Costin Roe Consulting

PRECISION | COMMUNICATION | ACCOUNTABILITY

# INTERIM AND ULTIMATE OSD9 & OSD10 STORMWATER MANAGEMENT PLAN (SSD 7628)

# MOOREBANK LOGISTIC PARK PRECINCT EAST

## MOOREBANK AVENUE
## MOOREBANK NSW

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***Rev*: E**

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# 1 INTRODUCTION

## 1.1 Introduction

Costin Roe Consulting Pty Ltd has been commissioned by Qube Holdings Limited (Qube) to prepare this *Stormwater Management Plan* (SMP) for construction of part of the 71 Ha Moorebank Intermodal Precinct East (MPE) Stage 2 site as approved by the NSW Department of Planning and Environment (DP&E) under SSD_7628 (January 2018).

The submission of the SMP for approval by DP&E has been staged in accordance with condition of consent (CoC) A14 and A15, as approved by DP&E on 2 July 2018 (refer **Appendix A**). This SMP presents an update to the approved staged SMP and the initial Warehouse 1 Precinct (W1P) as completed by Arcadis – *Moorebank Precinct East – Stage 2 Warehouse 1 Precinct Stormwater Management Plan* and interim operational conditions of the stormwater management relating to the approved works of MPE Stage 1 SSD 6766.

The subject area of this update to the approved staged management plan comprises the part of the Stage 2 development as approved under SSD 7628 that includes the initial Warehouse 1 Precinct (W1P) and Import/ Export (IMEX) terminal catchments and Moorebank Avenue which were approved as MPE Stage 1 under SSD 6766.

This report provides proposed strategy for an interim and ultimate water quality and quantity arrangements catchments which drain to OSD9 and OSD10.

The interim scenario is based on the condition prior to completion of construction of OSD10. In this scenario, the IMEX catchment drains to the manual phase basin (on the eastern side of Moorebank Avenue) then through OSD9 to the east-west culvert and ultimately The Georges River.

The ultimate scenario is based on the condition where the construction of OSD10 and the Moorebank Avenue Upgrade Works (MAUW) are complete, and the IMEX catchment drains across Moorebank Avenue to OSD10. This scenario also includes the final water quality conditions for both OSD9 and OSD10.

It is noted that, in addition to the above, areas of the MPE Stage 2 development which drain to the west through MPE Stage 1, and the western portion of Warehouse 5 and 8 are also included in this report.

Catchments which drain to the east, which include Warehouses 2, 3, 4, 6 & 7 and the eastern portions of Warehouses 5 & 8 (included in the approved Balance of Site Stormwater Management Plan per DPIE approval letter dated 18 March 2020) are not included in this report.

## 1.2 Scope

This SMP provides a summary of the following design principles and operational requirements of the stormwater management in accordance with the requirements of Condition A23 & B40 of SSD_7628 for each of the interim and ultimate scenarios for:

- Management of stormwater quantity
- Management of stormwater quality; and
- Flooding Considerations.

The engineering objectives for the development are to create a site which responds to the existing site topography and site constraints, and to provide an appropriate and economical stormwater management system which incorporates best practice in water sensitive urban design and is consistent with the requirements of council's water quality objectives and takes into consideration previously approved engineering strategies over the land.

The consent authority is the DP&E. As the site is located within the Liverpool City Council local government area, the requirements of the Liverpool City Council (LCC) *Development Control Plan 2018* are to be considered for the development.

## 1.3 Consent Conditions Compliance Matrix

The report and associated design have been completed in accordance with the approved stormwater management strategy defined by Arcadis and approved by DP&E in SSD_7628.

We provide the following table which confirms how and where, within the report or respective drawings and models, each of the Conditions of Consent (CoC) of SSD_7628 Conditions have been met.

It is noted that confirmation of relevant CoC's within A23, B40, B41 and B42 relating to WSUD and stormwater management have been included in the table. Conditions relating to infrastructure drainage layout, capacity and building designs are not included in this SMP and as such have not been included in the CoC compliance table.

***A23*** ***<u>Condition A23 – Water Sensitive Urban Design</u>***

*Prior to the commencement of early works and fill importation, the Applicant must prepare amended* ***WSUD plans*** *that incorporate water sensitive urban design principles, be generally in accordance with relevant Council Policies, plans and specifications and address Condition B40, to ensure that:*

*A23*

*Item (a)*

*The stormwater and drainage systems for the development will operate independently of any works proposed as part of the MPW Stage 2 development application (SSD 7709) that have not been incorporated in this development, unless development consent has been granted to those works under SSD 7709 prior to commencement of early works and fill importation;*

<u>Response - Interim and Ultimate Conditions</u>

The management measures set out in this SMP have been designed to be completely independent to any systems within the MPW Stage 2 for both the interim and ultimate conditions.

Discharge to the Georges River is available via constructed culverts beneath Moorebank Avenue and the existing east-west channel. Discharge from the site is not reliant on construction of either the east-west culvert of the east-west culvert drainage apron (proposed at the head of the east-west culvert adjacent to Moorebank Avenue) which are proposed to be constructed as part of MPW Stage 2 works.

*A23*

*Item (b)*

*Adequate overland flow paths have been provided in the event of stormwater system blockages and flows in excess of the 1% AEP rainfall event;*

Response - Interim and Ultimate Conditions

Consideration for storms in excess of the 1% AEP has been made such that overland flow will be conveyed either along roadways, or hardstand areas between buildings to the respective stormwater management basin, existing discharge location, and or flood compensation zones.

Flow paths leading to stormwater management basins have generally all been constructed through previous approvals and not covered as part of this SMP. We have provided information in this document to confirm how the interim and ultimate OSD9 and OSD 10 overflow/ overland flow configurations will operate.

The OSD9 system has been designed to ensure that, in the unlikely event of overtopping water or basin overflow, the overtopping water would be directed toward Moorebank Avenue, and the drainage apron on the west of Moorebank Avenue and north of OSD10. Drainage overflow would be conveyed from within the drainage apron through the east-west channel or east-west culvert once constructed.

The OSD 10/ Moorebank Avenue interface has been designed such that stormwater will overtop safely into the basin in the event it cannot enter the piped drainage network. In the event of blockage of the discharge control pit, OSD 10 has been designed with a lower embankment level at the northern end, to allow excess flow to overtop into the drainage apron prior to spilling into the western precinct.

The existing East-West channel and associated overbank areas has sufficient capacity to cater for the >1% AEP overflows from the contributing 75Ha OSD9 & OSD10 catchments.

Refer Costin Roe Consulting drawings in **Appendix A** which show building floor levels and confirmation of freeboard being achieved to overland flow paths.

*A23*

*Item (c)*

*On site detention basins are visually unobtrusive*

Response - Interim and Ultimate Conditions

The OSD 9 designs (Arcadis) have been designed to either be flush with final site levels, or constructed with vertical pre-cast concrete walls 2-3m in height, consistent with constructed warehouse dado panel walls. It is considered, based on the overall development, that OSD9 will be visually unobtrusive. OSD9 is also noted to be separated from Moorebank Avenue by landscaped corridors which will ensure limited viewing opportunity for public persons to the detention system.

The OSD 10 design provides visually amenable landscaped batters (maximum 1 in 4 slope). 1.8 m high chain mesh fencing around the perimeter of the basin ensure public safety by preventing unauthorised access.

Refer **Section 4** & **5** for further details and drawings **Appendix A**.

*A23 Item (d)*

*That the design of the basins, and, associated setbacks and fencing, ensures public safety.*

<u>Response - Interim and Ultimate Conditions</u>

The design of operational basins includes fencing which restricts public access. In addition, flood and on-site detention warning signs will be provided at appropriate locations to ensure adequate public (and site personnel) safety.

*A23 Item (e)*

*Adequate site area has been provided for stormwater treatment;*

<u>Response – Interim Conditions</u>

A minimum area of 1% of the contributing catchment Cat G09 Post within OSD9 has been made for bio-retention in the interim arrangement.

MUSIC modelling confirms treatment objectives are met during the proposed interim period arrangement.

Refer **Section 2.3**, **Section 3.2.2**, **Section 4** and **Section 5** of the SMP.

<u>Response – Ultimate Conditions</u>

The bioretention system provided in OSD9 for the interim condition will be made redundant and treatment flow diverted to OSD10. The bioretention area provided in OSD 10 is greater than 1% of the combined catchments draining to OSD 9 and OSD 10.

MUSIC modelling confirms treatment objectives are met during the proposed ultimate period arrangement.

Refer **Section 2.3**, **Section 3.2.2**, **Section 4** and **Section 5** of the SMP.

*A23 Item (f)*

*Design of stormwater treatment systems minimises the risk of failure; and*

<u>Response – Interim & Ultimate Conditions</u>

Stormwater treatment systems have been proposed which, have low risk of failure given the recommended maintenance is undertaken throughout the operational period of the proposed and installed systems. Refer **Section 6** of the SMP for *Maintenance and Monitoring* requirements.

Additional features of the system provided to reduce risk of failure include, pre-treatment by GPTs, provision of raingardens, scour protection, plant species selection, maintenance access and monitoring, bypass channel for larger flow events to minimise damage to raingardens within of OSD9 and OSD10 during the interim and ultimate conditions.

A planting palette for the raingardens illustrating the variety of species for varying sunlight exposure has been specified by the Landscape Architect.

*A23*

*Item (g)*

*Setback of drainage work and fencing has been finalised in consultation with RMS.*

Response – Interim & Ultimate Conditions

The set back of drainage works and boundaries has been completed in consultation with the RMS by Tactical Group based on the designs by BMD Constructions and their consulting Engineer.

***B40*** ***Condition B40 – Stormwater Management Plan***

*Prior to the commencement of early works and fill importation, an amended Stormwater Management Plan must be submitted and approved by the Secretary. The plans must be prepared by a suitably qualified person, and independently reviewed to ensure it meets the following criteria for:*

*B40* ***Water Sensitive Urban Design (WSUD):***

*Item (a)* *(i) convey flows from low order events (up to and including the 10% AEP event from the main part of the site within the formal drainage system, with flows from rarer events (up to the 1% AEP event) conveyed in controlled overland flow paths;*

Response

This condition is not relevant to the interim Stormwater Management Plan.

*(ii) Show the location and width of controlled overland flow paths*

Response

This condition is not relevant to the interim Stormwater Management Plan.

*(iii) Provide levels to AHD confirming building floor levels are a minimum of 150mm above the maximum design flow path levels.*

Response

This condition is not relevant to the interim Stormwater Management Plan.

*Item (b)* *(i) incorporate water sensitive urban design principles, be generally in accordance with relevant Council policies, plans and specifications*

Response

The design has been completed with consideration to WSUD principles. The design incorporates open landscaped detention systems with raingardens/bio-retention systems. Further, a treatment train of primary and tertiary treatments via proprietary systems and raingardens has been proposed to ensure the required pollution reduction objectives have been met per the consent conditions, council policy and best practice engineering.

*(ii) ensure that adequate overland flow paths have been provided in the event of stormwater system blockages and flows in excess of the 1% ARI rainfall event;*

<u>Response</u>

Refer Condition A23, Item (b) response.

*(iii) ensure on site detention basins are visually unobtrusive and ensure public safety;*

<u>Response</u>

Refer Condition A23, Item (c) response.

*(iv) ensure rainwater harvesting is provided for each warehouse;*

<u>Response</u>

Rainwater tanks for each warehouse will be provided and documented as part of future detail designs. Storage and capture requirements are to be based on the requirements as set out in the approval documents by Arcadis.

Details for the rainwater tanks will be provided as part of individual development construction certificate applications.

*(v) ensure adequate site area has been provided for stormwater treatment;*

<u>Response</u>

Refer Condition A23, Item (e) response.

*(vi) ensure design of stormwater treatment systems minimises the risk of failure; and*

<u>Response</u>

Refer Condition A23, Item (f) response.

*(vii) develop concept options for how 20% of the average annual volume of stormwater from the site can be reused via rainwater capture and reuse for activities including but not limited to:*

- *irrigation,*
- *all internal non-potable uses,*

- *washdown,*
- *cooling towers,*
- *heating, ventilation, and air conditioning, and*
- *ground source heat exchange.*

*The Applicant is to brief the Department on how these initiatives will be implemented prior to the completion of the Stormwater Management Plan.*

Response

Rainwater tanks for each warehouse will be provided, based on the requirements as set out in the approval documents. Details for the rainwater tanks will be provided as part of individual development construction certificate applications.

*B40* ***Water quantity:***

*Item (c)* *(i) on site detention is to be provided to attenuate peak flows from the development such that both the:*

- *1 in 1-year ARI event post development peak discharge rate is equivalent to the pre-development (un-developed catchment) 1 in 1-year ARI event*
- *1 in 100-year ARI event post development peak discharge rate is equivalent to the predevelopment (un-developed catchment) 1 in 100-year ARI event*

Response – Interim Condition

On-site detention has been provided to limit post development rates to predevelopment for storm events between the above noted ARI storm events within the combined IMEX Manual Phase Basin and OSD9.

Refer **Section 4** of this report for Water Quantity Management and confirmation of peak flows and storages.

Refer drawings in **Appendix A** which confirm configuration of the drainage detention systems.

Response – Ultimate Condition

On-site detention has been provided to limit post development rates to predevelopment for storm events between the above noted ARI storm events within OSD9, and OSD10.

Refer **Section 4** of this report for Water Quantity Management and confirmation of peak flows and storages.

Refer drawings in **Appendix A** which confirm configuration of the drainage detention systems.

*(ii) no new drainage infrastructure work within the Defence Joint Logistics Unit (DJLU) site*

Response – Interim and Ultimate Conditions

No new drainage infrastructure works are proposed within the DJLU site.

*(iii) all on site detention basins to have maximum batter slopes of 1V:4H or, for works immediately adjacent to the Moorebank Avenue upgrade, an alternate slope gradient agreed to by RMS;*

Response – Interim and Ultimate Conditions

OSD 9 has been adjusted in response to MPE Stage 2 SSD 7628 Mod 2 approval 31 January 2020 providing OSD 9 as an exception to the requirement for 1:4 batters, thereby removing the need to cover it as a tank. The basin is noted to be located in an area which is visually shielded from public view and meets all requirements of water quality and quantity measures.

OSD10 has been designed with maximum batter slopes of 1V:4H.

*(iv) siting and design of on-site detention basins to eliminate/ minimise excavation within the southern ordinance burial pits; and*

Response – Interim and Ultimate Conditions

OSD 9 and OSD 10 are located clear of the southern ordinance burial pits, hence no excavation will result.

*(v) maintenance access to be provided to each on site detention basin.*

Response – Interim and Ultimate Conditions

Maintenance access to OSD9 is provided for light vehicle at each end of the system. A lockable gates will be provided to prevent unauthorised access. Refer drawings in **Appendix A**.

Maintenance access is provided to OSD 10 off Moorebank Avenue. The access is designed for an Isuzu tipper truck (nom. 5 m length) with the standard 8.8 m service vehicle used as the checking vehicle to ensure larger vehicles may access the basin if required.

*B40* *Connection to natural creek-lines:*

*Item (d)* *(i) on site detention basin outlets to natural drainage lines must be constructed of natural materials to facilitate natural geomorphic processes and to include vegetation as necessary (gabion baskets and gabion mattresses are not acceptable).*

Response – Interim and Ultimate Conditions

There are no connections to natural creek lines proposed in the design or SMP.

*B40* *Stormwater Quality*

*Item (e)* *(i) have a stormwater quality treatment train comprised of gross* *pollutant traps and biofiltration/bioretention systems designed to meet the following criteria compared to a base case if there were no treatment systems in place:*

- *reduce the average annual load of total nitrogen by 45%;*
- *reduce the average annual load of total phosphorus by 65%; and*
- *reduce the average annual load of total suspended solids by 85%.*

<u>Response – Interim Conditions</u>

The design has been completed to meet the above referenced pollution reductions using MUSIC. The water quality reductions have been met through a treatment train of industry adopted methods including bio-retention, gross pollutant traps, at source pit inserts, filtration systems.

Refer **Section 5** of this report and drawings in **Appendix A** for details and locations of proposed measures.

*(ii) all stormwater quality elements are to be modelled in MUSIC as per the NSW MUSIC Modelling Guide*

<u>Response – Interim and Ultimate Conditions</u>

MUSIC modelling has been completed per NSW Music Modelling Guide, and per Liverpool City Council MUSIC Link.

*(iii) all stormwater quality elements are to be installed upstream of stormwater detention basins, unless it can be demonstrated that biofiltration/ bioretention systems within the OSD basins will not suffer damage from design flows and can be maintained to achieve the water quality criteria.*

<u>Response</u>

All primary treatment elements (i.e. GPT's) have been provided upstream of the OSD basins and systems.

Bio-retention systems are proposed within each of the open basin detention systems. Several measures have been employed to ensure the bio-retention can operate effectively including:

- water depths within the bio-retention section of the basin have been set such that a maximum water depth of 1.5m is maintained to the detention system in major storm events.

- Flow spreaders have been provided to spread flows around the system, reducing velocity and risk of local scour, and also ensuring filtration is spread throughout the whole of the system.

- High flow bypass of stormwater around bio-retention elements has been provided where possible to reduce the risk of scouring of bio-retention systems do not occur during major storm events and design flows in excess of that required to be managed and following first flush runoff.

Further noting that >90% of all stormwater runoff volume will be generated by low/ minor storm events.

*(iv) the area of biofiltration / bioretention systems is to be at least 1% of the catchment draining to the system, to ensure there is no short-circuiting of the system.*

Response

Refer Item A23(e) response.

*(v) bioretention systems which are greater than 1,000m$^2$ in area, are to be divided into cells with no individual cell greater than1,000m$^2$*

Response

Bio-retention greater than 1000m2 in area have been separated into cells per the condition.

The bio-retention in OSD9 is divided into 3 three cells each less than 1000m2.

The bioretention area in OSD 10 is divided into 10 cells of approximately 530 m2 each. Each cell is divided into four bays of approximately equal area. Reference should be made to Northrop Consulting Moorebank Avenue Upgrade Works Package **MAUW-NRP-CV-DWG** for details pertaining to the OSD10 bio-retention configuration.

*(vi) all filter media used in stormwater treatment measures must:*

- *be loamy sand with an appropriately high permeability under compaction and must be free of rubbish, deleterious material, toxicants, declared plants and local weeds, and must not be hydrophobic;*
- *have a hydraulic conductivity = 100-300 mm/hr, as measured using the ASTM F1815-06 method*
- *have an organic matter content less than 5% (w/w)*
- *be provided adequate solar access, considering the design and orientation of OSD basins.*

Response

Refer drawings in **Appendix A** for details and specifications for bio-retention systems, designed in accordance with recommendations from Monash University and as noted per the above condition.

*A copy of the independent review must be submitted with the Plan. A statement from the reviewer confirming their independence and declaring any actual, potential or perceived conflicts of interest must be provided as part of the reporting of the findings and recommendations of the review.*

Response

An independent review has been completed by Northrop Consulting Engineers. Please refer to Northrop review letter for details pertaining to this condition.

*Item B41* *Notwithstanding condition B40, the Stormwater Management Plan does not require the Secretary to approve drainage works that would be designed, approved by RMS, and delivered, in accordance with condition B13. However, the Stormwater Management Plan must:*

*(a) include confirmation that any such works are proposed to be designed and delivered in accordance with condition B13; and*
*(b) incorporate and be designed in consideration of, preliminary principles for that road drainage*

<u>Response</u>

The Moorebank Avenue Upgrade Works (MAUW) and OSD10 design packages are being approved by TfNSW (formerly RMS), thus are exempt from Secretary approval in accordance with this condition. We understand the MAUW and OSD10 works are to be completed in parallel and thus both satisfy CoC B41(a) & (b).

# 2 DEVELOPMENT SITE

## 2.1 Site Description

MPE site, including the project site, covers an area of 71 Ha. The MPE Stage 1 and 2 development footprint is generally rectangular in shape and located within Liverpool City Council Local Government Area as shown in **Figure 2.1**.

The development is located on the eastern side of Moorebank Avenue in the suburb of Moorebank, NSW approximately 800m south of the intersection of Moorebank Avenue with the M5 Motorway.

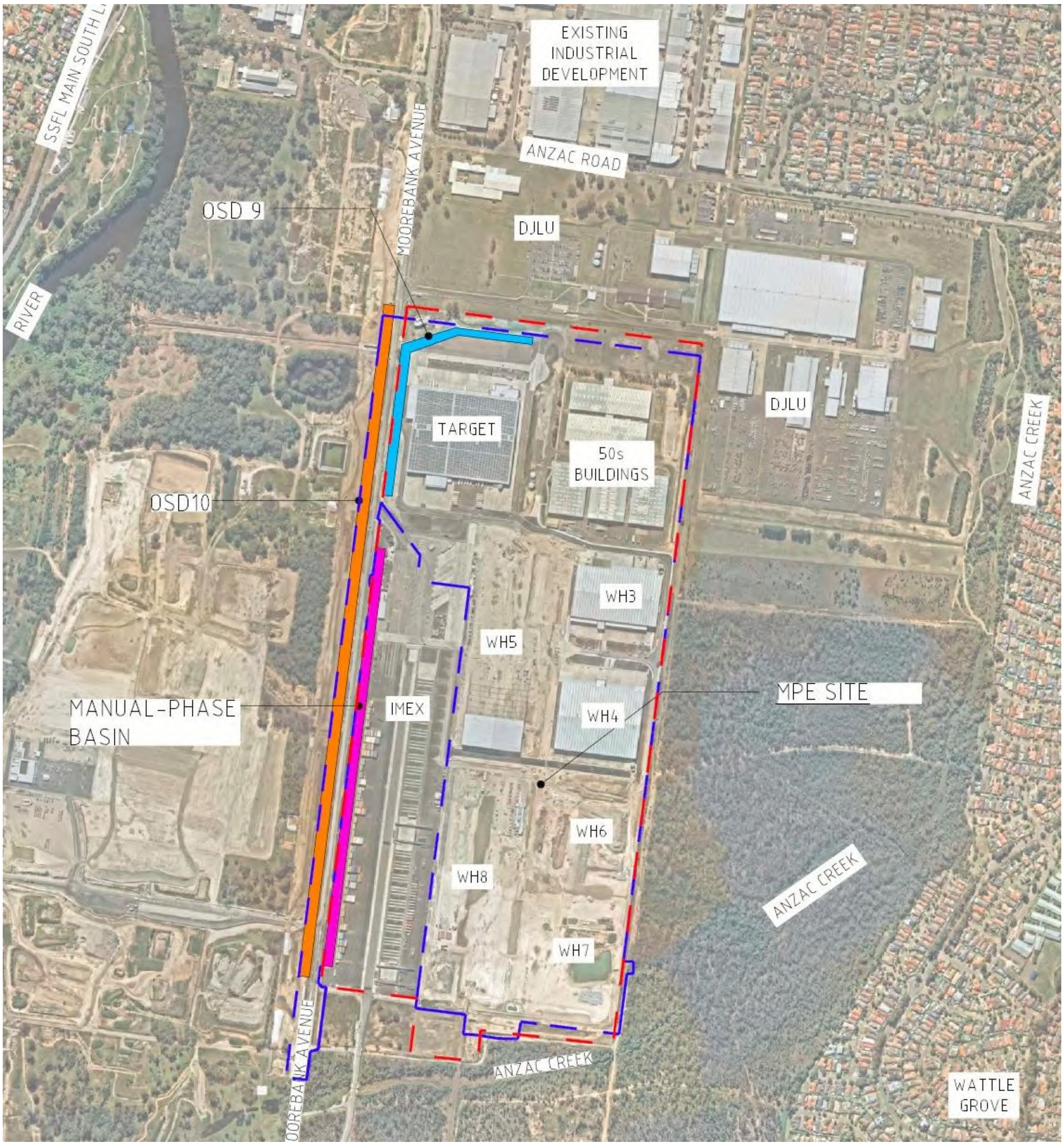



**Figure 2.1 Locality/ Site Context Plan**

The site is bounded on the north by existing defence land and 50’s Buildings, to the east by existing industrial land and heavily vegetated bushland on crown land, heavily vegetated and future development land to the south, and Moorebank Precinct West (MPW) to the west.

Access to the site is via Moorebank Avenue.

## 2.2 Proposed Development

MPE is located within the 243 Ha Moorebank Logistics Park (MLP) development, which as referenced on Qube MLP website, will be the largest intermodal freight precinct in Australia.

The MLP development will consist of the construction and operation of an IMEX terminal and an interstate terminal with capacity to transport up to 1.05 million TEU (twenty-foot equivalent units) a year of import-export freight and another 0.5 million TEU of interstate freight per year.

Moorebank Logistics Park will have related logistics activities including 850,000 square metres of high specification warehousing, as well as auxiliary services including retail and service offerings.

A rail connection to the Southern Sydney Freight Line (SSFL) will be built that has direct access to the park, with the M5 and M7 arterial roads minutes away providing a complete supply chain solution driving savings in time and costs for onsite tenants.

MPE Stage 1, which includes the IMEX is near completion of construction.

The proposed MPE Stage 2 development proposes the construction of eight (8) industrial warehouse buildings over the 41 Ha development area. The use for the warehouse buildings will be for distribution and logistics type use as defined in the *Environmental Impact Statement* (EIS) approved under the MPE Stage 2 SSD_7628 Development Consent (31 January 2018).

Typically, each of the buildings will comprise a single level steel framed warehouse, ancillary office space, car parking areas, truck circulation and loading zones, fire brigade perimeter access and landscaping. Connection to the MPE Stage 1 rail siding and staging area is made via dedicated private service roads. Buildings vary in size from circa 23,500m$^2$, 53,400m$^2$ and 62,500m$^2$. The proposed development layout has been defined in Estate Masterplan drawings by Reid Campbell Architects and adopted as a base for the engineering layout.

## 2.3 Interim and Ultimate Stormwater Management Scenarios

As noted in **Section 1.1**, this report provides proposed strategy for an interim and ultimate water quality and quantity arrangements catchments which drain to OSD9 and OSD10 which is required to address construction timing and on-site operational requirements.

The *interim scenario* is based on the condition prior to completion of construction of OSD10. In this scenario, the IMEX catchment continues to drain to the manual phase basin (located on the eastern side of Moorebank Avenue and documented by Arcadis) where primary treatment and management of water quantity is undertaken. Managed stormwater runoff from this system is then conveyed to OSD9 for tertiary treatment prior to discharge from the MPE via the east-west culvert. Ultimate discharge from the precinct is to The Georges River.

The *ultimate scenario* is based on the condition where the construction of OSD10 and the Moorebank Avenue Upgrade Works (MAUW) are complete, and the IMEX catchment drains across Moorebank Avenue to OSD10. This scenario also includes the final water quality conditions for both OSD9 and OSD10.

Refer **Section 3.2.2** and **Section 5.2** for further detailed descriptions relating to stormwater management and catchments, and **Figures 3.1** and **3.2** which confirm the contributing catchments for the interim and ultimate conditions.

# 3 STORMWATER & WATER SENSITIVE URBAN DESIGN (WSUD)

## 3.1 Water Sensitive Urban Design

As required of *Condition A23*, WSUD principles are to be incorporated within the design. These have been considered for both the interim and ultimate stormwater management arrangements.

A number of WSUD measures have been included in the stormwater management strategy and designs, which are set out in this report and the attached drawings. The following key WSUD considerations, specific to stormwater, have been included in the design:

- *Stormwater Quantity Management* (Refer **Section 4**)
- *Stormwater Quality Management* (Refer **Section 5**)
- *Flood Management & Large Rainfall Events*

A brief summary of the management objectives is described below:

- <u>*Stormwater Quantity Management (Refer **Section 4**)*</u>

  The intent of this criterion is to reduce the impact of urban development on existing drainage system by limiting post-development discharge within the receiving waters to the pre-development peak, and to ensure no affectation of upstream, downstream or adjacent properties.

  Attenuation of stormwater runoff from the development is proposed to be managed via a series of measures including detention tanks and open basins provided in strategic locations for each of the development catchments. These detention tanks are proposed to be in use during the operational phase of the site's development. As per the consent conditions the objective is to attenuate stormwater flow from the development to pre-developed flows, and to ensure no affectation to upstream, downstream and adjoining properties as a result of the development.

  Sizing of the basin systems has been completed using DRAINS modelling software in accordance with the Liverpool City Council Policy and the **CoC** for the 1 in 1-year ARI to 1 in 100-year ARI storms for various durations. The modelling accounts for the drainage system provided for the adjacent sites.

  Refer to **Section 4** of the document for confirmation of sizing of detention systems.

- <u>*Stormwater Quality Management*</u>

  There is a need to target pollutants that are present in stormwater runoff to minimise the adverse impact these pollutants could have on downstream receiving waters during warehouse operations.

  The required load-based reduction targets for the development can be seen below:

| | |
|---|---|
| Gross Pollutants | 90% |
| Total Suspended Solids | 85% |
| Total Phosphorus | 65% |
| Total Nitrogen | 45% |
| Total Hydrocarbons | 90% |

Reference to **Section 5** of this document should be made for detailed Stormwater Quality modelling and measures.

- *Flood Management and Large Rainfall Events*

  The proposed development considered flooding and large rainfall events, both from the adjacent Georges River, and from site generated runoff.

  The following measures have been incorporated in the design as included in previously approved management plans:

  - All buildings are sited 500mm above the 1% AEP design flood level of the Georges River.
  - Flood storage compensation has been provided where filling in localised pre-developed flood affected areas occurs;
  - Stormwater detention measures have been included to manage pre and post development runoff as discussed above and in **Section 4**; and
  - Overland flow paths to manage runoff in large storm events have been made including achieving at least 150mm freeboard to building levels from the flow paths.

## 3.2 Site Drainage

### 3.2.1 Pre-Existing and Current Site Drainage

Until recently, the MPE site was operating as the Defence National Storage and Distribution Centre (DNSDC); however, the Department of Defence have vacated the site and relocated this operation to the Defence Joint Logistics Unit (DJLU), immediately north of the MPE site.

As part of the previous uses on the site, existing remnant in-ground drainage structures are present. These systems will generally become redundant, other than existing drainage discharge locations.

Catchments draining west through the east-west culvert (including SIMTA S1, Ex NTH SIMTA, EXTERNAL S1, EXDNSDC) total an area of 57.62 Ha. The EXDNSDC of 5.29 Ha does not form part of the development area and bypasses all proposed management measures discussed in following sections of the report.

Two main catchments drain to the east, being Ex A1 (20.9 Ha) and Ex A2 (27.45 Ha), as depicted in the approved SWMP *Figure 4-1* by Arcadis and reproduced as *Figure 3.1* below. Eastern drainage catchments are noted to not form part of this SMP.

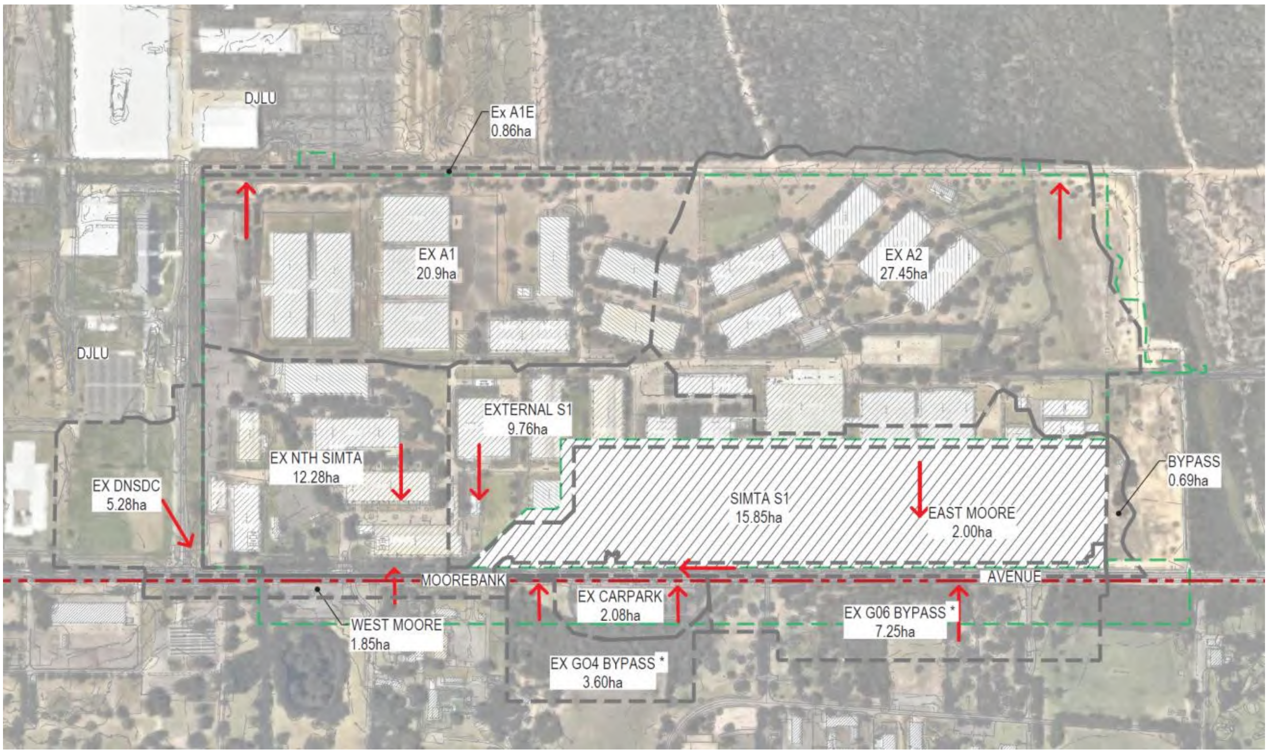



**Figure 3.1. Existing Catchments (Source: SSD7628 SWMP Fig 4-1 Arcadis 2016)**

### 3.2.2 Proposed Infrastructure Drainage

The general conditions of the interim and ultimate drainage scenarios proposed in this SMP are discussed in **Section 2.3**.

General hydraulic requirements are discussed as follows:

- As per general engineering practice, and with reference to LCC guidelines, the proposed stormwater drainage system for the development will comprise a minor and major system to safely and efficiently convey collected stormwater run-off from the development.
- The minor system is to consist of a piped drainage system which has been designed to accommodate the 5% AEP or 1 in 20-year ARI storm event (Q20). This results in the piped system being able to convey all stormwater runoff up to and including the 5% AEP event.
- The major system through new paved areas has been designed to cater for storms up to and including the 1% AEP or 1 in 100-year ARI storm event (Q100). The major system employs the use of defined overland flow paths to safely convey excess run-off from the site to the two discharge points allowing for 500mm of freeboard to building levels. Further consideration of overland flow for events greater than 1% AEP, or in the event of blockage has been made in the design as required of *Conditions A23* and *B40*. This includes ensuring a minimum 100mm freeboard is maintained for events greater than 1% AEP, or in the event of blockage.

- The overall stormwater management objectives, including, water quality objectives and water quantity discharge rates, remain consistent with the approved conditions of consent

A summary of the configuration of *interim* and *ultimate* stormwater systems and the key stormwater measures for the MPE Stage 1 & 2 western zone catchments, with reference to catchment and layout plans in **Appendix A**, is as follows:

*Interim Scenario*

- Catchments Cat G09 Post (11.6 Ha) and part Cat G10 Post – Called Cat OSD9-IMEX (25.5 Ha) to a total of 37.1 Ha are proposed to be managed during the interim condition. These catchments include MPE Stage 1, Warehouse 1, the proposed freight village and the western halves of Warehouses 5 & 8. The areas to which the interim conditions apply are shown in **Figure 3.2**.
- The period throughout which the interim condition will be necessary will be between establishment of operations of MPE Stage 1, and prior to construction and implementation of OSD Basin 10.
- Run off quantity from MPE Stage 1 catchments is currently being managed within the IMEX Manual Phase Basin which is located on the west of the IMEX area and east of Moorebank Avenue. The IMEX Basin is approximately 740m in length and is trapezoidal in cross section. The basin has an approximate active storage capacity in the 1% AEP storm event of 8000m$^3$. The IMEX Basin has been design by Arcadis and approved as part of MPE Stage 1 approvals. No changes to the IMEX Basin are proposed in the Interim Scenario. This basin is noted to have limited water quality functions.
- Runoff from Cat G09 Post is managed via OSD9, being an engineered structure with vertical precast concrete walls and concrete base. OSD9 has been designed by Arcadis and construction is now complete. OSD9 has an active storage in the 1% AEP event of approximately 9100m$^3$ without bio-retention installed and 8100m$^3$ with bio-retention installed.
- In order to meet water quantity requirements, and have an effective discharge arrangement for both OSD9 and IMEX Basin, it is proposed that:
  - The IMEX Basin is combined with OSD9, with a common outlet to the east-west channel via recently constructed culverts under Moorebank Avenue.
  - The discharge control from OSD9 outlet has been sized to ensure the flows from the combined catchment in the post development condition is attenuated to meet or be below the pre-developed for design storms from the 1-year ARI to 100-year ARI as required of the CoC.
- Water quality measures are proposed to be achieved via pre-treatment through gross pollutant traps (GPT's) and bio-retention. A minimum 1% of bio-retention is proposed provided for the catchment Cat G09 Post, being approximately 1160m$^2$. It is noted that the MPE State 1 catchment will also be treated by the bio-retention system in OSD9 for the interim period. Confirmation of achieving water quality objective has been made via MUSIC modelling.
- Discharge will be via the east-west channel.

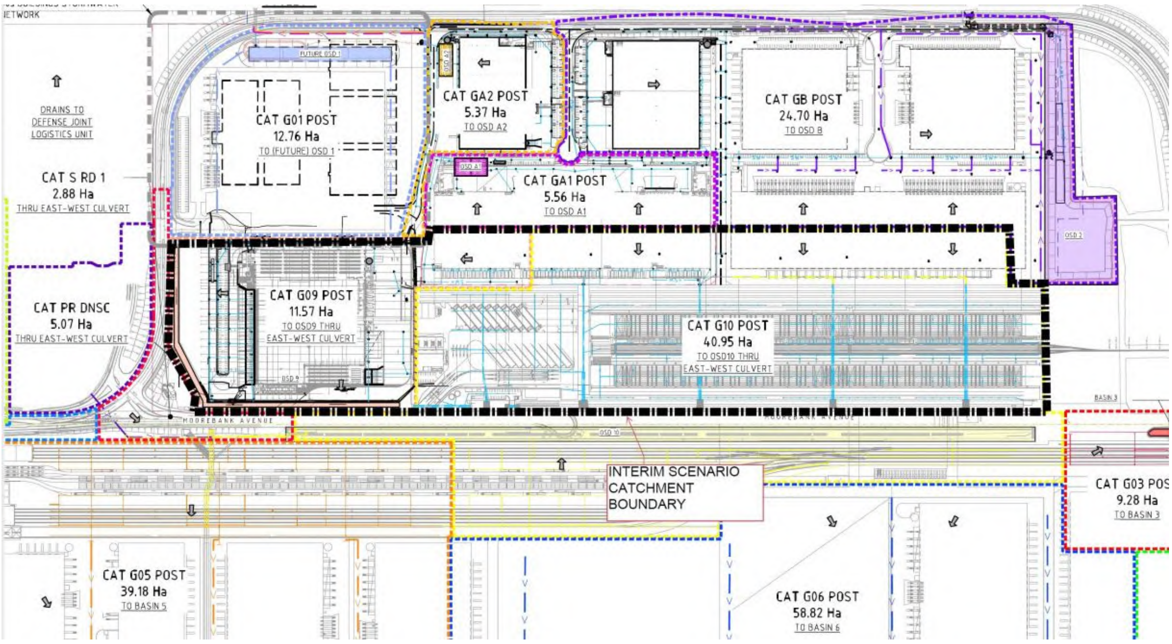


**Figure 3.2. Interim Scenario Catchment Boundary**

*Ultimate Scenario*

- Cat G09 Post (11.6 Ha) and the whole of Cat G10 Post (40.95 Ha) which includes MPE Stage 1 the Moorebank Avenue upgrade works, a portion of the interstate within MPW, Warehouse 1, the proposed freight village and the western halves of Warehouses 5 & 8 is proposed to be managed during the in the ultimate condition. The areas to which the ultimate conditions apply are shown in **Figure 3.3**.
- The ultimate condition will come into effect following construction and implementation of Basin 10 and the decommissioning of the IMEX Manual Phase Basin. This is anticipated to be 12-18months from time of writing subject to NSW RMS approvals and construction programming finalisation.
- Following construction and implementation of Basin 10 and the decommissioning of the IMEX Manual Phase Basin, runoff from MPE Stage 1 and areas within Cat G10 Post will be managed via Basin 10. Basin 10 provides a dual function for water quantity and quality management. Basin 10 will be constructed by BMD Constructions and designed by their consulting engineers as part of CoC B41.
- Cat G09 post will have water quantity managed by OSD9 as per original approved design, however it is proposed that the water quality be managed via bio-retention within OSD10. To enable this to occur the following is proposed:
  - Removal of interim bio-retention from OSD9.
  - Provision of a 375mm low flow pipe between OSD9 and OSD10. This low flow pipe will convey the treatable flow from the catchment (i.e. 3month ARI flow of approximately 0.5m$^3$/s).
  - Provision of an additional minimum 1160m$^2$ of bio-retention within OSD10 to ensure the CoC requirements for 1% of the contributing catchment to be provided as bio-retention.

- Minor storage and discharge adjustments to OSD9 and OSD10 to allow for the low flow pipe arrangement.

- Discharge will remain via the east-west culvert and channel.

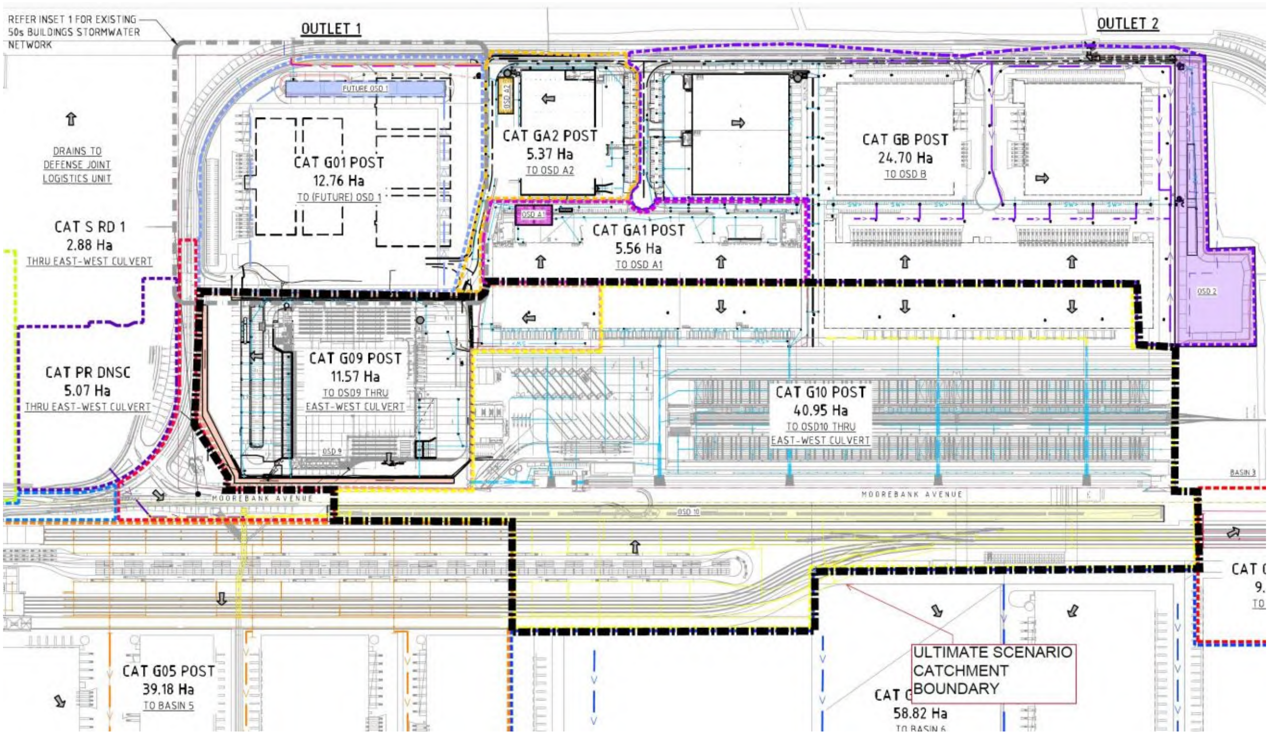



**Figure 3.3. Ultimate Scenario Catchment Boundary**

## 3.3 Hydrologic Modelling and Analysis

### 3.3.1 General Design Principles

The design of the stormwater system for this site will be based on relevant national design guidelines, Australian Standard Codes of Practice, LCC and accepted engineering practice.

Specifically, the design will be based on:

- Runoff from buildings will generally be designed in accordance with AS 3500.3 National Plumbing and Drainage Code Part 3 – Stormwater Drainage;
- Overall site runoff and stormwater management will generally be designed in accordance with the Institution of Engineers, Australia publication “Australian Rainfall and Runoff” (1987 Edition), Volumes 1 and 2 (AR&R) – It is noted that a design principle is not yet in place for on-site detention systems using AR&R 2016 data;
- LCC *Development Control Plan,*
- *LCC On-site detention Technical Specification,*
- New South Wales *Development Design Specification D5 Stormwater Drainage Design* (LCC January 2003)*;*
- Storm events for the 1 to 100 Year ARI event have been assessed.

### 3.3.2 Minor/ Major System Design

The piped stormwater drainage (minor) system has been designed to accommodate the 20-year ARI storm event (Q20). Overland flow paths (major) which will convey all stormwater runoff up to and including the Q100 event have also been provided which will limit major property damage and any risk to the public in the event of a piped system failure.

### 3.3.3 Rainfall Data

Rainfall intensity Frequency Duration (IFD) data used as a basis for ILSAX and RAFTS modelling for the 1 to 100 Year ARI events, was taken from Liverpool City Council *Stormwater Drainage Handbook.*

### 3.3.4 Runoff Models

In accordance with the recommendations and standards of Liverpool City Council, the calculation of the runoff from storms of the design ARI will be calculated with the catchment modelling software DRAINS. The ILSAX hydrological model component will be utilised for the post-development site and the RAFTS model component for broad scale catchments. This will be in accordance with previous studies and approvals for land in the area.

The design parameters for the ILSAX model are to be based on the recommendations as defined by LCC and parameters for the area and are as follows:

| Model | Model for Design and analysis run | Rational method | |
|---|---|---|---|
| | Rational Method Procedure | ARR87 | |
| | Soil Type-Normal | 3.0 | |
| | Paved (Impervious) Area Depression Storage | 1 | mm |
| | Supplementary Area Depression Storage | 1 | mm |
| | Grassed (Pervious) Area Depression Storage (Post Development) | 5 | mm |
| | Grassed (Pervious) Area Depression Storage (Pre-Development) | 15 | mm |
| AMC | Antecedent Moisture Condition (ARI=1-5 years) | 2.5 | |
| AMC | Antecedent Moisture Condition (ARI=10-20 years) | 3.0 | |
| AMC | Antecedent Moisture Condition (ARI=50-100 years) | 3.5 | |
| | Sag Pit Blocking Factor (Minor Systems) | 0 | |
| | On Grade Pit Blocking Factor (Minor Systems) | 0 | |
| | Sag Pit Blocking Factor (Major Systems) | 0.5 | |
| | On Grade Pit Blocking Factor (Major Systems) | 0.2 | |
| | Inlet Pit Capacity | | |

**Table 3.1. DRAINS ILSAX Parameters**

## 3.4 Hydraulics

### 3.4.1 General Requirements

Hydraulic calculations will be carried out utilising DRAINS modelling software during the detail design stage to verify that all surface and subsurface drainage systems perform to or exceed the required standard.

### 3.4.2 Freeboard

The calculated water surface level in open junctions of the piped stormwater system will not exceed a freeboard level of 150mm below the finished ground level, for the peak runoff from the Minor System runoff. Where the pipes and junctions are sealed, this freeboard would not be required.

Freeboard of 500mm has been achieved to building levels during the Major Storm Event as shown on drawing **Co13455.04-IC415**.

3.4.3 Public Safety

For all areas subject to pedestrian traffic, the product (dV) of the depth of flow d (in metres) and the velocity of flow V (in metres per second) will be limited to 0.4, for all storms up to the 100-year ARI.

For other areas, the dV product will be limited to 0.6 for stability of vehicular traffic (whether parked or in motion) for all storms up to the 100-year ARI.

3.4.4 Inlet Pit Spacing

The spacing of inlets throughout the site will be such that the depth of flow, for the Major System design storm runoff, will not exceed the top of the kerb (150mm above gutter invert).

3.4.5 Overland Flow

Dedicated flow paths have been designed to convey all storms up to and including the 100-year ARI to the OSD Basins. These flow paths will convey stormwater from the site to the estate road system and ultimately to the OSD Basins as shown on drawing **Co13455.04-IC415**.

## 3.5 External Catchments and Flooding

MPE Stage 1 & 2 is not affected by any overland flow paths or external catchments. As such no allowance for conveyance of upstream catchments is required in this SWMP.

The pre-developed site has some areas of known flood affectation as a result of runoff from within the development area. Flood storage consideration in line with the EIS by Arcadis has been included in the design in conjunction with the detention system sizing, as set out in this report has been included in the design as referenced in **Section 3.2** and **Section 4** of the SMP.

## 3.6 Site Discharge Configuration

No new discharge locations or structures are proposed as part of this SMP. All discharge locations are based on existing outlets and drainage structures as approved.

# 4 STORMWATER QUANTITY MANAGEMENT

## 4.1 Introduction

LCC and the DPIE requires water quantity management, or stormwater detention, to be provided to limit the runoff discharged from private property into the underground piped drainage system to pre-developed flow and to assist in mitigating the increased stormwater runoff generated by development.

The CoC B40 requires post development runoff to meet predevelopment runoff, as discussed in **Section 1.3** of the SMP.

Attenuation of stormwater runoff from the development is proposed to be managed for the interim and ultimate conditions via a series of measures as described in **Section 3.2.2** of this SMP.

As per the CoC, the objective for stormwater quantity management is to attenuate stormwater flow from the development to pre-developed flows for storms between the 1 in 1-year ARI to 1 in 100-year ARI storms for various durations, and to ensure no affectation to upstream, downstream and adjoining properties as a result of the development.

Sizing of the basin systems has been completed using DRAINS modelling software in accordance with the LCC Stormwater Detention Technical Handbook for the 1 in 1-year ARI to 1 in 100-year ARI storms for various durations.

An assessment of the required drainage attenuation storage requirement has been made for this SMP. The following sections confirm the hydrological and hydraulic performance of the detention systems. Details and locations of each of the systems are shown on drawings in **Appendix A**.

The methodology employed to determine the attenuation requirements are based on assessing storms for the 1 in 1-year ARI to the 1 in 100-year ARI for the pre and post development phases. The pre-developed flows are based on the approved assessment completed by Arcadis and included in *Table 4-1* of the approved MPE Stage 2 SMP (W1P).

## 4.2 Existing & Post Development Peak Flows

Intensity/Frequency/Duration (IFD) data was adopted from the Bureau of Meteorology and councils Development Guidelines used in conjunction with DRAINS ILSAX modelling to estimate peak flows for the site and surrounding catchments.

The pre and post development site discharge rates for the interim conditions are provided in **Table 4.1** below.

| ARI | Design Storm Duration | Peak Flow ($m^3/s$) | | |
|---|---|---|---|---|
| | | Pre-Developed | Post-Development | |
| | | | No Attenuation | With Attenuation |
| 1 | 25 mins | 3.35 | 7.46 | 1.82 |
| | 45 mins | 3.05 | 6.04 | 1.91 |
| | 1 hr | 3.15 | 6.61 | 2.01 |
| | 2 hr | 2.80 | 6.46 | 1.97 |
| | 3 hr | 2.23 | 3.63 | 1.74 |
| | 4.5 hr | 1.89 | 3.03 | 1.72 |
| 20 | 25 mins | 8.29 | 15.8 | 4.11 |
| | 45 mins | 7.26 | 13.0 | 4.42 |
| | 1 hr | 7.68 | 13.8 | 4.89 |
| | 2 hr | 6.91 | 13.9 | 5.20 |
| | 3 hr | 5.24 | 8.20 | 4.09 |
| | 4.5 hr | 4.78 | 7.32 | 4.32 |
| 100 | 25 mins | 10.3 | 18.5 | 5.6 |
| | 45 mins | 9.25 | 15.5 | 5.97 |
| | 1 hr | 9.60 | 17.1 | 6.33 |
| | 2 hr | 8.67 | 17.0 | 6.48 |
| | 3 hr | 6.55 | 9.96 | 5.54 |
| | 4.5 hr | 6.06 | 8.92 | 5.68 |

**Table 4.1. Interim Conditions Pre/ Post-Development Flows**

The pre and post development site discharge rates for the ultimate conditions are provided in **Table 4.2** below.

| ARI | Design Storm Duration | Peak Flow ($m^3/s$) | | |
|---|---|---|---|---|
| | | Pre-Developed | Post-Development | |
| | | | No Attenuation | With Attenuation |
| 1 | 25 mins | 4.0 | 12.95 | 3.43 |
| | 45 mins | 3.61 | 10.27 | 3.10 |
| | 1 hr | 3.77 | 11.06 | 3.30 |
| | 2 hr | 3.36 | 11.25 | 3.33 |
| | 3 hr | 2.62 | 6.18 | 2.54 |
| | 4.5 hr | 2.23 | 5.22 | 2.10 |
| 20 | 25 mins | 9.91 | 26.11 | 5.291 |
| | 45 mins | 8.73 | 21.88 | 5.063 |
| | 1 hr | 9.16 | 21.77 | 5.08 |
| | 2 hr | 8.53 | 22.26 | 5.51 |
| | 3 hr | 6.47 | 13.03 | 5.20 |
| | 4.5 hr | 6.00 | 11.98 | 5.01 |
| 100 | 25 mins | 12.4 | 29.4 | 5.91 |
| | 45 mins | 11.2 | 25.5 | 7.4 |
| | 1 hr | 11.6 | 26.09 | 8.01 |
| | 2 hr | 10.8 | 26.9 | 8.33 |
| | 3 hr | 8.22 | 16.2 | 7.79 |
| | 4.5 hr | 7.73 | 14.1 | 7.22 |

**Table 4.2. Ultimate Conditions Pre/Post-Development Flows**

## 4.3 Proposed Detention System Storage and Hydrology – Interim Conditions

Post development site discharge volumes, as well as the provided detention volumes and depths for the combined IMEX Manual Phase Basin and OSD9 is provided in **Table 4.3** below.

| ARI | Dur. (Hrs) | Peak Flow ($m^3/s$) | | Depth (mm) | Storage Volume ($m^3$) |
|---|---|---|---|---|---|
| | | Un-attenuated | Attenuated | | |
| 1 | 1 | 6.61 | 2.01 | 800 | 3950 |
| 20 | 2 | 13.9 | 5.2 | 1560 | 9233 |
| 100 | 2 | 16.9 | 6.48 | 1810 | 11610 |

**Table 4.3. Combined IMEX and OSD9 Basins Flow and Storage Volumes (Interim Conditions)**

As shown in **Table 4.3** above, an active detention storage of 11,610$m^3$ is available in the combined IMEX and OSD9 detention systems. The available storage and proposed discharge arrangement enables attenuation of post development runoff flows to less than pre-development runoff flows for the 1-year ARI to the 100-year ARI.

The provided storage and attenuation of pre and post flows meets the requirements of CoC B40 in the interim condition.

## 4.4 Proposed Detention System Storage and Hydrology – Ultimate Conditions

Post development site discharge volumes, as well as the provided detention volumes and depths for the OSD9 and OSD10 systems are provided in **Tables 4.4** & **4.5** below.

| ARI | Dur. (Hrs) | Peak Flow ($m^3/s$) | | Depth (mm) | Storage Volume ($m^3$) |
|---|---|---|---|---|---|
| | | Un-attenuated | Attenuated | | |
| 1 | 2 | 2.25 | 0.59 | 730 | 2648 |
| 20 | 2 | 4.7 | 1.08 | 1470 | 5324 |
| 100 | 2 | 5.65 | 1.2 | 1840 | 6658 |

**Table 4.4. OSD9 Flow and Storage Volumes (Ultimate Condition)**

| ARI | Dur. (Hrs) | Peak Flow ($m^3/s$) | | Depth (mm) | Storage Volume ($m^3$) |
|---|---|---|---|---|---|
| | | Un-attenuated | Attenuated | | |
| 1 | 2 | 7.65 | 1.39 | 1100 | 5820 |
| 20 | 2 | 18.0 | 1.49 | 1840 | 15285 |
| 100 | 2 | 19.1 | 4.9 | 1980 | 17470 |

**Table 4.5. OSD10 Flow and Storage Volumes (Ultimate Condition)**

As shown in **Table 4.4 and Table 4.5** above, an active detention storage of 6,658$m^3$ and 17,470$m^3$ is available in the OSD9 and OSD10 detention systems respectively. The available storage and proposed discharge arrangement enables attenuation of post development runoff flows to less than pre-development runoff flows.

The provided storage and attenuation of pre and post flows meets the requirements of CoC B40 in the ultimate condition.

# 5 STORMWATER QUALITY CONTROLS

## 5.1 Stormwater Management Objectives

There is a need to provide design which incorporates the principles of Water Sensitive Urban Design (WSUD) and to target pollutants that may be present in the stormwater so as to minimise the potential adverse impact these pollutants may have on receiving waters and to also meet the requirements specified by the Liverpool City Council and DP&E Consent CoC A23 and CoC B40.

Stormwater quality will comprise a treatment train which meets the percentage-based pollution reduction objectives as per the consent condition, noting these reductions are greater than those required of Liverpool City Council DCP which require lesser reduction of Total Suspended Solids (80%) and Total Phosphorus (45%).

The water quality objectives for the entire development are presented in terms of annual percentage pollutant reductions on a developed catchment per CoC B40:

| | |
|---|---|
| Gross Pollutants | 90% |
| Total Suspended Solids | 85% |
| Total Phosphorus | 65% |
| Total Nitrogen | 45% |
| Total Hydrocarbons | 90% |

Water quality for the catchment will require provision of a treatment train of water quality improvement devices. Proposed and constructed systems include gross pollutant traps to surface drainage systems and bio-retention filtration systems for final water polishing. Water quality measures will need to be provided for the whole of catchment in accordance with this document and the CoC.

## 5.2 Proposed Stormwater Treatment System

Roof, hardstand, car parking, roads, other paved areas and landscaping areas are required to be treated by the Stormwater Treatment Measures (STM's). The STM's shall be sized according to the whole catchment area of the development. The STM's for the development shall be based on a treatment train approach to ensure that all of the objectives above are met. A concept for the treatment of each the project has been presented for the interim and ultimate scenarios.

*Interim Condition*

Components of the treatment train for the interim condition will comprise the following elements:

- Primary treatment to parking, truck hardstand and loading areas, and connecting roads is to be performed by vortech type gross pollutant traps (GPT). The specified system is the Rocla CDS and these have been designed to treat a minimum 6-month ARI flow;
- Tertiary treatment is to be provided via estate-servicing bio-retention system located within the OSD9 system. A minimum 1% of bio-retention is proposed provided for the

catchment Cat G09 Post, being approximately $1160m^2$. It is noted that the MPE Stage 1 catchment will also be treated by the bio-retention system in OSD9 for the interim period. Confirmation of achieving water quality objective has been made via MUSIC modelling.

- A portion of the constructed building roofs will also be treated via rainwater reuse and settlement within building rainwater tanks. It is noted that we have not included rainwater reuse in the MUSIC model.
- Modelling of the IMEX Manual Phase Basin has been included. It is noted that this treatment node has been modelled for storage purposes only, with treatment from the basin being set to zero. This provides a conservative modelling outcome for the overall treatment train.
- Hydrocarbon removal to be achieved through treatment within the GPT and further within the bio-retention system as discussed in **Section 5.4**.

In order to confirm the bio-retention filtration areas and GPT sizing meet the requirements of the load-based pollution reduction objectives, a MUSIC model has been prepared based on the interim condition layout.

It is also to be noted that the bio-retention system has been designed with measures to enable these to remain effective whilst being located within the detention system. Measures include limiting depths of water to 2.5m in the 1% AEP event, providing flow spreaders, bypass high flows around bio-retention elements, limit cell size to $1000m^2$ and maintain flow velocity to less than 0.4m/s. The specified bio-retention system has been confirmed through MUSIC modelling, based on 1% of the contributing Cat G09 Post catchment area being treated in the system. This area is noted as meeting the specific MPE2 contributing catchment requirement. It is also noted that when considering the additional contributing catchment from IMEX that proposed bio-retention area is less than 1% of the total contributing catchment. Given however the relatively short-term period the interim period will be in operation for, compliance with the specific MPE2 requirement whilst still maintaining all of the water quality objectives that the conditions described above meet the requirements of consent for the interim period.

*Ultimate Condition*

Components of the treatment train for the ultimate condition will comprise the following elements:

- Primary treatment of runoff from paved areas and most roof catchments within Cat G09 Post and Cat G10 Post will be achieved through GPT's.
- Cat G10 Post will have tertiary water quality managed through bio-retention within OSD10;
- Cat G09 post will also have tertiary water quality managed via bio-retention within OSD10. To enable this to occur the following is proposed:
    - Removal of interim bio-retention from OSD9.
    - Provision of a 375mm low flow pipe between OSD9 and OSD10. This low flow pipe will convey the treatable flow from the catchment (i.e. 3month ARI flow of approximately $0.5m^3/s$).

- Provision of an additional minimum 1160m$^2$ of bio-retention within OSD10 to ensure the CoC requirements for 1% of the contributing catchment to be provided as bio-retention.
- Minor storage and discharge adjustments to OSD9 and OSD10 to allow for the low flow pipe arrangement.

## 5.3 Stormwater Quality Modelling

### 5.3.1 Introduction

The MUSIC model was required under CoC B40(e)(ii) to model water quality. This model has been released by the Cooperative Research Centre for Catchment Hydrology (CRCCH) and is a standard industry model for this purpose. MUSIC (the Model for Urban Stormwater Improvement Conceptualisation) is suitable for simulating catchment areas of up to 100 km$^2$ and utilises a continuous simulation approach to model water quality.

By simulating the performance of stormwater management systems, MUSIC can be used to predict if these proposed systems and changes to land use are appropriate for their catchments and are capable of meeting specified water quality objectives (CRC 2002). The water quality constituents modelled in MUSIC and of relevance to this report include Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN).

The pollutant retention criteria nominated in **Section 5.1** of this report were used as a basis for assessing the effectiveness of the selected treatment trains.

Two MUSIC models "*13455.04-MPE OSD9 & OSD10_Interim-Rev1.sqz*" and "*13455.04-MPE OSD9 & OSD10_Ultimate-Rev1.sqz*" were set up to examine the effectiveness of the water quality treatment train and to predict the load-based pollution reduction requirements have been achieved for development.

The models were set up using the latest Liverpool City Council *MUSICLINK* parameters, and in accordance with the NSW MUSIC Modelling Guide. The layout of the MUSIC model is presented in **Appendix C**.

### 5.3.2 Rainfall Data

Six-minute pluviographic data was provided by LCC which has been sourced from the Bureau of Meteorology (BOM) as nominated below. Evapo-transpiration data for the period was sourced from the Sydney Monthly Areal PET data set supplied with the MUSIC software.

| **Input** | **Data Used** |
|---|---|
| Rainfall Station | 67035 Liverpool (Whitlam) |
| Rainfall Period | 1 January 1967 – 31 December 1976 (10 years) |
| Mean Annual Rainfall (mm) | 857 |
| Evapotanspiration | Sydney Monthly Areal PET |
| Model Timestep | 6 minutes |

### 5.3.3 Rainfall Runoff Parameters

| **Parameter** | **Value** |
|---|---|
| Rainfall Threshold | 1.40 |
| Soil Storage Capacity (mm) | 170 |
| Initial Storage (% capacity) | 30 |
| Field Capacity (mm) | 70 |
| Infiltration Capacity Coefficient a | 210 |
| Infiltration Capacity exponent b | 4.7 |
| Initial Depth (mm) | 10 |
| Daily Recharge Rate (%) | 50 |
| Daily Baseflow Rate (%) | 4 |
| Daily Seepage Rate (%) | 0 |

### 5.3.4 Pollutant Concentrations & Source Nodes

Pollutant concentrations for source nodes are based on LCC land use parameters as per the **Table 5.1**.:

| Flow Type | Surface Type | TSS ($log_{10}$ values) | | TP ($log_{10}$ values) | | TN ($log_{10}$ values) | |
|---|---|---|---|---|---|---|---|
| | | Mean | Std Dev. | Mean | Std Dev. | Mean | Std Dev. |
| Baseflow | Roof | 1.20 | 0.17 | -0.85 | 0.19 | 0.11 | 0.12 |
| | Roads | 1.20 | 0.17 | -0.85 | 0.19 | 0.11 | 0.12 |
| | Landscaping | 1.2 | 0.17 | -0.85 | 0.19 | 0.11 | 0.12 |
| Stormflow | Roof | 1.30 | 0.32 | -0.89 | 0.25 | 0.30 | 0.19 |
| | Roads | 2.43 | 0.32 | -0.30 | 0.25 | 0.34 | 0.19 |
| | Landscaping | 2.15 | 0.32 | -0.6 | 0.25 | 0.30 | 0.19 |

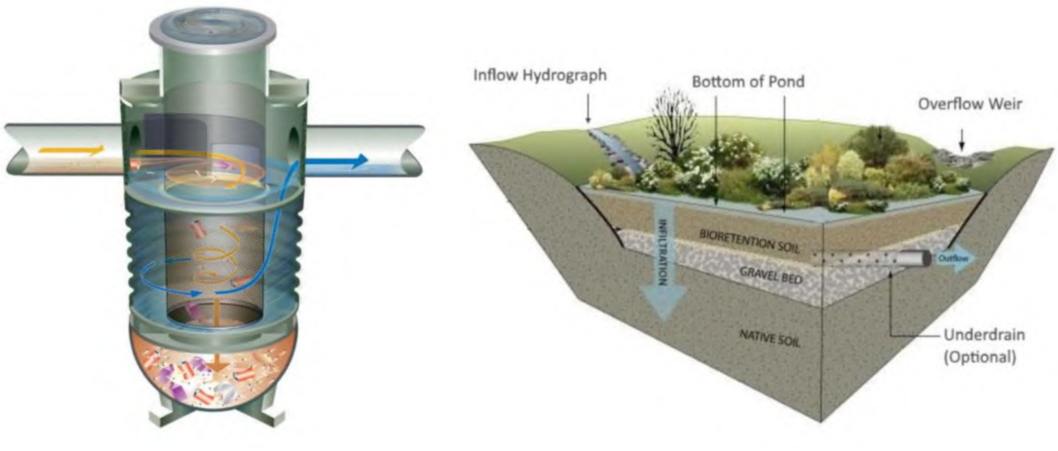
**Table 5.1. Pollutant Concentrations**

The MUSIC model has been setup with a treatment train approach based on the pollutant concentrations in **Table 5.1** above and the catchments shown in **Table 5.2**.

The relevant stormwater catchment sizes are shown figuratively in **Appendix C** and **Figure 5.1** below.

### 5.3.5 Treatment Nodes

GPT, bio-retention basin and detention basin nodes have been used in the modelling of the interim and ultimate conditions. Typical visual representation of the treatment measures is shown in **Figure 5.1** below and MUSIC nodes in **Figure 5.2**.




Typical *GPT* *Bio-retention System*

**Figure 5.1. Visual Representation of Treatment Measures**

## 5.4 Modelling Layout

The model layout for the interim condition is included in **Figure 5.2** and the ultimate in **Figure 5.3** below. Refer also to **Appendix C**.

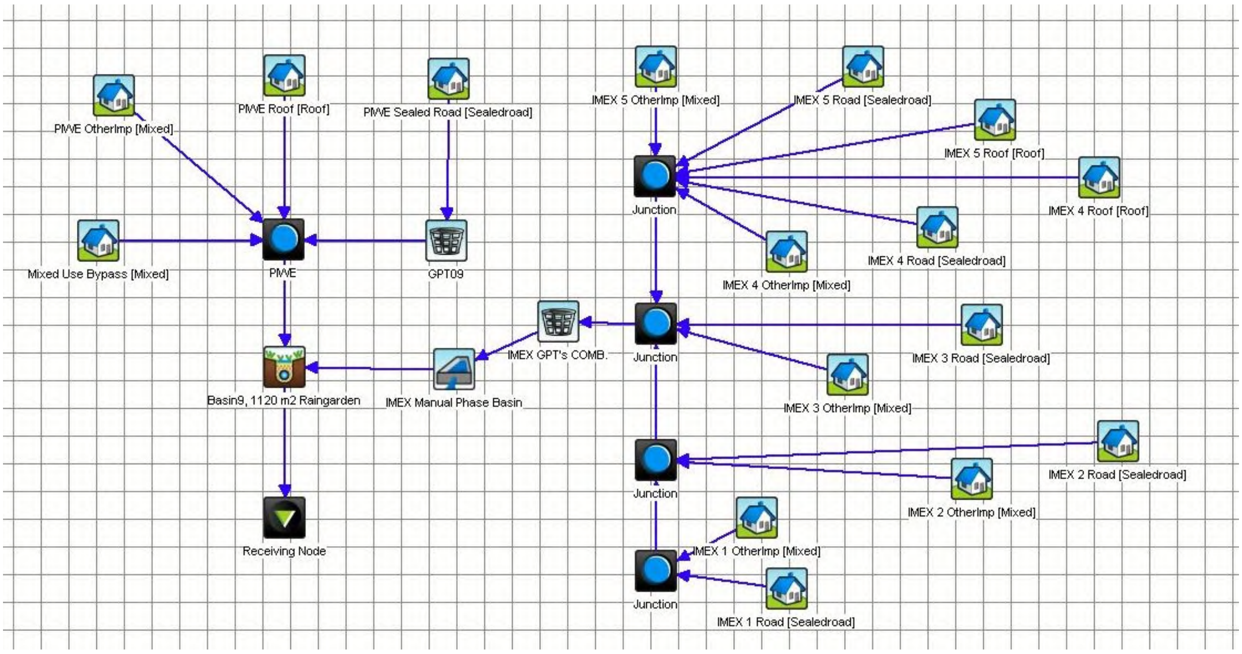



**Figure 5.2. MUSIC Model Layout – Interim Condition**

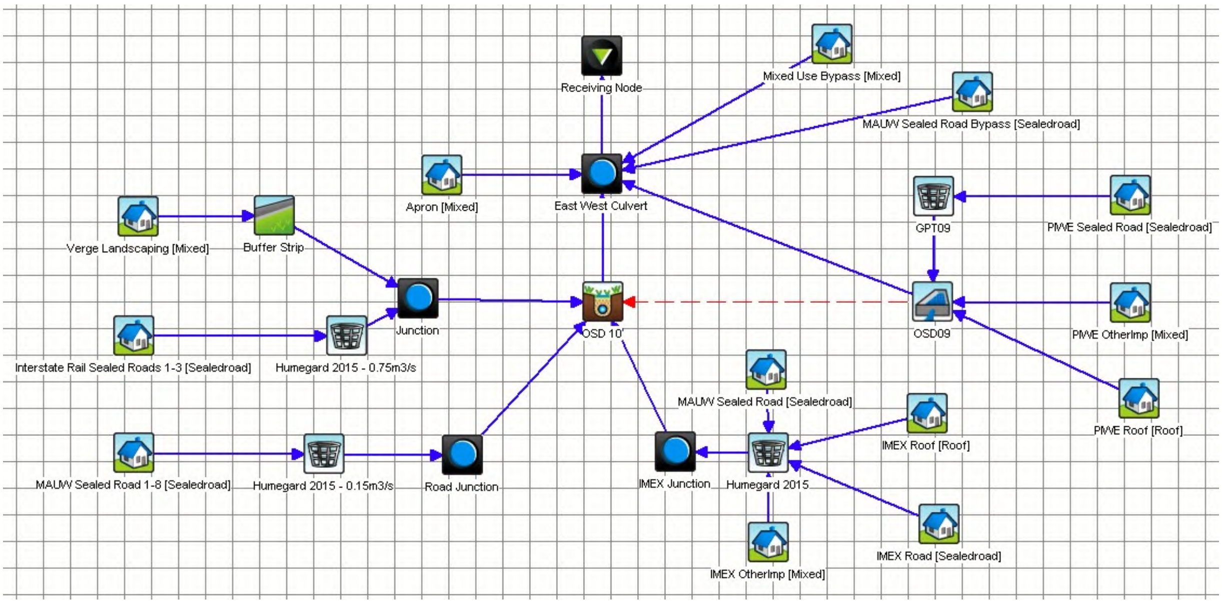



**Figure 5.3. MUSIC Model Layout – Ultimate Condition**

## 5.5 Modelling Results

### 5.5.1 Results

**Table 5.3** shows the results of the MUSIC analysis for the interim condition.

**Table 5.4** shows the results of the MUSIC analysis for the ultimate condition.

The reduction rate is expressed as a percentage and compares the post-development pollutant loads without treatment versus post-development loads with treatment over the modelled catchment.

| | Source | Residual Load | % Reduction | Target Met |
|---|---|---|---|---|
| **Flow (ML/yr)** | 282 | 280 | 1 | NA |
| **Total Suspended Solids (kg/yr)** | 65000 | 5620 | 91.3 | Y |
| **Total Phosphorus (kg/yr)** | 113 | 35.5 | 68.5 | Y |
| **Total Nitrogen (kg/yr)** | 647 | 342 | 47.1 | Y |
| **Gross Pollutants (kg/yr)** | 7440 | 0 | 100 | Y |

**Table 5.3. MUSIC analysis results – Interim Condition**

| | Source | Residual Load | % Reduction | Target Met |
|---|---|---|---|---|
| **Flow (ML/yr)** | 372 | 363 | 2.3 | NA |
| **Total Suspended Solids (kg/yr)** | 96600 | 10900 | 88.7 | Y |
| **Total Phosphorus (kg/yr)** | 167 | 44.4 | 73.4 | Y |
| **Total Nitrogen (kg/yr)** | 858 | 402 | 53.1 | Y |
| **Gross Pollutants (kg/yr)** | 9780 | 204 | 97.9 | Y |

**Table 5.4. MUSIC analysis results – Ultimate Condition**

5.5.2 Modelling Discussion

MUSIC modelling has been performed to assess the effectiveness of the selected treatment trains and to ensure that the pollutant retention requirements have been met.

The model results in **Tables 5.3 & 5.4** indicate that, through the use of the STM's in the treatment train, pollutant load reductions for Total Suspended Solids, Total Phosphorous, Total Nitrogen and Gross Pollutants will meet the requirements of consent for both interim and ultimate conditions.

As can be seen, the proposed treatment train achieves reductions greater than the required pollutant reduction objectives. This will any ensure any variance in assumed arrangements in the final building layouts will not affect the overall outcomes of the solution, and also to ensure overall reduction values are met.

Hydrocarbon reduction values, although not modelled, will achieve 90% reduction in the interim and ultimate conditions. Further discussion on hydrocarbon removal which is not readily modelled in MUSIC is provided in **Section 5.6** as follows.

## 5.6 Hydrocarbon Removal

The proposed distribution/ storage facility would be expected to produce relatively low source loadings of hydrocarbons. Potential sources of hydrocarbons would be limited to leaking engine sumps or for accidental fuel spills/leaks and leaching of bituminous pavements (carparking only). The potential for hydrocarbon pollution is low and published data from the CSIRO indicates that average concentrations from Industrial sites are in the order of 10mg/L and we would expect source loading from this site to be near to or below this concentration as further discussed below.

Hydrocarbon removal cannot be readily modelled with MUSIC software however there is sufficient information on the expected source loads and treatment.

*5.6.1 Hydrocarbon Sources*

The average storm flow concentration of hydrocarbons in an industrial facility is 9.5mg/L (3 & 30mg/L 95% confidence limits) sourced from Fletcher T, Duncan H, Poelsma P & Lloyd

S, 2004: *Stormwater Flow and Quality, and the Effectiveness of Non-Proprietary Stormwater Treatment Measures - A review and Gap Analysis. Cooperative Research Centre for Catchment Hydrology, Technical Report 04/8*;

### 5.6.2 <u>Bio-retention Treatment</u>

Removal of hydrocarbons within bio-retention systems is shown to occur due to several mechanisms.

Removal of oil, grease and hydrocarbons will take place due to entrainment to sediments within the bio-retention basin.

Research by Hseih (2005) has also shown that 97% of hydrocarbons are trapped and contained in the first few centimetres of a filtration system (i.e. filter swales and bio-retention systems). These are then broken down via organic processes in a period of 2-3 days.

Review of the volume of water and hydrocarbons treated by a bio-retention system with various extended detention depths has been undertaken by our office. An extended detention depth of 300mm results in treated volume of water and hydrocarbons of 67%.

### 5.6.3 <u>Rocla CDS Treatment</u>

The Rocla CDS GPT is reported to provide between 82-94% reduction in hydrocarbons and free oils.

The following information relating to the performance of the CDS GPT has been provided by the product manufacturers, Rocla:

> *As with nutrient capture there is also a high correlation of oils and grease removal with sediment capture in CDS Units.*
>
> *UCLA have reported 50-80% of oil and grease may be attached to sediments.*
>
> *Hoffman 1982: "Our data confirm the observations of the workers in that hydrocarbons are primarily associated with particulate material (83 – 93%)".*
>
> *CRCCH 1999: "Colwill found 70% of oil and approximately 85% PAH to be associated with solids in stormwater. That study subsequently demonstrated that over a period of dry weather conditions, increasing concentrations of oil become associated with particulates with the highest oil content found in the sediment range of 200µm to 400µm.*
>
> *CSIRO 1999: In the category of "attached pollutants" CDS Units were the only GPT device to even be considered capable of capturing anything.*
>
> *CDS Units can also capture free floating oil spills. However, when most of the oil is associated with fine particulates and sediments, CDS Units remove very high levels of oils and greases due to their very high capture rate of those fine particles.*

### 5.6.4 *Hydrocarbon Treatment Conclusion*

Overall, when combining a treatment train of Rocla CDS and bio-retention systems, a reduction of greater than 90% of hydrocarbons is achieved with an extended detention depth of 300mm within the bio-retention system, and the hydrocarbon removal could be achieved with the CDS alone.

Given the expected low source loadings of hydrocarbons and removal efficiencies of the treatment devices we consider that the requirements of the consent have been met for both the interim and MPE Stage 2 CoC.

# 6 MAINTENANCE AND MONITORING

It is important that each component of the water quality treatment train is properly operated and maintained. In order to achieve the design treatment objectives, a stormwater system maintenance schedule has been prepared (refer to **Section 6.3**).

Note that inspection frequency may vary depending on site specific attributes and rainfall patterns in the area. In addition to the maintenance requirements below it is also recommended that inspections are made following heavy rainfall or major storm events. Event heavy rain inspections should be carried out as soon as practicable following an intense period of rainfall, (i.e. greater than 100mm over 48 hours), as measured at the Horsley Park or Prospect Reservoir weather stations.

## 6.1 Types of Maintenance

Water Sensitive Urban Design (WSUD) assets require both proactive and reactive maintenance to ensure long term system health and performance.

Proactive maintenance refers to regular scheduled maintenance tasks, whereas reactive maintenance is required to address unscheduled maintenance issues. If an asset is not functioning as intended, then rectification may be required to restore the asset back to its intended functionality.

The preferred and recommended approach is for proactive maintenance.

### 6.1.1 Proactive Maintenance

Proactive maintenance is a set of scheduled tasks to ensure that the WSUD asset is operating as designed.

Proactive maintenance involves:

- Regular inspections of the WSUD asset;
- Scheduled maintenance tasks for issues that are known to require regular attention (e.g. litter removal, weed control); and
- Responsive maintenance tasks following inspections for issues which require irregular attention (e.g. sediment removal, mulching, and scour management).

Proactive maintenance in the first two years after the establishment period (construction and planting phases) are the most intensive and important to the long-term success of the treatment asset.

Proactive maintenance is a cost-effective means of reducing the long-term costs associated with operating stormwater treatment assets.

Maintenance activities specific to each WSUD asset type are detailed in the inspection and maintenance schedules and checklists provided in the report. The frequency of scheduled maintenance depends on the asset type and the issue being managed.

As a general guide, scheduled maintenance should be completed on a three to four-month cycle. The checklists provided should be used as a minimum guide to scheduled maintenance tasks and should be amended to suit site conditions and maintenance requirements.

Treatment assets should also be inspected at least once a year during or immediately after a significant rainfall event. This is important to confirm that the treatment system is functioning correctly under wet conditions.

A higher level of scheduled maintenance may be arranged for some treatment assets. This is often the case for treatment assets which are located in high profile locations (e.g. streetscapes and parklands), and where public amenity is considered to be a high priority. In these cases, a more frequent maintenance regime may be required to remove litter and weeds and to ensure vegetation health and cover is maintained to a high level.

### 6.1.2 Reactive Maintenance

Reactive maintenance is undertaken when a problem or fault is identified that is beyond the scope of proactive maintenance. Reactive maintenance may occur following a complaint about the WSUD asset (e.g. excessive odours or litter). Reactive maintenance often requires a swift response and may involve specialist equipment or skills.

### 6.1.3 Rectification

Rectification of a WSUD asset is undertaken when the system is not functioning as intended, and proactive and reactive maintenance activities are unable to return the asset to functional condition.

The lack of functional performance and therefore failure of a stormwater treatment asset may be related to many factors including inappropriate design, poor construction, and lack of regular maintenance or end of life cycle. In many cases, the design of assets has not included adequate consideration of the maintenance requirements, in terms of the system's ability to cope with catchment pollutant loads (i.e. sediments) and the frequency of maintenance required to maintain the system at a functional level.

Maintenance planning at the design phase is therefore crucial to both the long-term operating costs and the expected life cycle of the treatment system. In general, the expected lifecycle of a stormwater treatment asset (e.g. a bio-retention system) that has been well designed and constructed and is regularly maintained should be at least 15-20 years.

However, the lifecycle for each treatment system will be different and related to:

- whether the system has been designed, constructed and maintained according to best practice;
- catchment characteristics (influences the quality of the stormwater);
- the age and general health of the system; and
- the type of plants that have been used in the system.

Regular asset condition assessments should be undertaken to monitor the system condition and to inform where an asset is in terms of its expected lifecycle. Renewal of a system refers to replacing the main elements of the system including:

- infrastructure;

- removing deposited sediment, removing and replacing the topsoil (or filter media in the case of a bio-retention system) and profiling the topsoil level back to the design levels;
- re-planting; and
- pavement and sub-layers (in the case of permeable pavements).

A WSUD specialist may be required to assess whether a treatment system has reached the end of its life cycle and to provide advice on the renewal works.

Asset condition assessments can also identify assets that need to be rectified. The decision to continue with an increased maintenance regime or to rectify an asset, and over what timeframe, can be a difficult one to make. This is because certain maintenance items are more important to overall system function than others. For example, extended ponding on the surface of a bio-retention system or persistent scouring of a swale should be addressed more rapidly than recurrent weed problems.

## 6.2 Routine Inspections and Maintenance Schedule for General Stormwater System

Routine inspections are to be carried out to assess the need for maintenance and are primarily concerned with checking the functionality of the stormwater drainage facilities; items such as drains, drainage pits, box culverts, detention tanks and rainwater reuse tank systems. Maintenance of these items is vitally important for the ongoing drainage and treatment of stormwater.

Should the inspection reveal that maintenance of any item is required, this is to be reported to the building management for action.

Items that are to be subject to Routine Inspections for Maintenance may comprise, but not be limited to those listed in the table below. This table is to be read in conjunction with the Stormwater design drawings.

It is vitally important that each component of the stormwater system is properly operated and maintained. In order to achieve the modelled and design treatment outcomes, a maintenance schedule has been prepared (below) to assist in the effective operation and maintenance of the various drainage and water quality components.

## 6.3 Stormwater Maintenance Schedule

| MAINTENANCE ACTION | FREQUENCY | RESPONSIBILITY | PROCEDURE |
|---|---|---|---|
| **SWALES/ BATTERS/ LANDSCAPED AREAS** | | | |
| Check density of vegetation and ensure minimum height of 150mm is maintained. Check for any evidence of weed infestation | Six monthly | Maintenance Contractor | Replant and/or fertilise, weed and water in accordance with landscape consultant specifications |
| Inspect swale for excessive litter and sediment build up | Six monthly | Maintenance Contractor | Remove sediment and litter and dispose in accordance with local authorities' requirements. |
| Check for any evidence of channelisation and erosion | Six monthly/ After Major Storm | Maintenance Contractor | Reinstate eroded areas so that original, designed swale profile is maintained |
| Weed Infestation | Three Monthly | Maintenance Contractor | Remove any weed infestation ensuring all root ball of weed is removed. Replace with vegetation where required. |
| Inspect swale surface for erosion | Six Monthly | Maintenance Contractor | Replace topsoil in eroded area and cover and secure with biodegradable fabric. Cut hole in fabric and revegetate. |
| **RAINWATER TANKS** | | | |
| Check for any clogging and blockage of the first flush device | Monthly | Maintenance Contractor | First flush device to be cleaned out |
| Check for any clogging and blockage of the tank inlet -leaf/litter screen | Six monthly | Maintenance Contractor | Leaves and debris to be removed from the inlet leaf/litter screen |
| Check the level of sediment within the tank | Every two years | Maintenance Contractor | Sediment and debris to be removed from rainwater tank floor if sediment level is greater than the |

| MAINTENANCE ACTION | FREQUENCY | RESPONSIBILITY | PROCEDURE |
|---|---|---|---|
| | | | maximum allowable depth as specified by the hydraulic consultant |
| **INLET & JUNCTION PITS** | | | |
| Inside Pit | Six Monthly | Maintenance Contractor | Remove grate and inspect internal walls and base, repair where required. Remove any collected sediment, debris, litter. |
| Outside of Pit | Four Monthly/ After Major Storm | Maintenance Contractor | Clean grate of collected sediment, debris, litter and vegetation. |
| **STORMWATER SYSTEM** | | | |
| General Inspection of complete stormwater drainage system | Bi-annually | Maintenance Contractor | Inspect all drainage structures noting any dilapidation in structures and carry out required repairs. |
| **OSD SYSTEM** | | | |
| Inspect and remove any blockage from orifice | Six Monthly | Maintenance Contractor/ Owner | Remove grate and screen to inspect orifice. |
| Inspect trash screen and clean | Six Monthly | Maintenance Contractor/ Owner | Remove grate and screen if required to clean it. |
| Inspect flap valve and remove any blockage. | Six Monthly | Maintenance Contractor/ Owner | Remove grate. Ensure flap valve moves freely and remove any blockages or debris. |
| Inspect pit sump for damage or blockage. | Six Monthly | Maintenance Contractor/ Owner | Remove grate & screen. Remove sediment/ sludge build up and check orifice and flap valve is clear. |
| Inspect storage areas and remove debris/ mulch/ litter etc likely to block screens/ grates. | Six Monthly | Maintenance Contractor/ Owner | Remove debris and floatable materials. |
| Check attachment of orifice plate and screen to wall of pit | Annually | Maintenance Contractor | Remove grate and screen. Ensure plate or screen mounted securely, tighten fixings if required. Seal |

| MAINTENANCE ACTION | FREQUENCY | RESPONSIBILITY | PROCEDURE |
|---|---|---|---|
| | | | gaps if required. |
| Check orifice diameter is correct and retains sharp edge. | Five yearly | Maintenance Contractor | Compare diameter to design (see Work-as-Executed) and ensure edge is not pitted or damaged. |
| Check screen for corrosion | Annually | Maintenance Contractor | Remove grate and screen and examine for rust or corrosion, especially at corners or welds. |
| Inspect overflow weir and remove any blockage | Six monthly | Maintenance Contractor/ Owner | Ensure weir is free of blockage. |
| Inspect walls for cracks or spalling | Annually | Maintenance Contractor | Remove grate to inspect internal walls, repair as necessary. |
| Check step irons | Annually | Maintenance Contractor | Ensure fixings are secure and irons are free from corrosion. |
| **BIORETENTION BASIN/ SWALES** | | | |
| Check all items nominated for SWALES/ LANDSCAPED AREAS above | Refer to SWALES/ LANDSCAPED AREAS section above | Refer to SWALES/ LANDSCAPED AREAS section above | Refer to SWALES/ LANDSCAPED AREAS section above |
| Check for sediment accumulation at inflow points | Six monthly/ After Major Storm | Maintenance Contractor | Remove sediment and dispose in accordance with local authorities' requirements. |
| Check for erosion at inlet or other key structures. | Six monthly/ After Major Storm | Maintenance Contractor | Reinstate eroded areas so that original, designed profile is maintained |

| MAINTENANCE ACTION | FREQUENCY | RESPONSIBILITY | PROCEDURE |
|---|---|---|---|
| Check for evidence of dumping (litter, building waste or other). | Six monthly | Maintenance Contractor | Remove waste and litter and dispose in accordance with local authorities' requirements. |
| Check condition of vegetation is satisfactory (density, weeds, watering, replating, mowing/ slashing etc) | Six monthly | Maintenance Contractor | Replant and/or fertilise, weed and water in accordance with landscape consultant specifications |
| Check for evidence of prolonged ponding, surface clogging or clogging of drainage structures | Six monthly/ After Major Storm<br><br>5-10 years | Maintenance Contractor | Remove sediment and dispose in accordance with local authorities' requirements.<br><br>Replace filter media & planting – refer to appropriately qualified engineer or stormwater specialist |
| Check stormwater pipes and pits | Six monthly/ After Major Storm | Maintenance Contractor | Refer to INLET/ JUNCTION PIT section. |
| **GROSS POLLUTANT TRAPS** | | | |
| Refer manufacturers Operation and Maintenance Manual – refer Appendix | Refer manufacturers Operation and Maintenance Manual – refer Appendix<br><br>Minimum yearly / major storm | Maintenance Contractor | Refer manufacturers Operation and Maintenance Manual – refer Appendix |

Routine Inspections for Maintenance shall be carried out over the life of the development.

The inspections shall occur on a monthly frequency during the construction period, and shall continue on a regular basis as per the frequency specified above in perpetuity.

In addition to the normal inspection frequency nominated inspections should also be carried out following heavy rain events. Event heavy rain inspections should be carried out as soon as practicable following an intense period of rainfall, (i.e. greater than 100mm over 48 hours), as measured at Prospect Dam Weather Station No. 67019. A process to establish when periods of high rainfall occur should be put in place with Estate Management.

## 6.4 Records

Records detailing each of the routine inspections for maintenance should be completed during the inspection, and describe in detail any required maintenance. The inspection records are to be provided to Estate or Building Management for action and then filed appropriately.

Records of any maintenance carried out as a result of the inspection should be completed immediately after the works have been finalised, and filed appropriately with estate management services.

## 6.5 Personnel

Routine inspections for maintenance are required to establish the need for basic maintenance, as described above. On this basis, such inspections do not require professional engineering knowledge and may be carried out by any responsible person, including property management staff or maintenance staff.

# 7 CONCLUSION

This Stormwater Management Plan has been prepared for the Moorebank Logistic Park, MPE Stage 2 (SSD 7628) and short term for MPE Stage 1 in the interim period. This plan is prepared specifically relating to the management of stormwater within MPE Stage 1 & 2 during the:

- "*interim*" condition period between operation of IMEX and completion of OSD10; and
- "*ultimate*" condition following completion and implementation of OSD10.

This report provides information to confirm the requirements of State Significant Development Application SSD 7628, Conditions A23, B40, B41 and B42 have been met.

The civil engineering strategy in this SMP has been developed to provide a best practice solution within the constraints of the existing approvals, constructed works, the interim proposed construction program and ultimate construction arrangement. Within this design a stormwater quantity management strategy has been developed to reduce peak flows leaving this site to remain consistent with the existing flows as a permanent fixture.

The assessment has confirmed that water quality objectives have been met for both interim and ultimate construction arrangements.

The assessment has shown that the post development stormwater runoff can be attenuated to less than the pre-development catchments for the 1 in 1-year ARI to the 1 in 100-year ARI as required of the CoC.

# 8 REFERENCES


- Development Control Plan (2014), Liverpool City Council
- Design Specification Series D1-D9, Liverpool City Council
- Water Sensitive Urban Design – Technical Guidelines for Western Sydney (May 2004), URS Australia Pty Ltd
- Managing Urban Stormwater, Soils and Construction (1998) – The Blue Book, Landcom
- Managing Urban Stormwater: Soils and Construction – Installation of Services, Volume 2A (OEH 2008)
- Managing Urban Stormwater: Soils and Construction – Main Road Construction, Volume 2D (OEH 2008)
- Managing Urban Stormwater: Harvesting and Reuse – 2006 (NSW DEC)
- Managing Urban Stormwater: Source Control – 1998 (NSW EPA)
- Managing Urban Stormwater: Treatment Techniques – 1997 (NSW EPA)

# 9 GLOSSARY

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| Afflux | The rise in water level upstream of a hydraulic structure such as a bridge or culvert, caused by losses incurred from the hydraulic structure.<br>The change in flood surface or depth as a result in a modification or change to the hydraulic flood model scenario. |
| Australian Height Datum (AHD) | National survey datum corresponding approximately to mean sea level. |
| Annual Exceedance Probability (AEP) | The chance of a flood of a given size or larger occurring in any one year, generally expressed as percentage probability. For example, a 100-year ARI flood is a 1% AEP flood. An important implication is that when a 1% AEP flood occurs, there is still a 1% probability that it could occur the following year. |
| Average Recurrence Interval (ARI) | Is statistically the long-term average number of years between the occurrence of a flood as big as, or larger than the selected flood event. An ARI is the reciprocal of the AEP. |
| Catchment | The catchment at a particular point is the area of land which drains to that point. |
| Depth to velocity value (DV) | A ratio of flow depth and velocity used as a measure of safety for pedestrians and vehicles subject to flood water. Normally a maximum DV of 0.4 is recommended for pedestrian safety and 0.6 for vehicles. |
| Design floor level | The minimum (lowest) floor level specified for a building. |
| Design flood | A hypothetical flood representing a specific likelihood of occurrence (for example the 100 year or 1% probability flood). The design flood may comprise two or more single source dominated floods. |
| Development | Existing or proposed works which may or may not impact upon flooding. Typical works are filling of land, and the construction of roads, floodways and buildings. |
| Discharge | The rate of flow of water measured in terms of volume over time. It is not the velocity of flow which is a measure of how fast the water is moving rather than how much is moving. Discharge and flow are interchangeable. |
| Digital Terrain Model (DTM) | A three-dimensional model of the ground surface that can be represented as a series of grids with each cell representing an |

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| | elevation (DEM) or a series of interconnected triangles with elevations (TIN). |
| Effective warning time | The available time that a community has from receiving a flood warning to when the flood reaches their location. |
| First Flush | The initial surface runoff of a rainstorm. During this phase, water pollution in areas with high proportions of impervious surfaces is typically more concentrated compared to the remainder of the storm. |
| Flood | Above average river, creek, channel or other flows which overtop banks and inundate floodplains or urban areas. |
| Flood awareness | An appreciation of the likely threats and consequences of flooding and an understanding of any flood warning and evacuation procedures. Communities with a high degree of flood awareness respond to flood warnings promptly and efficiently, greatly reducing the potential for damage and loss of life and limb. Communities with a low degree of flood awareness may not fully appreciate the importance of flood warnings and flood preparedness and consequently suffer greater personal and economic losses. |
| Flood behaviour | The pattern / characteristics / nature of a flood. |
| Flooding | The State Emergency Service uses the following definitions in flood warnings:<br>*Minor flooding:* causes inconvenience such as closing of minor roads and the submergence of low-level bridges<br>*Moderate flooding*: low-lying areas inundated requiring removal of stock and/or evacuation of some houses. Main traffic bridges may be covered.<br>*Major flooding*: extensive rural areas are flooded with properties, villages and towns isolated and/or appreciable urban areas are flooded. |
| Flood frequency analysis | An analysis of historical flood records to determine estimates of design flood flows. |
| Flood fringe | Land which may be affected by flooding but is not designated as a floodway or flood storage. |
| Flood hazard | The potential threat to property or persons due to flooding. |
| Flood level | The height or elevation of flood waters relative to a datum (typically the Australian Height Datum). Also referred to as |

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| | "stage". |
| Flood liable land | Land inundated up to the probable maximum flood – flood prone land. |
| Floodplain | Land adjacent to a river or creek which is inundated by floods up to the probable maximum flood that is designated as flood prone land. |
| Flood Planning Levels (FPL) | Are the combinations of flood levels and freeboards selected for planning purposes to account for uncertainty in the estimate of the flood level. |
| Flood proofing | Measures taken to improve or modify the design, construction and alteration of buildings to minimise or eliminate flood damages and threats to life and limb. |
| Floodplain Management | The coordinated management of activities which occur on flood liable land. |
| Floodplain Management Manual | A document by the NSW Government (2001) that provides a guideline for the management of flood liable land. This document describes the process of a floodplain risk management study. |
| Flood source | The source of the flood waters. |
| Floodplain Management | A set of conditions and policies which define the benchmark from standard which floodplain management options are compared and assessed. |
| Flood standard | The flood selected for planning and floodplain management activities. The flood may be an historical or design flood. It should be based on an understanding of the flood behaviour and the associated flood hazard. It should also consider social, economic and ecological considerations. |
| Flood storages | Floodplain areas which are important for the temporary storage of flood waters during a flood. |
| Floodways | Those areas of the floodplain where a significant discharge of flow occurs during floods. They are often aligned with naturally defined channels or overland flow paths. Floodways are areas that, even if they are partially blocked, would cause significant redistribution of flood flows, or a significant increase in flood levels. |
| Freeboard | A factor of safety usually expressed as a height above the flood standard. Freeboard tends to compensate for the factors |

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| | such as wave action, localised hydraulic effects, uncertainties in the hydrology, uncertainties in the flood modelling and uncertainties in the design flood levels. |
| Geographical Information System (GIS) | A form of computer software developed for mapping applications and data storage. Useful for generating terrain models and processing data for input into flood estimation models. |
| High hazard | Danger to life and limb; evacuation difficult; potential for structural damage, high social disruption and economic losses. High hazard areas are those areas subject to a combination of flood depth and flow velocity that are deemed to cause the above issues to persons or property. |
| Historical flood | A flood which has actually occurred – Flood of Record. |
| Hydraulic | The term given to the study of water flow. |
| Hydrograph | A graph showing how flow rate changes with time. |
| Hydrology | The term given to the study of the rain-runoff process in catchments. |
| IMEX | Import Export Terminal within the MPE Stage 1 area. |
| Low hazard | Flood depths and velocities are sufficiently low that people and their possessions can be evacuated. |
| Map Grid of Australia (MGA) | A national coordinate system used for the mapping of features on a representation of the earth's surface. Based on the geographic coordinate system 'Geodetic Datum of Australia 1994'. |
| Peak flood level, flow or velocity | The maximum flood level, flow or velocity occurring during a flood event. |
| MPE | Moorebank Precinct East |
| MPE S1 | Moorebank Precinct East Stage 1. Includes the IMEX, Part Warehouse 5 West, and Warehouse 8 West. |
| MPE S2 | Moorebank Precinct East Stage 2. |
| MUSIC | Acronym for Model for Urban Stormwater Improvement Conceptualisation. A computer model which is used to simulate rainfall runoff, associated pollutants within the runoff and expected treatment of the pollutants using different |

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| | treatment measures. |
| Probable Maximum Flood (PMF) | An extreme flood deemed to be the maximum statistical flood likely to occur at a particular location. |
| Probable Maximum Precipitation (PMP) | The greatest statistical depth of rainfall for a given duration meteorologically possible over a particular location. Used to estimate the probable maximum flood. |
| Probability | A statistical measure of the likely frequency or occurrence of flooding. |
| Riparian Zone | Areas that are located adjacent to watercourses. Their definition is vague and can be characterised by landform, vegetation, legislation or their function. |
| Runoff | The amount of rainfall from a catchment which actually ends up as flowing water in the river of creek. |
| SIMTA | Sydney Intermodal Terminal Alliance. |
| Stage | Equivalent to water level above a specific datum- see flood level. |
| Treatment train | A term used to describe a series of water quality measures which act in conjunction with one another to provide a combined water quality outcome. |
| Triangular Irregular Network (TIN) | A mass of interconnected triangles used to model three-dimensional surfaces such as the ground (see DTM) and the surface of a flood. |
| Velocity | The speed at which the flood waters are moving. Typically, modelled velocities in a river or creek are quoted as the depth and width averaged velocity, i.e. the average velocity across the whole river or creek section |