LODGED
23/12/2019
BCC DS

MARKETPLACE DEVELOPMENTS
C/- PLANNERY CO

LAMINGTON MARKETS - DA SUBMISSION

53, 57 LAMINGTON AVE &
612 LUTWYCHE RD
LUTWYCHE QLD 4030

CIVIL ENGINEERING REPORT

DECEMBER
2019

Question today
Imagine tomorrow
Create for the future

Engineering report for Development Application

Marketplace Developments
C/- Plannery Co

WSP
Level 12, 900 Ann Street
Fortitude Valley QLD 4006

Tel: +61 7 3368 6600
wsp.com

REV	DATE	DETAILS
1	18.12.2019	Report issued for client review
2	20.12.2019	For DA Submission

	NAME	DATE	SIGNATURE
Prepared by:	Praneet Narayan	20.12.2019	
Reviewed by:	Stefan Spirig	20.12.2019	
Approved by:	Stefan Spirig	20.12.2019	

TABLE OF CONTENTS

Appendix

A - Civil engineering plans

B - Architectural plans

C - Survey

D - ESC Calculations + Erosion Hazard Assessment

E - Geotechnical Reports

F - Applicable Planning Codes

G - Dial Before You Dig

1 INTRODUCTION

WSP have prepared this Engineering Report on behalf of Marketplace Developments. The report supports a development application to Brisbane City Council (Council) for a proposed mixed use development located between Lamington Avenue and Lutwyche Road, Lutwyche. The proposed development is located within the Brisbane City Council (BCC) municipality and comprises an integrated mixed use development including:

- Multiple dwelling (within 2 landmark towers – 12 storeys each);
- Bar;
- Hotel;
- Centre activities (Food and drink outlet, Function facility, Health care service, Indoor sport and recreation, Office, Shop, Short Term accommodation, Theatre)

The purpose of this report is to provide an overview of the various engineering issues that relate to the site and how these issues have been addressed.

The following Engineering matters have been addressed in this report:

- Site works including site grading;
- Stormwater Management including water quantity and Water Sensitive Urban Design (WSUD); and
- Services connections for sewer and water.

A full set of Civil DA Drawings is provided in Appendix A of this report which detail the various engineering issues listed above. Refer to the architectural plans prepared by the architect Conrad Gargett attached in Appendix B of this report.

2 SITE CHARACTERISTICS

The proposed site area measures 7,336 m2 with access from both Lutwyche Road and Lamington Avenue. The address is 53, 57 Lamington Avenue and 612 Lutwyche Road, Lutwyche QLD 4030 and formally described as Lot 1 on SP252287, Lot 50 on SP263291 and Lot 101 on RP19352. The existing lots fall under the DC2 District Centre zone.

2.1 SITE LOCATION

The development is bounded by Lutwyche Road to the East, the Busway Tunnel entrance to the South and Lamington Avenue to the West. The Northern Busway enters from Lamington Avenue and continues under Lot 50 (SP263291). Refer to figure Fig. 1 for site location.

Fig. 1: Site Location 53 & 57 Lamington Ave and 612 Lutwyche Rd, Lutwyche

The site currently contains two apartment buildings, facing Lamington Avenue and a vacant land facing Lutwyche road. The northern busway tunnel is located under the vacant land with the bus station located immediately south to the development property.

2.2 EASEMENTS

The table below summarises the current easements within the development site:

EASEMENT NUMBER	BENEFITTING	BURDENING	SURVEY PLAN REFERENCE	PURPOSE OF EASEMENT
700 569 976	Lot 50 on SP263291	Lot 1 on SP252287	EMT A on RP880297	Drainage
715 448 503	Not applicable	Lot 50 on SP263291	EMT B on SP263291	Supply of Electricity
716 442 352	Volumetric Lot 117 on SP252339 Volumetric Lot 118 on SP252285	Lot 50 on SP263291	Lot 117 on SP252339 (Vol)	Support
718 724 603	Lot 50 on SP263291	Common Property of Spectrum Apartments Community Titles Scheme 49765	EMT A on SP300842	Right of way

Table 1: Easements

2.3 PROPOSED DEVELOPMENT

The development proposes construction of a mixed-use building of up to 12 floors with a 6-level basement.

The development will require extensive bulk earthworks to achieve appropriate grading for the building pad. Sewer and water reticulation is proposed to be connected to the surrounding existing network. Due to the increase of impervious area on the site additional runoff is generated. The new stormwater drainage is proposed to catch and treat the additional runoff appropriately before releasing it to the legal point of discharge.

The proposed site layout plan can be found within Conrad Gargett DA documentation for the building design (see Appendix B).

2.4 EXISTING TOPOGRAPHY

The existing site levels range from approximately RL27.6 (AHD) on the north-eastern boundary to RL19.86 (AHD) on the south-western boundary resulting in an average site grading of approximately 6.3% (refer Appendix C).

The site generally falls in a south-westerly direction towards Lamington Avenue. The lawful point of the discharge is to the Council stormwater system which is located on Lamington Avenue. Additionally, a part of Lutwyche Road drainage catchments (a section of road in front of the property) is collected in road side gully pits and conveyed to the existing drainage network in Lamington Avenue via pipe network located inside the proposed site.

The overall site overall measures approx. 0.7336 ha

3 ENGINEERING

3.1 PLANNING CODES

The following planning codes have been addressed in Appendix F of this report.

- State Development Assessment Provisions – Version 2.5, State code 3: Development in a busway environment;
- State Development Assessment Provisions – Version 2.5, State code 5: Development in a state controlled transport tunnel environment;
- Brisbane City Plan, Filling and excavation code, Effective 01.12.2019;
- Brisbane City Plan, Infrastructure design code, Effective 29.06.2019 and
- Brisbane City Plan, Stormwater code, Effective 29.06.2019.

3.2 EARTHWORKS

Extensive earthwork excavations will be required for the 6-level basements and to establish the required levels for the proposed mixed use building. The initial extent of the bulk earthworks has been determined but will be required to be finalised during detail design.

The preliminary calculations suggest an excess of approximately 63,500m^3 of cut over fill (see Table 2).

If imported fill is required, it will need to be engineered fill from an approved source specified as free of contaminates or deleterious material.

EXCAVATION AREA	CUT (M^3)	FILL (M^3)
Basement Earthworks (approx.)	63,000	0
Services Trenching (approx.)	500	0
Total	63,500	0
Balance	**63,500**	

Table 2: Preliminary bulk earthworks volumes

Preliminary bulk earthworks levels are outlined in Table 3 below:

EXCAVATION AREA	BULK EARTHWORKS LEVEL (RL) APPROX.
Lamington Avenue Basement 6	**8.21**
Lutwyche Road Basement 2	**17.70**

Table 3: Approximate excavation RL

The floor area over the Northern Busway is approximately 2m over the cut and cover protection slab. Bridging beams will need to be excavated to appropriate levels below the development floor level as per the structural drawings that will be outlined in detailed design phase.

Temporary retention works will be required for basement excavations. Further design and documentation of these retention works will be required during detailed design by an appropriate Geotechnical Engineer, however preliminary design indicates that soldier pile and shotcrete infill panel stabilisation will be implemented.

A detailed geotechnical investigation will be required prior to detailed design to confirm stability of soils on site. To comply with Council standards, all filling within lots associated with bulk earthworks should be completed under Level 1 Geotechnical Supervision and AS3798:2007.

Preliminary assessment against BCC City Plan 2014; Section 9.4.3 (Filling and Excavation Code) and State codes 3 & 5 have been made and are attached in Appendix F.

3.3 SITE GRADING AND RETAINING WALLS

The level difference between the two roads on either side of the development will be compensated through the basements. The main entrance is along Lutwyche road. The main entrance will have limited grades (max 5%) and flush kerbs with no steps. Furthermore, the main entrance area has to tie in with the adjacent property driveway. The preliminary grading negates any need for initial retaining walls. However, due to the proposed 6 level basement, further consideration of retaining walls may be required at the detailed design stage to accommodate desired pad sizes.

Assessment against BCC City Plan 2014; Section 9.4.3 (Filling and Excavation Code) has been made and can be found in Appendix F.

3.4 ROADWORKS

Road works for the proposed development will consist of four entry and exit points for the overall site. Entry & exit points via Lamington Avenue include a loading access point, vehicular entry point directly to the basement level 2 and vehicular access to the internal road and access path through the site. An additional access point to the internal road will be provided from Lutwyche Road and combine with the existing access point within the Brisbane Housing Corporation development as part of the right of way easement on Lot 50 (see Table 1). The grade of the entry point is to ensure that overland flow stormwater from the kerb and channel is not directed into the basement.

The maximum design vehicles for each access point based on AS2890.1 & AS2890.2 can be found in Table 4 below:

ACCESS POINT	MAXIMUM DESIGN VEHICLE
Loading Dock access via Lamington Avenue	Heavy Rigid Vehicle (HRV) - 12.5m
Basement 2 access via Lamington Avenue	B99 Vehicle – 5.2m car (2.4m height clearance)
Internal access road via Lamington Avenue	Medium Rigid Vehicle (MRV) - 8.8m
Internal access road via Lutwyche Road	10.5m Garbage Truck; Garbage

Table 4: Maximum design vehicles

Assessment against BCC City Plan 2014; Section 9.4.4 (Infrastructure Design Code) has been made and can be found in Appendix F.

3.5 STORMWATER DRAINAGE

Existing stormwater drainage is located in the south-west corner of the site and is to be utilised by the Proposed Development. This network discharges to the Kedron Brook waterway.

The existing drainage system within Lamington Avenue does not have accurate survey or Ebimap2 data. It is assumed that this pipe is undersized and will require upgrade to a 375mm pipe (See Fig. 2 & Appendix A). The length of the pipe that is to be upgraded is approximately 9m and is located on the intersection of Lamington Avenue and McGregor Avenue.

It is also proposed to construct new DN375 pipes and new inlet pit. The new stormwater system will connect into the existing pit on Lamington Avenue for the stormwater discharge from the development.

The stormwater attenuation strategy proposed for the development consists of installing a sequential water quality treatment train in combination with an onsite detention tank.

All incoming pipes from the roof and the hardstands are connected to the 50kL rainwater reuse tank, with overflows discharging into the catridge chamber of the 63kL stormwater treatment/ detention tank before discharging to the lawful point of discharge on Lamington Avenue. An orifice at the outlet limits the outflow to the current discharge rate. The proposed stormwater management strategy is outlined in Section 4 & 5 of this report, noting that detention and water quality treatment devices are proposed for the new development to comply with City Plan 2014; Section 9.4.9 (Stormwater Code), (Refer Appendix F).

3.6 SEWER RETICULATION

As per the Dial Before You Dig information, it is noted that existing sewer infrastructure (150mm) is located to the east (Lutwyche Road) and west (Lamington Avenue) of the proposed development. The sewer in Lutwyche Road is located on the eastern side. Therefore, it is proposed a connection is made at the western boundary of the site to the existing 150mm sewer main in Lamington Ave.

Preliminary sewerage loading calculations are based on Queensland Urban Utilities (QUU) supporting documentation to the Water Services Association of Australia (WSA) Code, Table 3.1. The Major Centre (MP2) classification is similar to the DC2 zoning classification, therefore 150 Equivalent Persons (EP) per hectare is appropriate. The demand for the proposed 2.895ha floor area (BCC definition) development equates to 434.3 EP. The WSA codes suggests 600 Equivalent People (EP's) can be serviced by a 150mm property connection.

A QUU Services Advise Notice (SAN) will be required to determine the suitability of the sewer reticulation network.

The Dial Before You Dig information is available in Appendix G.

3.7 WATER RETICULATION

As per the Dial Before You Dig information, it is noted that water infrastructure is located to the east (150mm water main in Lutwyche Road) and west (100mm water main in Lamington Avenue) of the property. It is proposed a connection is made at the western boundary of the site. A QUU SAN will be required at the detailed design stage to confirm the proposed demand and the suitability of the existing infrastructure.

Dial Before You Dig information is available at Appendix G.

3.8 OTHER SERVICES

The Dial Before You Dig information suggests electrical, telecommunication, and NBN services are available for the site to utilise as connection points. Further design and documentation of these connections and correspondence with service providers will be required during detailed design by an appropriate Services Engineer.

Dial Before You Dig information is available in Appendix G.

4 STORMWATER QUANTITY

4.1 EXISTING STORMWATER INFRASTRUCTURE

Currently, the stormwater from the developed section of the site (facing Lamington Avenue -Lot 1 SP 252287) discharges into the stormwater drainage system in Lamington Avenue. The major flows from this area would also discharge overland towards Lamington Avenue.

The vacant section (Lot 50 SP263291) of land adjacent to Lutwyche Road discharges overland to a field inlet pit located at the south of the property. It is assumed that the outlet from this field inlet pit discharges into the underground stormwater network in Lamington Avenue. The existing drainage was not surveyed, but the assumed connections, based on eBIMAP2 mapping service have been shown in Fig. 2.

Fig. 2: Proposed & Existing stormwater infrastructure

4.1.1 LAWFUL POINT OF DISCHARGE

It is proposed to discharge the runoff from the site via an on-site detention basin and a pit and pipe system into the existing stormwater system located in Lamington Ave. The existing stormwater system limits the amount of water that can be discharged into the system and onsite detention will be required.

4.1.2 FLOODING

A flood search was conducted for the site and found the Brisbane City Council flood awareness map indicates that the site is not affected by flooding as can be seen in Fig. 3.

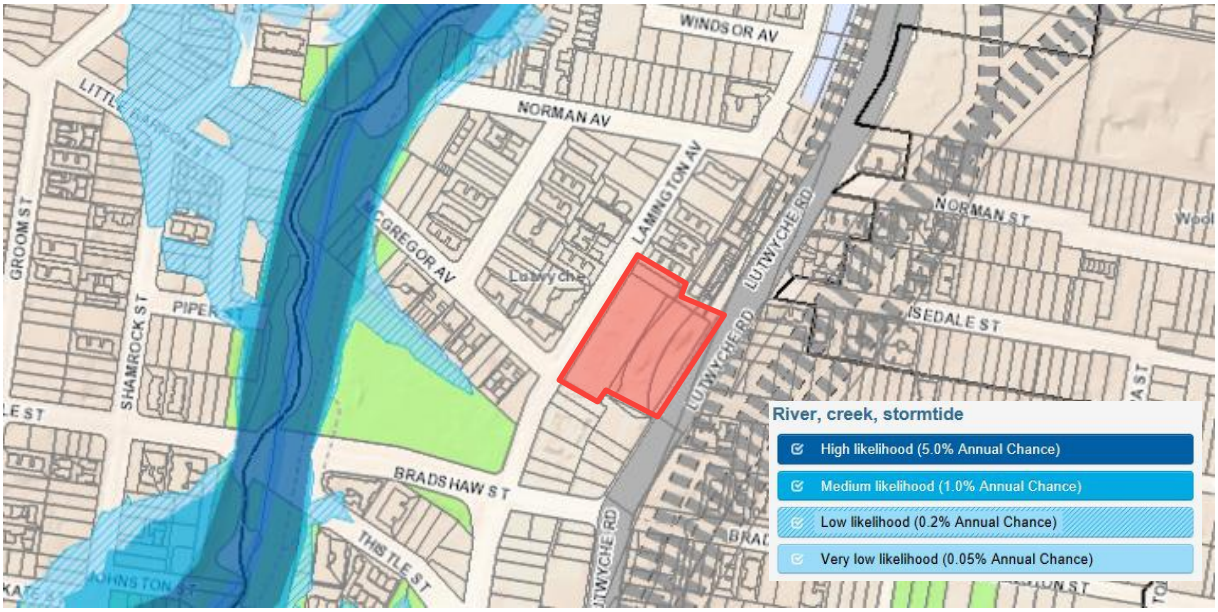


Fig. 3: 2019 Flood awareness map of 612 Lutwyche Rd, Lutwyche

4.2 PROPOSED INFRASTRUCTURE

The proposed stormwater drainage system involves capturing the roof water and surface drainage from the site and directing the flow into an on-site detention tank located within the basement of the building.

The detention tank will attenuate stormwater and protect the existing stormwater system in Lamington Ave from being overloaded, as the outflow from the site is larger than the capacity of the stormwater pipes in Lamington Ave. Stormwater quality treatment will also be provided with proprietary stormwater treatment devices located within the on-site detention tank. The stormwater will then be discharged to the nominated lawful point of discharge.

The zoning plan classifies the site as District centre (corridor) zone. The Brisbane City Council Planning Scheme Policy Chapter 7 Stormwater nominates the following minimum design standards for drainage systems (Table 7.2.2.3.B – Design standards for drainage systems) for medium to high residential developments and commercial land uses in centre zones.

Based on the above the following design parameters have been adopted for the development:

- Minor drainage System: 10% AEP (10y ARI)
- Major drainage System: 2% AEP (50y ARI)
- Roof water drainage: 1% AEP (100y ARI)

As the roof water drainage is to be designed for 1% AEP, therefore the on site detention tank needs to detain the 1% AEP volume, despite the major event of 2% AEP.

4.3 STORMWATER QUANTITY MANAGEMENT

To ensure the proposed development's stormwater runoff will not overload the existing drainage system, the existing and developed stormwater peak flows from the proposed developable areas have been calculated and analysed. These have been modelled using the hydraulic software DRAINS. The ILSAX hydrological model was used in the DRAINS analysis. The ILSAX hydrological model uses hydrological losses and depression storage.

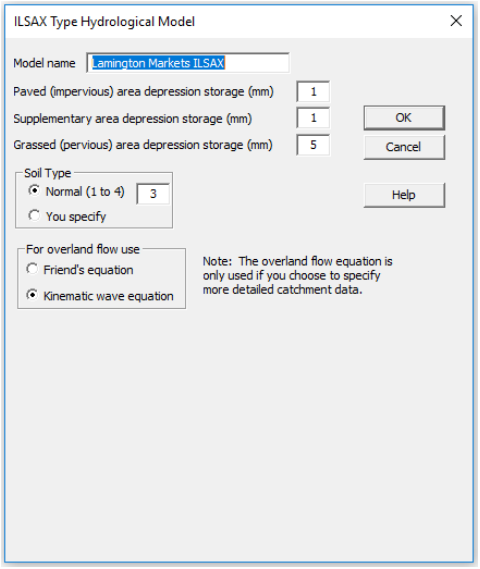


Figure 4: ILSAX Hydrological Model used in DRAINS

The Australian Rainfall Runoff 2016 (ARR2016) rainfall data was used in the DRAINS analysis. The following rainfall intensities were used for the model: 1 Exceedances per year (EY) (1 year Average Recurrence Interval (ARI)), 0.5EY (2 year ARI), 0.2EY (5 year ARI), 10% AEP (10 year ARI), 5% AEP (20 year ARI), 2%AEP (50 year ARI) and 1% AEP (100 year ARI). The following durations were used in the model: 5min, 10min, 15min, 20min, 25min, 30min, 45min, 1hr, 1.5hr, 2hr, 3hr and 4.5hr.

A catchment plan was developed for the pre- and post-developed scenarios to facilitate analysis and can be found in Appendix A. DRAINS input parameters for the developed catchments are shown in Fig. 6.

The existing site consists of mixed (residential and brownfield) areas of 0.7ha and is currently 70% pervious and 30% impervious. After the development takes place the whole site will be 100% impervious. The pre-developed peak flows from the development areas were analysed for all storms from the 10 year ARI to the 100 year ARI as per table 7.3.1 from the Queensland Urban Drainage Manual 2016.

The time of concentration was calculated in accordance with Section 4.6 of the Queensland Urban Drainage Manual 2016.

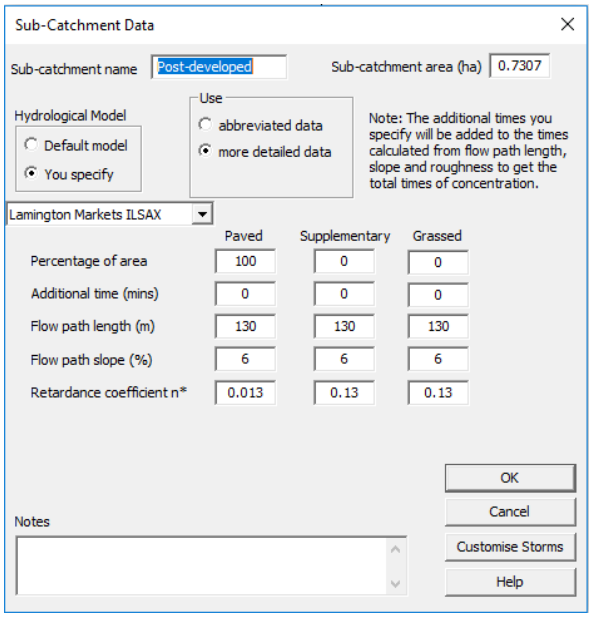


Fig. 6: Post developed catchment details

4.3.1 CATCHMENTS

The site currently consists of one large catchment. The whole site falls towards the boundary at Lamington Ave via pit and pipe system and overland flow. The current catchment is 70.4% pervious and 29.6% impervious. It must be noted that the current situation cannot be considered as the pre-developed catchment. The site has had residential and commercial developments in different configurations for decades, approximating to 80% impervious (see Figure 7). The busway was constructed in 2009 with the majority of the residential and commercial developments being removed. Therefore, the actual pre-developed site was estimated to be approx. 80% impervious. (see Fig. 8 for current catchment data).

Fig. 7: Pre Busway aerial image (2002, Source: QIMagery)

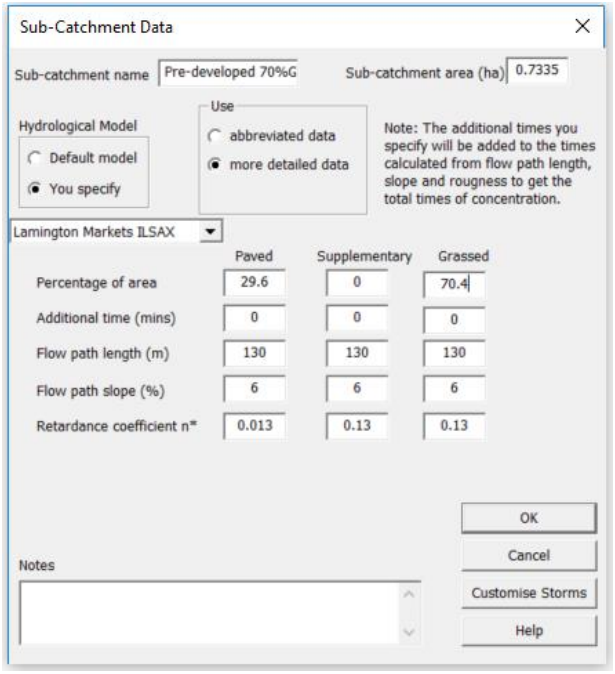


Fig. 8: Current catchment details

After the development proceeds, the following catchment site can be considered 100% impervious. The post-developed flows are matched to the pre-developed flows and therefore an on-site detention tank is utilised (See Fig. 9).

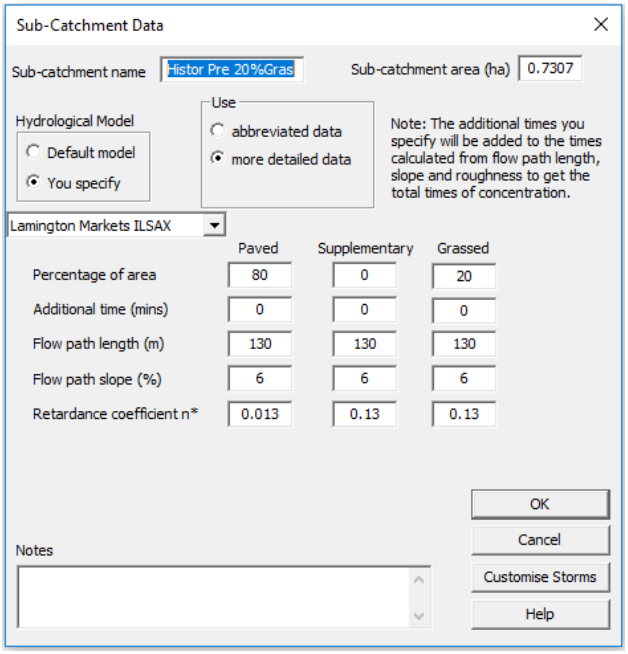


Fig. 9: Historic catchment details

4.3.2 ON-SITE DETENTION

The stormwater attenuation strategy proposed for the development consists of installing an on-site detention facility on the western side of the site. The proposed detention tank will capture the flow from the internal catchments. The stormwater gets discharged via new DN 375 pipe into the road reserve.

The detention tank was modelled in DRAINS. The following illustrations show the DRAINS results:

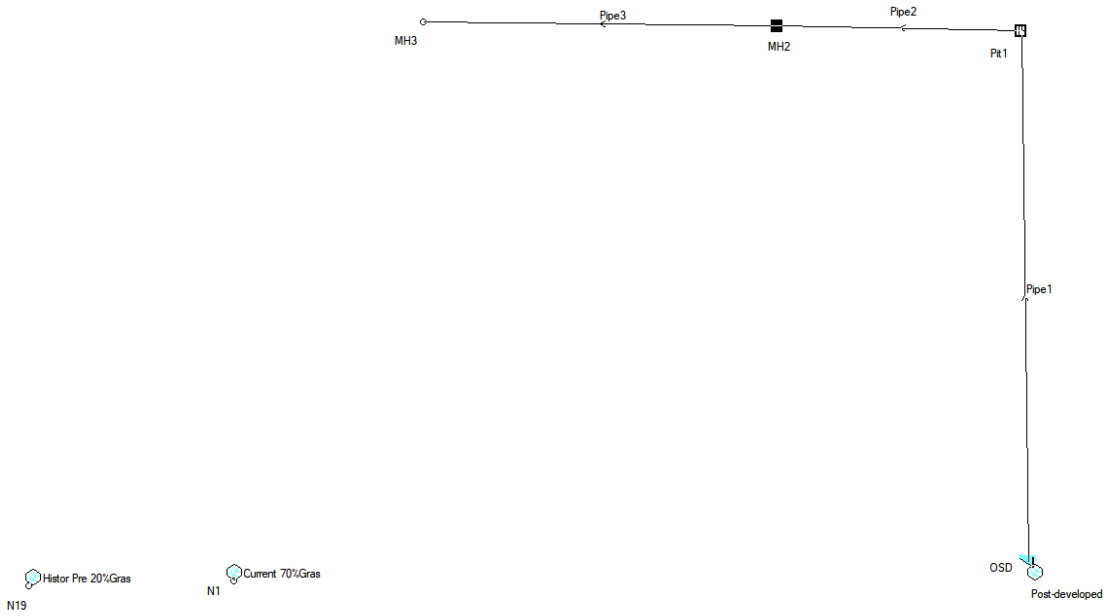


Fig. 10: DRAINS model setup

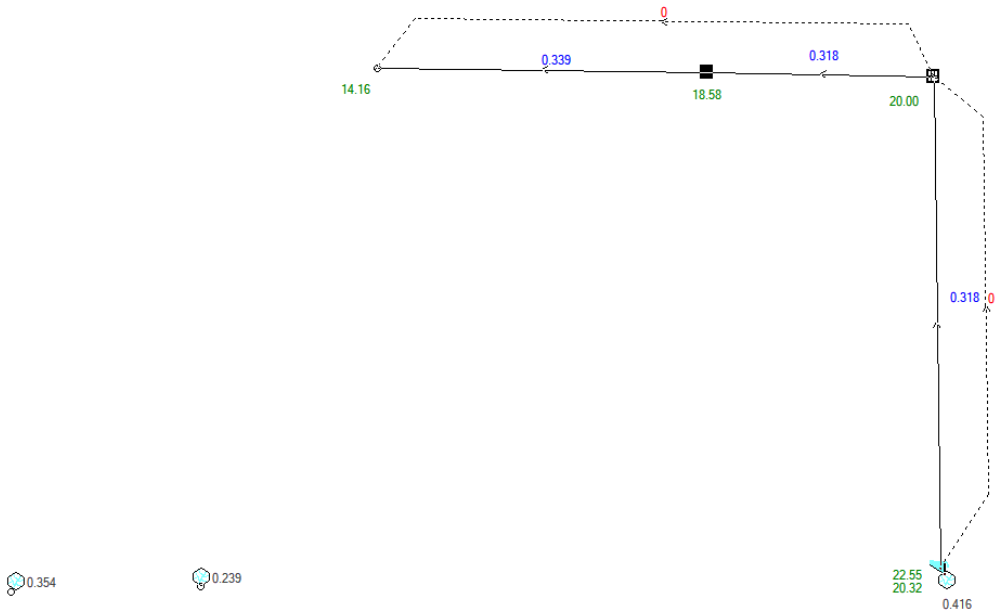


Fig. 11: 10 year minor flows for all catchments

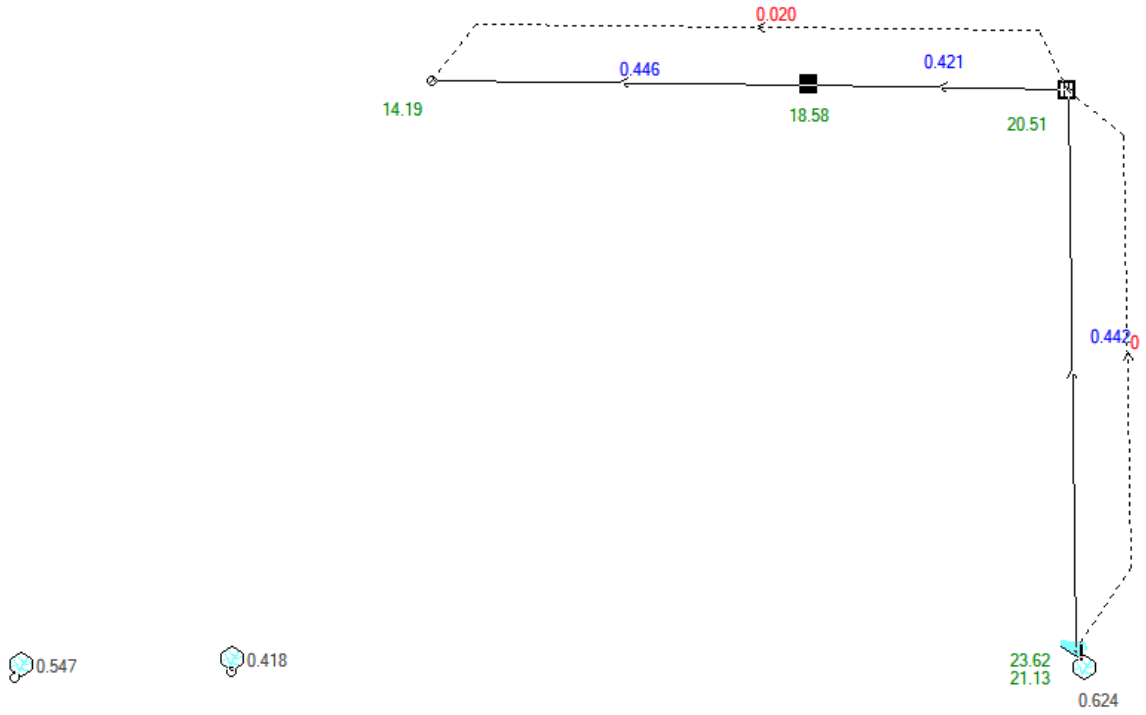


Fig. 12: 100 year major flows for all catchments

The post-developed flows that are generated by the overall catchment can be discharged into the stormwater system (without overloading it), if an onsite detention (OSD) tank is introduced. The overall storage volume of the detention tank is approx. 67m^3. The tank area measures approx. 30m^2 (at the base). The outlet then discharges into a DN375 pipe.

The OSD tank detains and reduces the runoff to the capacity of the existing stormwater system, refer to Table 5. The existing stormwater pipe in the road needs to be upgraded to a DN375 (see current civil documentation for details in Appendix A).

The resulting minor post-developed flows are less than the minor pre-developed flows (0.318m^3/s < 0.354m^3/s). The resulting major post-developed flows are smaller than the major pre-developed flows (0.442m^3/s < 0.547/s). It is proposed to construct the detention tank in the basement of the building. The tank has dual functionality and will function as on site detention (water quantity), but will also treat the stormwater via proprietary stormwater filters (water quality).

	Pre-developed flow generated by historic site (before constr. of the busway 2010, 20% pervious, 80% impervious) [m3/s]	Pre-developed flow generated by current site (after constr. of the busway 2010, 70% pervious, 30% impervious) [m3/s]	Post-developed flow generated by site without detention (100% impervious) [m3/s]	Post-developed flow discharged into stormwater system with On-site detention [m3/s]	Surcharge flow from site into Lamington Ave (surface flow) [m3/s]
Discharge from site for minor storm events (10% AEP, 10y ARI, with OSD)	0.354	0.239	0.416	0.318	0.000
Discharge from site for minor storm events (2% AEP, 50y ARI, with OSD)	0.486	0.358	0.56	0.405	0.000
Discharge from site for major storm events (1% AEP, 100y ARI, with OSD)	0.547	0.418	0.624	0.442	0.020

Table. 5: Site discharge for different storm events

4.3.3 COMPARISON OF DRAINS RESULTS WITH RATIONAL CALCULATION RESULTS

The following Rational Method calculations have been undertaken for the post-developed cases and compared with the DRAINS model results to evaluate the sensitivity of the DRAINS results. The comparison was completed for the post-developed site. The comparison between the DRAINS runoff and the Rational method is shown in Table 6 below.

ARI (YEARS)	POST-DEVELOPED PEAK RUNOFF – RATIONAL METHOD (M^3/S)	POST-DEVELOPED PEAK RUNOFF – DRAINS (M^3/S)
2	0.191	0.261
5	0.290	0.353
10	0.360	0.416
20	0.432	0.48
50	0.534	0.56
100	0.593	0.626

Table 6: Comparison of rational method with DRAINS model for post-developed case of the site catchment

The comparison between the Rational Method and the flows generated by the DRAINS model show that the flows from the Rational Method are on average approximately 2-7% lower than the DRAINS outputs. The DRAINS method therefore provides more conservative results compared to the Rational Method calculations.

5 STORMWATER QUALITY

The proposed development will increase the sites impervious area and subsequently increase the pollutants running off the site. The pollutants will vary between the construction phase and the operational phase of the development. The pollutants anticipated to be encountered are detailed in Table 7.

	CONSTRUCTION PHASE	OPERATIONAL PHASE
Road Areas	- Nutrients - Sediments - Trash and litter	- Heavy metals - Trash and litter - Sediments
Impervious Pavement Areas	- Nutrients - Sediments - Trash and litter	- Gross solids - Trash and litter

Table 7: Anticipated Pollutants During Construction Phase and Operational Phase

The urban runoff which is contaminated with nutrients, sediments and other pollutants adversely impact the downstream catchment. To limit the impact of these pollutants, the WSUD best practice guidelines were adopted. The WSUD guidelines nominate the use of stormwater quality measures such as bioretention basins, grassed swales, proprietary systems etc. Stormwater water quality measures reduce the impact of the contaminated runoff by treating the captured runoff. It is proposed to use water quality measures during the construction phase and operational phase to ensure minimal impact to the downstream catchments.

The increase of impervious area within the development, combined with the steep grade of the site puts it at a high risk of increasing nutrient/pollutant rich runoff. There are usually pollution reduction targets provided by Council/State guidelines that have to be met. The BCC Planning Scheme Policy Chapter 7.9.3 references table B of Appendix 3 of the State Planning Policy (DSDIP 2014) for the target rates.

From Table 3 of the DISDIP, the minimum pollution reductions are:

- 80% Total Suspended Solids Removed
- 60% Total Phosphorus Removed
- 45% Total Nitrogen Removed
- 90% Gross Pollutants (>5mm) Removed

5.1.1 MUSIC MODELLING

A MUSIC model has been developed to simulate the pollutant loads contained in the discharging stormwater runoff from the site. The catchment areas and boundaries are as per the stormwater quantity analysis discussed previously in section 4.0 of this report. The meteorological data set uses the Brisbane City Council (40214) AMO station, ten-year rainfall (1980 to 1990) 6-minute interval file. The mean annual rainfall over the climate period is 1178 mm.

The Mean Potential Evapo Transpiration (mm) (Climate Atlas of Australia) was used as described in the Water by Design's "MUSIC Modelling Guidelines - Version 1.0 - 2010) (see Table 8):

Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
188	146	146	107	74	63	65	84	111	144	171	192

Table 8: Brisbane Mean Evap Transpiration (mm)

MUSIC impervious areas for the models have been based on the site layout (100% impervious). Source node parameters for the model have utilised the standard parameters for Industrial sites as outlined within Water By Design's "MUSIC Modelling Guidelines – Version 1.0 - 2010".

The proposed water quality concept allows for the treatment of the runoff from the roads, hardstand and roof areas. The catchment areas are split between the roof and the hardstand area. It was assumed both areas are 100% impervious.

The treatment train proposes to collect all surface flow from the roofs and all hardstands pit and pipe system. The flows are directed into the on-site detention tank. Before the flows enter the detention tank, they are treated by gully pit baskets, filter cartridges and a rainwater tank.

5.1.2 PROPOSED TREATMENT MEASURES

The proposed treatment train incorporates the use of the following stormwater quality improvement measures for the developed site. The following stormwater quality improvement devices (SQID's) which will suit the characteristic of the proposed development and adapt with the constraints of the site have therefore been proposed:

SQID	**Comments**
Ocean Guard Pit basket	Ocean Guard Pit baskets are sediment filters that are inserted into pits. They are designed to remove gross pollutants, coarse sediment and associated pollutants (Hydrocarbons, metals & nutrients) at high flows.
Ocean Guard StormFilters	Tall 690 StormFilters PSorb are 690 mm high filter cartridges that clean stormwater through a passive filtration system. It improves the quality of stormwater runoff by removing non-point source pollutants, including sediment, oil and grease, soluble metals, nutrients, organics, and trash and debris.
50kL Rainwater tank	A Rainwater storage tank enables the reuse of roof runoff, primarily for irrigation purpose. The main contaminant removal process is the diversion of runoff from roof (impervious) areas to pervious areas (irrigation). The total irrigation demand is estimated as follows: Total landscaping areas = approx. 660m^2 Irrigation demand = 2mm/day (Based on Water by Design's MUSIC Modelling Guidelines Version 1.0-2010 Section 4.2.2) Total irrigation demand = 660 x 0.002 = **1.32kL/day** A detailed re-use analysis needs to be conducted in the detailed design phase to estimate the final rainwater tank size.

Table 9: Stormwater quality improvement devices

Stormwater runoff from all roof areas will be collected internally and discharged into a 50kL rainwater tank. The overflow from the rainwater tank will be connected to the stormwater treatment / detention tank which consists of 4 OceanGuard pit baskets and 8 Ocean protect PSorb Stormfilters (690mm high) or equivalent systems. This tank will be located below the ground level in basement level 2 near the loading dock. The invert level of the stormwater treatment/ detention tank is proposed to be located at RL 21.4m AHD.

All incoming pipes from the roof and the hardstands are connected to the 50kL rainwater reuse tank, with overflows from this tank discharging into the catridge chamber of the 63kL stormwater treatment/ detention tank before discharging to the lawful point of discharge.

The internal drainage details will be provided by the services consultant during the building application submission.

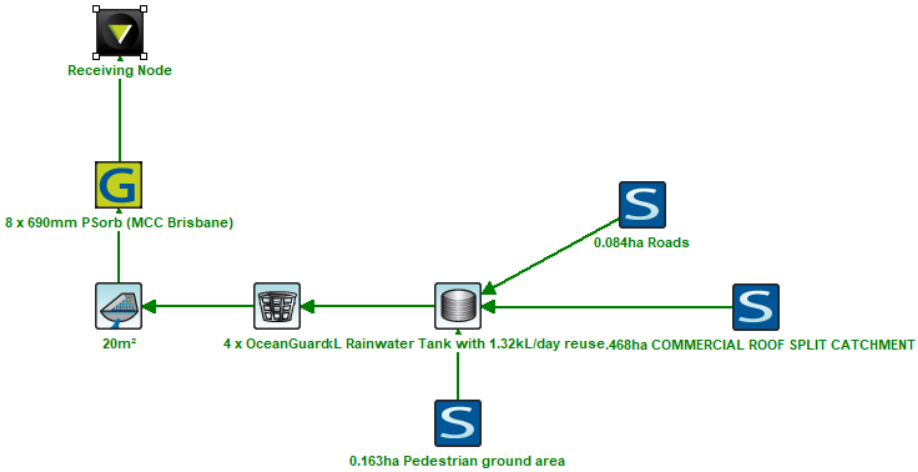
5.1.3 MUSIC RESULTS

The following treatment train is proposed. All surface runoff from the roofs, roads and hardstand will be captured by pits and pipes and directed towards the treatment train. It must be noted that the 63kL detention tank is required (refer Section 4.3.2), however it is not part of the proposed treatment train.

Treatment train:

- 1 x 50 kL Rainwater tank with 1.32kL/day reuse:
- 4 x OceanGuard Pit baskets: (OceanGuard pit baskets are to be installed within OSD tank prior to OceanGuard PSorb Filters)
- 8 x OceanGuard 690mm PSorb Filters:

The figure 13 below is the MUSIC model and the results for the post-development scenario:



Treatment Train Effectiveness - Receiving Node

	Sources	Residual Load	% Reduction
Flow (ML/yr)	7.69	7.21	6.2
Total Suspended Solids (kg/yr)	860	119	86.2
Total Phosphorus (kg/yr)	2.44	0.764	68.7
Total Nitrogen (kg/yr)	24.5	12.2	50.2
Gross Pollutants (kg/yr)	180	0	100

Fig. 13: MUSIC model

The results of the MUSIC model (see Table 10) show that the proposed water quality measures achieve the water quality targets. The treated water then gets discharged into the on-site detention tank.

ELEMENT	WATER QUALITY TARGET (%)	ACHEIEVED WATER QUALITY RATE (%)
Total suspended solids (TSS)	80	86.2
Total phosphorus (TP)	60	68.7
Total nitrogen (TN)	45	50.2
Gross pollutants	90	100

Table 10: MUSIC model results

5.1.4 MAINTENANCE

Maintenance for the SQIDs proposed for the development is to be consistent with the requirements of this report and the manufacturer's recommendations. The general requirement of maintenance during the operational phase will be:

- Ocean Protect StormFilter & OceanGuard:
  - In accordance with the manufacturer's recommendations / owner's manual.
- Rainwater tank:
  - Routine inspection, cleaning and maintenance.

5.1.5 STORMWATER ASSET HAND OVER:

It is intended that the stormwater quantity and quality controls detailed in this document will remain under private ownership and will not become a council asset. Therefore, no further assessment of asset handover is relevant to this site.

6 EROSION AND SEDIMENT CONTROL

6.1 SITE CONTROLS

It is proposed to provide a sedimentation basin to capture the sediments that occur from the disturbed soil during construction. The soil loss of the site and the necessary basin size have been assessed as per the book "Best Practice Erosion & Sediment Control" issued by the International Erosion Control Association (IECA) 2008 (see Appendix C for calculation details).

According to BCC's Erosion Hazard Assessment - June 2014 form, the proposed development is located in a "Medium" risk site with respect to erosion and sediment control. Refer Appendix D for a copy of the completed form. The geotechnical report also classifies the site as "Medium risk" with moderate potential for Erosion (page 7, Geotechnical report). There is a very low risk associated with the surface water flow as the soils exposed to water runoff will be contained within the basement excavation.

A geotechnical assessment was completed for the site by Douglas Partners in April 2016 (see Appendix E). The site can be divided into two halfs. The northern side consists of residual soil and the southern half consists of filling (because of the tunnel). Based on the geotechnical report, the soil both sides can be classified as a mix of silty clay to sandy clay. As it is not clear at what percentage the silt or clay are, a worst-case approach was taken and assumed that the dispersion percentage is at 20%. From this an assumed particle size distribution of 40% sand, 20% silt and 40% clay was adopted. This indicates a soil texture group of "D".

6.2 EROSION RISK ASSESSMENT

Erosion risk assessments have been carried out using the Revised Universal Soil Loss Equation (RUSLE) for each of the construction stages and are shown in the subsequent sections of this report. The RUSLE method will provide a predicted soil loss value which is then used to determine the type of sediment control required.

$$A = R * K * LS * C * P$$

Where:

A = *annual soil loss due to erosion (t/ha/yr)*

R = *rainfall erosivity factor*

K = *soil erodibility factor*

LS = *topographic factor derived from slope length and slope gradient*

C = *cover and management factor*

P = *erosion control practice factor*

RAINFALL EROSIVITY FACTOR

The rainfall erosivity (R-Factor) is constant for the site and therefore used for the calculation of each of the construction stages, it is calculated based on the Bureau of Meteorology (BOM) Intensity-Frequency-Duration (IFD) tables. An annual erosivity factor of **3540** has been calculated (see Appendix D). Silty clay has a K-factor of 0.025 as per table E4 of the IECA Appendix E.

CATCHMENTS

The site can be divided into two catchments. Catchments 1 grades towards Lamington Ave. Catchment 2 grades between Lamington Avenue and Lutwyche Road, towards and existing drop pit.

Fig. 14: ESC Catchments

SUB-CATCHMENT	1	2
Area [m2]	3,370	3,525
Slope Length [m]	105.8	100.9
Slope Gradient [%]	5.9	2.2
Calculated Soil loss [t/ha/yr]	196	57

Table 11: ESC catchment details

AREA LIMIT (M^2)	SOIL LOSS RATE (T/HA/YR)		
	TYPE 1	TYPE 2	TYPE 3
1,000	NA	NA	ALL CASES
2,500	NA	>75	75
>2,500	>150	150	75
>10,000	>75	75	75

Source: IECA (2008)

Table 12: Sediment Control Standard

SITE ELEMENT	ANNUAL SOIL LOSS	AREA	RATIONALISED ANNUAL SOIL LOSS
Sub-Catchment 1	196 t/ha/yr	0.34 ha	66.64 t/yr
Sub-Catchment 2	57 t/ha/yr	0.35 ha	19.95 t/yr
Total		**0.69 ha**	**86.59 t/yr**

Table 13: Rationalised Estimated Soil Losses Due to Erosion

A rational annual soil loss of **86.59 t/yr** due to erosion has been calculated based on the site R-Factor and the inputs (see Table 13). The Sub-Catchment 1 requires Type 1 soil loss measures (sedimentation basin/ settling pond) for sub-catchment 1. Sub-Catchment 2 requires Type 2 soil loss measures, but no sedimentation basin.

A sedimentation basin Type B is required for Sub-catchment 1. The required sedimentation basin size was calculated as per the IECA book (see Table 14).

The size of the Sediment basin Type B is mainly a function of the Jar testing rate (IECA Table B15) which measures the actual sediments to settle. The builder needs to confirm the actual settlement by conducting the Jar test. Based on the Jar testing results the required basin needs to attain a volume in the range of 480m3 to 1069m3.

JAR TESTING SETTLEMENT RATE AFTER 15 MINS [MM]	50	75	100	150	200
Approx. total basin volume [m3]	1069	712	534	484	480

Table 14: Jar Test

The proposed construction consists piling and excavation of the whole site. All runoff from the site will be fully contained within the site. Due to the depth of the excavation, no automatic dosing is required. The builder needs to arrange the dewatering of the site with pumps and appropriate testing. A sediment Basin Type B is required for Sub-Catchment 1, however the shape and location can be as per the builders Erosion and Sediment Control Management plan.

6.3 GENERAL

All erosion and sediment control measures are required to be installed and functional prior to works commencing. The following implementation sequence shall be adopted where practicable with the construction program. Plans shall be updated, and measures moved and reinstated to reflect the progression of the works.

A site based Erosion and Sediment Control Management Plan will be required and implemented under the direct supervision of a Registered Professional Engineer of Queensland. Indicative ESC measures will be required on the detailed design drawings and a final Erosion and Sediment Control Management Plan (ESCMP) shall be prepared by the Contractor as part of the Construction Management Plan for the information of the relevant parties prior to the Pre-start

Meeting. The ESCMP to be generally in accordance with Best Practice Erosion & Sediment Control Document published by International Erosion Control Association (Australasia) 2008.

In addition to the general environmental duty which applies to all persons, it is the contractor's responsibility to implement and maintain all erosion and sediment control measures on site, until all disturbed areas are reinstated.

The contractor is, at all times, responsible for the establishment, management and maintenance of the erosion and sediment control measures, to ensure minimal environmental harm and to comply with Council's standards.

Once the site is stripped, the contractor will need to ensure that sediment is not washed into drains and that the loose dense silty sand and clays are not eroded away and bypass the site. Sediment fencing around the area of works and to direct the flows needs to be provided.

6.4 IMPLEMENTATION SEQUENCE

It is proposed to construct a sediment fence along the boundaries and a Settling Pond in the western corner of the site as per the Civil ESC drawings located in Appendix A. The Settling Pond is to be flocculated and dewatered at appropriate intervals. Rock check dams and water diversion mounds can direct the water into the settling pond and existing runoff area.

It is noted that during the construction of the works, it is the Contractor's responsibility to implement the ESCMP to comply with the requirements of the Environmental Protection Act and Regulations and to provide written evidence of audit inspections on an as needed basis (minimum monthly basis) until all disturbed areas are reinstated / stabilised.

The following fundamental concepts shall form the foundation of the site's erosion and sediment control and should be reflected by the implemented measures.

- Erosion control measures favoured over sediment control devices, any exposed surfaces shall be stabilised as soon as practicable and sediment control devices used as last defence;
- Limit disturbance by only clearing and disturbing areas necessary for works, disturbance should only extend 2-5m from necessary works areas;
- Minimise the extent and duration of disturbance by staging the works. Disturbed areas should be kept to workable areas; and
- Divert all clean upstream stormwater runoff around the site and disturbed areas. Collect all dirty water from work areas for treatment.

6.4.1 PHASE 1 – PRIOR TO WORKS COMMENCING – STRIPPING AND BULK EARTHWORKS

- Prior to any stripping or bulk earthworks on site, all erosion and sediment control measures should be installed and operational.
- Provide a stabilised site access, either wash down area or shake down the device at the construction site entrance and exit to minimise the amount of sediment being tracked off site. It is proposed to provide 2 access points as the specific circumstances warrant an additional access point for bulk earthworks (see Appendix A).
- Sediment fences (or appropriate barrier fencing) are to be installed adjacent to the access point to confine ingress to and egress from the site to the established stabilised point.
- The wash down area/shake down device is to be drained to a suitable sediment capture device such as a sediment fence installed downstream of the construction entry.
- Inlet protection is to be provided to all gully pits, field or kerb inlets on all adjoining roads.
- All 'clean' upstream water is to be diverted from disturbed areas and stockpiles to minimise the amount of water flowing through the site, the amount of sediment mobilised and the amount of water requiring treatment.
- 'No-go' (restricted access) zones are to be established around areas of native vegetation to be retained and any areas which do not require disturbance, to limit the area of exposed soil.

- Earth banks are to be installed at intervals < 80 metres along slope contours to limit slope lengths.
- Sediment fences are to be installed 2-5 metres downstream of all works areas, including along the downstream property boundaries, downstream of batters and stockpiles, prior to stripping and throughout earthworks operations. All sediment fences are to be monitored and maintained throughout the duration of works.
- All nominated sediment basins and sediment traps are to be constructed with appropriately stabilised diversion structures and emergency spillways.

6.4.2 PHASE 2 – DURATION OF WORKS

- Works are to be staged to keep disturbed areas to workable sizes and are exposed for a short a period as practicable.
- All disturbed areas and clearings are to extend no more than 5 metres (preferable 2 metres) from essential works areas to minimise amount of exposed surface. Land outside the essential works areas should remain undisturbed and in its natural condition, ensuring topsoil remains in place. These areas are to be protected by barrier fencing.
- Topsoil is to be stripped and stockpiled for later use on site. Sediment fences should be established downstream of all topsoil stockpiles.
- Any stockpiles remaining on site for more than 10 days must be stabilised. Additionally, all disturbed areas are to be progressively grass seeded and stabilised using mulch, hydroseeding or hardstand to achieve 70% ground coverage within 20 days of inactivity or completion of works (even if works may continue later) for protection against both wind and water erosion.
- During windy and dry weather any unprotected areas are to have sufficient dust control measures implemented including watering, roughening or wind barrier fencing.
- All vehicles departing site shall ensure no sediment is carried or transported off site. Regular inspection of public roads adjacent to the site are to be conducted and any sediment deposits are to be manually removed (not washed down).
- Any vehicle or equipment washing and/or refuelling conducted on site should be conducted in specific bunded areas, away from concentrated flow paths and the stormwater system.

6.4.3 PHASE 3 – FINISHING WORKS & DEFECTS LIABILITY PERIOD

- All erosion and sediment control measures, including sediment fences and inlet traps, are to be maintained until completion of surface finishes including landscaping and turfing and only removed once the site is stabilised.
- At construction completion, all temporary earth structures, including soil stockpiles, are to be track rolled and seeded to achieve 70% strike rate within 20 days.
- Final site landscaping is to be conducted as soon as possible.

7 CONCLUSIONS

This report has reviewed the bulk earthworks, erosion and sediment control, roadworks, stormwater management, sewer reticulation, water reticulation and electrical & communications infrastructure in support of the development application for 53 & 57 Lamington Ave and 612 Lutwyche Rd, Lutwyche QLD.

This report provides details that indicate that the proposed development can be constructed in accordance with the Brisbane City Council guidelines for development and the relevant planning codes considering the proposed use, pending confirmation of QUU external water and sewer infrastructure capacity.

The stormwater modelling with DRAINS shows that including an On-site detention tank (63kL) within the basement can protect the existing stormwater system from being overloaded. MUSIC modelling was undertaken to demonstrate water quality targets are achieved via the use of a 50kL rainwater tank and proprietary products, in accordance with BCC guidelines and State Planning Policy requirements

It is inevitable that development will have an impact of the existing landform and stormwater runoff characteristics based on the:

- Earthworks
- Change of land-use
- Changes in impervious areas;

By providing a safe and efficient design, and implementing appropriate measures during construction and operation of the development, it can be predicted that there will be minimal impact on the existing environment as a result of the proposed development.

It should be noted that the results in this report are limited to use for preliminary assessment purposes only. Transport/traffic impacts were not included in this preliminary assessment as this was out of scope. During the detailed design stages, a further refinement of the modelling based on the detail design of the development will be necessary.