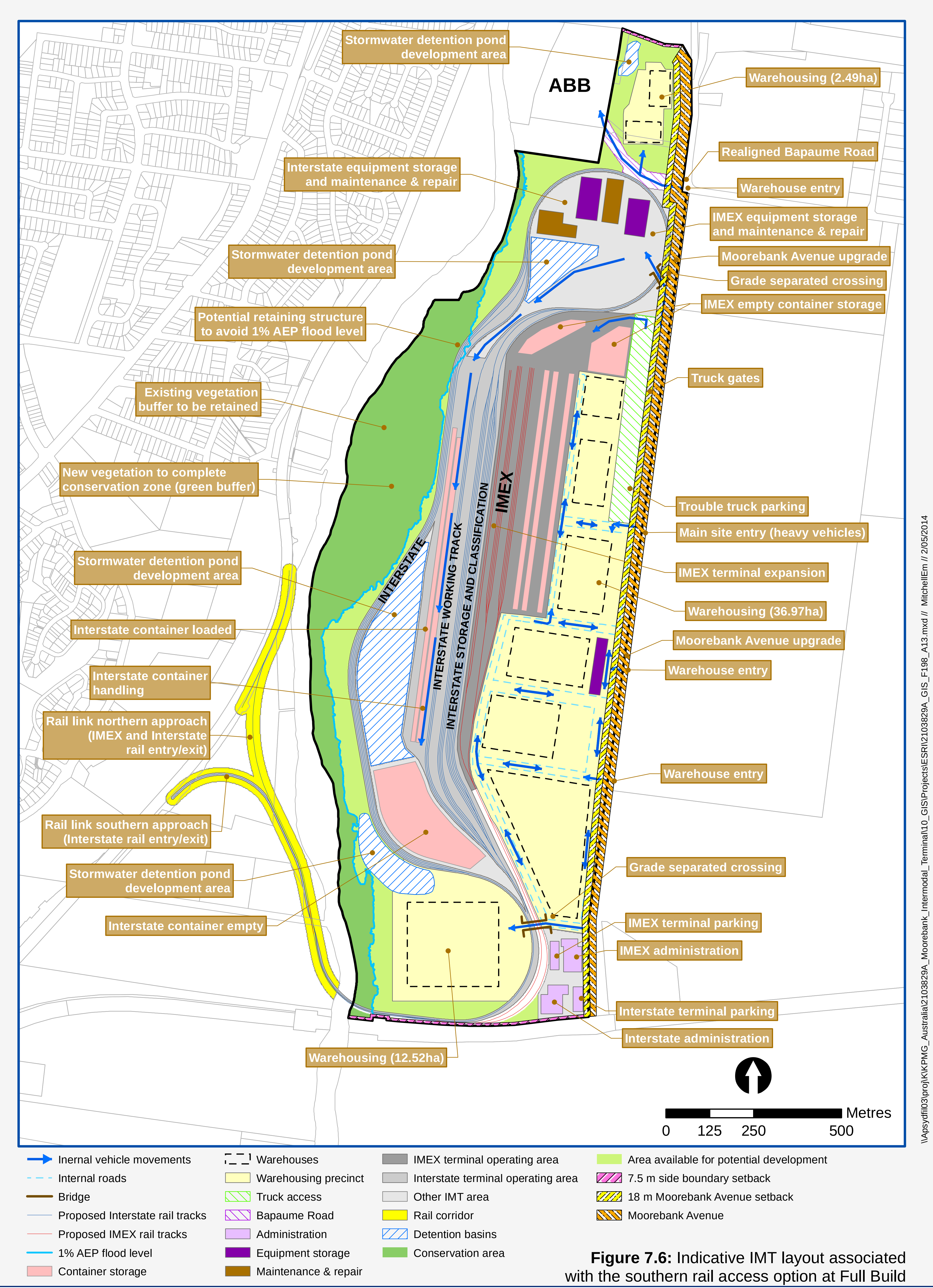


Figure 7.6: Indicative IMT layout associated with the southern rail access option at Full Build

INDICATIVE NORTHERN RAIL CONNECTION CONCEPT LAYOUT
MOOREBANK INTERMODAL TERMINAL

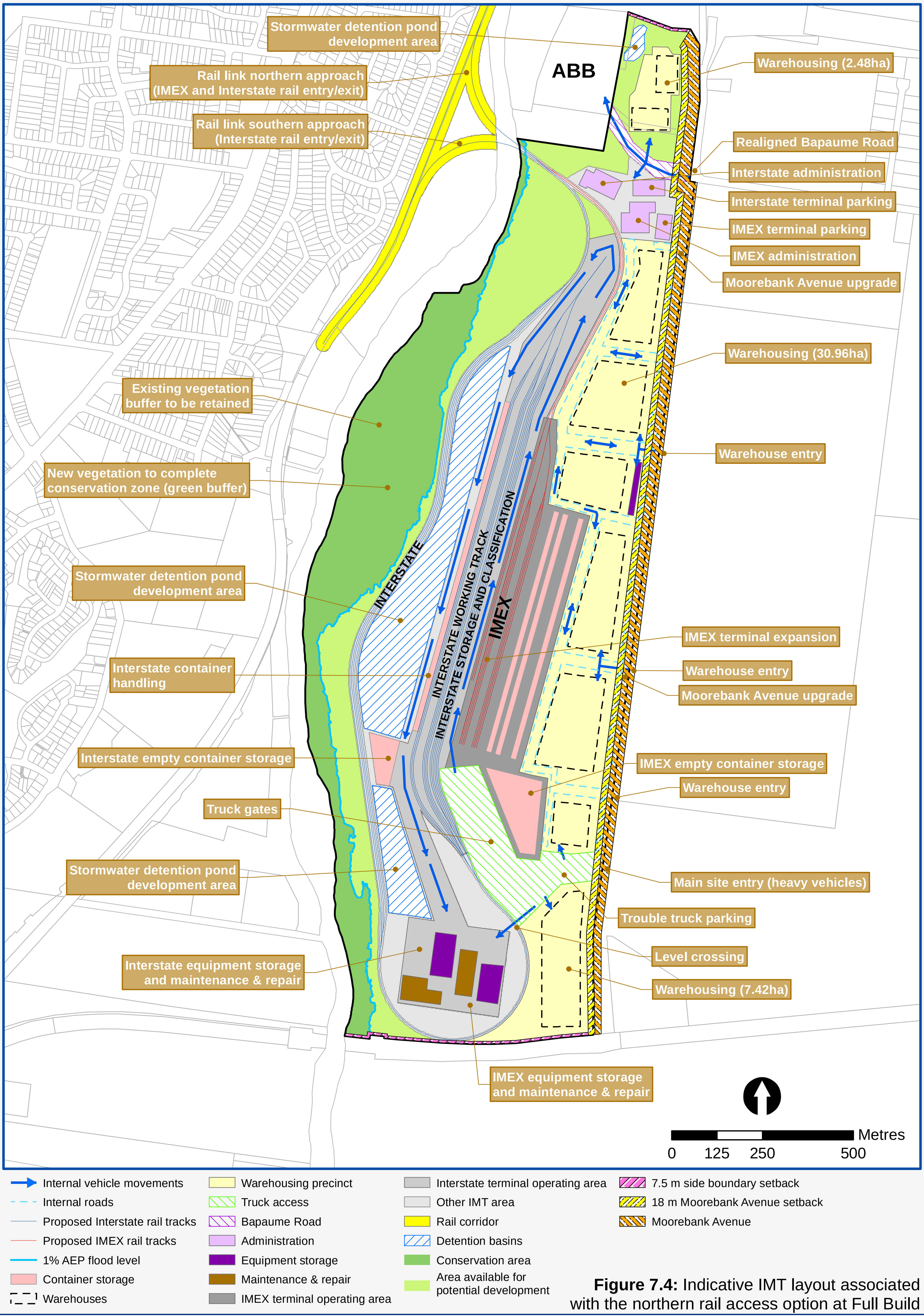


Figure 7.4: Indicative IMT layout associated with the northern rail access option at Full Build

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