PRECISION | COMMUNICATION | ACCOUNTABILITY

STORMWATER DEVELOPMENT DESIGN REPORT (SDDR)
SSD 7709

MOOREBANK LOGISTIC PARK PRECINCT WEST
MOOREBANK AVENUE
MOOREBANK NSW

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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 Design Development Report* (SDDR) for construction of Moorebank Precinct West as approved by the Independent Planning Commision (IPC) under SSD_7709 (dated 11 November 2019).

The submission of the SDDR for approval by the NSW Department of Planning, Industry and Environment (DPIE) has been completed in accordance with condition of consent (CoC) **B4, B5, B6** and associated conditions to **CoC B28**.

The subject area of this SDDR comprises the earthworks within Stages 2 of the MPW development extent (as defined in the *CEMP Figure 1-2*and SDDR **Figure 2.2**). These works include road and infrastructure drainage construction throughout MPW S2, required for the construction of Warehouses 1 through 6, and the interstate terminal.

1.2 Scope

This SDDR provides details of the following design principles and operational requirements of the stormwater management for MPW in accordance with the requirements of CoC B4 through B28 of SSD_7709:

- 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 DPIE. 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

This SDDR and associated designs have been completed in accordance with the approved stormwater management strategy defined by Arcadis and approved by DPIE in SSD_7709.

We provide the following table which confirms how and where, within the report or respective drawings and models, each of the requirements of SSD_7709 **CoC B4** through **B28** have been met:

<u>Revised Stormwater System Design</u>

B4 — *Prior to the commencement of construction, the Applicant must submit a* ***Stormwater Design Development Report*** *and* ***Revised Stormwater System Design Drawings*** *and* ***supporting documentation*** *to the Planning Secretary for approval.*

<u>Response</u>

This document forms the basis of SIMTA's submission of the SDDR, associated revised stormwater drawings and supporting documents.

Refer to **Appendix A** should be made for a full set of the proposed design drawings, and **Sections 1** through **9** of this SDDR for supporting documentation.

B5 — *The Stormwater Design Development Report must document how WSUD principles outlined in Condition B9 have been incorporated into the design and operation of the development.*

<u>Response</u>

WSUD principles have been incorporated into the design and operation of the development as required of **CoC B5** and **CoC B9**. Reference to **Sections 3, 4** and **5** of this **SDDR** and detailed responses set out for **CoC B9** should be made for confirmation of how WSUD principles have been integrated in the design.

B6 — *To ensure the site will be developed in an integrated manner and that the whole development will comply with the conditions of this consent, submission of the* ***Stormwater Design Development Report*** *and* ***Revised Stormwater System Design Drawings*** *and* ***supporting documentation*** *required by* ***Condition B4*** *cannot be staged.*

<u>Response</u>

The design, report and proposed stormwater management documentation is noted to not be staged per the requirements of the CoC.

<u>Stormwater Design Independent Peer Review</u>

B7 — *An Independent Peer Review report must be submitted with the Stormwater Design Development Report and Revised Stormwater System Design Drawings and supporting documentation*

Response

A peer review has been undertaken by *AT&L Consulting Engineers*. Reference to **Appendix G** should be made for the peer review letter and certification.

B8 ***The review must:***

Item (a) *include a review of the numerical models used to develop the revised stormwater design;*

Response

The peer review undertaken by *AT&L Consulting Engineers* (refer **CoC B8** response in **Appendix G)** includes assessment of numerical modelling. The model reviews include the DRAINS hydrologic and hydraulic model (for inground drainage and overland flow) and MUSIC modelling (for water quality and WSUD requirements).

B8

Item (b) *be undertaken by a technical expert, approved by the Planning Secretary, with over 15 years of experience in stormwater, flooding and water quality in NSW, including Water Sensitive Urban Design (WSUD), and not previously involved in preparation of drainage, flooding or hydrological designs or assessments for either MPW or MPE, or construction of either MPW or MPE; and*

Response

The peer review has been undertaken by AT&L under direction of Mr Anthony McLandsborough (Director) and Mr Andrew Tweedie (Associate Director). Both of these civil engineers have more than 15-years-experience in stormwater, flooding and water quality in NSW, including Water Sensitive Urban Design (WSUD), and have not been previously involved in design, assessment or construction of MPW or MPE.

The appointment of AT&L has been approved by the DPIE in their letter dated 10 February 2020, included in **Appendix G**.

B8

Item (b) *include an assessment of the Revised Stormwater System Design Drawings and supporting documentation against all relevant conditions, stating whether the condition has been satisfied, and comments justifying the position.*

Response

The peer review undertaken by AT&L Consulting Engineers (refer **Appendix G)** includes an assessment of the Revised Stormwater System Design Drawings and supporting documentation against all relevant conditions. The review confirms and justifies the relevant conditions have been satisfied.

Water Sensitive Urban Design (WSUD)

B9 *The revised stormwater system design, to be detailed in the **Stormwater Design Development Report** and **Revised Stormwater System Design Drawings** and **supporting documentation**, must be consistent with the objectives and principles set out in the NSW Office of Water's Guidelines for Controlled Activities and incorporate water sensitive urban design principles outlined in relevant Council policies, plans, guidelines and specifications and RMS's Water Sensitive Urban Design Guideline 2017, including:*

Response

The stormwater management strategy for MPW, as set out in this SDDR and supporting drawings and documentation, has been completed in accordance with relevant policy, CoC and consideration to the WSUD documents noted above.

Works within 40m of the Georges River, have been completed in accordance with *NSW Office of Water's Guidelines for Controlled Activities*, including naturalised drainage discharge systems, limited work zones and consideration to riparian and ecological amenity. Reference to **Section 3.6** and drawings **PIWW-COS-CV-DWG-0481-486** should be made for details of stormwater outlets to Georges River.

WSUD elements have been integrated into the design where practical, and consideration to the overall water cycle has been made as set out per the objectives included in SDDR **Section 3**, and confirmed per measures set out in **Sections 4 & 5**. Elements include frequent flow management via a (Stream Erosion Index assessment), stormwater quantity management, stormwater quality management (through a treatment train of proprietary and natural stormwater quality improvement devices including gross pollutant traps, bio-retention systems, buffer zones, sediment forebays), and rainwater reuse for each buildings non-potable water uses (including toilet flushing and landscape watering).

B9 *treating stormwater as a resource;*

Item (a) Response

Consideration to treating stormwater as a resource has been made through the use of rainwater reuse with the objective of reducing demand on potable water through non-potable uses including toilet flushing, landscaping irrigation, wash areas and similar non-potable reuse.

The demand reduction adopted for the development is 50% in accordance with **Table 2.1** of the Stormwater Trust Department of Environment & Conservation NSW document "*Managing Urban Stormwater – Harvesting and Reuse*". Reference to **Section 5.7** should be made for details pertaining to rainwater reuse and harvesting.

B9 *mimicking natural processes in the control of stormwater;*

Item (b) Response

The stormwater management strategy has been designed to mimic natural processes prior to discharge from the site to receiving waters. Detention systems manage water quantity such that post-development flows, increased through increased impervious surfaces, are limited to pre-development flows. Further a stream erosion assessment has been completed to ensure that the duration of stream forming flows is within acceptable ranges of 3.5-5.0 with a stretch target of 1.

Further, stormwater quality is managed through natural bio-retention systems which treat pollutants in runoff such as sediments and nutrients. Refer **Sections 3, 4** and **5** of this **SDDR** for details.

B9 *integrating drainage infrastructure and landscaping;*

Item (c) Response

Drainage infrastructure and landscaping has been integrated where practical. Detention systems integrate planning and landscaping through soft surfaces, gentle batter slopes (limited to 1v :4 h), and further through bio-retention systems and planting which includes native sedges and rushes. Any open swales are to be turfed and flanked with native water tolerant species.

Refer drawings in **Appendix A.**

B9 *managing water in a sustainable manner through considering the complete water cycle; and*

Item (d)

Response

Consideration of the complete water cycle has been made in the design and details pertaining to water cycle management as can be found in **Section 3**, and associated **Sections 4** and **5**.

B9 *considered design, construction and maintenance to minimise impacts on the natural water cycle.*

Item (e)

Response

Consideration of the design construction and maintenance has been made such that impact to the natural water cycle can be minimised. Details pertaining to water cycle management can be found in **Section 3**, and associated **Sections 4** and **5**.

Further, during construction, a **SWMP** and associated soil and erosion controls will be implemented by the contractor. Refer to the contractors **CEMP** and separate **CSWMP** report by Costin Roe Consulting, **Co13455.07-03.rpt**.

B10 *The Applicant must submit revised drawings and supporting documentation to the Planning Secretary for approval, in accordance with the design principles and design criteria listed in **Conditions B11** to **B22**.*

Response

This SDDR and revised stormwater drawings confirm how the criteria listed in CoC B11 to B22 have been met as outlined below.

Piped Stormwater Drainage and Overland Flow Paths

B11 *The stormwater system must be designed to:*

B11 Item (a) *convey flows up to and including the 10% AEP event within the formal piped drainage system, with flows from the 10% AEP to the 1% AEP event conveyed in controlled overland flow paths; and*

Response

The design of the inground drainage system has been based on a 5% AEP event (refer **Section 3.3**). The adopted 5% AEP provides a better operational outcome for the proponent and is more consistent with industry practice for industrial and intermodal facilities. The lower AEP will provide a higher level of service for the users of the facility resulting in less probability of nuisance flooding or ponding within roadways and gutters.

We confirm the flows greater than the 5% AEP and up to the 1% AEP have been allowed for in controlled overland flow paths. These generally align with roadways or other dedicated flow paths between buildings. All 1% AEP flow paths are directed toward respective detention systems.

Refer **Section 3.3** and drawings **PIWW-COS-CV-DWG-0401** to **0411**.

B11 Item (b) *provide adequate overland flow paths in the event of stormwater system blockages and flows in excess of the 1% ARI rainfall event.*

Response

We confirm that consideration to overland flow paths for storms greater than the 1% AEP have been allowed for in the design in controlled overland flow paths. These paths align with the dedicated flow paths provided for the 1% AEP event noted in response Item (a) above.

Refer **Section 3.**3 and drawings **PIWW-COS-CV-DWG-0401** to **0411**.

On-site Detention

B12 *On-site detention (OSD) must attenuate peak flows from the development such that both the:*

B12 Item (a) *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; and*

Response

We confirm 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 as confirmed in **Section 4** of this SDDR.

B12 Item (b) — *1 in 100-year ARI event post development peak discharge rate is equivalent to the pre-development (un-developed catchment) 1 in 100-year ARI event.*

Response

We confirm the 1 in 100-year ARI event post development peak discharge rate is equivalent to the pre-development (un-developed catchment) 1 in 100-year ARI event as confirmed in **Section 4** of this SDDR.

B13 — *OSD basins must:*

B13 Item (a) — *be visually unobtrusive and sit within the final landform and landscaping*

Response

The OSD basins are considered to be unobtrusive, fitting into natural topography. Landscaped uses local native planting flanking basins systems, with bio-retention systems planted out with nutrient removing native sedges and rushes. Overall the systems have a highly naturalised feel and aesthetically pleasing appeal.

B13 Item (b) — *ensure public safety by incorporation of 'safer by design' principles; and*

Response

The design of the 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.

Reference to drawings **PIWW-COS-CV-DWG-0431** to **0435** be made for locations and plan geometry of detention systems and drawings. **PIWW-COS-CV-DWG-0436** to **0438** to be made for typical sections of the detention systems.

B13 Item (c) — *have all sides with a maximum batter slope of 1V:4H.*

Response

We confirm the batter slopes of all basins adopted maximum batter slopes of 1V:4H.

Reference to drawings **PIWW-COS-CV-DWG-0431** to **0435** be made for locations and plan geometry of detention systems and **PIWW-COS-CV-DWG-0436** to **0438** to be made for typical sections of the detention systems.

Stormwater Quality

B14 — *All stormwater quality elements are to be modelled in MUSIC as per the NSW MUSIC Modelling Guide.*

Response

Stormwater quality elements have been modelled in MUSIC as per the NSW MUSIC Modelling Guide. Refer **Section 5** of this report for details of

MUSIC modelling and confirmation of achieving required water quality objectives.

B15 *The stormwater quality infrastructure must comprise rainwater tanks, 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:*

(a) reduce the average annual load of total nitrogen by 45%;
(b) reduce the average annual load of total phosphorus by 65%; and
(c) reduce the average annual load of total suspended solids by 85%.

Response

We confirm the pollution reduction objectives noted in CoC B15 (a) to (c) have been met as confirmed in **Section 5.5** of this SDDR.

B16 (a)-(c) *All stormwater quality elements must be installed upstream of OSD basins, unless it can be demonstrated to the satisfaction of the Secretary that biofiltration/ bioretention systems within the OSD basins:*

(a) will not suffer damage from design flows;
(b) can be maintained to achieve the water quality criteria; and
(c) will have adequate solar access ensuring that all bioretention systems are exposed to sunlight at midday on the winter solstice. This assessment is to include surrounding features of OSD basins, including but not limited to actual building heights and full mature height and size of proposed trees, as per the landscape plans.

Response

All primary treatment elements 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, as shown on drawings **PIWW-COS-CV-DWG-0433 to 0438** in **Appendix A,** including:

i. water depths within the bio-retention section of the basin have been set such that a maximum water depth of 2.55m is maintained to the detention system in major storm events and for short durations only. Generally for >90% of all stormwater events the water depth in and around bio-retention elements would be 0.4m (being the extended detention depth).
ii. 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.
iii. 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.

We confirm the systems can be maintained to achieve the required water quality objectives – refer to **Section 6** of this SDDR for details pertaining to maintenance requirements.

We confirm that adequate solar access is available to bio-retention elements. We confirm the bio-elements are not subject to any building shadowing and being located adjacent to 1v:4h batters will not be shadowed by landform. Planting will be limited to smaller species adjacent to bio-basins to ensure that storage requirements of OSD will not be affected which are noted to also help with reduction of shadowing and increase solar access. Refer shadow diagrams by Ground Ink Landscape Architects in **Appendix H**.

B17 *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

We confirm bio-retention areas are at least 1% of the contributing catchment. Refer to **Section 5** of this **SDDR** and associated drawings **PIWW-COS-CV-DWG-0433 to 0438** in **Appendix A**.

B18 *Bioretention systems which are greater than 1,000 m2 in area, are to be divided into cells with no individual cell greater than1,000 m2.*

Response

We confirm areas of bio-retention cells are limited to 1000m^2. Refer to **Section 5** of this **SDDR** and associated drawings **PIWW-COS-CV-DWG-0433 to 0438** in **Appendix A**.

B19 *All filter media used in stormwater treatment measures must:*

B19 Item (a) *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;*

Response

Refer bio-retention design details and media specification included in drawings **PIWW-COS-CV-DWG-0453**. The drawing and details show this specification to be met.

B19 Item (b) *have an hydraulic conductivity = 100-300 mm/hr, as measured using the ASTM F1815-06 method;*

Response

Refer bio-retention design details and media specification included in drawings **PIWW-COS-CV-DWG-0453**. The drawing and details show the proposed specification of 200mm/hr to be met.

B19 *have an organic matter content less than 5% (w/w); and*

Item (c) Response

Refer bio-retention design details and media specification included in drawings **PIWW-COS-CV-DWG-0453**. The drawing and details show the proposed specification of organic content being less than 5% to be met.

B19 *be provided adequate solar access, considering the design and orientation of OSD basins.*

Item (d)

Response

Adequate solar access has been provided as confirmed in response to **CoC B16(c)** and confirmed via shadow diagrams by Ground Ink Landscape Architects in **Appendix H**.

Stormwater Outlet Structures

B20 *Discharge of stormwater from the development must not cause scour/ erosion of the banks or bed, or pollution of the Georges River or Anzac Creek.*

Note: *Pollution of waters as defined under section 120 of the POEO Act.*

Response

Stormwater outlet structures and drainage connections to natural creek lines, including the Georges River and Anzac Creek, have been designed and will be provided using natural energy dissipaters in accordance with NSW Office of Water outlets to riparian corridor set of documents.

The naturalised systems are designed to minimise scour potential and to facilitate natural geomorphic processes.

Refer typical details on drawings **PIWW-COS-CV-DWG-0455**, and **Section 3.6** of this SDDR.

B21 *Outlet structures for the discharge of site stormwater drainage to the Georges River, Anzac Creek, external drainage or natural drainage lines must be constructed of natural materials to minimise erosion, facilitate natural geomorphic processes and include vegetation as necessary (gabion baskets and gabion mattresses are not acceptable).*

Response

Outlet structures and drainage connections to natural creek lines, including the Georges River and Anzac Creek, have been designed and will be provided using natural energy dissipaters in accordance with NSW Office of Water outlets to riparian corridor set of documents.

The naturalised systems are designed to minimise scour potential and to facilitate natural geomorphic processes.

Refer typical details on drawings **PIWW-COS-CV-DWG-0455**, and **Section 3.6** of this SDDR.

B22 *Outlet structures must ensure habitat connectivity and wildlife movement is maintained along the Georges River riparian corridor.*

Response

Connections to natural creek lines, including the Georges River and Anzac Creek, have been designed and will be provided using natural energy dissipaters in accordance with NSW Office of Water outlets to riparian corridor set of documents.

The naturalised systems are designed to maximise the potential for habitat connectivity and wildlife movement along the Georges River riparian corridor.

Refer typical details on drawings **PIWW-COS-CV-DWG-0455**, and **Section 3.6** of this SDDR.

Stormwater System Design Drawings

B23 *The Revised Stormwater System Design Drawings and supporting information to be submitted under **Condition B4** must include the details specified in **Conditions B24** to **B28**.*

Response

Refer to **Appendix A** for engineering design drawings which include the details specified in CoC B24 to B28.

B24 *Drawings must show:*

B24 Item (a) *all information on a drainage catchment plans and a schedule of stormwater drainage elements (pipelines and structures). Drainage drawing documentation is to be in accordance with the requirements detailed in Liverpool Council's Development Design Specification "D5 – Stormwater drainage design" clauses D5.22 and D5.24;*

Response

Refer to **Appendix A** for engineering design drawings which include the details specified noted in the CoC above.

We confirm proposed public infrastructure has been designed in accordance with Liverpool City Council's *Development Design Specification "D5 – Stormwater drainage design" clauses D5.22 and D5.24*.

B24 Item (b) *location and width of controlled overland flow paths;*

Response

Refer to drawing **PIWW-COS-CV-DWG-0461 & 0465** for engineering design drawings which include the details specified noted in the CoC above.

B24 Item (c) *maximum design flow levels to AHD;*

Response

Refer to drawing **PIWW-COS-CV-DWG-0461 & 0465** for engineering design drawings which include the details specified noted in the CoC above.

B24 Item (d) *maintenance access to each on OSD basin; and*

Response

Refer to drawing **PIWW-COS-CV-DWG-0481 & 0483** for engineering design drawings which include the details specified noted in the CoC above.

B24 Item (e) *the integration with MPE Stage 1 and MPE Stage 2 stormwater infrastructure including:*

(i) stormwater infrastructure on the MPW site that is intended to convey (pipes or overland flow paths) or treat or detain stormwater from MPE Stage 1 and MPE Stage 2, and/ or

Response

Reference to drawing **PIWW-COS-CV-DWG-0441 to 0443** should be made for details of the east west culvert which drains MPE OSD9 (62.7 Ha) and OSD10 (12.3 Ha) catchments through MPW to Georges River. Allowance to convey a peak flow in the 1% AEP event of 7.6m^3/s, per Arcadis *Table 5-1* and *Table 5-2* of their *Moorebank Precinct East Stage 2 SMP (Rev5)* report dated 7 June 2019.

No other systems relating to MPE are proposed on MPW Stage 2 nor included in documentation, including in this SDDR and associated documentation.

(ii) drawings demonstrating that stormwater detention and treatment infrastructure has been provided for and approved under MPE Stage 1 and MPE Stage 2 for western draining MPE catchments

Response

Refer to **Appendix F** for design information information pertaining to MPE Stage 1 and 2 systems which are proposed to drain through the east-west culvert to Georges River.

B25 *All stormwater quality elements are to be detailed in the drawings including:*

B25 Item (a) *general arrangement plans at 1:500 and detailed plans as required at 1:200, showing system layout with key features including pipe arrangement with pipe sizes, diversion structure, high flow bypass, pre-treatment system,* *inlets, outlets, underdrainage, and maintenance vehicular access. The plans must show how the bioretention system will achieve separate cells of a maximum area of 1000 m2 with flow splitting;*

Response

Refer drawings **PIWW-COS-CV-DWG-0401** through **0486** for the noted CoC items.

B25

Item (b)

long and cross sections showing key features and levels including liner (base level of bioretention system), submerged zone level, drainage layer, transition layer, filter surface level, extended detention level, bund/ embankment level, and level of detention storage;

Response

Refer drawings **PIWW-COS-CV-DWG-0401** through **0486** for the noted CoC items.

B25

Item (c)

pipe long sections, including invert levels, pipe sizes;

Response

Refer drawings **PIWW-COS-CV-DWG-0484-0486** through **0499** for the noted CoC items.

B25

Item (d)

details of key structures including diversion, pre-treatment system (make/ model), inlets, outlets;

Response

Refer drawings **PIWW-COS-CV-DWG-0401** through **0459** for the noted CoC items.

B25

Item (e)

landscape plan including plant species;

Response

Drawings have been coordinated with Ground Ink Landscape Architecture drawings. Refer to Ground Ink Landscape Architecture for landscape plans and plant species specification included in **Appendix I**.

B25

Item (f))

specification of filter media; and

Response

Refer bio-retention design details and media specification included in drawings **PIWW-COS-CV-DWG-0453**. Bio-retention media specification is based on Monash University recommendations and noted per this CoC.

B25

Item (g)

shadow diagrams, including surrounding features of OSD basins, actual building heights and full size of proposed trees, as per the landscape plans.

Response

Refer to Landscape Architecture for plans show shadow plans and confirmation of solar access in **Appendix H**.

B26 *Stormwater outlet drawings must show:*

B26 Item (a) *material type, size, thickness, with accompanying hydraulic calculations demonstrating the achievement of relevant stability thresholds;*

Response

Refer drawings **PIWW-COS-CV-DWG-0481** through **0486** for the noted CoC items.

B26 Item (b) *design arrangement including longitudinal sections, cross sections and typical arrangements;*

Response

Refer drawings **PIWW-COS-CV-DWG-0481** through **0486** for the noted CoC items.

B26 Item (c) *typical arrangements including details of any liners, keying into bed/ banks and filter material; and*

Response

Refer drawings **PIWW-COS-CV-DWG-0481** through **0486** for the noted CoC items.

B26 Item (d) *the tie in with the receiving water normal water level and/ or seasonal low flow levels*

Response

Refer drawings **PIWW-COS-CV-DWG-0481** through **0486** for the noted CoC items.

Stormwater System Design Supporting Documentation

B27 *As part of the* ***supporting documentation*** *required under* ***Condition B4****, the Applicant must document the sequence of construction, including interim drainage solutions, for:*

B27 Item (a) *the drainage line from MPE to the Georges River;*

Response

The proposed construction of the east-west culvert from MPE is for this system to be aligned away from the existing channel, such that the existing channel can operate until such time that the new culvert can be tied in at the upstream and downstream ends of the culvert. This will ensure that during construction, works can continue in the new culvert system without being affected by runoff from the upstream catchments. These works and proposed strategy have been proposed with consideration to the “in-stream works" guidelines provided by the ICEA in their best practice erosion and sediment control documents.

Reference to the separate CSWMP by Costin Roe Consulting (ref: **Co13455-07-03.rpt**) and drawings **PIWW-COS-CV-DWG-0200 to 0250** should be made for details.

B27 Item (b)

the northern portion of MPW, including infilling, OSD basins, transition of sedimentation basins to OSD basins; and

Response

Reference to *Section 5.8* of the separate CSWMP by Costin Roe Consulting (ref: **Co13455-07-03.rpt**) and drawings **PIWW-COS-CV-DWG-0200 to 0250** should be made for details of infilling and transition of sedimentation basins to OSD basins.

B27 Item (c)

the southern portion of MPW, including infilling, OSD basins, transition of sedimentation basins to OSD basins.

Response

Reference to *Section 5.8* of the separate CSWMP by Costin Roe Consulting (ref: **Co13455-07-03.rpt**) and drawings **PIWW-COS-CV-DWG-0200 to 250** should be made for details of infilling and transition of sedimentation basins to OSD basins.

B28

As part of the ***supporting documentation*** *required under* ***Condition B4****, outlet structure investigations and design inputs must be submitted to the Planning Secretary, including:*

B28 Item (a)

subsurface/ geotechnical assessment identifying underlying foundation conditions;

Response

Geotechnical assessments have been completed by Golders and PSM Geotechnical Engineering Consultants. *Section 3* of the Golders Geotechnical Spec (ref: 1416224-016-R-Rev 3) provides guidance on the properties on the underlying soils. Refer to **Appendix K** for Geotechnical Investigations completed.

B28 Item (b)

hydraulic modelling;

Response

Reference to **Sections 4 and 5** of this **SDDR** document should be made pertaining to hydraulic assessments.

B28 Item (c)

hydraulic calculations for stormwater outlet structures demonstrating achievement of relevant stability thresholds; and

Response

Refer drawings **PIWW-COS-CV-DWG-0481** through **0486** for the noted CoC items.

B28

Item (d)

design specifications including schedule of drainage elements (e.g. rock sizes, and structures).

Response

Refer drawings **PIWW-COS-CV-DWG-0481** through **0486** for the noted CoC items.

B34

Conversion of construction stage erosion and sediment control infrastructure into permanent stormwater quality or on-site detention infrastructure must only occur once the civil works (roads and drainage) have been completed for the associated site sub-catchment.

Response

Requirements relating to conversion of construction stage erosion and sediment control infrastructure into permanent stormwater quality or on-site detention infrastructure are addressed in **Section 5.8 & 6.4** of the **Construction Soil and Water Management Plan (CSWMP)** included in Appendix F of the CEMP.

B35

Where construction of sediment basins and stormwater outlet works (including clearing, scour protection/ erosion control) are to be undertaken outside the site on Crown land (being the banks and bed of the Georges River), design those works must be prepared with the input of an aquatic ecologist, and evidence of DPI (Crown Lands) approval is to be provided to the Planning Secretary prior to commencement of construction. Details of finished works are to be submitted to DPI (Crown Lands) for information.

Response

The majority of the construction works will remain clear of Crown Land, other than local works associated with outlet structures. No works in relation to sediment basins, filling works or bulk earthworks are proposed outside the site development boundary or on Crown Lands.

Reference to **Section 7** of the **CSWMP** (CEMP Appendix F) and associated drawings **PIWW-COS-CV-DWG-0246-0248** should be made pertaining to outlet requirements and outlet sediment controls during construction.

Refer to **SDDR Section 3.6** and drawings **PIWW-COS-CV-DWG-0481 to 0486** for operational outlet designs and requirements and **Appendix J** for review and consultation of ecological requirements completed by Cumberland Ecology.

B45

The design of fill batters must ensure stability, mitigate visual impacts, provide for maintenance activities and demonstrate that there are no impacts on adjacent lands, including bio-diversity offset areas and the riparian corridor.

Response

The design of short-term construction batters has been completed with maximum slopes of 1v:2h as defined in PSM Geotechnical report.

The design of operational batters has been made such that the maximum adopted slope for batters is 1v:4h.

In relation to demonstrating that there are no impacts on adjacent lands relating to fill batters, we confirm that all works (including fill batters) have been designed to be completed within the defined development boundary. This includes for a buffer zone, as defined in Reid Campbell Architects Masterplan, required of **CoC B2(a)(i)** and **B2(a)(ii).** The **CoC** which requires a buffer zone on the Georges River property frontage as the most inland of 40m from top of bank or the 1% AEP flood level, and allowing for an additional 10m where native vegetation is located adjacent to the buffer zone. The construction activities are to be completed in accordance with the approved design documents, hence impacts on adjacent areas have been mitigated. Refer engineering design drawings in **Appendix A**.

2 DEVELOPMENT SITE

2.1 Site Description

The MPW Stage 2 development footprint is irregular in shape being bounded by the Georges River on the west, M5 Motorway on the north (and existing ABB Facility), Moorebank Avenue and Moorebank Precinct East (MPE) on the east, and undeveloped crown land to the south. Also, on the eastern extent is MPE On-Site Detention Basin (OSD) 10 (being constructed on the western side of Moorebank Avenue as part of MPE works) and the interstate intermodal terminal and rail sidings.

Access to the site is via Moorebank Avenue and the Moorebank Avenue interchange with the M5 Motorway.

The site is noted to be located within Liverpool City Council Local Government Area. The development area is shown as **Figure 2.1**.

The site is noted to comprise relatively flat topography. The highest level on the site is RL 17.8m AHD located at the south-east corner of the site. The lowest level is RL 3.0m AHD adjacent to Georges River. Generally, the levels over the site fall between a range of RL 13.5m AHD to RL 7.5m AHD. Site grading is flat to undulating, as noted, however generally falls from east to west at grades of 0.5% to 1%.

It is noted that Moorebank Avenue reaches levels of RL 25.2m AHD at the East Hills Railway Line crossing and associated bridge abutment approach at the southern end of the development footprint.

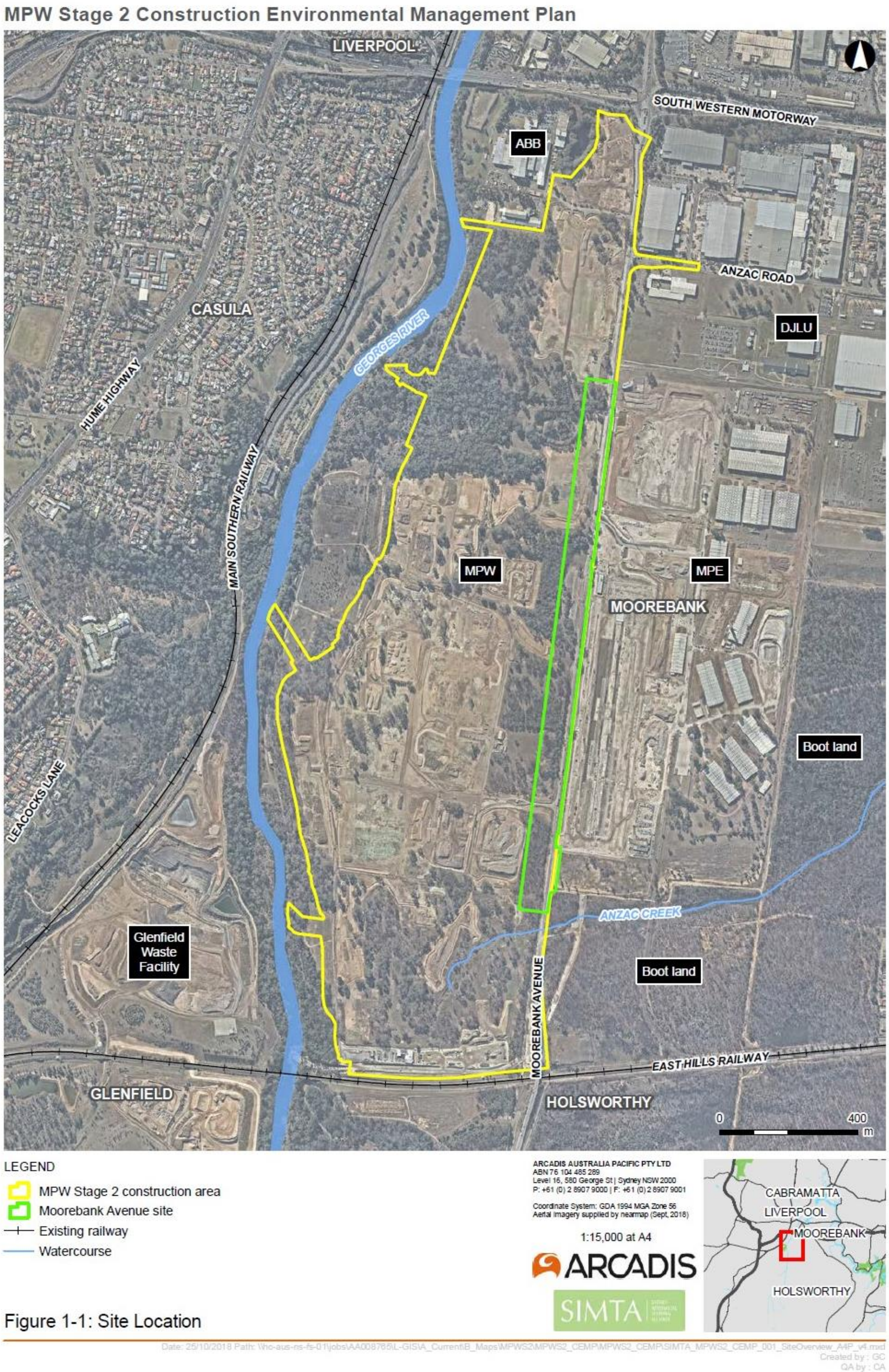


Figure 2.1 Locality Plan (Source: *CEMP Figure 1-1, Arcadis*)

The MPW Stage 2 site comprises five (5) key existing drainage catchments. Four of the five drainage catchments (totalling 121.2 Ha) drain in a westerly direction and directly to The Georges River. The fifth catchment (24.82 Ha), located at the south-east of the development area, drains south-east to Moorebank Avenue and Anzac Creek.

Reference to Arcadis *Figure 5-1: Existing Site Conditions (EIS Appendix R – Stormwater & Flooding Environmental Assessment)* confirm existing site conditions, and Costin Roe Consulting drawing **PIWW-COS-CV-DWG-0420** confirms existing catchment layout, areas and drainage outlet positions.

It is also noted that, a catchment of approximately 75 Ha from MPE (IMEX & OSD 10 – 62.7 Ha, MPE Basin 9 and part of Warehouse 5 – 12.3 Ha) drains through the site via an existing drainage channel. The existing channel is in a state of poor maintenance and will be upgraded as what has been coined as the "*East-West Culvert*". Construction of the *East-West Culvert* will comprise reinforced concrete box culverts (RCBC) with base slab extending from the existing Moorebank Avenue crossing to The Georges River. It is proposed that the alignment of the new culvert will be offset, however aligned parallel to the existing culvert (other than the start and end of the culvert) to ensure the existing channel can remain operational during the construction of the new culvert. This will assist in ensuring that potential for scour erosion is minimised and associated environmental impact associated with the construction is also minimised.

The east west culvert is to be designed to accommodate peak 1% AEP flows of $7.6m^3/s$ based on peak discharge from proposed OSD9 and OSD10 as designed by Arcadis and reported in *Table 5-1* and *Table 5-2* of their *Moorebank Precinct East Stage 2 SMP (Rev5)* report dated 7 June 2019.

Further discussion relating to catchments and existing drainage is made in **Section 3.2** of this report.

2.2 Proposed Development

The Project site is located approximately 27 kilometres (km) south-west of the Sydney Central Business District (CBD) and approximately 26 km west of Port Botany. The Project site is situated within the Liverpool Local Government Area (LGA), in Sydney's South West Sub-Region, approximately 2.5 km from the Liverpool City Centre.

The Project involves the construction and operation of a multi-purpose intermodal terminal (IMT) facility, Rail link connection, warehousing, freight village, and upgrades to the Moorebank Avenue and Anzac Road intersection. Details on the key components of the Project include:

- Construction and 24/7 operation of an intermodal terminal (IMT) facility to support a container freight throughput volume of 500,000 twenty-foot equivalent units (TEUs) per annum, including:
  - A rail terminal with nine rail sidings and associated locomotive shifter
  - A rail link connection from the sidings to the rail link constructed under MPE Stage 1 (SSD 6766) to the Southern Sydney Freight Line (SSFL)
  - A rail and truck container loading and unloading and container storage areas

    - Truck waiting area and emergency truck storage area
    - Container wash-down facilities and degassing area
    - Mobile locomotive refuelling station
    - Engineer’s workshop, administration facility and associated car parking
- Operation of the IMT facility includes operation of the rail link to the SSFL and container freight movements by truck to and from the Moorebank Precinct East (MPE) site
- Construction and 24/7 operation of a warehousing estate on the northern part of the site servicing the IMT facility and including:
    - Six warehouses with a total gross floor area (GFA) of 215,000 m^2 and, for each warehouse, associated offices, staff amenities, hardstands and truck and light vehicle parking
    - 800 m2 freight village (operating from 7am to 6pm, 7 days/ week) including staff/ visitor amenities
    - Internal roads, noise wall, landscaping, lighting and signage.
    - Intersection upgrades on Moorebank Avenue at:
        - Anzac Road providing site access
        - Bapaume Road for left turn only out of the site.
- Construction and operation of on-site detention basins, bioretention/ biofiltration systems and trunk stormwater drainage for the entire site
- Construction works and temporary ancillary facilities, including:
    - Vegetation clearing, topsoil stripping and stockpiling and site earthworks and temporary on-site detention
    - Importation of up to 1,600,000 m^3 of uncompacted fill, temporary stockpiling and placement over the entire site to raise existing ground levels by up to 3 m
    - Materials screening, crushing and washing facilities
    - Importation and placement of engineering fill and rail line ballast
    - Installation and use of a concrete batching plant
    - Utilities installation/ connection.

The proposed development overview has been defined in the *CEMP Figure 1-2* and is included for reference in this CSWMP as **Figure 2.2**.

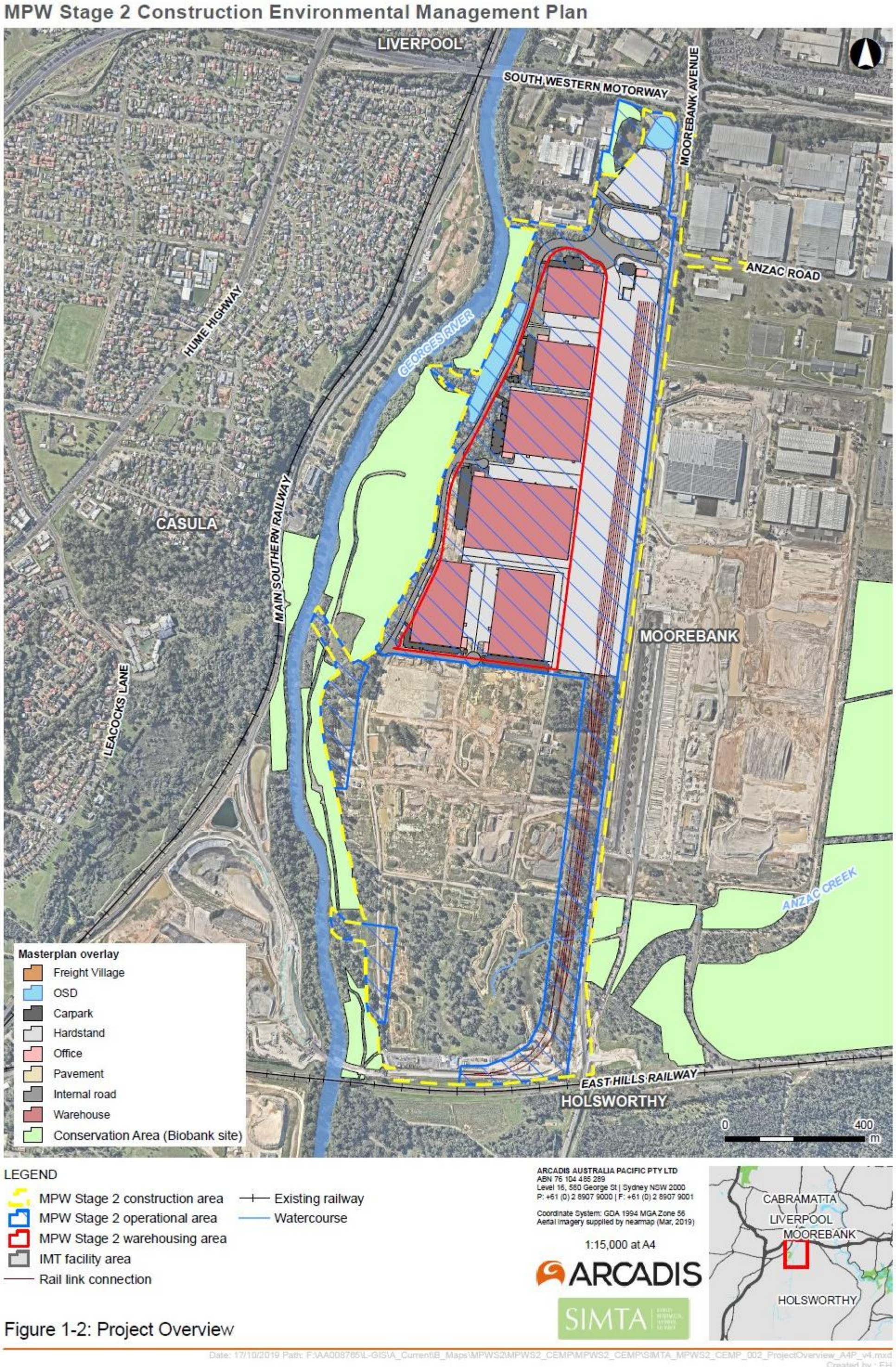


Figure 2.2. MPW Stage 2 Project Overview (Source: *CEMP Figure 1-2, Arcadis*)

3 WATER CYCLE MANAGEMENT & WATER SENSITIVE URBAN DESIGN (WSUD)

3.1 Water Cycle Management & WSUD Key Areas and Objectives

Water Cycle Management (WCM) is a holistic approach that addresses competing demands placed on a region's water resources, whilst optimising the social and economic benefits of development in addition to enhancing and protecting the environmental values of receiving waters.

Developing a WCMS at the SSD stage of the land development process provides guidance on urban water management issues to be addressed for the estate and development as a whole. This assists urban rezoning and estate infrastructure planning for the industrial development proposed on the land.

This WCMS has been prepared to inform the DPIE and stakeholders that the development is able to provide and integrate WCM measures into the stormwater management strategy for the MPW Stage 2. It presents guiding principles for WCM which includes establishing water management targets and identifying management measures required for future building developments to meet these targets.

Several WCM measures have been included in the WCMS and engineering design, which are set out in this report and the attached drawings. The key WCM elements and targets which have been adopted in the design are included in **Table 3.1** following.

As required of *CoC 5 & B9*, WSUD principles are to be incorporated within the design.

A number of WCM & 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*
- *Water Demand Reduction/ Rainwater Reuse*

Element	Target	Reference
Water Quantity	Maintaining or improving the volume of stormwater flows to from this site. "*it will be necessary to demonstrate that there will be no increase in runoff from the site as a result of the development for the 1 in 1-year ARI and the 1 in 100-year ARI storm events*".	CoC Liverpool Council - *Stormwater Management Policy*
Stream Erosion Index	A stream erosion index between 3.5-5.0 has been targeted to manage frequent flows resulting from the development.	Best Practice
Water Quality	Load-based pollution reduction targets based on an untreated urbanised catchment: Gross Pollutants 90% Total Suspended Solids 85% Total Phosphorus 60% Total Nitrogen 45% Total Hydrocarbons 90%	Council DCP DPIE
Flooding	Buildings and roads set 500mm above 1% AEP. No affectation to upstream downstream or adjoining properties as a result of development Local overland flow paths to achieve 150mm freeboard to building floor levels	Council DCP. NSW Floodplain Development Manual. Council DCP CoC
Water Supply	Reduce Demand on non-potable water uses by 50%.	Council DCP DPIE
Erosion and Sediment Control	Appropriate erosion and sedimentation control measures must be described in the environmental assessment for all stages of construction to mitigate potential impacts to receiving waters. Refer separate **Construction Soil and Water Management Plan** (CSWMP) by Costin Roe Consulting, Ref: **Co13455.03.rpt**.	Landcom Blue Book DPIE

Table 3.1. WCM/ WSUD Targets

A summary of how each of the WCM objectives will be achieved are described below. Reference to the relevant sections of the report should be made for further and technical details relating to the WCM measures:

A brief summary of the management objectives is described below:

- *Stormwater Quantity Management (Refer **Section 4**)*

  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 open detention basins provided in strategic locations for each of the development catchments. These detention basins 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 CoC's 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 detailed sizing of detention systems.

- *Stream Erosion Index Assessment (Refer **Section 4**)*

  The intent of this criterion is to reduce the impact of urban development on existing drainage system by limiting the duration of post-development discharge to a range of 3.5-5. This assists with the impact of frequent flows to receiving waters.

- *Stormwater Quality Management*

  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.

  Water quality, and pollution reduction objective shown in **Table 3.1**, are achieved through a treatment train of proprietary gross pollutant traps and natural bio-retention systems. 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:

  - 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 included which achieve at least 150mm freeboard to building levels from the flow paths.

- *Water Demand Reduction/ Rainwater Reuse*

  Rainwater reuse measures will be provided as part of future building development designs as set out in this SDDR. The requirement is to reduce demand on water for non-potable uses such as toilet flushing and irrigation. The intent is to reduce demand on non-potable uses by 50%.

3.2 Site Drainage

3.2.1 Pre-Existing and Current Site Drainage

Until recently, the MPW Stage site was operating as part of the School of Military Engineering. The Department of Defence have now vacated the 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.

As noted previously four main catchments drain to the west, being G04 (28.94 Ha), G05 (36.96 Ha), G06 (44.13 Ha) and G08 (11.17 Ha), and one to the east, G03 (24.82 Ha). Catchments are as depicted in the SWMP within the EIS (*Figure 5-1*) by Arcadis and reproduced as **Figure 3.1** below. Refer also to drawing **PIWW-COS-CV-DWG-0420**.

It is also noted that, a catchment of approximately 75 Ha from MPE (IMEX – 62.7 Ha, MPE Basin 9 and part of Warehouse 5 – 12.3 Ha) drains through the site via an existing drainage channel. The existing channel is in a state of poor maintenance and will be upgraded as what has been coined as the "*East-West Culvert*". Construction of the *East-West Culvert* will comprise reinforced concrete box culverts (RCBC) with base slab extending from the existing Moorebank Avenue crossing to The Georges River. It is proposed that the alignment of the new culvert will be offset, however aligned parallel to the existing culvert (other than the start and end of the culvert) to ensure the existing channel can remain operational during the construction of the new culvert. This will assist in ensuring that potential for scour erosion is minimised and associated environmental impact associated with the construction is also minimised.

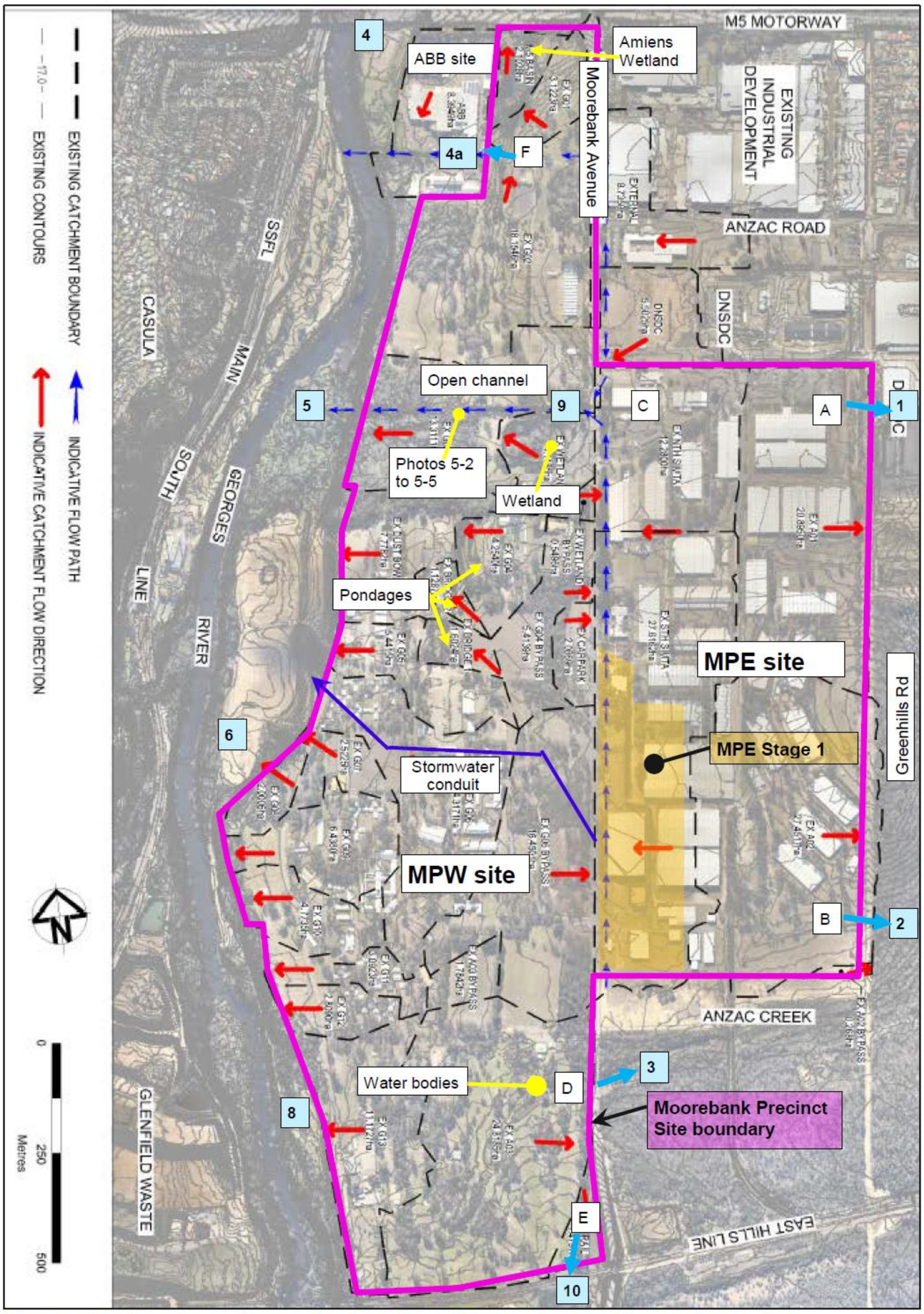


Figure 5-1: Existing Site Conditions (refer also to ***Appendix B*** *Existing Conditions catchment plan)*

Figure 3.1. Existing Catchments (Source: SSD16-7099 SWMP Fig 5-1 Arcadis 2018)

3.2.2 Proposed Infrastructure Drainage

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 350mm of freeboard to building levels, as shown on drawing **PIWW-COS-CV-DWG-0461 & 0465**. 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 ***CoC B5*** and ***B9***. This includes ensuring a minimum 150mm freeboard is maintained for events greater than 1% AEP, or in the event of blockage.

The overall stormwater management objectives, including catchment breakdown, water quality objectives and water quantity discharge rates, remain consistent with the Arcadis MPW Flooding and Stormwater Assessment, presented in the EIS for MPW Stage 2, and all of the CoC's. It is noted, however, that the proposed water quantity and quality management measures proposed for construction vary slightly from the approved extent and storage requirements as a result of detail design calculations and hydrological and hydraulic assessments, in consideration to the consent requirements and WCM outcomes.

A summary of the main stormwater measures for the MPW Stage 2 development, with reference to catchment plans **PIWW-COS-CV-DWG-0420** & **421**, and layout plans **PIWW-COS-CV-DWG-0401 to 0411**, is as follows:

Outlet 3

- Pre-development catchment of 24.82 Ha.
- Post developed catchment of 9.28 Ha proposed to be conveyed to *Outlet 3*. The proposed catchment is a reduction between pre and post development of 63%.
- Water quantity will be managed by a relatively small above ground basin. Due to the substantially reduced post development catchment, the increase in runoff from urbanisation remains at or below the 1 in 1-year ARI storm and the 1 in 100-year storm as required of the CoC at *Outlet 3*. The management basin as such will provide only a water quality and SEI function during operation.
- The open basin has been designed with the provision of 1V:4H batter slopes.
- Primary water quality will be managed by a Vortech style gross pollutant trap (Rocla CDS or approved equivalent) which treats hydrocarbons/ oil and grease, gross pollutants, sediments, some nutrients and litter.
- Tertiary water quality will be managed via a 1,000m^2 minimum bio-retention system. This system will further target hydrocarbons, fine sediments and nutrients. The minimum bio-retention media area is based on 1% of the contributing 9.28 Ha post development catchment and has a cell of less than 1000m^2 as required of the CoC.
- The basin discharges to the east to Anzac Creek via existing concrete box culverts underneath Moorebank Avenue.

Outlet 4

- Pre-development catchment of 28.94 Ha.
- Post developed catchment of 3.59 Ha is proposed to be conveyed to *Outlet 4*. The proposed catchment is a reduction between pre and post development of 89%.
- Water quantity will be managed by a relatively small above ground basin. Due to the substantially reduced post development catchment, the increase in runoff from urbanisation remains at or below the 1 in 1-year ARI storm and the 1 in 100-year storm as required of the CoC at *Outlet 4*. The management basin as such will provide only a water quality and SEI function during operation.
- Primary water quality will be managed by a Vortech style gross pollutant trap (Rocla CDS or approved equivalent) which treats hydrocarbons/ oil and grease, gross pollutants, sediments, some nutrients and litter.
- Tertiary water quality will be managed via a 400m^2 minimum bio-retention system (within future detention Basin 1 footprint) which will further target hydrocarbons, fine sediments and nutrients. The minimum bio-retention media area is based on 1% of the contributing 3.59 Ha catchment.
- Basin 4 discharges through pits and pipes within an existing easement sited to the north of the MPW site. No discharge works are proposed for this existing infrastructure.

Outlet 5

- Pre-development catchment of 36.96 Ha.
- Post developed catchment of 39.50 Ha proposed to be conveyed to *Outlet 5*.
- Water quantity will be managed by an above ground basin. The basin attenuates peak stormwater runoff from the post-developed catchment to pre-developed catchment for the 1 in 1-year ARI event and the 1 in 100-year ARI event with a maximum active storage in the 1 in 100-year ARI event of 23,200m^3.
- The open basin has been designed with the provision of 1V:4H batter slopes.
- Primary water quality will be managed by a Vortech style gross pollutant trap (Rocla CDS or approved equivalent) which treats hydrocarbons/ oil and grease, gross pollutants, sediments, some nutrients and litter.
- Tertiary water quality will be managed via a 4000m^2 minimum bio-retention system. This system will further target hydrocarbons, fine sediments and nutrients. The minimum bio-retention media area is based on 1% of the contributing 39.50 Ha post development catchment and has been separated into five cells of less than 1000m^2 as required of the CoC.
- It is also noted that discharge of the East-West Culvert will be made at Outlet 5. Stormwater flows from MPE management systems OSD9 and OSD10 bypass the proposed OSD5, and discharge directly to The Georges River. The contributing catchments of approximately 75 Ha from MPE (IMEX – 62.7 Ha, MPE Basin 9 and part of Warehouse 5 – 12.3 Ha) and peak flow of 7.6m^3/s will be conveyed within the *East-West Culvert*.
- The basin outlet, and discharge from the East-West Culvert, to The Georges River has been designed in accordance with NSW Office of Water Guidelines for Riparian Corridors comprising naturalised systems integrated into the existing riverbanks as required of the CoC.

Outlet 6

- Pre-development catchment of 44.13 Ha.
- Post developed catchment of 58.90 Ha proposed to be conveyed to *Outlet 6*.
- Water quantity will be managed by an above ground basin. The basin attenuates peak stormwater runoff from the post-developed catchment to pre-developed catchment for the 1 in 1-year ARI event and the 1 in 100-year ARI event with a maximum active storage in the 1 in 100-year ARI event of 39,790m^3.
- The open basin has been designed with the provision of 1V:4H batter slopes.
- Primary water quality will be managed by a Vortech style gross pollutant trap (Rocla CDS or approved equivalent) which treats hydrocarbons/ oil and grease, gross pollutants, sediments, some nutrients and litter.
- Tertiary water quality will be managed via a 5,900m^2 minimum bio-retention system. This system will further target hydrocarbons, fine sediments and nutrients. The minimum bio-retention media area is based on 1% of the contributing 58.9 Ha post development catchment and has been separated into six cells of less than 1000m^2 as required of the CoC.
- The basin outlet to The Georges River has been designed in accordance with NSW Office of Water Guidelines for Riparian Corridors comprising naturalised systems integrated into the existing riverbanks as required of the CoC.

Outlet 8

- Pre-development catchment of 11.17 Ha.
- Post developed catchment of 26.5 Ha proposed to be conveyed to *Outlet 8*.
- Water quantity will be managed by an above ground basin. The basin attenuates peak stormwater runoff from the post-developed catchment to pre-developed catchment for the 1 in 1-year ARI event and the 1 in 100-year ARI event with a maximum active storage in the 1 in 100-year ARI event of 20,300m^3.
- The open basin has been designed with the provision of 1V:4H batter slopes.
- Primary water quality will be managed by a Vortech style gross pollutant trap (Rocla CDS or approved equivalent) which treats hydrocarbons/ oil and grease, gross pollutants, sediments, some nutrients and litter.
- Tertiary water quality will be managed via a 2,700m^2 minimum bio-retention system. This system will further target hydrocarbons, fine sediments and nutrients. The minimum bio-retention media area is based on 1% of the contributing 26.5 Ha post development catchment and has been separated into three cells of less than 1000m^2 as required of the CoC.
- The basin outlet to The Georges River has been designed in accordance with NSW Office of Water Guidelines for Riparian Corridors comprising naturalised systems integrated into the existing riverbanks as required of the CoC.

3.3 Hydrologic Modelling and Analysis

3.3.1 General Design Principles

The design of the stormwater system for the MPW Stage 2 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 3.2. 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 350mm has been achieved to building levels during the Major Storm Event as shown on drawing **PIWW-COS-CV-DWG-0461 & 0465** in **Appendix A**.

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 systems as shown on drawings **PIWW-COS-CV-DWG-0461 & 0465.**

3.5 External Catchments and Flooding

MPW Stage 2 development footprint 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 site however is located adjacent to the Georges River hence flood considerations should be made for the development. A flood assessment was completed by Arcadis and formed Appendix R of the EIS (*Moorebank Precinct Intermodal Terminal Facility – MPW Stage 2 Stormwater and Flooding Environmental Assessment*).

Reference to **Figure 3.2** and **Table 3.3** below should be made for flood modelling information and levels.

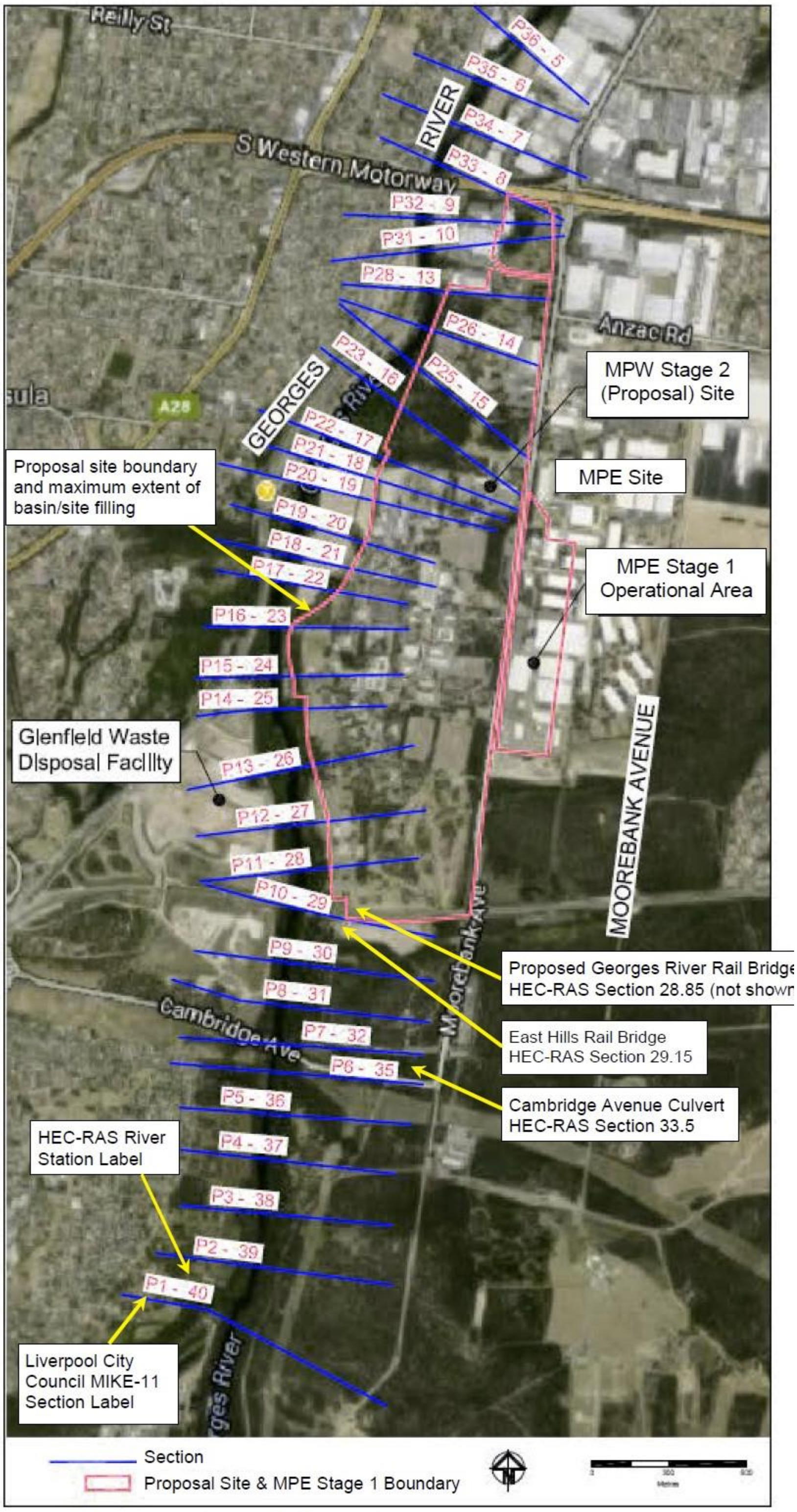


Figure 4-2: Location of HEC-RAS Model Sections

Figure 3.2. Location of HEC-RAS Flood Model Sections (Source: Arcadis Figure 4-2)

Table 3.3. MPW S2 Flood Levels (Source: Arcadis Table 4-1)

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

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

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

The 1% Average Exceedance Probability (AEP) flood line, as defined in the above EIS assessment, has also been shown on drainage layout drawings in **Appendix A**. This shows that all SDDR measures, including stormwater treatment basins 5, 6 & 8, are located clear and above the flood affected areas other than items associated with drainage outlets.

It is further noted that generally site levels are all higher than the PMF event, hence the site can be considered flood free in relation to the regional flood conditions.

Local flooding relates to site runoff and contributing catchments relating to the MPW Stage 2 development areas and conveyance of runoff in the east-west culvert only. Local drainage runoff and overland flow is addressed in the SDDR.

3.6 Site Discharge Configuration

The design of the proposed outlet structures has been assessed in accordance with the NSW Office of Water document *Controlled Activities: Guidelines for Outlet Structures.* The discharge arrangements are proposed to utilise existing discharge points with modifications as required to achieve natural outlet structures as noted and required by **CoC B20** to **B22, and B45**.

The established points to Georges River and Anzac Creek will be maintained for the new discharge locations. The established and proposed discharge points are shown on drawings **PIWW-COS-CV-DWG-0481-0483.**

The stormwater outlet consists of new and existing drainage structures. The new outlets will comprise a ‘natural’ energy dissipater. The outlet is aligned with the creek or riverbanks to minimise the potential for bank scour and shall include rip rap energy dissipaters designed and constructed in accordance with the *Outlet Structures Guidelines* as published by the *Department of Water & Energy* and *The Landcom Blue Book* and per consultation with Cumberland Ecology (refer **Appendix J**).

The arrangement is shown figuratively below in **Figure 3.1**. Further construction details regarding the configuration of dimensions, rock size and scour protection can be seen on drawing **PIWW-COS-CV-DWG-0455**. Rock Sizing is based on Figure 1 in the Catchment & Creeks document *Rock Sizing for Multi-Pipe & Culvert Outlets*, shown below.

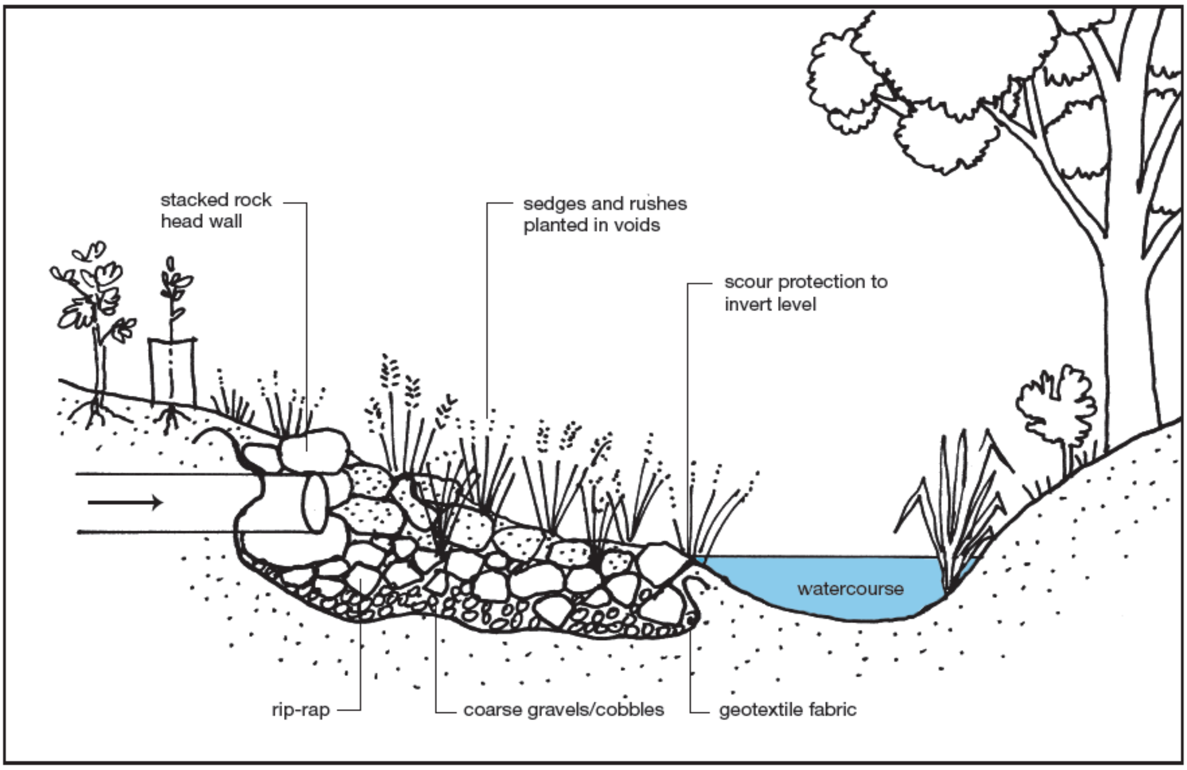


Figure 3.1. Outlet Structure – Typical Arrangement

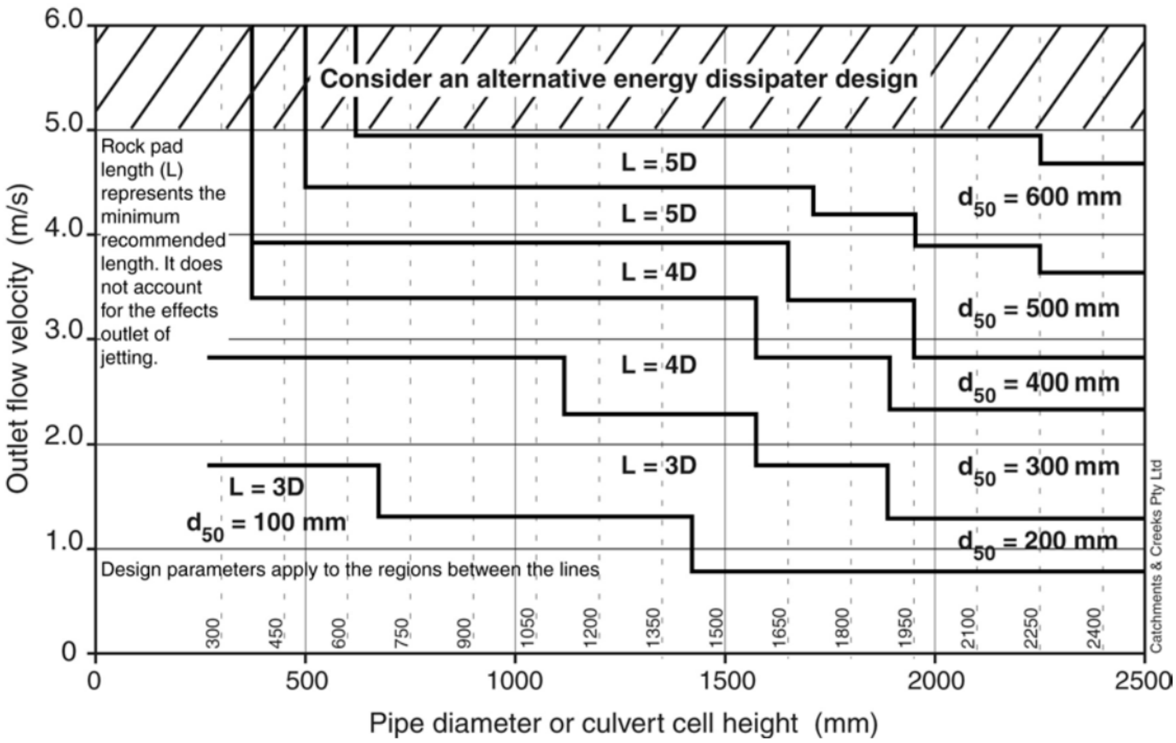


Figure 3.2. Outlet Structure – Energy Dissipater Size Chart

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 B12(a)** & **B12(b)** requires post-development runoff to meet pre-development runoff for the 1 in 1-year ARI storm and the 1 in 100-year ARI storm events, as discussed in **Section 1.3** of this SDDR.

Attenuation of stormwater runoff from the MPW Stage 2 development area is proposed to be managed via a series of water quantity management systems throughout the precinct. These will be formed as one of five open basins provided in strategic locations for each of the development catchments. As per the CoC the objective is to attenuate stormwater flow from the development to pre-developed flows the 1 in 1-year ARI storm and the 1 in 100-year ARI storm events, 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. The modelling accounts for the drainage system provided for the adjacent sites.

An assessment of the required drainage attenuation storage requirement has been completed for the MPW Stage 2 project and documented in this SDDR. The following sections of the SDDR confirm the hydrological and hydraulic performance of the detention systems. Details and locations of each of the systems are shown on drawings **PIWW-COS-CV-DWG-0431-0435,** and **0451** through **0455**.

The methodology employed to determine the attenuation requirements are based on assessing storms for the 1 in 1-year ARI and the 1 in 100-year ARI for the pre and post development phases per the CoC. Additional key storms have also been assessed including the 1 in 20-year ARI.

4.2 Existing & Post Development Peak Flows

Intensity/Frequency/Duration (IFD) data was adopted from the Bureau of Meteorology and LCC's 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 Systems draining to Outlet 3, 4, 5, 6 & 8 are provided in **Tables 4.1 to 4.5** below.

ARI	Design Storm Duration	Peak Flow (m3/s)		
		Pre-Developed	Post-Development (No Attenuation)	Post-Development (Attenuation)
1	20 mins	0.78	1.52	0.74
	30 mins	1.04	1.48	0.74
	1 hr	1.45	1.36	0.75
	2 hr	1.54	1.31	0.74
	3 hr	1.39	0.97	0.71
	6 hr	1.28	0.62	0.62
	9 hr	1.16	0.55	0.55
	12 hr	1.14	0.56	0.56
	18 hr	0.88	0.37	0.37
	24 hr	0.88	0.35	0.35
20	15 mins	1.78	2.94	0.82
	20 mins	2.24	3.19	0.84
	30 mins	2.94	3.12	1.00
	1 hr	3.7	2.84	1.43
	2 hr	3.79	2.82	1.37
	3 hr	3.23	2.13	0.86
	6 hr	2.97	1.38	0.81
	9 hr	2.64	1.22	0.79
	12 hr	2.73	1.22	0.77
	18 hr	2.15	0.84	0.73
	24 hr	2.12	0.81	0.73
100	15 mins	2.56	3.78	1.23
	20 mins	3.21	3.99	1.82
	30 mins	4.11	3.76	2.02
	1 hr	5.03	3.51	2.54
	2 hr	5.01	3.44	2.56
	3 hr	4.18	2.57	1.68
	6 hr	3.73	1.68	1.08
	9 hr	3.29	1.49	0.85
	12 hr	3.44	1.50	0.83
	18 hr	2.68	1.03	0.79
	24 hr	2.63	1.00	0.78

Table 4.1. Outlet 3 Pre/Post-Development Flows

ARI	Design Storm Duration	Peak Flow (m3/s)	
		Pre-Developed	Post-Development (No Attenuation)
1	15 mins	0.67	0.55
	20 mins	0.86	0.61
	30 mins	1.15	0.59
	1 hr	1.63	0.53
	2 hr	1.75	0.53
	3 hr	1.59	0.38
	6 hr	1.48	0.24
	9 hr	1.34	0.22
	12 hr	1.30	0.22
	18 hr	1.01	0.14
	24 hr	1.02	0.14
20	15 mins	1.98	1.19
	20 mins	2.48	1.28
	30 mins	3.27	1.25
	1 hr	4.19	1.11
	2 hr	4.28	1.14
	3 hr	3.71	0.83
	6 hr	3.42	0.54
	9 hr	3.06	0.47
	12 hr	3.13	0.47
	18 hr	2.48	0.33
	24 hr	2.45	0.31
100	15 mins	2.84	1.52
	20 mins	3.56	1.60
	30 mins	4.59	1.50
	1 hr	5.70	1.37
	2 hr	5.66	1.39
	3 hr	4.74	1.00
	6 hr	4.29	0.65
	9 hr	3.81	0.58
	12 hr	3.96	0.58
	18 hr	3.10	0.40
	24 hr	3.05	0.39

Table 4.2. Outlet 4 Pre/Post-Development Flows

ARI	Design Storm Duration	Peak Flow (m3/s)		
		Pre-Developed	Post-Development (No Attenuation)	Post-Development (Attenuation)
1	30 mins	1.36	4.68	1.10
	1 hr	1.96	4.88	1.13
	2 hr	2.12	4.94	1.13
	3 hr	1.95	3.75	1.12
	6 hr	1.86	2.58	1.10
	9 hr	1.69	2.31	1.08
	12 hr	1.61	2.33	1.06
	18 hr	1.26	1.52	1.04
	24 hr	1.28	1.46	1.04
20	15 mins	2.33	9.09	1.18
	20 mins	2.92	10.39	1.21
	30 mins	3.88	10.43	1.24
	1 hr	5.06	10.48	1.30
	2 hr	5.25	10.67	1.42
	3 hr	4.64	8.41	1.59
	6 hr	4.27	5.84	1.43
	9 hr	3.86	5.16	1.34
	12 hr	3.91	5.17	1.30
	18 hr	3.11	3.55	1.29
	24 hr	3.1	3.42	1.29
100	15 mins	3.35	11.81	1.23
	20 mins	4.19	13.15	1.26
	30 mins	5.46	12.59	1.30
	1 hr	6.95	13.10	2.25
	2 hr	6.89	13.16	2.87
	3 hr	5.9	10.22	2.82
	6 hr	5.37	7.13	2.67
	9 hr	4.81	6.29	3.28
	12 hr	4.95	6.34	2.71
	18 hr	3.89	4.37	2.21
	24 hr	3.85	4.22	2.33

Table 4.3. Outlet 5 Pre/Post-Development Flows

ARI	Design Storm Duration	Peak Flow (m3/s)		
		Pre-Developed	Post-Development (No Attenuation)	Post-Development (Attenuation)
1	20 mins	1.14	6.96	1.12
	30 mins	1.53	7.37	1.13
	1 hr	2.24	7.72	1.16
	2 hr	2.43	7.24	1.17
	3 hr	2.26	5.70	1.17
	6 hr	2.19	3.93	1.15
	9 hr	1.98	3.49	1.13
	12 hr	1.88	3.52	1.11
	18 hr	1.47	2.32	1.09
	24 hr	1.51	2.23	1.11
20	15 mins	2.63	12.91	1.20
	20 mins	3.29	15.14	1.23
	30 mins	4.38	15.73	1.27
	1 hr	5.79	16.09	1.33
	2 hr	6.11	15.53	1.62
	3 hr	5.46	12.46	2.09
	6 hr	5.03	8.77	2.11
	9 hr	4.57	7.75	2.49
	12 hr	4.59	7.76	2.22
	18 hr	3.65	5.35	2.35
	24 hr	3.67	5.15	1.60
100	15 mins	3.77	16.80	1.25
	20 mins	4.72	19.68	1.28
	30 mins	6.17	19.45	1.33
	1 hr	7.99	20.04	2.58
	2 hr	8.01	19.14	3.82
	3 hr	6.94	15.14	4.02
	6 hr	6.33	10.69	3.91
	9 hr	5.69	9.44	5.67
	12 hr	5.82	9.51	4.50
	18 hr	4.59	6.56	3.73
	24 hr	4.57	6.34	3.85

Table 4.4. Outlet 6 Pre/Post-Development Flows

ARI	Design Storm Duration	Peak Flow (m3/s)		
		Pre-Developed	Post-Development (No Attenuation)	Post-Development (Attenuation)
1	**30 mins**	0.60	3.20	0.48
	1 hr	0.79	3.43	0.50
	2 hr	0.78	3.38	0.50
	3 hr	0.67	2.54	0.50
	6 hr	0.62	1.75	0.49
	9 hr	0.54	1.57	0.48
	12 hr	0.56	1.58	0.48
20	**15 mins**	1.04	6.18	0.58
	20 mins	1.31	7.11	0.69
	30 mins	1.63	7.21	0.82
	1 hr	1.96	7.40	0.91
	2 hr	2.04	7.34	0.96
	3 hr	1.69	5.77	0.98
	6 hr	1.44	3.98	0.98
	9 hr	1.25	3.51	1.01
	12 hr	1.31	3.52	0.96
	18 hr	1.00	2.42	0.95
	24 hr	0.97	2.33	0.95
100	**15 mins**	1.50	8.06	0.79
	20 mins	1.87	9.03	0.85
	30 mins	2.25	8.71	0.92
	1 hr	2.63	9.23	1.02
	2 hr	2.67	9.05	1.08
	3 hr	2.18	7.01	1.10
	6 hr	1.80	4.86	1.11
	9 hr	1.56	4.29	1.15
	12 hr	1.64	4.32	1.13
	18 hr	1.24	2.97	1.11
	24 hr	1.20	2.87	1.08

Table 4.5. Outlet 8 Pre/Post-Development Flows

Post development site discharge volumes, as well as the provided detention volumes and depths for the different open basin detention systems are provided in **Tables 4.6** to **4.8** below.

ARI	Duration (mins)	Peak Flow (m^3/s)					Depth (mm)	Storage (m^3)
		No Attenuation	With Attenuation					
			Orifice	Weir	Emergency	Total		
1	2 Hr	4.940	1.130	0	0	1.130	0.90	5,500
20	3 Hr	8.405	1.334	0.253	0	1.587	2.01	18,500
100	9 Hr	6.290	1.374	1.90	0	3.274	2.33	22,900

Table 4.6. Detention System 5 Flow and Storage Volumes

ARI	Duration (mins)	Peak Flow (m^3/s)					Depth (mm)	Storage (m^3)
		No Attenuation	With Attenuation					
			Orifice	Weir	Emergency	Total		
1	2 Hr	7.240	1.172	0	0	1.172	1.0	10,600
20	9 Hr	7.745	1.382	1.11	0	2.492	2.23	32,900
100	9 Hr	9.437	1.414	4.25	0	5.664	2.56	39,800

Table 4.7. Detention System 6 Flow and Storage Volumes

ARI	Duration (mins)	Peak Flow (m^3/s)						Depth (mm)	Storage (m^3)
		No Attenuation	With Attenuation						
			Q2 Orifice	Q20 Orifice	Weir	Emergency	Total		
1	2 Hr	3.376	0.499	0.004	0	0	0.503	0.91	4,900
20	9 Hr	3.513	0.576	0.437	0	0	1.013	1.88	14,400
100	9 Hr	4.287	0.613	0.533	0	0	1.146	2.39	20,400

Table 4.8. Detention System 8 Flow and Storage Volumes

As shown in **Tables 4.6** and **4.8** above, a total active detention storage of 83,100m^3 has been provided in the various basins to attenuate the post development flows to pre-development flows for the 1 in 1-year ARI and 1 in 100-year ARI. The provided storage and attenuation of pre and post flows meets the requirements of **CoC B12**.

As discussed in previous sections, it is noted that not all outlets require detention storage to meet the requirement of CoC B12. This is due to the change in pre and post development catchments where the reduction in post development catchment offsets the additional runoff flows resulting from increased impervious surface areas.

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 **CoC B14** to **CoC B19**.

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 B14**:

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 including gross pollutant traps to surface drainage systems and 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 approved MPW Stage 2 stormwater management strategy.

5.2 Proposed Stormwater Treatment System

Future 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 have been sized according to the whole catchment area of the MPW Stage 2 development. The STM's for the MPW Stage 2 development shall be based on a treatment train approach to ensure that all of the objectives above are met. It is noted that the final MPW Stage 2 development layout has not been completed, however the MUSIC modelling completed is based on conservative land use allowances and minimum bio-retention areas. Further, items such as rainwater tanks, which will further improve the modelled water quality outcomes, have not been included in the modelling. A concept for the treatment of future warehouse buildings has been presented which would need to be adopted by each warehouse building to meet the load-based objectives noted above.

Components of the treatment train for the MPW Stage 2 development comprise the following elements:

- Primary treatment to roofs, 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 (or approved equivalent) 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 either dual-purpose open detention and bio-retention basins or bio-retention systems. As discussed previously the bio-retention systems have been designed with measures to enable these to remain effective whilst being located within the detention system. Measures include limiting depths of water to 1.5m 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 systems have been sized through MUSIC, and achieve the prescribed minimum area of 1% of the contributing catchment area being treated in the system;
- A portion of the roof 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.
- 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 estimate the bio-retention filtration area and GPT sizing required to meet the requirements of load-based pollution reduction objectives, a MUSIC model has been prepared based on the current approved masterplan layout for MPW Stage 2.

5.3 Stormwater Quality Modelling

5.3.1 Introduction

The MUSIC model was required under **CoC B14** to **B18** to model water quality and confirm water quality reduction objectives are achieved. The MUSIC modelling tool has been released by the Cooperative Research Centre for Catchment Hydrology (CRCCH) and is a standard industry model for the purpose of modelling treatment train of water quality measures. MUSIC (the *Model for Urban Stormwater Improvement Conceptualisation*) is suitable for simulating catchment areas of up to 100 km^2 and utilises a continuous statistical simulation approach to model water quality and effectiveness of stormwater quality systems.

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.

The MUSIC models "*13455.07-Rev1-Basin 3.sqz*, *13455.07-Rev1-Basin 4.sqz*, *13455.07-Rev1-Basin 5.sqz, 13455.07-Rev1-Basin 6.sqz & 13455.07-Rev1-Basin 8.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 the MPW Stage 2 development. Refer drawing **PIWW-COS-CV-DWG-0426 to 0429** which shows catchment breakdowns and key stormwater management measures.

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 BCC 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

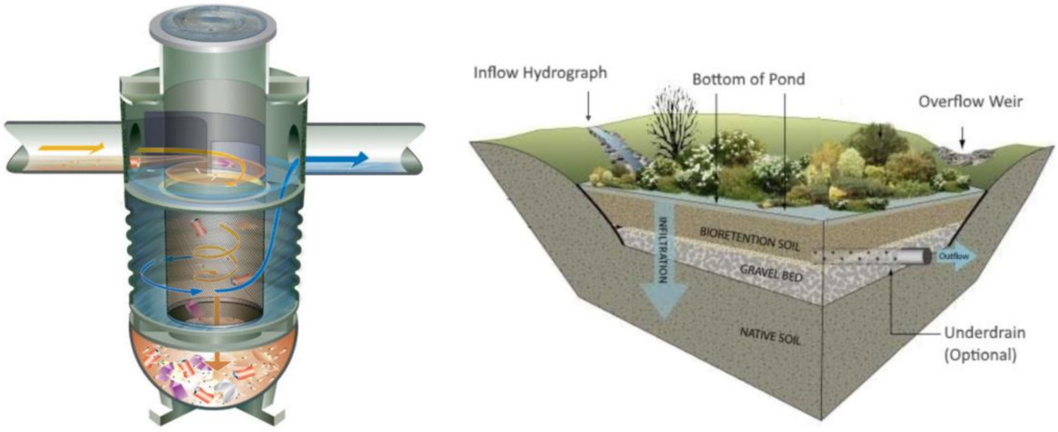
Table 5.1. Pollutant Concentrations

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

Rocla CDS, Bio-Retention Basin nodes have been used in the modelling of the development. Typical visual representation of the treatment measures is shown in **Figure 5.1** below and MUSIC nodes in **Figure 5.2**.



Rocla CDS GPT *Bio-retention System*

Figure 5.1. Visual Representation of Treatment Measures

5.4 Modelling Layout

A typical model layout is included in **Figure 5.2** below.

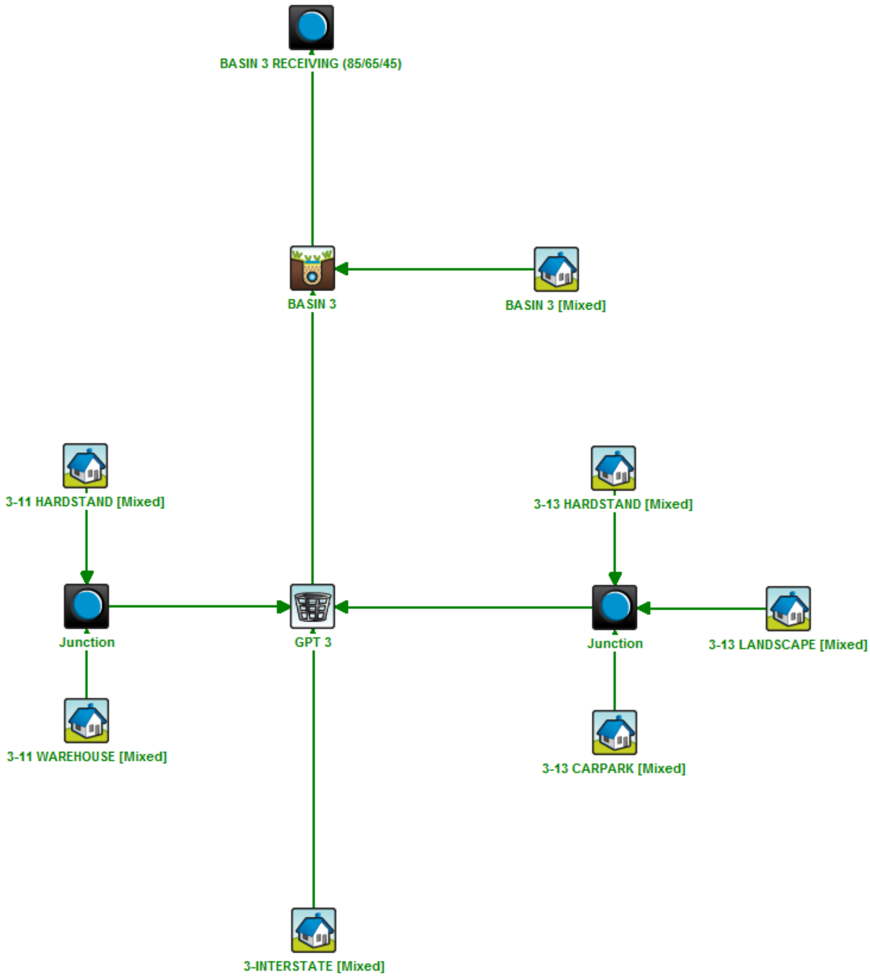


Figure 5.2. MUSIC Model Layout

5.5 Modelling Results

5.5.1 Results

Table 5.3 shows the results of the MUSIC analysis for the development.

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
Basin 3				
Flow (ML/yr)	68	65.6	3.6	NA
Total Suspended Solids (kg/yr)	20000	16.90	94.5	Y
Total Phosphorus (kg/yr)	35	8.27	76.4	Y
Total Nitrogen (kg/yr)	161	79.20	50.9	Y
Gross Pollutants (kg/yr)	1760	0	100	Y
Basin 4				
Flow (ML/yr)	17.8	16.9	5.3	NA
Total Suspended Solids (kg/yr)	5280	260	95.1	Y
Total Phosphorus (kg/yr)	9.26	1.68	81.8	Y
Total Nitrogen (kg/yr)	40.7	17.1	58	Y
Gross Pollutants (kg/yr)	377	0	100	Y
Basin 5				
Flow (ML/yr)	251	242	3.7	NA
Total Suspended Solids (kg/yr)	57600	6960	87.9	Y
Total Phosphorus (kg/yr)	107	29	72.8	Y
Total Nitrogen (kg/yr)	577	277	51.9	Y
Gross Pollutants (kg/yr)	6330	0	100	Y
Basin 6				
Flow (ML/yr)	387	374	3.5	NA
Total Suspended Solids (kg/yr)	61700	7570	87.7	Y
Total Phosphorus (kg/yr)	128	38.5	70	Y
Total Nitrogen (kg/yr)	877	408	53.5	Y
Gross Pollutants (kg/yr)	9850	0	100	Y
Basin 8				
Flow (ML/yr)	182	175	3.4	NA
Total Suspended Solids (kg/yr)	31700	3890	87.7	Y
Total Phosphorus (kg/yr)	63.2	19	69.9	Y
Total Nitrogen (kg/yr)	413	202	51	Y
Gross Pollutants (kg/yr)	4710	0	100	Y

Table 5.3. MUSIC analysis results

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 **Table 5.3** 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.

As can be seen, the proposed treatment train achieves reductions greater than the required pollutant reduction objectives. This will 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 MPW Stage 2 Development 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 the MPW Stage 2 Development 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 Bio-retention Treatment

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. An extended detention depth of 300mm typically results in treated volume of water and hydrocarbons of approximately 67%.

5.6.3 Rocla CDS Treatment

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 the MPW Stage 2 project.

5.7 Stormwater Harvesting

Stormwater harvesting refers to the collection of stormwater from the developments internal stormwater drainage system for re-use in non-potable applications. Stormwater from the stormwater drainage system can be classified as either rainwater where the flow is from roof areas, or stormwater where the flow is from all areas of the development.

For the purposes of this development, we refer to a rainwater harvesting system, where benefits of collected stormwater from roof areas over a stormwater harvesting system can be made as rainwater is generally less polluted than stormwater drainage.

Rainwater harvesting is proposed for the MPW Stage 2 development with re-use for non-potable applications. Internal uses include such applications as toilet flushing while external applications will be used for irrigation. The aim is to reduce the potable water demand for the development by a minimum of 50% per the indicative outcomes for large storage projects **Table 2.1** of the Stormwater Trust Department of Environment & Conservation NSW document "*Managing Urban Stormwater – Harvesting and Reuse*".

In general terms the rainwater harvesting system will be an in-line tank for the collection and storage of rainwater. At times when the rainwater storage tank is full rainwater can pass through the tank and continue to be discharged via gravity into the stormwater drainage system. Rainwater from the storage tank will be pumped for distribution throughout the development in a dedicated non-potable water reticulation system.

Rainwater tanks have been designed, using MUSIC software to balance the supply and demand, based on the below base water demands to provide 50% reduction in non-potable water demand.

5.7.1 Internal Base Water Demand

Indoor water demand has been based an allowance of 0.1kL/day/ toilet or urinal. No allowance is required for disable toilets. It is noted that for this assessment, the masterplan office configurations of MPW Stage 2, being warehouses number 1A, 1B, 2A, 2B, 3A & 3B, are being considered for rainwater reuse demand. It should be noted that these tanks will need to be appropriately sized during the detailed design phase of these developments.

The above rates result in the following internal non-potable demand:

Building 1A	12 Toilets	1.2kL/day
Building 1B	12 Toilets	1.2kL/day
Building 2A	23 Toilets	2.3kL/day
Building 2B	17 Toilets	1.7kL/day
Building 3A	17 Toilets	1.7kL/day
Building 3B	18 Toilets	1.7kL/day

The final number of toilets & subsequent re-use for Buildings 1A, 1B, 2A, 2B, 3A & 3B shall be confirmed during detailed design of each individual warehouse.

5.7.2 External Base Water Demand

The external base water demand has been based on an allowance of 0.3kL/year/m^2 as PET-Rain for subsurface irrigation.

The above regime for the landscaped area for the site gives the following yearly outdoor water demand:

Building 1A Irrigated Area (0.3kL/year/m^2)	9,500m^2	2,850 kL/year
Building 1B Irrigated Area (0.3kL/year/m^2)	3,880m^2	1,170 kL/year
Building 2A Irrigated Area (0.3kL/year/m^2)	11,060m^2	3,320 kL/year
Building 2B Irrigated Area (0.3kL/year/m^2)	12,505m^2	3,750 kL/year
Building 3A Irrigated Area (0.3kL/year/m^2)	2,490m^2	750 kL/year
Building 3B Irrigated Area (0.3kL/year/m^2)	6,420m^2	1,930 kL/year

5.7.3 Rainwater Tank Sizing

The use of rainwater reduces the mains water demand and the amount of stormwater runoff. By collecting the rainwater run-off from roof areas, rainwater tanks provide a valuable water source suitable for flushing toilets and landscape irrigation.

Rainwater tanks have been designed, using MUSIC software to balance the supply and demand, based on the calculated base water demands and proposed roof catchment areas. Allowances in the MUSIC model have been made for high flow bypass which will be managed by a dual high flow (225mm downpipe) and low flow (100mm downpipe) roofwater collection configuration along a portion of the southern elevation of the warehouse. The final configuration, including the arrangement of downpipes shall be sized and confirmed by the hydraulic engineering consultant during the detailed design of individual warehouses.

Building	Roof Catchment (m^2)	Highflow Bypass (l/s)	Tank Size in MUSIC (kL)	Predicted Demand Reduction (%)	Estimated Tank (kL)
1A	5,270	100	110	50.00	110
1B	5,170	100	40	53.23	40
2A	10,110	100	110	51.20	110
2B	7,680	100	140	50.68	140
3A	10,020	100	50	67.37	50
3B	7,970	100	60	51.05	60

Table 5.4. Rainwater Reuse Requirements

The MUSIC model, results summarised in **Table 5.4**, predicts that targeted demand reduction (50% reduction in non-potable water demand) will be met for the MPW Stage 2 Development.

We note that the final configuration and sizing of the rainwater tanks is subject to detail design considerations and optimum site utilisation.

5.8 Stream Erosion Index

A Stream Erosion Index (SEI) calculation has been made, in accordance with the methodology set out in the Draft NSW MUSIC Modelling Guide (Aug 2010). The assessment is targeting the post development duration of stream forming flows to be between 3.5-5.0 times the pre-development duration of stream forming flows.

Per **Section 4 & Section 5** above, there are 2 bio-filtration basins and 3 combined bio-filtration/on-site detention basins present within the MPW Stage 2 works area. The SEI has been calculated for the site area draining to each stormwater management basin on the MPW Stage 2 Development.

The four following steps, as defined in the NSW MUSIC Modelling document, were used in estimating the SEI:

1. Estimate the critical flow for the receiving waterway above which mobilisation of bed material or shear erosion of bank material commences.
2. Develop and run a calibrated MUSIC model of the area of interest for predevelopment conditions to estimate the mean annual runoff volume above the critical flow.
3. Develop and run a MUSIC model for the post developed scenario to estimate the mean annual runoff volume above the critical flow.
4. Use the outputs from steps 3 and 4 to calculate the SEI for the proposed scenario.

Use the outputs from steps 3 and 4 to calculate the SEI for the proposed scenario.

The critical flow contribution to the receiving water (25% of the 2-year ARI) has been estimated per **Table 5.4**.

A pre-developed model was set up based on the site being modelled as 95% pervious agriculture land. The pre-development runoff volume, above the critical flow, based on the calibrated MUSIC model was calculated at per **Table 5.4**.

The post-development runoff volume, above the critical flow, based on the post-developed MUSIC model was calculated per **Table 5.4**. The model also includes an allowance for the estate bio-retention systems located in Basins 3, 4, 5, 6 & 8 which are located between the site and the receiving waters. This has been based on the proportion of the MPW Stage 2 Development site over the total catchment draining to the Basins listed above. A bio-retention system of with 300mm extended detention & 500mm filtration depth, sized at a proportion of 1% of the contributing site catchment, has been included the model to properly replicate the SEI at the receiving waters downstream of the estate detention measures.

The SEI for the MPW Stage 2 development has been calculated per **Table 5.4**. This can be seen to be below the maximum allowable target of 5.0, hence the requirements of the SEI assessment have been met.

It is noted that the SEI assessment modelling has not included the storage volumes within detention systems. The inclusion of these would reduce the calculated SEI values from those quoted below. As such the assessment is considered to be conservative.

Refer to **Appendix C** for MUSIC model Output relating to the SEI.

	Basin 3	**Basin 4**	**Basin 5**	**Basin 6**	**Basin 8**
Catchment Area (Ha)	9.28	3.59	39.44	58.91	26.95
Rainfall Intensity (I_2 - mm/h)	56.35	65.68	41.88	38.69	44.98
Q2 (m^3/s)	0.65	0.29	2.04	2.81	1.50
$Q_{CRITICAL}$ (m^3/s)	0.161	0.073	0.510	0.703	0.374
Transfer Function Out (Pre-Dev - ML/yr)	2.04	0.76	10.69	16.73	6.96
Transfer Function Out (Post-Dev - ML/yr)	9.66	1.63	39.4	54.09	26.21
Stream Erosion Index	**4.7**	**2.1**	**3.7**	**3.2**	**3.8**

Table 5.5. Stream Erosion Index analysis results

6 MAINTENANCE AND MONITORING

6.1 Introduction

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.

6.2 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.

6.2.1 <u>Proactive Maintenance</u>

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 **Section 6.4** of the SDDR. 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.

6.2.2 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.

6.2.3 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.

6.3 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 appropriate manager 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 included in **Appendix A**.

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 (**Section 6.4**) to assist in the effective operation and maintenance of the various drainage and water quality components.

6.4 Stormwater Maintenance Schedule

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
SWALES/ 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 TANK			
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 are 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

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
			fixings if required. Seal 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 5-10 years	Maintenance Contractor	Remove sediment and dispose in accordance with local authorities' requirements. 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 – ROCLA CDS			
Refer manufacturers Operation and Maintenance Manual – refer Appendix	Refer manufacturers Operation and Maintenance Manual – refer Appendix	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.

6.5 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.

6.6 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 Design Development Report* (SDDR) and associated *Stormwater Design Drawings* (SDR's) have been prepared for the Moorebank Logistic Park development Moorebank Precinct West Stage 2 Development. The SDDR and SDR's specifically relating to the operation of stormwater within the precinct.

This report provides information to confirm the requirements of State Significant Development Application SSD 7709 (as approved dated 11 November 2019), **CoC B4** to **B28** have been met.

A civil engineering strategy for the MPW works has been developed which provides a best practice solution within the constraints of the existing landform, environment and proposed subdivision layout and ultimate constructed arrangement. Within this design a stormwater quantity management strategy, which integrates WSUD and WCM measures, has been developed to reduce peak flows leaving this site to remain consistent with the existing flows as a permanent fixture.

8 REFERENCES

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- Managing Urban Stormwater: Harvesting and Reuse – 2006 (NSW DEC)
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9 GLOSSARY

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. 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

	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: *Minor flooding:* causes inconvenience such as closing of minor roads and the submergence of low-level bridges *Moderate flooding*: low-lying areas inundated requiring removal of stock and/or evacuation of some houses. Main traffic bridges may be covered. *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 "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 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.
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'.
MPE	Moorebank Precinct East
MPW	Moorebank Precinct West
Peak flood level, flow or velocity	The maximum flood level, flow or velocity occurring during a flood event.
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 treatment measures.

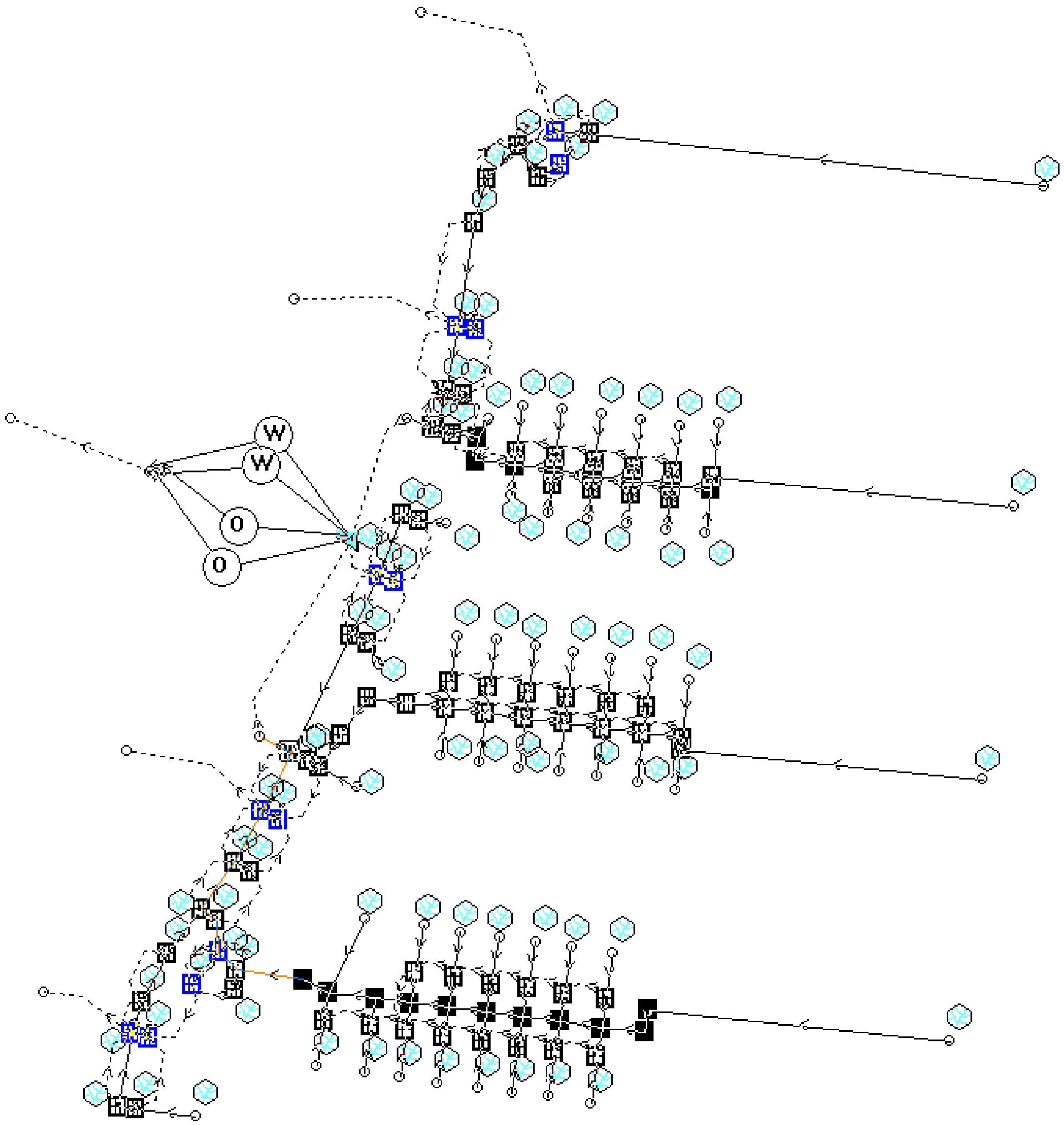
Probable Maximum Flood (PMF)	An extreme flood deemed to be the maximum statistical flood likely to occur at a particular location.
Probable Maximum Precipitation (PMP)	The greatest statistical depth of rainfall for a given duration meteorologically possible over a particular location. Used to estimate 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.
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

Appendix A

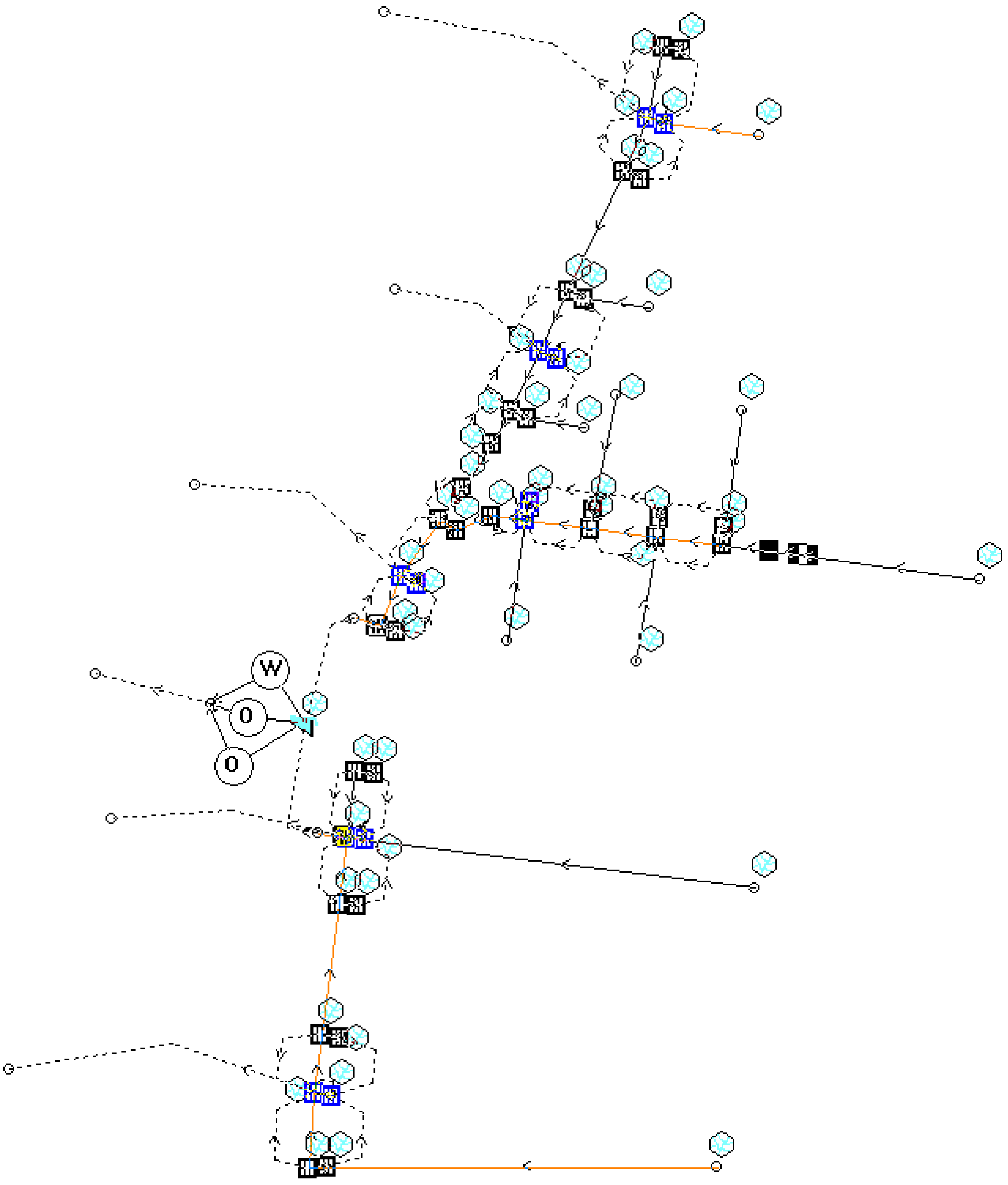
DRAWINGS BY COSTIN ROE CONSULTING

Appendix B

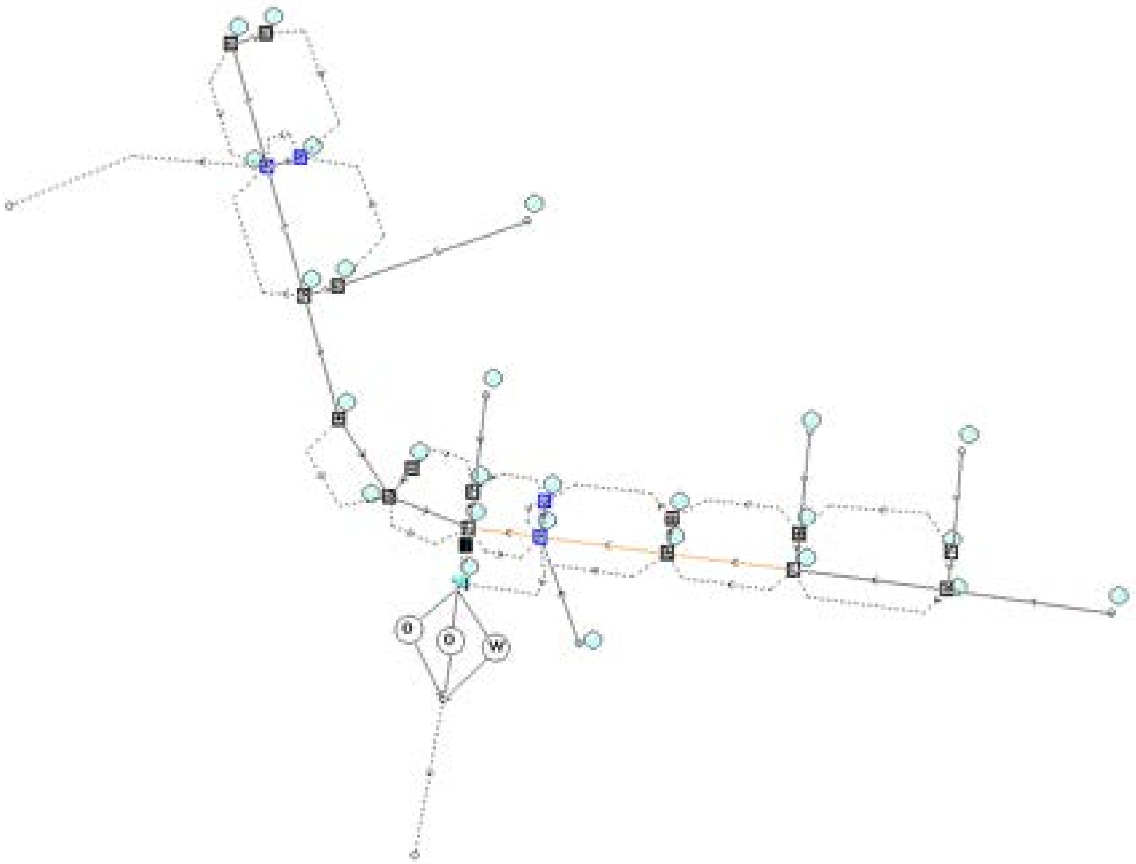
DRAINS MODEL CONFIGURATION



Basin 5



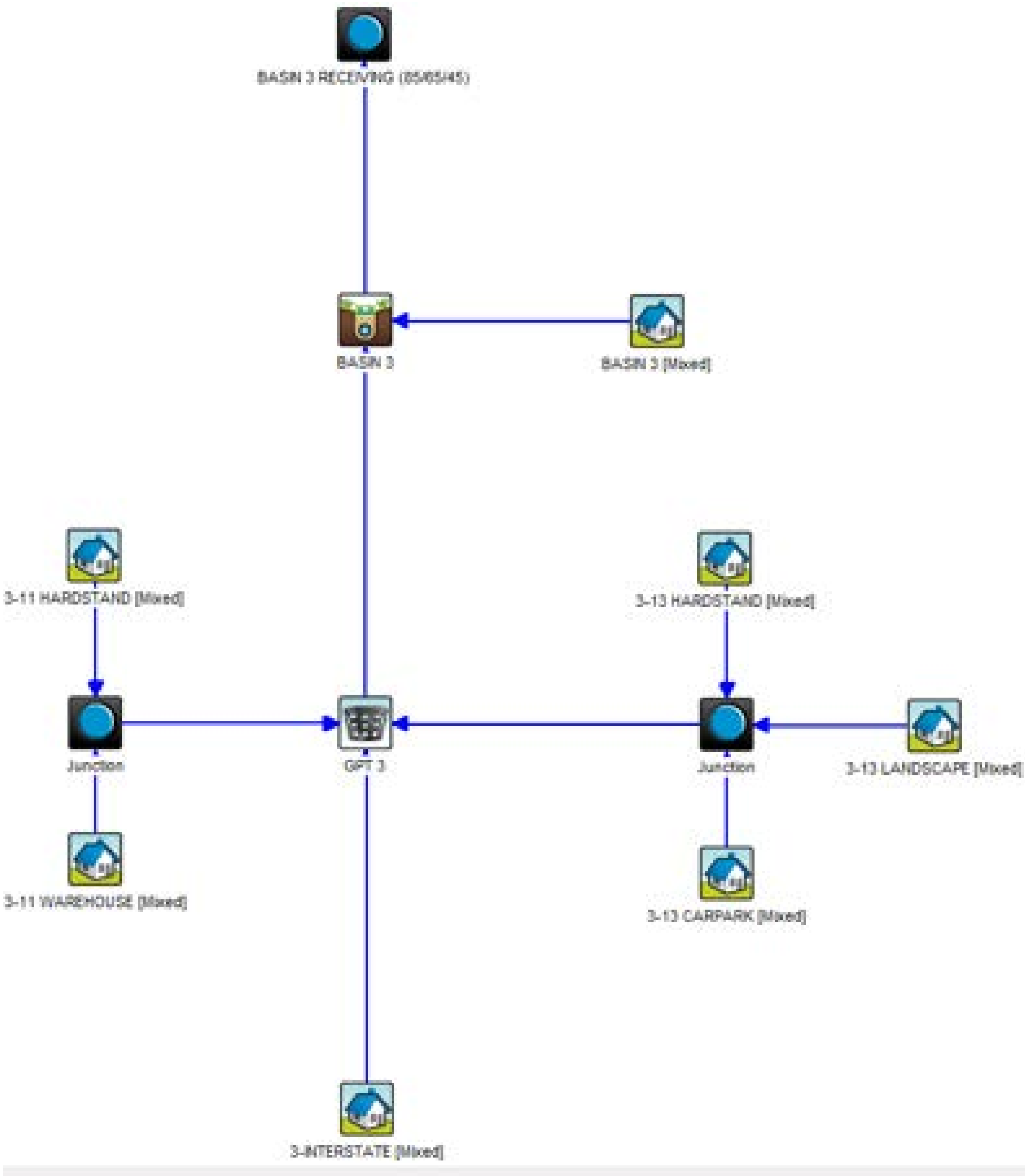
Basin 6



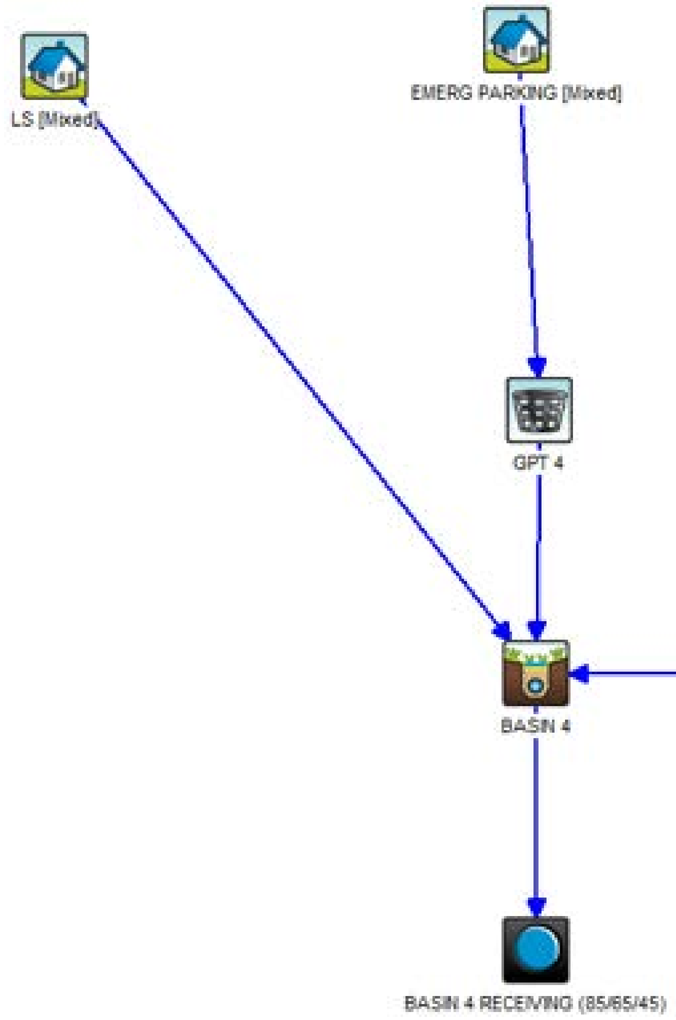
Basin 8

Appendix C

MUSIC MODEL CONFIGURATION



<u>Basin 3</u>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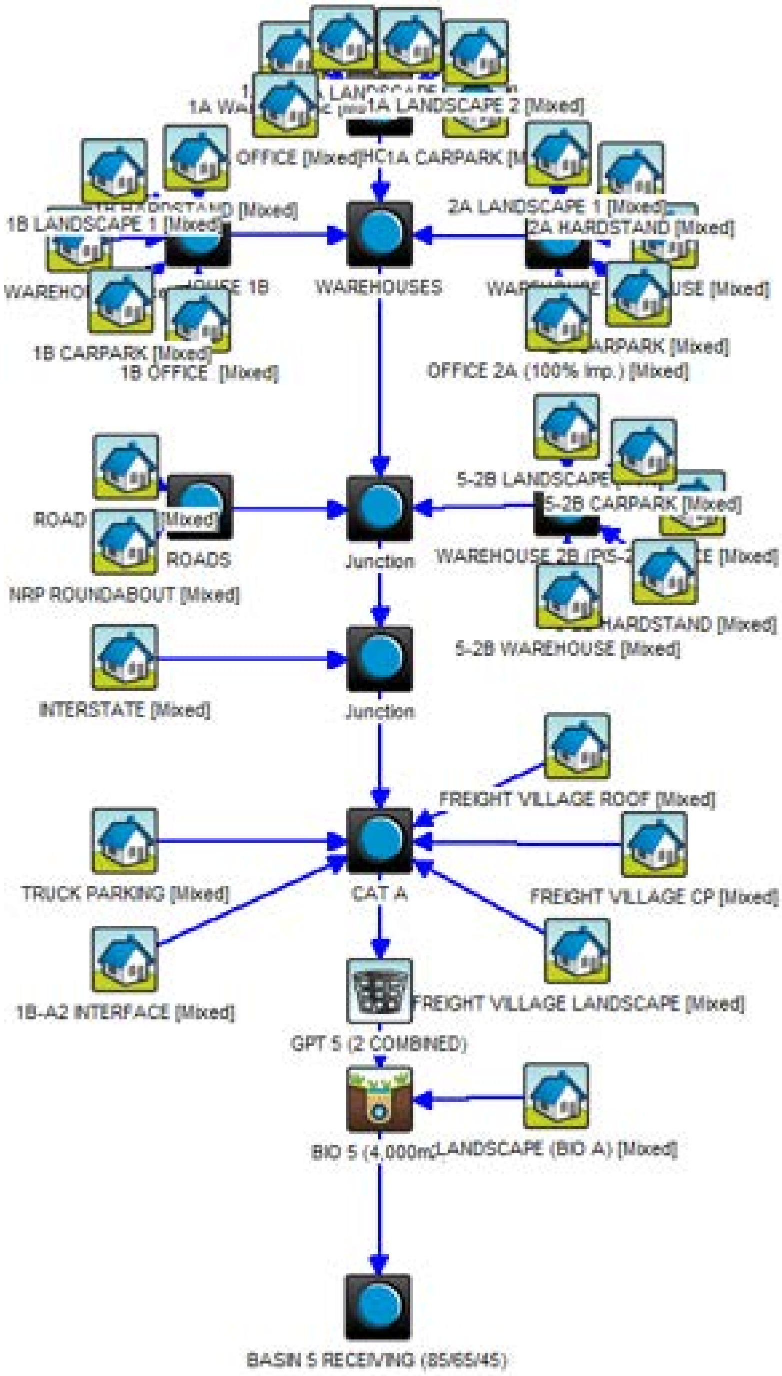
EMERG PARKING [Mixed]
GPT 4
BASIN 4
BASIN 4 CAT [Mixed]
BASIN 4 RECEIVING (85/65/45)

Basin 4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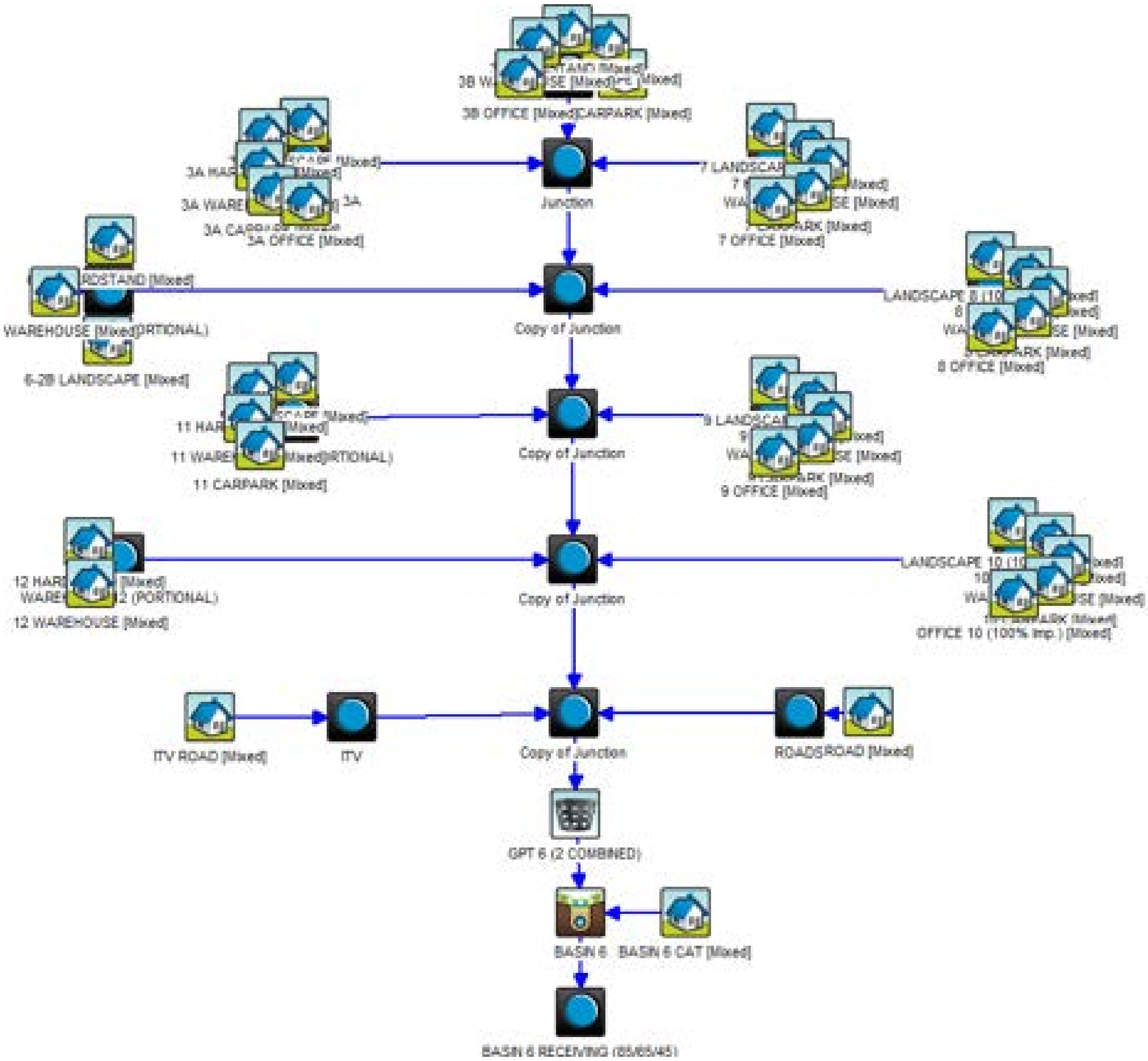
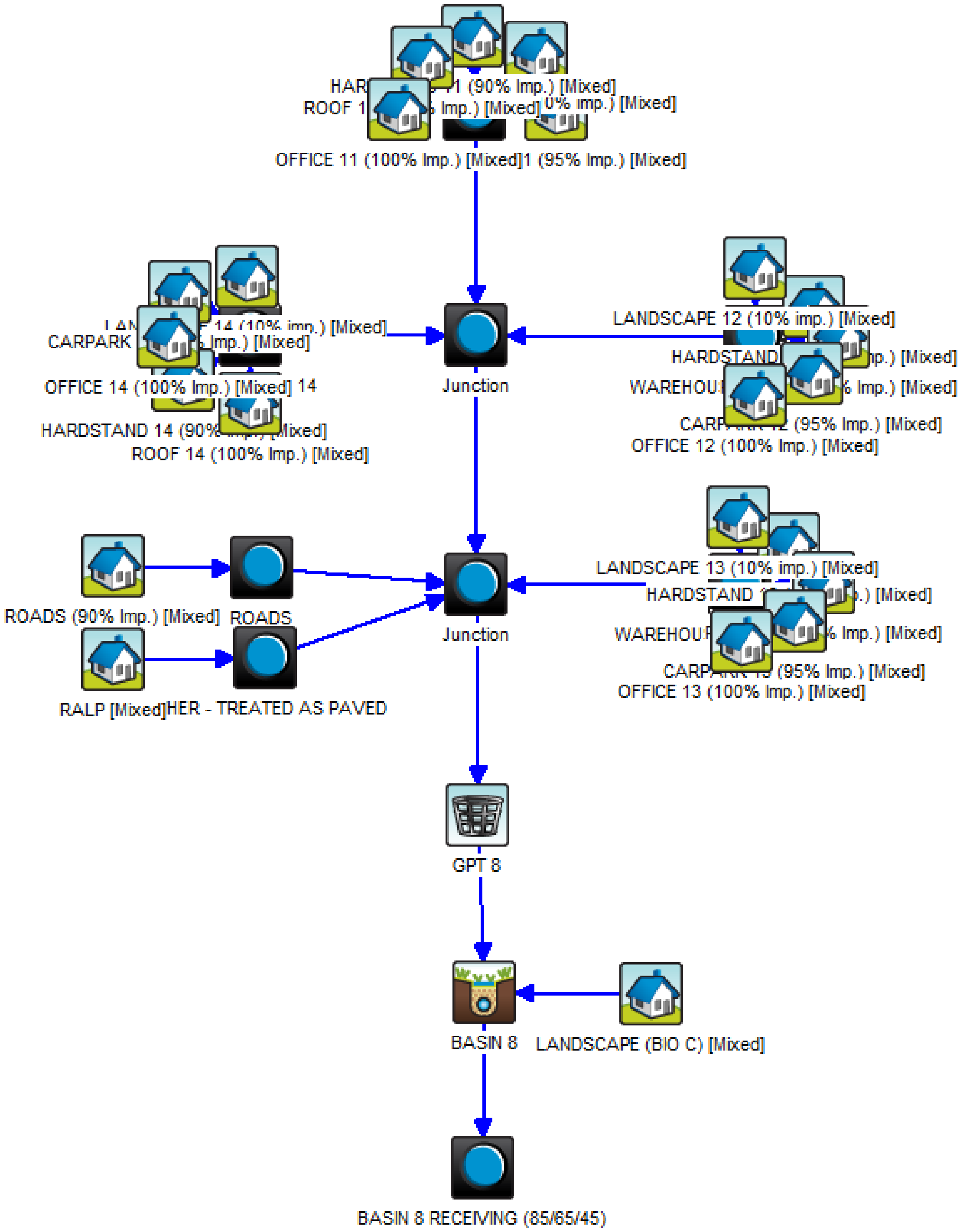
OFFICE [Mixed]
2A LANDSCAPE 1 [Mixed]
1B LANDSCAPE 1 [Mixed]
2A HARDSTAND [Mixed]
WAREHOUSES
1B CARPARK [Mixed]
1B OFFICE [Mixed]
OFFICE 2A (100% imp.) [Mixed]
5-2B CARPARK [Mixed]
ROADS
Junction
NRP ROUNDABOUT [Mixed]
5-2B WAREHOUSE [Mixed]
INTERSTATE [Mixed]
Junction
FREIGHT VILLAGE ROOF [Mixed]
TRUCK PARKING [Mixed]
CAT A
FREIGHT VILLAGE CP [Mixed]
1B-A2 INTERFACE [Mixed]
FREIGHT VILLAGE LANDSCAPE [Mixed]
GPT 5 (2 COMBINED)
LANDSCAPE (BIO A) [Mixed]
BASIN 5 RECEIVING (85/65/45)

<u>Basin 5</u>


3B OFFICE [Mixed]CARPARK [Mixed]
Junction
7 OFFICE [Mixed]
3A OFFICE [Mixed]
Copy of Junction
WAREHOUSE [Mixed]
6-2B LANDSCAPE [Mixed]
8 OFFICE [Mixed]
11 CARPARK [Mixed]
9 OFFICE [Mixed]
12 WAREHOUSE [Mixed]
OFFICE 10 (100% Imp.) [Mixed]
ITV ROAD [Mixed]
ITV
ROADS
ROAD [Mixed]
GPT 6 (2 COMBINED)
BASIN 6
BASIN 6 CAT [Mixed]
BASIN 6 RECEIVING (85/65/45)

<u>Basin 6</u>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Junction
LANDSCAPE 12 (10% imp.) [Mixed]
OFFICE 12 (100% Imp.) [Mixed]
ROOF 14 (100% Imp.) [Mixed]
ROADS (90% Imp.) [Mixed]
ROADS
RALP [Mixed]
Junction
LANDSCAPE 13 (10% imp.) [Mixed]
OFFICE 13 (100% Imp.) [Mixed]
GPT 8
BASIN 8
LANDSCAPE (BIO C) [Mixed]
BASIN 8 RECEIVING (85/65/45)

<u>Basin 8</u>

Appendix D

ROCLA CDS – OPERATION & MAINTENANCE MANUAL

CDS® UNIT TECHNICAL SUMMARY

CAPABILITIES

The CDS® Unit is the most awarded stormwater treatment device. CDS® pioneered the first gross pollutant trap in Australia in 1995 and since then the vast amount of validation and testing performed in Australia and overseas has led to both local and international leadership. Rocla Water Quality has a highly skilled design team devoted to improving stormwater quality. This dedication has made the CDS® Gross Pollutant Trap (GPT) the most efficient, cost effective and easy to clean GPT on the market.

Some the key parameters of the CDS® Units are summarised below;

Features	Benefits
Continuously Deflective Screen	- This insures the screen does not block. - Screens don't require cleaning or maintenance.
Vortex force	- The vortex aids the screen cleaning and draws the waste into the centre and down to the storage sump away from the treatment area.
Screening Chamber	- The sheer plane created by the screen between the vortex flow action keeps the screen clear of trapped pollution to ensure continuous and max treatment performance. - The flow regime in the screening chamber avoids re-suspension and wash-outs of stored pollutants.
Optional Maintenance Procedures	- Can be fully isolated from flow. - Doesn't require confined space entry. - Choice of the most effective cleaning process for the application.
Fixed weir	- Guarantees maximum treatment flow is diverted into screening chamber including all neutrally buoyant material.
Design Service	- Life cycle cost analysis. - Installation supervision. - Stormwater quality assessment. - Complete hydraulic assessment.
Continuous field validation.	- Provide design information for industry on the ability of CDS® Units to meet the latest developments and future demands in stormwater quality.
Design Flexibility	- Can customise designs to suit most applications.
Off-line storage	- Does not allow stored waste to be re-suspended. - Keeps the storage area isolated from the screening area, allowing for continuous and maximum treatment.

TECHNOLOGY

The CDS® Unit utilises the energy of the inflow to create a vortex flow regime within the CDS® screening chamber.

The stormwater inflow is introduced tangentially to the screening chamber via a customised inlet chute. The vortex motion within the screen chamber provides a continuous circular flow that directs the pollutants away from the screen towards the centre. This low energy zone is where most of the pollutants lose buoyancy and sink into the storage sump below.

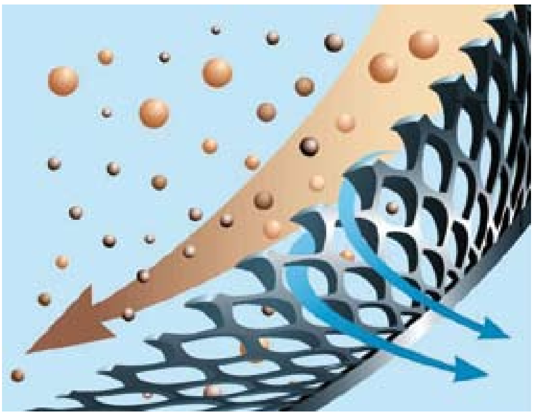


Figure 1: CDS® Unit deflective screen operation

The specially designed deflective screen shields the apertures from the pollution in rotational flow, which improves treatment operation and performance efficiency (as shown in Figure 1). The screen design along with the tangential flow and vortex forces provides all the benefits of a vortex separator and a physical filter without their limitations.

The CDS® Unit simply creates a whirlpool that draws all the deflected and settling pollutants to the centre of the screening chamber where they fall out into the storage sump below.

The pollutant storage sump located below the screening chamber allows pollutants to be removed from the flow path and away from the screens, thus maintaining a reliable treatment efficiency.

The unique CDS® technology is the most reliable way to effectively and efficiently treat gross pollutants in stormwater drainage systems.

FEATURES

The standard CDS® Unit design incorporates the key features shown in Figure 2.

Flexible Diversion chamber:

CDS® Units can be installed on pipe, culvert and open channel drainage systems.

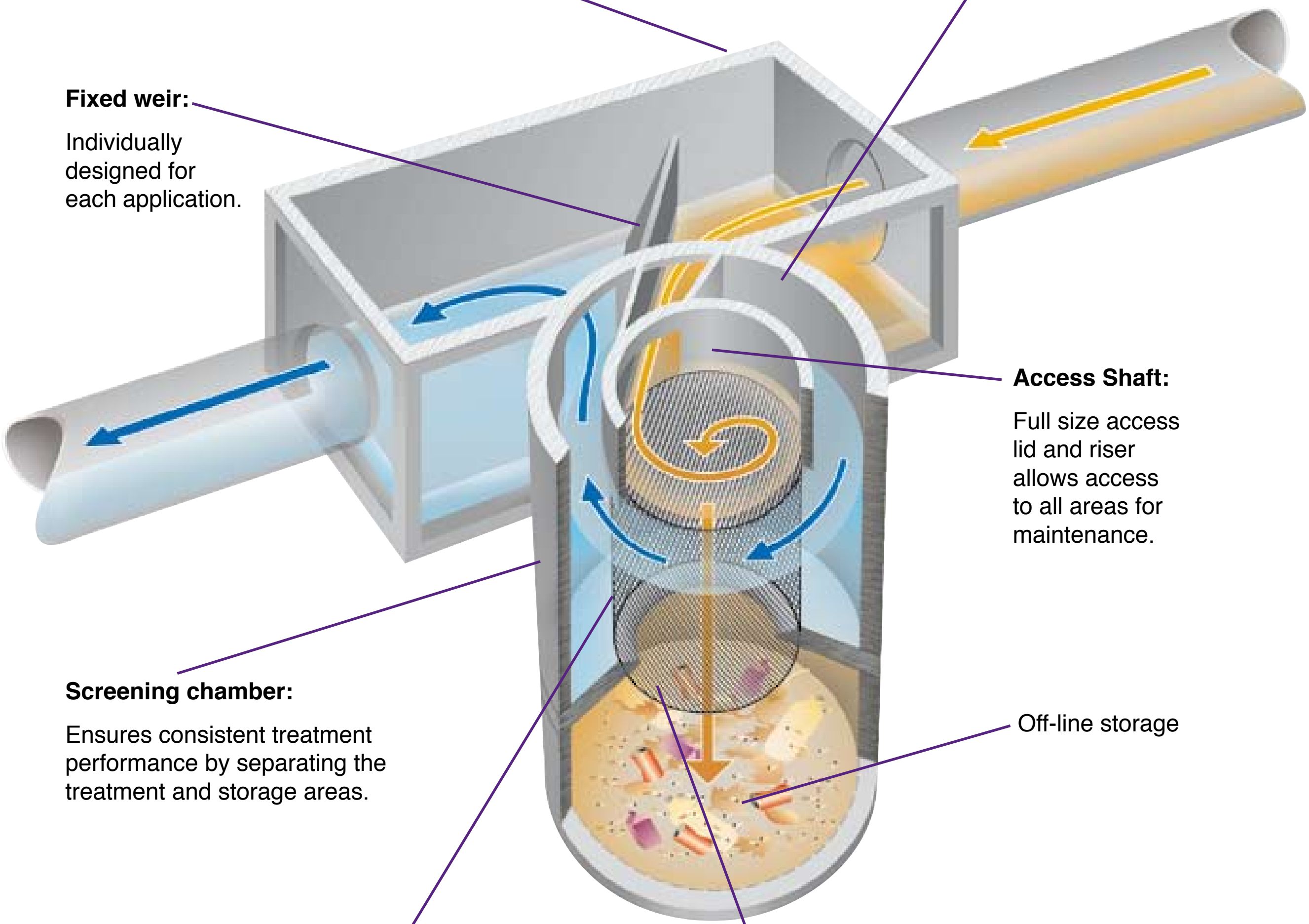
Every diversion chamber is designed to safely by-pass maximum flows.

Diversion chamber can be supplied as precast chambers, slab chambers or box culverts.

Off-line treatment

Fixed weir:

Individually designed for each application.



Access Shaft:

Full size access lid and riser allows access to all areas for maintenance.

Screening chamber:

Ensures consistent treatment performance by separating the treatment and storage areas.

Off-line storage

Deflective screens

Optional Removable Basket:

Flexible storage options allow the most economic and effective maintenance solutions to be utilised.

Figure 2: Key features of CDS® Units

CDS® UNIT PERFORMANCE

Since the inception of CDS® Units, performance has been the highest design imperative. The performance of CDS® Units has been an integral part of shaping stormwater quality standards worldwide. CDS® Units confidently achieve stormwater quality benchmarks even when markets can be focused on less important aspects of stormwater treatment. CDS® Units provide asset owners a high level of trust in stormwater treatment effectiveness and reliability. They can consistently achieve the following stormwater quality parameters:

CAPTURE EFFICIENCY

The screens in a standard CDS® Unit have a 4.7mm aperture, however, due to the deflective nature plus the vortex motion, 95% of material down to 1mm is captured. Although CDS® Units are designed as GPTs it is common to capture high volumes of particles less than 1mm as well. The specific pollutant groups targeted by a CDS® Unit are described following:

Gross pollutants (>5mm)

As per Allison 1996, "Field monitoring suggests that CDS® Units are efficient gross pollutant traps. During the 12 months of monitoring, practically all gross pollutants transported by the stormwater were trapped by the CDS® device".

As per CRCCH 1999 "The CDS® Unit can remove nearly all gross pollutants and a significant proportion of finer pollutants, particularly during storms".

As per CSIRO 1999: Circular Screens (CDS®) were the only category (device) to rate a Very High performance of over 90%. All other devices failed to meet this standard.

Fine particles

As per Portland State University 2002: "the experimental results show that the CDS® Unit generally removed over 95% of particles greater than 215 microns with screen apertures of both 2400microns and 4700 microns."

As per Sansalone Summary 2004: "the CDS® Unit was trapping over 90% of particles down to 75 microns." Also, capture of this particle size range was noted to contain approximately 80% of the heavy metals.

Suspended solids (excluding everything >1mm)

The common definition of Total Suspended Solids (TSS) excludes particles greater than 1mm. In accordance with this, TSS removal rates of CDS® Units exclude gross pollutants, organics, coarse sediment and any particles greater than 1mm. But most importantly the TSS removal rates of CDS® Units have been consistently field validated.

As per Sansalone Summary 2004: there was a notable net removal of particles less than 75 microns by the CDS® Unit. NJCAT removal of 49% TSS (better than any other GPT).

As per CRCCH 1999: "The CDS® trap removes a considerable amount of TSS above background concentrations during storm events, with a mean removal efficiency of approximately 70%".

As per Brevard County 1997: "Monitoring has shown the CDS® Unit has provided an average 52% removal efficiency for total suspended solids".

It is worth noting that devices which store Total Suspended Solids (TSS) in the treatment chamber are highly susceptible to re-suspension and loss.

Nutrients (Phosphorus)

Nutrient removal rates of CDS® Units show a correlation with sediment removal. Independent validation shows insoluble nutrient forms such as Phosphorus (P) are also reliably captured.

As per Brevard County 1997: "Monitoring has shown the CDS® Unit has provided…. 31% removal efficiency for phosphorus".

CRCCH 1999: "The CDS®… consistently retains TP, thought to be because P is in particulate form, with a mean removal efficiency of approximately 30%".

Sansalone Summary 2004: "There was a nett positive removal for TP for all events, with an averaged removal of over 30%".

Oil grease retention

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. Further information on oil removal can be provided upon request.

CAPTURE PERFORMANCE SUMMARY

A summary of the CDS® Unit performance parameters is outlined in Table 1 below;

Pollutant / Items	Removal Efficiency	Independent Reference Source
Suspended Solids (TSS)	70 %	CRCCH Report 99/2 Feb 1999
Total Phosphorous (TP)	30 %	CRCCH Report 99/2 Feb 1999
Total Nitrogen (TN)	0 %	Scattered results
Gross Pollutants (>5mm)	98 %	CRCCH Report 98/3 Apr 1998
Sediments>0.215mm	95 %	Portland State Uni, Oregon Oct 02
Fine sediment> 75 microns	90 %	Louisiana State University 2004
Heavy Metals	80 %	Louisiana State University 2004
Hydrocarbons, Oils & Grease	82-94 %	UCLA Report 1998

Table 1: CDS® Unit performance summary

ENVIRONMENTAL IMPACT

Anaerobic breakdown is a natural process involving the decay of organic material in drainage pipe systems. However, conventional treatment design practice prefers this process to occur in the CDS® Unit rather than the downstream drainage system. This way the decaying pollution can be more cost effectively controlled and removed from the stormwater system.

Dry sump treatment options do not remove the silts and finer sediments that contain higher stormwater contaminant loads. Therefore these treatment options do not contain the decaying process of these more volatile stormwater contaminants resulting in a less cost effective pollution removal and less environmental benefits.

The ability of the CDS® Unit to remove both coarse and fine organic material results in much better environmental and more cost-effective pollution removal gains.

The volume of a wet sump GPT is very minor in comparison to the volume of water in any one storm event. This means that together with the dilution and aeration of water in the GPT during a storm event the impact of water on a receiving stream would typically not even be measurable. Furthermore the odour generating potential of stormwater is minimal and no odour can be detected outside the CDS® Unit under normal conditions. More information on this subject can be provided upon request.

HYDRAULIC IMPEDANCE (HEAD LOSS)

Rocla Water Quality can provide hydraulic assessment for each project in order to ensure the hydraulic grade line (HGL) remains below ground level for the design storm event. If the HGL is determined to be approaching surface level, multiple options to avoid or minimise this situation are available. The worst case headloss condition is always used in hydraulic assessments of CDS® Units. The worst case K factor of a CDS® Unit is 1.3, which is equally the lowest validated K factor for a stormwater treatment device.

INDEPENDENT (MOSTLY UNSOLICITED) TESTING AND VALIDATION STUDIES OF CDS® UNITS HAVE BEEN PERFORMED BY:

- Allison, 1996
- Wong, 1997
- Brevard County, 1997
- Water Resources Management, 2003
- Cooperative Research Centre for Catchment Hydrology, 1999
- Monash University,
- Portland University, 2002
- Louisiana State University, 2004
- University of California LA
- University of NSW
- NSW Environment Protection Authority, 1997
- Willoughby Council
- Brisbane City Council
- Thiess Environmental Services

Full copies of any of the reports mentioned above are available upon request.

CDS® DESIGN

DESIGN PRINCIPLE

The design of a CDS® Unit for a specific catchment involves numerous parameters and is generally divided into two main steps. The first step in determining the suitability of a specific CDS® model is to consider the catchment and pollution load and the second is a hydraulic assessment.

STEP 1: Catchment Parameters and pollution load

The first step includes considering the following parameters:

- Catchment area;
- Site location and depth to invert;
- Tidal influence or other backwater influence;
- Treatable flow and its relation to the volumetric treatment efficiency;
- Target pollutants and land use;
- Treatment performance;
- Expected pollution loads; and
- Storage volume to minimise lifecycle costs.

Sometimes these parameters have competing project priorities and compromises are required. The CDS® Unit design can account for these and still provide high quality quantifiable treatment outcomes.

However, the CDS® Unit is generally sized on a flow volume basis, therefore the design aim is to treat a sufficient volume of the annual flow and remove a sufficient amount of pollution to meet a project's requirements.

The flow volume is based on the CDS® Unit having a reliable treatment flowrate which in turn means that the CDS® Unit will treat this flowrate in all events. The flowrate can be relied upon because of the Non-blocking functionality of the CDS® screen and the separate treatment/storage zones which provides the ability to treat runoff continuously. Thereby ensuring the stated pollution load is removed from the drainage system.

The patented CDS® Unit offers the most reliable treatable flowrate of any GPT because of these two unique design features. Very high volumetric treatment efficiencies are maintained consistently by lowering the likelihood of blockages as well as treating and storing stormwater pollutants in separate zones.

When using MUSIC modeling the treatment efficiencies of the CDS® Unit provides the highest integrity and most reliable design for stormwater quality treatment. Therefore no safety factors need to be applied to CDS® Unit treatment performance data shown in Table 1.

STEP 2: Hydraulic Analysis

Once a suitable CDS® model has been chosen for the catchment, step two is undertaken, the hydraulic analysis. This step determines whether the CDS® model chosen based on catchment and pollution characteristics will suit the hydraulic capacity of the drainage system. This step will also determine the most suitable position of the CDS® Unit.

Due to the headlosses involved with treating stormwater through any GPT, a weir needs to be installed in the drainage system to divert flow and maintain an energy level difference between the upstream and downstream side of the treatment device. Hydraulic weirs and floating weirs do not provide reliable flow diversion, therefore Rocla Water Quality prefer fixed weirs as best practice.

The hydraulic analysis takes the following important hydraulic parameters into consideration:

- The existing capacity of the drainage system (either closed or open system);
- Physical parameters of existing drainage system such as pipe or channel size and grade etc;
- Tidal influence or other backwater influence;
- Design flow of the system (Q20 or similar);
- Flow velocity;
- Flooding at the site; and
- Other site constraints or opportunities such as multiple pipes, drops, bends or multiple outlets for stormwater harvesting.

Rocla Water Quality uses a variety of design tools to determine the impact on the chosen site of any proposed CDS® Unit. The tool chosen will depend on the drainage system characteristics such as whether or not the system is open or closed and the geometry of the system.

Generally, Manning's equation is used to determine the capacity of the system if sufficient information on drainage geometry and grade is available. In open channel systems, HEC-RAS can be used to determine hydraulic capacity if sufficient information is available to create a reliable model.

The CDS® Unit diversion weir chamber and weir can function in three general ways, these are:

1. Free weir
2. Submerged weir
3. Orifice

It should be noted that Rocla Water Quality utilises the most conservative approach when calculating the depth of water flow over a weir. Sound hydraulic theory and analysis is used to assess proposed CDS® Unit installations on drainage systems. This ensures that it has been designed with sufficient bypass for the capacity or other nominated design events at the location of the weir.

Rocla Water Quality also has the option of using a lower weir with a twin unit arrangement, drop weirs, collapsible weirs, super collapsible weirs, and flume weirs. Where possible the use of moving parts such as a collapsible weir is avoided. Rocla Water Quality do not use hydraulic weirs or weirs incorporating assumptions on kinetic energy since these have proved false and unreliable in the field.

The diversion chamber design assumes that the CDS® Unit has not been maintained and that all flow must divert over the weir. This is the worst case design condition and this K factor of 1.3 for the CDS® Unit is one of the lowest available.

CONSTRAINTS

For any given site, the opportunity to treat the stormwater could be limited by a number of factors, these include:

- Site hydraulics
- Velocity impact
- Tidal or backwater levels
- Access for construction, and/or ongoing maintenance
- Geotechnical considerations such as rock, water or acid sulphate soils
- Physical obstacles such as property boundaries, roads, services, etc
- Budgetary limitations

When any of these factors are prevalent, Rocla Water Quality has more options and solutions than any other proprietor, and always consults with the Designer to find a solution. This can commonly require some compromises, but ultimately it will offer the most cost effective solution for any given site. It is often recommended to visit proposed GPT sites to canvas all available options in consultation with clients.

Following is a list of the more common CDS® Unit design options available;

- Multiple pipe configurations
- Bends and drops
- Various weir options (as per above)
- Extended inlets
- Tidal units with dual inlets
- Stormwater harvesting units with dual outlets
- Pump-down units (dry trap)
- Ex-filtration units (dry trap)
- Sump options (width and depth)
- Baskets
- Screen sizes
- Oil baffle volumes
- Multiple lid options
- Low flow polishing device (upflow media filter at CDS® Unit outlet)
- Multiple cleaning options
- Incorporation of penstocks and drop boards
- Exclusion bars
- Multiple CDS® Unit arrangements

DESIGN CERTIFICATION

CDS® Units have no moving parts, and are manufactured from tough corrosion resistant materials.

A operational life of 50 years for the 316 grade stainless steel and 80 years for the concrete could be expected under standard operating conditions.

The pre-cast concrete components of CDS® Units comply generally with the following Australian Standards, where relevant:

- **AS3600-2001** Concrete structures
- **AS3725-1989** Loads on buried pipes
- **AS3996-1992** Metal access covers, road grates and frames
- **AS4058-1992** Precast concrete pipes (pressure and non-pressure)
- **AS5100.2-2004** Bridge design, Part 2: Design Loads
- **AS5056-2005** Polyethylene and polypropylene pipes and fittings for drainage and sewer applications.

By following these Australian Standards requirements structural integrity is ensured. Additionally, CDS® Units are not affected by ground water buoyancy effects.

Rocla Water Quality have extensive technical resources supporting the CDS® Unit product range. Each model is supplied with a technical drawing including weights and dimensions, or a site specific design usually encompassing a set of drawings, and we provide a comprehensive installation instruction and maintenance manual for each unit. Standard CDS® Unit drawings are available upon request.

CDS® Units can be modified to suit applications. Sump storage sizes are listed on technical drawings. Penstocks, dewatering options, baskets and a variety of diversion options are available on request to suit virtually any application. These modifications are designed by the Rocla Water Quality design staff to ensure peak hydraulic performance, maximum maintenance and cleaning periods and flood risk elimination.

CDS® UNITS INSTALLATION

This information is provided as general guidance to assist with the installation of CDS® Unit Gross Pollutant Traps.

It is the purchaser's responsibility to ensure that installation work is carried out by competent tradespeople in accordance with all relevant drawings, codes of practise, legislation and regulations.

MODEL IDENTIFICATION

2018 L

The Screen Dia is 2.0 metres	The Screen Height is 1.8 metres	The Circular Treatment Chamber is to the LEFT of the pipe or channel

Check that the CDS® Unit model supplied is that which is specified on the project drawing and that the relevant Rocla Water Quality Operation and Maintenance manual has been provided.

INSTALLATION SUMMARY

CDS® Unit models generally consist of two main sections, the Diversion Chamber which is on line (in relation to the drainage system), and the treatment device which is off line and situated to one side of the diversion chamber.

However, for the P0506, P0708 and P0708 MAXI CDS® Unit models the diversion chamber is an integral part of the CDS® device. Hence there is only one section for these models.

When provided, the diversion chamber may be configured in several different ways for which there are separate guides. The customer should refer to the specific project drawings provided for detailed advice on these options.

The following is a general outline of the construction procedures and relevant reference literature;

ORDER	WORK PROCEDURE	REFERENCE
1	Site works and set out	CDS® Unit Model Operation & Maintenance manual
2	Excavate for CDS® Unit	
3	Construct CDS® Unit	
4	Fitting out	
5	Excavate for diversion chamber	Diversion Chamber Guide
6	Construct diversion chamber	
7	Backfilling and lids	Both Guides
8	Waste Removal Basket (if fitted)	Basket Guide

Ensure that all of the required reference manuals and guides are provided and understood before installation is commenced.

TYPICAL COMPONENTS

Diversion Chamber

The type of diversion chamber used will vary with the type of drainage system.

Typically a pre-cast diversion chamber is supplied. However slab chambers may be supplied or an in-situ option specified for the diversion chamber. Therefore refer to the specific project drawing to ensure that all the relevant manuals have been supplied.

Typical precast components for CDS® Unit models (not including diversion chamber) are as follows:

- Sump
- Shear Cone
- Lower Separation Chamber
- Upper Separation Chamber
- Top Hat
- "L" shaped Outlet Wall

Additional pre-cast concrete items that may be required include:

- Access shaft risers (One or more of varying length may be supplied depending on depth required)
- Prefabricated Screen cage

Assembly aids which also may be required and are delivered on a pallet include:

- Fibreglass Inlet Chute
- "H" brackets for assembling major components
- Right Angle Brackets for fixing the access riser
- Angle brackets for fixing screen cage to shear cone
- Bolts and Dynabolts for all the above
- Assorted sealants as required
- Fish plate brackets

CDS® UNITS MAINTENANCE

Whilst the frequency of cleaning will be dependant upon the pollutant loads of each catchment, there are three alternative methods of removing the collected waste from CDS® Units.

The following methods of cleaning can be used individually on any CDS® Unit, even well after installation.

This is a very significant feature that allows asset owners to choose the cheapest option available for ongoing maintenance given the required cleaning frequency and the respective cleaning services and resources available.

The three maintenance options available are described following:

1. MECHANICAL GRAB CLEANING

Cleaning by grab can be carried out without dewatering the unit and is a single person operation in most locations.

This results in a cleaning technique which is generally faster, cheaper and safer. It also allows a visible inspection of the pollution that was captured, as opposed to suction that doesn't.
No physical entry is required.

2. BASKET REMOVAL CLEANING

If a waste removal basket is fitted, it can be lifted at any time, without the need for dewatering. Also it provides a safe and cost effective method of cleaning. The cost benefit of this option depends on the CDS® Unit design and on waste disposal requirements. No physical entry is required.

3. SUCTION CLEANING

Due to the dewatering time, costs and disposal of the water, suction cleaning is generally the most expensive cleaning option. However by taking advantage of the large sump volumes available in CDS® Units, it may still be a very cost effective maintenance option.

Suction cleaning is used for most proprietary GPT's. Even if a more cost effective method is used at shorter intervals, suction cleaning is recommended for CDS® Units at one to two year intervals so that a thorough inspection of the screen and lower chambers can be carried out. Physical entry may or may not be required.

Normally a CDS® Unit would be sized with an appropriate sump volume to allow cleaning 3 or 4 times per year. These maintenance cleans would be carried out either by using a basket or a grab, with a single comprehensive clean per year completed by suction.

The best option for any particular unit will depend on tidal or backwater impact, pollution load and cleaning frequency as well as access and disposal costs for pump-down water.

CDS® Units may sometimes be required to use penstocks to isolate the unit during maintenance operations. This would be essential where a unit is affected by backwater and/or high levels of tidal inundation.

The main benefit of removable baskets is their speed and ease of cleaning, particularly in tidal zones. But the storage basket must be smaller than the screen to allow its removal. As such, the volume in a basket will be less than that of a large sump CDS® Unit volume.

Consequently, whilst it may be cheaper, cleaning removable baskets might also be required 4 or 5 times more often.

For larger CDS® Units, the grab truck cleaning option offers the removal of 80 – 90% of the pollution stored in a sump and is subjected to similar constraints as the removable basket option.

When considering GPT maintenance costs and procedures, the three maintenance options of CDS® Units offer greater operational flexibility and low life-cycle cost considerations.

More general GPT maintenance decision methodology information is available in the CDS® Unit Operation and Maintenance manuals or upon request.

Appendix E

SSD 7709 Consent Conditions

Appendix F

WEST-DRAINING MPW CATCHMENT INFO

Appendix G

Peer Review Letter and Certificate

AT&L Consulting Engineers

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19th December 2019

Qube Holdings Ltd
Level 27, 45 Clarence Street
Sydney NSW 2000

Your Ref:
Our Ref: 19-657-C002-01-ATL-Stormwater Design Independant Peer Review.docx
Direct phone: 02 9439 1777

Attention [redacted]

Dear [redacted]

MOOREBANK PRECINCT WEST STAGE 2 - SSD 7709 INDEPENDENT STORMWATER REVIEW – STAGE 1

Further to recent discussions and correspondence we understand that an independent peer review is required of the final stormwater design model and associated documentation and is to be submitted as part of the final submission to the Planning Secretary for SSD 7709 for approval prior to commencing construction works.

To ensure this condition is satisfied, AT&L have been engaged by Qube Holdings Ltd to undertake an independent peer review on Stormwater Design Drawings and Reports prepared by Costin Roe Consulting.

A Stormwater Design Independent Peer Review for the development has been undertaken to meet the requirements of Condition B7 within the SSD approval. For the Peer Review process Costain Roe Consulting provided the following documentation:

- Moorebank Precinct West Infrastructure Civil Works Package – Issued for Post Approvals dated 29th November 2019 (attached within Appendix A)
- Drains and Music models dated 29th November 2019
- Stormwater Development Design Report (SDDR) Rev A dated 29th November 2019 (attached within Appendix B)

The following conditions apply to this peer review with AT&L comments/ approval noted in **red** below each condition:

B7: An **Independent Peer Review** report must be submitted with the **Stormwater Design Development Report** and **Revised Stormwater System Design Drawings** and **supporting documentation**.

AT&L Response: This letter represents the Independent Peer Review as required

B8: The review must:

(a) Include a review of the numerical models used to develop the revised stormwater design
(b) Be undertaken by a technical expert, approved by the Planning Secretary, with over 15 years of experience in stormwater, flooding and water quality in NSW, including Water Sensitive Urban Design (WSUD), and not previously involved in preparation of drainage, flooding or hydrological designs or assessments for either MPW or MPE, or construction of either MPW or MPE; and
(c) Include an assessment of the Revised Stormwater Sydney Design Drawings and supporting documentation against all relevant conditions, stating whether the condition has been satisfied, and comments justifying the position

at&l

AT&L Response:

(a) AT&L have reviewed all numerical models (Drains and Music) provided by Costain Roe on 29th of November 2019 and are satisfied they accurately represent the design intent.
(b) AT&L can confirm this peer review had been undertaken by Anthony McLandsborough who has over 15 years' experience in stormwater, flooding and water quality design in NSW
(c) All comments on the assessment of the Revised Stormwater System Design Drawings and supporting documents are within this Peer Review letter. Note all relevant conditions have been responded to.

B9: The revised stormwater design, to be detailed in the **Stormwater Design Development Report** and Revised **Stormwater System Design Drawings** and **supporting documentation**, must be consistent with the objective and principles set out in the NSW Office of Water's Guidelines for Controlled Activities and incorporate water sensitive urban design principles outlined in relevant Council policies, plans, guidelines and specifications and RMS's Water Sensitive Urban Design Guidelines 2017, including:

(a) Treating stormwater as a resource
(b) Mimicking natural processes in the control of stormwater
(c) Integrating drainage infrastructure and landscaping
(d) Managing water in a sustainable manner through considering the complete water cycle; and
(e) Considering design, construction and maintenance to minimise impacts on the natural water cycle

AT&L Response: The responses in the SDDR provided by Costain Roe Consulting adequately addresses this condition

B10: The Applicant must submit revised drawings and supporting documentation to the Planning Secretary for approval, in accordance with the design principles and design criteria listed in **Conditions B11 to B22**

AT&L Response: Drawings and the SDDR submitted by Costain Roe Consulting adequately addresses this condition

B11: The stormwater system must be designed to:

(a) Convey flows up to and including the 10% AEP event within the formal piped drainage system, with flows from the 10% AEP to the 1% AEP event conveyed in controlled overland flow paths; and
(b) Provide adequate overland flow paths in the event of stormwater blockages and flows in excess of the 1% ARI rainfall event

AT&L Response: Based on review of the Costain Roe Drains models and SDDR it is noted the pipe drainage system is designed for the 5% AEP event and adequate flow paths are provided for the 1% AEP event. As such this condition is deemed to be satisfied.

B12: On-site detention (OSD) must attenuate peak flows from the development such that both the:

(a) 1 in 1-year ARI event post development peak discharge rate is equivalent to the pre-development (undeveloped catchment) 1 in 1-year ARI event; and
(b) 1 in 100-year ARI event post development peak discharge rate is equivalent to the pre-development (undeveloped catchment) 1 in 100-year ARI event

AT&L Response: Based on review of the Costain Roe Drains models and SDDR it is noted that all OSD basins have been designed to attenuate peak flows to pre-developed flows for all storm events from the 1 in 1 year up to the 1 in 100 year ARI events. As such this condition is deemed to be addressed adequately.

13: OSD basins must:

(a) Be visually unobtrusive and sit within the final landform and landscaping;
(b) Ensure public safety by incorporation of "safer by design" principles; and
(c) Have all sides with a maximum batter slope of 1V:4H, except at the OSD outlets

AT&L Response: Drawings and the SDDR submitted by Costain Roe Consulting adequately addresses this condition

B14: All stormwater quality elements are to be modelled in MUSIC as per the NSW MUSIC Modelling Guide

AT&L Response: Based on review of the Costain Roe SDDR and documentation it is noted stormwater quality across the site has been modelled with Music software. As such this condition is deemed to be satisfied.

B15: The stormwater quality infrastructure must compromise rainwater tanks, gross pollutant traps and biofiltration / bioretention system designed to meet the following criteria compared to a base case if there were no treatment system in place:

(a) Reduce the average annual load of total nitrogen by 45%
(b) Reduce the average annual load of total phosphorus by 65%; and
(c) Reduce the average annual load of total suspended solids by 85%

AT&L Response: Reviewing the results of the Music model provided by Costain Roe it is evident these treatment rates are achieved. As such this condition is deemed to be satisfied.

B16: All stormwater quality elements must be installed upstream of OSD basin, unless it can be demonstrated to the satisfaction of the Secretary that biofiltration/ bioretention system within the OSD basins:

(a) Will not suffer damage from design flows
(b) Can be maintained to achieve the water quality criteria; and
(c) Will have adequate solar access ensuring that all bioretention system are exposed to sunlight at midday on the winter solstice. This assessment is to include surrounding features of OSD basins, including but not limited to actual building heights and full mature height and size of proposed trees, as per the landscape plans

AT&L Response: Response within the Costain Roe Consulting SDDR is deemed acceptable. As such this condition is deemed to be satisfied

B17: The area of biofiltration / bioretention system is to be at least 1% of the catchment draining to the system, to ensure there is no short-circuiting of the system

AT&L Response: Response within the Costain Roe Consulting SDDR is deemed acceptable. As such this condition is deemed to be satisfied

B18: Bioretention system which are greater than 1,000m^2 in area, are to be divided into cells with no individual cell greater than 1,000m^2

AT&L Response: Reviewing the Civil Drawings prepared by Costain Roe Consulting this condition has been satisfied.

B19: All filter media used in stormwater treatment measures must:

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

AT&L Response: Reviewing the Civil Drawings prepared by Costain Roe Consulting this condition has been satisfied.

B20: Discharge of stormwater from the development must not cause scour/erosion of the banks or bed, or pollution of the Georges River or Anzac Creek

AT&L Response: Response within the Costain Roe Consulting SDDR is deemed acceptable.

B21: Outlet structures for the discharge of site stormwater drainage to the Georges River, Anzac Creek, external drainage or natural drainage lines must be constructed of natural materials to minimise erosion, facilitate natural geomorphic processes and include vegetation as necessary (gabion baskets and gabion mattresses are not acceptable)

AT&L Response: Response within the Costain Roe Consulting SDDR is deemed acceptable.

B22: Outlet structures must ensure habitable connectivity and wildlife movement is maintained along the Georges River riparian corridor

AT&L Response: Response within the Costain Roe Consulting SDDR is deemed acceptable.

B23: The Revised Stormwater System Design Drawings and supporting information to be submitted under **Condition B4** must include the details specified in **Conditions B24 to B28.**

AT&L Response: Drawings and the SDDR submitted by Costain Roe Consulting adequately addresses this condition

B24: Drawings must show:

(a) All information on a drainage catchment plan and a schedule of stormwater drainage elements (pipelines and structures). Drainage drawing documentation is to be in accordance with the requirements detailed in Liverpool Council's Development Design Specification "D5- Stormwater drainage design" clauses D5.22 and D5.24
(b) Location and width of controlled overland flow paths
(c) Maximum design flow levels to AHD
(d) Maintenance access to each OSD basin; and
(e) The integration with MPE Stage 1 and MPE Stage 2 stormwater infrastructure including:
    (i) Stormwater infrastructure on the MPW site that is intended to convey (pipes or overland flow paths) or treat or detain stormwater from MPE Stage 1 and MPE Stage 2, and/or
    (ii) Drawings demonstrating that stormwater detention and treatment infrastructure has been provided for and approved under MPE Stage 1 and MPE Stage 2 or western draining MPE catchment

AT&L Response: Drawings and the SDDR submitted by Costain Roe Consulting adequately addresses this condition

B25: All stormwater quality elements are to be detailed in the drawings including:

(a) General arrangement plans at 1:500 and detailed plans as required at 1:200, showing system layout with key features including pipe arrangement with pipe sizes, diversion structure, high flow bypass, pre-treatment system, inlets, outlets, underdrainage, and maintenance vehicular access. The plans show how the bioretention system will achieve separate cells of a maximum area of 1,000m^2 with flow splitting
(b) Long and cross sections showing key features and levels including liner (base level of bioretention system), submerged zone level, drainage layer, transition layer, filter surface level, extended detention level, bund/embankment level, and level of detention storage;
(c) Pipe long sections, including invert levels, pipe sizes
(d) Details of key structures, including diversion, pre-treatment system (make/model), inlets, outlets;
(e) Landscape plan including plant species
(f) Specification of filter material
(g) Shadow diagrams including surrounding features of OSD basins, actual building heights and full size of proposed tress, as per landscape plans

AT&L Response: Drawings and the SDDR submitted by Costain Roe Consulting satisfy Points a, b, c, d and f of this condition. Landscape Architectural drawings prepared by Ground Ink (DWGS PIWW-GNK-LN-DWG-001, 500 and 501 dated 27th November 2019) satisfy Points e and g of this condition

B26: Stormwater outlet drawings must show:

(a) Material type, size, thickness, with accompanying hydraulic calculations demonstrating the achievement of relevant stability thresholds;
(b) Design arrangement including longitudinal sections, cross sections and typical arrangements
(c) Typical arrangements including details of any liners, keying into bed/banks and filter material; and
(d) The tie in with the receiving water normal water level and/or seasonal low flow levels

AT&L Response: Drawings and the SDDR submitted by Costain Roe Consulting adequately addresses this condition

B27: As part of the **supporting documentation** required under **Condition B4**, the Applicant must document the sequence of construction, including interim drainage solutions; for

(a) The drainage line from MPE to the Georges River
(b) The northern portion of MPW, including infilling, OSD basins, transition of sedimentation basins to OSD basins; and
(c) The southern portion of MPW, including infilling, OSD basins, transition of sedimentation basin sot OSD basins

AT&L Response: Drawings and the SDDR submitted by Costain Roe Consulting adequately addresses this condition

B28: As part of the **supporting documentation** required under **Condition B4,** outlet structure investigations and design inputs must be submitted to the Planning Secretary, including:

(a) Subsurface/ geotechnical assessment identifying underlying foundation conditions;
(b) Hydraulic modelling
(c) Hydraulic calculations for stormwater outlet structures demonstrating achievement of relevant stability thresholds; and
(d) Design specifications including schedule of drainage elements (e.g. rock sizes and structures)

AT&L Response: Drawings and the SDDR submitted by Costain Roe Consulting satisfy Points b, c and d of this condition. Geotechnical Report prepared by Golder (PIWW-GLD-GI-MEM-0003- Rev0 dated 4th October 2019) satisfy Point a of this condition.

We note, this Peer Review was based on the information supplied by the designer at the time of writing this report. In no way does this report purport to include any changes that may occur with the drawings and or other relevant documentation associated with either the stormwater design and or the other infrastructure documentation prepared for the works.

Refer to the attached documentation for which this Peer Review was based.

Should there be any questions regarding the above please contact the undersigned.

Yours sincerely

[redacted]

[redacted]
Director
[redacted]

APPENDIX A

COSTIN ROE CONSULTING CIVIL ENGINEERING DRAWINGS

APPENDIX B

COSTIN ROE CONSULTING STORMWATER DEVELOPMENT DESIGN REPORT

Appendix H

Shadow Diagrams

Ground Ink Landscape Architects

Appendix I

Landscape Plans

Ground Ink Landscape Architects

Appendix J

Stormwater Outlet Ecologist Review

Cumberland Ecology

Appendix K

Geotechnical Information