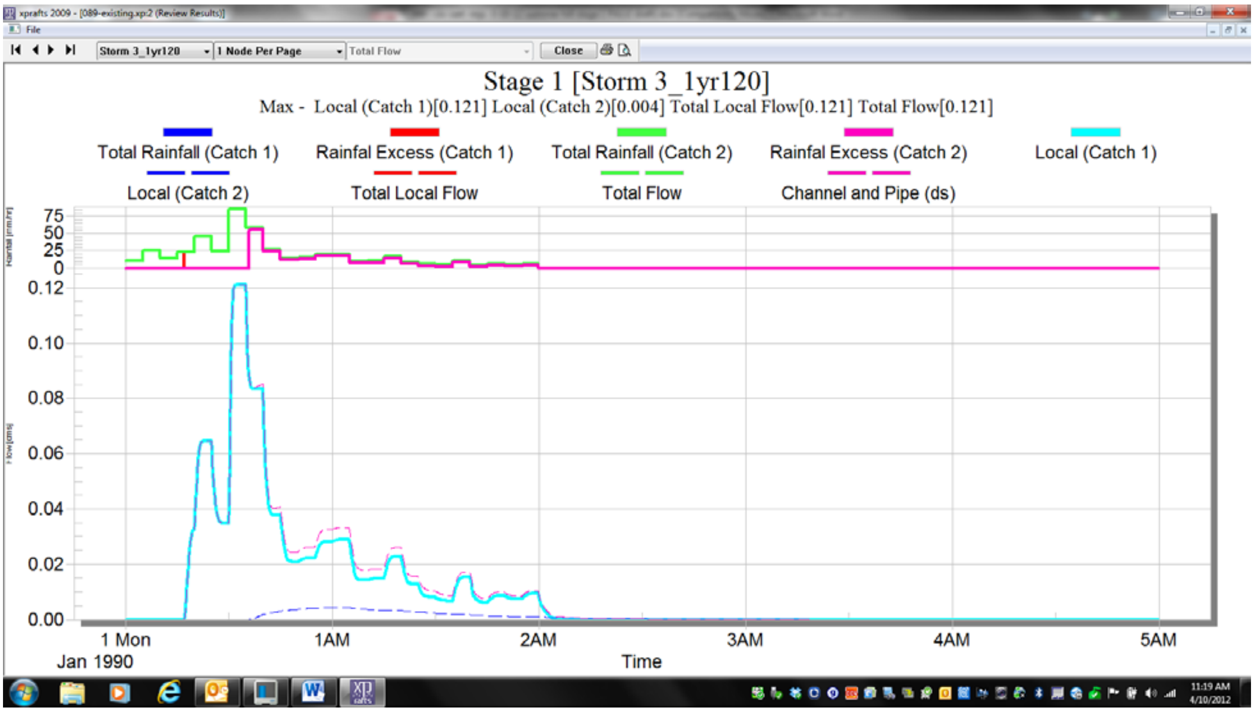

Diagram 1 – Existing Stage 1,1yr ARI 120min Hydrograph

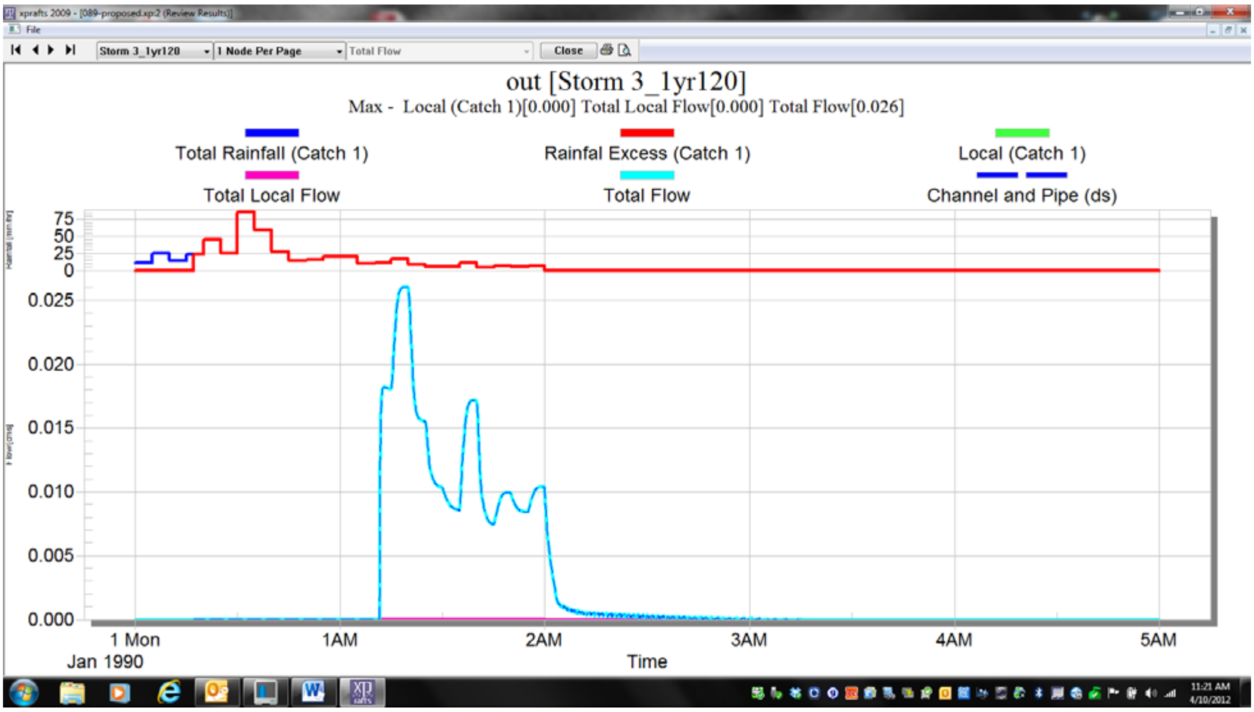

Diagram 2 – Proposed Stage 1,1yr ARI 120min Hydrograph

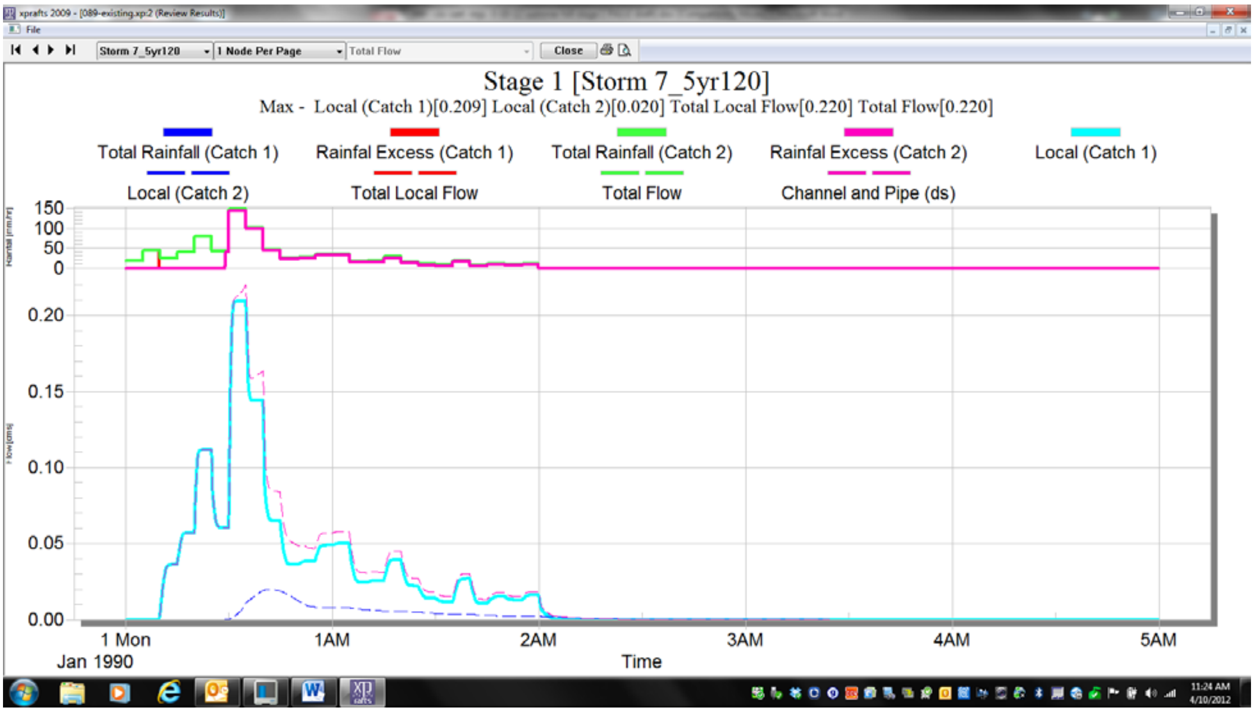

Diagram 3 – Existing Stage 1,5yr ARI 120min Hydrograph

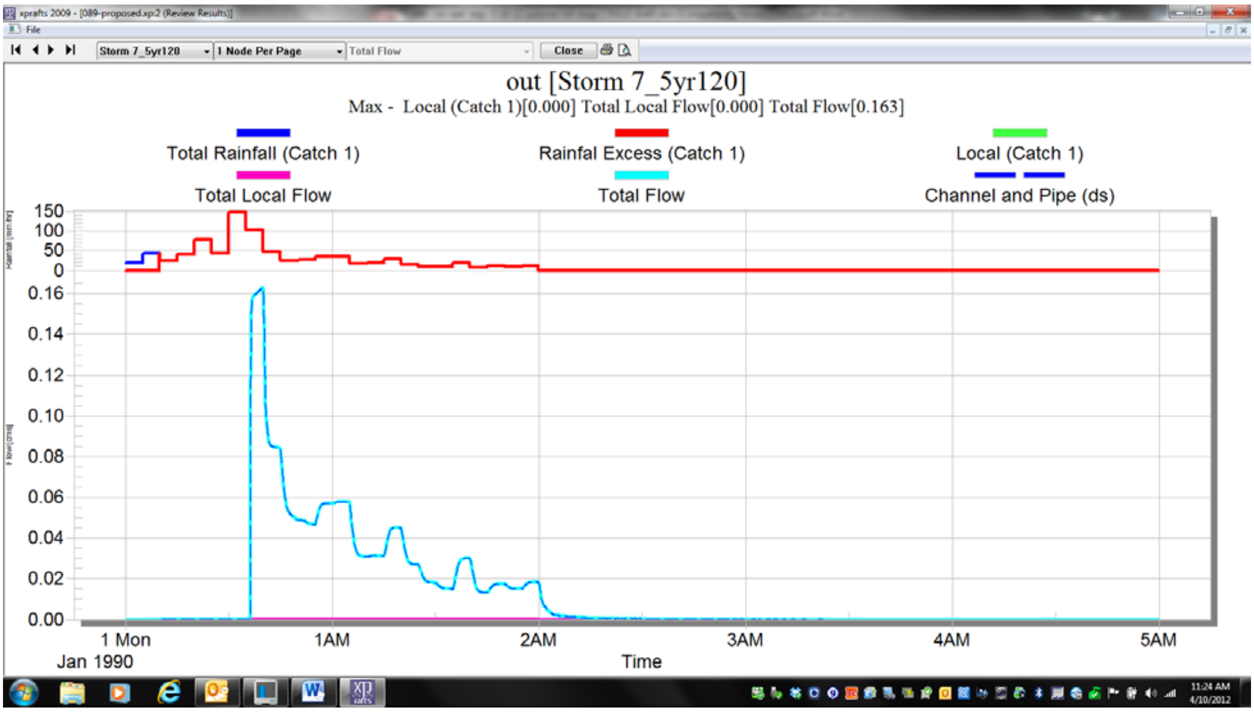

Diagram 4 – Proposed Stage 1,5yr ARI 120min Hydrograph

3 STORMWATER QUALITY

3.1 CONSTRUCTION PHASE

During demolition, bulk earthworks and construction of internal roads and associated infrastructure for Stage 1, sediment and erosion control facilities would be designed and constructed/installed in accordance with the DECC publication "*Managing Urban Stormwater – Soils and Construction*" January 2008 *(i.e. the Blue Book) and* all relevant Council codes/standards.

A sediment and erosion control plan would be prepared for Stage 1 prior to construction (*i.e. prior to issue of Construction Certificate*), outlining the strategies proposed to prevent excessive pollutant loads being exported from the site in runoff and due to wind during and immediately following construction.

A summary of the principle elements of a preferred sediment and erosion control plan for Stage 1 is summarised below:

- Minimising the extent of disturbed surfaces at any one time (*i.e. staging of earthworks etc*);
- Stabilising disturbed surfaces immediately upon completion of works (*i.e. hydromulch or vegetation*);
- Diverting clean runoff around disturbed work areas (*i.e. using earth bunds/diversion mounds/channels*);
- Protecting stockpiles (*i.e. using silt fence, diversion bunds, temporary vegetative cover etc*);
- Implementation of dust control/suppression measures during works(*i.e. perimeter fencing, wind velocity monitoring, cessation of earthworks activities during high wind conditions, watering down disturbed areas, setup of recycled water irrigation sprays etc*);
- Use of sediment basins;
- Use of silt fencing downslope of disturbed surfaces;
- Use of silt socks or equivalent around existing drainage structures;
- Use of rock/hay bale/mulch check dams along designated overland flow paths;
- Use of floating silt curtains /floating booms at the entry points to existing trunk drainage channels;
- Protection of exposed slopes;
- Restriction of vehicle entry/exit points to construction zones;
- Setup of stabilised site access points; and
- Setup of vehicle wash down/wheel wash baths at exit points of disturbed areas.

3.2 POST DEVELOPMENT PHASE

The post development WSUD stormwater management system for Stage 1 will consist of the following elements:

- Use of rainwater storage tank/s (*total volume 100KL)* for capture of roof runoff and reuse in toilet flushing, irrigation, cold water laundry and other non-potable uses;
- Use of bio-retention systems within the internal roads; and
- Installation of a Gross Pollutant Trap (*GPT*) near the outlet of the stormwater line draining Stage 1.

Water quality control will be implemented using a WSUD treatment train approach, the first step of which would be the use of rainwater tanks on an allotment group scale. The rainwater tanks will act to intercept and re-use rainwater for toilet flushing, irrigation and other non-potable uses. The reduction in stormwater runoff volume achieved through re-use will indirectly result in a reduction in pollutant load exported to the catchment as well as minimising potable water demand for the development. The next steps of the treatment train approach will be treatment of road runoff with bio-retention systems and then finally within a GPT at the discharge point into Hawthorne Canal.

The software package developed by the CRC for Catchment Hydrology termed "MUSIC" (*Model for Urban Stormwater Improvement Conceptualisation*) was used to assess the effectiveness of the proposed "*treatment train*".

Details of the MUSIC modelling exercise (*including results*) are included at **Appendix C** and summarised in the following sections.

3.3 WATER QUALITY OBJECTIVES

The water quality guidelines recommended by DECCW, SWC and Ashfield Council are presented below in **Table 5**. These same objectives will be adopted for the site as a whole, including Stage 1.

Table 5 – Water Quality Targets (*DECCW, SWC and Council*)

	WATER QUALITY % reduction in pollutant load			
	Gross Pollutants GP (> 5mm)	**Total suspended solids (TSS)**	**Total Phosphorus (TP)**	**Total Nitrogen (TN)**
Stormwater Management Objective	90	85	60	45

3.4 ASSESSMENT METHODOLOGY (*MUSIC*)

To ensure the objectives outlined in **Section 3.3** can be achieved, a MUSIC model has been established for the entire development site, including Stage 1. Because the treatment train for the site is an integrated system, both the performance of Stage 1 and the entire site was assessed for this report.

MUSIC is a continual-run conceptual water quality assessment model developed by the Cooperative Research Centre for Catchment Hydrology (*CRCCH*). MUSIC can be used to estimate the long-term annual average stormwater volume generated by a catchment as well as the expected pollutant loads. It is able to conceptually simulate the performance of a group of stormwater treatment measures (*treatment train*) to assess whether a proposed water quality strategy is able to meet specified water quality objectives.

MUSIC was chosen for this investigation because it has the following attributes:

- it can account for the temporal variation in storm rainfall throughout the year;
- modelling steps can be as low as 6 minutes to allow accurate modelling of treatment devices;
- it can model a range of treatment devices;
- it can be used to estimate pollutant loads at any location within the catchment; and
- it is based on logical and accepted algorithms.

Note that the Stage 1 MUSIC modelling has utilised the same site wide MUSIC model detailed in our March 2011 report but has been updated to align with the latest version of MUSIC and to include more details related to Stage 1.

3.4.1 Rainfall

Rainfall data adopted in the MUSIC modelling exercise was sourced from the Bureau of Meteorology (*BOM*). A rainfall range over a number of years (*1996 to 1999 inclusive*) was selected to exceed the annual average for the region. In addition, a mix of dry, average and wet years was included in the selected range.

3.4.2 Evaporation

Monthly areal Potential Evapotranspiration values were obtained for the site from the 'Climate Atlas of Australia, Evapotranspiration' (*Bureau of Meteorology, 2001*) and are shown in **Table 6**.

Table 6 – Adopted Monthly Areal Potential Evapotranspiration

Month	Areal Potential Evapotranspiration (mm)
January	170
February	145
March	130
April	80

Month	Areal Potential Evapotranspiration (mm)
May	61
June	45
July	45
August	60
September	90
October	130
November	151
December	165

3.4.3 Sub Catchment Areas

The total site was broken into a number of sub catchments in accordance with the proposed development layout and proposed treatment measure locations. Details of the sub catchment area characteristics are provided in **Table 7**. Stage 1 areas are highlighted in red.

Table 7 – Sub catchment Characteristics

Sub catchment Name	Area (m^2)	% Impervious
Roof-4 (Stage 1)	2,000	100
Non Roof-4 (Stage 1)	1,300	70
Road-4 Plus BRS2 (Stage 1)	640	80
Main Rd Plus BRS1(Stage 1)	560	80
Perv Balance	8,200	45
Roof-1A	1,920	100
Road-1A	630	100
BRS3	135	0
Roof-2AB	960	100
Non Roof-23	1,200	70
Roof-3ABCD	1,490	100
Road-23	1,880	85
Non Roof-5AB	475	70
Roof-5AB	690	100
Roof-5CD	1,235	100
Non Roof 5CD	1,687	70
TOTAL	**25,002**	**75%av**

3.4.4 Soil Data and Model Calibration

For this study the default MUSIC soil properties have been adopted. This data is summarised in **Table 8.** The resultant post developed volumetric run-off co-efficient for the site (*before treatment*) was equal to 0.78. This is within the anticipated range for the sites proposed impervious fraction.

Table 8 – Adopted Soil Data

	Units	Post Development	Pre Development
Impervious area parameters			
Rainfall threshold	mm/day	1.0	1.0
Pervious area parameters			
Soil storage capacity	mm	150	150
Initial storage	% of capacity	25	25
Field capacity	mm	50	50
Infiltration capacity coefficient – a		50	50
Infiltration capacity coefficient – b		2	2
Groundwater properties			
Initial depth	mm	50	50
Daily recharge rate	%	0.65	0.65
Daily base flow rate	%	0.85	0.85
Daily deep seepage rate	%	0	0

3.4.5 Adopted EMC Values

The EMC values contained in **Table 9** have been adopted in the MUSIC model. These values were determined by the CRCCH following an extensive literature review by Duncan et al 1999, drawing on data from throughout Australia, but particularly from studies within NSW.

It is important to note that all of these values are the 'default' values used within MUSIC.

Table 9 – EMC Values

	Storm Flow						**Base Flow**					
	TSS		**TP**		**TN**		**TSS**		**TP**		**TN**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Land use	*(all values expressed as log_{10} mg/l)*											
General urban Residential Industrial Commercial	**2.20**	***0.32***	**-0.45**	***0.25***	**0.42**	***0.19***	**1.10**	***0.17***	**-0.82**	***0.19***	**0.32**	***0.12***
Forest/Natural	**1.90**	***0.20***	**-1.10**	***0.22***	**-0.075**	***0.24***	**0.9**	***0.13***	**-1.50**	***0.13***	**-0.14**	***0.13***

*Rural EMC values taken from Chapter 2 – Review of Stormwater Quality and Runoff, CRC for Catchment Hydrology, Oct.2003

3.5 PROPOSED TREATMENT SYSTEM

An illustration of the constructed MUSIC network for the site as a whole and Stage 1 are contained at **Diagrams 5 and 6** respectively.

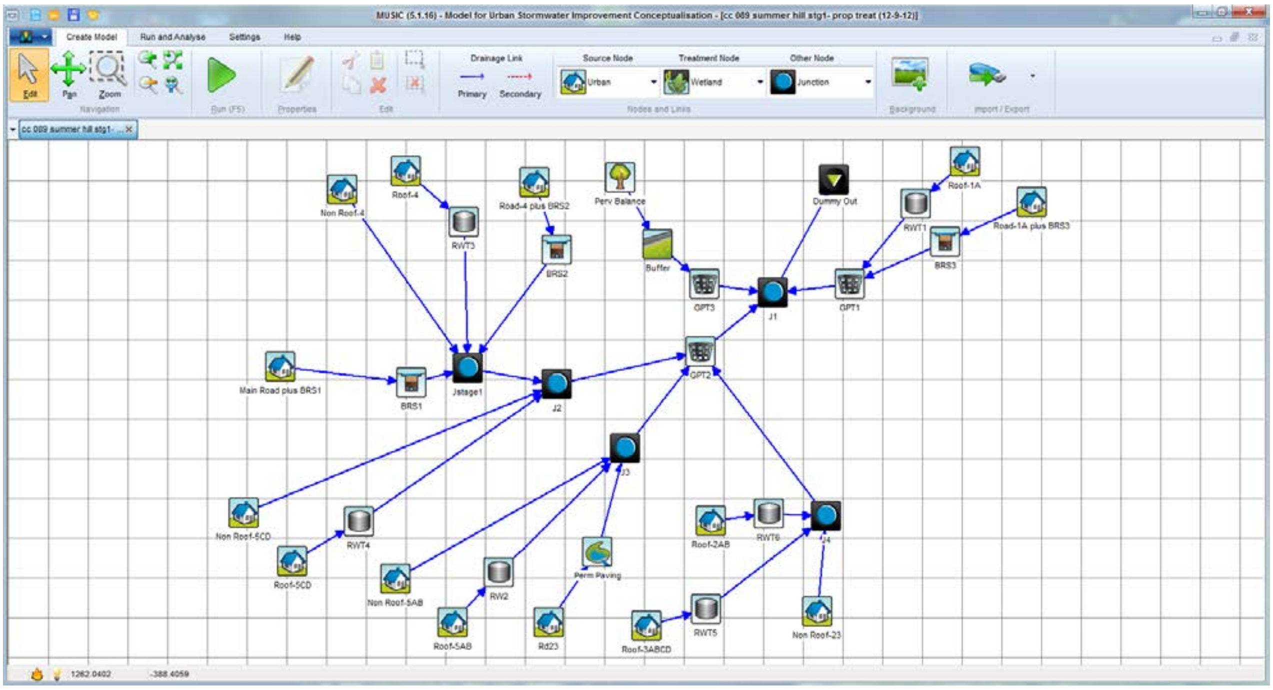

Diagram 5 - Post Development MUSIC Network Diagram (Site Wide)

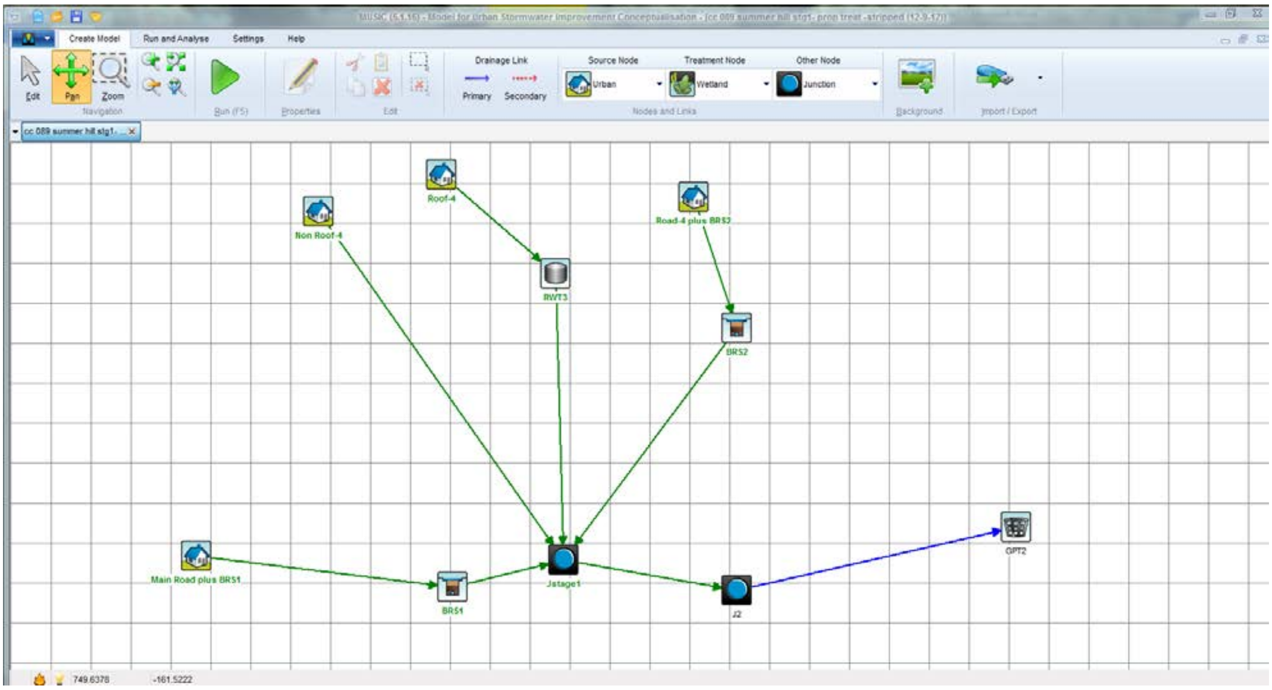

Diagram 6 - Post Development MUSIC Network Diagram (Stage 1)

For Stage 1 the proposed WSUD treatment measures will consist of rainwater tanks connected to non-potable uses within the habitable dwellings, bio retention swales within the roadways and an end of line gross pollutant trap.

For the remainder of the site a selection of commonly adopted best practice WSUD measures that were deemed to be suitable for this application were utilised. More detailed assessment for the remainder of the site stages may lead to revision of these overall measures.

An illustration of the treatment train Master plan for the overall site is contained at **Appendix D.**

3.5.1 Rainwater Tanks

Rainwater tanks indirectly reduce pollutant load by collecting and storing rainwater for reuse in non-potable applications. Furthermore, rainwater tanks will assist in the reduction of potable water demand. For this site we have assumed adoption of a modest storage volume and reuse rate as summarised below:

	Storage V(KL)	***Daily Reuse Demand (KL/d)***
• Building 1A (*assume 60 res. apartments*)	125	8.1
• Buildings 4A,B & C (Stage 1)	100	5.0
• Buildings 5C,D & E (*assume 30 res. Apt*)	125	4.0
• Buildings 5A&B (*assume 100 res. Apt.*)	250	13.5
• Buildings 3 D,C,B & A (*assume 120 res. Apt.*)	250	16.2
• Buildings 2A&B (*assume 10 res. Apt*)	25	1.35

3.5.2 Gross Pollutant Traps (GPTs)

A GPT is proposed to be constructed as part of Stage 1, at the main discharge point from the western part of the site into Hawthorne Canal. Based on the size of the total sub catchment draining to this line the GPT will be a Rocla CL1350 or equivalent treating a minimum of the 3 month ARI peak flow (*approx. 90% of the annual flow volume*).

Gross Pollutant Traps or GPT's are a form of primary treatment designed to capture litter, debris, and coarse sediment. While the pollutant capture efficiency of various traps may vary from model to model, the following generic capture rates have been adopted:

• gross pollutants	majority;
• total suspended sediments	up to 85%;
• total phosphorous	up to 30%; and
• total nitrogen	10%.

For this site we have assumed that all developable areas would be served by two primary gross pollutant traps located near the two proposed piped drainage outlets into Hawthorne Canal and litter baskets would be installed in all pits unable to drain to the proposed GPT's (*refer to **Appendix D***).

3.5.3 Bio-retention Systems

Bio-retention systems typically consist of a swale or above ground depression containing landscaping of native grasses, shrubs and trees underlain by an infiltration area and associated under drain. A typical bio-retention swale consists of 150mm sandy loam mixed topsoil, 1.0m filter media such as sandy loam, 150mm gravel transition layer under the filter media and subsoil drain at the base to collect filtered water through the media. The primary treatment mechanisms are detention/settling at the surface, take up of nutrients by plants, filtering treatment through the media and biological treatment from algal growth on the filter gravel.

For this site we have assumed adoption of a number of bio-retention systems as illustrated in **Appendix D** and summarised below in **Table 10**.

Two of the three bio-retention systems proposed to be constructed for the site are located in Stage 1 (*highlighted red in **Table 10***).

Table 10 – Assumed Configuration of Bio-Retention Systems

Inlet Properties	**BRS1**	**BRS2**	**BRS3**
Low Flow By-Pass (m^3/s)	0	0	0
High Flow By-Pass (m^3/s)	1	1	1
Storage			
Extended Detention Depth	0.25	0.25	0.25
Surface Area (m^2)	100	70	135
Seepage Loss (mm/hr)	10	10	10
Infiltration			
Filter Area (m^2)	90	65	67.5
Filter Depth (m)	1	1	1
Filter Particle Effective Diameter (mm)	5	5	5
Saturated Hydraulic Conductivity (mm/h)	100	100	100
Depth Below Underdrain Pipe (%)	5	5	0
Outlet			
Overflow Weir Width (m)	2	2	2

3.5.4 Permeable Paving

No permeable paving systems are proposed within Stage 1, however bands of permeable paving are proposed along the two internal roads at the upper end of the site.

This permeable paving will treat the road surface and immediately adjoining footpath areas only. The bands will be similar to raised thresholds used to slow traffic only instead of being raised they will be slightly depressed below the surrounding finished surface level of the road (*i.e. the opposite to a raised threshold*). In this way they will capture and treat locally generated road runoff.

The permeable paving will be underlain by a no-fines base course and underdrain system to collect treated runoff.

The proposed area of permeable paving is equivalent to approximately 25% of the total road catchment area.

The permeable paving treats runoff by deposition of fines at the surface and filtering of fines and nutrients through the permeable base-course.

The assumed properties of the proposed permeable paving are summarised below:

- Low flow bypass — 0 m^3/s;
- High flow bypass — 0.05 m^3/s;
- Depth to overflow — 0.2m;
- Infiltration rate — 25mm/h;
- Overflow weir — 20m.

3.5.5 Vegetated Buffer Strip

No vegetated buffer strips are proposed within Stage 1, however a large vegetated buffer area is proposed to treat the local pervious catchment near the lower end of the site. The buffer strip will be landscaped with a dense planting of species designed to act as a barrier to flow. The total area of the proposed buffer strip is approximately 50% of the “Perv Balance” sub catchment. The buffer strip will only treat locally generated runoff prior to it discharging/sheeting into Hawthorne Canal.

The vegetated buffer strip treats runoff by and filtering/deposition of fines and take up of nutrients.

For the purposes of the MUSIC model we have assumed the impervious fraction for the catchment draining to the buffer strip is approximately 45% and is subjected to a seepage loss of 10mm/h.

3.6 MUSIC MODELLING RESULTS

The post development MUSIC modelling results are summarised in **Tables 11 and 12**. **Table 11** presents the results for the overall site, whilst the Stage 1 results are contained in **Table 12**.

The results presented in **Tables 11 and 12** illustrate the following:

- Implementation of WSUD features as proposed readily allows achievement of the stated objectives both for Stage 1 and the site as a whole; and
- Proposed roof water capture and reuse provides a substantial effect on reducing the quantity of flows discharging from the site (*Total annual flow reduced by up to 49%).*

Table 11 – MUSIC MODELLING RESULTS (Site Wide)

Music model	Location	Annual Flow and Pollutant Load Results				
		Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	GP (kg/yr)
Developed (With Treatment)						
	All Source Nodes	27.3	4,690	8.93	65.0	648
	Residual Load at Outlet	14.2	258	2.49	26.6	5.79
% Treat Train Effectiveness		**48.0%**	**95.0%**	**72.0%**	**59.0%**	**99.0%**
Achieve Objectives			>85%	>60%	>45%	>90%
			Yes	Yes	Yes	Yes

Table 12 – MUSIC MODELLING RESULTS (*Stage 1*)

Music model	Location	Annual Flow and Pollutant Load Results				
		Flow (ML/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	GP (kg/yr)
Developed (With Treatment)						
	All Source Nodes	5.3	1,110	2.19	15.1	127
	Residual Load at Outlet	3.1	66.2	0.701	7.2	0.89
% Treat Train Effectiveness		**41.5%**	**94.0%**	**68.0%**	**52.4%**	**99.3**
Achieve Objectives			>85%	>60%	>45%	>90%
			Yes	Yes	Yes	Yes

3.7 MAINTENANCE OF WATER QUALITY CONTROL MEASURES

To maintain effectiveness, a maintenance regime would be required for all proposed treatment measures in Stage 1. This would typically consist of the following:

- Periodic (*6 monthly*) inspection and removal of any gross pollutants & coarse sediment that is deposited in the bio-retention systems and replacement of vegetation as necessary;
- Periodic (*3 monthly*) and episodic (*post storm greater than 1 yr ARI*) inspection and if required removal of trapped pollutants from all GPTs/litter baskets; and
- Periodic (*annually)* inspection (*and flushing if required*) of the bio-retention systems.

4 STORMWATER DRAINAGE CONCEPT PLAN

The elements of the proposed stormwater drainage concept plan for Stage 1 are illustrated in **Figures 1 and 2** and summarised as follows:

- The initial phases of the SDCP for Stage 1 have a significant emphasis on source control;
- All roof water is firstly captured by rainwater tanks and then reused internally in all habitable dwellings for toilet flushing, garden irrigation, car washing and laundry cold water;
- Two bio-retention swales are proposed to directly treat the majority of road runoff within Stage 1;
- Raised inlet grates will be installed within the swales to provide an extended detention depth of 0.25m;
- Overflow from the swales will spill into the raised grates and join with the trunk drainage system;
- The trunk drainage line for Stage 1 and the Smith Street augmentation will run along side or directly beneath the swales;
- Overflow from the rainwater tanks, bio retention swales and the majority of other pervious surfaces on site is directed to the trunk drainage system for Stage 1;
- A minor/major storm drainage philosophy has been adopted for Stage 1;
- A 20yr ARI capacity trunk drainage line will convey flows to an outlet into Hawthorne Canal. Flows in excess of the 20yr ARI up to the 100yr ARI will be safely conveyed aboveground (*i.e.* $d \times v < 0.4$) within the internal roads/overland flow paths;
- A GPT will be installed within the pipe drainage system to screen litter and coarse sediments;
- Additional inlet pits are proposed in Smith Street to reduce the quantity of 100yr ARI overland flow currently generated by the Smith Street branch;
- The trunk drainage system serving Stage 1 has also been sized to cater for both the Smith Street Augmentation works and connection of future upstream stages within the Summer Hill Flour Mill site; and
- The trunk drainage outlet into Hawthorne canal will be designed to minimise any localised hydraulic impact. The location of the outlet has been selected to streamline with the existing channel flows. It is intended that the new outlet will not extend into the existing channel flow area. The new outlet is likely to be higher than the existing channel invert and is proposed to be constructed of sandstone or similar to give a natural appearance.

5 INTEGRATED WATER MANAGAMENT

A detailed account of the ESD strategy for the proposed development over the entire Summer Hill site is provided in the ARUP report titled "*Ecologically Sustainable Development Report*" Issue 2, March 2011.

This same ESD strategy is proposed for Stage 1.

The water management components of the ESD strategy are summarised as follows:

- Rainwater capture from all residential roof areas, storage in tank/s totalling 100KL located in the basement space and recycled on site for
    - Landscape irrigation;
    - Wash down areas (*plant rooms*, *car wash areas*);
    - Toilet flushing and other non-potable uses;
- Landscaping will be water sensitive;
    - Native / low water requirement plants;
- Stormwater runoff from the site will be moderated by soft landscape elements ;
- The sewerage will be a standard gravity feed arrangement;
    - Reduced effluent flows by use of low flow fixtures and fittings;
- The kitchens and bathrooms will have water efficient fittings including;
    - 3 star (*minimum*) showerheads, taps ;
    - Low flush toilet;
    - Water efficient dishwasher.

The ESD strategy target for water is equivalent to that required by BASIX, which means a 40% reduction in water consumption will be achieved compared to the average NSW dwelling.

Based on the ESD strategy for Stage 1 over 90% of the catchment will either be captured for reuse or detained and treated in bio-retention systems before being discharged into Hawthorne Canal.

Wastewater generated by the development will be reduced compared to the average NSW dwelling. Blackwater treatment is not proposed. Discharge of wastewater will be to the nearby Sydney Water infrastructure.

A recycled effluent connection is currently not available to the site nor is it likely to be available in the near future due to the established density of the surrounding suburbs. Based on this, a third pipe (*ie to accommodate some future recycled water connection*) is not proposed for the subject site.

Potable water will be supplied to the site by Sydney Water via nearby water mains. However note that the proposed WSUD strategy will minimise the size of potable water infrastructure and the demand on this limited resource.

6 INFRASTRUCTURE MANAGAMENT PLAN

The proposed rainwater tanks, bio retention systems, GPT and drainage system will be managed onsite as part of strata or community title arrangement. A recommended maintenance regime is contained in **Section 3.7**.

Connection of the proposed trunk drainage infrastructure to Hawthorne canal will be undertaken in accordance with the requirements of Sydney Water Corporation (*SWC*). The location of the outlet has been selected to streamline with the existing channel flows. It is intended that the new outlet will not extend into the existing channel flow area. The new outlet is likely to be higher than the existing channel invert and is proposed to be constructed of sandstone or similar to give a natural appearance

Hawthorne canal *(other than the new drainage connection*) will remain unaffected by the proposed development. New safety fencing will be installed around the perimeter of the canal to ensure no unauthorised access into SWC controlled land.

Access will be provided to permit SWC to gain entry to the canal for maintenance purposes.

7 CONCLUSIONS

The conclusions from this study are provided below.

- A suite of WSUD treatment measures are proposed as part of the development utilising a treatment train approach to achieve best practice outcomes in terms of sustainability and stormwater quality. Overall, the development of Stage 1 will lead to a reduction in gross pollutants, nutrients and sediment that exceeds the minimum requirements specified by Sydney Water. Considering the past industrial use of the site this will result in a marked improvement in water quality conditions experienced downstream of the site;
- Stormwater detention is not required for the development due to its proximity to Hawthorne Canal and the benefit for the overall catchment of early release of flows from the site. Hydrological modelling has been completed to confirm nil impact compared to existing conditions;
- A stormwater drainage concept plan has been developed for the subject site that is in accordance with best practice and the requirements of Ashfield Council. The SDCP minimises nuisance flooding by conveying flows below the surface in all storm events up to and including the 20yr ARI. It also minimises flood hazard in major storm events by reducing the extent of overland flow generated by the Smith Street branch and safely conveying site generated 100yr flows within the internal roadways;
- All elements of the water cycle have been considered in development of the integrated water management plan for the proposed development. Reuse of roof runoff and treatment of surface runoff, along with implementation of water efficient plumbing fixtures and use of drought tolerant landscaping provide both water quality benefits and a significant reduce in potable water demand compared with the NSW average; and
- An infrastructure management plan has been developed to ensure the sites water infrastructure is maintained and continues to operate to its intended design. Stage 1 is of the Summer Hill site is not expected to have any significant impact on existing SWC trunk drainage infrastructure (*ie in terms of both capacity and functionality*).

8 REFERENCES

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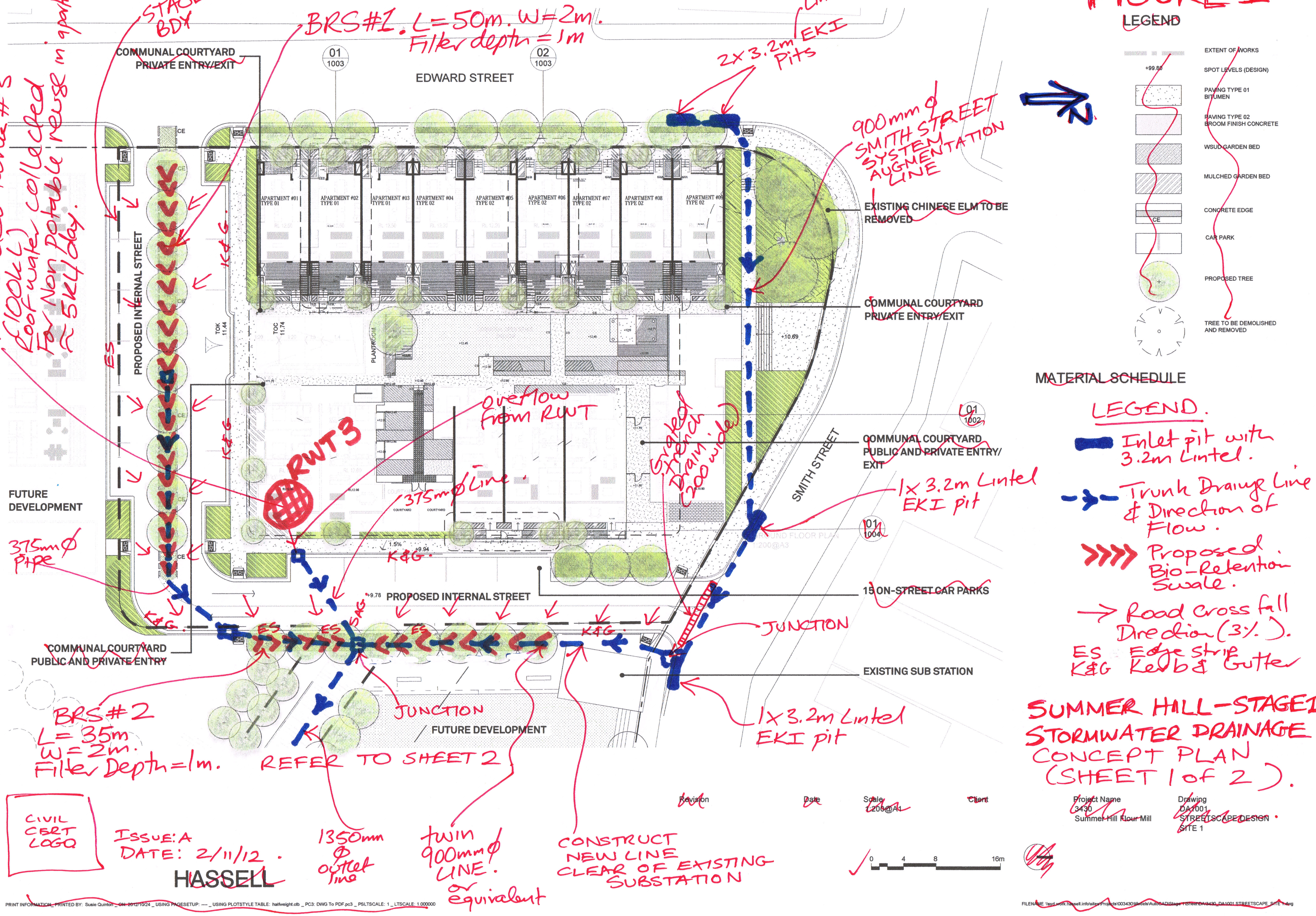
"*NSW Climate Impact Profile – The Impacts of Climate Change on the Biophysical Environment of NSW*" DECCW NSW, June 2010

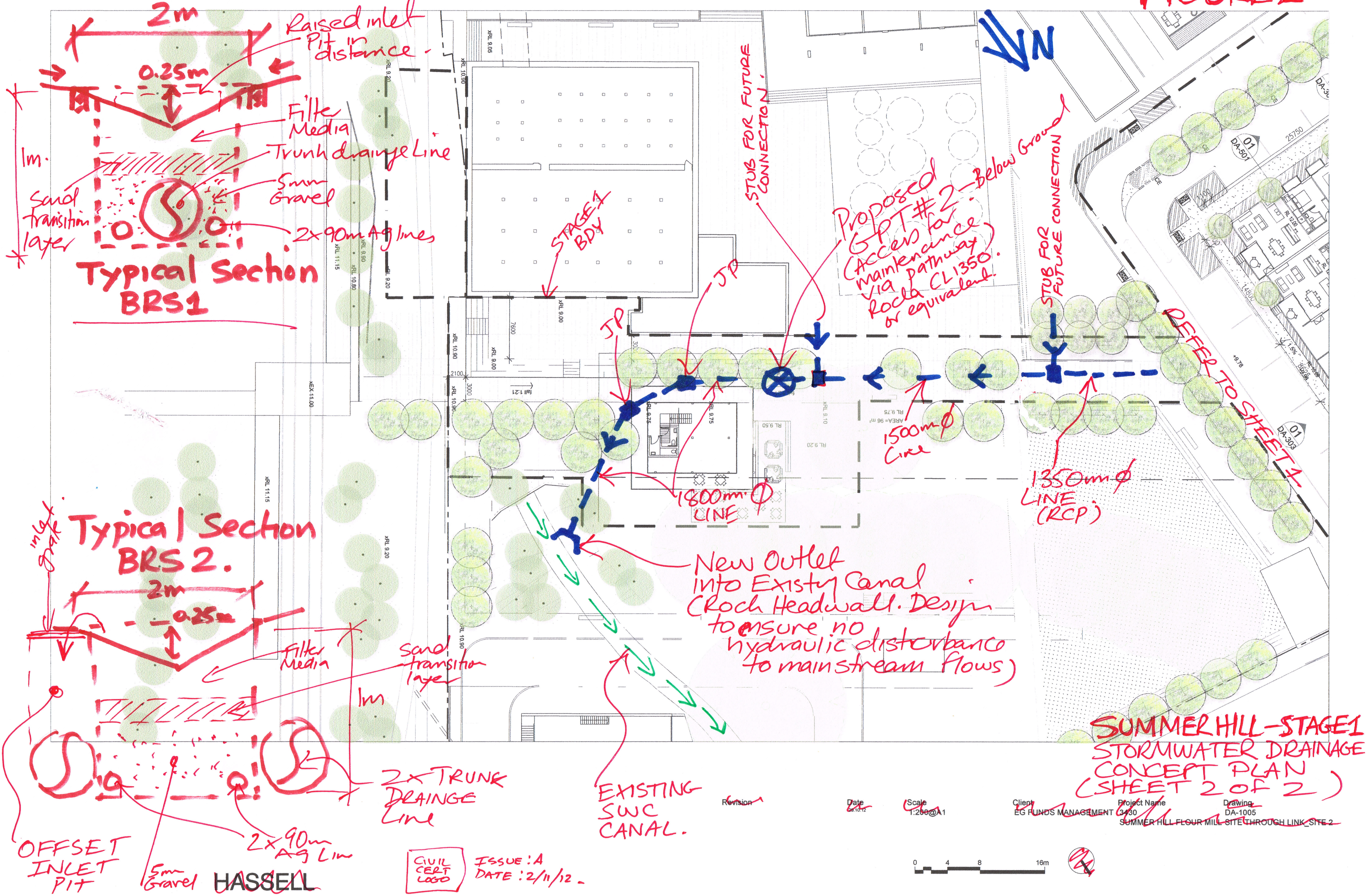
FIGURES

FIGURE 1



LEGEND
EXTENT OF WORKS
SPOT LEVELS (DESIGN)
PAVING TYPE 01 BITUMEN
PAVING TYPE 02 BROOM FINISH CONCRETE
WSUD GARDEN BED
MULCHED GARDEN BED
CONCRETE EDGE
CAR PARK
PROPOSED TREE
TREE TO BE DEMOLISHED AND REMOVED
MATERIAL SCHEDULE
LEGEND.
Inlet pit with 3.2m Lintel.
Trunk Drainage Line & Direction of Flow.
Proposed Bio-Retention Swale.
Road cross fall Direction (3%).
ES Edge strip
K&G Kerb & Gutter
EDWARD STREET
SMITH STREET
PROPOSED INTERNAL STREET
COMMUNAL COURTYARD PRIVATE ENTRY/EXIT
COMMUNAL COURTYARD PUBLIC AND PRIVATE ENTRY/EXIT
COMMUNAL COURTYARD PUBLIC AND PRIVATE ENTRY
EXISTING CHINESE ELM TO BE REMOVED
15 ON-STREET CAR PARKS
EXISTING SUB STATION
FUTURE DEVELOPMENT
PLANTROOM
STAGE 1 BDY
BRS#1. L=50m. W=2m. Filter depth = 1m
2x3.2m EKI Pits
Lintel
900mm Ø SMITH STREET SYSTEM AUGMENTATION LINE
1x 3.2m Lintel EKI pit
Grated Trench Drain (200 wide)
overflow from RWT
RWT3
375mm Ø Line
375mm Ø Pipe
Rainwater Tank #3 (100KL) Roofwater collected for Non Potable reuse in apartments ≈ 5KL/day.
JUNCTION
BRS#2 L=35m W=2m. Filter Depth=1m.
REFER TO SHEET 2
1350mm Ø outlet line
twin 900mm Ø LINE. or equivalent
CONSTRUCT NEW LINE CLEAR OF EXISTING SUBSTATION
SUMMER HILL-STAGE 1 STORMWATER DRAINAGE CONCEPT PLAN (SHEET 1 of 2).
CIVIL CERT LOGO
ISSUE: A DATE: 2/11/12.
HASSELL
Revision
Date
Scale 1:200@A1
Client
Project Name 3430 Summer Hill Flour Mill
Drawing DA1001 STREETSCAPE DESIGN SITE 1

FIGURE 2



SUMMER HILL - STAGE 1
STORMWATER DRAINAGE CONCEPT PLAN (SHEET 2 OF 2)

Revision	Date	Scale	Client	Project Name	Drawing
		1:200@A1	EG FUNDS MANAGEMENT	3430 SUMMER HILL FLOUR MILL SITE THROUGH LINK_SITE 2	DA-1005

0 4 8 16m

CIVIL CERT LOGO

ISSUE : A
DATE : 2/11/12.

HASSELL

APPENDIX A - CV

Civil Certification
Accredited Certifiers
Civil Engineering
ABN 87 532 718 229
0412 264 237

Michael J Shaw
BE MIEAust CPEng NPER

Principal
Civil Certification

Resume

1. SUMMARY

Michael is a senior civil engineer with over 18 years experience in the fields of civil engineering, road design, drainage, hydrology, stormwater management and urban infrastructure design. He operates his own business specialising in private certification and stormwater management. Michael has worked on many civil design projects ranging from development of large scale strategic masterplans to detailed design of stormwater management facilities and urban infrastructure for residential subdivisions. His expertise lies in solving complicated drainage problems, water sensitive urban design (*WSUD*), flooding, detailed civil design, understanding the local government approvals process and managing multidisciplinary teams. Michael's experience covers all facets of civil engineering for urban development from due diligence through to approvals, detailed design, superintendency and certification. He has also provided expert advice to the Land and Environment Court with relation to drainage and stormwater quality issues.

2. EXPERIENCE

Positions held -& Location

Oct 2010 – Present	▸ Principal, Civil Certification, Sydney, NSW, Australia
April 2008- Sept 2010	▸ Manager, Urban Infrastructure, Environment Group - Worley Parsons, Sydney, NSW, Australia.
Aug. 2007- March 2008	▸ Principal Engineer – Urban Infrastructure - Worley Parsons incorporating Patterson Britton & Partners, Sydney, NSW, Australia;
Nov. 1997- Jul. 2007	▸ Senior Associate – Urban Infrastructure - Patterson Britton & Partners, Sydney, NSW, Australia;
Aug. 1996- Oct 1997	▸ Water Resources Engineer – Willing & Partners, Sydney, NSW, Australia;
Feb. 1991- Aug. 1994	▸ Design Engineer, Development Engineer, Investigation Engineer & Survey Assistant – Ryde City Council, Sydney, NSW, Australia.

Standout Projects

▸ ***Stormwater Management Strategies(SMS)***

-Port Jackson South Stormwater Management Plan *(2,870ha catchment*);
-Drummoyne Council Stormwater Quality Strategy *(830ha catchment*);
-Lake Illawarra South Stormwater Quality Strategy *(1,548ha catchment*);
-Elliot Lake Stormwater Quality Strategy *(1,220ha catchment*);
-Scotland Island SMS *(53ha catchment*);
-Corks Lane Milton, DA Stage SMS (*150 lot residential subdivision*);
-Pasadena, Church Point, DA Stage Stormwater Management and Reuse Strategy (*mixed use dev.*);

-Yallambee Ave West Gosford, DA Stage SMS *(100 lot residential subdivision*)

-CSIRO Greystanes, Employment Lands SMS *(60ha industrial site*);

-Warriewood Valley, Sector 3, Rezoning Stage SMS *(130 lot residential subdivision*);

-Warriewood Valley, Sector 8, Rezoning to Subdivision Certificate Stage SMS *(140 lot residential subdivision*);

-Warriewood Valley, Buffer Areas 1 and 2, Rezoning and DA Stage SMS (*300 lot residential subdivision*

-Warriewood Valley, Buffer Area 3, Rezoning and DA Stage SMS (*250 townhouse subdivision*);

-Macarthur Square Regional Centre Masterplan DA Stage WSUD Strategy (*61ha residential subdivision*);

-Department of Defence Site, Ermington ("*Ermington Riverfront*") DA Stage SMS (*20ha residential subdivision*

-West Kembla Grange, Wollongong, Aquatic Issues Assessment (*858ha catchment*);

-Eastwood Quarry, Masterplan/Rezoning Stage SMS (*20ha residential subdivision*);

-Perentie and Dawes Road Masterplan, Belrose, Stormwater Quality Strategy (*30ha residential subdivision*);

-Walter Road, Ingleside DA Stage SMS (*15ha rural residential subdivision*);

-Domayne, Austlink Park Belrose SMS (large *commercial use development*);

-Grassmere LES, Camden SMS (*50ha rural residential subdivision*);

-Warriewood Valley (*Sectors C, D, & 12*) Rezoning Stage SMS *(100 lot residential subdivision*); and

-Summer Hill Flour Mill Concept Plan Application Stormwater Management Plan and Flood Study (*250 dwelling high density residential subdivision*).

-Mt Penang Stormwater Management Strategy

-Ashlar Golf Course Redevelopment – Flood and WSUD Strategy for 100 dwelling Residential Subdivision.

- ***Water Sensitive Urban Design (WSUD)***

-Sand Filtration Unit, Drummoyne Park (*ie Stormwater Treatment*);

-Barnwell Park Golf Course Stormwater Treatment and Reuse;

-Powell Creek Reserve Eco Carpark

-Warriewood Valley, Sector 10, Detailed Design of WSUD elements (*bio-retention systems and wetland for 170 lot residential subdivision*);

-Warriewood Valley, Sector 12, Detailed Design of WSUD elements (*bio-retention systems and wetland for 180 lot residential subdivision*);

-Rouse Hill Regional Centre – Detailed design and performance analysis of bio retention systems, raingardens and constructed wetland;

-Hezlett Road, North Kellyville – Generic lot based raingarden design, road bio-retention swale design and detention offset analysis;

-Yoyager Point (DHA) – Detailed Design of Detention/Bio-Retention Basins for 200 lot residential subdivision.

- ***Riparian/Creek Design/Investigation***

-Wollondilly Shire Riparian Corridor Definition Study;

-Parsley Bay, Woollahra, Creekline Rehabilitation;

-Embankment Stabilisation Design, Koloona Ave, Byarong Creek ,Wollongong;

-Embankment Stabilisation Design, 5 sites along Cabbage Tree Creek, Towradgi Creek and Byarong Creek, Wollongong;

-Prospect Creek, Fairfield – Design of confluence stabilisation and creek rehabilitation measures;

-Narrabeen Creek, Pittwater – Detailed design of creek rehabilitation and embankment stabilisation measures from Graf Ave to Ponderosa Parade;

-Little Bay Central Drainage Corridor – Controlled Activity Approval and detailed design of Central Corridor Drainage Features (*ie wetlands, bio-retention basins, weirs, elevated walkways, bridges, pool/riffle creekline*).

-Sector 8 Warriewood – Controlled Activity Approval for residential development adjoining Fern Creek.

- ***Civil Subdivision Design***

-Potts Hill, Eastern Precinct – Lead design team for 13ha Industrial development of Sydney Water Surplus Lands. Engaged by Landcom to provide approval documentation for Part 3 Major Project and to deliver detailed design of all subdivision infrastructure (*ie civil, roads, RE walls, stormwater, power, sewer, water, recycled water and utility services*).

-Tweed Road, Lithgow, Detailed Design of Civil Infrastructure (*roads, drainage, water, sewer and all other utility services*) for a 38 lot residential subdivision;

-Sector 20, Warriewood, Detailed Design of Civil Infrastructure (*roads, drainage, water, sewer and all other utility services*) for a 63 lot residential subdivision;

-7 Orchard Road, Warriewood, Detailed Design of Lot Based Stormwater Management Facilities and Access Road for a 10 lot residential subdivision;

-Heritage Estates, Shoalhaven, Conceptual Design of Civil Infrastructure. (*water, sewage, utility services, roads and drainage*) for 20ha residential subdivision;

-Randwick Defence Site (*Stage 1A*), Detailed Design of Civil Infrastructure (*roads, drainage, water, sewer and all other utility services*) for a 80 lot residential subdivision; and

-Cooks Cove Development, Upgrade to Scarborough and Bicentennial Parks – Lead design team for approvals and detailed design of upgrade to park facilities, including carparks, creekline, stormwater drainage, bulk earthworks, access roads, services etc to accommodate future relocation of facilities from Cooks Cove development site (*Part 3A Major Project*).

Drainage Analysis/Design

-Canada Bay Council city wide DRAINS modelling project *(970ha catchment*);

-Canada Bay Council Detention modelling and OSD policy development;

-City of Canada Bay Council MAPINFO drainage database update;

-Old Bathurst Road, Emu Plains, Detailed Design of Stormwater Management Facilities *(24ha industrial subdivision*)

-Andrew Road, Penrith, Detailed Design of Stormwater Management Facilities *(8ha industrial subdivision*)

-St Mervyns Ave, Woollahra, Stormwater Outlet Extension;

-Grosvenor Street Stormwater Drainage Study;

-Perentie and Dawes Road Masterplan, Belrose, Stormwater Drainage Concept Plan;

-Yulong Concept Drainage Study, Dept Defence Moorebank *(25ha industrial subdivision);*

-Headland Road, Curl Curl OSD Design;

-Cooper Park Amphitheatre , Woollahra, Detailed Stormwater Drainage Design;

-Paradise Avenue, Paradise Beach, Detailed Stormwater Drainage Design;

-Georges River Sailing Club, Seawall and Beach Nourishment Design;

-St Andrew Church, Wahroonga OSD and Stormwater Drainage Design;

-North Sydney Catchment Management Studies (*in total 86ha catchment*);

-Greystanes Estate, Northern Residential Lands, Detailed Design of Water Management Facilities (*70ha residential development*); and

-Barina Downs Road, Detention Basin Design (*large regional detention facility*).

-Robertson Road, Scotland Island – Detailed Stormwater Drainage Design

-Jenkins Road, Dundas - Detention System Design

-Lot 2 Muir Road, Chullora – Drainage and Detention System Design for Large Industrial Development.

Flood Studies (FS)

-Prospect Creek Channel Enhancement FS;

-Oats Ave, Gladesville FS;

-Casa Paloma Caravan Park FS;

-Kiaora Place Development, Double Bay FS;

-Darling Park/Cross City Tunnel - Flood impact assessment;

-Mowbray Road, Nursing Home, Assessment of overland flow impacts;

-Macquarie Links Golf Course FS (*Bunburry Curran Creek, Campbelltown*);

-Wigan Road, Dee Why FS;

-Green Road FS;

-Anzac Creek, Moorebank FS;

-Eastwood Hotel Drainage/Flooding Study;

-Mona Street, Mona Vale FS;

-Frenchs Creek FS;

-Darling Walk Flood Assessment, Darling Harbour; and

-Lynwood Ave, Dee Why Flood Assessment.

▸ ***Dam Hazard Assessment***

-Kellyville Ridge Dam, Second Ponds Creek, Dam Hazard Assessment;

-UWS Campbelltown Dam Hazard Assessment;

-Hume Golf Course, Albury Dam Hazard Assessment; and

-CSIRO, Greystanes Dam Hazard Assessment.

▸ ***Water Quality Monitoring***

-Sectors 2, 8 and 11 Warriewood, Post construction (*ie residential subdivision*) stormwater quality monitoring;

-Warriewood Valley (*Various Sectors*) Approval Stage Water Quality Monitoring over an 8 year period

-Shellharbour Council Stormwater Monitoring Strategy (*entire Shellharbour LGA - 14,000ha*);

-St Marys Eastern Precinct Water Quality Monitoring Strategy *(160ha residential subdivision*);

-Rouse Hill Regional Centre – Post development water quality monitoring of treatment measures and receiving waters (*Auto sampling and grab sampling*);

-Water Quality Sampling for Metal Recycling development, Ingleburn.

▸ ***Major Culvert Amplification Design***

-Careel Creek/Barrenjoey Road Culvert Amplification Works (*Pittwater Council and RTA*);

-Nareen Creek /Narrabeen RSL Culvert Entry Upgrade (*Pittwater Council)*;

-Howell Reserve Culvert Entry Upgrade and Drainage Diversion Line (*Pittwater Council);*

-Fern Creek/Garden Street Culvert Amplification (*Pittwater Council*);

-Narrabeen Creek/Ponderosa Pde Culvert Amplification (*Pittwater Council*); and

-Garie Beach Culvert Amplification (*RTA and NPWS*).

▸ ***Road/Carpark Design***

-Transport Infrastructure Development Corporation (*TIDC*) Commuter Car Park Program, Detailed Design of At Grade Carparks at Emu Plains Station, Woonona Station and Waterfall Station (over $1 million in fees)

- Rookwood Road Potts Hill, Detailed Design of RTA signalised intersection upgrade (*Landcom)*

-Brunker Road Potts Hill, Detailed Design of RTA signalised intersection upgrade (*Landcom)*

-Scotland Island Road Reserve Masterplan (*53ha area*);

-P&O Port Botany, Detailed Design of Staff Carparking Facilities *(50 spaces*);

-McKeown Street, Maroubra Beach, Detailed Road Design for streetscape improvement works;

-Department of Defence Site, Randwick (*Stages 1A, 1B and Community Centre*), Detailed Road Design for large residential subdivision(*5.6ha residential subdivision*);

-Greystanes Estate Northern Residential Land, Detailed Road Design for large residential subdivision *(50ha residential subdivision*);

-Sector 20 Warriewood, Detailed Road Design for large residential subdivision *(50ha residential subdivision*);

-Lidcombe Botanica, Detailed Road Design for heritage precinct of large residential subdivision; and

-Heffron Park Randwick, Detailed Design of 100 space carpark and associated road improvement works.

- ***Infrastructure/Servicing Strategies***

-Ermington Naval Stores *(700 lot residential development*);

-Greystanes Estate, Prospect (*250ha residential & employment development*);

-UWS Werrington *(48ha residential development*) ;

-Airds Town Centre Masterplan;

-Sector 7 (*2 Daydream Avenue*), Warriewood *(3ha mixed use commercial/light industrial development*);

-St Mary's (*ADI Site-Eastern Precinct-160ha residential development*);

-Green Square Master Plan, South Sydney (*Zetland*); and

-Mt Penang, Gosford Business Park development.

- ***Gross Pollutant Traps (GPT's)***

-Dee Why Beach GPT design (*special non proprietary*);

-Birkenhead Point and Brent Street GPTs (*special non proprietary*);

-St Georges Crescent Catchment Oil/Grit Separators (*multiple proprietary*);

-Stormwater Trust Application Assistance, Waterways Authority - Blackwattle Bay GPT;

-Brookvale Creek Rehabilitation – detailed design of large offline GPT/trash rack; and

-Drummoyne Council - Three Ways to Improve The Bays GPT Design Project (*special non proprietary*).

- ***General Civil Engineering***

-BER Sydney South, provision of general civil engineering design for Abigroup for a number of Schools in Sydney South.; and

-McCarr's Creek Road/Pittwater Road Inventory and Condition Assessment.

- ***Expert Advice / L&E Court / Certification***

-DA Stormwater management, West Ryde Urban Village Redevelopment for Ryde City Council (*ie acting on behalf of Council*);

-DA Stormwater management, Top Ryde Shopping Centre Redevelopment for Ryde City Council(*ie acting on behalf of Council*);

-Yulong Moorebank , review of road design for Department of Defence;

-Rushcutters Bay Flood Study Peer Review for Lindsay Bennelong Developments;

-Review of Managing Urban Stormwater Manual April 2004 on behalf of Landcom;

-Clontarf Street, Seaforth – Civil inspections for Landcom res. dev. on behalf of Manly Council;

-Sector 20, Warriewood – Superintendency for $6 million Civil Works Contract;

-Bunya Collector Road CC – Private certification assessment for Landcom

-Expert witness (*water quality on industrial site*) for L&E Court Case - Phiney Place, Ingleburn (*representing private developer*);

-Expert witness (*drainage, S88K easement)*) for L&E Court Case – Park Street, Mona Vale (*representing adjoining land owner*);

-Expert witness (*drainage/absorption system/easement*) for L&E Court Case – 120 Hopetoun Avenue, Vaucluse (*representing owner/developer*);

-Expert witness (*drainage/riparian corridor*) for L&E Court Case – 23B Macpherson Street, Warriewood (*representing private developer*);

-Expert witness (*riparian matters/controlled activity application/culvert creek cro*ssing) for Supreme Court Case – Wambo Coal Mine, Warkworth (*representing mine operator*);

-Expert witness (*water management, riparian definition*) for L&E Court Case – 70A Willandra Rd, Beacon Hill (*Retirement Village Appeal, Representing Warringah Council*)

-Expert Advice on behalf of Warringah Council – Kimbriki Redevelopment Proposal;

-Cat5 Compliance Inspections (*Private Certification*) for Civil Infrastructure at Putney Hill Residential Development, Charles Street Ryde;

-Expert Drainage advice for stormwater/seawall damage at a private property in Prince Alfred Parade, Newport;

-Construction Certificate issue (*Private Certification*) for subdivision works at Mount Street, Constitution Hill;

- Construction Certificate issue (*Private Certification*) for subdivision works at Crescent Road, Mona Vale.

-Muir Road, Chullora – Construction Stage Inspections (civil) for industrial development.

3. EDUCATION & PROFESSIONAL AFFILIATIONS

- Bachelor of Engineering (*Civil*), University of Technology, Sydney, 1996;
- Member, Institution of Engineers, Australia (*MIEAust*);
- Charted Professional Engineer (*CPEng*);
- National Professional Engineers Register (*NPER - Civil*);
- NSW Accredited Certifier (*BPAct 2005*) – Categories B1, C1, C2, C3, C4, C6, C15 (*BPB 0816)*

APPENDIX B - RAFTS

Proposed Conditions

```
Run started at:  4th  October  2012  10:11:10

#####################################################################################
                        RUNTIME          RESULTS
#####################################################################################
 Max. no. of links allowed =       1500
Max. no. of routng increments allowed =     250000
Max. no. of rating curve points =     250000
Max. no. of storm temporal points =     250000
Max. no. of channel subreaches =         25
Max link stack level =         50
Input Version number =         800
 LINK Stage 1           1.000

 ESTIMATED VOLUME (CU METRES*10**3) =                   0.1392
 ESTIMATED PEAK FLOW         (CUMECS) =                   0.12
 ESTIMATED TIME TO PEAK         (MINS) =                 23.80

 LINK node1             1.000

 ESTIMATED VOLUME (CU METRES*10**3) =                   0.1392
 ESTIMATED PEAK FLOW         (CUMECS) =                   0.12
 ESTIMATED TIME TO PEAK         (MINS) =                 23.80

 iosd llkta         0         2
 LINK out               1.000

 ESTIMATED VOLUME (CU METRES*10**3) =                   0.2566E-05
 ESTIMATED PEAK FLOW         (CUMECS) =                   0.24E-05
 ESTIMATED TIME TO PEAK         (MINS) =                 20.10

#####################################################################################
Summer Hill Stage 1 - 4-10-12 proposed with det rwts

Results for period from  0: 0.0  1/ 1/1990
                     to  5: 0.0  1/ 1/1990
#####################################################################################


                               ROUTING INCREMENT (MINS) =      0.10
                               STORM DURATION (MINS)    =       60.
                               RETURN PERIOD (YRS)      =        1.
                               BX                       =    1.0000
                               TOTAL OF FIRST SUB-AREAS  (ha) =       0.51
                               TOTAL OF SECOND SUB-AREAS (ha) =       0.09
                               TOTAL OF ALL SUB-AREAS (ha)    =       0.60
```

SUMMARY OF CATCHMENT AND RAINFALL DATA

Link Label	Catch. Area #1 (ha)	Catch. Area #2 (ha)	Slope #1 (%)	Slope #2 (%)	% Impervious #1 (%)	% Impervious #2 (%)	Pern #1	Pern #2	B #1	B #2	Link No.
Stage 1	0.5100	0.0900	2.000	2.000	99.90	.1000	.018	.040	.0010	.0073	1.000
node1	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	1.001
out	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	1.002

Link Label	Average Intensity (mm/h)	Init. Loss #1 (mm)	Init. Loss #2 (mm)	Cont. Loss #1 (mm/h)	Cont. Loss #2 (mm/h)	Excess Rain #1 (mm)	Excess Rain #2 (mm)	Peak Inflow (m^3/s)	Time to Peak	Link Lag mins
Stage 1	30.677	5.000	20.00	0.000	2.500	25.666	9.257	0.1210	23.80	0.000
node1	30.677	5.000	0.000	0.000	0.000	25.666	0.000	0.1210	23.80	0.000
out	30.677	5.000	0.000	0.000	0.000	25.666	0.000	0.0000	20.10	0.000

SUMMARY OF BASIN RESULTS

Link Label	Time to Peak	Peak Inflow (m^3/s)	Time to Peak	Peak Outflow (m^3/s)	Total Inflow (m^3)	Basin Vol. Avail	Basin Vol. Used	Basin Stage Used
node1	23.80	.1210	23.80	0.000	139.17	0.0000	139.17	0.9278

SUMMARY OF BASIN OUTLET RESULTS

Link Label	No. of	S/D Factor (m)	Dia (m)	Width (m)	Pipe Length (m)	Pipe Slope (%)
node1	1.0	1.000		0.000	5.000	0.2000

LINK Stage 1 2.000

ESTIMATED VOLUME (CU METRES*10**3) = 0.1681
ESTIMATED PEAK FLOW (CUMECS) = 0.13
ESTIMATED TIME TO PEAK (MINS) = 30.00

LINK node1 2.000

ESTIMATED VOLUME (CU METRES*10**3) = 0.1681
ESTIMATED PEAK FLOW (CUMECS) = 0.13
ESTIMATED TIME TO PEAK (MINS) = 30.00

iosd llkta 0 2
LINK out 2.000

ESTIMATED VOLUME (CU METRES*10**3) = 0.1777E-01
ESTIMATED PEAK FLOW (CUMECS) = 0.17E-01
ESTIMATED TIME TO PEAK (MINS) = 70.00

###
Summer Hill Stage 1 - 4-10-12 proposed with det rwts

Results for period from 0: 0.0 1/ 1/1990
to 5: 0.0 1/ 1/1990
###

ROUTING INCREMENT (MINS) = 0.10
STORM DURATION (MINS) = 90.
RETURN PERIOD (YRS) = 1.
BX = 1.0000
TOTAL OF FIRST SUB-AREAS (ha) = 0.51
TOTAL OF SECOND SUB-AREAS (ha) = 0.09
TOTAL OF ALL SUB-AREAS (ha) = 0.60

SUMMARY OF CATCHMENT AND RAINFALL DATA

Link Label	Catch. Area #1 (ha)	Catch. Area #2 (ha)	Slope #1 (%)	Slope #2 (%)	% Impervious #1 (%)	% Impervious #2 (%)	Pern #1	Pern #2	B #1	B #2	Link No.
Stage 1	0.5100	0.0900	2.000	2.000	99.90	.1000	.018	.040	.0010	.0073	1.000
node1	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	1.001
out	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	1.002

Link Label	Average Intensity (mm/h)	Init. Loss #1 (mm)	Init. Loss #2 (mm)	Cont. Loss #1 (mm/h)	Cont. Loss #2 (mm/h)	Excess Rain #1 (mm)	Excess Rain #2 (mm)	Peak Inflow (m^3/s)	Time to Peak	Link Lag mins
Stage 1	23.789	5.000	20.00	0.000	2.500	30.674	13.103	0.1284	30.00	0.000
node1	23.789	5.000	0.000	0.000	0.000	30.674	0.000	0.1284	30.00	0.000
out	23.789	5.000	0.000	0.000	0.000	30.674	0.000	0.0174	70.00	0.000

SUMMARY OF BASIN RESULTS

Link Label	Time to Peak	Peak Inflow (m^3/s)	Time to Peak	Peak Outflow (m^3/s)	Total Inflow (m^3)	Basin Vol. Avail	Basin Vol. Used	Basin Stage Used
node1	30.00	.1284	70.00	.0174	168.08	0.0000	150.23	1.0229

SUMMARY OF BASIN OUTLET RESULTS

Link Label	No. of	S/D Factor (m)	Dia (m)	Width (m)	Pipe Length (m)	Pipe Slope (%)
node1	1.0	1.000		0.000	5.000	0.2000

LINK Stage 1 3.000

ESTIMATED VOLUME (CU METRES*10**3) = 0.1906
ESTIMATED PEAK FLOW (CUMECS) = 0.12
ESTIMATED TIME TO PEAK (MINS) = 33.50

LINK node1 3.000

ESTIMATED VOLUME (CU METRES*10**3) = 0.1907
ESTIMATED PEAK FLOW (CUMECS) = 0.12
ESTIMATED TIME TO PEAK (MINS) = 33.50

iosd llkta 0 2
LINK out 3.000

ESTIMATED VOLUME (CU METRES*10**3) = 0.4031E-01
ESTIMATED PEAK FLOW (CUMECS) = 0.26E-01
ESTIMATED TIME TO PEAK (MINS) = 79.10

###
Summer Hill Stage 1 - 4-10-12 proposed with det rwts

Results for period from 0: 0.0 1/ 1/1990
to 5: 0.0 1/ 1/1990
###

ROUTING INCREMENT (MINS) = 0.10
STORM DURATION (MINS) = 120.
RETURN PERIOD (YRS) = 1.
BX = 1.0000
TOTAL OF FIRST SUB-AREAS (ha) = 0.51
TOTAL OF SECOND SUB-AREAS (ha) = 0.09
TOTAL OF ALL SUB-AREAS (ha) = 0.60

SUMMARY OF CATCHMENT AND RAINFALL DATA

Link Label	Catch. Area #1 (ha)	Catch. Area #2 (ha)	Slope #1 (%)	Slope #2 (%)	% Impervious #1 (%)	% Impervious #2 (%)	Pern #1	Pern #2	B #1	B #2	Link No.
Stage 1	0.5100	0.0900	2.000	2.000	99.90	.1000	.018	.040	.0010	.0073	1.000
node1	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	1.001
out	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	1.002

Link Label	Average Intensity (mm/h)	Init. Loss #1 (mm)	Init. Loss #2 (mm)	Cont. Loss #1 (mm/h)	Cont. Loss #2 (mm/h)	Excess Rain #1 (mm)	Excess Rain #2 (mm)	Peak Inflow (m^3/s)	Time to Peak	Link Lag mins
Stage 1	19.788	5.000	20.00	0.000	2.500	34.565	16.065	0.1211	33.50	0.000
node1	19.788	5.000	0.000	0.000	0.000	34.565	0.000	0.1211	33.50	0.000
out	19.788	5.000	0.000	0.000	0.000	34.565	0.000	0.0260	79.10	0.000

SUMMARY OF BASIN RESULTS

Link Label	Time to Peak	Peak Inflow (m^3/s)	Time to Peak	Peak Outflow (m^3/s)	Total Inflow (m^3)	--------- Basin --------- Vol. Avail	Vol. Used	Stage Used
node1	33.50	.1211	79.10	.0260	190.65	0.0000	150.32	1.0323

SUMMARY OF BASIN OUTLET RESULTS

Link Label	No. of	S/D Factor (m)	Dia (m)	Width (m)	Pipe Length (m)	Pipe Slope (%)
node1	1.0	1.000		0.000	5.000	0.2000

LINK Stage 1 4.000

ESTIMATED VOLUME (CU METRES*10**3) = 0.2252
ESTIMATED PEAK FLOW (CUMECS) = 0.66E-01
ESTIMATED TIME TO PEAK (MINS) = 45.00

```
 LINK node1             4.000

 ESTIMATED VOLUME (CU METRES*10**3) =                 0.2252
 ESTIMATED PEAK FLOW          (CUMECS) =               0.66E-01
 ESTIMATED TIME TO PEAK          (MINS) =             45.00

 iosd llkta         0          2
 LINK out               4.000

 ESTIMATED VOLUME (CU METRES*10**3) =                 0.7487E-01
 ESTIMATED PEAK FLOW          (CUMECS) =               0.23E-01
 ESTIMATED TIME TO PEAK          (MINS) =             85.00

#####################################################################################
Summer Hill Stage 1 - 4-10-12 proposed with det rwts

Results for period from  0: 0.0  1/ 1/1990
                     to  5: 0.0  1/ 1/1990
#####################################################################################


                               ROUTING INCREMENT (MINS) =       0.10
                               STORM DURATION (MINS)    =       180.
                               RETURN PERIOD (YRS)      =         1.
                               BX                       =     1.0000
                               TOTAL OF FIRST SUB-AREAS  (ha) =       0.51
                               TOTAL OF SECOND SUB-AREAS (ha) =       0.09
                               TOTAL OF ALL SUB-AREAS (ha)    =       0.60


     SUMMARY OF CATCHMENT AND RAINFALL DATA
 Link      Catch. Area      Slope    % Impervious     Pern        B        Link
 Label      #1     #2      #1    #2      #1    #2     #1    #2    #1    #2     No.
           (ha)             (%)           (%)
Stage 1   0.5100 0.0900  2.000 2.000  99.90 .1000  .018 .040  .0010 .0073  1.000
node1     .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000  1.001
out       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000  1.002


 Link    Average  Init. Loss  Cont. Loss    Excess Rain   Peak    Time    Link
 Label  Intensity  #1    #2    #1    #2      #1    #2    Inflow   to      Lag
          (mm/h)    ( mm )      (mm/h)       ( mm )     (m^3/s)  Peak   mins
Stage 1   15.219 5.000 20.00  0.000 2.500  40.653 19.924  0.0655  45.00 0.000
node1     15.219 5.000 0.000  0.000 0.000  40.653  0.000  0.0655  45.00 0.000
out       15.219 5.000 0.000  0.000 0.000  40.653  0.000  0.0235  85.00 0.000


      SUMMARY OF BASIN RESULTS

 Link     Time   Peak   Time   Peak     Total   --------- Basin ---------
 Label     to   Inflow   to   Outflow  Inflow      Vol.     Vol.    Stage
          Peak  (m^3/s) Peak  (m^3/s)   (m^3)     Avail    Used      Used
node1     45.00  .0655 85.00   .0235    225.21   0.0000   150.30  1.0296

      SUMMARY OF BASIN OUTLET RESULTS

  Link     No.     S/D     Dia    Width     Pipe     Pipe
  Label    of     Factor                   Length    Slope
                   (m)     (m)     (m)      (m)      (%)
node1     1.0     1.000           0.000     5.000  0.2000


 LINK Stage 1           5.000

 ESTIMATED VOLUME (CU METRES*10**3) =                 0.2758
 ESTIMATED PEAK FLOW          (CUMECS) =               0.22
 ESTIMATED TIME TO PEAK          (MINS) =             25.00

 LINK node1             5.000

 ESTIMATED VOLUME (CU METRES*10**3) =                 0.2758
 ESTIMATED PEAK FLOW          (CUMECS) =               0.22
 ESTIMATED TIME TO PEAK          (MINS) =             25.00
```

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 iosd llkta        0         2
 LINK out              5.000

 ESTIMATED VOLUME (CU METRES*10**3) =              0.1255
 ESTIMATED PEAK FLOW        (CUMECS) =               0.11
 ESTIMATED TIME TO PEAK        (MINS) =             30.00

####################################################################################
Summer Hill Stage 1 - 4-10-12 proposed with det rwts

Results for period from  0: 0.0  1/ 1/1990
                     to  5: 0.0  1/ 1/1990
####################################################################################


                              ROUTING INCREMENT (MINS) =       0.10
                              STORM DURATION (MINS)    =        60.
                              RETURN PERIOD (YRS)      =         5.
                              BX                       =     1.0000
                              TOTAL OF FIRST SUB-AREAS  (ha) =       0.51
                              TOTAL OF SECOND SUB-AREAS (ha) =       0.09
                              TOTAL OF ALL SUB-AREAS (ha)    =       0.60


     SUMMARY OF CATCHMENT AND RAINFALL DATA
 Link      Catch. Area      Slope    % Impervious     Pern        B        Link
 Label      #1      #2     #1     #2      #1    #2     #1     #2    #1    #2     No.
            (ha)              (%)           (%)
Stage 1   0.5100 0.0900  2.000 2.000  99.90 .1000  .018 .040  .0010 .0073  1.000
node1     .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000  1.001
out       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000  1.002


 Link    Average  Init. Loss  Cont. Loss    Excess Rain   Peak    Time   Link
 Label  Intensity  #1     #2    #1     #2      #1     #2    Inflow   to     Lag
          (mm/h)    ( mm )     (mm/h)         ( mm )     (m^3/s)  Peak  mins
Stage 1   53.519 5.000 20.00  0.000 2.500  48.499 31.795  0.2225  25.00 0.000
node1     53.519 5.000 0.000  0.000 0.000  48.499  0.000  0.2225  25.00 0.000
out       53.519 5.000 0.000  0.000 0.000  48.499  0.000  0.1083  30.00 0.000


      SUMMARY OF BASIN RESULTS

 Link     Time   Peak   Time   Peak     Total   --------- Basin ---------
 Label     to   Inflow   to   Outflow  Inflow      Vol.      Vol.     Stage
          Peak  (m^3/s) Peak  (m^3/s)   (m^3)     Avail      Used      Used
node1     25.00  .2225 30.00   .1083    275.81   0.0000    151.03  1.1034

      SUMMARY OF BASIN OUTLET RESULTS

  Link     No.     S/D     Dia    Width     Pipe     Pipe
  Label    of     Factor                   Length    Slope
                   (m)     (m)     (m)      (m)      (%)
node1     1.0     1.000           0.000     5.000  0.2000


 LINK Stage 1          6.000

 ESTIMATED VOLUME (CU METRES*10**3) =              0.3252
 ESTIMATED PEAK FLOW        (CUMECS) =               0.24
 ESTIMATED TIME TO PEAK        (MINS) =             30.00

 LINK node1            6.000

 ESTIMATED VOLUME (CU METRES*10**3) =              0.3252
 ESTIMATED PEAK FLOW        (CUMECS) =               0.24
 ESTIMATED TIME TO PEAK        (MINS) =             30.00

 iosd llkta        0         2
 LINK out              6.000

 ESTIMATED VOLUME (CU METRES*10**3) =              0.1748
 ESTIMATED PEAK FLOW        (CUMECS) =               0.24
 ESTIMATED TIME TO PEAK        (MINS) =             30.00
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