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CIVIL ENGINEERING REPORT
HORSLEY DRIVE BUSINESS PARK
S96 APPLICATION

PROPOSED DEVELOPMENT AT
HORSLEY DRIVE & COWPASTURE ROAD
WETHERILL PARK NSW

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1 INTRODUCTION

1.1 Introduction

Australand, on behalf of The Western Sydney Parkland Trust, proposes to develop a tract of land at Wetherill Park, NSW, as an industrial estate. The land, located on the corner of The Horsley Drive and Cowpasture Road, comprises an area of 21.38Ha Ha and is located within the Western Sydney Parkland corridor in the South Western Sydney region.

A State Significant Development Approval (SSD-5169, dated 8 January 2013) has been granted for this land by the NSW Department of Planning and Infrastructure (DoPI) based on access to the land from an upgraded intersection at Cowpasture Road and Newton Road. The current S96 Application is for an amendment to the current approval with access being made from a new intersection which is located on Cowpasture Road between its intersection with Newton Road and Victoria Street.

1.2 Scope

Costin Roe Consulting Pty Ltd has been commissioned by Australand to prepare this Engineering Report in support of the proposed S96 Application for the site.

This report provides a summary of the design principles and planning objectives for the following civil engineering components of the project:

- Roads and Transportation
- Earthworks;
- Stormwater Management; and
- Erosion Control.

The engineering objectives for the development are to create a site which, based on the proposed architectural layout, responds to the 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.

A concept set of drawings have been prepared to show the proposed road construction, bulk earthworks for future lots, retaining walls, stormwater drainage and services. The information provided is conceptual only, providing sufficient detail to show that the development can be performed within the objectives of Fairfield City Council and The NSW Department of Planning.

1.3 Authority Jurisdiction

The subject site is located within Fairfield City Council area however as a state significant development, the NSW Department of Planning is the consent authority. The development is to be completed in accordance with the Director General's Environmental Assessment Requirements, SSD5169 dated 16 March 2012.

1.4 Design Differences

As noted in **Section 1.1**, this S96 Application is for an amendment to the current State Significant Development Approval, SSD-5169, dated 8 January 2013. The revised application is a result of market demand and access problems with the approved layout which require a new location for the site access to be made. The new location for the access road intersection will be located on Cowpasture Road approximately midway between its intersection with Newton Road and Victoria Street.

Generally the engineering strategy will remain consistent with the approved development however some differences due to the new access road location and consequent adjustment to the internal lot layout will be made.

The main differences in the design and engineering strategy for the development are as follows.

Erosion and Sediment Control

During the construction phase of the development, an Erosion and Sediment Control Program will be implemented to minimise water quality impacts. The overall strategy for erosion and sediment control for the development remains consistent with the original submission with adjustment to the layout and access road as shown on new drawings Co11492.05-DA20 and DA25.

The proposed erosion and sediment control measures are based on the guidelines contained in the Landcom document *Managing Urban Stormwater, Soils and Construction – The Blue Book (1998)* and Fairfield Council specifications. A detailed Erosion and Sediment Control Program will be employed throughout the site. The program shall include measure such as temporary sediment basins, silt fences, cut-off drains for polluted stormwater and diversion channels for clean stormwater run-off.

Design Adjustments – Road Works and Intersection Design

The proposed access road is shown on drawings **Co11492.05-DA41 & Co11492.02-DA42.** The road alignment, cross section and pavement details all remain consistent with the previously approved arrangement.

Differences between the S96 drawings and approved development are as follows:

- Intersection location has been adjusted to be located on Cowpasture Road at the peak of the hill approximately midway between its intersection with Newton Road and Victoria Street. A roundabout layout has been provided to be generally consistent with the requirements of SSD-5169 Condition A15 however the new location allows for a right out manoeuvre onto Cowpasture Road; and
- The new access road terminates with a Cul-de-sac turning head on the southern side of the development.

Design Adjustments – Earthworks and Retaining Walls

The proposed earthworks are shown on drawings **Co11492.05-DA31 through Co11492.05-DA32.** Adjustment to the lot configuration approved in SSD-5169 is proposed to facilitate larger development lots which are more consistent with the current market demand and to suit the new masterplan layout. The development pads hence earthworks levels have been adjusted to suit these large development lots.

The proposed earthworks levels for the development lots are as follows:

- Pads 1, 2 & 3 – RL 72.0m A.H.D.
- Pad 4, 5 & 6 - RL 74.5m A.H.D.

The indicative locations of the proposed retaining walls are shown on drawings **Co11492.05-DA61, Co11492.05-DA62 and Co11492.05-DA65.** As a result of the adjustments to the lot configuration and earthwork levels, retaining wall locations and heights have also been adjusted. The location & height of the retaining walls shown on the above drawings are indicative only. The intention, where possible, is to integrate the retaining walls into landscaping areas by utilising aesthetically pleasing wall construction (such as boulders, gabion and stencilled concrete panels), introducing tiers and landscaping around walls. In particular this integration will occur in areas of high prominence such as The Horsley Drive frontage and at the estate entrance.

Where walls are in less prominent (e.g. behind buildings and in cut) standard wall construction will be performed.

Final details of walls will be completed in conjunction with Landscape Architects during detail design/ construction certificate stage of the project.

Design Adjustments – Stormwater Management

The proposed drainage layout is shown on drawings **Co11492.02-DA41 & Co11492.02-DA42.** The proposed stormwater management strategy (as detailed in **Sections 5 & 6** of this report remains consistent with the previously approved arrangement however the revised Masterplan Layout allows for the upstream catchments (from West of the Sydney Water Channel and north of the site) to be diverted around the northern on-site detention/ bio-retention basin (Basin 2). Overall storage volumes and bio-retention filtration areas are able to be reduced substantially as a result of this adjustment. The development catchment breakdown remains consistent with approved documents.

The differences in the drainage layout between the S96 drawings and approved development are as follows:

- Adjusted drainage layout to facilitate the new Masterplan Layout, road alignment and lot configuration;
- Diversion of upstream catchments, from the western side of the Sydney Water Channel and from the north of the site, around the development site and bypassing the estate on-site detention/ bio-retention basin (Basin 2);
- Adjusted layout, storage volume and bio-retention filtration area for Basin 2 as a result of the above diversion of upstream catchments around the basin;
- Realignment of the inter-allotment drains and overland flow paths; and
- Overall catchments draining to Basins 1 and 2 from the development site remain consistent with documents approved under SSD5169.

2 DEVELOPMENT SITE

2.1 Existing Site

The property is currently generally undeveloped however two residential dwellings are located within the bounds of the site and we understand the site has previously been used for farming and other rural uses. The rectangular shaped site covers a total area of 21.84Ha and is bounded by the undeveloped Parkland Trust land to the north, Cowpasture Road to the East, The Horsley Drive to the south and a Sydney Water Supply Channel to the west.

The property currently comprises undeveloped rural land and some residential dwellings. The topography consists of undulating land of grades generally between 2% to 10%. The highest elevation is approximately RL 85m (AHD) and the lowest is at RL 63m.

The existing site is shown in **Figure 2.1** below.

Figure 2.1. Site Location

2.2 Proposed Development

The proposed development is for a 6 lot industrial lease-hold estate and incorporates the following civil engineering elements:

- Earthworks walls to facilitate a local roads and development blocks;
- Local subdivision access road;
- Infrastructure works including stormwater, energy, telecommunications and sewer; and potable water supply;
- Realignment of an overland flow path from an upstream catchment to facilitate the development earthworks; and
- The construction of two stormwater detention/ stormwater quality basins.

The proposed development is shown in **Figure 2.2** below.

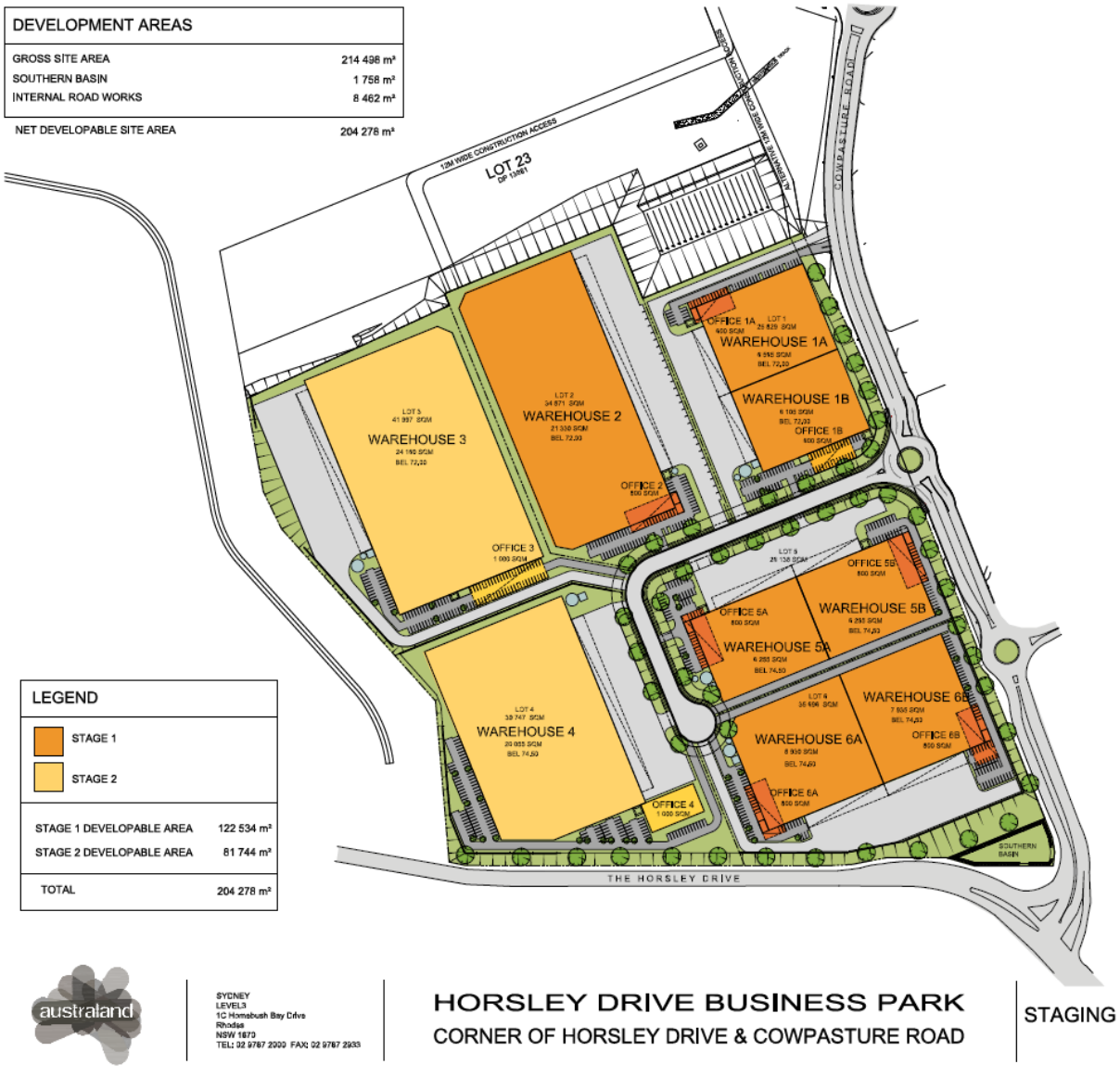


Figure 2.2 Proposed Development Layout

3 ROADS AND TRANSPORTATION

3.1 Road Widths

The proposed road cross section has been discussed and agreed upon with Fairfield City Council and can be defined as follows:

Road Type & Traffic Volume	Carriageway	Verge (1.2m Footpath Pedestrian)	Verge	Total Road Reserve	Number of lanes
Access Road	13.0m (2 x 6.5m)	3.5m	3.5m	20.0m	2 travel/ 1 parking lane

Table 3.1. Proposed Estate Road Cross Section

All roads will have concrete kerb and gutter and carriageway surface finished with asphaltic concrete as per the requirements of Fairfield City Council.

The dimensions of the adopted design cross section are shown on Drawing No. **Co11492.05-DA50, Appendix A**.

3.2 Road Alignments

The proposed road alignments generally meet Council requirements. The proposed road layout incorporates best practice for both horizontal and vertical alignments with empathy to the landform and proposed development lot layout. Priority has been given in the design for the safety of vehicles and pedestrians.

The B-Double has been adopted as the design vehicle for the development.

The Horizontal alignments generally meet Council standards. Minimum horizontal radii in accordance with Austroads, have been provided.

A minimum longitudinal grade of 1% and a maximum of 6% have been generally provided. Where change of grade is in excess of 0.6%, a vertical curve in accordance with the RTA Road Design Guide, for a design speed of 70 km/h (60km/hr posted), has been provided.

3.3 Estate Access and Proposed Intersection

The estate access is proposed to be located on Cowpasture Road approximately midway between its intersection with Newton Road and Victoria Street.

It is proposed to construct a new roundabout that facilitates left in, left out and right in, right out manoeuvres for the b-double design vehicle. The location for the intersection maximises site distances.

A concept layout for the intersection has been shown on drawings **Co11492.05-SK01 and SK02**.

3.4 Pedestrian Facilities and Transportation

As discussed and agreed with Fairfield City Council, a pedestrian path is to be provided to one side of the new access road.

Bus shelters and transport routes are available in nearby streets. Provision for pedestrian access has been provided within the estate. Strategic crossings at intersections to enable access to these locations are available or will be provided as part of intersection works for the development.

Typical sections shown on drawing **Co11492.05-DA50** nominates the allowances for pedestrian paths.

4 SITE WORKS

4.1 Bulk Earthworks

The proposed development attempts to be sympathetic to the site topography and the environment by minimising excessive cut and fill. This will be achieved by a smoothing of contours to provide smooth transition across the site and to facilitate access through the proposed internal estate layout. However, given that the differences between existing and future levels and the falls over the existing site, it is inevitable that some areas will be in large amounts of cut, and others in fill.

The existing surface levels and proposed pad levels are shown on Drawings **Co11492.05-DA31** and **DA32** in **Appendix A**.

The finished Bulk Earthwork Levels (B.E.L) shown on above plans are based on creating a balance of the earthworks. This will require neither importation nor exportation of material other than stripped topsoil and any other deleterious vegetation. The Bulk Earthwork Levels have been selected based on the proposed estate lot layout and site access while attempting to follow the surrounding levels and to allow for access and minimise retaining walls. The pad levels shown are subject to final geotechnical investigations and detailed earthworks analysis. Pad levels may vary within +/-1000mm from those indicated in the provided approval documents.

The earthwork cut to fill balance allows for a calculated shortfall of fill to allow for material bulking, detail excavation and services excavation as follows:

Factor	**Allowance**
Clay Bulking Factor	4% of cut material
Rock Bulking Factor	8% of cut material
Detailed/service excavation	1200 m^3/Ha

Table 4.1. Earthworks Allowances

Soil Erosion and Sediment Control measures including sedimentation basins are to be placed in accordance with submitted drawings and the Soil and Water Management Plan in Section 6 of this report.

4.2 Embankment Stability

To assist in maintaining embankment stability permanent batters slopes in clay will be no steeper than 3 horizontal to 1 vertical while temporary batters will be no steeper than 2 horizontal to 1 vertical.

Permanent batters in rock may be formed no steeper than 1 horizontal to 1 vertical while temporary batters will be no steeper than 0.75 horizontal to 1 vertical.

Permanent batters will also be adequately vegetated or turfed which will assist in maintaining embankment stability. Stability of batters and reinstatement of vegetation shall be in accordance with the submitted drawings and the Soil and Water Management Plan in Section 7.

4.3 Supervision of Earthworks

All geotechnical testing and inspections performed during the earthworks operations will be undertaken to Level 1 geotechnical control, in accordance with AS3798-1996.

4.4 Retaining Walls

Due to the existing topography and the nature of the proposed development, retaining walls will be required over the site. These are generally confined to internal lot boundaries and perimeter boundaries. An indicative retaining wall layout and elevation drawings have been provided to give an indication of potential retaining wall heights, location and construction. The intention is to limit retaining walls through landscaped batters in setback areas and fitting of pads to external contours and the proposed access road levels.

The final alignment, height and construction methods for the walls will be subject to adjustments during detail design stage due to specific site layouts for individual development lots. These will be completed in conjunction with the builder and landscape architect requirements.

5 STORMWATER MANAGEMENT

5.1 Hydrologic Modelling and Analysis

5.1.1 General Design Principles

The design of the stormwater system for this site will be based on relevant national design guidelines, Australian Standard Codes of Practice, Fairfield City Council (FCC) and accepted engineering practice.

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).

Storm events for the 2 to 100 Year ARI event have been assessed.

5.1.2 Minor/ Major System Design

In accordance with FCC Engineering Guide for Development and generally accepted engineering practice, 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 for flows above the capacity of the piped system.

5.1.3 Rainfall Data

Rainfall intensity Frequency Duration (IFD) data used as a basis for ILSAX modelling for the 2 to 100 Year ARI events, was taken from FCC's drainage policy

5.1.4 Runoff Models

In accordance with the recommendations and standards of FCC, the calculation of the runoff from storms of the design ARI will be calculated with the catchment modelling software DRAINS and RAFTS.

The design parameters for the DRAINS/ ILSAX model are to be based on typically accepted 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	5	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	0.5	
	On Grade Pit Blocking Factor	0.2	

Table 5.1: DRAINS ILSAX Parameters

5.2 Hydraulics

5.2.1 General Requirements

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

5.2.2 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.

5.2.3 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.

5.2.4 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).

5.2.5 Overland Flow

Dedicated flow paths have been designed to convey all storms up to and including the 100-year ARI. These flow paths will convey stormwater from the site to the estate road system to the estate basins and Wetherill Park Drainage Channel.

5.3 Site Drainage

5.3.1 Existing Site Drainage

The property is currently undeveloped with little to no formal drainage located on site. The proposed site comprises a catchment area of 21.44Ha which can be considered as 100% pervious.

The property essentially comprises two catchments with areas of 7.56Ha (Catchment C1) and 13.88Ha (Catchment C2b and C3b). The site is split roughly through the bottom third by a peak and spur with falls to the north and south of the site.

Catchment C1 discharges to the south of the site at the intersection of The Horsley Drive and Cowpasture Road.

Catchment C2 discharges to the north of the site via an overland flow path and three 900mm R.C.P. culverts located at the intersection of Cowpasture Road and Victoria Street. Catchment C2 is part of a greater catchment of approximately 83.6Ha which drains to this point. The greater catchment comprises agricultural land and Parkland Trust land.

5.3.2 Proposed Site Drainage

The proposed stormwater system consists of a major/ minor system which conveys surface water from roadways with provision for connection of individual development lots at strategic locations (i.e. rear lot easements or connection to street drainage). The two catchments will generally be kept at or near to the existing catchment breakup to ensure that pre and post development stormwater flows closely match each other.

On-site detention will be provided at an estate level as discussed in Section 5.5. Provision for water quality will also be provided as discussed in Section 6.

Provision for piped discharge into the overland flow path will be made as a "natural outlet" with consideration to the guidelines contained in the NSW Office of Water document *Controlled Activities: Guidelines for Outlet Structures*. Apron and rock sizing will be performed in accordance with method outlined in the Catchments & Creeks Pty Ltd document *Rock Sizing for Single Pipe Outlets 2011*.

Following earthworks and prior to development of individual lots erosion control and stormwater management will be performed as per Fairfield Council Guidelines and recommendations of the Blue Book.

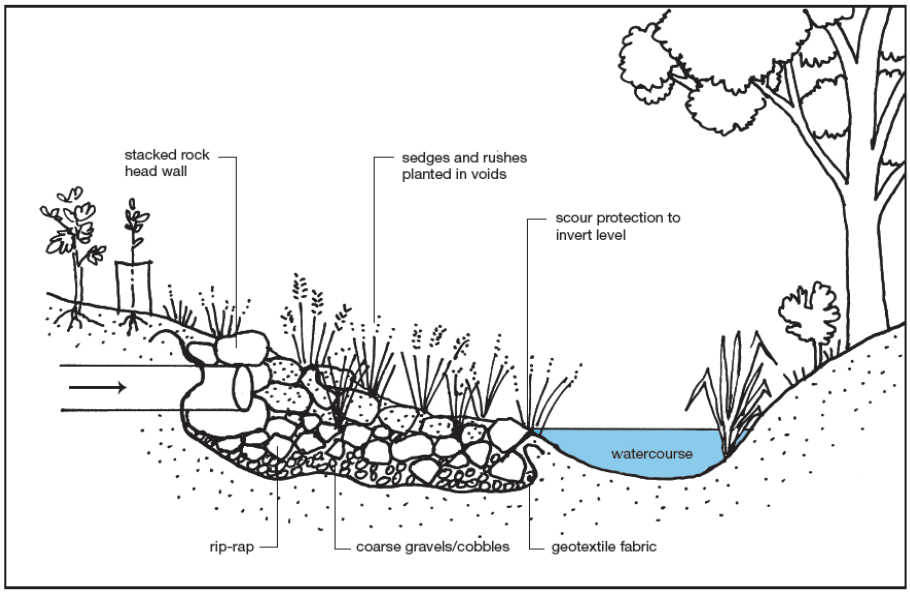
Reference to drawings Co11492.05-DA40, DA42 and DA42 shows the proposed drainage layout.

5.3.3 Site Discharge

The design and construction of the proposed outlet structures to overland flow paths and waterways has been assessed with consideration to the guidelines contained in the NSW Office of Water document *Controlled Activities: Guidelines for Outlet Structures*. Apron and rock sizing will be performed in accordance with method outlined in the Catchments & Creeks Pty Ltd document *Rock Sizing for Single Pipe Outlets 2011*.

Discharge from the estate access road and Basin 2 are proposed at the northern side of the development site. These are shown on drawings **Co11492.05-DA41** and **DA42**.

Stormwater outlets are to consist of a reinforced concrete pipe and 'natural' energy dissipater. The outlet is to be aligned with the creek to remove the potential for bank scour and shall include rip rap energy dissipaters constructed in accordance with the Outlet Structures Guidelines as published by the Department of Water & Energy and The Blue Book. This is shown figuratively below in Figure 5.1 below. Further construction details regarding the dimensions, rock size and scour protection can be seen on drawing **Co11492.05-DA45**.



5.4 External Catchments

The site in its undeveloped state is affected by overland flows from the west, upstream of the Sydney Water Supply Channel. Allowance has been made in the drainage network to convey runoff from the two external catchments in the drainage system to the north of the property.

The southern most of the two catchments (Catchment 2a as nominated on drawing **Co11492.05-DA40**) is located midway along the estate boundary. Flows from this catchment will be piped and diverted along the western boundary of the site via a 2.5m wide easement.

Discharge from the northern of the two catchments (Catchment 3a as nominated on drawing **Co11492.05-DA40**) is located 100m south of the north-western corner of the site. Discharge from this catchment is via two 750mm R.C.P.'s which begin on the northern side of the Sydney Water Supply Channel and discharge onto our site on its western boundary. It is proposed to connect and pipe flows from this catchment to the northern extent of the development to the existing overland flow path present to the north of the property. Flow from upstream catchments will bypass Basin 2 and will not require allowance for these flows within the estate design.

5.5 Flooding at The Intersection of Cowpasture Road and Victoria Street

As part of the Director General's Requirement, an assessment of the potential for flooding on the south-west side of the intersection of Cowpasture Road and Victoria Street is required for the pre and post development conditions.

A conservative 1D analysis of this system has been performed using a RAFTS/ DRAINS model. The model is based on the following configuration:

- A total of catchment of 81.54Ha drains to the low point adjacent to the Cowpasture Road and Victoria Street intersection. This has been shown on drawing **Co11492.05-DA40**.
- As requested by Fairfield Council an additional catchment of 2.06Ha, which is located on the east side of Trivet Street, has also been included in the model. The total catchment in this case is now 83.6Ha. This catchment would likely enter the drainage system downstream of the system however the exact location is unclear and the inclusion of this catchment will result in a conservative estimate of flooding levels at the intersection with Victoria St.
- The 83.6Ha catchment can be broken down into two broad sub-catchments and a number of smaller sub-sub-catchments. These are also noted on drawing **Co11492.05-DA40**.
- The overall catchment is generally undeveloped however agricultural land is located on the western side of the Sydney Water Supply Channel.
- Stormwater is conveyed overland as sheet flow to gullies and natural low points in the topography where it continues as overland flow. There are a number of culverts which convey stormwater from the western side of the Sydney Water

Supply Channel to the eastern side. For the purpose of our assessment it has been assumed that all stormwater will pass unimpeded across the Supply Channel.

- Stormwater is conveyed overland through the catchment to a low point on the western side of the Cowpasture Road and Victoria Street intersection. Stormwater, downstream of this point, is then conveyed via an underground drainage system in a north-easterly direction to its ultimate discharge point.
- The configuration of the underground drainage network is two inlet structures, consisting of 3x900mm R.C.P. culverts (which pick up the two broader sub-catchments), located 70m apart from each other. The two culverts connect and stormwater is then conveyed via a 3.0m wide and 2.4m high box culvert. The drainage configuration is based on information provided by Fairfield Council (Refer to Appendix D) and detail survey.
- The catchment low point forms a natural basin which, based on survey information, has an active storage volume of approximately 3,000m^3 at overflow level and 4300m^3, 0.2m above overflow level. The overflow level is defined by the Cowpasture Road level of 58.5m.
- Overflow at Cowpasture Road has been modelled as a broad-crested weir with free-flowing downstream conditions. Based on site inspections made this is considered consistent with flow regime in the area.

Our assessment of the pre-development Q100 ARI event, based on the above model configuration, found the following:

- Peak flows from the catchment are in the order of 20m^3/s and the 2 hour storm is the critical duration.
- The culvert configurations have a capacity in the order of 13m3/s depending on the level of water in the adjacent 'basin' area.
- Stormwater flows will overtop Cowpasture Road for storm durations greater than or equal to 1 hour. A maximum flow of 1.6m3/s can be expected in an overtopping event.
- A maximum water surface level of 58.7m can be expected during the Q100 event. This equates to 200mm flow over Cowpasture road and 4300m^3 of active storage.
- Overtopping of Cowpasture Road does not occur during a 5 year ARI storm however it is expected to occur in events greater than the 5 year ARI storm.

Based on the above assessment we recommend that a flood planning level of 59.20m be set for developments adjacent to the Cowpasture Road and Victoria Street Intersection. This allows for a 500mm freeboard to the assessed flood level.

Following the development and implementation of the OSD basin discussed in the following section, a minor reduction in peak flow and flooding levels is expected at the intersection of Cowpasture Road and Victoria Road. This means there will be no effect on downstream properties as a result of this development.

5.6 On-site Detention

Fairfield City Council, in common with many other local authorities in the Sydney region, limit the runoff discharged from private property into the underground piped drainage system. As part of the Director General's Requirements for the development, the OSD sizing is to be performed in consultation with Fairfield City Council. Although a departure from Fairfield City Councils adopted OSD policy (which requires post-development peak flows to be less than pre-development flows), Fairfield City Council Engineers have requested that the OSD for the site be assessed using the principals outlined in document *WSUD: Basic Procedures for 'Source Control' of Stormwater*, by John R Argue. The strategy outlined in this document is to target not only reductions in peak flow from the development but also reduction in peak stormwater volume. This requires an assessment of the greater catchment and the location of the development within the catchment and respective time of concentrations and differing local and regional storm durations. In terms of this development, Fairfield Council has advised that the Wetherill Park Catchment has a time of concentration of 30 minutes, hence for outlet controls the basins must be sized for the critical local storm (2hours) and the 30minute duration storm. The results of this analysis can be seen in the following tables. We also note that, for Basin 2, due to the capacity and hydraulic characteristics of the receiving system downstream of the basin at the intersection of Victoria Street and Cowpasture Road (as discussed in Section 5.5) that the effect from our development is actually beneficial to downstream flooding with a minor reduction in peak flows and flood levels with a marginal change in the overall outflow hydrographs.

Due to the presence of two catchments on the site, two basins are proposed for the development and these are shown on drawings **Co11492.05-DA41** and further detailed on drawing **Co11492.05-DA43**. Pre and post-development flows were calculated using a RAFTS model (using in-built function within DRAINS model) which includes road network and external catchments. Tables 5.3 and 5.4 shows the pre and post development flows over the catchment and the proposed storage capacity for each of the two basins.

ARI (yrs)	Storm Duration (hrs)	Flow (m^3/s)			Water Level (m)	Storage (m^3)
		Pre-Devel.	Post Devel. (un-attenuated)	Post Devel. (with attenuation)		
2	0.5	0.376	1.88	0.326	62.32	1100
2	2	0.701	1.90	0.348	62.52	1350
100	0.5	1.77	3.77	1.411	63.16	2300
100	2	2.62	3.83	2.575	63.27	2450

Table 5.3. BASIN 1, Pre and Post Development Flows and OSD Storage

ARI (yrs)	Storm Duration (hrs)	Flow (m^3/s)			Water Level (m)	Storage (m^3)
		Pre-Devel.	Post Devel. (un-attenuated)	Post Devel. (with attenuation)		
2	0.5	0.565	3.45	0.551	61.90	2150
2	2	1.13	3.43	0.626	62.20	2800
100	0.5	2.96	6.97	1.14	63.1	5750
100	2	4.36	7.03	2.19	63.35	6050

Table 5.4. BASIN 2, Pre and Post Development Flows and OSD Storage

In order to maintain the above flow attenuation in Basin 1 a total of 2,450m^3 of active storage will be provided with a maximum depth of 1.7m during the Q100 ARI storm event. Also in accordance with Section 1.4.1 of Fairfield City Council On-Site Detention Policy, during a Q100 ARI, 9hr duration storm, the outflow from Basin 1 is 1.08m^3/s and meets the policy requirement for the permissible site discharge (PSD) to be less than 0.14m^3/s/Ha (7.77Ha catchment, PSD = 1.09m^3/s).

In order to maintain the above flow attenuation in Basin 2 a total of 6,050m^3 of active storage will be provided with a maximum depth of 1.03m during the Q100 ARI storm event. Basin 2 has a minimum floor level of 61.0m which is above the flood planning level nominated in Section 5.5 above. Also in accordance with Section 1.4.1 of Fairfield City Council On-Site Detention Policy, during a Q100 ARI, 9hr duration storm, the outflow from Basin 2 is 1.88m^3/s and meets the policy requirement for PSD to be less than 0.14m^3/s/Ha (13.9Ha catchment, PSD = 1.95m^3/s).

300mm freeboard above the maximum top water level nominated in Tables 5.3 and 5.4 will be provided to the embankments of Basin1 and 2.

6 STORMWATER QUALITY CONTROLS

6.1 Regional Parameters

There is a need to provide design which incorporates the principles of Water Sensitive Urban Design (WSUD) and to target pollutants that are present in the stormwater so as to minimise the adverse impact these pollutants could have on receiving waters and to also meet the requirements specified by the Fairfield City Council.

Fairfield City Council have nominated the requirements for stormwater quality to be performed on a catchment wide basis and in accordance with the Sydney Catchment Management Authority. These are presented in terms of annual percentage pollutant reductions on a developed catchment and are as follows:

Gross Pollutants (GP's)	90%
Total Suspended Solids (TSS)	85%
Total Phosphorus (TP)	65%
Total Nitrogen (TN)	45%
Total Hydrocarbons (TH)	90%

6.2 Proposed Stormwater Treatment System

Development lots, verges and road areas are required to be treated by the Stormwater Treatment Measures (STM's). The STM's shall be sized according to the whole catchment area. The STM's for the development shall be based on a treatment train approach to ensure that all of the objectives above are met.

Components of the treatment train for the estate development are as follows:

- Treatment of gross pollutants will need to be provided on each development lot prior to discharging into the estate stormwater system. Site STM's will need to meet minimum removal rates of 80% of GP's, 70% of TSS, 15% of TP, 0% of TN and 60% of TH.
  Treatment of runoff in this manner is required for pre-treatment of stormwater from developments development sites prior to discharge into the infrastructure drainage system. This will help to ensure that the estate system is free from gross pollutants and coarse sediments and to reduce the potential for early onset sedimentation of the estate bio-retention basin.
  STM's for development site are to be specified based on individual use on each development lot. Typical examples of acceptable site STM's include end-of-line gross pollutants traps (GPT's) such as Ecosol RSF4000, Rocla CDS, Humeceptor and at source methods such as pit inserts (Stormwater360 Enviropods); and
- Estate detention/ bio-retention basins which will act as tertiary treatment for suspended solids, gross pollutants, hydrocarbons and nutrients.

6.3 Stormwater Quality Modelling

6.3.1 Introduction

The MUSIC model was chosen to model water quality. This model has been released by the Cooperative Research Centre for Catchment Hydrology (CRCCH) and is a standard industry model for this purpose. MUSIC (the Model for Urban Stormwater Improvement Conceptualisation) is suitable for simulating catchment areas of up to 100 km2 and utilises a continuous simulation approach to model water quality.

By simulating the performance of stormwater management systems, MUSIC can be used to determine 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 6.1 of this report were used as a basis for assessing the effectiveness of the selected treatment trains.

The MUSIC model "*11492.05 WSPT AUSTRALAND Rev1.sqz*" was set up to examine the effectiveness of the water quality treatment train and to determine if FCC requirements have been achieved. The layout of the MUSIC model is presented in Appendix B.

6.3.2 Rainfall Data

Six minute pluviographic data 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

6.3.3 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

6.3.4 Pollutant Concentrations

Pollutant concentrations for source nodes are based on values nominated by Blacktown City Council for industrial land use as per the Table 6.1.:

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	-1.11	0.48	0.14	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

Table 6.1. Pollutant Concentrations

6.3.5 Source Nodes

The MUSIC model has been setup with source nodes based on the pollutant concentrations in Table 6.1 above. As exact areas of land use are not know at this time, pollutants catchments breakdown for development lots have been modelled as following:

Estate Road	As per plan
Roof	50% of development lot.
Hardstand	50% of development lot

6.3.6 Treatment Nodes

Bioretention and gross pollutant trap nodes have been used in the modelling of the development.

There are two proposed bio-retention basins which will be provided in accordance with industry best practice and the guidelines of the Monash University Facility for Advancing Water Biofiltration with the following parameters:

Bioretention 1

Parameter	**Value**	
Storage Properties		
Extended Detention Depth	300	mm
Storage Surface Area	1300	m^2 (minimum)
Filter and Media Properties		
Filtration Area	1150	m^2
Saturated Hydraulic Conductivity	100	mm/hr
Filter Depth	600	mm

Bioretention 2

Parameter	**Value**	
Storage Properties		
Extended Detention Depth	300	mm
Storage Surface Area	2000	m^2 (minimum)
Filter and Media Properties		
Filtration Area	2000	m^2
Saturated Hydraulic Conductivity	100	mm/hr
Filter Depth	500	mm

6.3.7 Results

Table 6.2 shows the results of the MUSIC analysis. The reduction rate is expressed as a percentage and compares the post-development pollutant loads without treatment versus post-development loads with treatment.

	Source	**Residual Load**	**% Reduction**
Total Suspended Solids (kg/yr)	27900	2250	91.9
Total Phosphorus (kg/yr)	55.2	18.7	66.1
Total Nitrogen (kg/yr)	346	141	59.4
Gross Pollutants (kg/yr)	4010	0.0	100

Table 6.2. MUSIC analysis results

6.3.8 Modelling Discussion

MUSIC modelling has been performed to assess the effectiveness of the selected treatment trains and to ensure that the pollutant retention requirements nominated in Section 6.1 have been met. The MUSIC modelling predicts that the proposed treatment measures meet the requirements of the NSW Department of Planning and Infrastructure and Fairfield Council.

6.4 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 only, 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 future development lots within this 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

non-potable water demand for the individual future developments in the range of 50-80%.

In general terms the rainwater harvesting systems will be in-line tanks 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 falling on roofs is soft, clear and generally low in microbial and chemical contamination. Any contamination of rainwater generally occurs during collection and storage. The use of simple and cost effective rainwater collection and treatment systems ensures reliable operation and water quality for non-potable use. The proposed rainwater treatment will be a first flush diverter in accordance with council engineering guidelines.

Indoor and outdoor water demand and rainwater tanks sizing will be based on individual site requirements and form part of separate future development applications over these development lots in accordance with Fairfield Council requirements and the targets nominated above.

6.5 Maintenance And Monitoring

It is important that each component of the water quality treatment train is properly operated and maintained. In order to achieve the design treatment objectives, an indicative maintenance schedule has been prepared (refer to **Table 7.4** below) to assist in the effective operation and maintenance of the various water quality components.

Note that inspection frequency may vary depending on site specific attributes and rainfall patterns in the area. In addition to the below nominated frequency it is recommended that inspections are made following large storm events.

Table 7.4. Indicative 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 top soil in eroded area and cover and secure with biodegradable fabric. Cut hole in fabric and revegetate.
OSD BASIN			
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

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
			blockages or debris.
Inspect pit sump for damage or blockage.	Six Monthly	Maintenance Contractor/ Owner	Remove grate & screen. Remove sediment/ sludge build up and check orifice and flap valve is clear.
Inspect storage areas and remove debris/ mulch/ litter etc likely to block screens/ grates.	Six Monthly	Maintenance Contractor/ Owner	Remove debris and floatable materials.
Check attachment of orifice plate and screen to wall of pit	Annually	Maintenance Contractor	Remove grate and screen. Ensure plate or screen mounted securely, tighten fixings if required. Seal 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.
INLET & JUNCTION PITS			
Inside of 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.

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
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.

BIORETENTION BASIN			
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
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 10-15 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 below.

7 EROSION & SEDIMENT CONTROL PLAN

An erosion and sediment control plan (ESCP) is shown on drawings **Co11492.05-DA20 and DA25**. These are conceptual plans only providing sufficient detail to clearly show that the works can proceed without undue pollution to receiving waters. A detailed plan will be prepared once consent is given and before works start.

7.1 General Conditions

1. The ESCP will be read in conjunction with the engineering plans, and any other plans or written instructions that may be issued in relation to development at the subject site.
2. Contractors will ensure that all soil and water management works are undertaken as instructed in this specification and constructed following the guidelines stated in Managing Urban Stormwater, Soils and Construction (1998) and Fairfield Council specifications.
3. All subcontractors will be informed of their responsibilities in minimising the potential for soil erosion and pollution to down slope areas.

7.2 Land Disturbance

1. Where practicable, the soil erosion hazard on the site will be kept as low as possible and as recommended in Table 1

Land Use	Limitation	Comments
Construction areas	Limited to 5 (preferably 2) metres from the edge of any essential construction activity as shown on the engineering plans.	All site workers will clearly recognise these areas that, where appropriate, are identified with barrier fencing (upslope) and sediment fencing (downslope), or similar materials.
Access areas	Limited to a maximum width of 5 metres	The site manager will determine and mark the location of these zones onsite. They can vary in position so as to best conserve existing vegetation and protect downstream areas while being considerate of the needs of efficient works activities. All site workers will clearly recognise these boundaries.
Remaining lands	Entry prohibited except for essential management works	

Table 7.1 Limitations to access

7.3 Work Schedule Conditions

Works will be undertaken in the following sequence. The management of water and soil for the proposed development is to be staged in conjunction with the proposed construction sequence to ensure that minimal land disturbance occurs. Each subsequent stage is not to be commenced until the previous one is completed.

Works

Stage 1 works are detailed on drawing Co11492.05-DA20 (refer to Appendix) and are to be carried out in the following sequence:

1. Installation of stabilised site entry.
2. Installation of sediment fencing and construction of catch drains.
3. Construction of diversion channels
4. Construction of sedimentation basins as nominated on plan.
5. Diversion of existing overland flow path around the works.
6. Grading of site to Bulk Earthworks Levels
7. Construction of estate road and stormwater drainage lines.
8. Finalisation of construction of OSD basins.
9. Sediment basins on development lots are to remain until such time that the disturbed areas are stabilised and/ or building works take place.

7.4 Erosion Control Conditions

1. Clearly visible barrier fencing shall be installed as shown on the plan and elsewhere at the discretion of the site superintendent to ensure traffic control and prohibit unnecessary site disturbance. Vehicular access to the site shall be limited to only those essential for construction work and they shall enter the site only through the stabilised access points.
2. Soil materials will be replaced in the same order they are removed from the ground. It is particularly important that all subsoils are buried and topsoils remain on the surface at the completion of works.
3. Where practicable, schedule the construction program so that the time from starting land disturbance to stabilisation has a duration of less than six months.
4. Notwithstanding this, schedule works so that the duration from the conclusion of land shaping to completion of final stabilisation is less than 20 working days.
5. Land recently established with grass species will be watered regularly until an effective cover has properly established and plants are growing vigorously. Further application of seed might be necessary later in areas of inadequate vegetation establishment.
6. Where practical, foot and vehicular traffic will be kept away from all recently established areas
7. Earth batters shall be constructed in accordance with the Geotechnical Engineers Report or with as law a gradient as practical but not steeper than:
    - 2H:1V where slope length is less than 7 meters
    - 2.5H:1V where slope length is between 7 and 10 meters
    - 3H:1V where slope length is between 10 and 12 meters

- 4H:1V where slope length is between 12 and 18 meters
- 5H:1V where slope length is between 18 and 27 meters
- 6H:1V where slope length is greater than 27 meters

8. All earthworks, including waterways/drains/spillways and their outlets, will be constructed to be stable in at least the design storm event.
9. During windy weather, large, unprotected areas will be kept moist (not wet) by sprinkling with water to keep dust under control. In the event water is not available in sufficient quantities, soil binders and/or dust retardants will be used or the surface will be left in a cloddy state that resists removal by wind.

7.5 Pollution Control Conditions

1. Stockpiles will not be located within 5 meters of hazard areas, including likely areas of high velocity flows such as waterways, paved areas and driveways.
2. Sediment fences will:
   a) Be installed where shown on the drawings, and elsewhere at the discretion of the site superintendent to contain the coarser sediment fraction (including aggregated fines) as near as possible to their source.
   b) Have a catchment area not exceeding 720 square meters, a storage depth (including both settling and settled zones) of at least 0.6 meters, and internal dimensions that provide maximum surface area for settling, and
   c) Provide a return of 1 meter upslope at intervals along the fence where catchment area exceeds 720 square meters, to limit discharge reaching each section to 10 litres/second in a maximum 20 year t_c discharge.
3. Sediment removed from any trapping device will be disposed in locations where further erosion and consequent pollution to down slope lands and waterways will not occur.
4. Water will be prevented from directly entering the permanent drainage system unless it is relatively sediment free (i.e. the catchment area has been permanently landscaped and/or likely sediment has been treated in an approved device). Nevertheless, stormwater inlets will be protected.
5. Temporary soil and water management structures will be removed only after the lands they are protecting are stabilised.

7.6 Waste Management Conditions

Acceptable bind will be provided for any concrete and mortar slurries, paints, acid washings, lightweight waste materials and litter. Clearance service will be provided at least weekly.

7.7 Site Inspection and Maintenance

1. A self-auditing program will be established based on a Check Sheet. A site inspection using the Check Sheet will be made by the site manager:
    - At least weekly.
    - Immediately before site closure.
    - Immediately following rainfall events in excess of 5mm in any 24 hour period.

    The self audit will include:
    - Recording the condition of every sediment control device
    - Recording maintenance requirements (if any) for each sediment control device
    - Recording the volumes of sediment removed from sediment retention systems, where applicable
    - Recording the site where sediment is disposed
    - Forwarding a signed duplicate of the completed Check Sheet to the project manager/developer for their information
2. In addition, a suitably qualified person will be required to oversee the installation and maintenance of all soil and water management works on the site. The person shall be required to provide a short monthly written report. The responsible person will ensure that:
    - The plan is being implemented correctly
    - Repairs are undertaken as required
    - Essential modifications are made to the plan if and when necessary

    The report shall carry a certificate that works have been carried out in accordance with the plan.
3. Waste bins will be emptied as necessary. Disposal of waste will be in a manner approved by the Site Superintendent.
4. Proper drainage will be maintained. To this end drains (including inlet and outlet works) will be checked to ensure that they are operating as intended, especially that,
    - No low points exist that can overtop in a large storm event
    - Areas of erosion are repaired (e.g. lined with a suitable material) and/or velocity of flow is reduced appropriately through construction of small check dams of installing additional diversion upslope.
    - Blockages are cleared (these night occur because of sediment pollution, sand/soil/spoil being deposited in or too close to them, breached by vehicle wheels, etc.).
5. Sand/soil/spoil materials placed closer than 2 meters from hazard areas will be removed. Such hazard areas include and areas of high velocity water flows (e.g. waterways and gutters), paved areas and driveways.

6. Recently stabilised lands will be checked to ensure that erosion hazard has been effectively reduced. Any repairs will be initiated as appropriate.
7. Excessive vegetation growth will be controlled through mowing or slashing.
8. All sediment detention systems will be kept in good, working condition. In particular, attention will be given to:
    a) Recent works to ensure they have not resulted in diversion of sediment laden water away from them
    b) Degradable products to ensure they are replaced as required, and
    c) Sediment removal, to ensure the design capacity or less remains in the settling zone.
9. Any pollutants removed from sediment basins or litter traps will be disposed of in areas where further pollution to down slope lands and waterways should not occur.
10. Additional erosion and/or sediment control works will be constructed as necessary to ensure the desired protection is given to down slope lands and waterways, i.e. make ongoing changes to the plan where it proves inadequate in practice or is subjected to changes in conditions at the work site or elsewhere in the catchment.
11. Erosion and sediment control measures will be maintained in a functioning condition until all earthwork activities are completed and the site stabilised
12. Litter, debris and sediment will be removed from the gross pollutant traps and trash racks as required.

8 CONCLUSION

This Civil Engineering Details Report has been prepared to support a S96 Development Application for a proposed industrial subdivision development over the Western Sydney Parkland Trust land located at the corner of The Horsley Drive and Cowpasture Road.

As noted in **Section 1.1**, this S96 Application is for an amendment to the current State Significant Development Approval, SSD-5169, dated 8 January 2013. The revised application is a result of market demand and access problems with the approved layout which require a new location for the site access to be made. The new location for the access road intersection will be located on Cowpasture Road approximately midway between its intersection with Newton Road and Victoria Street.

A civil engineering and infrastructure strategy for the site has been developed which provides a best fit solution within the constraints of the existing landform and proposed estate layout. Within this strategy a stormwater quantity and quality management strategy has been also been developed to mitigate downstream effect from increased stormwater runoff and to reduce pollutant loads in stormwater leaving this site in accordance with principle of WSUD and long term council policy. Generally the proposed engineering strategy will remain consistent with the approved development however some differences due to the new access road location and consequent adjustment to the internal lot layout will be made.

It is recommended that the management strategies mentioned in this report be incorporated into the future detailed design. Detailed design may result in changes to the concept however design criteria will be followed.

9 REFERENCES

- Fairfield City Council Development Control Plan.
- Fairfield City Council Urban Area On-Site Detention Handbook, 1997.
- Managing Urban Stormwater: Harvesting and Reuse – 2006 (NSW DEC);
- Managing Urban Stormwater: Source Control – 1998 (NSW EPA);
- Managing Urban Stormwater: Treatment Techniques – 1997 (NSW EPA);
- Managing Urban Stormwater: Soils & Construction – 2004(LANDCOM);
- WSUD: Basic Procedures for 'Source Control of Stormwater', John R Argue, 2008.
- Water Sensitive Urban Design – "Technical Guidelines for Western Sydney" by URS Australia Pty Ltd, May 2004

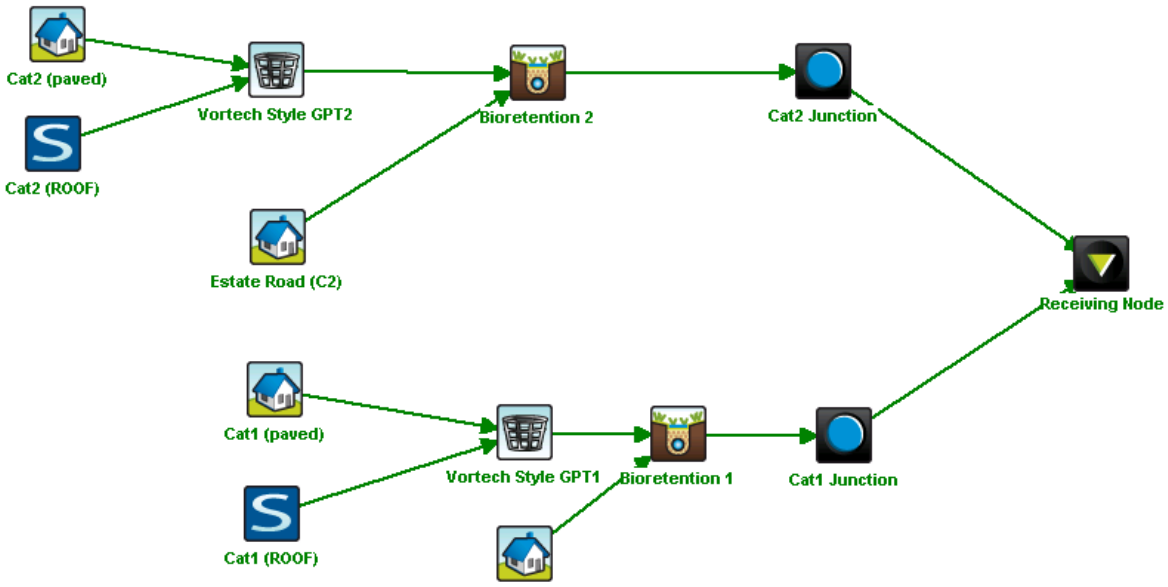
Appendix A

DRAWINGS BY COSTIN ROE CONSULTING

Co11492.05-DA10	DRAWING LIST & GENERAL NOTES
Co11492.05-DA20	EROSION & SEDIMENT CONTROL PLAN
Co11492.05-DA25	EROSION & SEDIMENT CONTROL DETAILS - SHEET 1
Co11492.05-DA31 & DA32	BULK EARTHWORKS PLAN – SHEETS 1 & 2
Co11492.05-DA33 & DA34	BULK EARTHWORKS SECTIONS – SHEETS 1 & 2
Co11492.05-DA40	STORMWATER CATCHMENT PLAN
Co11492.05-DA41 to DA42	CONCEPT STORMWATER & FINISHED LEVELS PLAN, SHEETS 1 & 2
Co11492.05-DA43	BIO-RETENTION BASIN PLANS
Co11492.05-DA45 & DA46	STORMWATER DETAILS – SHEETS 1 & 2
Co11492.05-DA50	ROAD TYPICAL DETAILS
Co11492.05-DA61 & DA62	RETAINING WALL PLANS, SHEETS 1 & 2
Co11492.05-DA65	RETAINING WALL DETAILS
Co11492.05-DA66 to DA68	RETAINING WALL ELEVATIONS, SHEETS 1 to 3
Co11492.05-SK01	ROUNDABOUT LAYOUT AND GENERAL ALIGNMENT PLAN
Co11492.05-SK02	ROUNDABOUT TURNING PATH PLAN

Appendix B

MUSIC MODEL CONFIGURATION

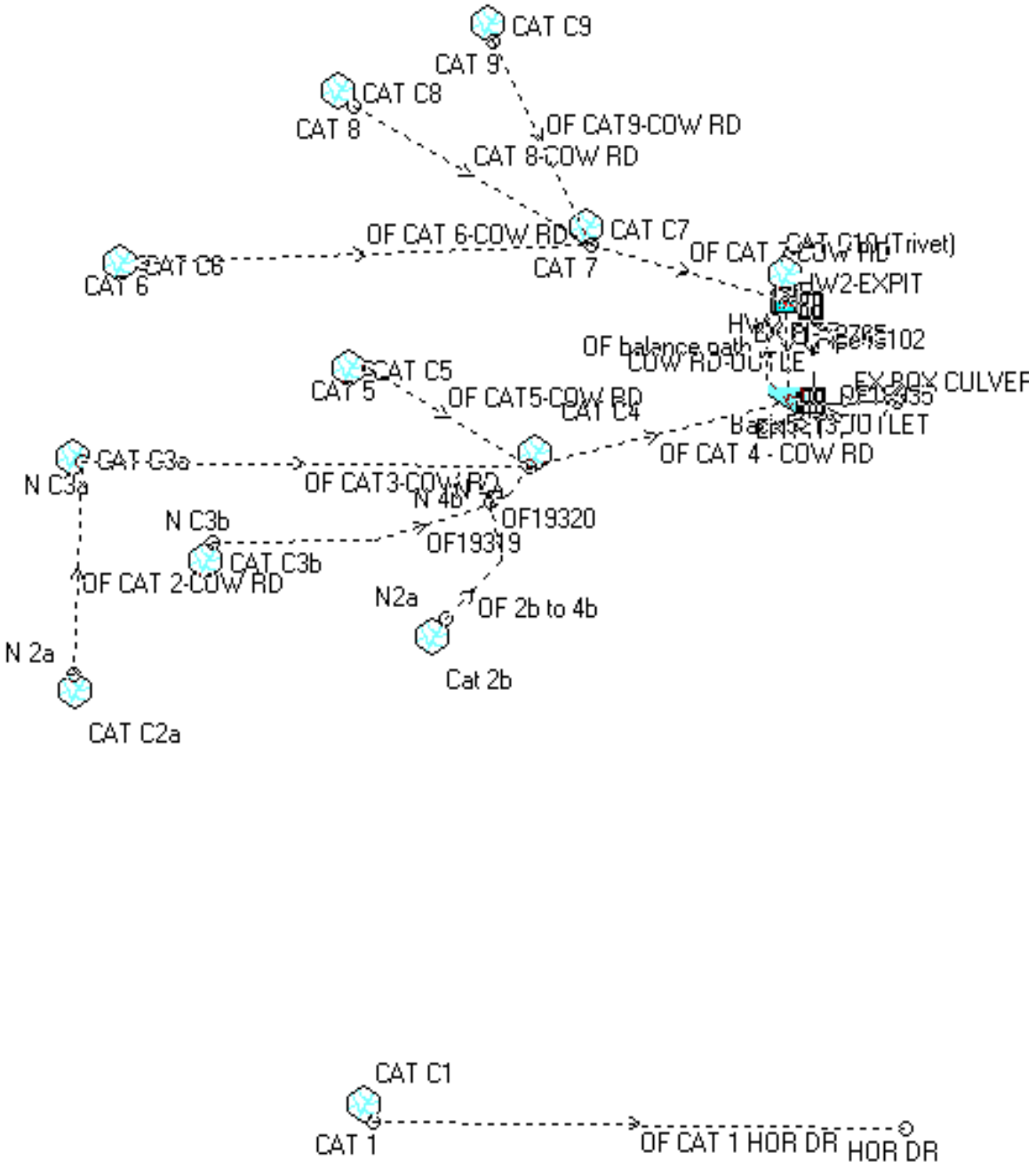


	Sources	Residual Load	% Reduction
Flow (ML/yr)	151	141	6.8
Peak Flow (m3/s)	2.78	5.48	-97.3
Total Suspended Solids (kg/yr)	27.9E3	2.25E3	91.9
Total Phosphorus (kg/yr)	55.2	18.7	66.1
Total Nitrogen (kg/yr)	346	141	59.4
Gross Pollutants (kg/yr)	4.01E3	0.00	100.0

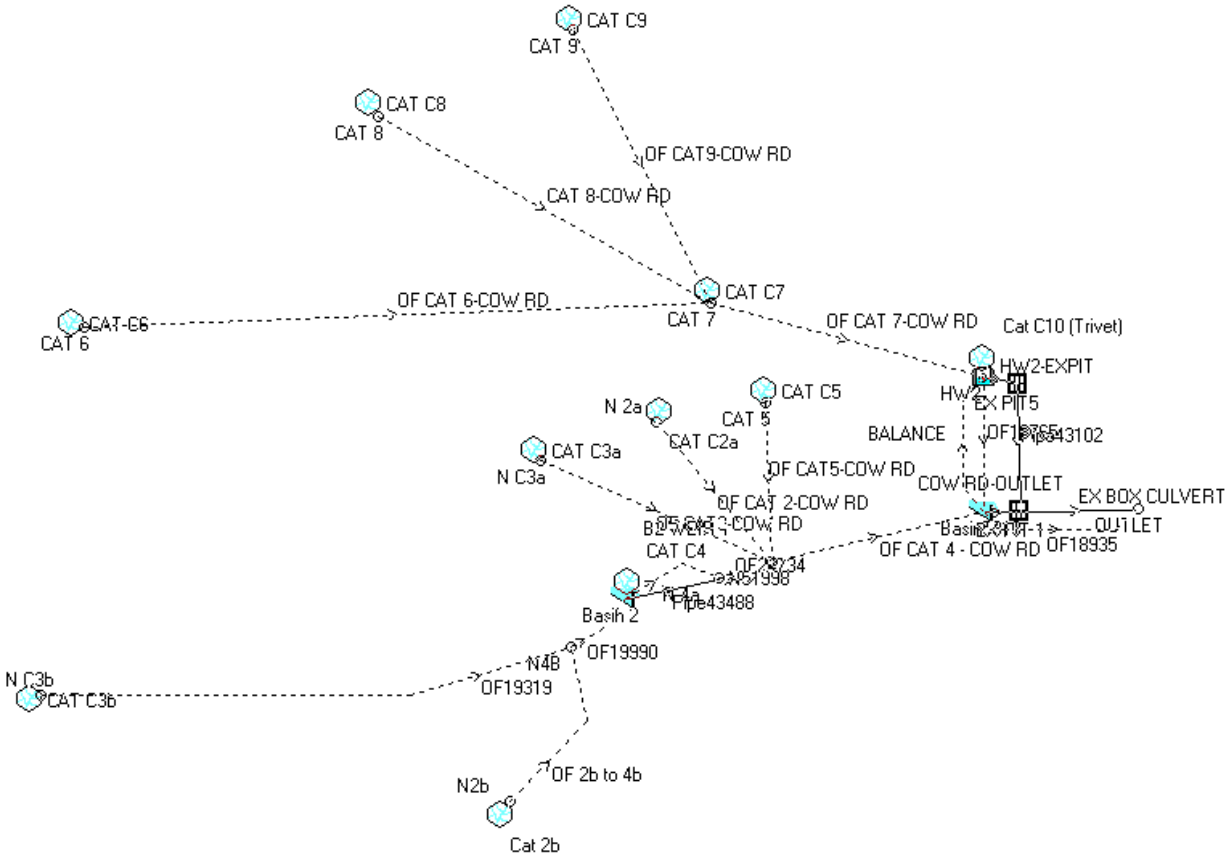
Appendix C

DRAINS MODEL CONFIGURATION

PRE-DEVELOPED LAYOUT



POST DEVELOPED LAYOUT



Appendix D

DRAINAGE CONFIGURATION AT COWPASTURE ROAD & VICTORIA STREET INTERSECTION