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Project name:
Cranbrook School Redevelopment

Project ref:
60549969

From:
Daniel Fettell

Date:
December 13, 2018

Memo

Subject: Water Sensitive Urban Design and Water Balance

1.0 Introduction

The Cranbrook School is undertaking a redevelopment project, which involves the delivery of a new sports and fitness centre under Hordern Oval and a new integrated learning centre known as the Centenary Building to replace the existing War Memorial Hall and Mansfield Buildings. Located in the eastern suburb of Bellevue Hill, the Cranbrook School Senior Campus is approximately 5km East of the Sydney CBD and is bounded by New South Head Road to the North and West and Rose Bay Avenue to the East.

The overall site is approximately 4.2 Ha in size and is situated on a hill that slopes in a northerly direction. The current site consists of significant impervious areas including paved roads, bitumen driveways, paved footpaths and buildings. Pervious areas include the grassed oval and garden beds. A report on Geotechnical Investigation was prepared by Douglas & Partners in February 2016 indicating that the site is predominantly underlain by silty sand with groundwater at depths between RL 6.7m to RL 12.8m AHD.

The purpose of this memo is to propose a Water Sensitive Urban Design (WSUD) and rainwater reuse strategy which satisfies existing Council, Waterways Authority and Sydney Water design parameter requirements. Additionally, this report assesses water balance measures to target Ecologically Sustainable Development (ESD) outcomes for the development.

A site plan with the extent of proposed works is outlined below in Figure 1.

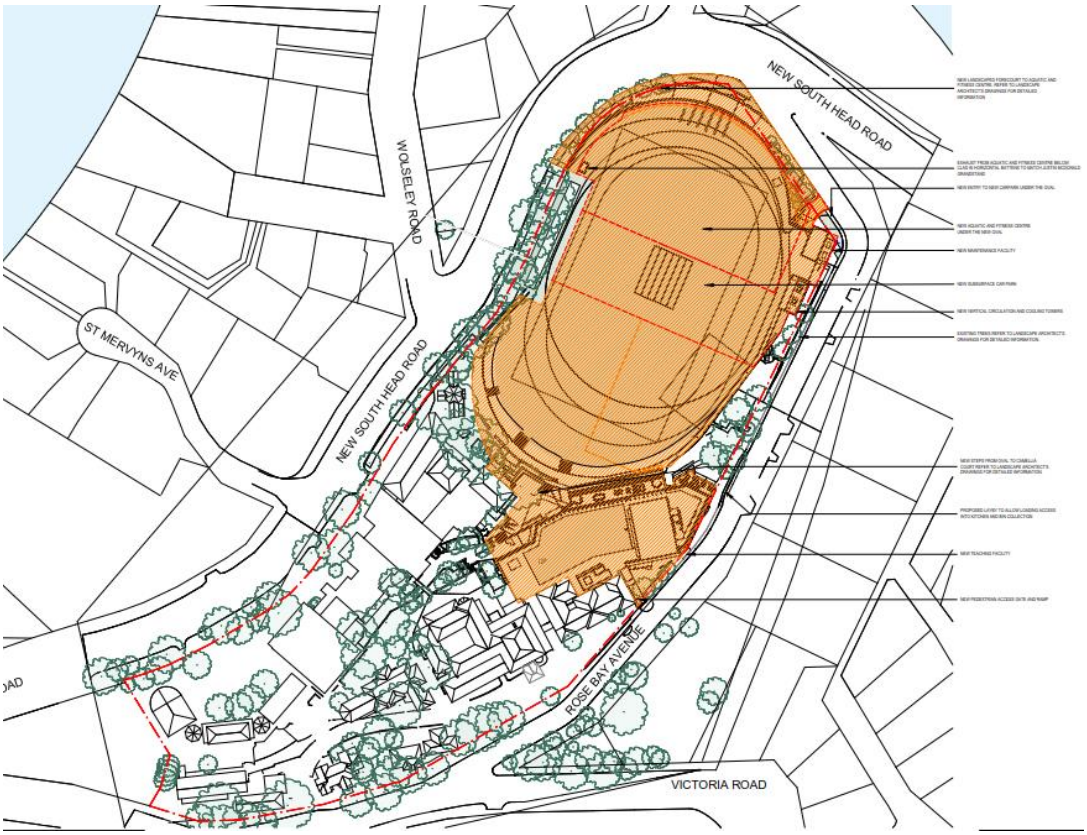


Figure 1 Proposed Site Works

2.0 Woollahra Council WSUD Requirements

The Cranbrook School is located within the Woollahra Council LGA with WSUD constraints being governed by the Woollahra Council Development Control Plan (2015).

Woollahra Council DCP *Section E2.2.3* details the water quality requirements for developments with the intent to minimise the discharge of pollutants from paved and other impermeable surfaces into Sydney Harbour, surrounding waterways and drainage systems. Additionally, Cranbrook have restated these conditions within their comments on the Cranbrook State Significant Development Application.

The DCP specifies stormwater treatment is required for:

- All properties with connections to Sydney Harbour, waterways and open watercourses;
- All new commercial developments and residential flat buildings; and
- All major alterations and additions to commercial developments and residential flat buildings.

The environmental targets for stormwater runoff leaving the site as established in *Clause C7* of the DCP and **Condition 6 & 28** of the council response are:

- 90% removal of gross pollutants (>5mm);
- 85% removal of total suspended solids;
- 65% removal of total phosphorous; and
- 45% removal of total nitrogen.

Several WSUD measures have been proposed for implementation and the effectiveness of each will be assessed through MUSIC modelling.

2.0 Woollahra Council Rainwater Requirements

As a part of the Woollahra Council comments, they have provided the following requirements:

Condition 5. The applicant is to provide integrated water sensitive design which includes the following at a minimum:

- A rainwater/stormwater collection tanks/s (harvest tanks) with a minimum additional capacity of 200m^3;
- A stormwater diversion system that continually diverts and treats water from the existing Council drainage system is to be implemented;
- All new roof areas hard paved areas are to be directed to the harvest tanks; and
- The integrated water sensitive design system is to be designed to meet or exceed Councils water treatment guidelines.

Condition 28: The Construction Certificate plans and specifications, required by Clause 13 9 of the Regulation, must include a Stormwater Management Plan for the site. The Stormwater Management Plan must detail:

a. General design in accordance with stormwater plans prepared by AECOM, with the following amendments:
   1. The applicant is to provide integrated water sensitive design which includes the following at a minimum:
      I. A rainwater/stormwater collection tanks/s (harvest tanks) with a minimum additional capacity of 200m.
      II. A stormwater diversion system that continually diverts and treats
      III. water from the existing Council drainage system is to be
      IV. implemented
      V. All new roof areas hard paved areas are to be directed to the harvest tanks.
      VI. The integrated water sensitive design system is to be designed to meet or exceed Councils water treatment guidelines.
   2. Water quality measures are installed that meet the following environmental targets for stormwater runoff leaving the site:
      I. 90% removal of gross pollutants(> 5mm);
      II. 85% removal of total suspended solids;
      III. 65% removal of total phosphorous; and
      IV. 45% removal of total nitrogen.
b. Compliance the objectives and performance requirements of the BCA;
c. The installation of minimum I00m3 rainwater tank which is to be connected for non-potable uses such as all toilet flushings, laundry devices and garden irrigations. Overflow from the rainwater tank shall be directed to the proposed on-site absorption system;
d. The installation of a bio-retention system to achieve the water quality targets stipulated in Chapter E2.2.3 of Council's DCP; and
e. General compliance with the Council's Woollahra DCP 2015 Chapter E2- Stormwater and Flood Risk Management.

The Stormwater Management Plan must also include the following specific requirements

Layout plan

A detailed drainage plan at a scale of 1: 100 based on drainage calculations prepared in accordance with the Institute of Engineers Australia publication, Australian Rainfall and Runoff 1987 edition or most current version thereof. It must include:

a. All pipe layouts, dimensions, grades, lengths and material specification;
b. Location of proposed rainwater tanks;
c. All invert levels reduced to Australian Height Datum (AHD);
d. Location and dimensions of all drainage pits;
e. Point and method of connection to Councils drainage infrastructure; and
f. Overland flow paths over impervious areas.

Rainwater Reuse System details:

a. Any potential conflict between existing and proposed trees and vegetation;
b. Internal dimensions and volume of the proposed rainwater storage;
c. Plans, elevations and sections showing the rainwater tanks, finished surface level and adjacent structures;
d. Details of access and maintenance facilities;
e. Construction and structural details of all tanks and pits and/or manufacturer's specifications for proprietary products; and
f. Details of the emergency overland flow-path (to an approved Council drainage point) in the event of a blockage to the rainwater tanks.

3.0 WSUD Implementation

A number of WSUD measures have been considered for the Cranbrook School development site which includes:

Rainwater tanks

Two rainwater tanks are proposed for use on the site:

- Tank 1: A new underground rainwater harvesting tank is to be located adjacent the proposed Centenary Building to provide irrigation to landscape planting around the Centenary Building and new landscaped elements to the south of the Hordern Oval; and
- Tank 2: Existing two 2kL rainwater tanks located underneath Justin McDonald oval to remain as shown in Figure 2 below. Refer to ARUP Oval detail drawing [AFC-O-SK-050].

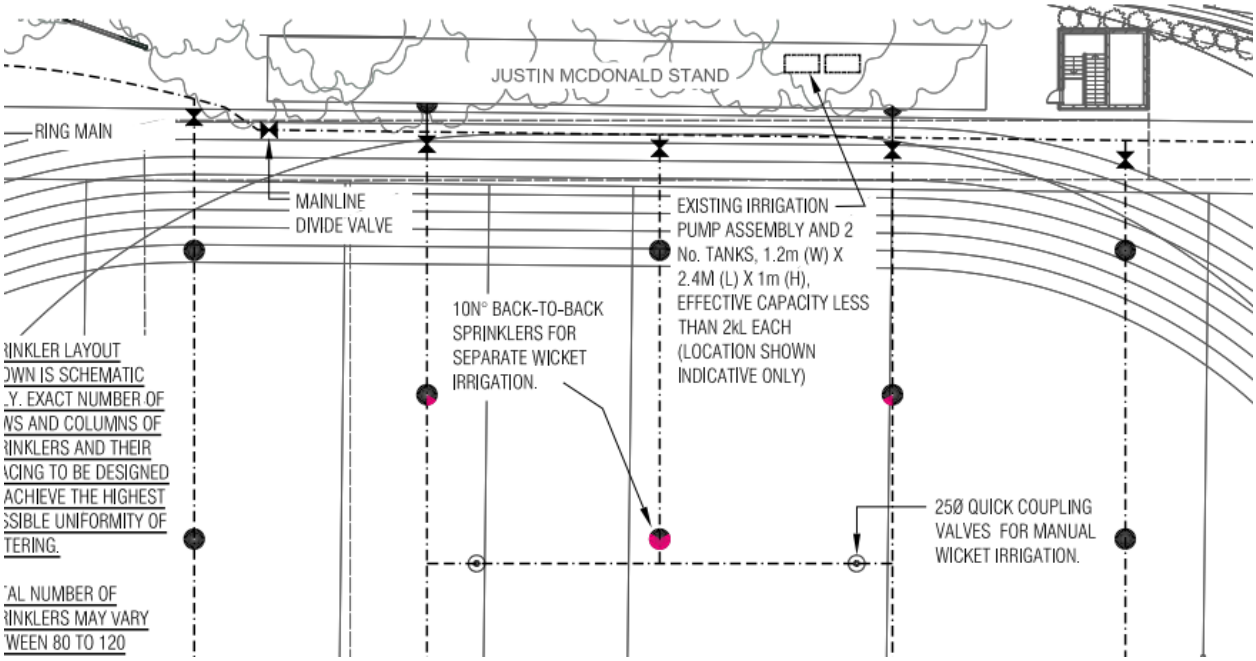


Figure 2 Hordern Oval Irrigation Layout

The sizing of Tank 1 has been determined and optimised based on the MUSIC modelling results with consideration for meeting pollution reduction targets and required water demands. Appendix A outlines indicative rainwater tank location schematic.

It is noted that some further design works are required to ensure that the existing stormwater can be connected to the existing irrigation tanks and system.

Grassed swales

Located along the perimeter of the oval to remove pollutants and divert surface runoff from the oval to nearby drainage pits to prevent ponding. Shallow v-profile swales have been considered to suit the School's preference to minimise surface drainage infrastructure. Due to the grade of the oval, swales will have a longitudinal grade typically between 0.7 to 0.9%. Swales will be 'leaky' to facilitate infiltration of stormwater. Refer to *Cranbrook School Redevelopment – Hordern Oval Design Brief, 2018* [256385-60 RPT 001] and drawings AFC-O-SK-010[P4] to AFC-O-SK-061[P3] for oval drainage details. Refer to Appendix A for locations.

Gross Pollutant Traps (GPTs)

GPTs adopted as part of the development's WSUD strategy should be sized based on catchment area and treatment effectiveness. The *Rocla CDS Nipper 0506* has been used here for modelling purposes. Technical Specifications for this GPT can be found below:

http://www.rocla.com.au/CDS-Units.php

Biofiltration

Biofiltration has been proposed due to its reduced footprint size, relatively cheap cost and effectiveness at removing pollutants. Table 1 below summarises the typical biofiltration properties that were input into MUSIC modelling.

Table 1 Biofiltration Properties

Biofiltration Properties	Units	Value
Extended Detention Depth	m	0.15
Filter Depth	m	0.45
Saturated Hydraulic Conductivity	mm/hour	100.00
Exfiltration Rate	Mm/hour	75.00

The viability of these WSUD strategies in reaching pollution reduction targets and their impact on the site's water balance has been assessed through MUSIC modelling outlined in the following Section. The integration of proposed WSUD elements into the surface drainage layout produced by ARUP (refer Appendix A) can be further resolved at detailed design. Biofiltration could be incorporated into garden beds or as stand-alone biofiltration street tree pits.

4.0 Demonstration of Compliance (MUSIC Modelling)

MUSIC modelling has been undertaken to assess the quality of stormwater runoff discharged from the proposed development site to ensure water quality requirements are met. Results for the area within the extent of works demonstrate that integrating the proposed WSUD techniques allows the pollution reduction targets as outlined in Section 2.0 to be satisfied.

For planning purposes, a rainfall record with an average annual rainfall depth of 1490mm was selected using a 6 minute time step. The music model structure is shown in Figure 3 and a Land Use Schedule is presented in Table 2.

MUSIC modelling indicates that to achieve the required pollution reduction targets additional treatment measures will be required as summarised below. Locations and indicative spatial requirements for these are also shown in Appendix A.

- Rainwater tank 50kL size located adjacent Centenary Building;
- Two existing rainwater tanks each 2kL located inside Justin McDonald Stand;
- Biofiltration (approx. 20m^2 size) located downstream from the Oval 1 catchment;
- Biofiltration (approx. 10m^2 size) to treat the frontage public domain catchment area;
- GPT treating Centenary Building and Oval 3 catchment area. AECOM recommends *Rocla CDS Nipper Series* or equivalent GPT to be used;
- Grassed Swale (Oval 1 catchment) - 40m @ 0.6% grade;
- Grassed Swale (Oval 2 catchment) – 70m @ 0.8% grade;
- Grassed Swale (Oval 3 catchment) – 100m @ 0.9% grade; and
- Buffer area located in public domain.

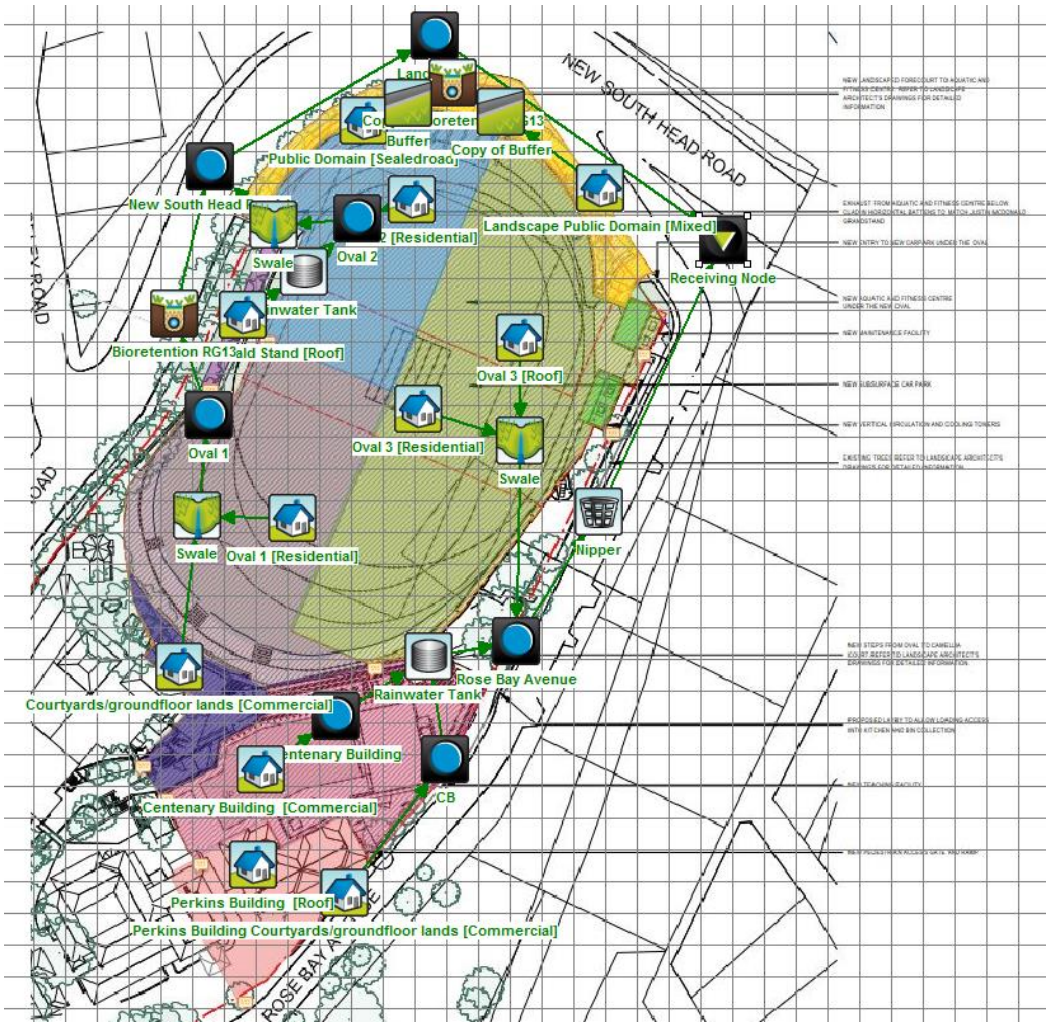


Figure 3 MUSIC model structure (file ref: 60549969-Cranbrook_School_V5_RWT.sqz)

Table 2 Land Use Schedule

Catchment	Area (Ha)
Centenary Building	
Roof areas (rain garden)	0.330
Perkins Building	
Roof areas	0.096
Courtyards/ground floor lands	0.133
Justin McDonald Stand	
Roof areas	0.040
Oval (South)	
Oval 1	0.870
Courtyards/ ground floor lands	0.180
Oval (North)	
Oval 2	0.646
Oval (East)	
Roof areas	0.041
Oval 3	1.345
Frontage	
Public Domain	0.130
Landscaped Public Domain	0.139

Results of the MUSIC modelling are provided in Table 3

Table 3 MUSIC Modelling Results

Pollutants	Sources (`kg/yr)	Residual Load (kg/yr)	% Reduction	Compliance
Total Suspended Solids	3,250	564	82.7%	Yes
Total Phosphorus	6.4	1.7	73.4%	Yes
Total Nitrogen	46.7	18.7	59.9%	Yes
Gross Pollutants	291	0	100%	Yes

The proposed WSUD strategy will meet the water quality targes prescribed by Woollahra Council for stream health and stability. The proposed development would therefore have an acceptable impact on the Sydney Harbour.

5.0 Integrated Water Cycle Management and Rainwater Reuse

An annual water balance for the proposed development has been investigated to show the quantum of stormwater volumes discharged. A range of 30-50mm/week demand for landscape irrigation was recommended by Arcadia, which is equivalent to approximately 1.56 - 2.6kL/m2/year. It has been proposed that roof runoff from the Centenary Building will be used to irrigate surrounding planting landscape area totalling 2903m^2 while harvested rainwater from Justin McDonald Stand be used for irrigating Hordern Oval totalling totals 13,000m^2. Excess water from the Centenary Building tank will also be used for Hordern Oval irrigation.

Based on the MUSIC modelling, all of the Centenary Building runoff is used with a tank size of 50kL and any additional storage would provide a negligible increase in non-potable water for irrigation. The proposed new Centenary Building rainwater tank will provide up to 31.35% of the required non-potable water demand while the Justin McDonald Stand tanks will provide up to 0.39%, as such a potable water connection will still be required for irrigation.

It is noted that the proposed tanks are smaller than the 200m^3 initially proposed by Woollahra council however they meet the required WSUD functions and are sized to reuse all water collected from the Centenary Building green roof and hard paved areas at roof level. The green roof covers approximately 30% of the roof area and serves the function of reducing runoff and improving water quality. Additionally as the entire roof runoff is being used for irrigation, this does not leave non-potable water available for toilet flushing's and laundry devices.

6.0 Recommendation

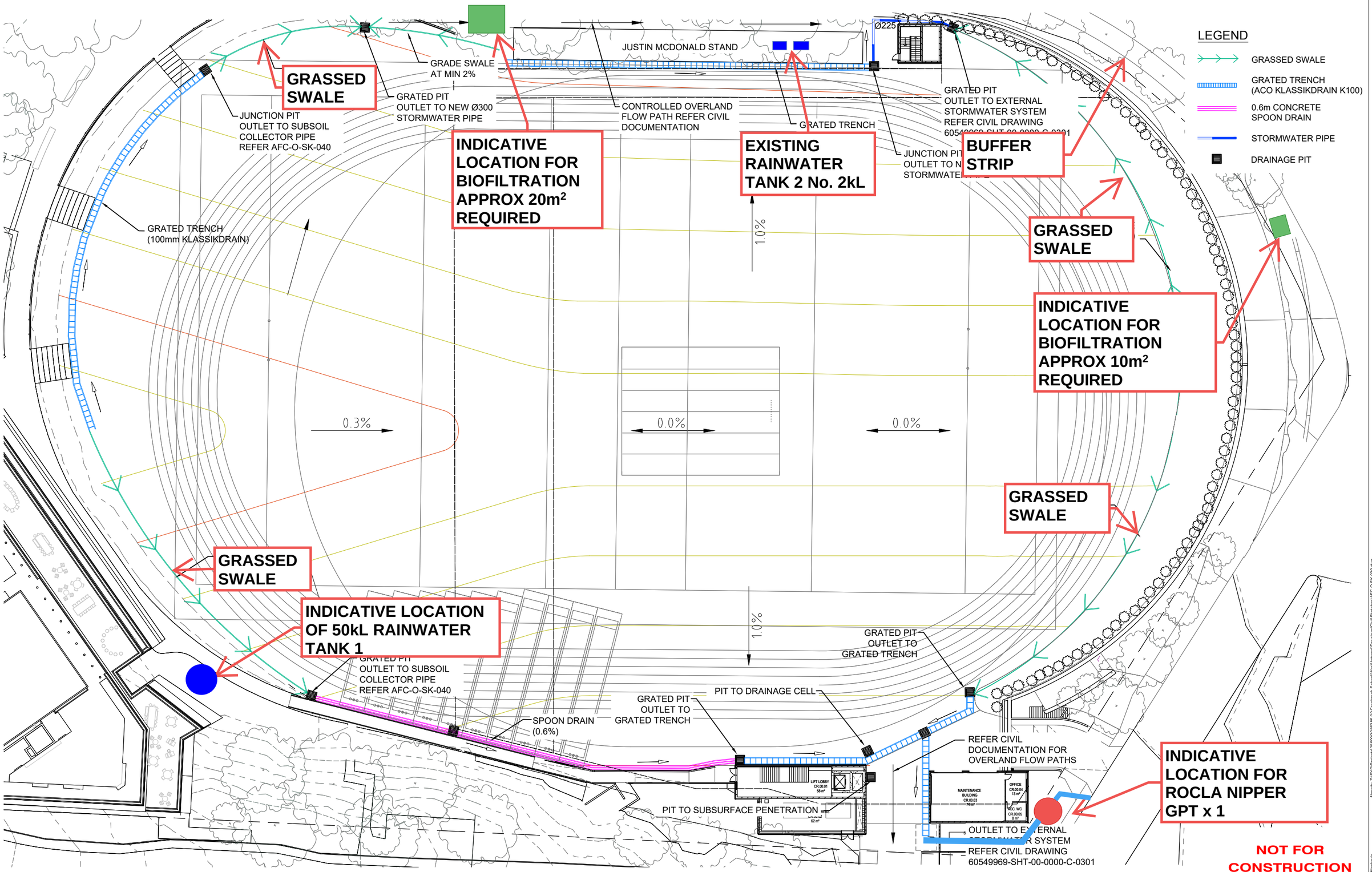
To achieve the project objectives and meet the required WSUD objectives, the following is proposed:

- Rainwater tank 50kL size located adjacent Centenary Building;
- Two existing rainwater tanks each 2kL located inside Justin McDonald Stand;
- Biofiltration (approx. 20m^2 size) located downstream from the Oval 1 catchment;
- Biofiltration (approx. 10m^2 size) to treat the frontage public domain catchment area;
- A GPT treating Centenary Building and Oval 3 catchment area. AECOM recommends *Rocla CDS Nipper Series* or equivalent GPT to be used;
- Grassed Swale (Oval 1 catchment) - 40m @ 0.6% grade;
- Grassed Swale (Oval 2 catchment) – 70m @ 0.8% grade;
- Grassed Swale (Oval 3 catchment) – 100m @ 0.9% grade; and
- Buffer area located in public domain.

The current design shows the stormwater layout plans as required in Council Condition 28 and as a part of design development the Rainwater Reuse System details as outlined in Council Condition 28 will be added to the design documentation.

As such the design complies with the intent of the Woollahra Council conditions, utilising rainwater tanks that have been sized to optimise runoff (based on the water balance) and achieving WSUD requirements.

Appendix A



Rev	Date	By	Chkd	Appd
P4	7/27/2018	SM	PJS	PJS
	For Information			
P3	5/25/2018	SM	PJS	PJS
	For Information			
P2	5/7/2018	SM	PJS	PJS
	For Information			
P1	4/23/2018	SM	PJS	PJS
	For Information			

NORTH

0 5 10 Metres

Scale 1:250

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Client: Cranbrook School

Project Title: Cranbrook School Redevelopment

Drawing Title: Hordern Oval Surface Drainage Layout

Scale at A1: 1:250

Role: Oval

Suitability: Scheme Design

Arup Job No: 256385

Rev: P4

Name: AFC-O-SK-030

Do not scale

plot date: 27/07/2018 10:01:38 AM by: Stephanie Markovic

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