John M. Daly
and Associates Pty Ltd
ABN 88 051 977 989

Development
Consultants

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Our Ref: 14005M
Date: 28 November 2019

Ernest Dupree
Director
Benedict Industries Pty Ltd.

By Email: Ernest@benedict.com.au

Dear Ernest,

RE: Georges Cove Marina – Proposed Marina Development of the RE2 Zone land in Lot 70 in DP1254895
Water Quality Assessment – Issue C

1. Introduction

As requested, JMD have undertaken an assessment of the water quality measures required to ensure that the stormwater runoff from the proposed marina development complies with Liverpool City Council's Design Specifications. This report details the method and findings of this assessment.

a. Site Description

The project site is known as Lot 70 in DP1254895, 146 Newbridge Road, Moorebank.

The site fronts Newbridge Road to the north, Lot 2 in DP in 602988 (Flower Power Nursery) to the north east (recently closed), the Georges River to the South East, Lot 6 in DP1065574 (EQ Projects) to the south and the access handle to Lot 6 in DP1065574 to the west.

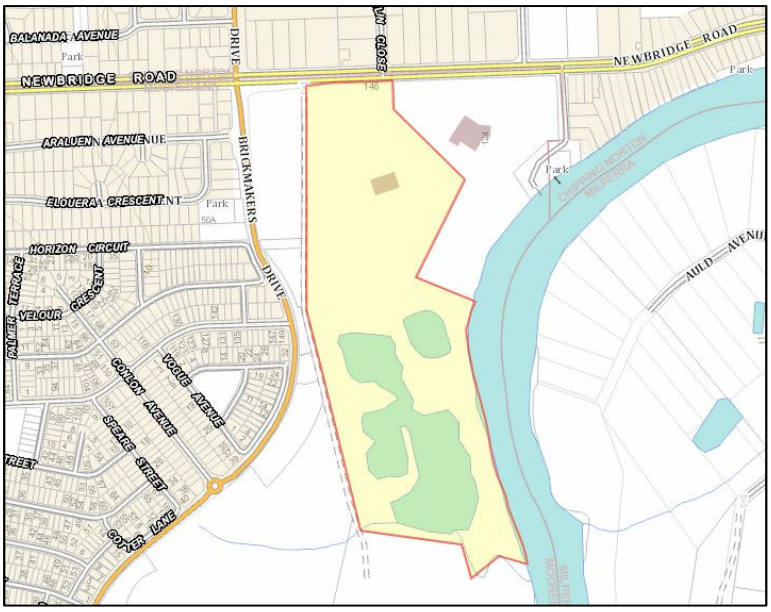

Figure 1: Site Location

An existing man made drainage channel is located immediately inside the western boundary. This drainage channel conveys stormwater flows from the existing development located north of Newbridge Road to an existing creek located in Lot 6 to the south. This creek eventually discharges into the Georges River.

b. Existing Conditions & Other Applications

The site has most recently been used for recycling operations and sand extraction by Benedicts and is currently in a stripped state with limited vegetation located along the boundaries of the site. The southern portion of the site (RE2 zone) contains an existing sand extraction pond which varies in depth but contains a water level similar to the Georges River. Stockpiles are located in various locations around the site.

DA24/2017 prepared and lodged by Mirvac Home proposes that the subject site (Lot 70 in DP1254895) be subdivided in the two stages.

Stage 1 of DA24/2017 creates three lots – Lot 1 (B6), Lot 2 (R3) and Lot 3 (RE2). Under this stage of the development no roads or buildings will be created or constructed. The purpose of this stage is to separate the three zonings on the lot into separate lots.

Stage 2 of DA24/2017 involves the development of Lot 2 (land zoned R3) created under stage 1. This portion of the site will allow the creation of superlots as well as new roads, drainage, utilities, services and pedestrian linkages for approximately 179 medium density residential lots to be constructed in the future. It is noted that the final number of residential lots is to be finalised under future Development Applications. Under this stage of DA24/2017 it is proposed that two raingardens are constructed. Raingarden No.1 is located in the B6 land and outlets to the existing drainage channel. Raingarden No.2 is located in the north eastern area of the RE2 land. Raingarden No.1 serves the northern portion of the residential development while Raingarden No.2 only serves the southern portion of the residential development.

c. Description of Development

This development will involve the development of Lot 3 (RE2) created under Stage 1. It is proposed that this private recreational area is to be developed into a Marina. The proposed Marina contains two water quality facilities. It is proposed that the southernmost water quality facility (Raingarden No.3) serve the Marina while the water quality facility located in the north-eastern corner of the Marina (Raingarden No.2) continue to serve the southern portion of the residential development only.

Included with this letter is an Engineering Concept for Raingarden No.3 (Ref: 14005E39, Sheets 1-2, and dated 28-11-2019). The proposed marina is illustrated on Sheet 1 which also includes an overall Plan of all development within Lot 70. The plan also shows the areas of the site that will drain to Raingarden No.3. In order to meet the water quality targets identified in Liverpool City Council's design code, the stormwater flows off each catchment will need to pass through a GPT and raingarden prior to discharging to the existing creek system.

The only areas that drain into Raingarden No.3 are the roof area, carpark and roads as well as the majority of the landscaped areas within the site. The areas within the Marina that do not drain to the raingarden are the foreshore area, drainage channel, landscaped area grading to the southern creek and marina rock embankment.

This report is limited to the analysis of Raingarden No.3. Raingardens No.1 and No.2 have been assessed in a separate report for the residential development.

2. Description of development

This report primarily supports the development application (DA) to develop the RE2 zoned portion of the site. The DA seeks approval to create two buildings, three carparks, marina and landscaping.

a. Raingarden No.3 Catchment

The catchment area of the Marina site captures stormwater flows from approximately 37,600sqm. This area is broken up as follows:

Table 2-1 – Areas

Roof	12,566 sqm
Road/carpark	18,473 sqm
Landscaping	5,878 sqm

b. Proposed Design

From the EIS for the site it is understood that:

> *Runoff from the Maritime Building and Private Marina Clubhouse roofs will be collected in rainwater tanks (see Section 2.9.2).*
>
> *Given a roof area of approximately 13,140 m2, an average annual rainfall of 654 mm and an average annual volumetric runoff coefficient of 0.7, the average annual runoff volume would be approximately 6,015 m3. There are an average of 82 wet days per year in Moorebank. Therefore, an average of approximately 70 m3 (70,000 L) of water will be discharged from the roofs on each wet day. Of this, up to 50,000 L will be captured in the rainwater tanks for irrigation of landscaped areas and/or for use as recycled water use within the buildings. Overflows from the rainwater tanks will discharge into the marina basin.*

Despite rainwater tanks being used, the Music Modelling assumes a worst case that no rainwater collection will be utilised and the roof water will be directed to the piped drainage system in the roads. JMD note that this is a **conservative approach** as rainwater reuse would actually further enhance the stormwater leaving the site.

Stormwater flows off the roads and carpark will be collected in a piped drainage system and discharged via a SPEL Ecoceptor 1500 (or equivalent) to the end of the raingarden where water will spread out over the raingarden and infiltrate the media before discharging to the Georges River via the Discharge Control Pit.

To address water quality, a number of Water Sensitive Urban Design (WSUD) measures are proposed. It is proposed that stormwater pits throughout the development capture water and convey the water As more than one treatment measure is often needed to capture the large range of pollutants it is proposed that an inline GPT be placed within the pipe system prior to the outlet into the raingarden. This treatment train system works to capture gross pollutants as well as Total Suspended Solids, Phosphates, and Nitrates.

The proposed GPT to be used is a SPEL Ecoceptor 1500 (or equivalent) unit which is manufactured by SPEL. It is noted that an alternative GPT unit is an Ecosol unit. The raingarden is proposed to be a minimum of 2,500sqm with a media level of RL1.6.

A detailed section of the raingarden is included on Sheet 2 of the plans. It is proposed to have a media depth of 300mm thick. This media will be made of sandy loam. A 100mm thick transition layer separates the media from the 200mm gravel layer. The gravel layer contains 100mm dia. subsoil drainage which connects to 150mm dia. solid pipes. The solid pipes connect to the discharge control pit which discharges to the Georges River.

The grate of the Discharge Control Pit is 300mm higher than the bed of the raingarden (top of the media). This provides an extended detention level of 300mm before flows discharge into the top of the pit or overtop into the marina water body. The raingarden media will be landscaped as plants will help filter the water and reduce pollutants.

The thickness of the media is limited by the requirement to maintain a maximum effective materials depth of 600mm within the raingarden. This is a result of the adjoining river foreshore area being at RL1.9 and an outlet level of RL1.0. An outlet level of RL1.0 has been adopted as it ensures that the raingarden can continue to operate during a high tide.

The GPT unit has been placed within 3m of the roadway so it can be cleaned using a vacuum truck. A typical GPT requires cleaning once a year and an operation and maintenance manual for the proposed units is available on the SPEL website. It is proposed that this could be provided to council with the Construction Certificate documentation. The raingarden should require less maintenance, however, a maintenance track into the raingarden has been shown on the plans. It is proposed that this maintenance track utilise part of the cycleway within the river foreshore.

3. Water Quality Model

The proposed water quality measures were modelled using the MUSIC computer model developed by eWater. The model for the developed site was created in accordance with the recommendations described in Liverpool City Council's "Music Link". Sandy Loam soil properties have been adopted for this site as it is close to the Georges River and the site was previously used for sand extraction. Liverpool City Council's "Music Link" also includes the rainfall data that is to be applied to the catchment.

The model for the site was developed with separate nodes for roofs, roads and landscape area as depicted at Figure 3-1. Parameters for each node were updated in accordance with Liverpool City Council's Music Link including the pollutant load parameters. The effectiveness of the GPT was taken from data provided directly by SPEL.

It is proposed that water quality issues will be addressed using a series of components which in combination will act to meet the requirements detailed in Council's current design code. Presently, Council's code requires water quality systems to reduce pollutant loads to the following level:-

Total suspended solids	80% reduction
Total Phosphorus	65% reduction
Total Nitrogen	45% reduction

A model for the proposed developed conditions was produced based on the areas measured for each of the three pollutant areas. A summary of these areas is included above in Table 2-1.

An exhibit of the Music model for the Raingarden No.3 catchment is depicted in Figure 3.1 below.

To confirm that a reduction in pollutant loads is achieved, JMD has run the proposed model using the "Music Link" for Liverpool Council. The Music Link then provides a report which summarises the result of the analysis.

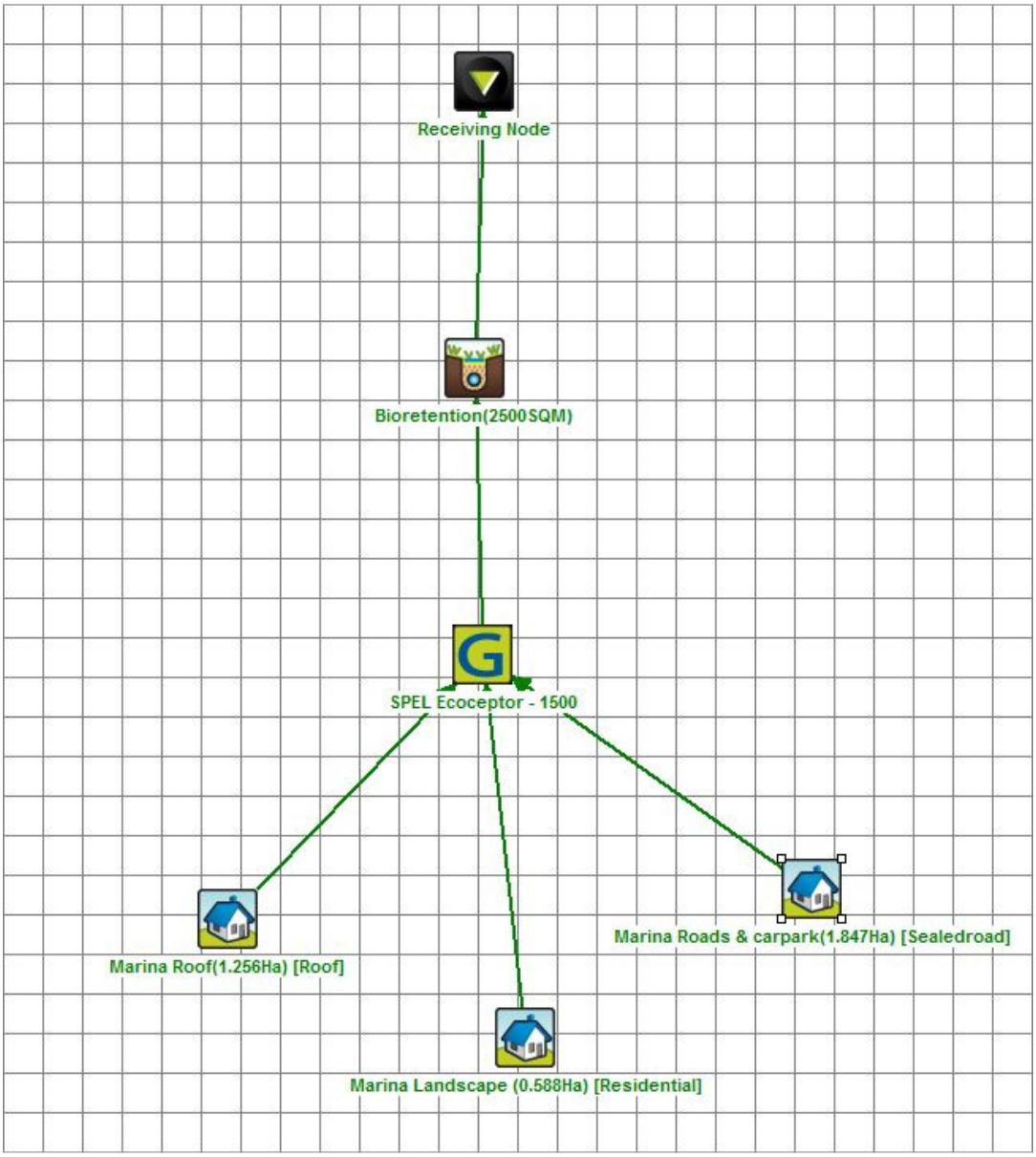

Figure 3.1 – Screen Capture of MUSIC model for Raingarden No.3

A copy of the Music Link Report is appended to this letter. It shows that the WSUD measures proposed reduces pollutant loads by a greater amount than the minimum standards required by Liverpool City Council's Design Specifications.

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	Bioretention(2500SQM)	Exfiltration Rate (mm/hr)	0	None	0
Bio	Bioretention(2500SQM)	Hi-flow bypass rate (cum/sec)	0	None	0.3
Bio	Bioretention(2500SQM)	Orthophosphate Content in Filter (mg/kg)	0	55	40
Bio	Bioretention(2500SQM)	PET Scaling Factor	2.1	2.1	2.1
Bio	Bioretention(2500SQM)	Total Nitrogen Content in Filter (mg/kg)	1	800	750
Receiving	Receiving Node	% Load Reduction	None	None	16.5
Receiving	Receiving Node	GP % Load Reduction	90	None	98.5
Receiving	Receiving Node	TN % Load Reduction	45	None	70.8
Receiving	Receiving Node	TP % Load Reduction	65	None	83.1
Receiving	Receiving Node	TSS % Load Reduction	85	None	95.8
Urban	Marina Landscape (0.588Ha)	Area Impervious (ha)	None	None	0.058
Urban	Marina Landscape (0.588Ha)	Area Pervious (ha)	None	None	0.529
Urban	Marina Landscape (0.588Ha)	Total Area (ha)	None	None	0.588
Urban	Marina Roads & carpark(1.847Ha)	Area Impervious (ha)	None	None	1.847
Urban	Marina Roads & carpark(1.847Ha)	Area Pervious (ha)	None	None	0
Urban	Marina Roads & carpark(1.847Ha)	Total Area (ha)	None	None	1.847
Urban	Marina Roof(1.256Ha)	Area Impervious (ha)	None	None	1.256
Urban	Marina Roof(1.256Ha)	Area Pervious (ha)	None	None	0
Urban	Marina Roof(1.256Ha)	Total Area (ha)	None	None	1.256

Only certain parameters are reported when they pass validation

Figure 3.2 – Exhibit of the Music Link Report Results for Raingarden No.3

4. Conclusion

This assessment has been undertaken to determine the extent of treatment devices required on the Georges Cove Marina development (Lot 70 in DP1254895) such that the stormwater runoff from the developed site will be effectively treated as required by Liverpool City Council.

The assessment has found that a combination of a GPT and a 2500sqm raingarden (bio-retention basin) will exceed council's specifications and will achieve the required level of treatment.

Yours faithfully

…….
Shane Gray
Senior Civil Engineer
BE (Civil)

APPENDIX A

ENGINEERING PLANS (REF: 14005M-E2) - SHEETS 1-2 of 2 – ISSUE B

PROPOSED RESIDENTIAL SUBDIVISION TO BE DESIGNED & CONSTRUCTED BY OTHERS UNDER DA 24/2017

RAINGARDEN NO.2 (SOUTHERN RAINGARDEN) TO BE CONSTRUCTED UNDER (DA 24/2017)

TOTAL CATCHMENT AREA DRAINING TO MARINA RAINGARDEN = 37,612m²

CATCHMENT BREAKDOWN

	DENOTES ROOF	= 12,566m²
	DENOTES ROAD/CARPARK	= 18,473m²
	DENOTES LANDSCAPING	= 5,878m²

TO ALLOW ALL DRAINAGE PITS TO DRAIN TO THE MARINA RAINGARDEN, PIPES WILL NEED TO GRADE AT APPROXIMATELY 0.5%. SHOULD COUNCIL NOT ALLOW PIPES TO GRADE AT 0.5%, PIT 'A' WILL NEED TO BE CONSTRUCTED AS A SMALL PUMP STATION & PUMP STORMWATER FLOWS TO PIT 'B'

PROPERTY BOUNDARY

LOT 70 PROPERTY BOUNDARY

LIMITS OF MARINA (SUBJECT TO DA)

CARPARK 1 TO BE PIPED TO MARINA RAINGARDEN

PIT A

CHANNEL

DRAINAGE

EXISTING

DRAINAGE PIPES TO BE SLUNG FROM UNDERSIDE OF BUILDING

ROOF 1

ROOF 2

ROOF DOWNPIPES TO BE CONNECTED TO PIT 'B'

RAINGARDEN No.3 (MARINA RAINGARDEN) REFER TO DETAILS ON SHEET 2

PROPOSED DRAINAGE TO DRAIN MAJOR FLOWS TO RIVER

PIT C

CARPARK 2

PIT B

CARPARK 3

LIMITS OF MARINA (SUBJECT TO DA)

LANDSCAPING IN THIS AREA FALLS TO EXISTING CHANNEL/CREEK

EXISTING CREEK

ALL PIPES DRAINING FROM PIT 'B' TO PIT 'C' WILL BE CONSTRUCTED WITH A MINIMUM GRADE OF 1%

EXISTING CREEK

GEORGES RIVER

N

PROPOSED MARINA WORKS

RATIO 1:1000

NEWBRIDGE ROAD

FUTURE B6 (COMMERCIAL) DEVELOPMENT TO BE COMPLETED BY OTHERS INCL. COLLECTOR RD CONNECTING TO LOT 2 DP602988

PT 310 DP1118048

PROPOSED RESIDENTIAL SUBDIVISION TO BE DESIGNED & CONSTRUCTED BY OTHERS UNDER DA 24/2017

LOT 2 DP 602988 (FLOWER POWER)

309 DP1118048

PT 310 DP1118048

FUTURE FORESHORE DEDICATION

PT 200 DP1117280

DRIVE

RAINGARDEN NO.2 BEING COMPLETED UNDER THE RESIDENTIAL SUBDIVISION BY OTHERS (DA 24/2017)

201 DP1117280

LOT 70 PROPERTY BOUNDARY

BRICKMAKERS

GEORGES RIVER

PT 200 DP1117280

PT 310 DP1118048

MARINA RAINGARDEN (RAINGARDEN NO.3)

6 DP1065574

FUTURE FORESHORE DEDICATION

LIMITS OF MARINA (SUBJECT TO DA)

6 DP1065574

0 2.5 5 10 15 20 25 50

SCALE :- 1 : 2000

0 5 10 20 30 40 50 100

SCALE :- 1 : 1000

OVERALL DEVELOPMENT PLAN

RATIO 1:2000

Issue	App	Date	Description
B	S.G.	28-11-2019	MINOR AMENDMENTS PER CLIENT COMMENTS
A	S.G.	25-11-2019	ISSUED AS PART OF THE WATER QUALITY ASSESSMENT FOR DA

Client: BENEDICTS

Designed by : S.G.

Date of Drawing : 25-11-2019

Ratio (A1) : VARIOUS

Datum : AHD

Origin of Levels :

Date of Survey : N/A

JMD Development Consultants

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Surveying Engineering Project Management Licensed Water Service Co ordinators
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FAX (02) 4628 2013
email: admin@jmd.com.au

Project : GEORGES COVE MARINA
NEWBRIDGE ROAD, MOOREBANK

Sheet 1 of 2 sheets

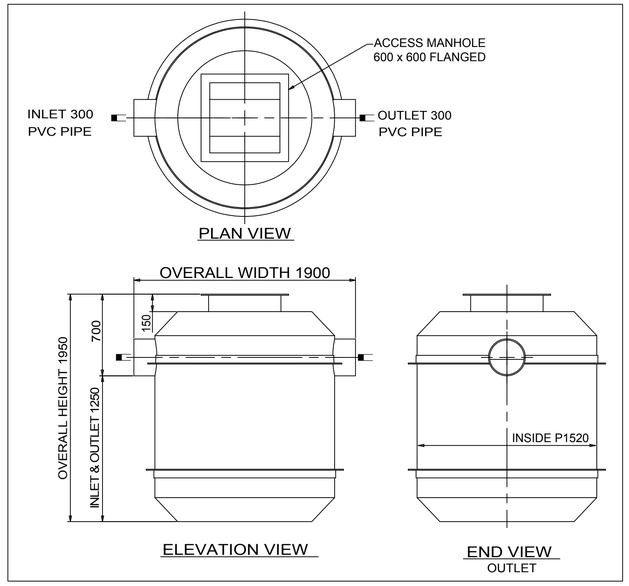
OVERALL PLAN

Ref: 14005M-E2

Locality : MOOREBANK

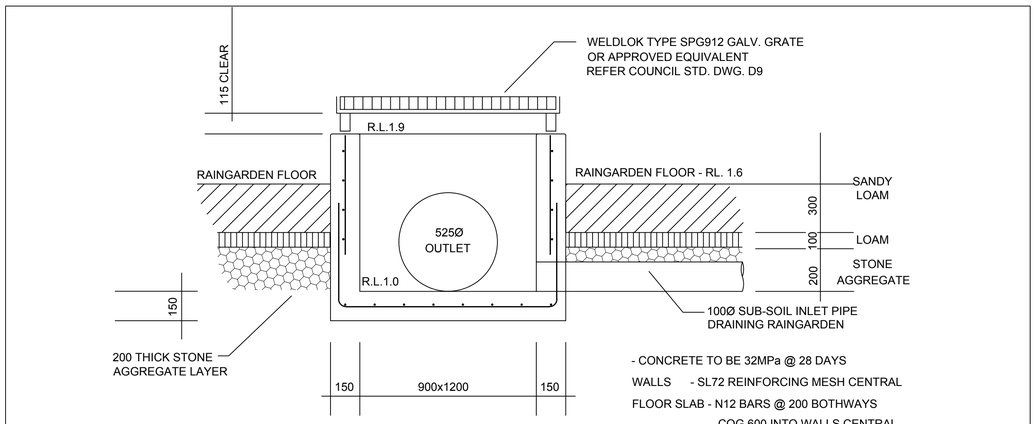
L.G.A. : LIVERPOOL

CAD Ref: S:\JOBS\14\14005\14005M - MARINA\ENG\CAD\E2 - WATER QUALITY\14005M-E2 - WQ BASE



GPT OPTION - SPEL ECOCEPTOR 1500 ELEVATIONS

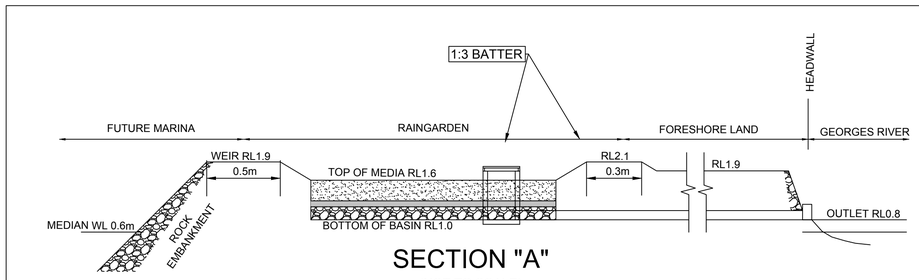
NOT TO SCALE



- CONCRETE TO BE 32MPa @ 28 DAYS
WALLS - SL72 REINFORCING MESH CENTRAL
FLOOR SLAB - N12 BARS @ 200 BOTHWAYS
COG 600 INTO WALLS CENTRAL

DISCHARGE CONTROL OUTLET PIT

NOT TO SCALE



SECTION "A"

(NOT TO SCALE)

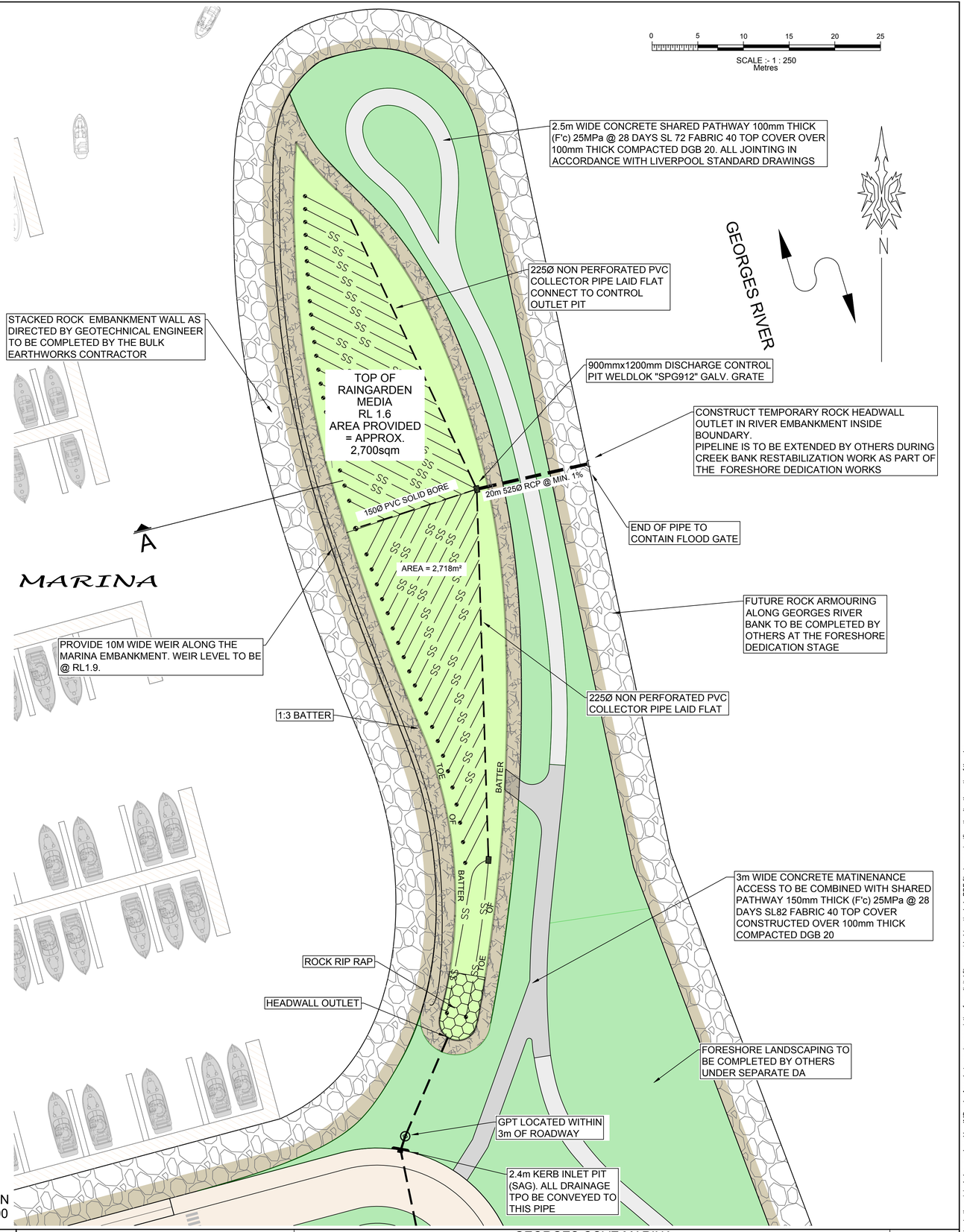
LEGEND

- 225Ø NON PERFORATED PVC PIPE LAID FLAT & 150Ø PVC NON PERFORATED RISER FLUSHING EYE
- 100Ø PERFORATED PVC SUBSOIL PIPELINE & 150Ø PVC NON PERFORATED RISER FLUSHING EYE

SUBSOIL DRAINAGE PIPE DETAILS

MAIN FEED LINE - 225Ø NON PERFORATED PVC PIPE LAID FLAT
INFILTRATION LINE - 100Ø PERFORATED PVC PIPELINE LAID 45° TO MAIN LINE @ 2m SPACINGS

NOTE : FLUSHING EYES ARE TO RETURN TO 5cm ABOVE THE RAINGARDEN SURFACE (NON PERFORATED) & CAPPED OFF WITH A REMOVABLE COVER FOR FLUSHING ACCESS.



PLAN
1:400

Issue	App	Date	Description
B	S.G.	28-11-2019	MINOR AMENDMENTS PER CLIENT COMMENTS
A	S.G.	25-11-2019	ISSUED AS PART OF THE WATER QUALITY ASSESSMENT FOR DA

Client: MIRVAC HOMES (NSW) PTY LTD.
Designed by : S.G.
Date of Drawing : 25-11-2019
Ratio (A3) : 1:250
Datum : AHD
Origin of Levels :
Date of Survey : N/A

JMD Development Consultants

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Project : GEORGES COVE MARINA
NEWBRIDGE ROAD, MOOREBANK

MARINA RAINGARDEN

Sheet 2 of 2 sheets
Ref: 14005M-E2

Locality : MOOREBANK
L.G.A. : LIVERPOOL
CAD Ref: S:\JOBS\14\14005\14005M - MARINA\ENG\CAD\E2 - WATER QUALITY\14005M-E2 - WQ BASE

APPENDIX B
MUSIC LINK REPORT

LIVERPOOL CITY COUNCIL

music@link

MUSIC-*link* Report

Project Details		Company Details	
Project:	Georges Cove Marina - Marina Water Quality Assessment	**Company:**	JMD Development Consultants
Report Export Date:	27/11/2019	**Contact:**	Shane Gray
Catchment Name:	Marina Raingarden with treatment2	**Address:**	32 Iolanthe Street, Campbelltown NSW 2560
Catchment Area:	3.691ha	**Phone:**	4625 5055
Impervious Area*:	85.65%	**Email:**	sgray@jmd.com.au
Rainfall Station:	67035 LIVERPOOL(WHITLAM		
Modelling Time-step:	6 Minutes		
Modelling Period:	1/01/1967 - 31/12/1976 11:54:00 PM		
Mean Annual Rainfall:	857mm		
Evapotranspiration:	1171mm		
MUSIC Version:	6.3.0		
MUSIC-link data Version:	6.32		
Study Area:	Liverpool Sandy Loam Soil		
Scenario:	Liverpool Development		

* takes into account area from all source nodes that link to the chosen reporting node, excluding Import Data Nodes

Treatment Train Effectiveness

Node: Receiving Node	Reduction
Flow	16.5%
TSS	95.8%
TP	83.1%
TN	70.8%
GP	98.5%

Treatment Nodes

Node Type	Number
Bio Retention Node	1
Generic Node	1

Source Nodes

Node Type	Number
Urban Source Node	3

Comments

The Raingarden Filter Media Depth is 0.3m thick which is slighly smaller than the recommended minimum of 0.4m thick. This is because the raingarden levels are limited by the existing foreshore land levels that must be maintained and the requirement to ensure that the raingarden can drain in the mean high tide within the Georges River. Regardless of this the modelling shows that it works and all water quality improvements are met.

All other parameters meet Liverpool Council's recommendations for a Sandy loam soil type.

LIVERPOOL CITY COUNCIL

music@link

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	Bioretention(2500SQM)	Exfiltration Rate (mm/hr)	0	None	0
Bio	Bioretention(2500SQM)	Hi-flow bypass rate (cum/sec)	0	None	0.3
Bio	Bioretention(2500SQM)	Orthophosphate Content in Filter (mg/kg)	0	55	40
Bio	Bioretention(2500SQM)	PET Scaling Factor	2.1	2.1	2.1
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Urban	Marina Roads & carpark(1.847Ha)	Area Pervious (ha)	None	None	0
Urban	Marina Roads & carpark(1.847Ha)	Total Area (ha)	None	None	1.847
Urban	Marina Roof(1.256Ha)	Area Impervious (ha)	None	None	1.256
Urban	Marina Roof(1.256Ha)	Area Pervious (ha)	None	None	0
Urban	Marina Roof(1.256Ha)	Total Area (ha)	None	None	1.256

Only certain parameters are reported when they pass validation

LIVERPOOL CITY COUNCIL

music *link*

Failing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	Bioretention(2500SQM)	Filter depth (m)	0.4	0.8	0.3

Only certain parameters are reported when they pass validation