Queensland Government

Department of Infrastructure, Local Government and Planning

Our reference: SDA-0317-037666
Your reference: DA/13/2017

3 May 2017

The Chief Executive Officer
Gladstone Regional Council
info@gladstonerc.qld.gov.au

Attention: Rian Tait

Dear Sir

Concurrence agency response—with conditions
1 Olsen Avenue - New Auckland, 11 SP112850
(Given under section 285 of the *Sustainable Planning Act 2009*)

The referral agency material for the development application described below was received by the Department of Infrastructure, Local Government and Planning under section 272 of the *Sustainable Planning Act 2009* on 28 March 2017.

Applicant details

Applicant name:	CQ Wolves Football Club Inc. C/- LG Planning Services
Applicant contact details:	PO Box 3168 Tannum Sands Qld 4680 natalie@lgplanning.com.au

Site details

Street address:	1 Olsen Avenue - New Auckland, QLD 4680
Lot on plan:	11 SP112850
Local government area:	Gladstone Regional Council

Application details

Proposed development:	Development Permit for a Material Change of Use for a Car Wash

Fitzroy/Central Regional Office
Level 2, 209 Bolsover Street
PO Box 113
Rockhampton QLD 4700

Referral triggers

The development application was referred to the department under the following provisions of the *Sustainable Planning Regulation 2009*:

Referral trigger — Schedule 7, Table 3, Item 15A—Railways

Schedule 7, Table 3, Item 1—State-controlled road

Conditions

Under section 287(1)(a) of the *Sustainable Planning Act 2009*, the conditions set out in Attachment 1 must be attached to any development approval.

Reasons for decision to impose conditions

Under section 289(1) of the *Sustainable Planning Act 2009*, the department must set out the reasons for the decision to impose conditions. These reasons are set out in Attachment 2.

Approved plans and specifications

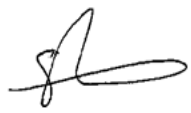
The department requires that the following plans and specifications set out below and in Attachment 3 must be attached to any development approval.

Drawing/Report Title	Prepared by	Date	Reference no.	Version/ Issue
Aspect of development: material change of use				
Conceptual Management Stormwater Plan	VDM Engineering Pty Ltd	March 2013	GL120052-C0703-W-R-CSMP-01	1

A copy of this response has been sent to the applicant for their information.

For further information, please contact Maaret Sinkko, Principal Planning Officer, SARA Fitzroy & Central on (07) 4924 2907, or email RockhamptonSARA@disgp.qld.gov.au who will be pleased to assist.

Yours sincerely



Carl Porter
A/Manager Planning
Fitzroy & Central

cc: CQ Wolves Football Club Inc. C/- LG Planning Services, natalie@lgplanning.com.au
enc: Attachment 1—Conditions to be imposed
Attachment 2—Reasons for decision to impose conditions
Attachment 3—Approved Plans and Specifications

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Attachment 1—Conditions to be imposed

No.	Conditions	Condition timing
Material Change of Use		
7.3.1—Pursuant to section 255D of the *Sustainable Planning Act 2009*, the chief executive administering the Act nominates the Director-General of *Department of Transport and Main Roads* to be the assessing authority for the development to which this development approval relates for the administration and enforcement of any matter relating to the following condition(s):		
1.	The development must be in accordance with the Conceptual Stormwater Management Plan prepared by VDM Engineering Pty Ltd dated March 2013, reference GL120052-C0703-W-R-CSMP-01, revision 1.	At all times

Our reference: SDA-0317-037666
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Attachment 2—Reasons for decision to impose conditions

The reasons for this decision are:

- To ensure that the impacts of stormwater events associated with development are minimised and managed to avoid creating any adverse impacts on the state-transport corridor.

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Attachment 3—Approved plans and specifications

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Conceptual Stormwater Management Plan

Lot 11 on SP112850 – 1 Olsen Avenue, New Auckland, Gladstone

WOLVES SOCCER CLUB INCOPORATED

Project No.: GL120052

Project Name: Proposed Development – 1 Olsen Avenue, New Auckland

Document No.: GL120052-C0703-W-R-CSMP-01

March 2013

Document Control Record

Prepared by:	ANNA KLEINSCHMIDT	Approved by:	BRAD COMLEY
Position:	ENGINEER – WATER	Position:	DICIPLINE MANAGER – WATER
Signed:		Signed:	
Date:	MARCH 2013	Date:	MARCH 2013
RPEQ certification:			

REVISION STATUS

Revision No.	Description of Revision	Date	Approved
0	First Issue – Final	September 2012	
1	IRR - Final	March 2013	RPEQ 8093

Recipients are responsible for eliminating all superseded documents in their possession.

VDM Engineering (Eastern Operations) Pty Ltd
ACN: 087 601 296

Level 8, Australia Fair Tower
42 Marine Parade
SOUTHPORT QLD 4215

PO Box 3766, Australia Fair
SOUTPORT QLD 4215

Telephone: +61 7 5509 6400
Facsimile: +61 7 5509 6411
Email: goldcoast@vdmgroup.com.au
Internet: www.vdmconsulting.com.au

Executive Summary

VDM Consulting has been commissioned by Wolves Soccer Club Incorporated to prepare a Conceptual Stormwater Management Plan (CSMP) for the proposed commercial development (the subject site) on Lot 11 on SP112850, 1 Olsen Avenue, New Auckland. Issue 1 of this report was prepared to accompany and be considered part of a Development Application (DA) to Gladstone Regional Council (GRC). This issue (Issue 2) has been prepared to respond to items raised by Council within an Information Request issued on 7 February 2013.

This report identifies the stormwater treatment measures required to satisfy the requirements of Gladstone Regional Council.

Stormwater Quantity

Upstream external catchment flows will be conveyed around the development area via a designated drainage system. A portion of the existing 375 mm RCP, which currently conveys minor flows from the upstream catchment through the development area, will be decommissioned. Instead all flows from the upstream catchment will be conveyed via an open swale to the north eastern corner of the development. As the swale will not grade to an open outlet, a low flow orifice will be provided to drain the swale into the lower portion of the existing 375 mm RCP, which will be retained. Flows in excess of the 125 mm orifice will be discharged as sheet flow via a grass weir and will flow across the lower portion of Lot 11 on SP112850, as occurs in the pre-development case.

All internal flows from the development area will be directed as sheet flow across the hardstand areas and into internal grass swales. These swales will convey flows up to the Q_{100} storm event to the north eastern corner of the site. At this location flows will be collected within a field inlet that will discharge directly into the retained portion of the existing 375 mm RCP.

Detention of upstream flows will ensure that the increase in peak discharge resulting from the proposed development is mitigated to pre-development flows at the discharge location. This detention system will achieve a Lawful Point of Discharge in accordance with Section 3.02 of QUDM.

Stormwater Quality

In accordance with Gladstone Regional Council's current Stormwater Quality Policy a monetary contribution is proposed in lieu of the provision of stormwater quality treatment on site. This monetary contribution is calculated at a rate of $525.00 per m^2 of required bioretention, as determined through MUSIC modelling. Based on the results of this assessment a bioretention filter area of 37 m^2 is required to meet the Queensland Water Quality Objectives (2009). Therefore a monetary contribution of $19,425.00 would be applicable.

Treatment Train Effectiveness

Results of the water quality modelling indicate the 85%, 70% and 45% reduction target for TSS, TP and TN respectively can be achieved for the rainfall data set simulated, as summarised below Table E1.

Table E1: Treatment Train Effectiveness

Pollutant	Inflows (kg/yr)	Outflows (kg/yr)	Reduction (kg/yr)	Reduction Achieved (%)	Water Quality Objective (%)
TSS	445	63.3	381.7	**85.8**	85.0
TP	0.855	0.256	0.599	**70.1**	70.0
TN	5.4	2.37	3.03	**56.1**	45.0

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1. Introduction

VDM Consulting has been commissioned by Wolves Soccer Club Incorporated to prepare a Conceptual Stormwater Management Plan (CSMP) for the proposed commercial development on to be located on a portion of Lot 11 on SP112850, 1 Olsen Avenue, New Auckland (the subject site). This report has been prepared to accompany and be considered part of a Development Application (DA) to Gladstone Regional Council (GRC).

A comprehensive review of available Stormwater Quality Improvement Devices (SQID) and Best Management Practices (BMP) was undertaken as part of this investigation. The following sections provide a summary of the mitigation measures required to meet Council's stormwater quality and quantity objectives during both the construction and operational phases of the development.

This management plan is to be considered as part of a Development Application and provides conceptual stormwater management design details. The level of detail provided within this report is not suitable for construction purposes, a Detailed Stormwater Management Plan outlining detailed designs will need to be completed in conjunction with detailed civil design documentation.

Issue 1 of this report was prepared to accompany a development application to Council. This issue (Issue 2) has been prepared to respond to items raised by Council within an Information Request issued on 7 February 2013.

1.1 Council Request for Information

Council's Information Request dated 7 February 2013 requested additional information and clarification in regards to a number of items. Table 1.1 provides responses to the items raised by Council and cross references to where these have been addressed in the report.

Table 1.1 Council Request for Information

General	
1. The proposed filling of the site has the potential to change the existing overland flow paths across the subject site, particularly draining from the caravan park site. Provide an updated detailed site based Stormwater Management Report for approval that: a) Demonstrates how stormwater runoff between the caravan park and the proposed site will be managed to a lawful point of discharge in a safe and controlled manner;	A 1.33 ha upstream catchment (Ext B) directs minor flows onto the development area via an existing 375 mm pipe and major flows via overland sheet flow. It has been estimated that this upstream catchment will generate a peak discharge of around 0.67 m^3/sec during a 100 year ARI. It is estimated that the 375 mm RCP will have a peak capacity of approximately 0.2 m^3/sec. Therefore it is estimated that a peak flow of 0.47 m^3/sec, will discharge onto the site as sheet flow.

	It is proposed to decommission the section of the existing 375 mm RCP that is located through the development area. Instead all flows from the upstream catchment will be conveyed via a pipe and open swales to the north eastern corner of the development. As the swale will not grade to an open outlet, a low flow orifice will be provided to drain the swale into the lower portion of the existing 375 mm RCP, which will be retained. As such the swale will act to detain flows from the upstream catchment. Flows in excess of the pipe outlet will be discharged as sheet flow via a grass weir and will flow across the lower portion of Lot 11 on SP112850, as occurs in the pre-development case.
b) Address stormwater issues during a Q_{100} storm event;	All internal flows from the development area will be directed as sheet flow across the hardstand areas and into internal grass swales. These swales will convey flows up to the Q_{100} storm event to the north eastern corner of the site. At this location flows will be collected within a field inlet that will discharge directly into the retained section of the existing 375 mm RCP. Modelling indicates that all flows up to the Q100 from the internal development area will be capable of discharging into the 375 mm RCP which will convey flows under Olsen Ave. Detention has been provided to ensure that peak flow rates will be maintained at the discharge point and the downstream Lawful Point of Discharge (LPD) through the inclusion of on-site detention. This detention system will achieve a Lawful Point of Discharge in accordance with Section 3.02 of QUDM.
c) Demonstrate how the proposed driveway accesses into the site will impend stormwater flows on the Olsen Avenue verge.	Culverts have been provided at both driveway access points allow stormwater flows to continue along the Olsen Avenue verge.
d) Demonstrate to Council that all runoff flows draining towards Olsen Avenue will not create an unacceptable risk to adjoining property owners or road users. This assessment should also consider the consequences of the	All internal flows from the development area will be collected within internal grass swale located around the development footprint. These swales will direct flows up to the Q_{100} ARI towards a field inlet pit located in the north eastern corner of the development. Modelling indicates that all flows

Q_{100} storm event in this location.	up to the Q100 from the internal development area will be capable of discharging into the 375 mm RCP which will convey flows under Olsen Ave. As such there will be no increase in the existing flows to the Olsen Avenue road reserve.
2. According to VDM's Concept Stormwater Management Plan – Executive Summary (page iii) – it is proposed to offer council a monetary contribution in lieu of providing a bio-retention basin facility on the site. However, VDM's Pre-Development plan SK005 details a proposed bio-retention basin to be constructed on the site. Please advise which option is being applied for.	It is anticipate that a monetary contribution be made lieu of onsite stormwater treatment. All stormwater treatment devices have been removed from the OPW drawings.
3. There is a conflict between VDM's Pre-Development catchment plan Dwg N200 (Ver A) and the Car Wash Builders Site plan Page 1 of 9 (Rev 1). VDM's external catchment plan shows that overland flows will flow in an easterly direction between the Caravan Park and the proposed site, whilst the Site Plan shows these flows drain back into the Caravan Park and onto Olsen Road. Please advise which is correct.	Amended plans have been prepared.
4. VDM's stormwater drainage calculations have adopted a time of concentration (t_c) for the post development car wash site of 12+ minutes. Council suggests that a more appropriate t_c for the post development site is 5 minutes. Please amend the calculations accordingly.	A revised Tc of 6 minute has been used to assess the post development peak discharge for the development area.
5. It is apparent from VDM's drawings that stormwater flows from the external catchment area are to merge with the development flows along the eastern boundary of the car wash site. Please advise how these flows will be managed in a safe and controlled manner. Please advise the potential impacts of the Q_{100} storm event along this boundary line.	The revised stormwater management proposal will to merge external and internal flows. Internal flows will be directed to a field inlet and will be conveyed via the retained portion of the existing 375 mm RCP under Olsen Ave. Upstream flows will be conveyed around the development area and will discharge as overland sheet flow as occurs in the existing undeveloped case. As such the existing LPD outlets will be retained. These outlets include, a 375 mm RCP for minor flows and overland sheet flow for flows in excess of the RCP capacity. At the outlet from the swale/basin located to the north western corner of the development, flows will flow across the remaining area of Lot 11 towards Police Creek and the sites existing LPD as occurs in the

	current scenario. Through providing detention of upstream flows, peak discharges will be mitigated to the pre-development peak discharge. By maintaining the existing discharge points and peak discharge rates there will be no worsening during all storm events up to the Q_{100} at the downstream discharge points and ultimately at the site's LPD into Police Creek.
6. VDM's plan SK008 (Ver A) shows that the outlet from the proposed bio-retention basin is to discharge into an existing grated pit east of the site. Provide details on the drawings of this existing drainage structure, where it discharges to and if it has capacity to accommodate the outflow discharge from the proposed development.	The existing 375 mm RCP currently conveys flow, of approximately 0.2 m^3/sec, from the upstream catchment and internal site areas. It is proposed to decommission the upstream portion of this RCP and direct upstream flows into two (2) 300 mm RCPs to convey minor flows and a grass swale for larger flows around the development area. Upstream flows into the 375 mm RCP will be restricted to that which can be conveyed through a 125 mm orifice plate. This will provide capacity in the RCP to discharge all internal site flows to the RCP via a 300 m RCP.
7. VDM's assessment that peak stormwater flows do not require attenuation because they are being discharged into a grass swale (Executive summary page iii) is not accepted by Council. Given the site is arguably a flood risk, it is essential that the Applicant attenuate the difference between the pre and post development flows for all storm events. Details of this attenuation are to be shown on the design plans together with RPEQ certified calculations are to be submitted to Council for consideration and approval.	A revised stormwater treatment system has been development which will include detention within the upstream conveyance swale. The outlet configuration from this swale/basin has been designed to mitigate the increase in peak discharge from the development area and ensure that peak discharge at the proposed discharge location and at the site's LPD into Police Creek is not increased from the existing condition. This stormwater management plan has been reviewed and approved by a RPEQ.
8. Council has identified that the proposed dog wash structure is located within the pathway of concreted stormwater flows from the hardstand area of the development site. Provide amended plans relocating the pathway of the concentrated flows clear of any proposed buildings or relocate the buildings accordingly.	Refer to amended Drawing SK007.

1.2 Scope

Specifically, this report details the following:

- Catchment hydrology and stormwater conveyance including:
  - ✓ topography; and
  - ✓ vegetation.
- Water Quality issues including:
  - ✓ an estimate of sediment and nutrient transport from the subject site; and
  - ✓ water quality objectives of the receiving waters.
- Stormwater Management Controls for the construction and operational phases; and
- Maintenance and Monitoring Program.

To minimise the impact of the proposed development on the external environment the proponent shall implement this CSMP. To avoid significant and/or sustained deterioration in downstream water quality this CSMP may be amended as required, in response to the Monitoring and Maintenance Program described herein.

1.3 Objective

The objective of this CSMP is to ensure:

- No increase in peak discharge from the subject site (up to the Q100 storm event) to ensure conveyance and flooding on downstream properties is not adversely impacted;
- Discharge of sediment laden stormwater is avoided for the nominated design storm and minimised when the nominated design storm is exceeded during the construction phase; and
- Compliance with the load based reduction targets during the 'operational' (post-construction) phase of the development, in accordance Queensland Water Quality Guidelines (2009).

These objectives will be achieved through the implementation of:

- Management strategies designed to maintain pre-development peak discharges for the full range of ARI events at the existing Lawful Points of Discharge (LPD);
- Specific construction phase controls to minimise erosion and control sediment loss;
- Water quality control measures to achieve load based reduction targets during the 'operational' (post-construction) phase of the development, in accordance with Queensland Water Quality Guidelines (2009);
- A monitoring and maintenance program for both the construction and operational phases; and
- Defined performance criteria and actions to be taken if the criteria are not met.

1.4 Description of Subject Site

The lot containing the subject site is triangular in shape and covers an area of 1.999 ha. It is noted however that only the western extent of the lot is subject to development, covering an area of 0.227 ha, and this area is the focus of this CSMP. The sites western boundary fronts Olsen Ave which provides access to the allotment. The site is located on the eastern outskirts of the township

of New Auckland within the Gladstone Regional Council area. The Coral Sea is approximately 8 km to the east of the site. For more information regarding the site location, please refer to Figure 1.1.

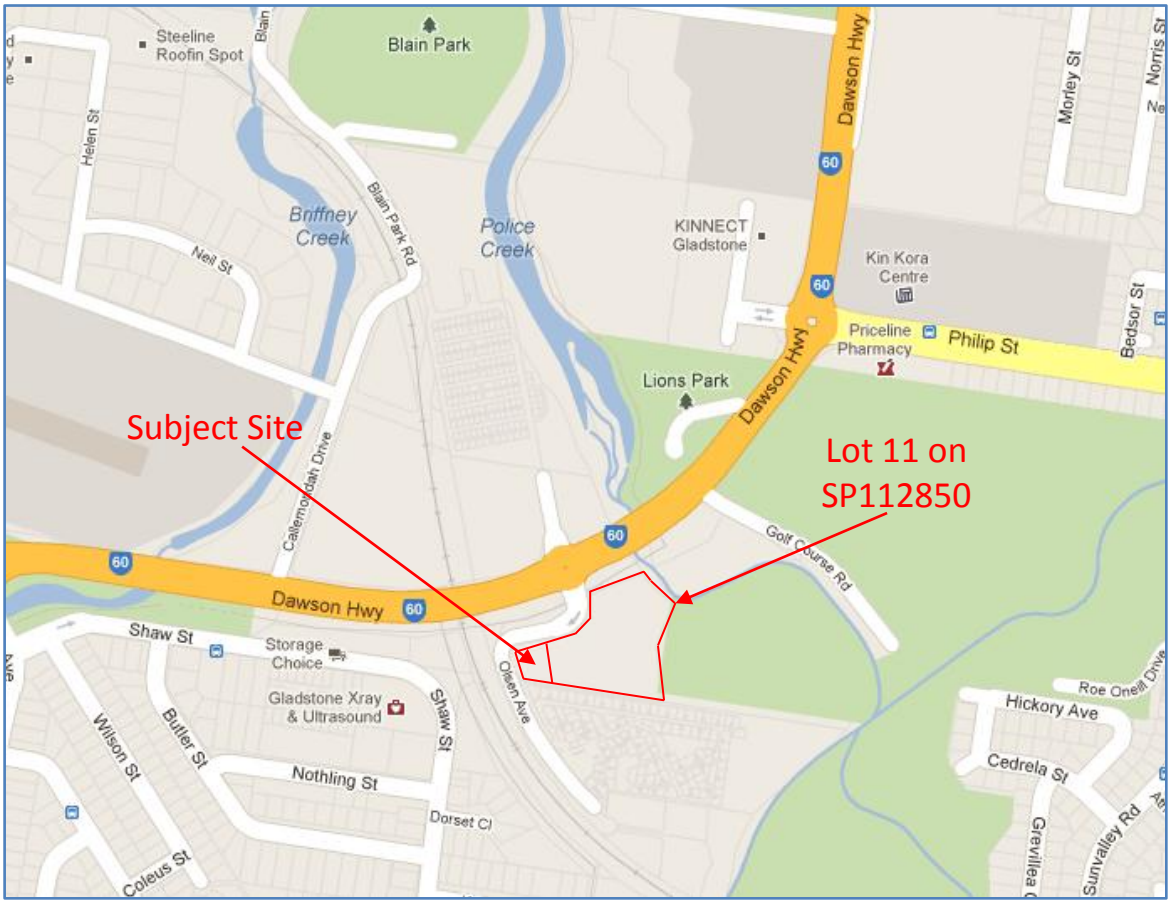


Figure 1.1 Site Locality Plan

1.4.1 Land Use and Vegetation

The site is currently unimproved consisting of grassed land. Vegetation clearing has occurred in association with previous land uses. Aerial photography and site inspections reveal the subject site to comprise mainly of areas with poor grass cover and bare soil, mediated by large isolated trees. The site is also currently utilised as an alternative entrance to the adjacent caravan park.

1.4.2 Topography and Stormwater Conveyance

The subject site's highest elevation of approximately 8.49 m AHD is located along the site's southern boundary. The lowest elevation is located along the northern boundary of the site being approximately 7.70 m AHD. The subject site is very flat and the ground slopes in a northern direction consistently at a grade of approximately 1.0%.

The development area has been identified to have two (2) external catchments. The larger upstream catchment directs discharge onto the site via a 375 mm RCP and as concentrated channel flow. An additional upstream catchment of approximately 0.25 ha, conveys runoff towards the development area along the eastern and southern boundaries as sheet flow.

The proposed development is located on a portion of Lot 11 as such the site has two (2) existing Lawful Points of Discharge (LPD). Minor flows currently discharge to a 375 mm RCP which runs under Olsen Ave (LPD1), major flows are conveyed across the subject site (Lot 11) to the east and into Police Creek, (LPD2).

1.4.3 Downstream Environment

Minor runoff events from the subject site are discharged into the existing stormwater pipe network (375 mm RCP), which ultimately discharges to Police Creek. During major events, runoff is conveyed eastward via a natural overland flow paths into Police Creek.

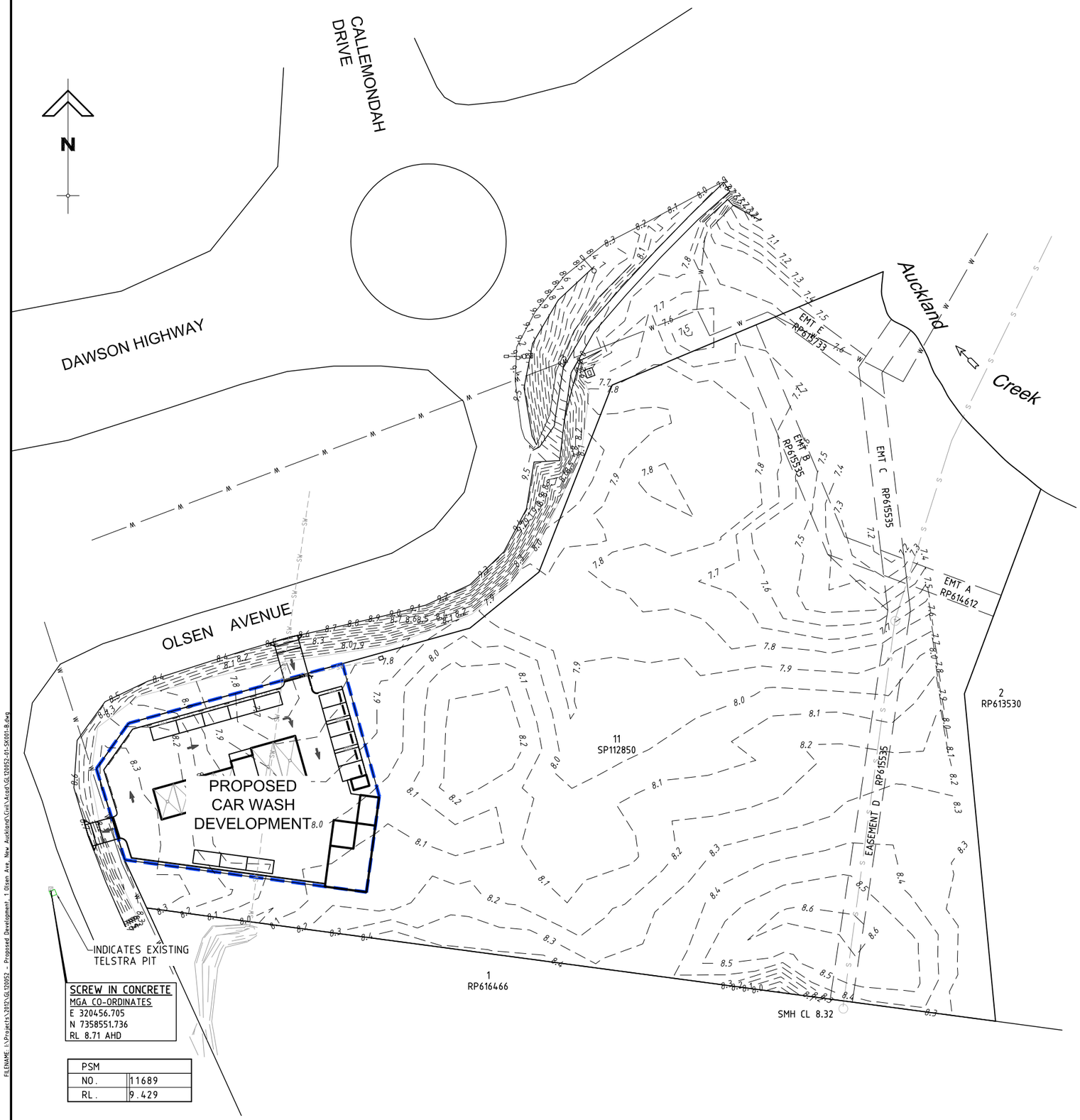
1.4.4 Rainfall

Mean annual rainfall for the site has been estimated to be 908 mm from the data set obtained from the nearest local rainfall station (Gladstone Radar 39123). A range of design rainfall estimates for various AEPs and durations is provided in Tables A3 and A4 in Appendix A.

1.5 Description of Development

The proposed development is located within the eastern portion of Lot 11 on SP112850 and will include the following (refer Figure 1.2):

- Three (3) Vacuum Areas;
- One (1) Car Wash Area;
- One (1) Detailing Shed/Store Front;
- One (1) Dog Wash Area;
- An Internal Road Network; and
- Landscaping.



LAYOUT PLAN

SCALE 5 0 5 10 15 20 25 (metres)
1 : 500 (FULL SIZE)

LEGEND :

8.0 EXISTING SURFACE LEVELS

DEVELOPMENT BOUNDARY

GENERAL NOTES :

1. **CONTRACT DOCUMENTATION**
ALL DRAWINGS UNDER THIS CONTRACT ARE TO BE READ IN CONJUNCTION WITH THE PROJECT SPECIFICATION.

2. **SURVEY INFORMATION**
CONTROL SURVEY INFORMATION WILL BE ESTABLISHED ON SITE BY THE PRINCIPAL'S SURVEYOR. SETOUT INFORMATION SHALL NOT BE OBTAINED BY SCALING FROM THESE DRAWINGS.

3. **DATUM**
ALL LEVELS SHOWN ON DRAWINGS ARE A.H.D.

4. **EXISTING SURVEY CONTROL STATIONS**
THE CONTRACTOR IS TO ENSURE THAT SURVEY CONTROL STATIONS ARE NOT DAMAGED OR DISTURBED IN ANY WAY BY CONSTRUCTION ACTIVITIES.

5. **EXISTING SERVICES**
EXISTING SERVICES LOCATIONS WHERE SHOWN ON THE DRAWINGS ARE INDICATIVE ONLY. THE CONTRACTOR SHALL CONTACT THE RELEVANT AUTHORITIES TO ASCERTAIN THE EXACT LOCATION OF ALL EXISTING SERVICES PRIOR TO COMMENCEMENT OF WORK AND SHALL TAKE ALL NECESSARY PRECAUTIONS TO AVOID DAMAGE TO EXISTING SERVICES.

6. **SITE ACCESS**
THE CONTRACTOR SHALL GAIN ACCESS TO THE SITE AT LOCATIONS APPROVED BY THE SUPERINTENDENT. FREEDOM OF ACCESS TO OTHER WORK AREAS ON THE SITE SHALL BE MAINTAINED AT ALL TIMES.

7. **PROVISION FOR TRAFFIC**
PROVISION FOR TRAFFIC ON LOCAL ROADS IS TO BE IN ACCORDANCE WITH THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES AND LOCAL AUTHORITY REQUIREMENTS.

8. **WORK BOUNDARIES**
THE CONTRACTOR IS TO RESTRICT ACTIVITIES TO THOSE AREAS DESIGNATED AS WORK AREAS UNDER THIS CONTRACT. AT NO TIME SHALL THE CONTRACTOR ENTER ADJOINING PROPERTIES OR CONTRACT WORK AREAS ON THE SITE WITHOUT WRITTEN AUTHORISATION FROM THE SUPERINTENDENT.

9. **SITE CLEARING**
CLEARING AND GRUBBING SHALL BE CARRIED OUT TO ALL WORK AREAS AS SPECIFIED AND SHALL INCLUDE THE REMOVAL OF ALL EXISTING TREES (UNLESS NOMINATED TO BE PRESERVED), EXISTING VEGETATION, TIMBER, FENCES AND ANY OTHER DEBRIS.

10. **TOPSOIL STRIPPING**
ALL TOPSOIL STRIPPED FROM WORK AREAS SHALL BE STOCKPILED FOR LATER RE-SPREADING TO ALL FOOTPATHS, BATTERS AND FILL AREAS.

11. **EARTHWORKS (GENERAL)**
ALL FILL MATERIAL PLACED SHALL BE COMPACTED AND TRIMMED TO FINAL EARTHWORKS LEVELS AND PROFILES SHOWN ON THE CONTRACT DRAWINGS AND TESTED IN ACCORDANCE WITH THE PROJECT SPECIFICATION AND AS3798 "GUIDELINES FOR EARTHWORKS FOR COMMERCIAL AND RESIDENTIAL DEVELOPMENTS'.

12. **COMPACTION STANDARDS**
ALL FILL MATERIAL PLACED UNDER THIS CONTRACT SHALL BE COMPACTED IN ACCORDANCE WITH COUNCIL STANDARD SPECIFICATION. ALL TESTING OF THE EXCAVATION BASE AND SUBSEQUENT FILL LAYERS SHALL BE CARRIED OUT ON ALL FILLS IN ACCORDANCE WITH AS3798 INCLUDING RELATIVE COMPACTION TESTING IN ACCORDANCE WITH AS1289 SERIES 5.

13. **STORMWATER DRAINAGE**
LOCATION AND ALIGNMENT OF ALL STORMWATER DRAINLINES IS TO BE VERIFIED ON SITE WITH THE SUPERINTENDENT PRIOR TO EXCAVATION.
THE DESIGN SURFACE LEVELS OF MANHOLES AND OTHER STRUCTURES ARE TO BE VERIFIED ON SITE WITH THE SUPERINTENDENT.
ALL DRAINAGE CONSTRUCTION SHALL BE IN ACCORDANCE WITH GLADSTONE REGIONAL COUNCIL STANDARD DRAWINGS AND SPECIFICATION.

14. **ELECTRICAL RETICULATION**
ALIGNMENTS OF ALL CONDUIT CROSSINGS ARE TO BE VERIFIED ON SITE WITH THE SUPERINTENDENT PRIOR TO EXCAVATION.
ALL TRENCHING AND CONDUIT WORKS ARE TO BE CONSTRUCTED IN ACCORDANCE WITH THE RELEVANT AUSTRALIAN STANDARD.

15. **TOPSOIL REPLACEMENT AND GRASSING**
FOLLOWING COMPLETION OF ROADWORKS CONSTRUCTION AND BULK EARTHWORKS OPERATIONS THE FULL EXTENT OF FOOTPATHS, BATTERS AND FILL AREAS IS TO BE RE-TOPSOILED TO A MINIMUM DEPTH OF 100mm AND GRASSED AS FURTHER DETAILED IN THE SPECIFICATION.

16. **TESTING**
ALL TESTING SHALL BE CARRIED OUT BY AN APPROVED N.A.T.A. TESTING AUTHORITY IN ACCORDANCE WITH THE PROJECT SPECIFICATION.

17. **"AS CONSTRUCTED" SURVEY**
"AS CONSTRUCTED" SURVEY SHALL BE CARRIED OUT BY THE PRINCIPAL'S SURVEYOR AS WORK PROCEEDS.

18. **MAINTENANCE OF SITE CONDITION**
AT THE COMPLETION OF WORKS THE SITE IS TO BE LEFT IN A CLEAN AND TIDY CONDITION TO THE SATISFACTION OF THE SUPERINTENDENT AND COUNCIL.

PROPOSED CAR WASH DEVELOPMENT

LOTS 11 on SP112850
1 OLSEN AVENUE
NEW AUCKLAND
GLADSTONE
QUEENSLAND

prepared for

WOLVES SOCCER CLUB INCORPORATED

PRELIMINARY ISSUE

VER.	DESCRIPTION	APPR.	DATE
B	REVISED ISSUE		20-03-13
A	ORIGINAL ISSUE		07-09-12

VDM CONSULTING
GLADSTONE
Unit 3, 124 Goodoon Street, Gladstone QLD 4680
PO Box 541, Gladstone QLD 4680
Phone: +61 7 4972 9522
Fax: +61 7 4972 9577
Email: Gladstone@vdmgroup.com.au
VDM Engineering (Eastern Operations) Pty Ltd
ABN 91 087 601 296

DRAWING TITLE :

LAYOUT PLAN AND GENERAL NOTES

DEVEL. APPLIC. No.: -		DATE: 07-09-12	
PROJECT LEADER: GARY CLARKE			
DESIGNER: JOHN HENRY			
DRAFTSPERSON: ANNETTE LEGGE / ILZA MITCHELL			
CHECKED: JOHN HENRY			
APPROVED FOR AND ON BEHALF OF VDM ENGINEERING (EASTERN OPERATIONS) PTY LTD ACN 087 601 296			
RPEQ No.:			
SCALE: AS SHOWN	DATUM: AHD	FULL SIZE: A1	
PROJECT No.: GL120052-01	DRAWING No.: SK001	VERSION: B	

FILENAME: \\Projects\2012\GL120052 - Proposed Development, 1 Olsen Ave, New Auckland\Civil\Acad\GL120052-01-SK001-B.dwg
PLOTTED: 20 Mar 2013

2. Hydrological Analysis

The natural hydrology of the site has been assessed in accordance with QUDM 2008 Section 4. The Rational Method has been relied upon to gain an initial understanding of the relative impact of the proposed development on peak flow rates at the site's Lawful Point of Discharge. The Rational Method provides a basic method for assessing peak flow rates and is considered suitable given the catchment area is less than 500 ha.

2.1 Pre-Development Catchment Delineation

In the pre-development scenario, two (2) external catchments have been identified to the development area. Catchment Ext A has an area of 0.25 ha in size and discharges runoff towards the development area from the east and south, from upstream areas on the subject site.

A 1.33 ha upstream catchment (Ext B) directs minor flows onto the development area via an existing 375 mm pipe and major flows via overland sheet flow.

Flows from both external catchments currently combine with overland sheet flows from the subject site catchment (0.227 ha) and are concentrated toward the northern corner of the development area. At this point minor flows from the combined site and upstream catchments discharge into an existing 375 mm RCP conveying flows under Olsen Ave, (LPD1). Major flows are conveyed across the remainder of the subject site as channel flow and into Police Creek, (LPD2). The pre-development catchment areas are summarised in Table 2.1 with the pre-development catchment delineation shown in Table 1.1.

Table 2.1 Catchment Delineation

Catchment ID	Pre-Development (ha)	
Int A	Internal	0.23
Ext A	External	0.25
Ext B	External	1.33
$LPD1_{(Minor\ flows)}$	**Total**	**1.81**
$LPD2_{(Major\ Flows)}$	**Total**	**1.81**

2.2 Pre-Development Hydrology

The existing hydrology of the site has been assessed in accordance with QUDM 2008 Section 4. Results of this assessment are contained within Table 2.2. A detailed summary of the hydrologic calculations are contained in Appendix A. In the pre-development scenario, runoff coefficients have been calculated through the use of site plans, site investigation, aerial photography and QUDM. Details of these assumptions, time of concentration and Rational Method calculations are contained in more detail within Appendix A. It should be noted that the southern catchment is already partially urbanised, and its existing condition (fraction impervious) has been included in this base case assessment. For assessment purposes the existing 375 mm RCP has been assessed to convey minor flows up to 0.2 m^3/sec.

Table 2.2 Pre-Development Hydrology

Catch.	**Area** (ha)	**tc** (min	**Average Recurrence Interval - Years**						
			Q_{100} (m^3/s)	**Q_{50}** (m^3/s)	**Q_{20}** (m^3/s)	**Q_{10}** (m^3/s)	**Q_5** (m^3/s)	**Q_2** (m^3/s)	**$Q_{0.25}$** (m^3/s)
INT A	0.23	14	0.12	0.10	0.08	0.06	0.05	0.04	0.02
EXT A	0.25	12	0.14	0.12	0.09	0.07	0.06	0.04	0.02
EXT B	1.33	17	0.67	0.59	0.46	0.37	0.32	0.22	0.11
LPD1$_{(Minor\ Flows)}$	1.81	18	0.20*	0.20*	0.20*	0.20*	0.20*	0.20*	0.14
LPD2$_{(Major\ Flows)}$	1.81	18	0.67	0.56	0.39	0.28	0.21	0.08	-
Combined LPD's	1.81	18	0.87	0.76	0.59	0.48	0.41	0.28	0.14

*estimated capacity of the existing 375 mm RCP has been assessed to convey up to 0.2 m^3/sec.

N

LEGEND

- PRE-DEVELOPMENT CATCHMENT
- OVERLAND FLOW PATH
- PIPED FLOW

PROPOSED CAR WASH DEVELOPMENT

LOTS 11 on SP112850
1 OLSEN AVENUE
NEW AUCKLAND
GLADSTONE
QUEENSLAND

prepared for

WOLVES SOCCER CLUB INCORPORATED

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		—

VDM CONSULTING
GOLD COAST
Level 8, Australia Fair Tower
42 Marine Parade, Southport QLD 4215
PO Box 3766, Australia Fair, Southport QLD 4215
Phone: +61 7 5509 6400
Fax: +61 7 5509 6411
Email: goldcoast@vdmgroup.com.au
VDM Engineering (Eastern Operations) Pty Ltd
ABN 91 087 601 296

PROJECT:

DRAWING TITLE:
PRE-DEVELOPMENT CATCHMENT DELINIATION

DEVEL. APPLIC. No.:	DATE: 19-03-13
PROJECT LEADER: GARY CLARKE	
DESIGNER: BC	
DRAFTSPERSON: AK	
CHECKED: BC	

APPROVED FOR AND ON BEHALF OF VDM ENGINEERING (EASTERN OPERATIONS) PTY LTD ACN 087 601 296

RPEQ No.:

SCALE: 1:500	DATUM: AHD	FULL SIZE: A1
PROJECT No.: GL120052	DRAWING No.: N200	VERSION: B

FILENAME: \\Projects\2012\GL120052 - Proposed Development, 1 Olsen Ave, New Auckland\Specialist Services\ACAD\Water\GL120052-N200-B.dwg
PLOTTED: 19 Mar 2013

2.3 Post-Development Catchment Delineation

In the post-development scenario, it is proposed to decommission a portion of the existing 375 mm RCP, which conveys up to 0.2 m^3/sec of flow from the upstream catchment. Instead upstream flows will be conveyed around the development area within a grass swale. As the swale will not grade to an open outlet, a low flow orifice will be provided to drain the swale into the lower portion of the existing 375 mm RCP, which will be retained. Flows in excess of the pipe outlet will be discharged as sheet flow via a weir and will flow across the lower portion of Lot 11 on SP112850, as occurs in the pre-development case. All internal flows from the development area will be collected within internal grass swales. These swales will convey flows up to the Q_{100} storm event to the north eastern corner of the site. At this location, flows will be collected within a field inlet that will discharge directly into the retained portion of the existing 375 mm RCP, which will convey flows under Olsen Ave. The post-development catchment areas are summarised in Table 2.3 with the post-development catchment delineation shown in Figure 2.2.

Table 2.3 Post-Development Catchment Delineation

Catchment ID	**Pre-Development (ha)**	
Int A	Internal	0.23
Ext A	External	0.25
Ext B	External	1.33
$LPD1_{(Minor\ flows)}$	**Total**	**1.81**
$LPD2_{(Major\ Flows)}$	**Total**	**1.81**

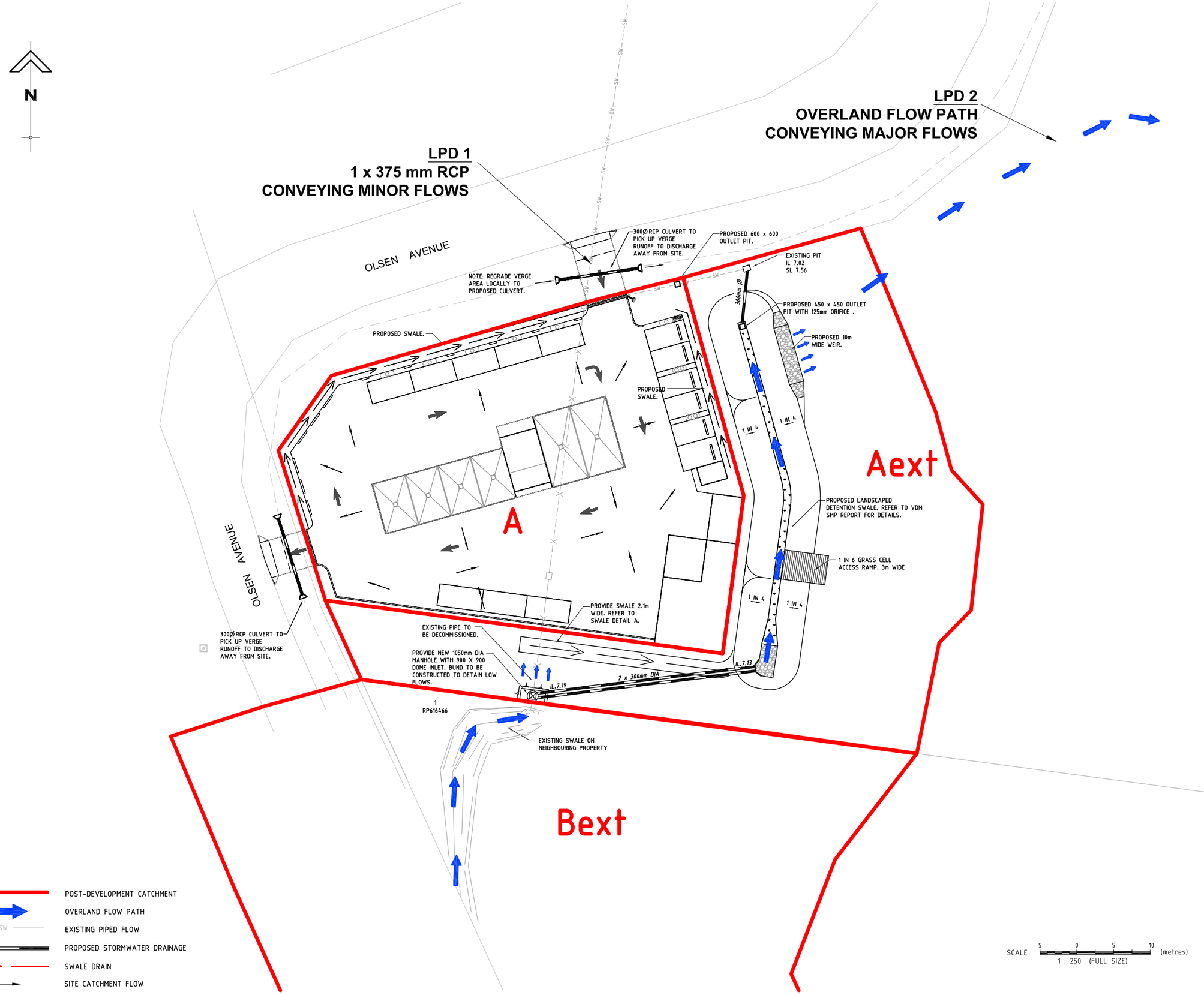
2.4 Post-Development Hydrology

The post development hydrology of the site has been assessed in accordance with QUDM 2008 Section 4. Results of this assessment are contained within Table 2.4. In the post-development scenario, runoff coefficients have been calculated through the use of proposed site plans and QUDM. Details of these assumptions, time of concentration and Rational Method calculations are contained in more detail within Appendix A.

Table 2.4 Post-Development Hydrology

Catch.	**Area** (ha)	**tc** (min	**Average Recurrence Interval - Years**						
			Q_{100} (m^3/s)	**Q_{50}** (m^3/s)	**Q_{20}** (m^3/s)	**Q_{10}** (m^3/s)	**Q_5** (m^3/s)	**Q_2** (m^3/s)	**$Q_{0.25}$** (m^3/s)
INT A	0.23	6	0.20	0.17	0.14	0.11	0.09	0.06	0.03
EXT A	0.25	12	0.14	0.12	0.09	0.07	0.06	0.04	0.02
EXT B	1.33	17	0.67	0.59	0.46	0.37	0.32	0.22	0.11
$LPD1_{(Minor\ Flows)}$	1.81	18	0.20*	0.20*	0.20*	0.20*	0.20*	0.20*	0.14
$LPD2_{(Major\ Flows)}$	1.81	18	0.69	0.58	0.40	0.30	0.22	0.09	-
Combined LPD's	1.81	18	0.89	0.78	0.60	0.50	0.42	0.29	0.15

*estimated capacity of the existing 375 mm RCP has been assessed to convey up to 0.2 m^3/sec.



PROPOSED CAR WASH DEVELOPMENT

LOTS 11 on SP112850
1 OLSEN AVENUE
NEW AUCKLAND
GLADSTONE
QUEENSLAND

prepared for

WOLVES SOCCER CLUB INCORPORATED

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		19.03.13

VDM CONSULTING
GOLD COAST
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PO Box 3766, Australia Fair, Southport QLD 4215
Phone: +61 7 5509 6400
Fax: +61 7 5509 6411
Email: goldcoast@vdmgroup.com.au
VDM Engineering (Eastern Operations) Pty Ltd
ABN 91 087 601 296

PROJECT:

DRAWING TITLE:
FIGURE 2.2 - POST-DEVELOPMENT CATCHMENT DELINIATION

DEVEL. APPLIC. No.:	DATE: 19-03-13
PROJECT LEADER: GARY CLARKE	
DESIGNER: BC	
DRAFTSPERSON: AK	
CHECKED: BC	
APPROVED FOR AND ON BEHALF OF VDM ENGINEERING (EASTERN OPERATIONS) PTY LTD ACN 087 601 296	
RPEQ No.:	
SCALE: 1:250	DATUM: AHD / FULL SIZE: A1
PROJECT No.: GL120052	DRAWING No.: N201 / VERSION: B

PLOTTED: 20 Mar 2013
FILENAME: J:\Projects\2012\GL120052 - Proposed Development - 1 Olsen Ave, New Auckland\Specialist Services\VAC&D\Vector\GL120052-N201-B.dwg

2.5 Comparative Analysis of Pre- and Post- Development Hydrology

Two Lawful Points of Discharge have been identified. LPD1 is the existing 375 mm RCP which directs flows under Olsen Ave. In both pre- and post-development cases flow to this RCP will be maintained at approximately 0.2 m^3/sec. In the pre-development case this flow will be generated by upstream catchments. In the post-development case, the upstream catchment flows to this RCP will be restricted by a 125 mm orifice at the base of the proposed conveyance swale. This will create capacity within the pipe to discharge flows from the internal developed catchment. The 375 mm pipe will therefore run at capacity in both the pre- and post- development cases.

Peak flows to the proposed discharge point and at Police Creek would be expected to increase in the post-development case. This increase will be created through restricting upstream discharge into the existing 375 mm pipe and directing increased flows over the remaining area of the subject site (Lot 11) and into Police Creek (LPD2).

The hydrological analysis indicates that this increase in peak discharge is expected to be in the order of 0.02 m^3/sec during all storm events.

Table 2.5 Comparison of Pre- and Post-Hydrology

Peak Discharge	Average Recurrence Interval - Years						
	Q_{100} (m^3/s)	Q_{50} (m^3/s)	Q_{20} (m^3/s)	Q_{10} (m^3/s)	Q_5 (m^3/s)	Q_2 (m^3/s)	$Q_{0.25}$ (m^3/s)
$LPD1_{(Minor\ Flows)\ PRE}$	0.20*	0.20*	0.20*	0.20*	0.20*	0.20*	0.14
$LPD1_{(Minor\ Flows)\ POST}$	0.20*	0.20*	0.20*	0.20*	0.20*	0.20*	0.14
Difference	0	0	0	0	0	0	0
$LPD2_{(Major\ Flows)\ PRE}$	0.67	0.56	0.39	0.28	0.21	0.08	-
$LPD2_{(Major\ Flows)\ POST}$	0.69	0.58	0.40	0.30	0.22	0.09	-
Difference	0.02	0.02	0.01	0.02	0.02	0.01	-

*estimated capacity of the existing 375 mm RCP has been assessed to convey up to 0.2 m^3/sec.

3. Quantity Management – Operational Controls

To ensure the expected increased flow rates from the developed proposal have minimal impact and protect the receiving waterway and mitigate any increase in flooding on downstream properties, the following hydrological objective has been set for stormwater exiting the subject site.

- No increase in peak discharge from the site for events up to the Q100.

To achieve this objective, it is proposed that flows discharged to the site's LPD's be adequately treated prior to discharge.

3.1 Conveyance of External Flows

It is estimated that flows from the upstream catchment will have a peak discharge of 0.67 m^3/sec at the upstream property boundary. These flows are currently conveyed onto the subject site via a 375 mm RCP and as overland sheet flows. In the post-development scenario, it is proposed to decommission the majority of the existing 375 mm RCP and replace the upper sections with two (2) 300 mm RCPs to convey minor flows and a grass swale for larger flows. Both minor and major flows will then be directed into a grass swale, aligned around the boundary of the development area. As the swale will not grade to an open outlet, due to topographical constraints, a 125 mm low flow orifice will be provided to drain the swale into the lower portion of the existing 375 mm RCP, which will be retained. Flows in excess of the pipe outlet will be discharged as sheet flow via a grass weir and will flow across the lower portion of Lot 11 on SP112850, as occurs in the pre-development case.

3.2 Conveyance of Site Flows

All internal flows from the development area will be directed as sheet flow across the hardstand areas and into internal grass swales. These swales will convey flows up to the Q_{100} storm event to the north eastern corner of the site. At this location, flows will be collected within a field inlet that will discharge directly into the retained section of the existing 375 mm RCP, which will convey flows under Olsen Ave.

3.3 Detention Requirements

It is proposed that the post-development peak discharge to LPD2 be mitigated through the inclusion of on-site detention. The detention is to be located within the upstream conveyance swale.

3.4 Discharge Conditions

In the pre-development case stormwater flows are discharged as pipe flow to LPD1 and as sheet flow across the remainder of Lot 11 to Police Creek (LPD2). Pipe discharge to LPD1 is proposed to be maintained. In order to maintain the existing discharge condition at LPD2 a weir will be used to convert channel flow to overland sheet flow. These measures will ensure that a Lawful Point of Discharge for the development in accordance with section 3.02 of QUDM.

4. Quantity Analysis – XP-STORM

In order to further progress and advance the proposed stormwater quantity controls XP-STORM was utilised to model the performance of the proposed quantity controls. This modelling software is a link-node model capable of performing hydrology and hydraulics of stormwater drainage systems simultaneously.

4.1 Rainfall Parameters

Australian Rainfall and Runoff (ARR) temporal patterns and IFD data from the Bureau of Meteorology has been utilised. The IFD data used in the hydrologic analysis for a range of storm events is presented in Table 4.1.

Table 4.1 Adopted Intensity Frequency Data (mm/hr)

Storm Duration (min)	Average Recurrence Interval - Years						
	1	2	5	10	20	50	100
10	86	111	142	162	188	223	250
15	73	94	120	136	157	186	210
20	64	82	105	119	137	163	183
25	57	74	94	106	123	146	163
30	52	67	86	97	112	133	149
45	42.2	54	69	78	90	107	119
60	36.1	46.5	59	66	77	91	102
90	27.7	35.8	45.9	52	61	72	81
120	22.9	29.7	38.4	43.8	51	61	69

To input the IFD information into XP-STORM, rainfall multipliers are generated to represent the depth of rainfall for a given storm event and storm duration. The rainfall multipliers are then applied to the temporal patterns within XP-STORM to generate flood hydrographs for use within the hydraulic analysis.

Table 4.2 Rainfall Multipliers Applied to Temporal Patterns (mm)

Storm Duration (min)	Average Recurrence Interval - Years						
	1	2	5	10	20	50	100
10	14.3	18.5	23.7	27.0	31.3	37.2	41.7
15	18.3	23.5	30.0	34.0	39.3	46.5	52.5
20	21.3	27.3	35.0	39.7	45.7	54.3	61.0
25	23.8	30.8	39.2	44.2	51.3	60.8	67.9
30	26.0	33.5	43.0	48.5	56.0	66.5	74.5
45	31.7	40.5	51.8	58.5	67.5	80.3	89.3
60	36.1	46.5	59.0	66.0	77.0	91.0	102.0
90	41.6	53.7	68.9	78.0	91.5	108.0	121.5
120	45.8	59.4	76.8	87.6	102.0	122.0	138.0

4.2 Laurenson Routing Parameters

In this study, the "Laurenson" routing method was applied to XP-STORM for hydrograph generation. To enable this method to be used, each catchment must be split into pervious (undeveloped) and impervious (developed) portions. Adopted parameters for the Laurenson routing method included:

- The fraction impervious has been determined by analysis of aerial photographs and the proposed development layout;
- Manning Roughness coefficient (n):
  - ✓ Pervious portion: ranging from 0.025 to 0.035; and
  - ✓ Impervious portion: ranging from 0.014 to 0.015.
- Initial Loss (IL) and Continuing Losses (CL) have been applied to the hydrologic model. Details of IL and CL parameters applied in the XP-STORM model are presented in Table 4.3.

Table 4.3 Adopted Initial & Continuing Losses

Impervious Area		Pervious Area	
IL (mm)	**CL (mm/hr)**	**IL (mm)**	**CL (mm/hr)**
0	0	15	2.5

Analysis of the catchment has been undertaken to determine the average slope, with the results of this being applied to the model.

Table 4.4 Pre-Development Catchment Parameters

Catchment	Impervious Area			Pervious Area		
	Area (ha)	**Fraction Impervious (%)**	**Slope (%)**	**Area (ha)**	**Fraction Impervious (%)**	**Slope (%)**
Pre A	0	100	-	0.23	0	2.0
Ext A	0	100	-	0.25	0	1.5
Ext B	0.53	100	1.0	0.80	0	1.0

Table 4.5 Post-Development Catchment Parameters

Catchment	Impervious Area			Pervious Area		
	Area (ha)	**Fraction Impervious (%)**	**Slope (%)**	**Area (ha)**	**Fraction Impervious (%)**	**Slope (%)**
Post A	0.23	100	1.0	0	100	-
Ext A	0	100	-	0.25	0	1.5
Ext B	0.53	100	1.0	0.80	0	1.0

4.3 Model Verification

A comparison between the peak discharge values obtained using the Rational Method and the XP-STORM model for the 100 year ARI event at the Lawful Point of Discharge is contained in Table 4.6. The peak discharges generated by XP-STORM compare well to the values obtained from Rational Method calculations. Similar variations were observed for all other ARI events, and are therefore considered appropriate for subsequent hydraulic analysis.

Table 4.6 Rational Method vs XP-STORM Generated Peak Discharges

Catchment	Pre-Development			Post-Development		
	Rational (m^3/s)	STORM (m^3/s)	Difference (%)	Rational (m^3/s)	STORM (m^3/s)	Difference (%)
A	0.12	0.127	5.8	0.20	0.189	5.5
Ext A	0.14	0.125	10.7	0.14	0.125	10.7
Ext B	0.67	0.621	7.5	0.67	0.621	7.5

4.4 OSD Configuration

XP-STORM requires a depth area relationship to be defined when modelling an onsite detention (OSD). A summary of the total depth-area relationship applied to the storage node of the XP-STORM model in the post-development (mitigated) scenario is contained in Table 4.7.

Table 4.7 Depth - Area Relationship Adopted for OSD

Swale/Basin	RL (mAHD)	Depth (m)	Surface Area (m^2)
A	7.05	0.0	55
	8.05	1.0	440

4.5 OSD Outlet Configuration

XP-STORM requires appropriate outlet structures to be defined when modelling an OSD. A summary of the outlet structures modelled is provided in Table 4.8. All proposed outlet structures will be refined at Operational Works stage of the development.

Table 4.8 Modelled Outlet Structures of OSDs

Swale/Basin	Outlet Structures			
	Orifice	Outlet Pit	Outlet Pipe	Overflow Weir
A	1*125 mm @ RL 7.05 m AHD	1 x 450*450 mm @ RL 7.86 m AHD	1*300 mm dia @ RL 7.05 m AHD	10 m wide @ RL 7.91 m AHD

4.6 Performance of OSD

To confirm the performance of the proposed OSD, a pre- and post-development model was constructed. These models compare the discharge hydrographs for a range of storm durations at the existing Lawful Point of Discharges for the site. The 100, 50, 20, 10, 5 and 2-year ARI events have been simulated for 10, 15, 20, 25, 30, 45, 60, 90 and 120 - minute ARR storms. Copies of these models can be provided upon request.

A summary of the modelling results for different ARI events is contained in Table 4.9. In both pre- and post-development cases flow to LPD1 will be maintained at approximately 0.2 m^3/sec. The proposed detention swale/basin is capable of maintaining the pre-development peak discharges for the all storm events up to the 100 year ARI event at LPD2.

Table 4.9 Pre-Development vs Post-Development (Mitigated) Peak Discharges at LPD

Peak Discharge	Average Recurrence Interval - Years					
	Q_{100} (m^3/s)	**Q_{50}** (m^3/s)	**Q_{20}** (m^3/s)	**Q_{10}** (m^3/s)	**Q_5** (m^3/s)	**Q_2** (m^3/s)
$LPD1_{(Minor\ Flows)\ PRE}$	0.211	0.209	0.204	0.199	0.196	0.191
$LPD1_{(Minor\ Flows)\ POST}$	0.199	0.197	0.192	0.168	0.147	0.104
$LPD2_{(Major\ Flows)\ PRE}$	0.60	0.485	0.371	0.247	0.172	0.054
$LPD2_{(Major\ Flows)\ POST}$	0.431	0.329	0.216	0.133	0.080	0.0

A plot of the pre-development vs post-development (mitigated) hydrographs for the 100-year ARI event is included as Figure 4.1 and Figure 4.2. The detention volume required to achieve these results is summarised in

Table 4.10, taken at the peak water depth.

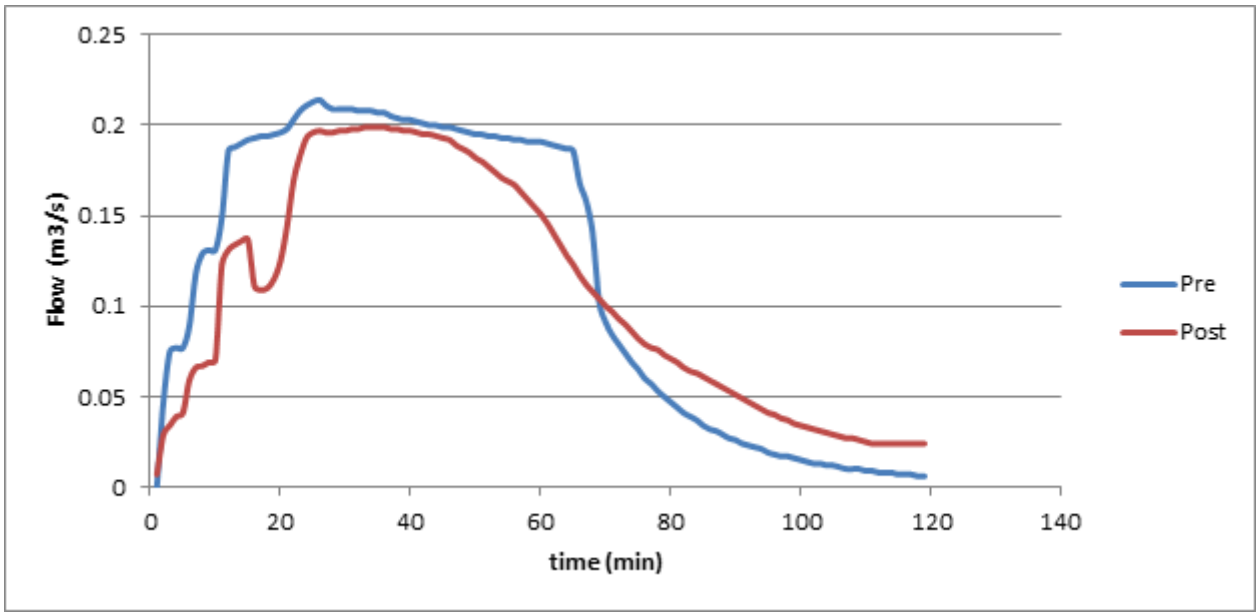


Figure 4.1 Plot of Pre - Development vs Post - Development Q100 Hydrographs LPD1

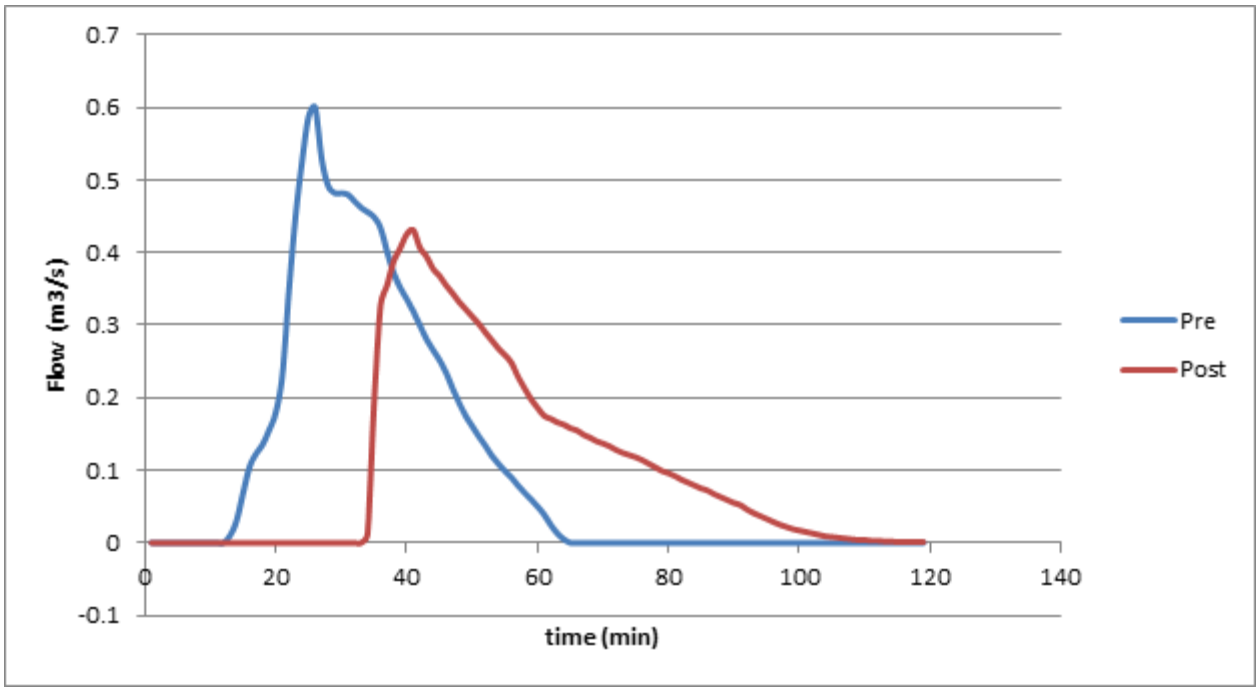


Figure 4.2 Plot of Pre - Development vs Post - Development Q100 Hydrographs LPD2

Table 4.10 OSD Volume

OSD	Volume (m^3)
A	275

4.6.1 Basin Depth

QUDM requires demonstration of the depth of water in the detention basin does not exceed 1.2 m during the Q20 storm event. The Q20 storm event was simulated for the post development scenario to confirm this requirement and the results are presented in Table 4.11. Results demonstrate that the depth of water within the proposed basin does not exceed 1.2 m during the Q20 storm event.

Table 4.11: Detention Basin Depths 20-year ARI Event

Basin Floor Level (m AHD)	Peak Water Surface (m AHD)	Peak Depth of Water (m)
7.05	7.98	0.93

Table 4.11 demonstrates the depth of water within the proposed basin does not exceed 1.2 m during the Q20 storm event.

QUDM requires that during a Q100 storm event, that a basin is designed so as to achieve:

- a peak water depth of no greater than 1.5 m;
- a freeboard of 0.3 m; and
- a depth flow of no greater than 0.3 m over the highflow weir.

The Q100 storm event was simulated for the post development scenario to confirm these requirements and the results are presented in Table 4.12.

Table 4.12: Detention Basin Depths 100-year ARI Event

Q_{100}					
Basin Floor Level (m AHD)	Top of Bund Level (m AHD)	Peak Water Surface (m AHD)	Peak Depth of Water (m)	Freeboard Achieved (m)	Peak Depth of Water over Weir (m)
7.05	8.05	8.025	0.975	0.025	0.115

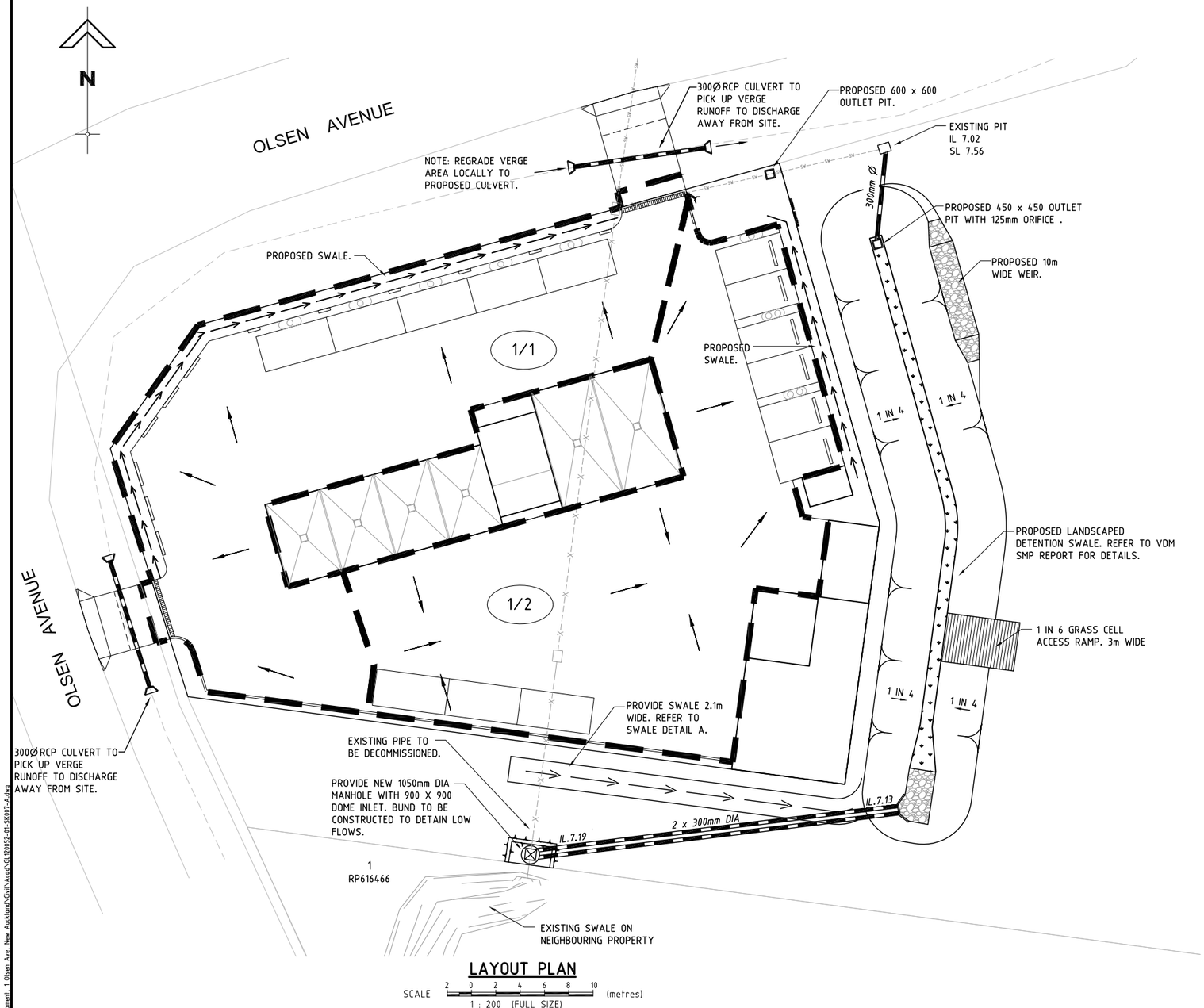
4.6.2 Sensitivity Analysis

In accordance with the requirements of QUDM Section 5.08.2, consideration has been given to the consequences of a fully blocked low level outlet. In this case, the low flow components of the outlet structure were turned off, leaving only the high flow weir. A summary of the results observed during the 100 year ARI event is contained in Table 4.13.

Table 4.13 Sensitivity Analysis Results for 100-year ARI Event

Peak Water Level (m AHD)	Top of Bund (m AHD)
8.046	8.05

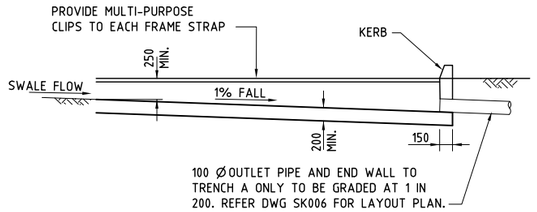
Based on the conceptual basin design, the peak water level does not exceed the TOB during a 100 year ARI event in the unlikely scenario that the low level outlet becomes fully blocked. The requirements of QUDM Section 5.08.2 are therefore satisfied. All proposed outlet structures will be refined at Operational Works stage of the development.



LAYOUT PLAN

SCALE 2 0 2 4 6 8 10 (metres)

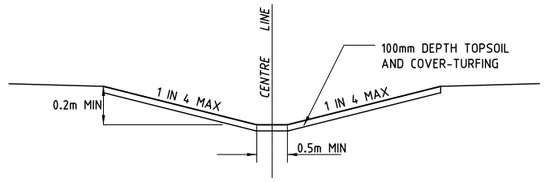
1 : 200 (FULL SIZE)



TYPICAL LONGSECTON THROUGH GRATED TRENCH

N.T.S.

NOTES:
1. REFER TO DWG SK006 FOR TYPICAL CROSS SECTION.
2. GRATE AND FRAME TO BE: WEBFORGE GALVANIZED CLASS 'D' (HEAVY DUTY) OR EQUIVALENT.



TYPICAL TURFED OPEN DRAIN DETAIL 'A'

N.T.S.

LEGEND:

- CATCHMENT BOUNDARY
- PROPOSED STORMWATER DRAINAGE
- EXISTING 375mm STORMWATER PIPE
- EXISTING PIPE TO BE DECOMMISSIONED
- SWALE DRAIN
- 1/1 CATCHMENT NUMBER
- RAINWATER CATCHMENT FLOW

SCHEDULE OF CATCHMENTS	
CATCHMENT No.	AREA
1/1	0.880 Ha.
2/1	0.859 Ha.

NOTES:

1. BEDDING TO STORMWATER LINES TO BE IN ACCORDANCE WITH GLADSTONE REGIONAL COUNCIL STD DWGS.
2. ALL PIPES UP TO AND INCLUDING 600mm DIA. ARE TO BE RUBBER-RING JOINTED.

PROPOSED CAR WASH DEVELOPMENT

LOTS 11 on SP112850
1 OLSEN AVENUE
NEW AUCKLAND
GLADSTONE
QUEENSLAND

prepared for

WOLVES SOCCER CLUB INCORPORATED

PRELIMINARY ISSUE

VER.	DESCRIPTION	APPR.	DATE
B	REVISED ISSUE		20-03-13
A	ORIGINAL ISSUE		07-09-12

VDM CONSULTING
GLADSTONE
Unit 3, 124 Goodoon Street, Gladstone QLD 4680
PO Box 541, Gladstone QLD 4680
Phone: +61 7 4972 9522
Fax: +61 7 4972 9577
Email: Gladstone@vdmgroup.com.au
VDM Engineering (Eastern Operations) Pty Ltd
ABN 91 087 601 296

DRAWING TITLE :

STORMWATER DRAINAGE CATCHMENT PLAN

DEVEL. APPLIC. No.: -	DATE: 07-09-12
PROJECT LEADER: GARY CLARKE	
DESIGNER: JOHN HENRY	
DRAFTSPERSON: ANNETTE LEGGE / ILZA MITCHELL	
CHECKED: JOHN HENRY	
APPROVED FOR AND ON BEHALF OF VDM ENGINEERING (EASTERN OPERATIONS) PTY LTD ACN 087 601 296	
RPEQ No.:	
SCALE: AS SHOWN	DATUM: AHD / FULL SIZE: A1
PROJECT No.: GL120052-01	DRAWING No.: SK007 / VERSION: B

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PLOTTED: 20 Mar 2013

5. Quality Management – Construction Controls

During the construction phase of the development the following sediment and erosion control devices and stormwater management controls will be implemented on the site. Developed in accordance with IECA *Best Practice Erosion and Sediment Control* (2008) guidelines, the location of control devices is presented in Figure 5.1.

It is important to note that the measures identified below are a generic approach to construction phase stormwater quality management. Erosion and sediment control is highly dependent on local site conditions and staging of the proposed earth disturbing activities. Therefore, further details of the erosion and sediment control systems and procedures will be provided at the detailed design stage when more information is available regarding in-situ soils and development staging.

5.1 Sediment Basin Requirements

Sediment basins are generally required where:

- The disturbed area is greater than 2,500 m²;
- The disturbed solids are dispersive; and/or
- Where there is a need to control runoff suspended solids/turbidity.

As the subject site is less than 2,500 m², no sediment basin will be required, however during the construction phase, the bioretention system will act as a temporary sediment basin (refer to Section 4.4 for more details).

5.2 Pre-Construction

The following erosion control measures will be implemented to minimise disturbance and ensure the performance criteria for water quality are met:

- Designation and marking of transport routes across undisturbed portions of the site to ensure minimal vegetation disturbance. Transport routes will have construction exits in accordance with IEAust Guidelines at the designated exit points on the site;
- Diversions will be constructed to divert clean stormwater away from exposed soils and development areas. The exact location and time of construction for each diversion measure will depend on the composition of future development stages. To help facilitate the diversion of clean stormwater it is recommended that piped networks, within road reserves be constructed at early stages of development;
- Where possible proposed open space areas are to be fenced and remain as buffer zones/filter strips; and
- Site personnel complete an environmental induction covering the erosion and sediment controls.

5.3 During Construction

Measures to mitigate water quality impacts during the construction will include:

- Sediment fences to be erected at the base of all batters to prevent sediment laden stormwater from flowing onto road surfaces;
- Grass filter strips to be placed along all road verges;
- Progressive re-vegetation of filled and disturbed areas;
- Sediment fences to be erected around soil stockpiles;
- Regular inspections as soon as practicable after storm events to check and maintain controls;
- Sediment to be removed from fences when controls are 40% full and at the completion of construction. All material to be re-used or stored on-site in a controlled manner or taken off-site for re-use or disposal at a licensed waste disposal facility; and
- Monitoring of water quality to determine the effectiveness of the sediment and erosion control management practices (refer to Section 6).

LAYOUT PLAN

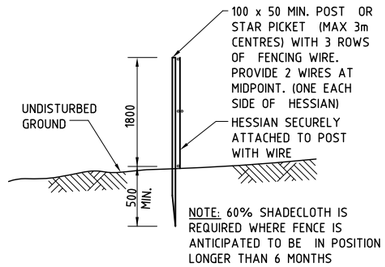
SCALE 2 0 2 4 6 8 10 (metres)
1 : 200 (FULL SIZE)

LEGEND :

- DUST FENCE
- SILT FENCE
- SHAKEDOWN AREA
- SWALE DRAIN

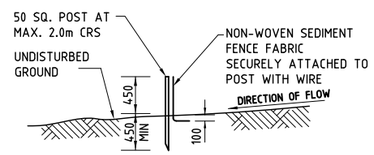
GENERAL NOTES:

1. THIS DRAWING HAS BEEN PREPARED AS A GUIDE. IT IS THE CONTRACTOR'S RESPONSIBILITY TO MANAGE SITE SEDIMENT AND EROSION CONTROL MEASURES AND DURING THE CONSTRUCTION PERIOD INSTALL ADDITIONAL MEASURES WHERE SCOUR OR SEDIMENT TRANSPORT IS LIKELY TO OCCUR.
2. DELAY CLEARING, GRUBBING AND TOPSOIL STRIPPING UNTIL NECESSARY.
3. COMMENCE WORK ON SITE ONLY AFTER SEDIMENT AND EROSION CONTROL MEASURES ARE IN PLACE.
4. MANAGE SITE ENTRY/EXIT POINTS TO ENSURE SEDIMENT IS NOT TRACKED OFF SITE.
5. SHAKEDOWN AREA: PROVIDES FOR CONSTRUCTION, SERVICE AND STAFF VEHICLES ENTERING PUBLIC ROADS. CONTRACTOR SHALL LOCATE TO SUIT SITE ACTIVITIES. CONSTRUCTED AS 250mm THICK LAYER OF COARSE (150mm -200mm) RIVER GRAVEL OVER A SINGLE LAYER OF HIGH STRENGTH GEOTEXTILE (15m x 5m).
6. THE CONTRACTOR SHALL INSTALL EITHER STORMWATER INLET SEDIMENT TRAPS OR THE EXCAVATED INLET ARRANGEMENT AT ALL STORMWATER STRUCTURES DURING THE CONSTRUCTION.
7. FILTER ROLLS SHALL BE INSTALLED AT GULLY PITS IMMEDIATELY AFTER GULLY PIT CONSTRUCTION AND LEFT IN PLACE DURING THE MAINTENANCE PERIOD. OPERATION OF ROLLS DURING PERIODS OF HEAVY RAIN TO BE MONITORED TO PREVENT FLOODING AND EROSION DAMAGE ELSEWHERE.
8. ARRANGE FOR EROSION CONTROL MEASURES TO BE INSTALLED AS CLOSE AS POSSIBLE TO THE SOURCE OF EROSION.
9. ENSURE STOCKPILED TOPSOIL AND EARTHWORKS ARE NOT ERODED BY WIND AND STORMWATER RUN-OFF AND ARE PROVIDED WITH A SILT FENCE AROUND THE LOW SIDE.
10. ERECT SILT FENCES WHERE SHOWN ON THE DRAWINGS, GENERALLY ALONG THE LOW SIDE OF THE CONSTRUCTION SITE AND ALONG A LINE OF CONSTANT LEVEL. AS AN ALTERNATIVE TO BURYING THE SILT FENCE LOWER EDGE, THE CONTRACTOR MAY ELECT TO PLACE 200mm OF THE FABRIC ON THE GROUND UP-SLOPE OF THE FENCE AND COVER WITH 100mm MIN LAYER OF AGGREGATE.
11. TO PREVENT EROSION, TOPSOIL AND SEED IMMEDIATELY AFTER COMPLETION OF BULK EARTHWORKS TO FINISHED PROFILES.
12. PRIOR TO COMPLETION OF CONSTRUCTION OF PAVEMENT AND SEALING, PLACE SANDBAGS AT 45° TO ARREST SCOUR AGAINST KERB AND CHANNEL AS FOLLOWS:
    ROAD GRADE 0.5% - 5% - 25m MAX CRS.
    5% - 10% - 10m MAX CRS.
    10% - 15% - 15m MAX CRS.
    15% - 20% - 5m MAX CRS.
13. SWEEP EXTERNAL ROADS WHERE SEDIMENT HAS BEEN DROPPED FROM CONSTRUCTION VEHICLES. DO NOT WASH SILT INTO THE STORMWATER SYSTEM.
14. ALL SEDIMENT AND EROSION CONTROL STRUCTURES, TRENCHES ETC. SHALL BE REGULARLY MAINTAINED AND INSPECTED FOR EFFECTIVENESS.



DUST CONTROL FENCE

N.T.S.



SILT FENCE

N.T.S.

NOTE :
PROPOSED SILT AND DUST FENCES TO BE INSTALLED WITHIN THE SITE, SHOWN OFFSET FROM THE DEVELOPMENT BOUNDARY FOR CLARITY.

PROPOSED CAR WASH DEVELOPMENT

LOTS 11 on SP112850
1 OLSEN AVENUE
NEW AUCKLAND
GLADSTONE
QUEENSLAND

prepared for

WOLVES SOCCER CLUB INCORPORATED

PRELIMINARY ISSUE

VER.	DESCRIPTION	APPR.	DATE
B	REVISED ISSUE		20-03-13
A	ORIGINAL ISSUE		07-09-12

VDM CONSULTING
GLADSTONE
Unit 3, 124 Goodoon Street, Gladstone QLD 4680
PO Box 541, Gladstone QLD 4680
Phone: +61 7 4972 9522
Fax: +61 7 4972 9577
Email: Gladstone@vdmgroup.com.au
VDM Engineering (Eastern Operations) Pty Ltd
ABN 91 087 601 296

DRAWING TITLE :

SEDIMENT AND EROSION CONTROL PLAN

DEVEL. APPLIC. No. : -	DATE : 07-09-12
PROJECT LEADER : GARY CLARKE	
DESIGNER : JOHN HENRY	
DRAFTSPERSON : ANNETTE LEGGE / ILZA MITCHELL	
CHECKED : JOHN HENRY	
APPROVED FOR AND ON BEHALF OF VDM ENGINEERING (EASTERN OPERATIONS) PTY LTD ACN 087 601 296	
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SCALE : AS SHOWN	DATUM : AHD / FULL SIZE : A1
PROJECT No. : GL120052-01	DRAWING No. : SK002 / VERSION: B

PLOTTED: 20 Mar 2013
FILENAME: I:\Projects\2012\GL120052 - Proposed Development, 1 Olsen Ave, New Auckland\Civil\Acad\GL120052-01-SK002-B.dwg

6. Quality Management – Operational Controls

The modification of an urban residential area has the potential to affect many water quality parameters within stormwater. The key pollutants generated by various urban developments are listed in the Queensland Water Guidelines for both the Operational (Post-Construction) and Construction phases.

Key stormwater performance indicators need to be identified for differing types of development as:

- Different types of development have differing waterborne pollutants which may be exported from a site; and
- The environmental value of a waterway may also be sensitive to particular waterborne pollutants.

To minimise the potential adverse impacts, the proposed development should reduce contamination in stormwater runoff through the incorporation of Water Sensitive Urban Design (WSUD) measures such as constructed wetlands, bio-retention systems and swales.

For a residential development, the following pollutants have been identified as the minimum key performance indicators:

- Suspended Solids (sediment),
- Nutrients (Total Nitrogen & Total Phosphorus), and
- Litter.

This SMP will concentrate on the potential increase in pollutant values as a result of the proposed development, and in turn, the required treatment to mitigate potential increases.

6.1 Water Quality Objective (WQO)

In accordance with the Queensland Water Quality Guidelines (2009), the total effect of permanent water quality control measures are to achieve reductions in the mean annual load generated by the development site at a minimum of:

- 85% for Suspended Sediment;
- 45% for Total Nitrogen;
- 70% for Total Phosphorus; and
- 90% for Gross Pollutants.

This will ensure the environmental values of the downstream receiving waters are maintained and have been chosen as the WQO for the development.

6.2 Treatment Train

In accordance with Council's current policy, it is proposed that a contribution be made to Council in lieu of implementing WSUD improvements as part of this development proposal. This monetary contribution is calculated at a rate of $525.00 per m^2 of required bioretention, as determined through MUSIC modelling.

Based on the site characteristics and the range of available SQIDs, this study has developed a modelling concept that will satisfy the requirements of downstream environmental protection. Figure 6.1 shows a schematic representation of the proposed treatment train elements.

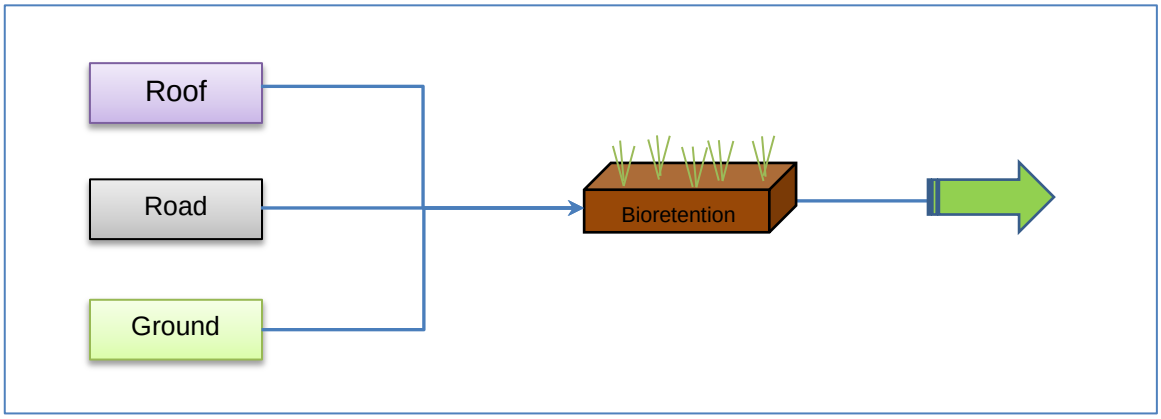


Figure 6.1 Proposed Stormwater Treatment Train

6.2.1 Bioretention System

Bioretention systems operate by filtering runoff through a soil media prior to discharge into the drainage system. These systems remove pollutants through a number of processes, including:

- Sedimentation in the extended detention storage;
- Filtration by the filter media;
- Nutrient uptake by biofilms;
- Nutrient adsorption and pollutant decomposition by soil bacteria; and
- Adsorption of metals and nutrients by filter particles (Somes & Crosby, 2007).

Water captured in the ponding area should be no more than 400 mm deep for a maximum of four (4) days to prevent anaerobic conditions, plant death and insect breeding.

7. Quality Analysis – MUSIC

Water quality modelling has been undertaken of the post-development (mitigated) scenario using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software to demonstrate the load based reduction targets are achieved. A stormwater treatment train has been developed and modelled to determine the effectiveness of the proposed system in achieving the relevant water quality objectives.

7.1 Rainfall and Evapotranspiration Parameters

MUSIC modelling was based on 6-minute interval data obtained from the Bureau of Meteorology (BOM) for rainfall station Gladstone, as summarised in Table 7.1.

Table 7.1 Meteorological and Rainfall Runoff Data Reporting Table

Input	Data Used in Modelling
Rainfall station	39123 Gladstone
Time step	6 minute
Modelling period	1/01/1981 to 31/12/1990 (10 years)
Mean annual rainfall (mm)	908
Evapotranspiration	1,721
Rainfall runoff parameters	Commercial
Pollutant export parameters	Commercial

7.2 Catchment Parameters

Based on the proposed land uses within the development, the subject site has been modelled as a Commercial land use, as detailed in Table 7.2. The catchment has been divided into roof and road source nodes, without a ground level source node due to the development nature where the ground areas are carparks (i.e. roads). The pollutant loads and runoff parameters for each source node are based on the data from the Water by Design MUSIC Modelling Guidelines (2010), as summarised in Table 6.3 and Table 6.4.

Table 7.2 Land Use Parameters

Catchment ID	Area (ha)	Land use	Total Impervious (%)
A – Commercial Roof	0.073	Commercial - Roof	100
A – Commercial Road	0.153	Commercial - Road	72
A – Bioretention	0.004	-	-
TOTAL	**0.230**	-	-

Table 7.3 Rainfall Runoff Parameters

Parameter	All Nodes
Landuse	Urban Residential
Rainfall threshold (mm)	1
Soil storage capacity (mm)	18
Initial storage (% capacity)	10
Field capacity (mm)	80
Infiltration capacity coefficient a	243
Infiltration capacity exponent b	0.6
Initial depth (mm)	50
Daily recharge rate (%)	0
Daily baseflow rate (%)	31
Daily deep seepage rate (%)	0

Table 7.4 Pollutant Load Parameters

Urban Residential	Total Suspended Solids (log mg/L)		Total Phosphorous (log mg/L)		Total Nitrogen (log mg/L)	
	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
Storm Flow Concentration	1.30(1) 2.43(2)	0.38	-0.89(1) -0.30(2)	0.34	0.37(1) 0.37(2)	0.34
Base Flow Concentration	0(1) 0.78(2)	0(1) 0.39(2)	0(1) -0.60(2)	0(1) 0.50	0(1) 0.32(2)	0(1) 0.30(2)

NOTE: (1) Values applied to "Roof" areas
(2) Values applied to "Road" areas

7.3 Treatment Node Parameters

The following sections describe the modelling parameters applied to MUSIC for each of the treatment nodes included as part of the water quality assessment.

7.4 Bioretention Parameters

The input parameters for the bioretention system are summarised in Table 7.5 below.

Table 7.5 Bioretention Parameters

Catchment ID	Bioretention
Surface area (m^2)	38
Has the filter area been calculated appropriately? (Y / N / N/A)	Yes
Extended detention depth (m)	0.2
Filter area (m^2)	37
Unlined filter media perimeter (m)	0.01
Saturated hydraulic conductivity (mm/hour).	200
Filter depth (m)	0.4

TN content of filter media (mg/kg)	400
Proportion of organic material in filter (%)	-
Orthophosphate content of filter media (mg/kg)	45
Is the base lined? (Y/N)	Yes
Effectiveness of plant TN removal (effective/ineffective/unvegetated)	Effective
Overflow weir width (m)	5.00
Exfiltration rate (mm/hr)	0.00
If an exfiltration rate has been used, have node water balance losses been used in calculation of treatment train effectiveness? (Y / N / N/A)	N/A
If exfiltration rate has been used, is the exfiltration rate justified? (Y / N / N/A)	N/A
Underdrain present? (Y/N)	Yes
Submerged zone with carbon present?	No
Depth of submerged zone (m)	N/A
Confirmation that K and C* remain default? (Y/N)	Yes

7.5 MUSIC Results

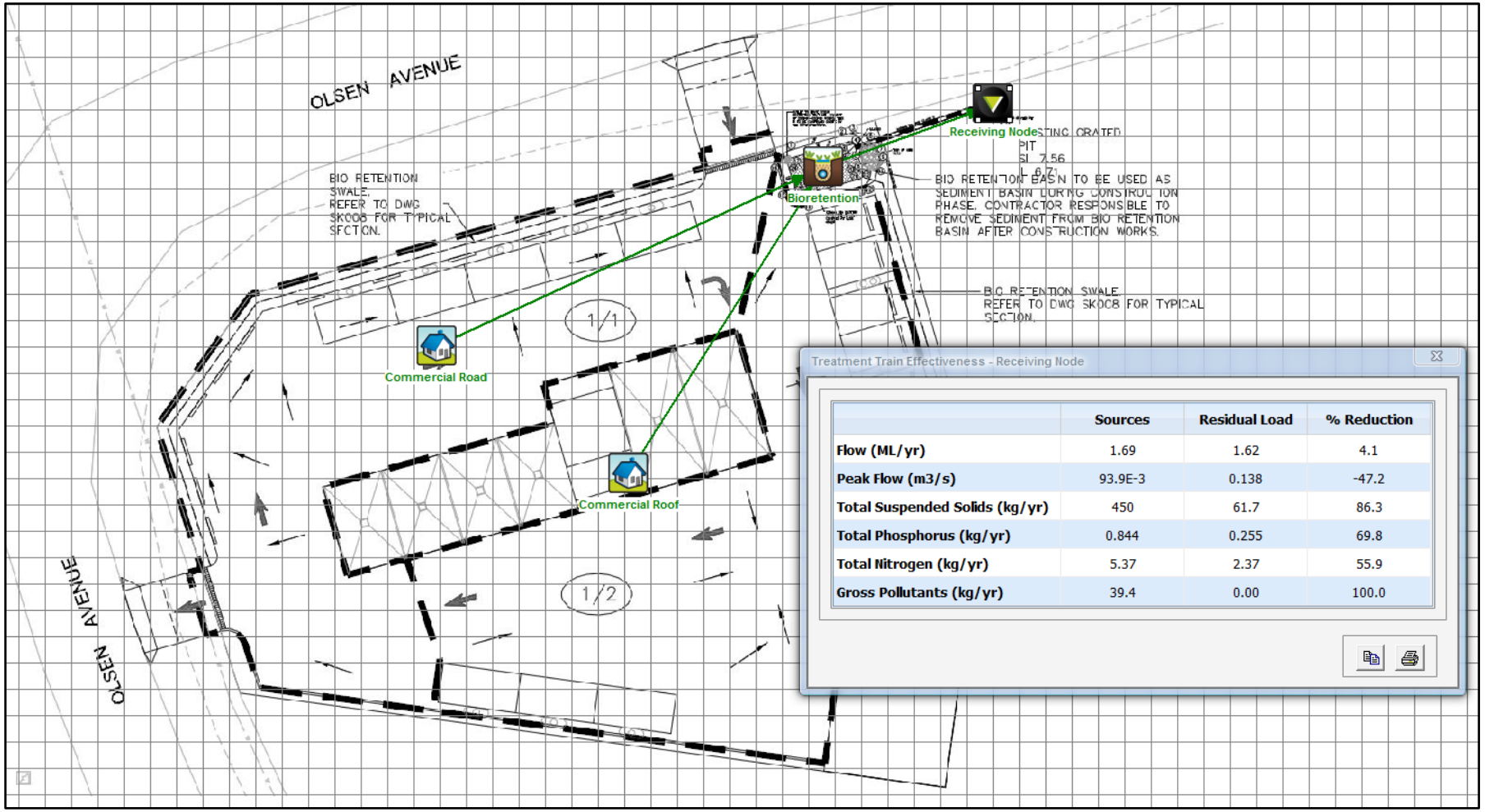
Results of the MUSIC modelling for the treatment train effectiveness are summarised in Table 7.6. The results indicate the 85%, 70%, 45% and 90% reduction target for TSS, TP, TN and gross pollutants respectively are achieved for the rainfall data set simulated. A screen capture of the MUSIC modelling results is included as Figure 7.1.

Table 7.6 Treatment Train Effectiveness

Pollutant	Inflows (kg/yr)	Outflows (kg/yr)	Reduction (kg/yr)	Reduction Achieved (%)	Water Quality Objective (%)
TSS	445	63.3	381.7	85.8	85.0
TP	0.855	0.256	0.599	70.1	70.0
TN	5.4	2.37	3.03	56.1	45.0

NOTE: All simulations have been run with pollutant export estimation set to “stochastic generation”.

In accordance with Gladstone Regional Council’s current Stormwater Quality Policy a monetary contribution is proposed in lieu of the provision of stormwater quality treatment on site. This monetary contribution is calculated at a rate of $525.00 per m^2 of required bioretention, as determined through MUSIC modelling. Based on the results of this assessment a bioretention filter area of 37 m^2 is required to meet the Queensland Water Quality Objectives (2009). Therefore a monetary contribution of $19,425.00 would be applicable.



	Sources	Residual Load	% Reduction
Flow (ML/yr)	1.69	1.62	4.1
Peak Flow (m3/s)	93.9E-3	0.138	-47.2
Total Suspended Solids (kg/yr)	450	61.7	86.3
Total Phosphorus (kg/yr)	0.844	0.255	69.8
Total Nitrogen (kg/yr)	5.37	2.37	55.9
Gross Pollutants (kg/yr)	39.4	0.00	100.0

Figure 7.1 Treatment Train Layout & MUSIC Results

8. Water Quality Monitoring

To minimise the impact of the proposed changes on the external environment the proponent shall implement this SMP. This SMP shall be amended as required in response to the Monitoring and Maintenance Program described herein to avoid significant and/sustained deterioration in existing water quality of waterways downstream, when operational works are approved.

8.1 Construction Phase Monitoring

Prior to construction onsite, it is recommended the developer undertake a series of data collection exercises to define the existing stormwater quality. This will comprise the collection of water samples after the following rainfall events:

- 3 storm events of greater than 25 mm; and
- 3 smaller rainfall events.

Samples will be analysed for total suspended solids (TSS), pH, dissolved oxygen (DO) and hydrocarbons with the results being used as water quality indicators for construction phase monitoring. Monitoring during the construction phase will be conducted to determine the impact of activities on the subject site only.

Monitoring sites:	At the outlet of any sediment basins or site discharge points.
Parameters:	TSS, pH, DO and hydrocarbons.
Frequency:	Monthly and following single rain events in excess of 25 mm per day during the construction phase.
Monitoring Procedures:	Sampling by the proponent in accordance with procedures set out in the Environmental Protection Authority's Water Quality Sampling Manual. A NATA registered laboratory will be used to perform the analysis of collected samples.
Corrective Actions:	TSS - Artificial flocculation will be applied on retained runoff to assist in the settling process. This will be completed via the application of Gypsum within 24 hours of the conclusion of each storm event and before any pumping out of the basin. Application of the Gypsum will occur by broadcasting it over the surface by hand, ensuring an even spread over the basin surface at a rate of 32 kg per 100 m^3 of water.
pH:	Addition of hydrated lime to raise the pH to an acceptable level. To be undertaken in accordance with the dosing rates specified in Table 5 of the State Planning Policy 2/02 Guideline – Acid Sulfate Soils.
DO:	Mechanical aeration until DO reaches a minimum of 6mg/L.
Hydrocarbons:	Locate source of hydrocarbons to prevent further contamination. Licensed waste contractor to be used to remove contaminated water. If the source cannot be located, a floating boom may be required to contain any future spills.
Reporting:	Monthly reports to be compiled upon request.

8.2 Operational Phase Monitoring

Monitoring during the operational phase will be undertaken to determine the impact of activities on the receiving waters. Surface water quality monitoring is to be undertaken at discharge points from the site. Water quality monitoring will be completed following a rainfall events of 25 mm or greater in any 24 hour period monthly for a minimum period of 12 months, or as specified by the Local Authority conditions of approval for the development.

Monitoring sites:	Outlet of treatment devices
Parameters:	TSS, Total-N and Total-P.
Frequency:	Monthly a following single rain events in excess of 25 mm per day until the site is fully stabilised.
Monitoring Procedures:	Sampling by the proponent in accordance with procedures set out in the Department of Environment and Resource Management (DERM) Monitoring and Sampling Manual. Alternatively calibrated probes may be used.
Reporting:	Monthly reports to be compiled.

Investigation Indicators

The following indicators are used to identify if the objectives of the SMP are being met:

- Visible evidence of deterioration of baseline water quality of downstream watercourses that is directly attributable to the site;
- Pollutant concentrations that exceed the water quality objectives (TSS 90th Percentile all other anolytes 80th percentile);
- Visible significant erosion; and/or
- Failure of control measures.

The triggering of an investigation indicator will require the following remedial actions:

- Locate source of water quality deterioration;
- Prevent continuing deterioration with temporary controls;
- Repair existing controls, construct additional controls or modify procedures to prevent future deterioration in water quality; and
- During the operational phase of the development, if there is a significant deterioration in water quality, the management plan and strategies will be reviewed.

9. Conclusions

This study has reviewed the hydrology and hydraulics of the site for pre-development and post-development scenarios and investigated the impact of the proposed development on downstream properties and receiving waters.

Based on this study the following conclusions have been drawn:

- Diversion of upstream external catchment flows via a grassed swale system will be required;
- A portion of the existing 375 mm RCP, which currently conveys low flows from the upstream catchment through the development area, will be decommissioned;
- Instead all flows from the upstream catchment will be conveyed via an open swale to the north eastern corner of the development;
- As the swale will not grade to an open outlet, a low flow orifice will be provided to drain the swale into the lower portion of the existing 375 mm RCP which will be retained.
- Flows in excess of the 125 mm orifice will be discharged as sheet flow via a grass weir and will flow across the lower portion of Lot 11 on SP112850, as occurs in the pre-development case;
- A detention/swale has been included to detain upstream flows to ensure that the increase in peak discharge resulting from the proposed development is mitigated to pre-development flows at the discharge location;
- The proposed detention swale/basin is capable of maintaining the pre-development peak discharges for the all storm events up to the 100 year ARI event at LPD2;
- All internal flows from the development area will be directed as sheet flow across the hardstand areas and into grass swales. These swales will convey flows up to the Q100 storm event to the north eastern corner of the site. At this location, flows will be collected within a field inlet that will discharge directly into the existing 375 mm RCP, which will convey flows under Olsen Ave. In both pre- and post-development cases flow to LPD1 will be maintained at approximately 0.2 m3/sec; and
- In accordance with Gladstone Regional Council's current Stormwater Quality Policy a monetary contribution is proposed in lieu of the provision of stormwater quality treatment on site. This monetary contribution is calculated at a rate of $525.00 per m2 of required bioretention, as determined through MUSIC modelling. Based on the results of this assessment a bioretention filter area of 37 m2 is required to meet the Queensland Water Quality Objectives (2009). Therefore a monetary contribution of $19,425.00 would be applicable.

References

The information presented herein has been prepared with reference to the following:

1. Department of Environment and Resource Management 2009, Monitoring and Sampling Manual, September 2009.
2. Department of Environment and Resource Management 2009, Queensland Water Quality Guidelines September 2009.
3. DesignFlow 2010. *Burnett-Mary Stormwater Quality Modelling – Development of Rainfall datasets*.
4. Healthy Waterways 2006, WSUD Technical Guidelines for South East Queensland.
5. Water by Design, 2009. *Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands*, South East Queensland Healthy Waterways Partnership, Brisbane, Queensland.
6. Water by Design, 2010. *MUSIC Modelling Guidelines.* South East Queensland Healthy Waterways Partnership, Brisbane, Queensland.
7. Water by Design, 2010. Deemed to Comply Solutions – Stormwater Quality Management (South East Queensland), South East Queensland Healthy Waterways Partnership, Brisbane, ISBN 978-0-9806278-2-4.
8. Strategic Planning for Stormwater Management in Urban Catchments. Proceedings 2005 Adelaide Public Works Conference, Institute of Public Works Australia. August 2005.
9. Watershed Scale Evaluation of a System of Stormwater Detention Basins. Journal of Hydrological Engineering, American Society of Civil Engineers, June 2005.

Appendix A – Time of Concentration and Rational Method Calculations

Pre-Development Hydrology

The natural hydrology of the site has been assessed in accordance with QUDM 2008 Section 4.06.3. The time of concentration for all catchments has been determined using Friend's Equation as per QUDM Table 4.06.3, combined with a channel time flow calculation. Discharges are calculated firstly for individual sub-catchments (Pre A, Ext A, Ext B) in order to allow a more direct comparison of increase in runoff from individual sites. However for the total runoff estimates calculated at LPD A, the full catchment is assumed to be contributing, and a Tc value is selected which represents the full catchment.

Friend's Equation $tc = (107nL^{0.333})/S^{0.2}$

Table A.1 presents a summary of the catchment parameters used within Friend's Equation and the calculated time of concentration for the pre-development scenario.

Table A1 – Time of Concentration for Development Scenario

Catchment ID	Int A	Ext A	Ext B	LPD1/2
Overland Flow				
Estimated Sheet flow Length (Table 4.06.3)	51	35	30	30
Horton's Roughness Value	0.035	0.035	0.035	0.035
Slope (%)	1.0	1.0	1.0	1.0
tc (minutes)	14	12	12	12
Channelised Flow				
Channel Length (m)			260	360
Flow Velocity (m/s)			1.0	1.0
tc (minutes)			5	6
TOTAL tc (minutes)	**14**	**12**	**17**	**18**

Post-Development Hydrology – Unmitigated

The total time of concentration calculated for the subject site contains a standard inlet time of 5 minutes and pipe flow time. Table A2 presents a summary of the catchment parameters used for the calculated time of concentration for the post-development scenario.

Table A2 – Time of Concentration for Post-Development Scenario

Catchment ID	Int A	Ext A	Ext B	LPD1/2
Standard Inlet Time				
tc (minutes)	5	0	0	0
Overland Flow				
Estimated Sheet flow Length (Table 4.06.3)		35	30	30
Horton's Roughness Value		0.035	0.035	0.035
Slope (%)		1.0	1.0	1.0
tc (minutes)		12	12	12
Channelised or Pipe Flow				
Length (m)	43		260	360
Flow Velocity (m/s)	1.0		1.0	1.0
tc (minutes)	0.7		5	6
TOTAL tc (minutes)	**6**	**12**	**17**	**18**

Design storm event flows across the site were derived using the Rational Method as per the above-mentioned manuals. This involved:

- Determination of a C_{10} value (derived in accordance with QUDM Table 4.05.3(b)). A value of 0.7 was applied to the pre-development catchments and 0.7 to 0.88 were applied to the post-development catchments. These are then multiplied by an appropriate factor to achieve other AEP events;
- Derivation of design rainfall using IFD data for Gladstone; and
- Calculation of design flows through the site for Q_{100}, Q_{50}, Q_{20}, Q_{10}, Q_5, Q_2 and Q_{3month}, where Q_{3month} is deemed to be 50% of Q_1.

Summaries of the hydrologic calculations are contained in Table A3 and Table A4 for pre and post-development (un-mitigated) scenarios respectively.

Table A3 Pre-Development Hydrology

Catch.	Area (ha)	tc (min)	I_{100} (mm/hr)	C	Q_{100} (m³/s)	I_{50} (mm/hr)	C	Q_{50} (m³/s)	I_{20} (mm/hr)	C	Q_{20} (m³/s)	I_{10} (mm/hr)	C	Q_{10} (m³/s)	I_5 (mm/hr)	C	Q_5 (m³/s)	I_2 (mm/hr)	C	Q_2 (m³/s)	I_1 (mm/hr)	C	$Q_{0.25}$ (m³/s)
INT A	0.23	14	216	0.84	0.12	192	0.81	0.10	162	0.74	0.08	140	0.7	0.06	123	0.67	0.05	97	0.6	0.04	75	0.56	0.02
EXT A	0.25	12	232	0.84	0.14	206	0.81	0.12	174	0.74	0.09	150	0.7	0.07	132	0.67	0.06	103	0.56	0.04	80	0.56	0.02
EXT B	1.33	17	198	0.92	0.67	176	0.91	0.59	148	0.84	0.46	128	0.79	0.37	113	0.76	0.32	89	0.68	0.22	69	0.64	0.11
PRE LPD1	1.81	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.28	67	0.62	0.14
PRE LPD2	1.81	18	192	0.90	0.87	171	0.88	0.76	144	0.81	0.59	125	0.77	0.48	110	0.73	0.41	86	0.65	-	-	-	-

Table A4 Un-Mitigated Post-Development Hydrology

Catch.	Area (ha)	tc (min)	I_{100} (mm/hr)	C	Q_{100} (m³/s)	I_{50} (mm/hr)	C	Q_{50} (m³/s)	I_{20} (mm/hr)	C	Q_{20} (m³/s)	I_{10} (mm/hr)	C	Q_{10} (m³/s)	I_5 (mm/hr)	C	Q_5 (m³/s)	I_2 (mm/hr)	C	Q_2 (m³/s)	I_1 (mm/hr)	C	$Q_{0.25}$ (m³/s)
INT A	0.23	6	306	1	0.20	272	1	0.17	228	0.93	0.14	197	0.88	0.11	173	0.84	0.09	135	0.75	0.06	104	0.71	0.03
EXT A	0.25	12	236	0.84	0.14	209	0.81	0.12	175	0.74	0.09	151	0.7	0.07	133	0.67	0.06	103	0.6	0.04	80	0.56	0.02
EXT B	1.33	17	198	0.92	0.67	176	0.91	0.59	148	0.84	0.46	128	0.79	0.37	113	0.76	0.32	89	0.68	0.22	89.50	0.64	0.11
POST LPD1	1.81	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.29	67	0.63	0.15
POST LPD2	1.81	18	192	0.92	0.89	171	0.90	0.78	144	0.83	0.60	125	0.79	0.50	110	0.75	0.42	86	0.67	-	-	-	-