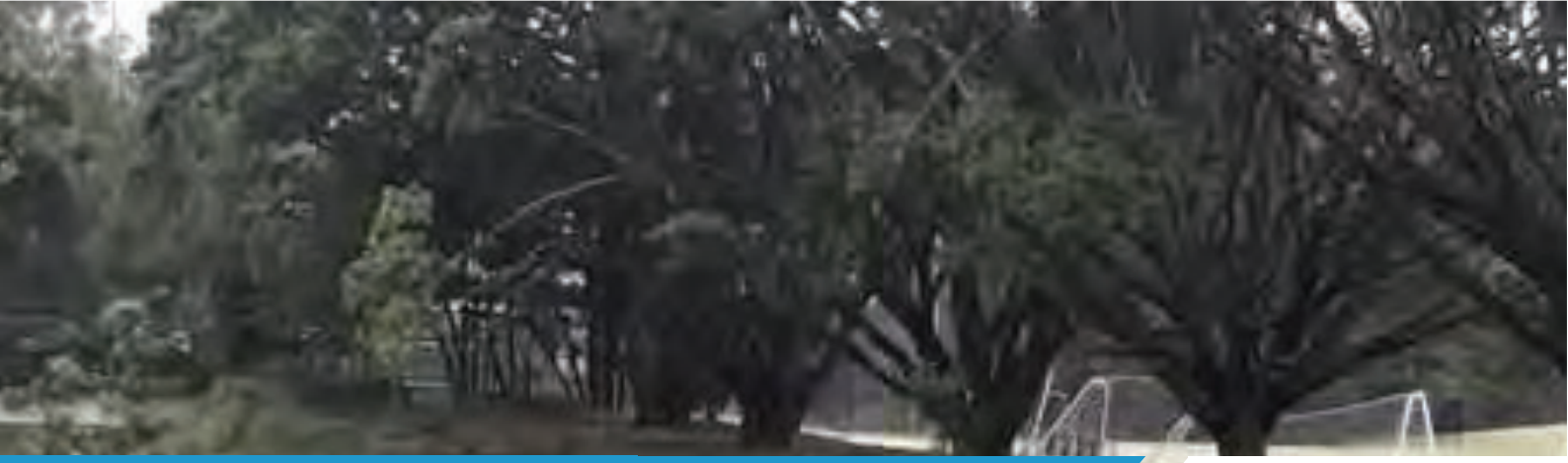

EXPERIENCE. PRECISION. EXCELLENCE.

PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

Approval no: DEV2020/1136

Date: 28 July 2021

Queensland Government

WSA

Wilkinson Shaw & Associates
consulting engineers

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205-219 Teviot Road, Greenbank - Greenbank Health Centre

# STORMWATER MANAGEMENT REPORT

Client: TFG Properties Tier 7 Pty Ltd ATF

Project No: P19-199

# REPORT CONTROL SHEET

| | |
|---|---|
| **W.S.A. Ref:** | P19-199 |
| **Project Name:** | 205 – 219 Teviot Road, Greenbank |
| **Report Title:** | Stormwater Management Report |
| **Report Author:** | Kym Wilkinson |

| Revision / Checking | | | | | |
|---|---|---|---|---|---|
| **Rev No.** | **Date** | **Revised By** | **Signed** | **Reviewed By** | **Signed** |
| 1.1 | 20.08.2020 | KW | | SPW | |
| 1.0 | 23.07.2020 | | | | |
| | | | | | |
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| | | | | | |
| **Authorised by:** | | | **RPEQ No. :** **7549** | **Date:** 20.08.2020 | |

This document has been approved by the following appropriately qualified and experienced professional civil engineer:

**Steven Wilkinson**
*Registered Professional Engineer of Queensland No. 7549*

Downloadable Files:
Storm Injector Results (WBNM): 19199V1.esi
Storm Injector Viewer: Version 1.2.4
MUSIC (Version 6.3): P19-199 V1 stage 1 and 4.sqz

## Disclaimer

This report has been prepared on behalf of and for the exclusive use of TFG Properties Tier 7 Pty Ltd ATF and is subject to and issued in accordance with TFG Properties Tier 7 Pty Ltd ATF's instruction to Wilkinson Shaw Associates (WSA). The content of this report was based on previous information, survey and/or studies supplied as listed below:

- Site layout is based on 19021-SK06 "Concept Plan – Ground Floor Stage 1 and Stage 4" dated 05.06.2020 provided by Verve Building design Co.

- Detailed survey is based on "Plan of Contour detail Survey" provided by Statewide Survey Group

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## List of Tables

# 1.0 Introduction

Wilkinson Shaw & Associates (WSA) has been engaged by TFG Properties Tier 7 Pty Ltd ATF to prepare Stormwater Management Report to support the proposed allied health precinct at 205-219 Teviot Road, Greenbank. Please refer to Table 1 below for the property details.

Table 1: Property Particulars

| | |
|---|---|
| Property Address | 205-219 Teviot Road, Greenbank |
| Property Description | Lot 10 on RP184067 |
| Registered Site Area | 20,010 $m^2$ |
| Council | Logan City Council |


Figure 1: Site Location

The proposed development involves a material change of use to a mixed-use health care precinct.

## 1.1 Scope of Report

WSA have been commissioned by Everett Property Development Management on behalf of TFG Properties Tier 7 Pty Ltd ATF to undertake an assessment of stormwater quality and quantity impacts associated with

the proposed development. Stormwater management strategies are also to be identified for the proposed development as required.

The scope of the works undertaken for this project is summarised below:

- Assessment of the development against the State and Local Government legislation to identify water quality management measure to be adopted.
- Undertake pollutant export modelling of anticipated pre and post development pollutant loads for Stages 1 and 4 and conceptual design of water quality improvement devices.
- Assessment of the pre and post development stormwater discharge. Full routing and preliminary sizing of mitigation devices required to control discharge will be undertaken for Stages 1 and 4 and "rule of thumb" sizing for Stages 2 and 3.

# 2.0 Data

## 2.1 Government Policies (State and Local)

The Planning Scheme Policy 5 – Infrastructure and the Infrastructure Code from Logan City Council's Planning Scheme Version 7.0, the State Planning Policy – July 2017 and the PDA Guideline No. 13 – Engineering Standards have been used as guidelines to establish the required stormwater objectives and requirements for the development.

## 2.2 Level and Modelling Data

Contour information for the site and adjoining areas was obtained from survey data prepared by Statewide Survey Group and was supplemented by LiDAR obtained as part of the Logan LGA 2013 Project.

Rainfall data for the site was extracted from AR&R 2016 through the IFD tool on the Bureau of Meteorology website for Latitude of -27.7345 and Longitude of 152.9837 on the 19th April 2020. The Queensland Urban Drainage Manual (QUDM) Fourth Edition and the Australian Rainfall and Runoff, 2016 have been used to guide and established the modelling inputs and methodologies applicable for the development for stormwater quantity.

Stormwater Quality Modelling has been undertaken in accordance with the Water by Design (2010) MUSIC Modelling Guidelines.

# 3.0 Site Description

## 3.1 Existing Site Conditions

An inspection of the site was conducted on the 18 November 2019 to confirm the information that is accessible from Council Records and Aerial photography. The site contains an existing residential dwelling with numerous ancillary structures such as sheds, animal husbandry equipment and yards, fencing and access points to Teviot Road. Ground cover is almost absent, and surface run off is expected to move quickly. Figure 2 shows the current land use of the site.

Figure 2: Current Land Use (NearMap 21.07.20)

## 3.2 Existing Site Catchments and Drainage

Contours obtained using a combination of physical survey and LIDAR shows that the subject property generally falls from the frontage along Teviot Road to the rear boundary. Levels on the site range between 68.16m and 66.14m (AHD) along the frontage of Teviot Road and 63.12m and 62.24m (AHD) along the rear boundary. The site drains a westerly direction at a grade of approximately 3%.

Once stormwater enters the table drain within Leanne Court it travels to the low point located on the boundary of 28-32 and 18-26 Leanne Court prior to entering the culvert at the head of the mapped waterway shown in Figure 3.

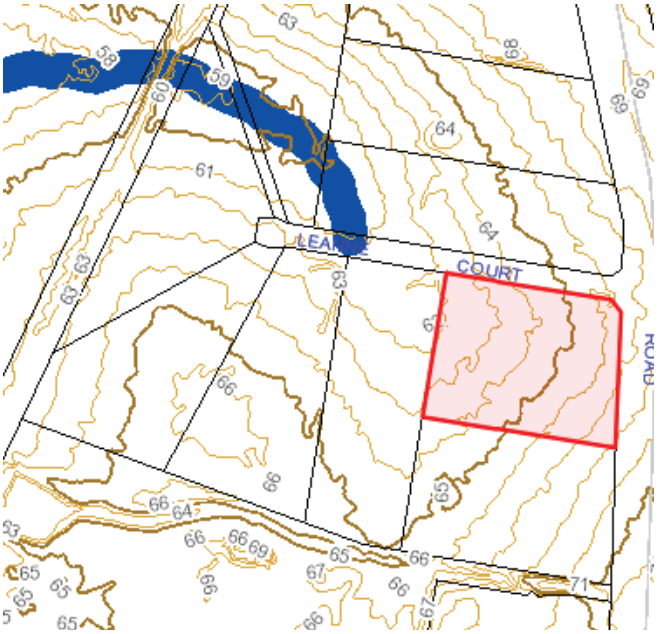


Figure 3: Waterway Corridor

### 3.3 Existing Flooding Conditions

Logan City Council's Planning Scheme indicates that the site is note constrained by the Flood Overlay Code. Refer to Figure 4 below for the LCC Flood Overlay extents.

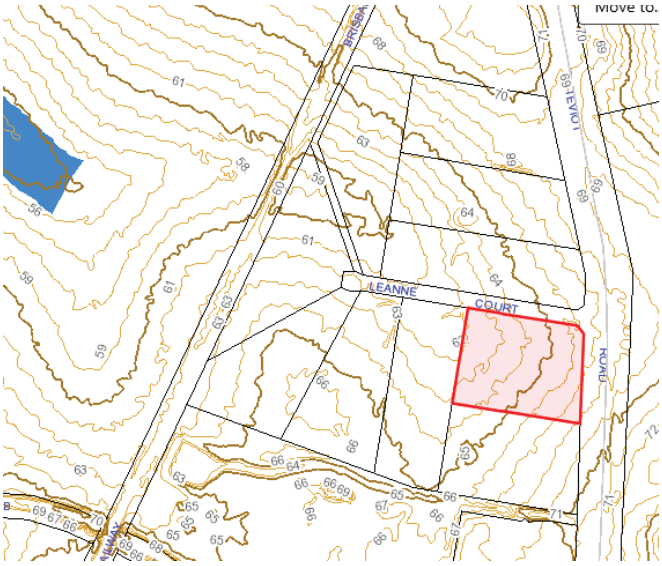


Figure 4: Flood Overlay

## 4.0 Lawful Point of Discharge

With the release of the latest version of QUDM the determination of whether a property has a lawful point of discharge at a particular location has been altered. The criteria for determining a lawful point of discharge are:

(i) Will the proposed development alter the site's stormwater discharge characteristics in a manner that may substantially damage a third-party property?

- If not, then no further steps are required to obtain tenure for a lawful point of discharge (assuming ay pervious changes were lawful).
- If there is a reasonable risk of such damage, then consider issue (ii) or (iii).

(ii) Is the location of the discharge from the development site under the lawful control of the local government or other statutory authority form whom permission to discharge has been received? This will include a park, watercourse, drainage or road reserve, stormwater registered drainage easement, or land held by local government (including freehold land).

- If so, then no further steps are required to obtain tenure for a lawful point of discharge.
- If not, then consider issue (iii). A land owner or regulator may require that the developer obtain an authority to discharge as described in (iii) in order for the stormwater to ultimately flow to a location described in (ii).

(iii) An authority to discharge over affected properties will be necessary. In descending order of certainty, an authority may be in the form of:

- Dedication of a drainage reserve or park
- A registered easement for stormwater discharge/works
- Written discharge approval.

The lawful point of discharge has been identified as the existing table drain in Leanne Court.

# 5.0 Opportunities and Constraints

## 5.1 Site Opportunities

The site opportunities regarding stormwater management are discussed briefly below.

- There is considerable fall on the site thus allowing for adequate capture and cover for stormwater;
- There are no stormwater quality measure on site and thus there is an opportunity to improve the quality of stormwater prior to it being discharged from the site.

### 5.2 Site Constraints

Constraints identified for the site regarding stormwater management include:

- The development will contribute to increase flows and may negatively impact downstream catchments unless appropriately managed;
- Currently there is no internal site drainage or connection to the stormwater network for the site.

## 6.0 Water Quality Management

### 6.1 State Planning Policy Assessment

An assessment has been undertaken to determine if the State Planning Policy is triggered for the State Interest of Water. Table 2 below is used to determine if a proposed development requires compliance with the State Planning Policy (SPP). If all responses in Table 2 are "No", then compliance with the SPP is not required and best practice may be adopted.

Table 2: State Planning Policy Triggers

| | Triggers | Response |
|---|---|---|
| 1 | A material change of use for urban purposes that involves premises 2500 $m^2$ or greater in size and;<br>a Will result in six or more dwellings; or<br>b Will result in an impervious area greater than 25 per cent of the net developable area; or | Yes |
| 2 | Reconfiguring a lot for urban purposes that involves premises 2500$m^2$ or greater in size **and** will result in six or more lots; or | No |
| 3 | Operational works for an urban purpose that involves disturbing a land area 2500$m^2$ or greater in size. | No |

As a compliance area has been trigger the site is considered high risk. As such, in order to demonstrate the required stormwater quality objects are achieved, pollutant export modelling will be incorporated in the design of stormwater quality treatment train for the site.

### 6.2 Water Quality Objectives

#### *6.2.1 Construction Phase*

During the construction phase of a project it has been identified that eroded soils and litter are the major pollutant. To limit the impact of the construction phase of the project it is therefore proposed to prepare an erosion and sediment control plan during the detailed design phase. This plan will incorporate a number of control measure that will require implementation during the construction phase of the project.

Table 3: Construction Phase Pollutants- Management Measures

| Pollutant | Sources | Control Measures |
|---|---|---|
| Litter | – Food packaging<br>– Construction Packaging<br>– Off cuts | – Education of personnel<br>– Contract requirements re waste containment /disposal.<br>– Developer to enforce |
| Sediment | – Unprotected exposed soils<br>– Stockpiles | – Refer to a Site Based Erosion and Sediment Control Plan |
| Hydrocarbons | – Fuel & oil spills, leaks from<br>– Construction equipment | – Nominated equipment parking, fuelling and service location on site.<br>– Bunding of the nominated area with topsoil rill to provide containment.<br>– Clean up and dispose of affected soils and wastes if spills occur. |
| PH altering substances | – Acid Sulphate Soils<br>– Cement slurry and wash waters | – ASS will be managed with the appropriate dosage rates indicated.<br>– Control substances to avoid runoff as for toxic substances |
| Pathogens/ Faecal coli forms (bacteria & viruses) | – Site Facilities | – Unsuitable materials to be disposed to an approved refuse station off site. |
| Toxic Materials | – Cement slurry<br>– Asphalt prime<br>– Cleaning Agents<br>– Wash water eg. tile works | – Civil and building excess materials to be contained to particular areas and disposed to off site refuse stations.<br>– Asphalt prime to be applied at appropriate weather condition to avoid runoff. No application off intended surface<br>– Wash waters/cleaning waters to be spread and absorbed to areas to be covered by hardstand such as driveways or spread to grassed surfaces where absorption can take place if appropriate for waste.<br>– Materials more appropriately disposed to approved waste dumps would be documented and appropriate disposal checked.<br>– Materials able to be disposed to sewer (with permit if necessary) would be disposed that way rather than to site for runoff to waterways. |

An overview of the most likely potential pollutants during the construction phase and means of managing/minimising that pollutant are summarised in Table 3.

### *6.2.2 Operational Phase Pollutants*

The pollutants that are likely to be observed during the operation phase are listed below:

- Litter
- Sediment
- Nutrients (N & P)
- Pathogens/Faecal coli forms (bacteria & viruses)
- Hydrocarbons (oil & grease) – (associated with car park facilities)
- Heavy Metals (assoc. with fine sediment)
- Surfactants

To effectively management stormwater quality treatment devices target the removal of suspended sediments and nutrients. The design objectives for the operational phase of the development are identified in the following Table 4 in accordance with the State Planning Policy.

Table 4: Stormwater Quality Objectives

| Minimum Reductions in Mean Annual Loads (%) | | | |
|---|---|---|---|
| Total Suspended Solids (TSS) | Total Phosphorus (TP) | Total Nitrogen (TN) | Gross Pollutants |
| 80 | 60 | 45 | 90 |

## 6.3 Modelling Approach

Best Management Practice (BMP) was adopted in selecting management alternatives for the construction phase of the project. This was undertaken as the pollutants of concern during the construction phase are not easily modelled due to the site-specific nature of pollutant sources. These pollutant sources vary throughout the construction phase and are largely depended upon site management practices and the activities being undertaken at the time. This approach enabled a quantitative assessment of stormwater runoff quality during construction to be considered.

Modelling of the proposed development has been conducted using Model for Urban Stormwater Improvement Conceptualisation (MUSIC) to access the predicted future discharge of key pollutants from the site. MUSIC provides estimates of stormwater pollution generation and removal rates based on the performance of management devices that are used in parallel or series to form a treatment train.

### *6.3.1 Meteorological Data*

In order to create a MUSIC model, you have to select the relevant time step for the meteorological data. An appropriate time step must have been chosen by taking into consideration the size of catchment and the size of the treatment nodes. The selection of the time step is therefore based on the size of the smallest source node and treatment nodes within the entire catchment using a simple three-step process as outlined by the MUSIC User Guide:

1. Calculate or estimate the time of concentration (tc) of the smallest sub-catchment within the model,
2. Calculate or estimate the shortest expected detention time of proposed treatment measures,
3. Select a time step which is equal to or smaller than the smaller of 1 and 2.

The time step used in the MUSIC modelling program was: New Beith 6 minutes 1980 – 1989.

### *6.3.2 Source Nodes*

The second step in creating a MUSIC model is to define Source Nodes or sub-catchments. Source nodes for modelling were defined in accordance with Water by Design (2010) MUSIC Modelling Guidelines.

Each MUSIC Source Node requires the definition of Soil Properties within a catchment. These values along with the rainfall data determine the runoff generation from a catchment. The soil parameters shown in the Table 4 have been adopted in accordance with Water By Design MUSIC Modelling Guidelines.

Table 5: Recommended MUSIC Runoff Generation Parameters

| Parameters (SEQ) | Commercial and Industrial |
|---|---|
| Rainfall Threshold (mm) | 1 |
| Soil Capacity (mm) | 18 |
| Initial Storage (%) | 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 |

#### *6.3.2.1 Source Node Assumptions*

In preparing the model, the following assumptions have been made.

1. 90 percent of the development is impervious (excluding the communal open space areas).
2. Only Stage 1 and 4 are being modelled at this stage.

### *6.3.3 Pollution Concentration*

MUSIC generates pollutant concentrations for both the storm flow and base flow components of runoff generated from the rainfall runoff model. The pollutant concentration parameters shown in the Table 6 have been used in the modelling. These have been adopted from Music Modelling Guidelines Version 1.0.

Table 6: Music Base and Storm Flow Concentration Parameters

| Land Use | Flow Type | TSS ($Log_{10}$mg/L) | | P($Log_{10}$mg/L) | | N($Log_{10}$mg/L) | |
|---|---|---|---|---|---|---|---|
| | | Mean | Std Dev | Mean | Std Dev | Mean | Std Dev |
| Commercial | Baseflow | 0.78 | 0.39 | -0.60 | 0.50 | 0.32 | 0.30 |
| | Stormflow | 2.16 | 0.38 | -0.39 | 0.34 | 0.37 | 0.34 |

### *6.3.4 Treatment Nodes*

Once base level pollutant concentrations have been modelled this can be compared against the WQOs to select and model the appropriate treatment options. Music models the performance of seven stormwater quality devices in addition to a generic treatment device. The types of devices that can be modelled are:

- Vegetated Swales
- Bioretention Systems
- Buffer Strips
- Constructed Wetlands
- Ponds
- Gross Pollutant Traps
- Sediment Basins
- Infiltration Systems
- Rainwater tanks

The generic node is used for modelling the performance of other treatment measures (including non-structural measures such as community education) that are not included in the default set.

## 6.4 Proposed Treatment Train

A simple treatment train has been used in this development. This sequence of the treatment trains as shown in Figure 3 will achieve the water quality objectives outlined by the State Planning Policy.

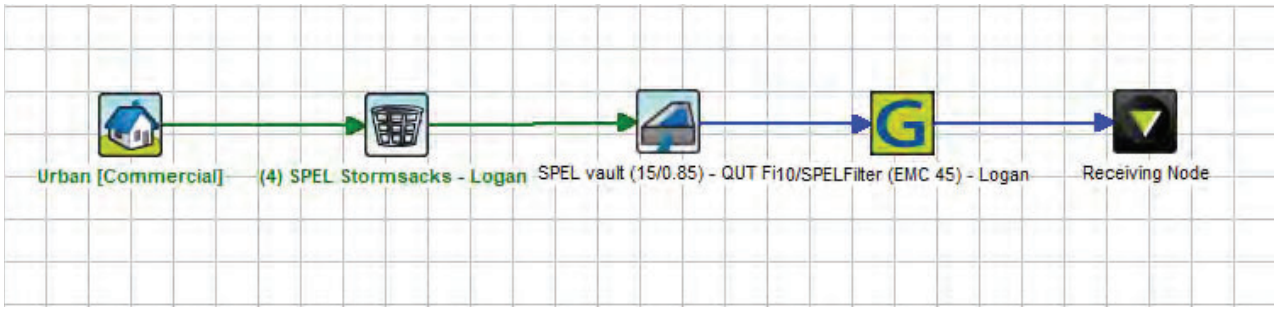


Figure 5: Treatment Train

### *6.4.1 SPEL Stormsacks*

Stormsacks is a proprietary product that can be easily retrofitted into new and existing gullies to remove sediment, rubbish and other pollutants entering the underground stormwater network. Stormsacks are used as a pre-treatment measure for tertiary treatment by the filter cartridges. These devices are to be installed in the new gullies within the development to act as a primary treatment mechanism.

### *6.4.2 SPEL Filter Cartridges*

SPEL Filter cartridges are a stormwater filtration system that offers high levels of pollutant removal. The cartridges are housed within the proposed underground tank and the filtered water is discharged into the main area of the tank prior to discharge. Modelling has been based on a total of 10 cartridges that are capable of treating 28.3 l/s before the system goes into bypass mode. The treatment node has been obtained and modelled by SPEL Environmental.

## 6.5 Expectant Pollutant Loads

The expectant loads of pollutants within the stormwater system have been modelled for the developed site without mitigation and with stormwater quality devices based on the model parameter outlined previously and are shown in Table 7. This table also shows the Reduction Targets and Target Loads for the development.

Table 7: Water Quality Outflows

| Pollutant | Unmitigated Load in Kg/year | Mitigated Load in Kg/year | SEQ Water Quality Percentage Reduction Targets | Removal Efficiency Achieved |
|---|---|---|---|---|
| Suspended Solids | 956 | 137 | 80 | 85.7 |
| Total Phosphorous | 2.42 | 0.622 | 60 | 74.3 |
| Total Nitrogen | 14.1 | 5.72 | 45 | 59.6 |
| Gross Pollutants | 117 | 0 | 90 | 100 |

It can be seen that the loads for the mitigated developed case from the MUSIC modelling process have reduced the loads significantly and meet the water quality objectives outlined by the State Planning Policy. A copy of the MUSIC report is contained in Appendix 1

### 6.6 Proposed SQID Monitoring Program

To ensure that the water quality objectives are maintained a monitoring and maintenance program will be required. The schedules shown below in Tables 8 and 9 are a guideline only. Routine clean out of sediment should be scheduled based on the outcome of routine inspections and SQID specifications.

Table 8: Schedule of Site Visits

| Inspection | |
|---|---|
| 1. | Routine Inspection |
| 1.1 | Routine inspection should be carried out on a regular monthly basis. The purpose of the inspection is to indicate when the cleanout of the SQID is required. |
| 1.2 | The depth of the sediment in the SQID should be measured according to the design specifications. |
| 2. | Annual Inspection |
| 2.1 | Once a year the condition of the SQID should be closely inspected. Any damage or problems should be noted on the Maintenance Form for action. |
| **Routine Cleanout of Sediment** | |
| 1. | Setup and Prepare Site for Cleanout |
| 1.1 | Setup equipment onsite including pump |
| 2. | Cleanout of Sediment |
| 2.1 | The preferred method of cleanout of the minor SQID is by using equipment as specified by the SQID designer. |
| 2.2 | Position the equipment on the side of the SQID to allow easy access into the sediment area and transfer the material into the adjacent truck. |
| 2.3 | Drain waste in the truck thoroughly before proceeding to the disposal site. |

Table 9: Schedule of Site Visits

| Purpose of Visit | Frequency | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Routine inspection | Monthly | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Routine inspection | Yearly | | | | ✓ | | | | | | | | |
| Routine cleanout | Quarterly | ✓ | | | ✓ | | | ✓ | | | ✓ | | |

## 7.0 Hydrological Assessment

In accordance with Logan City Council‘s planning policy detention storage is required to limit discharge off the above site after the development is complete to no worse than the existing situation. This requirement is to be achieved for each of the 1, 2, 5, 10, 0.2EY, 0.5EY and 1EY AEPs. By achieving this situation of no worsening of the design flows, discharge from the proposed development will not cause an actionable nuisance to downstream properties.

This following sub-sections only related to the development of Stage 1 and 4.

## 7.1 Stormwater Runoff

Peak discharges for the site were calculated using the Rational Method in both the current condition and the developed situation. The discharge location for these calculations is the table drain in Leanne Court. The Rational Method calculations were undertaken in accordance with the Queensland Urban Drainage Manual (QUDM2017) for a range of storm events.

In determining the peak probable runoff from the site a study of the current and proposed allotment conditions were undertaken. The following observations and assumptions were made:

- The impervious area of the existing allotments is 0.15.
- The future development will have a fraction impervious of 0.90.

As shown in Table 10 the peak discharge from the site increases by approximately 180 l/s or 73% The calculations for these anticipated runoffs are shown in Appendix 3. This increase in flows is due to the concentration of flows from water re-routing into a series of down pipes and/or gully pits through the development as well as the increase in impervious area. The strategy for offsetting the impact on the downstream catchment due to increase is discussed below.

Table 10: Expected Stormwater Runoff.

| Average Reoccurrence Interval (ARI) in years | Annual Exceedance Probability | Peak Discharge ($m^3/s$) | | Change in Peak Discharge | |
|---|---|---|---|---|---|
| | | Existing | Developed | $m^3/s$ | % |
| 1 | 1EY | 0.062 | 0.106 | 0.044 | 71.0 |
| 2 | 0.5EY | 0.084 | 0.143 | 0.060 | 70.9 |
| 5 | 0.2EY | 0.120 | 0.205 | 0.085 | 71.1 |
| 10 | 10% | 0.146 | 0.251 | 0.104 | 71.4 |
| 20 | 5% | 0.177 | 0.304 | 0.127 | 71.9 |
| 50 | 2% | 0.226 | 0.390 | 0.164 | 72.5 |
| 100 | 1% | 0.262 | 0.439 | 0.177 | 67.7 |

### *7.1.1 Mitigation Solution*

It is proposed to discharge as much water as practicably possibly in the 1% AEP storm event to a privately owned and maintained underground detention tank. This tank and other associated stormwater drainage will then discharge via a single stormwater line into the existing table drain in Leanne Court. The proposed stormwater layout can be seen in Appendix 1.

## 7.2 WBNM Models

To be able to evaluate the effect of the proposed detention system the design rainfall runoff for the catchment can be represented as a hydrograph. By allowing for the attenuations of the stormwater in the detention tank the size of the tank can be appropriately sized to ensure that the flows leaving the site are equal or less than the current flows.

The Watershed Bounded Network Model (WBNM) was the model selected for generating runoff routing and the associated hydrographs. WBNM is a program developed by the University of Wollongong. WBNM 2007 was used for this study. The program can be accessed via Reinco Consulting's web page.

### *7.2.1 Catchments*

The existing and developed scenario sub-catchment delineation prepared for the WBNM model. A range of information sources were used when preparing these models which included:

- Detailed physical survey
- Aerial imagery
- Site inspection

### *7.2.2 Rainfall Intensity and Losses*

IFD Design Rainfall Intensity (mm/hr) for the site are presented in Table 11 and were obtained using site specific IFD parameters from the Bureau of Meteorology online IFD tool based on AR&R(2016).

The rainfall losses for the design events were extracted from the ARR Data Hub and have been varied between design events as per the latest ARR2016 advice. A Rational Method validation of the model was undertaken as there are not any site-specific hydrological data available to enable other methods of calibration. The base initial losses adopted for the model are summarised in Table 12 with the median Preburst depths shown in Table 13. The losses adopted within the WBNM model are based on the Global Initial Loss – Medium Preburst Loss for each storm event and where this is a negative number it is set to 0. The Median Preburst Depths for the 1EY and 0.5EY are based on the 50% AEP and are consistent based on industry guidance.

Table 11: IFD Design Rainfall Intensity (mm/hr)

| Duration | Duration in min | Annual Exceedance Probability (AEP) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1EY | 0.5EY | 0.2EY | 10% | 5% | 2% | 1% |
| 1 min | 1 | 142 | 180 | 230 | 267 | 309 | 363 | 404 |
| 2 min | 2 | 114 | 145 | 186 | 219 | 257 | 307 | 347 |
| 3 min | 3 | 108 | 137 | 176 | 206 | 240 | 286 | 322 |
| 4 min | 4 | 104 | 131 | 168 | 197 | 229 | 271 | 304 |
| 5 min | 5 | 99.9 | 127 | 162 | 189 | 219 | 258 | 288 |
| 7 min | 7 | 83.1 | 105 | 134 | 156 | 180 | 210 | 233 |
| 10 min | 10 | 70.4 | 89.4 | 114 | 132 | 152 | 178 | 198 |
| 15 min | 15 | 61 | 77.5 | 98.9 | 115 | 132 | 155 | 172 |
| 20 min | 20 | 53.9 | 68.4 | 87.5 | 102 | 118 | 138 | 153 |
| 25 min | 25 | 48.3 | 61.3 | 78.5 | 91.6 | 106 | 125 | 139 |
| 30 min | 30 | 37.2 | 47.2 | 60.6 | 70.9 | 82.3 | 97.4 | 109 |
| 45 min | 45 | 30.5 | 38.7 | 49.8 | 58.4 | 68 | 80.9 | 90.9 |
| 1 hour | 60 | 22.9 | 29 | 37.3 | 44 | 51.4 | 61.6 | 69.6 |
| 1.5 hour | 90 | 18.6 | 23.6 | 30.4 | 35.9 | 42 | 50.5 | 57.3 |
| 2 hour | 120 | 14 | 17.7 | 22.8 | 26.9 | 31.7 | 38.3 | 43.6 |
| 3 hour | 180 | 10.6 | 13.4 | 17.2 | 20.4 | 24 | 29.1 | 33.3 |
| 4.5 hour | 270 | 8.73 | 11 | 14.2 | 16.9 | 19.9 | 24.2 | 27.6 |
| 6 hour | 360 | 6.73 | 8.52 | 11 | 13.1 | 15.4 | 18.7 | 21.5 |
| 9 hour | 540 | 5.63 | 7.14 | 9.25 | 11 | 13 | 15.8 | 18.1 |
| 12 hour | 720 | 4.4 | 5.59 | 7.29 | 8.69 | 10.3 | 12.5 | 14.3 |
| 18 hour | 1080 | 3.69 | 4.7 | 6.17 | 7.37 | 8.73 | 10.6 | 12.2 |
| 24 hour | 1440 | 3.21 | 4.1 | 5.42 | 6.48 | 7.69 | 9.39 | 10.8 |
| 30 hour | 1800 | 2.86 | 3.66 | 4.86 | 5.83 | 6.93 | 8.47 | 9.73 |
| 36 hour | 2160 | 2.36 | 3.04 | 4.06 | 4.89 | 5.83 | 7.16 | 8.24 |
| 48 hour | 2880 | 1.77 | 2.28 | 3.09 | 3.74 | 4.48 | 5.53 | 6.38 |
| 72 hour | 4320 | 1.41 | 1.83 | 2.48 | 3.01 | 3.63 | 4.49 | 5.2 |
| 96 hour | 5760 | 1.17 | 1.52 | 2.05 | 2.5 | 3.02 | 3.75 | 4.35 |
| 120 hour | 7200 | 1 | 1.29 | 1.74 | 2.12 | 2.56 | 3.18 | 3.69 |
| 144 hour | 8640 | 0.87 | 1.12 | 1.49 | 1.82 | 2.2 | 2.73 | 3.17 |
| 168 hour | 10080 | 142 | 180 | 230 | 267 | 309 | 363 | 404 |

Table 12: Global Loss Parameters

| AEP | Initial Loss (mm) Pervious | Continuing Loss (mm) Pervious | Initial Loss (mm) Impervious |
|---|---|---|---|
| 0.2EY - 1% | 25.0 | 1.1 | 0 |
| 1EY and 0.5EY | 15.0 | 1.1 | 0 |

Table 13: Median Preburst Depths

| Duration in min | Annual Exceedance Probability (AEP) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1EY/0.5EY | 50% | 0.2EY/20% | 10% | 5% | 2% | 1% |
| 60 | 1.6 | 1.6 | 3.5 | 4.7 | 5.8 | 8.7 | 10.9 |
| 90 | 0.7 | 0.7 | 3.2 | 4.9 | 6.5 | 12.4 | 16.8 |
| 120 | 0.5 | 0.5 | 7.2 | 11.7 | 16.0 | 15.7 | 15.5 |
| 180 | 1.2 | 1.2 | 6.8 | 10.5 | 14.0 | 22.5 | 28.8 |
| 360 | 1.8 | 1.8 | 12.1 | 18.9 | 25.4 | 44.5 | 58.8 |

### *7.2.3 Validation of the Hydrologic Model*

As this is a site-specific investigation and there is no gauged local catchment, there is no site-based data to calibrate the runoff for the site. Accordingly, the WBNM hydrologic model has been validated against the Rational Method. Validation was performed at the table drain in Leanne Court.

Table 14: Rational Method Comparison with Hydrologic Model (Undeveloped)

| Annual Exceedance Probability | Peak Discharge ($m^3/s$) | | Variation | |
|---|---|---|---|---|
| | Rational | WBNM | $m^3/s$ | % |
| 1EY | 0.062 | 0.060 | -0.002 | -3.6 |
| 0.5EY | 0.084 | 0.092 | 0.008 | 9.6 |
| 0.2EY | 0.120 | 0.109 | -0.011 | -8.8 |
| 10% | 0.146 | 0.143 | -0.003 | -2.2 |
| 5% | 0.177 | 0.203 | 0.026 | 14.9 |
| 2% | 0.226 | 0.233 | 0.007 | 3.0 |
| 1% | 0.262 | 0.270 | 0.008 | 3.1 |

Table 15: Rational Method Comparison with Hydrologic Model (Stage 1 and 4 Developed)

| Annual Exceedance Probability | Peak Discharge ($m^3/s$) | | Variation | |
|---|---|---|---|---|
| | Rational | WBNM | $m^3/s$ | % |
| 1EY | 0.106 | 0.124 | 0.018 | 16.5 |
| 0.5EY | 0.143 | 0.159 | 0.016 | 10.8 |
| 0.2EY | 0.205 | 0.206 | 0.001 | 0.7 |
| 10% | 0.251 | 0.257 | 0.006 | 2.5 |
| 5% | 0.304 | 0.305 | 0.001 | 0.5 |
| 2% | 0.390 | 0.353 | -0.037 | -9.6 |
| 1% | 0.439 | 0.394 | -0.045 | -10.3 |

The WBNM results are generally within 10% of the Rational Method result across all of the design AEP Events considered and are therefore considered acceptable. It is acknowledged that there is a large variance in the 1EY and 0.5EY for the developed situation however this situation will ensure that additional

stormwater is provided during smaller and more regular storm events. Accordingly, the WBNM model has been adopted to inform design discharge estimates from the development and sizing of the proposed detention tank.

### 7.3 Results

It is proposed that an onsite underground detention tank be constructed to mitigate the increase in runoff generated by the development. As such, the detention system was sized by using WBNM and the details of the tank is shown in Table 16.

Table 16: Proposed Detention Dam Details

| | |
|---|---|
| Location | Under slab of ground level |
| Basin Type | Private tank |
| Storage Depth | 2.5m (allowing for 300mm freeboard) |
| Available Storage Volume | 187.5m$^3$ |
| Lower Outlet | 170mm orifice |
| Lower RL | Base of tank |
| Second Outlet | 150mm orifice |
| Second Outlet RL | 850mm above base of tank |
| Third Outlet | 240mm orifice |
| Third Outlet RL | 1500mm above base of tank |
| Overflow Weir Length | 1.0m |
| Overflow Weir RL | 2200mm above base of tank |

The analysis using WBNM shows that for a detention tank with peak storage volume of approximately 163 m$^3$ will ensure that total discharge off the site after the development is complete will be no worse than the existing situation. The maximum water level reached in the detention dam in the 1% AEP 25-minute storm is 2.173m with additional results shown in Table 17. Table 18 tabulates the maximum outflow for all storm events analysed. The discharges are tabulated for the existing situation and the developed situation with detention included.

Table 17: Maximum Detention Depths and Outflow for Each Critical Storm Event for the Tank

| AEP Event | Depth of Water (m) | Peak Inflow (m$^3$/s) | Peak Discharge (m$^3$/s) |
|---|---|---|---|
| 1EY | 0.805 | 0.097 | 0.054 |
| 0.5EY | 1.042 | 0.112 | 0.078 |
| 0.2EY | 1.355 | 0.156 | 0.106 |
| 10% | 1.583 | 0.212 | 0.128 |
| 5% | 1.751 | 0.279 | 0.170 |
| 2% | 1.966 | 0.278 | 0.216 |
| 1% | 2.173 | 0.323 | 0.248 |

Table 18: Total Discharge Results (Maximum Flow Rate)

| Annual Exceedance Probability | Peak Discharge ($m^3/s$) | | Variation | |
|---|---|---|---|---|
| | Undeveloped | Developed with Detention | $m^3/s$ | % |
| 1EY | 0.060 | 0.054 | -0.006 | -10.0 |
| 0.5EY | 0.092 | 0.078 | -0.014 | -15.2 |
| 0.2EY | 0.109 | 0.106 | -0.003 | -2.8 |
| 10% | 0.143 | 0.128 | -0.015 | -10.5 |
| 5% | 0.203 | 0.170 | -0.033 | -16.3 |
| 2% | 0.233 | 0.216 | -0.017 | -7.3 |
| 1% | 0.270 | 0.248 | -0.022 | -8.1 |

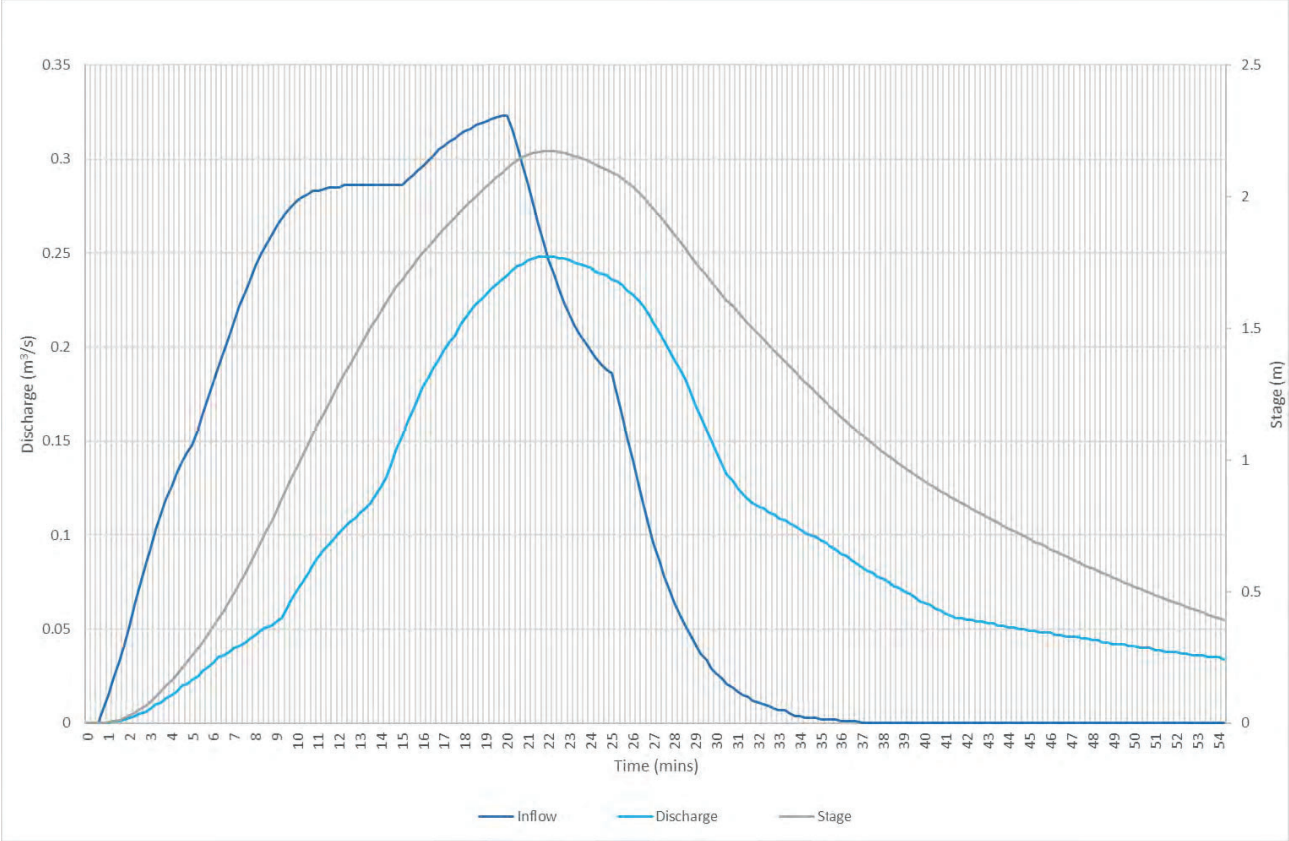


Figure 6: Hydrographs of inlet flow and outlet flow from the detention storage (1% AEP, 10-minute storm)

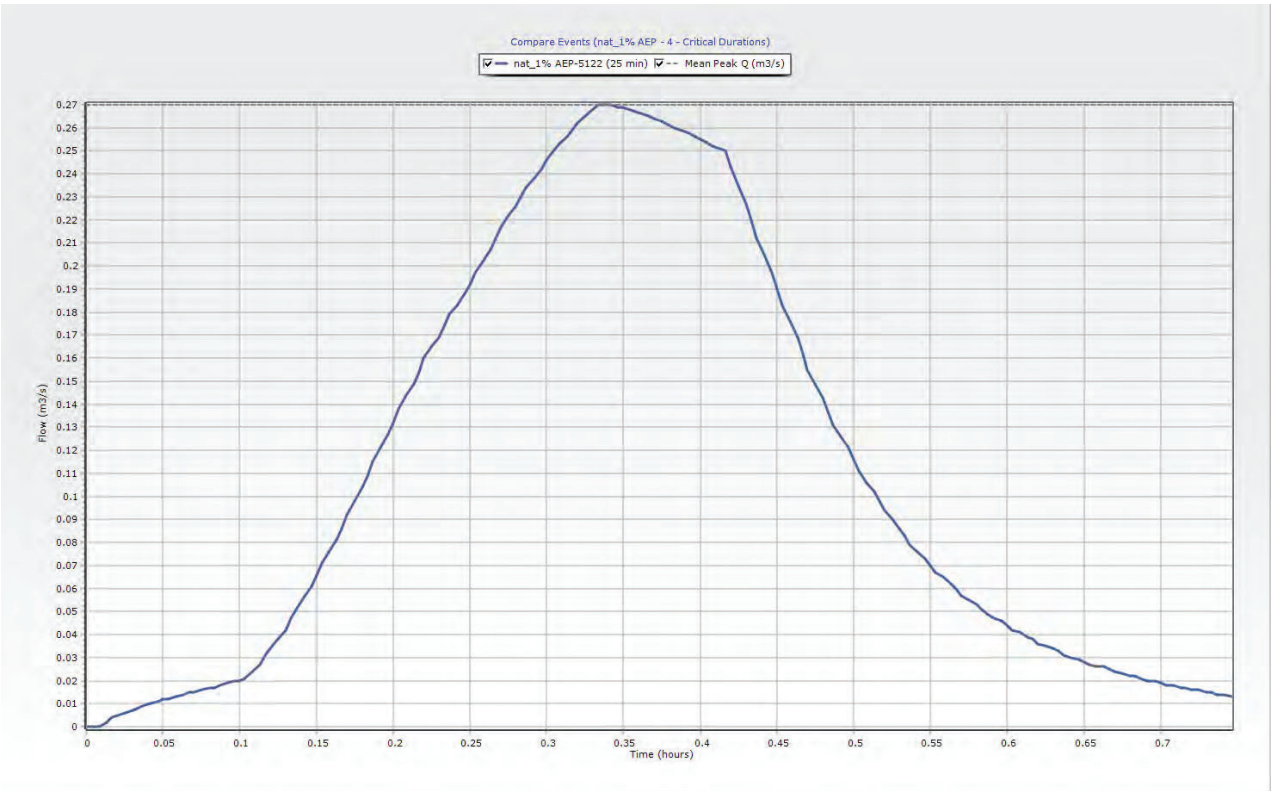


Figure 7: Outlet Hydrograph for the current situation (1% AEP, 25-minute storm)

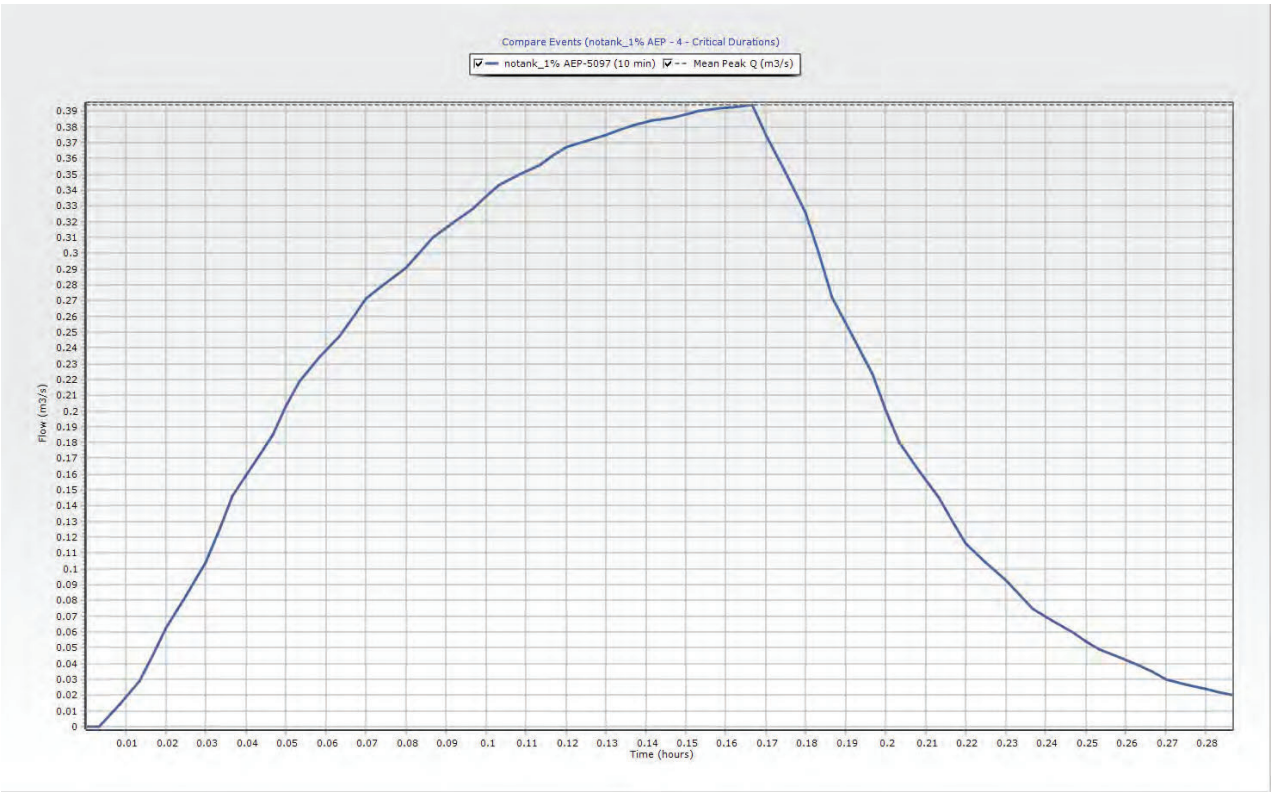


Figure 8: Outlet Hydrograph for the developed situation without detention (1% AEP, 10-minute storm)

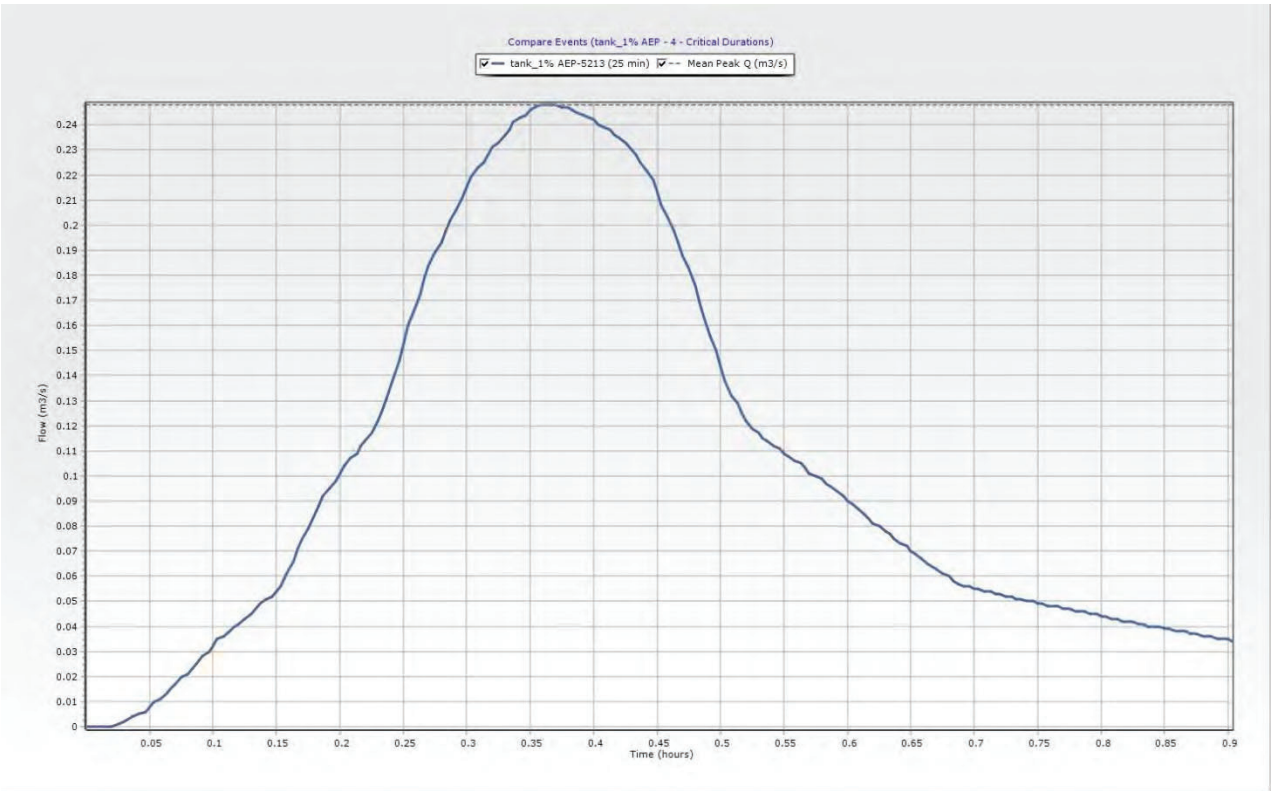


Figure 9: Outlet Hydrograph for the developed situation with detention (1% AEP, 25-minute storm)

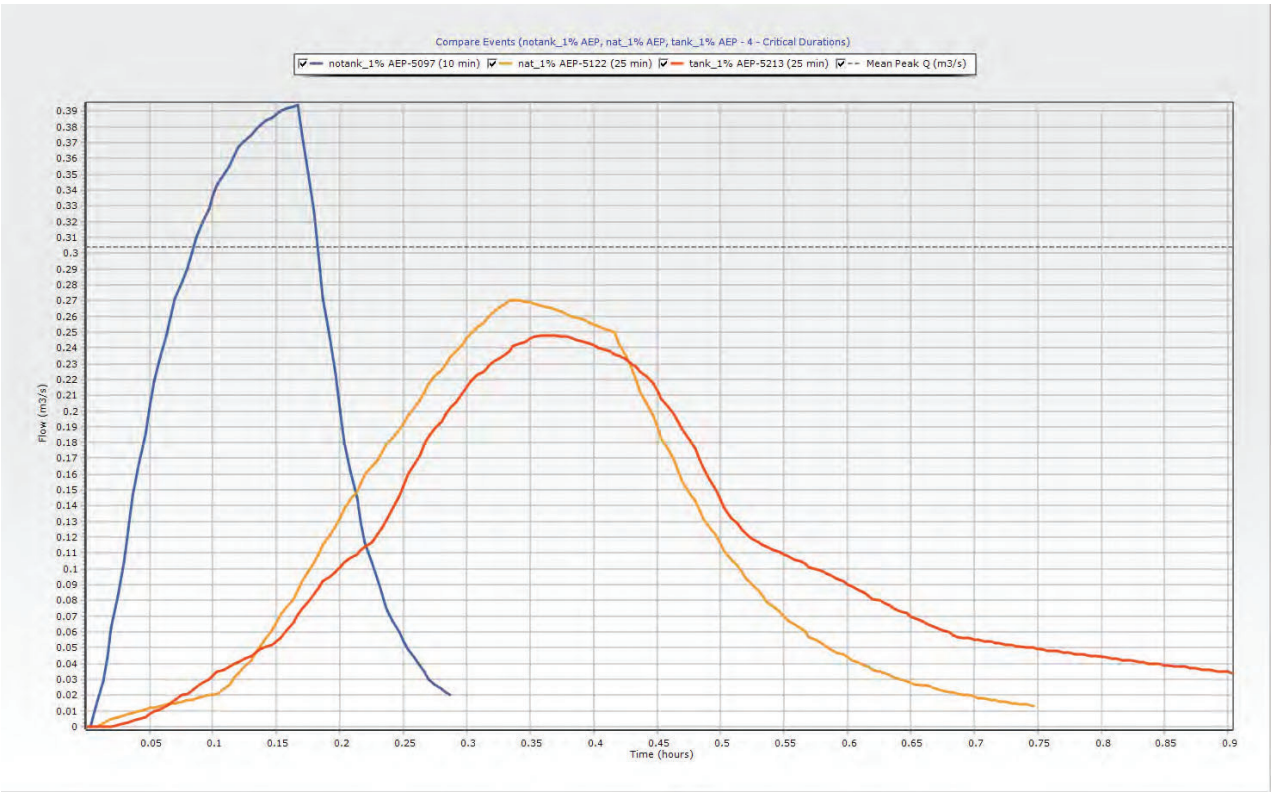


Figure 10: Combination of all Hydrographs for 1%AEP

# 8.0 Preliminary Assessment of Stages 2 and 3

Preliminary massing studies have been undertaken to determine the possible yield available for Stages 2 and 3 of the development however conceptual design in relation to stormwater quality and quality have not be undertaken as part of the application.

Preliminary indications to the amount of detention required for the site can be undertaken by general "rule of thumbs". Assuming the further development will have an impervious area of approximately 90% a site storage of 345m3/ha would be deemed appropriate for a high-level assessment. The balanced site has an area of approximately 1.4ha and as such an allowance of 483m$^3$ of storage should be allowed for in future design.

Based on the stormwater quality results for Stages 1 and 4 by adopting a similar ratio of pollutant generation approximately 24 stormwater filter cartridges would be required to meet the current stormwater quality objectives.

# 9.0 Erosion and Sediment Control

## 9.1 Proposed Measures

1. Controlled Entry/Exit
2. Install silt fences along the perimeter of the development.
3. The use of turf filter strips to act as cut-off drains to trap run-off from site.
4. Cover existing stormwater access points, gully pits and stormwater manholes within the development
5. Temporary grassing to prevent erosion of disturbed areas.

## 9.2 Staging Requirements

The Contractor shall plan and carry out the work to avoid erosion, contamination, and sedimentation of the site and surrounding areas. The following program should be followed:

- Construction of silt management devices;
- Undertaking earthworks and construction of retaining walls;
- Construction of development and connection of services;
- Construction of road pavement;
- Landscaping;
- Removal of silt management devices.

The Contractor shall adopt such additional measures as may be necessary for erosion control, including the following where applicable:

- Staging of operations
- Progressive restoration of disturbed areas
- Removal of erosion control devices only when all operation works completed and landscaped areas are fully developed.

### 9.3 Maintenance

Every day and after each rain event, inspect, clean and repair if required, temporary erosion and sediment control works during construction. Monitoring and maintaining permanent devices and buffers during the maintenance period in accordance with Tables 7 and 8.

## 10.0 Conclusion

This report addresses the proposed development of 205 – 219 Teviot Road, Greenbank for a Material Change of Use for a proposed allied health precinct. Modelling using WBNM has shown that a stormwater detention tank with a volume of 163m$^3$ is required to limit discharge off the site to no worse than the existing situation for all adopted AEPs and storm events for Stages 1 and 4. Stormwater quality objectives will be obtained via treatment with SPEL StormSacks and Filter cartridges in the privately owned detention system.

Further analysis will be undertaken at the time of development of Stages 2 and 3 however preliminary calculations estimate a detention volume of 483 m$^3$ required for the subsequent stages of the development. Stormwater quality treatment will also be address during the subsequent applications required for the site however an initial estimate of 24 filter cartridges in a private system would be required.

The stormwater management proposed in this report has demonstrated that the proposed development satisfies the lawful point of discharge as per QUDM. This Site Based Stormwater Management Plan is considered consistent with the Stormwater Code of the Logan City Council Planning Scheme.

This report shows that stormwater can be managed effectively for the site analysed without the need to upgrade the stormwater network. It is the opinion Wilkinson Shaw & Associates that the proposed stormwater quantity and quality management proposed are suitable for a development of this scale. It is recommended that Development Approval conditions are issued accordingly.

## Qualifications

1. In preparing this document, including all relevant calculations, modelling and drawings, Wilkinson Shaw & Associates (WSA) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

2. WSA has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and documents are as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

3. WSA reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:
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5. This document is for the use of the party to whom it is addressed and for no other persons. No responsibility is accepted to any third party for the whole or part of the contents of this report, calculations and drawings.

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7. This report does not provide legal advice.

# References

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Institution of Engineers Australia (2003) "Draft Australian Runoff Quality", Institution of Engineers Australia

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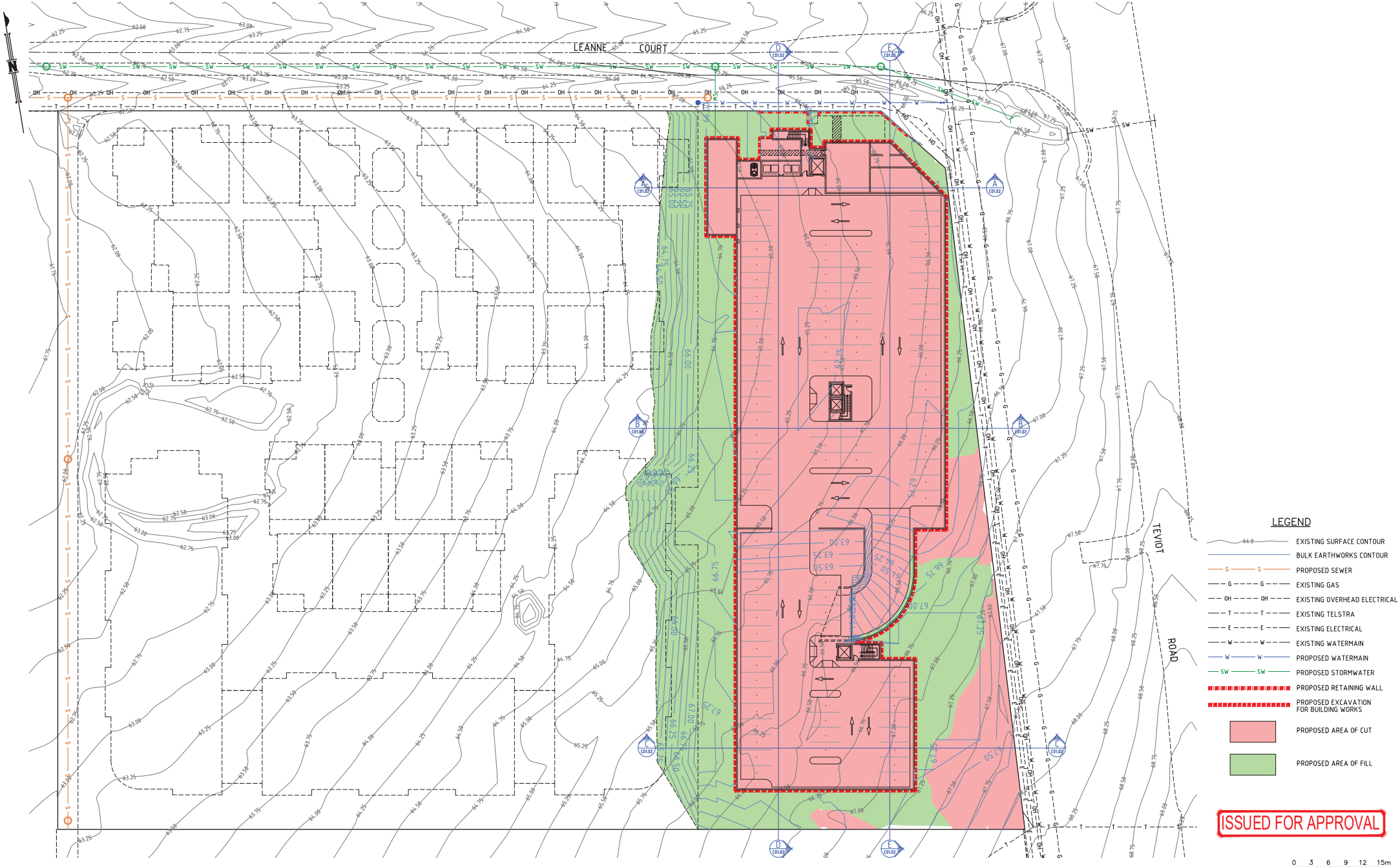
# Appendix 1 ~ Engineering Drawings

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ABN: 29 104 860 497
OFFICE: 182 PINE ROAD (WEST), RICHLANDS QLD 4077
MAIL: PO BOX 583 INALA QLD 4077
PHONE: (07) 3555 9888
EMAIL: office@wilkinsonshaw.com.au
WEB: www.wilkinsonshaw.com.au


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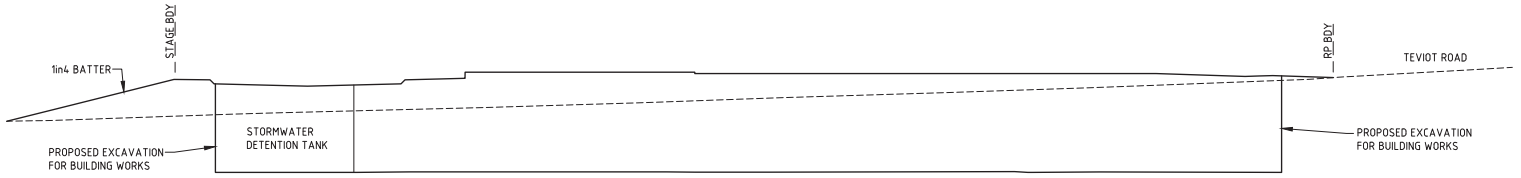


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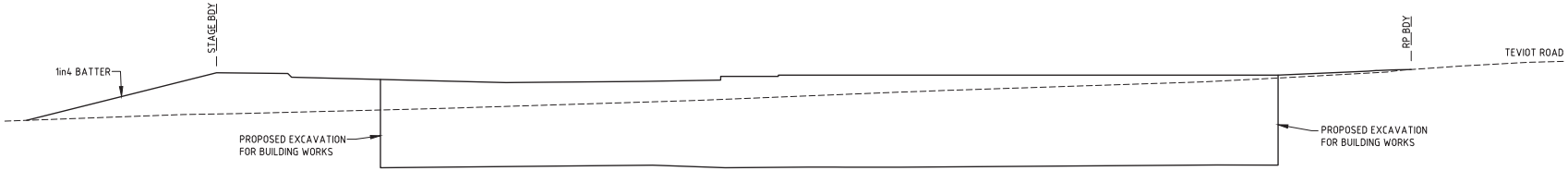


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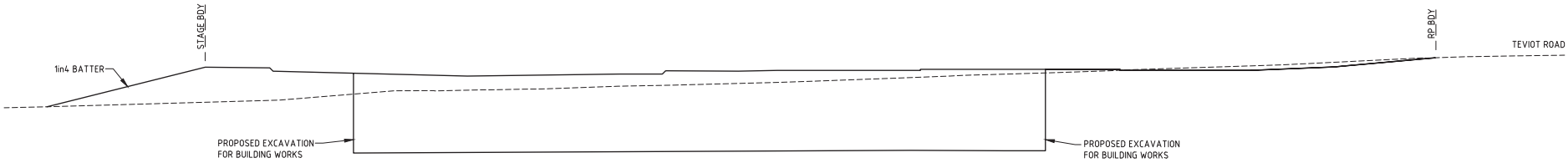


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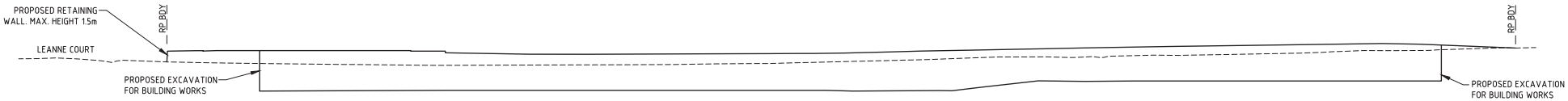


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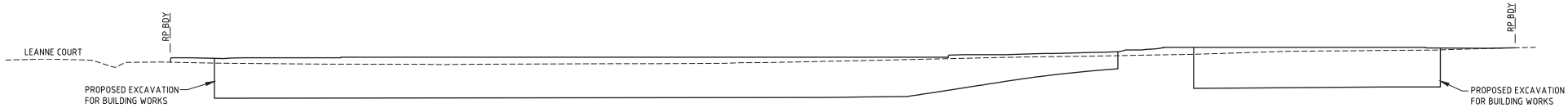


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MAIL: PO BOX 583 INALA QLD 4077
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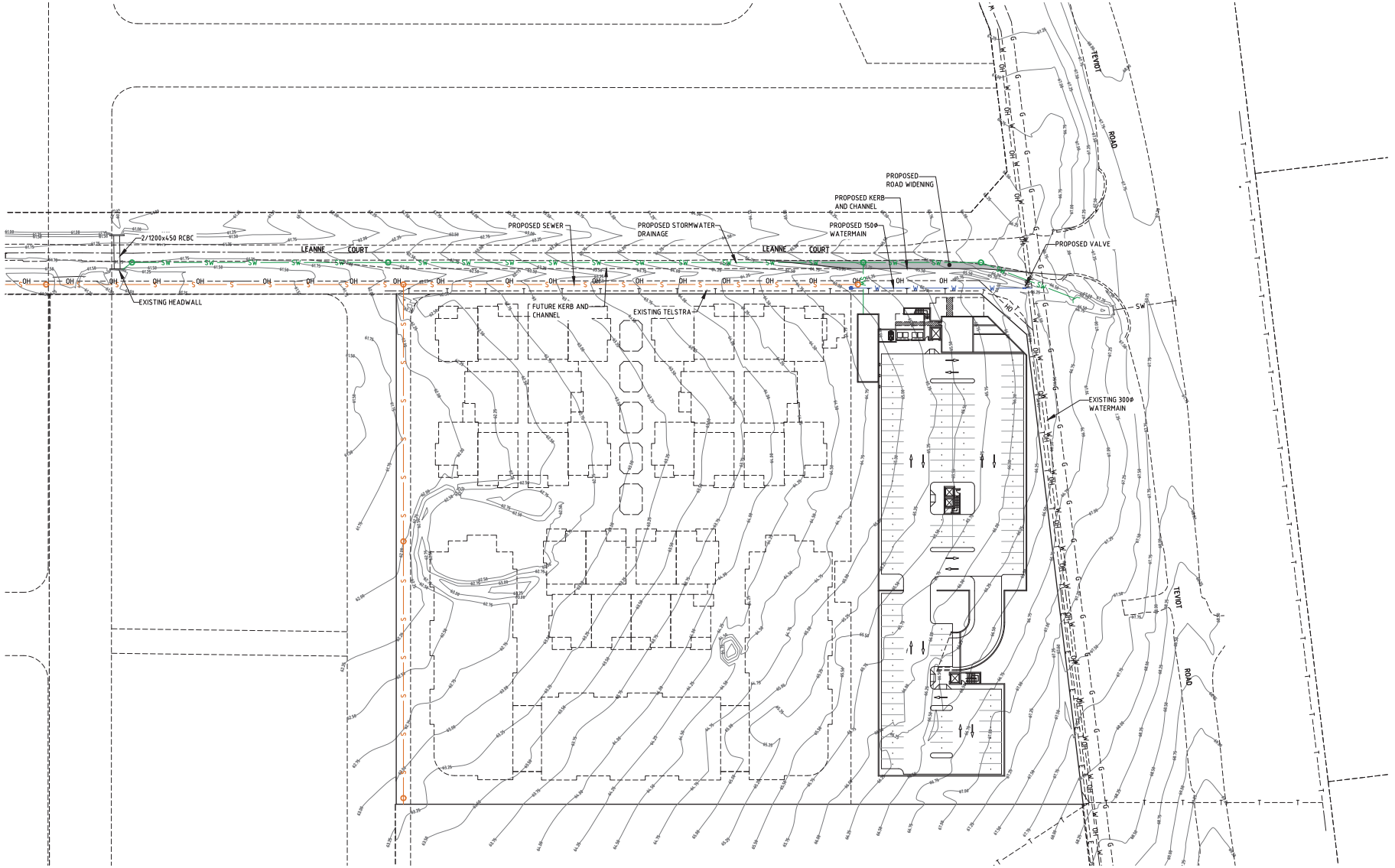


LEGEND

- EXISTING SURFACE CONTOUR
- PROPOSED SEWER
- EXISTING GAS
- EXISTING OVERHEAD ELECTRICAL
- EXISTING TELSTRA
- EXISTING ELECTRICAL
- EXISTING WATERMAIN
- PROPOSED WATERMAIN
- PROPOSED STORMWATER

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OFFICE: 182 PINE ROAD (WEST), RICHLANDS QLD 4077
MAIL: PO BOX 583 INALA QLD 4077
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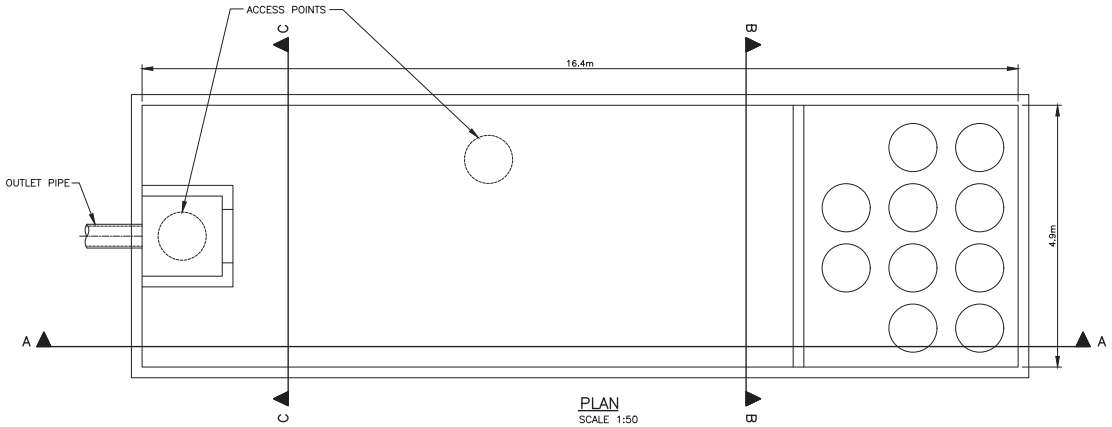


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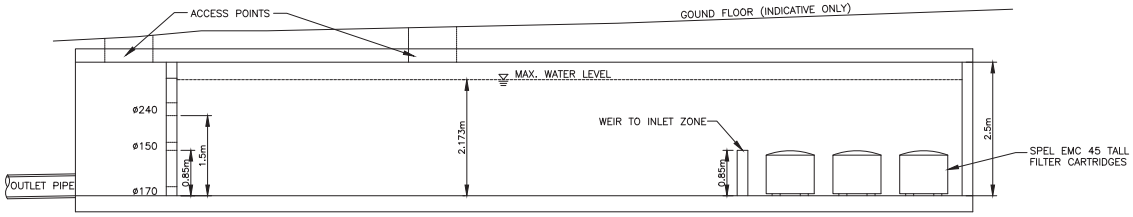


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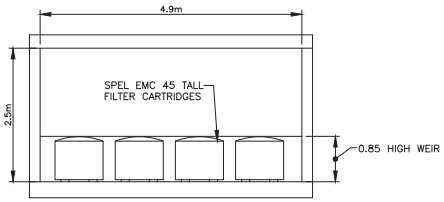


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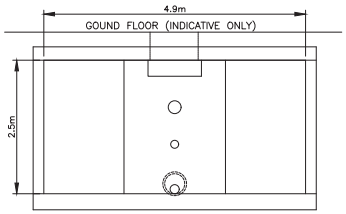


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## Appendix 2 ~ MUSIC- Report

Source nodes
Location,Urban
ID,1
Node Type,UrbanSourceNode
Zoning Surface Type,Commercial
Total Area (ha),0.61
Area Impervious (ha),0.548681343283582
Area Pervious (ha),0.061318656716418
Field Capacity (mm),80
Pervious Area Infiltration Capacity coefficient - a,243
Pervious Area Infiltration Capacity exponent - b,0.6
Impervious Area Rainfall Threshold (mm/day),1
Pervious Area Soil Storage Capacity (mm),18
Pervious Area Soil Initial Storage (% of Capacity),10
Groundwater Initial Depth (mm),50
Groundwater Daily Recharge Rate (%),0
Groundwater Daily Baseflow Rate (%),31
Groundwater Daily Deep Seepage Rate (%),0
Stormflow Total Suspended Solids Mean (log mg/L),2.16
Stormflow Total Suspended Solids Standard Deviation (log mg/L),0.38
Stormflow Total Suspended Solids Estimation Method,Stochastic
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Baseflow Total Phosphorus Standard Deviation (log mg/L),0.5
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Baseflow Total Phosphorus Serial Correlation,0
Baseflow Total Nitrogen Mean (log mg/L),0.32
Baseflow Total Nitrogen Standard Deviation (log mg/L),0.3
Baseflow Total Nitrogen Estimation Method,Stochastic
Baseflow Total Nitrogen Serial Correlation,0
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Flow based constituent generation - flow file,
Flow based constituent generation - base flow column,
Flow based constituent generation - pervious flow column,
Flow based constituent generation - impervious flow column,

Flow based constituent generation - unit,
OUT - Mean Annual Flow (ML/yr),4.46
OUT - TSS Mean Annual Load (kg/yr),939
OUT - TP Mean Annual Load (kg/yr),2.47
OUT - TN Mean Annual Load (kg/yr),14.5
OUT - Gross Pollutant Mean Annual Load (kg/yr),117
Rain In (ML/yr),5.21473
ET Loss (ML/yr),0.749904
Deep Seepage Loss (ML/yr),0
Baseflow Out (ML/yr),0
Imp. Stormflow Out (ML/yr),4.23802
Perv. Stormflow Out (ML/yr),0.226797
Total Stormflow Out (ML/yr),4.46482
Total Outflow (ML/yr),4.46482
Change in Soil Storage (ML/yr),2.8E-6
TSS Baseflow Out (kg/yr),0
TSS Total Stormflow Out (kg/yr),938.704
TSS Total Outflow (kg/yr),938.704
TP Baseflow Out (kg/yr),0
TP Total Stormflow Out (kg/yr),2.46838
TP Total Outflow (kg/yr),2.46838
TN Baseflow Out (kg/yr),0
TN Total Stormflow Out (kg/yr),14.4979
TN Total Outflow (kg/yr),14.4979
GP Total Outflow (kg/yr),116.834

No Imported Data Source nodes

USTM treatment nodes
Location,SPEL vault (15/0.85) - QUT Final
ID,2
Node Type,DetentionBasinNode
Lo-flow bypass rate (cum/sec),0
Hi-flow bypass rate (cum/sec),100
Inlet pond volume,0
Area (sqm),15
Initial Volume (m^3),
Extended detention depth (m),0.85
Number of Rainwater tanks,
Permanent Pool Volume (cubic metres),0
Proportion vegetated,0
Equivalent Pipe Diameter (mm),153
Overflow weir width (m),1
Notional Detention Time (hrs),70.4E-3
Orifice Discharge Coefficient,0.6
Weir Coefficient,1.7
Number of CSTR Cells,1
Total Suspended Solids - k (m/yr),8000
Total Suspended Solids - C* (mg/L),20
Total Suspended Solids - C** (mg/L),20

Total Phosphorus - k (m/yr),6000
Total Phosphorus - C* (mg/L),0.13
Total Phosphorus - C** (mg/L),0.13
Total Nitrogen - k (m/yr),500
Total Nitrogen - C* (mg/L),1.4
Total Nitrogen - C** (mg/L),1.4
Threshold Hydraulic Loading for C** (m/yr),3500
Horizontal Flow Coefficient,
Reuse Enabled,Off
Max drawdown height (m),
Annual Demand Enabled,Off
Annual Demand Value (ML/year),
Annual Demand Distribution,
Annual Demand Monthly Distribution: Jan,
Annual Demand Monthly Distribution: Feb,
Annual Demand Monthly Distribution: Mar,
Annual Demand Monthly Distribution: Apr,
Annual Demand Monthly Distribution: May,
Annual Demand Monthly Distribution: Jun,
Annual Demand Monthly Distribution: Jul,
Annual Demand Monthly Distribution: Aug,
Annual Demand Monthly Distribution: Sep,
Annual Demand Monthly Distribution: Oct,
Annual Demand Monthly Distribution: Nov,
Annual Demand Monthly Distribution: Dec,
Daily Demand Enabled,Off
Daily Demand Value (ML/day),
Custom Demand Enabled,Off
Custom Demand Time Series File,
Custom Demand Time Series Units,
Filter area (sqm),
Filter perimeter (m),
Filter depth (m),
Filter Median Particle Diameter (mm),
Saturated Hydraulic Conductivity (mm/hr),
Infiltration Media Porosity,
Length (m),
Bed slope,
Base Width (m),
Top width (m),
Vegetation height (m),
Vegetation Type,
Total Nitrogen Content in Filter (mg/kg),
Orthophosphate Content in Filter (mg/kg),
Is Base Lined?,
Is Underdrain Present?,
Is Submerged Zone Present?,
Submerged Zone Depth (m),
B for Media Soil Texture,-9999
Proportion of upstream impervious area treated,

Exfiltration Rate (mm/hr),0
Evaporative Loss as % of PET,0
Depth in metres below the drain pipe,
TSS A Coefficient,
TSS B Coefficient,
TP A Coefficient,
TP B Coefficient,
TN A Coefficient,
TN B Coefficient,
Sfc,
S*,
Sw,
Sh,
Emax (m/day),
Ew (m/day),
IN - Mean Annual Flow (ML/yr),4.46
IN - TSS Mean Annual Load (kg/yr),501
IN - TP Mean Annual Load (kg/yr),1.53
IN - TN Mean Annual Load (kg/yr),9.80
IN - Gross Pollutant Mean Annual Load (kg/yr),2.76
OUT - Mean Annual Flow (ML/yr),4.46
OUT - TSS Mean Annual Load (kg/yr),345
OUT - TP Mean Annual Load (kg/yr),1.22
OUT - TN Mean Annual Load (kg/yr),9.58
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00
Flow In (ML/yr),4.46482
ET Loss (ML/yr),0
Infiltration Loss (ML/yr),0
Low Flow Bypass Out (ML/yr),0
High Flow Bypass Out (ML/yr),0
Orifice / Filter Out (ML/yr),4.23408
Weir Out (ML/yr),0.230695
Transfer Function Out (ML/yr),0
Reuse Supplied (ML/yr),0
Reuse Requested (ML/yr),0
% Reuse Demand Met,0
% Load Reduction,0.00100788
TSS Flow In (kg/yr),501.121
TSS ET Loss (kg/yr),0
TSS Infiltration Loss (kg/yr),0
TSS Low Flow Bypass Out (kg/yr),0
TSS High Flow Bypass Out (kg/yr),0
TSS Orifice / Filter Out (kg/yr),310.743
TSS Weir Out (kg/yr),34.2331
TSS Transfer Function Out (kg/yr),0
TSS Reuse Supplied (kg/yr),0
TSS Reuse Requested (kg/yr),0
TSS % Reuse Demand Met,0
TSS % Load Reduction,31.1591
TP Flow In (kg/yr),1.53262

TP ET Loss (kg/yr),0
TP Infiltration Loss (kg/yr),0
TP Low Flow Bypass Out (kg/yr),0
TP High Flow Bypass Out (kg/yr),0
TP Orifice / Filter Out (kg/yr),1.12557
TP Weir Out (kg/yr),0.0949747
TP Transfer Function Out (kg/yr),0
TP Reuse Supplied (kg/yr),0
TP Reuse Requested (kg/yr),0
TP % Reuse Demand Met,0
TP % Load Reduction,20.3622
TN Flow In (kg/yr),9.80304
TN ET Loss (kg/yr),0
TN Infiltration Loss (kg/yr),0
TN Low Flow Bypass Out (kg/yr),0
TN High Flow Bypass Out (kg/yr),0
TN Orifice / Filter Out (kg/yr),8.9043
TN Weir Out (kg/yr),0.676786
TN Transfer Function Out (kg/yr),0
TN Reuse Supplied (kg/yr),0
TN Reuse Requested (kg/yr),0
TN % Reuse Demand Met,0
TN % Load Reduction,2.26413
GP Flow In (kg/yr),2.75505
GP ET Loss (kg/yr),0
GP Infiltration Loss (kg/yr),0
GP Low Flow Bypass Out (kg/yr),0
GP High Flow Bypass Out (kg/yr),0
GP Orifice / Filter Out (kg/yr),0
GP Weir Out (kg/yr),0
GP Transfer Function Out (kg/yr),0
GP Reuse Supplied (kg/yr),0
GP Reuse Requested (kg/yr),0
GP % Reuse Demand Met,0
GP % Load Reduction,100
PET Scaling Factor,

Generic treatment nodes
Location,10/SPELFilter (EMC 45) - Logan,(4) SPEL Stormsacks - Logan
ID,3,5
Node Type,GenericNode,GPTNode
Lo-flow bypass rate (cum/sec),0,0
Hi-flow bypass rate (cum/sec),0.0283,0.044
Flow Transfer Function
Input (cum/sec),0,0
Output (cum/sec),0,0
Input (cum/sec),10,10
Output (cum/sec),10,10
Input (cum/sec), ,
Output (cum/sec), ,

Input (cum/sec), ,
Output (cum/sec), ,
Input (cum/sec), ,
Output (cum/sec), ,
Input (cum/sec), ,
Output (cum/sec), ,
Input (cum/sec), ,
Output (cum/sec), ,
Input (cum/sec), ,
Output (cum/sec), ,
Input (cum/sec), ,
Output (cum/sec), ,
Input (cum/sec), ,
Output (cum/sec), ,
Gross Pollutant Transfer Function
Enabled,True,True
Input (kg/ML),0,0
Output (kg/ML),0,0
Input (kg/ML),15,15
Output (kg/ML),0,0
Input (kg/ML), ,
Output (kg/ML), ,
Input (kg/ML), ,
Output (kg/ML), ,
Input (kg/ML), ,
Output (kg/ML), ,
Input (kg/ML), ,
Output (kg/ML), ,
Input (kg/ML), ,
Output (kg/ML), ,
Input (kg/ML), ,
Output (kg/ML), ,
Input (kg/ML), ,
Output (kg/ML), ,
Input (kg/ML), ,
Output (kg/ML), ,
Total Nitrogen Transfer Function
Enabled,True,True
Input (mg/L),0,0
Output (mg/L),0,0
Input (mg/L),100,100
Output (mg/L),56,65
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,

Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Total Phosphorus Transfer Function
Enabled,True,True
Input (mg/L),0,0
Output (mg/L),0,0
Input (mg/L),100,100
Output (mg/L),43,59
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Total Suspended Solids Transfer Function
Enabled,True,True
Input (mg/L),0,0
Output (mg/L),0,0
Input (mg/L),1000,1000
Output (mg/L),250,500
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,
Input (mg/L), ,
Output (mg/L), ,

Input (mg/L), ,
Output (mg/L), ,
TSS Flow based Efficiency Enabled,Off,Off
TSS Flow based Efficiency, ,
TP Flow based Efficiency Enabled,Off,Off
TP Flow based Efficiency, ,
TN Flow based Efficiency Enabled,Off,Off
TN Flow based Efficiency, ,
GP Flow based Efficiency Enabled,Off,Off
GP Flow based Efficiency, ,
IN - Mean Annual Flow (ML/yr),4.46,4.46
IN - TSS Mean Annual Load (kg/yr),345,939
IN - TP Mean Annual Load (kg/yr),1.22,2.47
IN - TN Mean Annual Load (kg/yr),9.58,14.5
IN - Gross Pollutant Mean Annual Load (kg/yr),0.00,117
OUT - Mean Annual Flow (ML/yr),4.46,4.46
OUT - TSS Mean Annual Load (kg/yr),132,501
OUT - TP Mean Annual Load (kg/yr),0.625,1.53
OUT - TN Mean Annual Load (kg/yr),5.88,9.80
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,2.76
Flow In (ML/yr),4.46476,4.46482
ET Loss (ML/yr),0,0
Infiltration Loss (ML/yr),0,0
Low Flow Bypass Out (ML/yr),0,0
High Flow Bypass Out (ML/yr),0.449788,0.316881
Orifice / Filter Out (ML/yr),0,0
Weir Out (ML/yr),0,0
Transfer Function Out (ML/yr),4.01497,4.14796
Reuse Supplied (ML/yr),0,0
Reuse Requested (ML/yr),0,0
% Reuse Demand Met,0,0
% Load Reduction,-7.83917E-5,-0.000468103
TSS Flow In (kg/yr),344.971,938.706
TSS ET Loss (kg/yr),0,0
TSS Infiltration Loss (kg/yr),0,0
TSS Low Flow Bypass Out (kg/yr),0,0
TSS High Flow Bypass Out (kg/yr),60.6022,63.537
TSS Orifice / Filter Out (kg/yr),0,0
TSS Weir Out (kg/yr),0,0
TSS Transfer Function Out (kg/yr),71.0924,437.586
TSS Reuse Supplied (kg/yr),0,0
TSS Reuse Requested (kg/yr),0,0
TSS % Reuse Demand Met,0,0
TSS % Load Reduction,61.8244,46.6156
TP Flow In (kg/yr),1.22052,2.46838
TP ET Loss (kg/yr),0,0
TP Infiltration Loss (kg/yr),0,0
TP Low Flow Bypass Out (kg/yr),0,0
TP High Flow Bypass Out (kg/yr),0.176109,0.186051
TP Orifice / Filter Out (kg/yr),0,0

TP Weir Out (kg/yr),0,0
TP Transfer Function Out (kg/yr),0.449105,1.34657
TP Reuse Supplied (kg/yr),0,0
TP Reuse Requested (kg/yr),0,0
TP % Reuse Demand Met,0,0
TP % Load Reduction,48.7746,37.9098
TN Flow In (kg/yr),9.58106,14.4979
TN ET Loss (kg/yr),0,0
TN Infiltration Loss (kg/yr),0,0
TN Low Flow Bypass Out (kg/yr),0,0
TN High Flow Bypass Out (kg/yr),1.17833,1.08407
TN Orifice / Filter Out (kg/yr),0,0
TN Weir Out (kg/yr),0,0
TN Transfer Function Out (kg/yr),4.70555,8.71896
TN Reuse Supplied (kg/yr),0,0
TN Reuse Requested (kg/yr),0,0
TN % Reuse Demand Met,0,0
TN % Load Reduction,38.5885,32.3829
GP Flow In (kg/yr),0,116.833
GP ET Loss (kg/yr),0,0
GP Infiltration Loss (kg/yr),0,0
GP Low Flow Bypass Out (kg/yr),0,0
GP High Flow Bypass Out (kg/yr),0,2.75505
GP Orifice / Filter Out (kg/yr),0,0
GP Weir Out (kg/yr),0,0
GP Transfer Function Out (kg/yr),0,0
GP Reuse Supplied (kg/yr),0,0
GP Reuse Requested (kg/yr),0,0
GP % Reuse Demand Met,0,0
GP % Load Reduction,100,97.6419

Other nodes
Location,Receiving Node
ID,4
Node Type,ReceivingNode
IN - Mean Annual Flow (ML/yr),4.46
IN - TSS Mean Annual Load (kg/yr),132
IN - TP Mean Annual Load (kg/yr),0.625
IN - TN Mean Annual Load (kg/yr),5.88
IN - Gross Pollutant Mean Annual Load (kg/yr),0.00
OUT - Mean Annual Flow (ML/yr),4.46
OUT - TSS Mean Annual Load (kg/yr),132
OUT - TP Mean Annual Load (kg/yr),0.625
OUT - TN Mean Annual Load (kg/yr),5.88
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00
% Load Reduction,1.17E-3
TSS % Load Reduction,86.0
TN % Load Reduction,59.4
TP % Load Reduction,74.7
GP % Load Reduction,100

Links
Location,Drainage Link,Drainage Link,Drainage Link,Drainage Link
Source node ID,2,3,1,5
Target node ID,3,4,5,2
Muskingum-Cunge Routing,Not Routed,Not Routed,Not Routed,Not Routed
Muskingum K, , , ,
Muskingum theta, , , ,
IN - Mean Annual Flow (ML/yr),4.46,4.46,4.46,4.46
IN - TSS Mean Annual Load (kg/yr),345,132,939,501
IN - TP Mean Annual Load (kg/yr),1.22,0.625,2.47,1.53
IN - TN Mean Annual Load (kg/yr),9.58,5.88,14.5,9.80
IN - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,117,2.76
OUT - Mean Annual Flow (ML/yr),4.46,4.46,4.46,4.46
OUT - TSS Mean Annual Load (kg/yr),345,132,939,501
OUT - TP Mean Annual Load (kg/yr),1.22,0.625,2.47,1.53
OUT - TN Mean Annual Load (kg/yr),9.58,5.88,14.5,9.80
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,117,2.76

Catchment Details
Catchment Name,P19-199 V1 stage 1 and 4
Timestep,6 Minutes
Start Date,1/01/1980
End Date,31/12/1989 11:54:00 PM
Rainfall Station, 40312 NEW
ET Station,User-defined monthly PET
Mean Annual Rainfall (mm), 855
Mean Annual ET (mm), 1448

# Appendix 3 ~ Rational Method Calculations

## Rational Method Peak Flow Calculation

Job No: 19-199
Job Type: RoL
Address: 205 - 219 Teiot Road, Greenbank
Council: LCC

WILKINSON SHAW & ASSOCIATES consulting engineers
Experience. Precision. Excellence.

IFD Data: Latitude 0 | Data Obtained 19-Apr-20 | Soil info for Zero $C_{10}$: Medium Bush Med permeability
Longitude 0
Minor Storm: $Q_{10}$
$^1I_{10}$ 58 mm/hr | Major Storm: $Q_{100}$

Notes: This caluations sheet examines the change in flow due to the proposed development to the table drain in Leanne Court

### Pre-Development

**Time of Concentration**

**Standard Inlet Time**
Standard Inlet Time — mins

**Sheet Flow (Friends Equation)**
Sheet Flow length (L) 60 m
Ground Cover Type Poorly Grassed Surface
roughness (n) 0.035
Fall of NSL 2.43 m
Slope o Surface 4.05 %
total **11.1** mins

**Concentrated Flow**
Flow distance — m
Fall of NSL — m
mins
Surface type miltiplier
Total **0** mins

**Pipe Flow**
Flow distance — m
velocity — m/s
mins **0** min

**Total $t_c$** **11.1** mins

**Runoff Volume Calculations**

| Name | Area (m2) | $t_c$ | $f_i$ | $C_{10}$ |
|---|---|---|---|---|
| Stage 1/4 | 6011 | | 0.15 | 0.5825 |
| | | | | 0 |
| | | | | 0 |
| | | | | 0 |
| | | | | 0 |
| | | | | 0 |
| | | | | 0 |
| Total | 6011 | 11.1 | | 0.583 |

| AEP | Frequency factor ($F_y$) | $C_y$ ($F^y.C_{10}$) | $I_y$ | $Q_y$ ($m^3/s$) |
|---|---|---|---|---|
| 3 mth | | | | 0.031 |
| 1EY | 0.8 | 0.466 | 80 | 0.062 |
| 0.5EY | 0.85 | 0.495 | 102 | 0.084 |
| 0.2EY | 0.95 | 0.553 | 129 | 0.120 |
| 10% | 1 | 0.583 | 150 | 0.146 |
| 5% | 1.05 | 0.612 | 173 | 0.177 |
| 2% | 1.15 | 0.670 | 202 | 0.226 |
| 1% | 1.2 | 0.699 | 224 | 0.262 |

### Post-Development

**Time of Concentration**

**Standard Inlet Time**
Standard Inlet Time 6 mins

**Sheet Flow (Friends Equation)**
Sheet Flow length (L) — m
Ground Cover Type Poorly Grassed Surface
roughness (n) 0.035
Fall of NSL — m
Slope o Surface 0 %
total **0.0** mins

**Concentrated Flow**
Flow distance
velocity
mins
Surface type miltiplier
Total **0** mins

**Pipe Flow**
Flow distance 90 m
velocity 1.5 m/s
mins **1** min

**Total $t_c$** **7.0** mins

**Runoff Volume Calculations**

| Name | Area (m2) | $t_c$ | $f_i$ | $C_{10}$ |
|---|---|---|---|---|
| Stage 1/4 | 6011 | | 0.9 | 0.86 |
| | | | | 0 |
| | | | | 0 |
| | | | | 0 |
| | | | | 0 |
| | | | | 0 |
| | | | | 0 |
| Total | 6011 | 7.0 | | 0.860 |

| AEP | Frequency factor ($F_y$) | $C_y$ ($F^y.C_{10}$) | $I_y$ | $Q_y$ ($m^3/s$) |
|---|---|---|---|---|
| 3 mth | | | | 0.053 |
| 1EY | 0.8 | 0.688 | 93 | 0.106 |
| 0.5EY | 0.85 | 0.731 | 118 | 0.143 |
| 0.2EY | 0.95 | 0.817 | 150 | 0.205 |
| 10% | 1 | 0.860 | 175 | 0.251 |
| 5% | 1.05 | 0.903 | 201 | 0.304 |
| 2% | 1.15 | 0.989 | 236 | 0.390 |
| 1% | 1.2 | 1.000 | 263 | 0.439 |