APPENDIX 3

BROWN
Smart Consulting

WATER CYCLE MANAGEMENT
CEDAR GROVE ESTATE
STAGE 2

June 2013
Report No. X12064-01
Prepared for White Constructions Pty Ltd

COMMERCIAL IN CONFIDENCE

DOCUMENT CONTROL

X12064 120518 Water Cycle Report.dotx

Issue	Date	Issue Details	Author	Checked	Approved
A	May 12	Draft Report	TE		
B	Jul 12	Report	TE	RP	
C	Jun 13	Updated Report	TE	RP	

WATER CYCLE MANAGEMENT

CEDAR GROVE STAGE 2

FOR CLIENT

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LIST OF ABBREVIATIONS

AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
DIPNR	Department of Infrastructure, Planning and Natural Resources
DLWC	Department of Land and Water Conservation NSW
DEM	Digital Elevation Model
DTM	Digital Terrain Model
FPDM	Floodplain Development Manual
FPL	Flood Planning Level
FPMM	Floodplain Management Manual
FPRMS	Floodplain Risk Management Study
FSL	Flood Surface Level
GIS	Geographic Information System
ha	Hectare (Area = 10,000m^2)
LEP	Local Environmental Plan
LGA	Local Government Area
MGA	Map Grid Australia
m^3/s	Cubic meters per second
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
RCP	Reinforced Concrete Pipe
RCBC	Reinforced Concrete Box Culvert
RTA	Roads and Traffic Authority of NSW
SEPP	State Environmental Planning Policy
SMP	Stormwater Management Plan
TIN	Triangular Irregular Network

Water Cycle Management

1 INTRODUCTION

Brown Consulting has been engaged by White Constructions Pty Ltd to prepare the Water Cycle Management for Cedar Grove Estate stage 2 to support the rezoning application.

The site is located in Kiama, NSW. Cedar Grove Stage 2 is located south of the Stage 1 development and bounded to the east by Willow Gully Creek and rural properties to the west. The site drains to Willow Gully Creek with a portion of the western catchments discharge into Spring Creek. The Northern catchments drain to the Cedar Grove Stage 1 basins (basin 1 & 2), refer to figure 2.

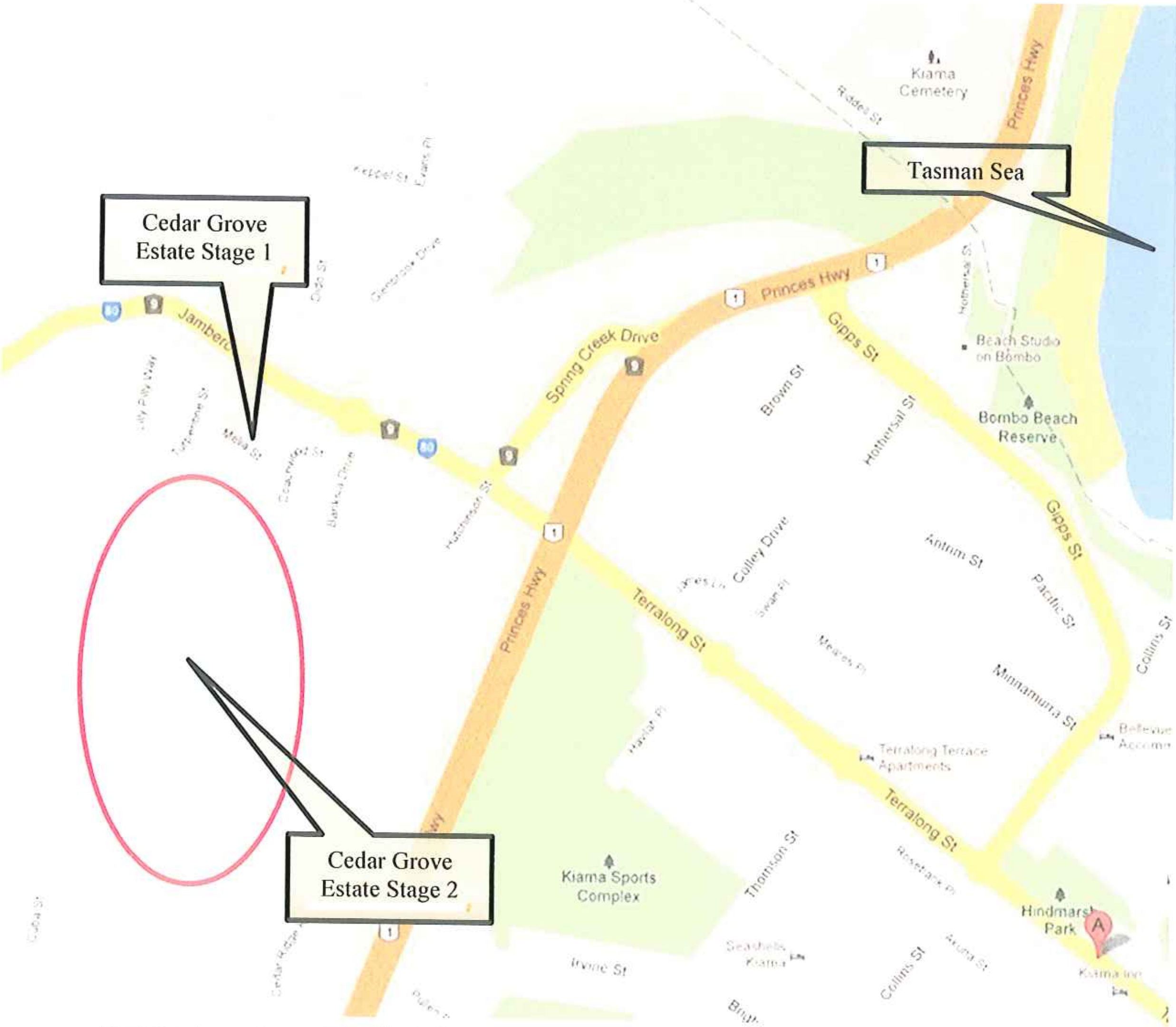


Figure 1 Locality Sketch

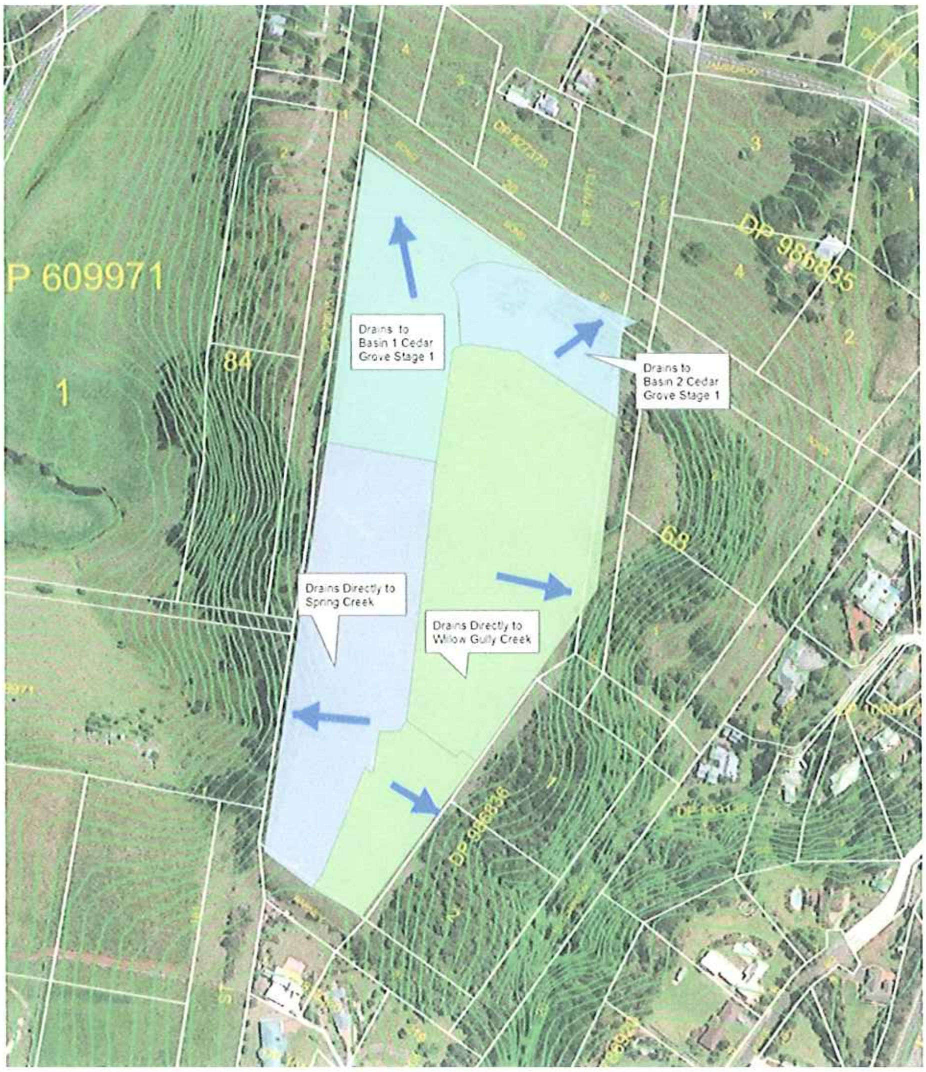


Figure 2 Catchments

1.1 OBJECTIVES

The water cycle management report aims to provide a stormwater strategy suitable for the rezoning of stage 2 Cedar Grove Estates. The report provides a stormwater strategy that is suitable for managing stormwater quantity and quality for a proposed development. Greater detail will be provided during the various design phases.

2 HYDROLOGY

The stormwater masterplan undertaken for Cedar Grove Estate stage 1 (Brown, 2004) reported on the hydrological modelling of Willow Gully Creek. The study established that the catchments that drain directly to Willow Gully Creek did not require OSD due to the lag time associated with the upstream Catchment. The study showed that development conditions with no OSD did not impact the peak flows in Willow Gully Creek because of the close location to the creek outlet, the Ocean.

Basin 1 within Stage 1 Cedar Grove, provided OSD detention for the developed catchment to ensure no aggravating of flows within Spring Creek. The design of basin 1 and 2 included receiving flows from a portion of the existing stage 2 catchments.

3 DETENTION

The Kiama Municipal Council Water Sensitive Urban Design Policy identifies the On-site retention/ On-site detention requirements for a development. Where rainwater tanks are over 5000 litres and utilised for toilets, laundry and external uses, Council will allow 40% of the rainwater tank volume to be credited to OSD.

3.1 Catchments Draining to Willow Gully Creek

The catchments draining directly to Willow Gully Creek are close to the ocean outlet and will not provide OSD to avoid aligning peak flood levels with the upstream Creek catchments. The lots will provide rainwater tanks for reuse (2000-3000 L) and manage environmental flows, for larger events the flows will discharge directly into Willow Gully Creek.

An XP-RAFTS model was developed to assess the impact of allowing the Willow Gully Creek to discharge uncontrolled. The model parameters were adjusted to match the original Watershed Bounded Network Model (WBNM) prepared for Willow Gully Creek. The modelling showed that the catchment with no OSD would discharge to the ocean prior to the peak flow from the 47ha Willow Gully Creek Catchment arrives. The results presented below show the flow from Subcatchment 4 (including the site catchment) and the outlet for the 100 year ARI storm event.

	Sub catchment 4 m3/s	Outlet m3/s
Pre-developed	1.96	21.36
Developed	2.86	20.94

The results showed although the flow for the site catchment was increased as a result of the development, the peak flow arriving at Jamberoo Road were reduced as a result of a shorter time of concentration.

3.2 Catchments Draining to Cedar Grove Stage 1 Basin 1

Cedar Grove Estate Stage 1 provided detention storage for all storms up to the 100 year ARI storm event, and included the existing catchment upstream of the developed (stage 2). The proposal for stage 2 Cedar Grove reduces the catchment area draining to the constructed stage 1 basin 1, and therefore a proportion of the storage within the stage 1 basin can be utilised to manage the flows off stage 2.

The preliminary modelling has shown an OSD component of 410m³ will maintain the flows provided in the stage 1 design and not aggravate existing flows discharging from the stage 1 outlet. The OSD volume within stage 2 can be achieved through a number of options including the combination of either/or an OSD storage along the boundary or the lots to provide rainwater tanks with a detention component.

3.3 Catchments Draining to Cedar Grove Stage 1 Basin 2

Cedar Grove Estate Stage 1 study established that the catchment area draining to basin 2 did not require stormwater detention to ensure peak flood levels downstream were not aggravated as a result of the development. A portion of the stage 2 development is included in the basin 2 catchment area, and will not require On-site detention.

The preliminary modelling has shown an OSD component of 150m³ will maintain the flows provided in the stage 1 design and not aggravate existing flows discharging from the stage 1 outlet. The OSD volume within stage 2 can be achieved through a number of options including the combination of either/or an OSD storage along the boundary or the lots to provide rainwater tanks with a detention component.

3.4 Catchments Draining Directly to Spring Creek

The catchments along the western boundary drain directly to Spring Creek and will provide stormwater detention. The Kiama Municipal Council Water Sensitive Urban Design Policy identifies a site storage requirement of 132 m³/ha and permissible site discharge of 600 L/s/ha. Where rainwater tanks are over 5000 litres and utilised for toilets, laundry and external uses, 40% of the rainwater tank volume to be credited to OSD, and the remainder of storage shortfall could be contained within the air gap of the rainwater tank or elsewhere within the lot. Alternatively the OSD component can be contained within a basin downstream of the development prior to discharging into Spring Creek. The proposed lot configuration and detention strategy is subject to detailed design.

4 WATER QUALITY

The Kiama Municipal Council Water Sensitive Urban Design Policy identifies the pollutant removal targets, the targets are as follows;

Pollutant	Target (% Removal)
Total Suspended Solids (TSS)	80
Total Nitrogen (TN)	45
Total Phosphorus (TP)	45

The Cedar Grove Stage I developed a treatment train to utilise gross pollutant traps and bio-filtration basins for treatment of minor storm events (approximately 3 month ARI).
The Stage I bio-filtration basin filter surface areas are as follows:

- Basin I 250 m^2
- Basin 2 385 m^2

The results water quality treatment devices showed a significant reduction in developed loads, 91% reduction in suspended solids, 53% reduction in total nitrogen and 63% reduction in total phosphorous.

Preliminary water quality modelling of a proposed development located at Stage 2 Cedar Grove has been undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software package developed by the Cooperative Research Centre for Catchment Hydrology (CRCCH). MUSIC enables the user to model the transfer of pollutants through a catchment and provides an aid in determining the treatment strategy required to meet the water quality objectives applicable to the site. The critical pollutants to be modelled are Gross Pollutants, Total Nitrogen (TN), Total Phosphorous (TP) and Total Suspended Solids (TSS).

The generation, transfer and removal of these critical pollutants will be modelled through a proposed treatment strategy. Only the critical pollutants will be further addressed in this report, however the treatment devices will provide mitigation of other pollutant loads, such as heavy metals, since they are predominantly associated with fine sediment. The Primary Pollutant trap will intercept pollutants such as litter, rubbish, leaves etc therefore minimising the runoff of oxygen demanding substances.

4.1 Catchments Draining to Willow Gully Creek

The catchments draining directly to Willow Gully Creek will utilise rainwater tanks within each lot and bioretention swales. Preliminary modelling suggests a bioretention area of 120 m^2 (northern outlet) and

40 m² (southern outlet) would be required throughout the catchment, the bioretention can be provided within each lot, within open space or swales within the road corridors.

4.2 Catchments Draining to Cedar Grove Stage 1 Basin 1

The catchment areas draining to basin 1 stage 1 utilises the bioretention within the basin. Furthermore the stage 2 lots within the catchment will provide rainwater tanks, and a vegetated buffer strip is located along the boundary upstream of stage 1 for further treatment.

4.3 Catchments Draining to Cedar Grove Stage 1 Basin 2

The catchment areas draining to basin 2 stage 1 utilises the bioretention within the basin. Furthermore the stage 2 lots within the catchment will provide rainwater tanks, and a vegetated buffer strip is located along the boundary upstream of stage 1 for further treatment.

4.4 Catchments Draining Directly to Spring Creek

The catchments draining directly to Spring Creek will utilise rainwater tanks within each lot and bioretention swales. Preliminary modelling suggests a bioretention area of 80 m² would be required throughout the catchment to meet the removal targets, the bioretention can be provided within each lot, open space areas or swales within the road corridors. Alternatively the bioretention can be contained within a basin located downstream of the lots prior to discharging into Spring Creek.

4.5 Removal Efficiencies

Preliminary MUSIC modelling for the rezoning of stage 2 Cedar Grove Estates shows the water quality treatment strategy proposed above will achieve the following pollutant removal ;

Pollutant	Inflow (kg/yr)	Outflow (kg/yr)	% Removal	Achieved Target
Total Suspended Solids (TSS)	16400	3130	80.9	Yes
Total Nitrogen (TN)	35.4	10.8	69.5	Yes
Total Phosphorus (TP)	269	144	46.5	Yes
Gross Pollutants (GP)	2260	0	100	Yes

5 CONCLUSION

The stormwater management for the rezoning of Cedar Grove Stage 2 has been prepared in accordance with the Kiama Municipal Council Water Sensitive Urban Design Policy (2005). The stormwater components of the development of the land would be designed to meet the principal including;

- Ensuring peak flows are maintained at a rate not exceeding existing conditions,
- Improve water quality of stormwater discharging from the site such that pollutant loads are no worse than existing conditions and meet the removal targets specified by Council,
- Manage environmental flows of Spring Creek and Willow Gully Creek, and
- Promote Water Sensitive Urban Design.

The stormwater management is a conceptual plan for the rezoning, the proposal will be reviewed and detailed for the development application when further details of the subdivision are available.

6 REFERENCES

Brown Consulting (2004). Stormwater Masterplan for Development Application at Cedar Grove Estate, Kiama.

Kiama Municipal Council (2005)Kiama Municipal Council Water Sensitive Urban Design Policy

7 GLOSSARY OF TERMS

Afflux	The rise in water level upstream of a hydraulic structure such as a bridge or culvert, caused by losses incurred from the hydraulic structure.
Australian Height Datum	National survey datum corresponding approximately to mean sea level.
Annual Exceedance Probability	The chance of a flood of a given size or larger occurring in any one year, generally expressed as percentage probability. For example, a 100 year ARI flood is a 1% AEP flood. An important implication is that when a 1% AEP flood occurs, there is still a 1% probability that it could occur the following year.
Average Recurrence Interval	Is the long term average number of years between the occurrence of a flood as big as, or larger than the selected flood event.
Catchment	The catchment at a particular point is the area of land which drains to that point.
Design floor level	The minimum (lowest) floor level specified for a building.
Design flood	A hypothetical flood representing a specific likelihood of occurrence (for example the 100 year or 1% probability flood). The design flood may comprise two or more single source dominated floods.
Development	Existing or proposed works which may or may not impact upon flooding. Typical works are filling of land, and the construction of roads, floodways and buildings.
Discharge	The rate of flow of water measured in terms of volume over time. It is not the velocity of flow which is a measure of how fast the water is moving rather than how much is moving. Discharge and flow are interchangeable.
Digital Terrain Model	A three-dimensional model of the ground surface that can be represented as a series of grids with each cell representing an elevation (DEM) or a series of interconnected triangles with elevations (TIN).
Effective warning time	The available time that a community has from receiving a flood warning to when the flood reaches their location.
First Flush	The initial surface runoff of a rainstorm. During this phase, water pollution in areas with high proportions of impervious surfaces is typically more concentrated compared to the remainder of the storm.
Flood	Above average river or creek flows which overtop banks and inundate floodplains.
Flood awareness	An appreciation of the likely threats and consequences of flooding and an understanding of any flood warning and evacuation procedures. Communities with a high degree of flood awareness respond to flood warnings promptly and efficiently, greatly reducing the potential for damage and loss of life and limb. Communities with a low degree of flood awareness may not fully appreciate the importance of flood warnings and flood preparedness and consequently suffer greater personal and economic losses.
Flood behaviour	The pattern / characteristics / nature of a flood.

Flooding	The State Emergency Service uses the following definitions in flood warnings: *Minor flooding:* causes inconvenience such as closing of minor roads and the submergence of low level bridges *Moderate flooding:* low-lying areas inundated requiring removal of stock and/or evacuation of some houses. Main traffic bridges may be covered. *Major flooding:* extensive rural areas are flooded with properties, villages and towns isolated and/or appreciable urban areas are flooded.
Flood frequency analysis	An analysis of historical flood records to determine estimates of design flood flows.
Flood fringe	Land which may be affected by flooding but is not designated as a floodway or flood storage.
Flood hazard	The potential threat to property or persons due to flooding.
Flood level	The height or elevation of flood waters relative to a datum (typically the Australian Height Datum). Also referred to as "stage".
Flood liable land	Land inundated up to the probable maximum flood – flood prone land.
Floodplain	Land adjacent to a river or creek which is inundated by floods up to the probable maximum flood that is designated as flood prone land.
Flood Planning Levels	Are the combinations of flood levels and freeboards selected for planning purposes to account for uncertainty in the estimate of the flood level.
Flood proofing	Measures taken to improve or modify the design, construction and alteration of buildings to minimise or eliminate flood damages and threats to life and limb.
Floodplain Management	The coordinated management of activities which occur on flood liable land.
Floodplain Management Manual	A document by the NSW Government (2001) that provides a guideline for the management of flood liable land. This document describes the process of a floodplain risk management study.
Flood source	The source of the flood waters.
Floodplain Management Standard	A set of conditions and policies which define the benchmark from which floodplain management options are compared and assessed.
Flood standard	The flood selected for planning and floodplain management activities. The flood may be an historical or design flood. It should be based on an understanding of the flood behaviour and the associated flood hazard. It should also take into account social, economic and ecological considerations.
Flood storages	Floodplain areas which are important for the temporary storage of flood waters during a flood.
Floodways	Those areas of the floodplain where a significant discharge of flow occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if they are partially blocked, would cause significant redistribution of flood flows, or a significant increase in flood levels.

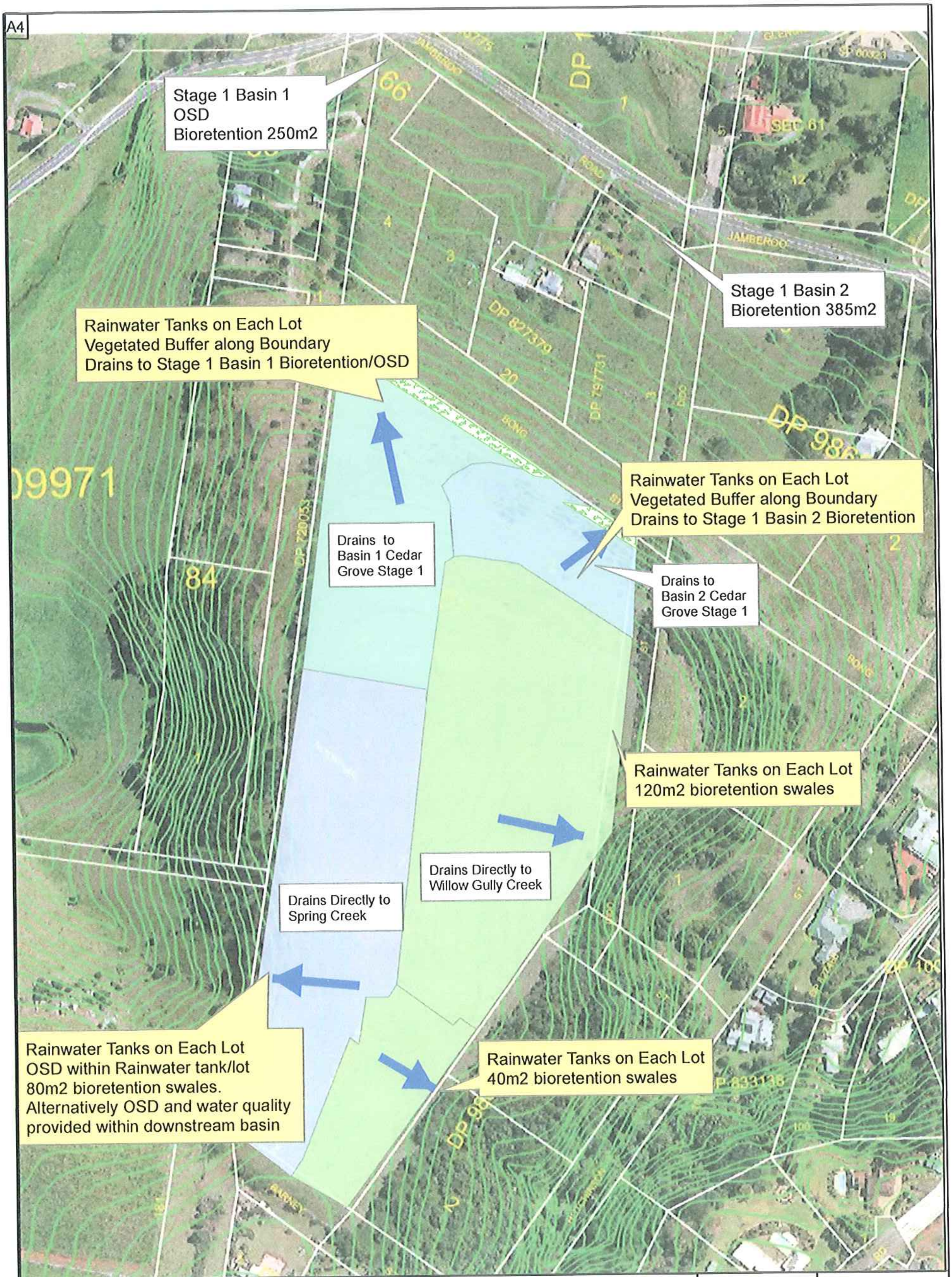
Freeboard	A factor of safety usually expressed as a height above the flood standard. Freeboard tends to compensate for the factors such as wave action, localised hydraulic effects and uncertainties in the design flood levels.
Geographical Information System	A form of computer software developed for mapping applications and data storage. Useful for generating terrain models and processing data for input into flood estimation models.
High hazard	Danger to life and limb; evacuation difficult; potential for structural damage, high social disruption and economic losses. High hazard areas are those areas subject to a combination of flood depth and flow velocity that are deemed to cause the above issues to persons or property.
Historical flood	A flood which has actually occurred – Flood of Record.
Hydraulic	The term given to the study of water flow in rivers, estuaries with coastal systems.
Hydrograph	A graph showing how a river or creek's discharge changes with time.
Hydrology	The term given to the study of the rain-runoff process in catchments.
Low hazard	Flood depths and velocities are sufficiently low that people and their possessions can be evacuated.
Management plan	A clear and concise document, normally containing diagrams and maps, describing a series of actions that will allow an area to be managed in a coordinated manner to achieve defined objectives.
Map Grid Australia	A national coordinate system used for the mapping of features on a representation of the earths surface. Based on the geographic coordinate system 'Geodetic Datum of Australia 1994'.
Peak flood level, flow or velocity	The maximum flood level, flow or velocity occurring during a flood event.
Probable Maximum Flood	An extreme flood deemed to be the maximum flood likely to occur at a particular location.
Probable Maximum Precipitation	The greatest depth of rainfall for a given duration meteorologically possible over a particular location. Used to estimate the probable maximum flood.
Probability	A statistical measure of the likely frequency or occurrence of flooding.
Riparian Zone	Areas that are located adjacent to watercourses. Their definition is vague and can be characterised by landform, vegetation, legislation or their function.
Runoff	The amount of rainfall from a catchment which actually ends up as flowing water in the river of creek.
Stage	Equivalent to water level above a specific datum- see flood level.
Stage hydrograph	A graph of water level over time.
Triangular Irregular Network	A mass of interconnected triangles used to model three-dimensional surfaces such as the ground (see DTM) and the surface of a flood.
Velocity	The speed at which the flood waters are moving. Typically, modelled velocities in a river or creek are quoted as the depth and width averaged velocity, i.e. the average velocity across the whole river or creek section.

8 APPENDICES

Appendix A	Drawings

APPENDIX A

DRAWINGS



BROWN Smart Water

Project : Cedar Grove Estate Stage 2

Drawing Title :

FIGURE A1
STORMWATER CONCEPT

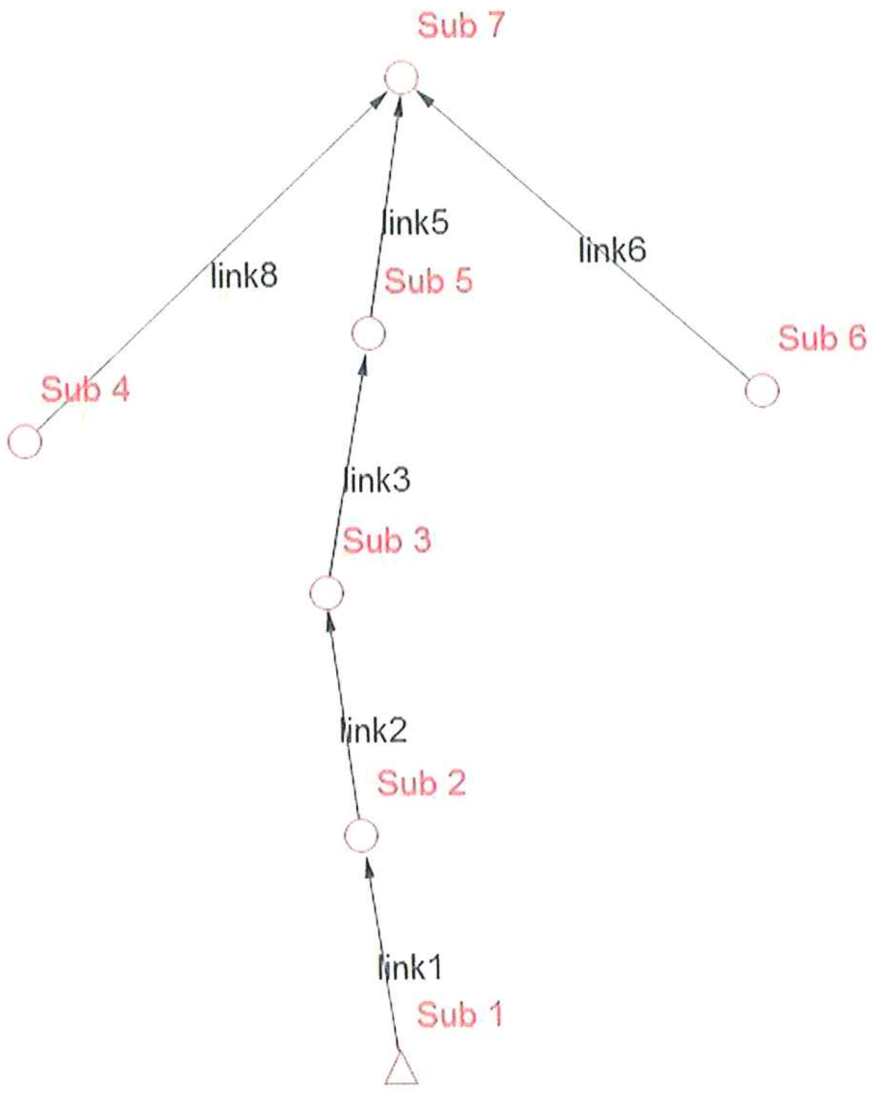
Scale : 1:3000

Drawn : TE

Checked :

Job No : X012064

Existing Scenario



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 LINK Sub 2                 1.000

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 ESTIMATED TIME TO PEAK          (MINS) =                    40.00

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 ESTIMATED TIME TO PEAK          (MINS) =                    47.00

 LINK Sub 6                 1.000

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Kiama

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                              RETURN PERIOD (YRS)      =        100.
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SUMMARY OF CATCHMENT AND RAINFALL DATA

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Sub 2	6.720	10.080	1.000	1.000	99.00	1.000	.025	.045	.0081	.1266	1.001
Sub 3	7.236	16.884	1.000	1.000	99.00	1.000	.025	.045	.0084	.1656	1.002
Sub 5	4.192	6.288	2.000	2.000	99.00	1.000	.025	.045	.0045	.0701	1.003
Sub 6	0.0100	2.900	1.000	1.000	99.00	1.000	.025	.045	.0003	.0662	2.000
Sub 4	0.1000	4.100	3.500	3.500	99.00	1.000	.025	.045	.0005	.0425	3.000
Sub 7	.00001	0.000	1.000	0.000	1.000	0.000	.025	0.00	0.000	0.000	1.004

Link Label	Average Intensity (mm/h)	Init. Loss #1 (mm)	Init. Loss #2	Cont. Loss #1 (mm/h)	Cont. Loss #2	Excess Rain #1 (mm)	Excess Rain #2	Peak Inflow (m^3/s)	Time to Peak	Link Lag mins
Sub 1	113.00	1.500	0.000	0.000	0.000	111.50	0.000	6.167	25.00	7.500
Sub 2	113.00	1.500	10.00	0.000	3.000	111.50	100.40	11.851	33.00	7.000
Sub 3	113.00	1.500	10.00	0.000	3.000	111.50	100.40	16.677	40.00	7.000
Sub 5	113.00	1.500	10.00	0.000	3.000	111.50	100.40	19.339	47.00	5.000
Sub 6	113.00	1.500	10.00	0.000	3.000	111.50	100.40	0.9246	42.00	2.000
Sub 4	113.00	1.500	10.00	0.000	3.000	111.50	100.40	1.961	31.00	5.000
Sub 7	113.00	1.500	0.000	0.000	0.000	111.50	0.000	21.364	52.00	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
Sub 1	25.00	6.167	25.00	7.593	8385.9	0.0000	996.19	69.833

SUMMARY OF BASIN OUTLET RESULTS

Link Label	No. of	S/D Factor (m)	Dia (m)	Width (m)	Pipe Length (m)	Pipe Slope (%)
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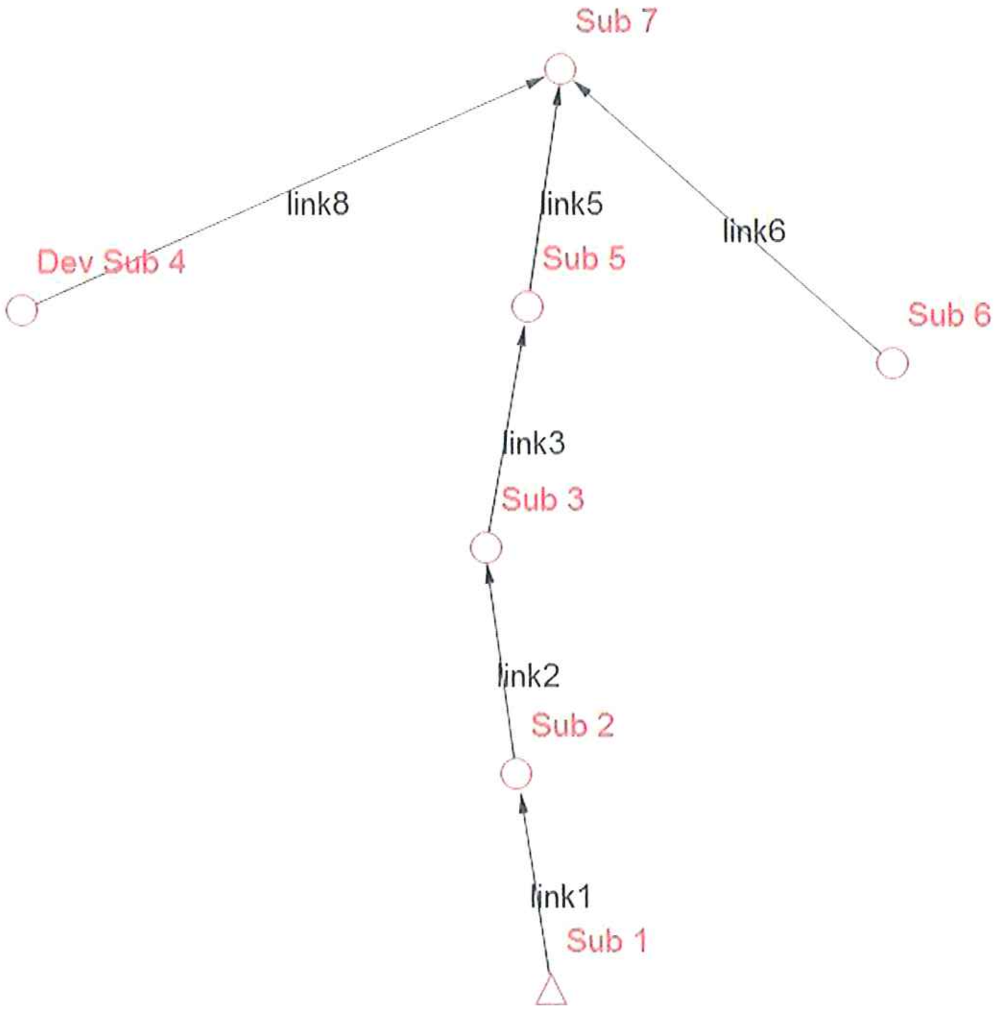
Developed Scenario



DEVELOPED

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 LINK Sub 2               1.000

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 ESTIMATED PEAK FLOW           (CUMECS) =                      12.
 ESTIMATED TIME TO PEAK           (MINS) =                   33.00

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 ESTIMATED PEAK FLOW           (CUMECS) =                      17.
 ESTIMATED TIME TO PEAK           (MINS) =                   40.00

 LINK Sub 5               1.000

 ESTIMATED VOLUME (CU METRES*10**3) =                        61.88
 ESTIMATED PEAK FLOW           (CUMECS) =                      19.
 ESTIMATED TIME TO PEAK           (MINS) =                   47.00

 LINK Sub 6               1.000

 ESTIMATED VOLUME (CU METRES*10**3) =                        2.933
 ESTIMATED PEAK FLOW           (CUMECS) =                     0.92
 ESTIMATED TIME TO PEAK           (MINS) =                   42.00

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Kiama

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                     to  8:20.0  1/ 1/1990
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                               STORM DURATION (MINS)    =         60.
                               RETURN PERIOD (YRS)      =        100.
                               BX                       =      1.0000
                               TOTAL OF FIRST SUB-AREAS  (ha) =        28.27
                               TOTAL OF SECOND SUB-AREAS (ha) =        37.67
                               TOTAL OF ALL SUB-AREAS (ha)    =        65.93
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SUMMARY OF CATCHMENT AND RAINFALL DATA

Link Label	Catch. Area #1 (ha)	Catch. Area #2	Slope #1 (%)	Slope #2	% Impervious #1 (%)	% Impervious #2	Pern #1	Pern #2	B #1	B #2	Link No.
Sub 1	7.524	0.000	1.000	0.000	99.00	0.000	.025	0.00	.0086	0.000	1.000
Sub 2	6.720	10.080	1.000	1.000	99.00	1.000	.025	.045	.0081	.1266	1.001
Sub 3	7.236	16.884	1.000	1.000	99.00	1.000	.025	.045	.0084	.1656	1.002
Sub 5	4.192	6.288	2.000	2.000	99.00	1.000	.025	.045	.0045	.0701	1.003
Sub 6	0.0100	2.900	1.000	1.000	99.00	1.000	.025	.045	.0003	.0662	2.000
Dev Sub 4	2.583	1.517	3.500	3.500	99.00	1.000	.025	.045	.0026	.0253	3.000
Sub 7	.00001	0.000	1.000	0.000	1.000	0.000	.025	0.00	0.000	0.000	1.004

Link Label	Average Intensity (mm/h)	Init. Loss #1 (mm)	Init. Loss #2	Cont. Loss #1 (mm/h)	Cont. Loss #2	Excess Rain #1 (mm)	Excess Rain #2	Peak Inflow (m^3/s)	Time to Peak	Link Lag mins
Sub 1	113.00	1.500	0.000	0.000	0.000	111.50	0.000	6.167	25.00	7.500
Sub 2	113.00	1.500	10.00	0.000	3.000	111.50	100.40	11.851	33.00	7.000
Sub 3	113.00	1.500	10.00	0.000	3.000	111.50	100.40	16.677	40.00	7.000
Sub 5	113.00	1.500	10.00	0.000	3.000	111.50	100.40	19.339	47.00	5.000
Sub 6	113.00	1.500	10.00	0.000	3.000	111.50	100.40	0.9246	42.00	2.000
Dev Sub 4	113.00	1.500	10.00	0.000	3.000	111.50	100.40	2.865	25.00	5.000
Sub 7	113.00	1.500	0.000	0.000	0.000	111.50	0.000	20.937	52.00	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
Sub 1	25.00	6.167	25.00	7.593	8385.9	0.0000	996.19	69.833

SUMMARY OF BASIN OUTLET RESULTS

Link Label	No. of	S/D Factor (m)	Dia (m)	Width (m)	Pipe Length (m)	Pipe Slope (%)
Sub 1	1.0	1.000		0.000	20.000	0.2000

Run completed at: 25th June 2013 8:39:00