Flood Study

For

Proposed Rezoning

At

Lot 7 & Part Lot 8 DP1025196
and
Lot 4 DP881346

Sutton Road and Faithfull Street
Gundaroo

For

Dr R & Mrs M Meischke

4 July 2014
BH Ref: 2916

barker harle
consulting engineers

4 July 2014
BH Ref: 2916

Dr R & Mrs M Meischke
25 Faithfull Street
Gundaroo NSW 2620

Dear Dr & Mrs Meischke,

Re: Flood Study for Proposed Rezoning of Lot 7 & Part Lot 8 DP1025196 & Lot 4 DP881346 Sutton Road and Faithfull Street, Gundaroo

The following report presents the results of a Flood Study undertaken on the Yass River catchment upstream of the confluence of the Yass River and Back Creek, and the catchments of Lot 7 & Part Lot 8 DP1025196 & Lot 4 DP881346 in order to prepare a flood hazard analysis.

The report has been prepared in response to a letter from Yass Valley Council, dated 6 February 2014, in relation to Planning Proposal 2013_01 (proposed rezoning of land known as Sutton Road and Faithfull Street, Gundaroo), which set out details of matters that needed to be addressed as part of the current planning proposal, as a result of advice received by Yass Valley Council from: NSW Office of Environment & Heritage; Murrumbidgee Catchment Management Authority; NSW Department of Primary Industries - Office of Water and NSW Health.

A copy of this letter can be seen in the attachments section of this report.

If you have any further enquiries please do not hesitate to contact the undersigned.

Yours faithfully
Barker Harle

Robert Barker
FIE Aust, CPEng, NPER (Civil, Structural).

Contents

Attachments

1. Drawings 2916/F1 – 2916/F17
2. Letter from Yass Valley Council, Dated 6 February 2014
3. DRAINS Data Files

History Of This Document

Document status and review

Revision	Author	Reviewer	Date Issued
0	Rob Barker	Justin Frost	4 July 2014

Distribution of copies of this document

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0	1	1	Salvestro Planning
	1	1	Dr R & Mrs M Meischke
	1	1	Barker Harle file/archives
	1		Yass Valley Council

Flood Study Investigation

Proposed Rezoning

Lot 7 & Part Lot 8 DP1025196 and Lot 4 DP881346

Sutton Road and Faithfull Street, Gundaroo

1. Executive Summary

Barker Harle carried out a flood study on the Yass River catchment upstream of the confluence of the Yass River and Back Creek, contributing to the floodwater levels at the subject site, Lot 7 & part Lot 8 DP1025196 & Lot 4 DP881346 [*the Site*], at the request of Dr and Mrs Meischke.

The purpose of this investigation was to determine and report the 100 year average recurrence interval [*ARI*] and probable maximum flood [*PMF*] floodwater levels within the Site, as part of a flood hazard analysis, thereby, allowing Yass Valley Council to progress consideration of the rezoning proposal.

The flood study for the Site was prepared in accordance with the NSW Floodplain Development Manual: The Management of Flood Liable Land, and Section 117(2) of the Environmental Planning and Assessment Act 1979, Direction 4.3 Flood Prone Land.

Yass Valley Council's Local Environmental Plan [*LEP*] 2013, Section 6.2 Flood Planning, cl 5, defines the flood planning level [*FPL*] for development to be the 100 year ARI flood event plus 0.5m freeboard.

Floodwater impacts on the Site as a result of floodwater from the Yass River and the 2 sub-catchments, which traverse the Site, were assessed. It was determined that the critical duration 100 year ARI floodwater levels from the Yass River did not reach the Site.

The critical duration flood levels in the Yass River and across the Site are shown on Drawings 2916/F7 - F17.

2. Introduction

This report presents the findings of a flood study undertaken on the Yass River catchment, upstream from the confluence of the Yass River and Back Creek, contributing to the floodwater levels impacting Lot 7 & part Lot 8 DP1025196 & Lot 4 DP881346 [*the Site*] to support the proposed rezoning of Lot 7 & part Lot 8 DP1025196 and Lot 4 DP881346. The flood study was undertaken at the request of the proponents, Dr and Mrs Meischke.

The purpose of the flood study was to determine the:

- 100 year average recurrence interval [*ARI*] discharge within the catchment, and
- 100 year ARI floodwater level on the Site.
- Probable maximum flood [*PMF*] level on the Site

The investigation comprised the following tasks:

- Desktop study, including a review of topographic maps to determine the catchment boundary, main branches and channel characteristics;
- Review of available historical records of flood events along Yass River in the vicinity of Gundaroo;
- Catchment survey on 8 April 2014 to confirm the catchment boundary and to determine terrain parameters to be used in the hydrological analysis;
- Extensive topographical survey through the Site and along the main channel (Yass River) upstream and downstream of the Site, to determine the design channel cross sections to be used in the hydraulic analysis;
- Development of numerical models using the computer program DRAINS to perform the hydrological and hydraulic analysis;
- Interpretation of data and reporting.

The flood study has been undertaken in accordance with:

- Australian Rainfall and Runoff, volumes 1 & 2 (1997) [Ref 1];
- Section 117(2) of the Environmental Planning and Assessment Act 1979, Direction 4.3 Flood Prone Land [Ref 2], and
- NSW Floodplain Development Manual: The Management of Flood Liable Land (May 2005) [Ref 3];
- Yass Valley Council's Local Environmental Plan (2013), Section 6.2 Flood Planning [Ref 4].

3. Background

3.1 Rezoning Proposal

An application, Planning Proposal 2013_01 (proposed rezoning of land known as Sutton Road and Faithfull Street, Gundaroo), has been lodged by the proponents, Dr R & Mrs M Meischke with Yass Valley Council for the rezoning of the Site from RU1 to R2 and RU5 in accordance with Yass Valley Council's LEP 2013, and is summarised below;

- RU5 Village zone for the main urban areas of the village between Cork Street and Lute Street with minimum lot sizes of 2,000m^2;
- R2 Low Density Residential zone for the land between Lute Street and Judith Street, with minimum lot sizes of 5,000m^2.

The flood study report has been prepared in response to a letter from Yass Valley Council, dated 6 February 2014, in relation to Planning Proposal 2013_01, which set out details of matters that needed to be addressed as part of the assessment of the current planning proposal, as a result of advice received by Yass Valley Council from: NSW Office of Environment & Heritage; Murrumbidgee Catchment Management Authority; NSW Department of Primary Industries - Office of Water and NSW Health.

The purpose of the flood study was to provide a flood hazard analysis that would demonstrate that rezoning of the Site would be consistent with Section 117(2) of the Environmental Planning and Assessment Act 1979, Direction 4.3 Flood Prone Land [Ref 2], and the NSW Floodplain Development Manual: The Management of Flood Liable Land (May 2005) [Ref 3].

3.2 Site Description

The Site was located to the east of Sutton Road and to the south of Faithfull Street. The Site was bordered by rural property to the east, south and west and by residential properties within the Gundaroo village to the north. The location of the Site can be seen on drawing 2916/F1.

Topographically the Site sloped down from the east to the west with undulating slopes varying between 1% and 5% with some local slopes up to 10% on the flanks of small rises. Surface levels on the site ranged between AHD RL 574m and RL 592m.

The topography of the Site created a northern and southern sub-catchment. The northern sub-catchment, had a catchment area of 54.6 Ha. The southern sub-catchment which incorporated Harrow Creek, had a catchment area of 274 Ha.

At the time of the flood study investigation there was a large erosion gully varying typically between 2m to 3m deep x 6m to 12m wide, known locally as Harrow Creek, running centrally through the southern sub-catchment of the Site in an east – west direction. The gully conveys flow under Sutton Road through a 3 x 1.8m diameter pipe culvert, and discharges into the Yass River on the western side of Sutton Road. Photograph P1 shows the pipe culvert conveying Harrow Creek flows under Sutton Road.

Vegetation on the site consisted of improved grasslands over the area of the site used for grazing, with a mixture of native and exotic trees and shrubs forming gardens in close proximity to the existing commercial and residential properties. The market garden area on Lot 1 DP840631, which was not included in the rezoning proposal, was intensively farmed.

The existing site layout and contour plan can be seen on drawing 2916/F2.

Photograph P1 – Upstream view of the 3 x 1.8m diameter pipe culvert conveying flow in Harrow Creek under Sutton Road.

3.3 Study Area and Catchment

The total catchment area considered in the flood study of the Yass River was approximately 488km^2. The catchment was bordered by Lake George Range to the east, topographical

ridgelines defining the NSW/ACT border to the south-west, the limit of the Back Creek catchment to the north-west, and the limit of the McLeods Creek catchment to the north.

The catchment outlet, for the purposes of the flood study, was positioned approximately 1.2km north of the Gundaroo village, beyond the confluence of the Yass River and Back Creek; to enable an assessment to be made of potential backwater effects on the Site, arising from the merging of floodwater at the junction of the Yass River and Back Creek. The confluence of Back Creek with the Yass River was located approximately 0.9km to the north west of the Gundaroo village

The catchment typically consisted of rural farmland and undisturbed natural forests on undulating hills with elevations ranging between AHD RL 565m to 918m.

A catchment plan can be seen on Drawing 2916/F3.

Photographs P2 – P4 show the typical terrain through the catchment.

Photograph P2 – View of the terrain of the south-eastern portion of the catchment, taken on Sutton Road, approximately 4km south of Sutton

Photograph P3 - View of the terrain of the south-western portion of the catchment, taken on Sutton Road, approximately 7km south of Sutton

Photograph P4 - View of the terrain of the main Yass River catchment, taken on Dairy Creek Road, approximately 2km east of Gundaroo, facing south

3.4 Major Rivers/Creeks

The main branches that make up the Yass River catchment contributing to floodwater levels downstream of Gundaroo Bridge, are shown on Drawing 2916/F3 and are summarised in Table 1, below.

Table 1 – Summary of Main Branches

Branch	Catchment Area (km^2)
Yass River	210.2
Back Creek	122.8
Brooks Creek	122.1
Dairy Creek	18.5
McLeods Creek	14.4

3.4.1 Yass River

Yass River is the main drainage line within the catchment and runs predominantly in a south - north direction, centrally through the catchment. Yass River was found to have a slope of approximately 1% - 1.5% at the upstream end of the catchment, and a slope <0.5% further down the catchment, in the vicinity of Gundaroo Bridge. Photograph P5 shows the Yass River along the western side of Gundaroo village.

Photograph P5 - View of the Yass River, facing south-east (upstream), toward Gundaroo, taken from the top of the river bank, approximately 400m west of Gundaroo Park

The Yass River catchment was bordered by topographical ridgelines defining the Yass River and Brooks Creek catchments to the east, topographical ridgelines defining the Yass River and Back Creek catchments to the west, and topographical ridgelines defining the NSW/ACT border to the south.

3.4.2 Back Creek

Back Creek forms a major part of the studied catchment. Back Creek collects runoff from the north western side of the catchment and discharges into the Yass River approximately 1km north west (downstream) of the Gundaroo village. The Back Creek catchment was bordered by topographical ridgelines defining the Back Creek and Yass River catchments to the east and north, and by topographical ridgelines defining the NSW/ACT border on the remaining sides. Back Creek was found to have an average slope of approximately 1%.

The Back Creek catchment has been included in the flood study in order to enable an assessment to be made of the potential backwater effects arising upstream along the Yass River at the at the Site as a result of the merging of the flows from each sub-catchment.

Photograph P6 shows the topography of the floodplain in the vicinity of the junction between the Yass River and Back Creek.

Photograph P6 - View of Yass River and Back Creek junction, predominantly flood plain, taken from an access road approximately 700m west of the Gundaroo village, facing north (downstream)

3.4.3 Brooks Creek

Brooks Creek collects runoff from the eastern side of the studied catchment and discharges into the Yass River, approximately 4km south of the Gundaroo village, upstream of Gundaroo Bridge. The Brooks Creek catchment was bordered by Lake George Range to the east, topographic ridgelines defining the Brooks Creek and the Yass River catchments to the west and by topographical ridgelines defining the Brooks Creek and Dairy Creek catchments to the north.

Brooks Creek was found to have a slope of approximately 2% at the upstream end of the catchment, and less than 1% at the downstream end, approaching the junction of Brooks Creek and the Yass River.

3.4.4 Dairy Creek

Dairy Creek forms a small part of the studied catchment and collects runoff from the north eastern side of the catchment and discharges into Brooks Creek approximately 2km east of the junction between the Yass River and Brooks Creek. The Dairy Creek catchment was bordered by Lake George Range to the east, topographical ridgelines defining the Dairy Creek and Brooks Creek catchments to the south, topographical ridgelines defining the Dairy Creek and the Yass River catchments to the west, and by topographical ridgelines defining the Dairy Creek and McLeods Creek catchments to the north.

Dairy Creek was found to have an average slope of approximately 2º.

3.4.5 McLeods Creek

McLeods Creek forms a small part of the studied catchment and collects runoff from the northern side of the catchment directly downstream of the Gundaroo village. The McLeods Creek catchment was bordered by topographical ridgelines defining the McLeods Creek and Dairy Creek catchments to the south, and by topographical ridgelines defining the McLeods Creek and the Yass River catchments on the remaining sides.

McLeods Creek was found to have an average slope of approximately 3% and conveyed runoff from the catchment into the Yass River.

Runoff was conveyed under Gundaroo Road through 3 - 3.1m x 3.1m square reinforced concrete box culverts approximately 400m upstream from the junction between McLeods Creek and the Yass River.

McLeods Creek catchment has been included in the flood study, along with the Back Creek catchment, in order to enable an assessment to be made of the potential backwater effects arising upstream along the Yass River at the Site as a result of the merging of the flows from each sub-catchment.

3.5 Sub-Catchments

The main catchments identified in this study were subdivided into a number of sub-catchments for modelling purposes. A total of 20 sub-catchments were used to model the catchment contributing to floodwater levels downstream of Gundaroo Bridge, and can be seen on Drawing 2916/F4.

The sub-catchment C, which contained the Site, was further subdivided into sub-catchments which related to the drainage paths across the Site.

The smaller, 54.6Ha, northern sub-catchment, C2, conveyed water from two contributing minor drainage depressions/creeks toward an outlet at the north western corner of the Site and contributed to flows along Faithfull Street at the corner of Sutton Road and Faithfull Street.

The larger, 274Ha, southern sub-catchment was identified as sub-catchment C3 - Harrow Creek and conveyed floodwater to the Harrow Creek erosion gully running in an east - west direction through the Site and under Sutton Road through the 3 x 1.8m diameter pipe culvert, where the runoff then discharged to the Yass River.

Sub-catchments C2 and C3 may be seen in Drawings 2916/F5 and F6

3.6 Survey Data

A detailed survey of the Site, cross sections through the Yass River at Gundaroo Bridge and downstream of Gundaroo Bridge and cross sections along Harrow Creek within the Site, were prepared by Capital Surveys.

The detailed survey of the Site contour information was used to determine design cross sections within sub-catchment C2 through the Site.

The cross sections were used in the hydraulic analysis.

The location of the cross sections can be seen on Drawings 2916/F1 and F2.

3.7 Previous Studies

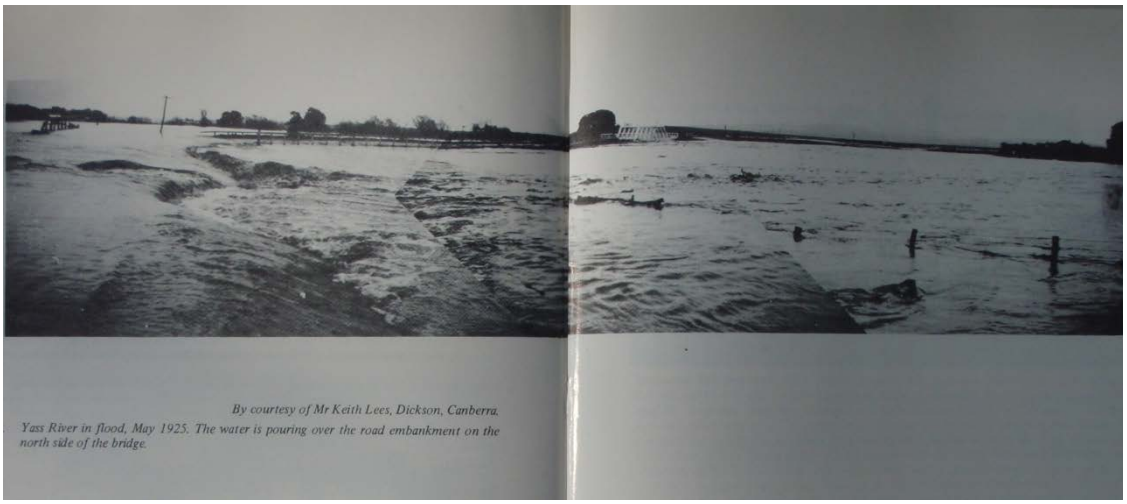
It was understood that there have been no previous flood studies undertaken that have determined floodwater levels along the Yass River directly downstream of Gundaroo Bridge and within the Site. Enquiries identified that historical stream gauge records were not available from Yass Valley Council.

3.8 Historical Records

3.8.1 May 1925 - Gundaroo Bridge

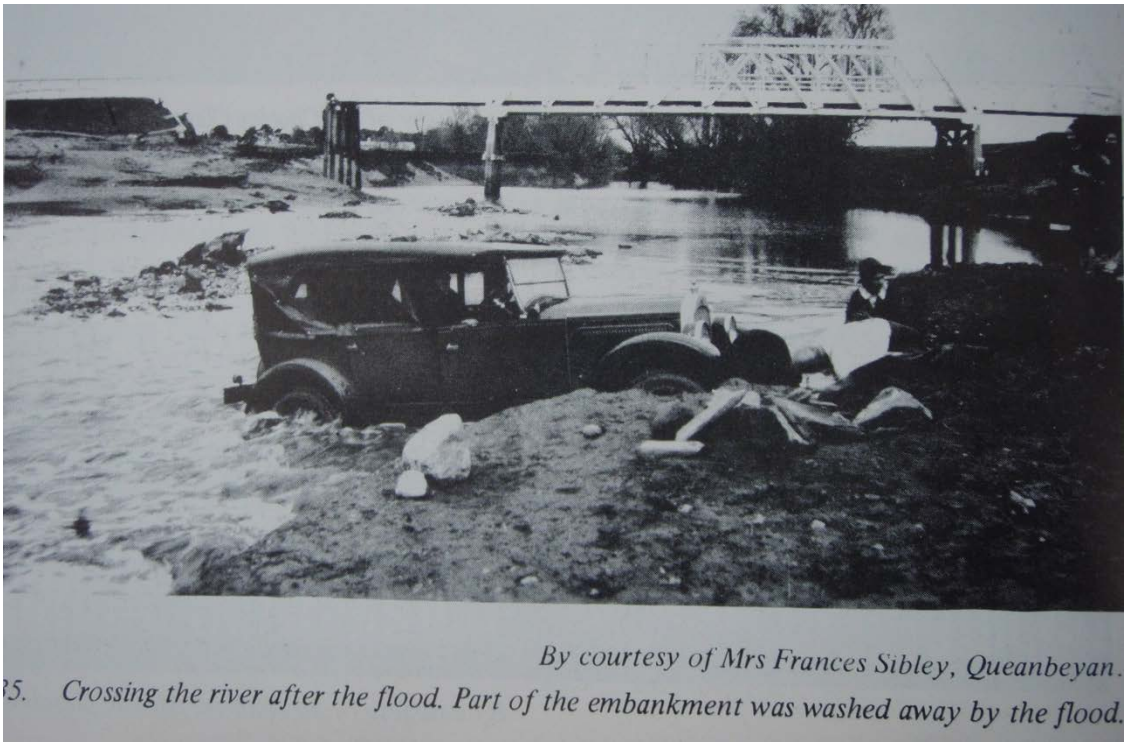
A search of available historical records identified photographic records of a major flood event in 1925, depicting the flood waters impacting the former timber truss Gundaroo Bridge, which was demolished in April-May 2014. The photographs depict the flood water at the underside of the timber deck beams and the erosion of an approach embankment on the eastern side of the bridge. Instead of reconstructing the lost road embankment, the bridge was extended to the east, resulting in an increased waterway area beneath the bridge.

Details of the floodwater level at the timber bridge may be seen in photograph P7, and the aftermath of the flood in photograph P8, below.



Photograph P7 - May 1925, floodwater across Sutton Road and beneath Gundaroo Bridge.

The current Gundaroo Bridge was constructed with the underside of the concrete trough girders generally below the underside of the timber deck beams in the original timber Gundaroo Bridge and timber framed approach spans. The relative positions and levels of the former and current bridges may be seen in photographs P 9 and P10, below.



Photograph P8 – May 1925, receding floodwater at Gundaroo Bridge, looking upstream.

Photograph P9 - The current and former Gundaroo Bridge – March 2014

Photograph P10 - The current and former Gundaroo Bridge, looking east – 11 March 2014

Visual assessment, while the 2 bridges were still in place, on 11 March 2014, indicated that the waterway area beneath the current Gundaroo Bridge was less than the available waterway area beneath the former timber bridge.

3.8.2 8 March 2014 - Corner Sutton Road and Faithfull Street & Gundaroo Bridge

Photographs provided by Yass Valley Council of a storm on 8 March 2014, show floodwater along Faithfull Street and flowing in a concentrated flow across Lot 7 DP 1025196. See photographs P11 and P12, below.

Photograph P11 - Floodwater on the southern side of Faithfull Street and on Lot 7 DP 1025196

Source: Yass Valley Council

Photograph P12 - Floodwater discharging from Lot 7 DP 1025196 – 8 March 2014
Source: Yass Valley Council

Observations made by Barker Harle on 11 March 2014, of debris deposited in trees, debris along the Yass River bank and on the bridge piers and gabion protection mattresses at the Gundaroo Bridge abutments, indicated that the floodwater on 8 March 2014 rose to approximately 574m AHD, 1.2m below the underside of the concrete trough girders, as shown in photograph P13, below.

Photograph P13 - Approx. floodwater level from storm on 8 March 2014 at the western abutment of Gundaroo Bridge.

4. Methodology

4.1 General

The investigation comprised an hydrological and hydraulic analysis to determine the discharge within the Yass River catchment upstream of the confluence of the Yass River and Back Creek, and hence determine the level and areal extent of the critical 100 year ARI floodwater in the Yass River at the Site and the 100 year ARI and PMF discharge and flood levels through the Site.

4.2 Hydrological Modelling

1:25,000 scale topographical maps and the NSW Department of Land Spatial Information Exchange Maps website were used in conjunction with aerial photographs and a visual survey to determine catchment/sub-catchment boundaries and area. The physical survey also enabled the determination of the terrain parameters (slope, flow paths, roughness, percentage pervious) that were required to be used in the hydrological analysis

Additional survey by Capital Surveys was also used to determine flow path cross sections and slope data within the Site and within the Yass River between Gundaroo Bridge and Faithfull Street.

Existing stormwater culverts & overland flow routes were located to determine sub-catchment areas and controls.

The numerical software DRAINS (version 2014.04 and 2014.07) was used to determine the discharge through the catchment, for the design storm events. DRAINS modelled a range of storm durations to determine the critical storm duration that created the peak discharge for each sub-catchment. The storm events modelled, ranged from 15 minute duration to 36 hour duration.

The design storm events up to and including the 100 year ARI, determined from Intensity Frequency Duration [*IFD*] data obtained from the Bureau of Meteorology and the PMP determined in accordance with The Estimation of Probable Maximum Precipitation in Australia - Generalised Short-Duration Method [Ref 5]. The data used to create the hydrological models is summarised in Tables 2 to 4, below.

Input data to model the catchment consisted of the river and channel cross-section details, sub-catchment percentage impervious/pervious, flow-path slope and flow-path roughness.

The catchment data can be seen in the DRAINS data files, found in the attachments section of this report and is summarised in Drawings 2916/F3 to F6.

Table 2 – IFD data for Gundaroo

Latitude	Longitude	Skew
35.025S	149.275E	0.22
	Intensity (mm/hr)	
Duration	2 yr ARI	50 yr ARI
1 hr	21.4	44.9
12 hr	4.21	8.25
72 hr	1.14	2.15

Table 3 – PMP data for Sub-catchment C2 and C3 – Catchment Properties

Probable Maximum Precipitation Data	
Catchment Area (km^2):	3.29
Percent Rough (%):	0
Elevation of Catchment (m)	600
Moisture Adjustment Factor (%):	66
Limit (hr):	5

Table 4 – PMP data for Sub-catchment C2 and C3 – Total Rainfall Depth Vs Duration

Duration (hr)	Smooth Depth (mm)	Rough Depth (mm)	Averaged Depth (mm)	Adjusted Depth (mm)	Rounded Depth (mm)
0.25	225	0	225	149	150
0.5	230	0	230	152	150
0.75	415	0	415	274	270
1	485	0	485	320	320
1.5	555	0	555	366	370
2	620	0	620	409	410
2.5	660	0	660	436	440
3	695	0	695	459	460
4	760	0	760	502	500
5	820	0	820	541	540
6	-	-	-	-	-

4.3 Hydraulic Modelling

Flood levels within the Yass River between Gundaroo Bridge and Faithfull Street, and within the Site were determined from the hydraulic analysis.

Channel sections were determined from a detailed survey of the Yass River extending from Gundaroo Bridge to the confluence of the Yass River and Back Creek. Design cross sections used in the determination of flood levels in the Yass River and at the Site can be seen on Drawings 2916/F1, F2, and F9 – F17.

Due to the size of the catchment and available survey information, the channel characteristics outside the area of interest were approximated. It was determined that design channel cross section Y3, shown on Drawing 2916/F11, provided a reasonable approximation for the main drainage line between each sub catchment.

In the hydraulic analysis, it was assumed that the 3 x 1.8m diameter pipe culverts conveying flow from sub-catchment C3 - Harrow Creek, under Sutton Road would be blocked during a major storm event. This assumption was deemed reasonable as during a major storm, debris would be conveyed within the floodwater and could potentially block the culvert. Applying a blockage factor of 100% was considered to provide the most conservative approximation of floodwater levels within the Site and the floodwater levels resulting from a 100% blocked culvert have been shown within the Site on Drawings 2916/F7 and F8 and on the Harrow Creek cross sections on Drawing 2916/ F13 and F14.

5. Peak Discharge & Critical Flood Levels

5.1 100 Year ARI Peak Discharge

5.1.1 Yass River

The numerical hydrological analysis performed by DRAINS, determined the peak discharge at each sub-catchment outlet for the 100 year ARI, 1 hour to 36 hour storm events. The calculated peak discharge in the Yass River is summarised in Table 5, below.

The orange shaded cells within Table 5 indicate the critical storm duration for each sub-catchment as calculated by DRAINS.

Output files from the numerical analysis can be seen in the attachments section of this report.

Table 5 – Sub-catchment outlet discharge for the 100 year ARI, 1 hour to 36 hour storm events

Sub	Discharge (m^3/s)											
Catch.	1hr	1.5hr	2hr	3hr	4.5hr	6hr	9hr	12hr	18hr	24hr	30hr	36hr
A	13.6	12.6	12.4	13.3	11.3	10.5	9.7	11.2	9.6	9.0	6.4	6.5
B	67.6	77.8	81.8	81.8	79.6	77.5	68.3	68.8	65.2	74.4	71.1	71.9
C*	23.3	25.7	26.7*	26.4	25.6	24.3	22.3	22.7	21.8	22.8	21.5	21.8
D	50.4	61.7	69.2	73.7	73.6	72.6	59.4	62.7	56.7	68.9	69.4	69.1
E	24.9	30.6	34.9	41.9	48.6	53.6	58.6	58.8	65.7	60.0	55.7	53.8
F	47.1	58.0	66.2	79.3	88.9	93.8	95.6	89.3	99.9	91.0	91.0	86.6
G	51.2	62.9	71.7	83.9	87.7	90.0	76.9	76.7	78.3	82.9	84.9	80.6
H	69.6	85.5	97.0	108	110	111	89.2	96.0	88.3	104	104	101
I	60.9	74.1	81.5	84.6	83.8	83.3	68.7	69.3	64.2	79	79.4	79.6
J	56.3	69.1	79.0	94.6	105	111	112	104	116	105	107	102
K	80.8	99.2	113	127	130	131	105	113	105	122	122	119
L	83.3	102	117	138	145	149	131	127	131	137	142	134
M	80.2	98.5	112	125	128	129	103	111	103	121	120	117
N	36.9	45.4	51.8	60.4	62.9	64.5	54.3	55.0	55.8	59.4	60.7	57.8
O	17.5	21.5	24.5	29.0	30.7	31.7	28.6	27.0	28.5	29.3	30.4	28.5
P	42.2	49.7	52.9	53.3	52.2	51.8	43.9	44.5	41.7	49.5	48.0	48.4
Q	37.0	38.7	40.0	39.4	37.2	35.3	32.6	34.3	33.8	32.0	29.4	29.9
R	9.5	9.5	9.7	9.7	8.9	8.4	7.8	8.3	8.3	7.4	6.4	6.5
S	48.3	59.1	66.5	71.4	71.3	70.6	57.5	61.4	55.0	66.9	67.3	66.8
T	96.5	118	133	142	142	140	114	121	109	133	134	133
Total	**997**	**1200**	**1340**	**1482**	**1522**	**1540**	**1339**	**1361**	**1337**	**1454**	**1450**	**1412**

** Peak discharge in sub-catchment C, Harrow Creek*

It was determined that the critical flood levels within the Site would coincide with one of the following storm events:

1. Storm duration creating the peak flow at node 1-2, the confluence of Back Creek and the Yass River, to allow for any potential backwater effects at the Site from the concurrent contribution of all the drainage lines in the catchment, or

2. Storm duration creating the peak flow within Yass River at node 1-3, potentially choking the flow in sub-catchment C, or.

3. Storm duration creating the peak flow within sub-catchments C2 & C3, combined with a 100% blockage of the culvert conveying the flows in Harrow Creek under Sutton Road.

5.1.2 The Site

In order to examine the flows through the Site, 2 additional refined sub-catchments, C2 and C3 (Harrow Creek), were created in order to model the 2 catchments directing floodwater through the Site. The sub-catchments may be seen on Drawings 2916/F5 and F6.

The numerical hydrological analysis performed by DRAINS, determined the peak discharge in each sub-catchment outlet for the 100 year ARI, 1 hour critical duration storm event. The calculated peak discharge in each sub-catchment on the Site is summarised in Table 6, below.

Table 6 – Sub-catchment outlet discharge for the 100 year ARI, 1 hour critical duration storm events

Sub-catchment	Discharge (m^3)
C2 – Northern part of the Site	7.1
C3 – Southern part of the Site (including Harrow Creek)	27.8

5.2 100 Year ARI Critical Flood Levels

The 100 year ARI flood levels within the Yass River, between Gundaroo Bridge and Faithfull Street, and within the Site were determined by numerical hydraulic analysis undertaken within DRAINS.

5.2.1 Yass River

The critical flood levels within the Yass River, resulting from the 100 year ARI storm events, at the design cross sections, are summarised in Table 7, below.

Table 7 – 100 year ARI critical flood levels in the Yass River at the design cross sections

Section	Location	Flood Level (m AHD)
Y1	Through the Yass River, at the upstream side of Gundaroo Bridge.	575.59
Y2	Through the Yass River, adjacent to the southern boundary of the site.	574.80
Y3	Through the Yass River, adjacent to the 3 x 1.8m diameter pipe culvert conveying runoff under Sutton Road from Harrow Creek.	574.48
Y4	Through the Yass River, in line with the centreline of Faithfull Street, adjacent to the northern boundary of the site.	572.93

The location of the design cross sections and the interpolated areal extent of the 100 year ARI floodwater can be seen on Drawings 2916/F1 and F7. The level of the 100 year ARI floodwater at each design cross section can be seen on Drawings 2916/F9 – F12.

The critical flood levels within the Yass River, downstream of Gundaroo Bridge, resulted from a storm duration of 18 hours. The analysis showed that the critical flood levels within the Yass River did not reach Sutton Road and did not encroach onto the Site. The 100 year ARI flood level remained well within the Yass River flood plain to the west of Sutton Road, as shown on Drawing 2916/F7.

The Gundaroo Bridge becomes an inlet controlled structure, i.e. the approaching floodwater level on the upstream side of the bridge is above the top of the available waterway area beneath the bridge during the 100 ARI flood. The upstream floodwater level was found to be approximately 0.4m above the level of the bottom of the bridge trough girders.

5.2.2 The Site

The critical flood levels resulting from floodwater flowing through the Site within each sub-catchment (C2 and C3), resulting from the 100 year ARI storm events, corresponded with a storm duration of 1 hour.

Runoff through the smaller northern sub-catchment, C2, flowed along 2 separate drainage depressions from the east, before converging at the location of an existing dam southwest of the existing veterinary clinic on Lot 5 DP1002259 and then flowed to the north western corner of Lot 7, DP 10251969 where it discharged onto Faithfull Street and Sutton Road, joining with floodwater flowing to the west along Faithfull Street. The confluence of the floodwater flowing from the Site with the Faithfull Street flows, following a storm on 8 March 2014, may be seen in photograph P12.

Runoff within the larger southern sub-catchment, C3, Harrow Creek, was conveyed under Sutton Road through a 3 x 1.8m diameter pipe culvert and discharged to the Yass River on the western side of Sutton Road. The floodwater levels were determined by analysing the culvert control in different 3 conditions:

1. Applying a 0% blockage factor, allowing the culvert to run at full capacity;

2. Applying a 50% blockage factor, to allow for the potential debris reducing the waterway area of the culvert pipes by 50%;

3. Applying a 100% blockage factor, thus effectively totally blocking the culvert, to determine a worst case flood level in Harrow Creek upstream of the culvert within the Site. In this design condition the runoff would have to be stored within Harrow Creek until the water level rose sufficiently to allow floodwater to spill over Sutton Road.

The critical flood levels within Harrow Creek, resulting from the 100 year ARI storm events, at the design cross sections with the different blockage conditions applied to the culvert, are summarised in Table 8, below. It was shown that the backwater affects from the blockage raised the floodwater level at design section HC2, at the western end of the site at the boundary with Lot 1 DP 857918, by 0.25m. As a result of the relatively steep longitudinal grade of Harrow Creek, backwater effects arising from the ponding of flood water upstream of the blocked culvert, dissipated very quickly with distance upstream and did not affect the floodwater level at HC3 or further upstream.

The 100 year ARI floodwater was found to be contained within the banks of the Harrow Creek erosion gully in the southern portion of the Site

Table 8 – 100 year ARI Critical flood levels in Harrow Creek at the design cross sections

Section	Flood Level (m AHD)		
	0% Blockage	50% Blockage	100% Blockage
HC1	575.67	575.90	576.04
HC2	575.87	576.02	576.12
HC3	577.08	577.08	577.08
HC4	579.52	579.52	579.52
HC5	581.02	581.02	581.02
HC6	583.0	583.0	583.0
HC7	585.28	585.28	585.28

The floodwater flow from Harrow Creek with a 0% blockage resulted in a 20mm deep flow of floodwater across Sutton Road. It was determined that applying a blockage factor of 50% and 100% resulted in higher floodwater levels on the upstream side of the culvert and deeper floodwater flowing over Sutton Road at depths ranging from 120mm to 175mm for a 50% and 100% blockage condition at the culvert, respectively.

Table 9 – 100 year ARI max. discharge, velocity & floodwater level at the design sections.

Section	Q max (m^3/s)	V max (m/s)	H max (m AHD)
C21	7.13	1	574.6
C22	7.14	3.36	575.6
C23	6.75	6.7	576.39
C24	6.53	2.4	577.6
C25	5.56	1.17	580.7
C26	5.56	5.25	582.18
C27	5.56	5.11	584.33
C28	5.58	1.16	587.06
C29	4.91	9.84	587.75
C26(B)	1.15	0.99	582.6
C28(B)	1.15	0.73	587.1
C29(B)	0.38	0.78	589.6
HC1	27.8	1.81	576.04#
HC2	27.8	1.58	576.12#
HC3	27.9	4.73	577.08#
HC4	26.5	3.47	579.52
HC5	26.5	5.82	581.02
HC6	26.5	5.48	583.0
HC7	24.9	5.59	585.28

 # calculated for 100% blockage of the culvert

The location of the design cross sections, and the interpolated areal extent of the 100 year ARI flood levels, can be seen on Drawings 2916/F2 and F7.

The level of the 100 year ARI floodwater at each design cross section within the Site can be seen on Drawings 2916/F13 to F17. The 100 year ARI flood levels depicted in Harrow Creek on Drawings 2916/F13 and F14 have been plotted for the 100% blockage factor applied to the Sutton Road culvert.

5.3 On-Site Effluent Dispersal

The results of the hydraulic analysis presented on Drawing 2916/F7 indicate that the southern portion of the Site will not be inundated by floodwater from the critical 100 year ARI storm event. Accordingly, floodwater will not be a constraint to the provision of on-site domestic effluent management systems that incorporate on-site dispersal of treated effluent for properties located within the southern sub-catchment, C3.

The results of the hydraulic analysis presented on Drawing 2916/F7 indicate that drainage depressions within the northern portion of the Site within sub-catchment, C2, will be inundated by floodwater from the critical 100 year ARI storm event. Accordingly, floodwater will be a constraint to be considered in the provision of on-site domestic effluent management systems that incorporate on-site dispersal of treated effluent for properties located within the sub-catchment, C2.

Based on a review of the calculated floodwater flows in sub-catchment, C2, it is Barker Harle's opinion the stormwater flows through the Site will be able to be managed by a minor – major flow strategy along the route of the existing drainage paths, in such a way as to facilitate a subdivision layout that will enable each created lot to utilise on-site dispersal of treated effluent in areas that will be above the final 100 year ARI flood level.

6. Probable Maximum Flood

6.1 Planning Guidelines

Section 117(2) of the Environmental Planning and Assessment Act 1979, Direction 4.3 Flood Prone Land, requires that the planning proposal must include provisions that give effect to and are consistent with the *NSW Flood Prone Land Policy* and the principles of *the Floodplain Development Manual 2005* and the *Guideline on Development Controls on Low Flood Risk Areas*.

The *Guideline on Development Controls on Low Flood Risk Areas – Floodplain Development Manual,* identifies 3 categories of flood prone land:

1 **Floodway**: Floodways are the areas of the floodplain which are essential to convey flood waters.

2 **Below the residential FPL** (Flood Planning Level): The area of the floodplain where residential development is subject to flood related development controls. FPLs for typical residential development would generally be based around the 100 year ARI flood level, plus an appropriate freeboard, which is typically taken to be 0.5m.

3 **Above the Residential FPL:** The area of flood prone land above the residential FPL and therefore these are areas where residential development is not subject to flood related development controls. In areas which are above the FPL, but which are considered to be low flood risk areas, consideration may need to be given to the safety of people and associated emergency response.

Harrow Creek and the drainage depressions within the northern portion of the Site within sub-catchment C2, would be considered to be floodways as they are essential for the conveyance of floodwater through the undeveloped Site. Future development of the Site will need to address the management of the floodwater through the Site and stabilisation of the Harrow Creek erosion gully banks. Provided the management of the stormwater flows through the Site and any remedial works to the floodway provided by Harrow Creek are undertaken in accordance with suitable civil engineering design, the 100 year ARI floodwaters will be able to be adequately and safely conveyed through the Site.

The remainder of the Site that is more than 0.5m above the critical 100 year ARI flood level associated with floodwater flowing through the Site is therefore considered to be above a reasonable residential FPL.

The *NSW Flood Prone Land Policy, Section 1.1.2 Policy Provisions* notes that:

> *"The policy provides for a merit based approach to the selection of appropriate flood planning levels (FPLs). This recognises the need to consider the full range of flood sizes, up to the probable maximum flood (PMF) and the corresponding risks associated with each flood, whilst noting that with few exceptions, it is neither feasible nor socially or economically justifiable to adopt the PMF as the basis for FPLs. FPLs for typical residential development would generally be based on the 1% AEP (Annual Exceedance Probability) flood plus an appropriate freeboard (typically 0.5m)".*

[Note: the 100 ARI and the 1% AEP are different ways of describing the same flood event.]

6.2 Probable Maximum Flood Levels

6.2.1 Yass River

The Yass River catchment comprises 20 sub-catchments covering an area of 488km^2. The determination of the PMF within the Yass River adjacent to the Site was not considered to be a cost-effective exercise given; the complexity of the upstream and downstream catchments; the wide range of variables being considered; the consequent low confidence level in the resulting output and the significant restriction to the flow of floodwater, upstream of the Site provided by the Gundaroo Bridge.

It has been demonstrated that the Gundaroo Bridge becomes an inlet controlled structure, i.e. the approaching floodwater level on the upstream side of the bridge is above the top of the available waterway area during the 100 year ARI flood. The upstream 100 year ARI floodwater level is above the level of the bottom of the bridge trough girders. It is anticipated that in a PMF scenario, the Gundaroo Bridge and the Sutton Road approach embankments will be overtopped.

6.2.2 The Site

The probable maximum flood [*PMF*] levels within the Site were determined using the probable maximum precipitation [*PMP*] determined in accordance with The Estimation of Probable Maximum Precipitation in Australia - Generalised Short-Duration Method [Ref 5]. The data used to create the hydrological models is summarised in Tables 3 and 4, above.

The PMF was determined for sub-catchments C2 and C3 - Harrow Creek within the Site.

The interpolated areal extent and flood levels at the design cross sections for the PMF in Sub-catchment , C2 and C3 – Harrow Creek, within the Site, may be seen in Drawings 2916/F8 and F13 to F17.

7. Discussion

7.1 Climate Change

Consideration was given to the potential effects of future climate change on flood levels within the Yass River. The impacts and ramifications of possible climate change are discussed in detail in the Department of Environment and Climate Change, Floodplain Risk Management Guideline: Practical Consideration of Climate Change (Oct 2007) [Ref 6]

Based on the estimates of potential increase in rainfall set out in Table 1 of Ref 6, which indicate a possible increase in the 40 year daily rainfall Murrumbidgee and Southern Rivers

of up to 7%, the potential impact of a 10% increase in the 100 year ARI was examined by increasing the intensity of all critical storm durations used in the Yass River DRAINS model by 10%. The impact of a 10% increase in the relevant 100 year ARI storm intensities resulted in a 15.8% increase in the discharge at the Gundaroo Bridge and a 260mm increase in the flood level. The discharge increased from the current 714m^3/s to 827m^3/s and the flood level increased from 575.59 m AHD to 575.85 m AHD.

A comparison between the results from the 100 year ARI event and the modified events in the Yass River are set out in Table 10, below.

Table 10 – 100 year ARI and 100 year ARI with 10% increase in storm intensity

Section	100 year ARI		100 year ARI + 10% increase in critical storm intensity	
	Flood Level (m AHD)	Discharge (m^3/s)	Flood Level (m AHD)	Discharge (m^3/s)
Y1 (Gundaroo Bridge)	575.59	714	575.85	827
Y2	574.91		575.1	
Y3	574.48		574.63	
Y4	572.93		573.19	

The flood levels resulting from the 10% increase in storm intensity across the Yass River catchment modified has resulted in an increase in the flood level in the Yass River adjacent to the Site that varied between 0.15m and 0.26m. The increased flood level at cross section Y4, on the centreline of Faithfull Street, indicated that the 100 year ARI flood level from the modified storm intensity could impact directly on the intersection of Sutton Road and Faithfull Street. The edge of bitumen on the western side of the intersection was 573.16m AHD and the design flood level was 573.19m AHD.

The flood levels from the Yass River did not reach the Site.

Consideration of the impact of modified storm events on the Site was not modelled, as an increase of 20% in the discharge from the each sub-catchment, H2 and H3 – Harrow Creek, i.e. an increase from 7.1m^3/s and 27.2m^3/s to 8.4 m^3/s and 32.6 m^3/s, respectively, would still be significantly less than the PMF discharges of 61.9 m^3/s and 293.4 m^3/s.

The small increase in the discharge resulting from potential climate change within the Site could be readily addressed during more detailed evaluation of the Site during the detailed design stage for the subdivision.

The potential impact of climate change on the stormwater flows through the Site were considered to be minor and potential impacts could be readily addressed by the selection of a suitable FPLs for future lots.

7.2 Flood Hazard Assessment

A review of the potential flood hazard on the Site in accordance with the guidelines in Appendix L of Ref 3, indicated that the main northern drainage path conveying the 100 year ARI floodwater through sub-catchment C2 should currently be classified as a High Hazard - Floodway. The southern arm of the sub-catchment was classified as a Low Hazard - Floodway.

The Harrow Creek erosion gully was classified as a High Hazard – Floodway.

The area of the Site between the limit of the 100 year ARI floodwater and the PMF should be classified as a Flood Fringe. The hazard level of the areas within the Flood Fringe will depend on the final shape of the developed Site and stormwater management system.

The area of the Site outside the limits of the PMF is considered to be flood free.

The discharge over Sutton Road from Harrow Creek with a 100% blocked culvert condition resulted in velocity x depth = 0.45 for the sheet flow across Sutton Road, indicating that it should be classified as a Low Hazard – Floodway.

The design of the proposed subdivision on the Site should take into account suitable means of providing safe pedestrian and vehicular access across the identified floodways.

7.3 Underground Stormwater Infiltration Tanks

The management of stormwater on the Site involving; collection, routing, storing and disposal, may include a range of approaches including; minor – major flow paths, surface and subsurface infiltration; detention basins, constructed wetlands and bio filtration ponds. The appropriate mix of methodologies will be resolved at the detailed design phase in response to the identified site constraints. Subsurface stormwater infiltration tanks are only one of a number of methodologies that may be considered, and if found to be inappropriate, would not need to be utilised.

8. Conclusions

It was determined that the critical flood levels resulting from the 100 year ARI storm events were safely contained within the Yass River floodway to the west of Sutton Road, downstream of the Gundaroo Bridge.

The critical 100 year ARI flood levels within Harrow Creek where determined by applying a 100% blockage factor to the culvert beneath Sutton Road. This assumption determined the worst case flood levels within Harrow Creek. It was found that the floodwater will still be contained within the limits of the existing erosion gully when the culvert is totally blocked.

The analysis determined the areal extent of the 100 year ARI and PMF within the Site, which can be used in future development planning within the site. The areal extent of flooding within the site area can be seen on Drawings 2916/F7 and F8.

The flood study has identified that there is substantial portion of the site above the 100 year ARI flood level which will be able to be considered for the on-site dispersal of treated effluent.

Detailed civil engineering design of the stormwater management associated with future development of the Site will be able to effectively and safely manage the collection, routing, storage and disposal of stormwater on the Site and facilitate safe pedestrian and vehicular access over the Site.

For more information please contact the undersigned.

Author

Rob Barker
FIE Aust, CPEng, NPER (Civil, Structural)

Reviewer

Justin Frost
B Eng (Civil) Hons.

9. References

1. *Pilgrim, D. H. (1997). Australian Rainfall and Runoff. Barton, ACT: The Institute of Engineers, Australia.*

2. *NSW Government. (1979). Environmental Planning and Assessment Act (Section 117(2)).*

3. *Government, N. S. (April 2005). Floodplain Development Manual - The Management of Flood Liable Land.*

4. *Yass Valley Council (2013). Local Environmental Plan (Section 6.2).*

5. *Commonwealth Bureau of Meteorology (June 2003). The Estimation of Probable Maximum Precipitation in Australia: generalised Short-Duration Method.*

6. *Department of Environment and Climate Change, Floodplain Risk Management Guideline: Practical Consideration of Climate Change (Oct 2007).*

Attachments

1 Drawing 2916/F1 to F17

Attachments

2 Yass Valley Council

letter – 6 February 2014

yass valley council

the country the people

Your Reference: N/A
Our Reference: PP.2013.01
Document No:
Contact: Will Mayes
Phone: (02) 6226 9219

Address all correspondence to:
General Manager
Yass Valley Council
PO Box 6
YASS NSW 2582

6 February 2014

Dr R & Mrs M Meischke
25 Faithfull Street
Gundaroo NSW 2620

Dear Roger and Marion

Planning Proposal 2013-01 – Corner Sutton Road & Faithfull Street, Gundaroo

I refer to the requirements of the Gateway Determination issued by the NSW Department of Planning for Planning Proposal 2013_01 (proposed rezoning of land known as Sutton Road and Faithfull Street, Gundaroo).

In accordance with Section 56(2)(d) of the Environmental Planning & Assessment Act 1979 the Planning Proposal has been referred to NSW Office of Environment & Heritage, Murrumbidgee Catchment Management Authority, NSW Department of Primary Industries – Office of Water and NSW Health for comment.

The abovementioned public authorities have outlined a number of issues in relation cultural heritage, floodplain risk management and groundwater sources. In accordance with these comments, matters that require your immediate attention are listed below:

- NSW Office of Environment & Heritage
  - Due diligence be undertaken to identify any significant Aboriginal objects in accordance with the requirements of the Due Diligence Code of Practice for the *Protection of Aboriginal Objects in NSW (DECCW 2010)*. Areas closest to Yass River and McLeods Creek are of particular interest.
    Note: Having already conducted an AHIMS search, a visual inspection of the area needs to be undertaken to see if Aboriginal objects can be identified or are likely to be present below the surface. This visual inspection must be undertaken by a person with expertise in locating and identifying Aboriginal objects. This person may be an Aboriginal person or landholder with expertise in locating and identifying Aboriginal objects or a consultant with appropriate qualifications or training in locating and identifying Aboriginal objects.
  - Analysis of flood hazard to be undertaken in order to demonstrate consistency with *Section 117 Direction 4.3 – Flood Prone Land* (i.e. Consistency with *NSW Flood Prone Lands Policy* and principles of the *Floodplain Development Manual 2005*).
    Note: Council has recently been successful in obtaining grant funding to undertake Floodplain Risk Management Plans for Yass, Sutton and Gundaroo. Council understands you wish to proceed with the Planning Proposal prior to the completion of these plans, and as such you will be required to undertake a specific flood hazard analysis for this site.

- NSW Department of Primary Industries – Office of Water
  - Further assessment be carried out in relation to the long term effects of using underground storage tanks for infiltration of stormwater given shallow groundwater sources in the area.
  - Area of 'vulnerable groundwater' identified in the Planning Proposal (Drawing 2916/1) be extended to include the area around subsurface testpit 7 (TP7) where groundwater source is known to be shallow.
  - In accordance with *Environment & Health Protection Guidelines On-Site Sewage Management for Single Households (1998)*, demonstrate that on-site sewerage application areas will not be inundated by 1 in 100 year flood.

Note: NSW Office of Water has stated that anecdotal evidence provided is not sufficient. Greater landscape/ terrain analysis is required.

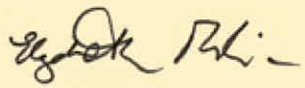
- One (1) monitoring bore be constructed on the western edge of the site (near the existing avenue identified on the 'Concept Masterplan') to a depth of 10 metres or first groundwater.

  Notes:
  - ***Monitoring of water level and quality be undertaken every 6 months for a period of 5 years.***
  - ***Minimum of two samples (one winter, one summer) required prior to development.***
  - ***Review of monitoring results be undertaken after 5 years to determine future monitoring/management requirements.***
  - ***A minimum of 3 casing volumes be extracted from the bore OR the bore be pumped/ bailed dry (whichever comes first) prior to each sampling.***
  - ***Water quality monitoring to test biological oxygen demand, chemical oxygen demand, dissolved oxygen, nitrates, E.coli, faecal coliform, pH and electrical conductivity (EC).***

Other matters identified by the abovementioned public authorities do not need to be addressed as part of the Planning Proposal process. However, matters relating to the development of the site should be noted for future reference. Copies of the comments provided by the abovementioned public authorities are attached to this letter for your information.

Should you require further information in relation to the comments provided by the abovementioned public authorities or any associated reference materials please contact Will Mayes on (02) 6226 9219 or at will.mayes@yass.nsw.gov.au.

Yours sincerely



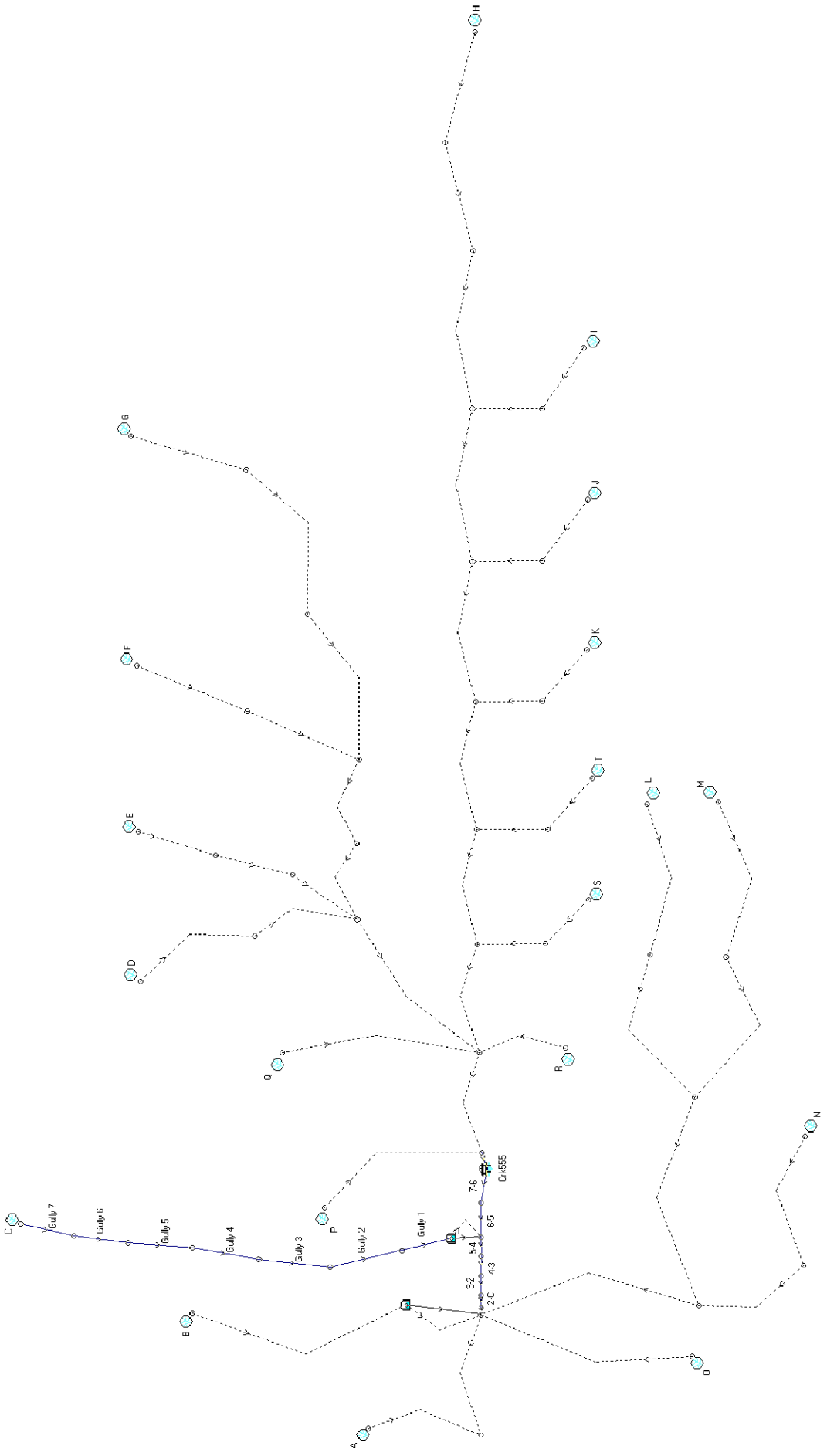
Liz Makin
Strategic Planning Manager

Attachments

3 DRAINS Data Files

- Yass River
- C2 sub-catchment
- C3 sub-catchment (Harrow Creek)

Total Catchment DRAINS Model - Schematic



TOTAL CATCHMENT INPUT DATA

PIT / NODE DETAILS *Version 12*

Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id
5.1	Node					840		0		322.037	71.713		69
1.12	Node					880		0		975.658	-158.254		85
2.4	Node					750		0		443.815	-277.186		86
2.3	Node					770		0		445.157	-326.174		87
N (Node)	Node					700		0		214.983	-385.898		253
O (Node)	Node					600		0		63.536	-308.336		276
A (Node)	Node					620		0		14.071	-85.428		308
B (Node)	Node					800		0		93.3	36.049		318
C (Node)	Node					758		0		154.721	154.511		337
CH777.37	Node					583.274		0		146.488	117.462		11782
CH675.51	Node					581.292		0		141.593	80.402		11752
CH542.33	Node					579.798		0		138.383	36.005		11753
CH415.29	Node					578.48		0		130.36	-9.463		11754
CH275.38	Node					576.292		0		125.029	-58.493		11756
CH104.24	Node					575.095		0		136.637	-108.151		11755
HW2	Headwall				0.5	575.633		0		145.023	-142.435		11839
1.3	Node					573.116		0		145.696	-162.761		199
Section 4	Node					568.759		0		132.484	-162.904		11864
Section 3	Node					568.669		0		119.381	-162.665		11865
Section 2	Node					566.938		0		105.683	-162.785		11866
End Sect 2	Node					569		0		96.987	-162.785		11891
R (Node)	Node					611		0		275.921	-220.972		364
P (Node)	Node					650		0		165.857	-54.953		377
Q (Node)	Node					720		0		272.846	-26.054		391
E (Node)	Node					757		0		424.723	73.557		475
F (Node)	Node					840		0		539.091	74.172		505
4.4	Node					860		0		697.116	78.476		506
S (Node)	Node					750		0		377.991	-236.959		554
T (Node)	Node					830		0		461.616	-239.418		573
K (Node)	Node					768		0		550.159	-235.729		591
J (Node)	Node					715		0		653.459	-236.344		605
I (Node)	Node					918		0		757.989	-233.27		625
Crit-D	Node					715		0		353.396	-6.993		449
Mid-H	Node					805		0		899.413	-137.963		639
1.11	Node					730		0		825.012	-157.639		101
Mid-L	Node					667.5		0		340.472	-279.2		418
Mid-M	Node					677.5		0		338.459	-331.542		222
2.2	Node					585		0		242.102	-310.13		91
Crit-N	Node					641		0		126.403	-385.227		266
2.1	Node					582		0		98.633	-312.504		235
HW1	Headwall				0.5	574.266		0		99.164	-110.937		10622
1.2	Node					569		0		92.29	-162.761		198
Crit-E1	Node					701.33		0		408.736	20.062		486
Crit-E2	Node					645.67		0		395.208	-32.818		476
Crit-F	Node					787.5		0		507.732	-1.459		535
4.3	Node					735		0		673.75	-0.844		66
Mid-F	Node					697.5		0		574.754	-43.271		516
4.2	Node					660		0		474.528	-78.934		67
Mid-E	Node					625		0		416.729	-77.089		465
4.1	Node					590		0		364.464	-77.704		68
Crit-S	Node					665		0		347.862	-206.83		555
Crit-T	Node					707.5		0		426.567	-208.674		574
Crit-K	Node					679		0		515.11	-204.985		589
Crit-J	Node					657.5		0		611.647	-204.985		604
Crit-I	Node					769		0		716.177	-204.985		622
1.1	Node					620		0		716.177	-157.024		124
1.9	Node					600		0		611.032	-157.024		131
1.8	Node					590		0		514.496	-158.869		11
1.7	Node					585		0		426.567	-159.484		8
1.6	Node					580		0		347.247	-160.099		32
1.5	Node					575		0		272.846	-161.943		36
1.4	Node					568.999		0		203.979	-163.173		200
Section 6	Node					568.777		0		169.188	-162.565		11853
1.1	Node					565		0		9.061	-163.07		197

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area	Impervious Area	Avg Slope(%)	Mannings n	Time lag (mins)	Rainfall Multiplier	Hydrological Model
D	5.1	1850	0	2.2	0.04	0	1	Gundaroo RAFTS
H	1.12	3200	0	1.35	0.03	0	1	Gundaroo RAFTS
L	2.4	5230	0	1.09	0.03	0	1	Gundaroo RAFTS
M	2.3	3750	0	1.42	0.03	0	1	Gundaroo RAFTS
N	N (Node)	2150	0	0.8	0.03	0	1	Gundaroo RAFTS
O	O (Node)	1150	0	0.5	0.03	0	1	Gundaroo RAFTS
A	A (Node)	120	0	3.2	0.025	0	1	Gundaroo RAFTS
B	B (Node)	1440	0	2.8	0.03	0	1	Gundaroo RAFTS
C	C (Node)	420	0	2	0.03	0	1	Gundaroo RAFTS
R	R (Node)	120	0	2	0.03	0	1	Gundaroo RAFTS
P	P (Node)	1010	0	2	0.03	0	1	Gundaroo RAFTS
Q	Q (Node)	560	0	3	0.03	0	1	Gundaroo RAFTS
E	E (Node)	4250	0	0.36	0.04	0	1	Gundaroo RAFTS

F	F (Node)	4350	0	0.72	0.035	0	1	Gundaroo RAFTS
G	4.4	3050	0	1.39	0.04	0	1	Gundaroo RAFTS
S	S (Node)	1840	0	1.7	0.035	0	1	Gundaroo RAFTS
T	T (Node)	3610	0	2.4	0.035	0	1	Gundaroo RAFTS
K	K (Node)	3850	0	1.4	0.03	0	1	Gundaroo RAFTS
J	J (Node)	4950	0	1	0.04	0	1	Gundaroo RAFTS
I	I (Node)	1900	0	2.3	0.035	0	1	Gundaroo RAFTS

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From
Triple Pipe	HW2	1.3	15	573.116	573.1	0.11	Concrete	1800	2100	0.013	Existing	3	HW2
Triple Box	HW1	1.2	15	570.315	570.165	1	Box	3.1 x 3.1		0.013	Existing	3	HW1

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Width (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed
Gully 7	C (Node)	CH777.37	Irregular	4022.63	758	583.274							
Gully 6	CH777.37	CH675.51	Irregular	101.86	583.274	581.292							
Gully 5	CH675.51	CH542.33	Irregular	133.18	581.292	579.798							
Gully 4	CH542.33	CH415.29	Irregular	127.04	579.798	578.48							
Gully 3	CH415.29	CH275.38	Irregular	171.14	578.48	576.292							
Gully 2	CH275.38	CH104.24	Irregular	104.24	576.292	575.095							
Gully 1	CH104.24	HW2	Irregular	104.24	575.095	573.116							
Sect 5-4	1.3	Section 4	Irregular	183.267	568.797	568.759							
Sect 4-3	Section 4	Section 3	Irregular	227.364	568.759	568.669							
Sect 3-2	Section 3	Section 2	Irregular	1088.06	568.669	566.938							
Sect 2-C	Section 2	End Sect 2	Irregular	510.667	566.938	569							
Crk555	1.4	B2	Irregular	600	568.999	568.998							
Sect 7-6	B2	Section 6	Irregular	222.374	568.998	568.777							
Sect 6-5	Section 6	1.3	Irregular	202.107	568.777	568.797							

OVERFLOW ROUTE DETAILS

Name	From	To	Length (m)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Storms (m)	SafeDepth Minor Storms (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %	id
Critical channel D1	5.1	Crit-D	6100				Gundaroo Typ	4.5	1	0.6	2.2	0	443
Main channel H1	1.12	Mid-H	5550				Gundaroo Typ	4.5	1	0.6	1.35	0	643
Main channel L1	2.4	Mid-L	7550				Gundaroo Typ	4.5	1	0.6	1.09	0	419
Main channel M1	2.3	Mid-M	6500				Gundaroo Typ	4.5	1	0.6	1.42	0	217
Critical channel N1	N (Node)	Crit-N	7350				Gundaroo Typ	4.5	1	0.6	0.8	0	258
Critical channel O	O (Node)	1.2	6100				Gundaroo Typ	4.5	1	0.6	0.6	0	275
Critical channel A	A (Node)	1.1	1700				Gundaroo Typ	4.5	1	0.6	3.2	0	312
Critical channel B	B (Node)	HW1	8200				Gundaroo Typ	4.5	1	0.6	2.8	0	319
Culvert O/Flow 2	HW2	1.3	15	575.633	15	1.7	Gundaroo Typ	5	1	0.6	1	0	11840
Sect 2 - Culvert	End Sect 2	1.2	10				Gundaroo Typ	5	1	0.6	1	0	11892
Critical channel R	R (Node)	1.5	1800				Gundaroo Typ	4.5	1	0.6	2	0	366
Critical channel P	P (Node)	1.4	6900				Gundaroo Typ	4.5	1	0.6	1.2	0	378
Critical channel Q	Q (Node)	1.5	4800				Gundaroo Typ	4.5	1	0.6	3	0	393
Critical channel E1	E (Node)	Crit-E1	6833				Gundaroo Typ	4.5	1	0.6	0.8	0	477
Critical channel F1	F (Node)	Crit-F	6000				Gundaroo Typ	4.5	1	0.6	1.5	0	527
Main channel G	4.4	4.3	9000				Gundaroo Typ	4.5	1	0.6	1.39	0	521
Critical channel S1	S (Node)	Crit-S	5650				Gundaroo Typ	4.5	1	0.6	1.7	0	556
Critical channel T1	T (Node)	Crit-T	5600				Gundaroo Typ	4.5	1	0.6	2.4	0	571
Critical channel K1	K (Node)	Crit-K	6450				Gundaroo Typ	4.5	1	0.6	1.4	0	590
Critical channel J1	J (Node)	Crit-J	5650				Gundaroo Typ	4.5	1	0.6	1	0	606
Critical channel I1	I (Node)	Crit-I	6400				Gundaroo Typ	4.5	1	0.6	2.3	0	624
Critical channel D2	Crit-D	4.1	6100				Gundaroo Typ	4.5	1	0.6	2.2	0	450
Main channel H2	Mid-H	1.11	5550				Gundaroo Typ	4.5	1	0.6	1.35	0	646
Main channel I	1.11	1.1	9100				Gundaroo Typ	4.5	1	0.6	1.21	0	616
Main channel L2	Mid-L	2.2	7550				Gundaroo Typ	4.5	1	0.6	1.09	0	408
Main channel M2	Mid-M	2.2	6500				Gundaroo Typ	4.5	1	0.6	1.42	0	229
Main channel N	2.2	2.1	1900				Gundaroo Typ	4.5	1	0.6	0.16	0	237
Critical channel N2	Crit-N	2.1	7350				Gundaroo Typ	4.5	1	0.6	0.8	0	267
Main channel O	2.1	1.2	5800				Gundaroo Typ	4.5	1	0.6	0.29	0	242
Culvert O/Flow 1	HW1	1.2	15	574.266	45	1.7	Gundaroo Typ	5	1	0.6	1	0	10626
Main Channel A	1.2	1.1	700				Gundaroo Typ	4.5	1	0.6	0.57	0	303
Critical channel E2	Crit-E1	Crit-E2	6833				Gundaroo Typ	4.5	1	0.6	0.8	0	489
Critical channel E3	Crit-E2	4.1	6833				Gundaroo Typ	4.5	1	0.6	0.8	0	478
Critical channel F2	Crit-F	4.2	6000				Gundaroo Typ	4.5	1	0.6	1.5	0	533
Main channel F1	4.3	Mid-F	5200				Gundaroo Typ	4.5	1	0.6	0.72	0	507
Main channel F2	Mid-F	4.2	5200				Gundaroo Typ	4.5	1	0.6	0.72	0	512
Main channel E1	4.2	Mid-E	9650				Gundaroo Typ	4.5	1	0.6	0.36	0	457
Main channel E2	Mid-E	4.1	9650				Gundaroo Typ	4.5	1	0.6	0.36	0	466
Main channel Q	4.1	1.5	2200				Gundaroo Typ	4.5	1	0.6	0.68	0	397
Critical channel S2	Crit-S	1.6	5650				Gundaroo Typ	4.5	1	0.6	1.7	0	557
Critical channel T2	Crit-T	1.7	5600				Gundaroo Typ	4.5	1	0.6	2.4	0	575
Critical channel K2	Crit-K	1.8	6450				Gundaroo Typ	4.5	1	0.6	1.4	0	595
Critical channel J2	Crit-J	1.9	5650				Gundaroo Typ	4.5	1	0.6	1	0	610
Critical channel I2	Crit-I	1.1	6400				Gundaroo Typ	4.5	1	0.6	2.3	0	629
Main channel J	1.1	1.9	4700				Gundaroo Typ	4.5	1	0.6	0.43	0	602
Main channel K	1.9	1.8	4100				Gundaroo Typ	4.5	1	0.6	0.24	0	587
Main channel T	1.8	1.7	6200				Gundaroo Typ	4.5	1	0.6	0.08	0	567
Main channel S	1.7	1.6	3300				Gundaroo Typ	4.5	1	0.6	0.15	0	545
Main channel R	1.6	1.5	1200				Gundaroo Typ	4.5	1	0.6	0.42	0	352
Main channel P	1.5	1.4	4000				Gundaroo Typ	4.5	1	0.6	1	0	347

100yr ARI Results

DRAINS results prepared 04 July, 2014 from Version 2014.07

PIT / NODE DETAILS *Version 8*

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
C (Node)	759.65		26.697				
CH777.37	585.29		26.716				
CH675.51	583.01		26.734				
CH542.33	581.02		26.734				
CH415.29	579.16		26.728				
CH275.38	577.07		26.72				
CH104.24	575.8		26.717				
HW2	575.43		26.694		0.2	0	None
1.3	574.48		713.814				
Section 4	573.83		721.227				
Section 3	573.54		721.016				
Section 2	572.93		719.585				
End Sect 2	572.33		717.82				
HW1	573.18		81.866		1.09	0	None
1.2	569		984.529				
1.4	576.13		714.443				
Section 6	574.8		713.811				

SUB-CATCHMENT DETAILS

Name	Max Flow (cu.m/s)	Due to Storm
D	73.711	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2
H	111.547	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
L	149.078	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
M	129.446	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
N	64.444	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
O	31.695	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
A	13.278	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2
B	81.866	AR&R 100 year, 2 hours storm, average 31.9 mm/h, Zone 2
C	26.697	AR&R 100 year, 2 hours storm, average 31.9 mm/h, Zone 2
R	9.748	AR&R 100 year, 2 hours storm, average 31.9 mm/h, Zone 2
P	53.263	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2
Q	40.019	AR&R 100 year, 2 hours storm, average 31.9 mm/h, Zone 2
E	65.721	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
F	99.863	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
G	90.029	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
S	71.422	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2
T	142.014	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2
K	131.407	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
J	115.79	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
I	84.597	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
Triple Pipe Culvert	26.677	2.67	575.048	575.2	AR&R 100 year, 2 hours storm, average 31.9 mm/h, Zone 2
Triple Box Culvert	76.586	6.17	572.652	571.501	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm
Gully 7	26.716	5.57	AR&R 100 year, 2 hours storm, average 31.9 mm/h, Zone 2
Gully 6	26.734	5.49	AR&R 100 year, 2 hours storm, average 31.9 mm/h, Zone 2
Gully 5	26.734	5.82	AR&R 100 year, 2 hours storm, average 31.9 mm/h, Zone 2
Gully 4	26.728	6.65	AR&R 100 year, 2 hours storm, average 31.9 mm/h, Zone 2
Gully 3	26.72	1.98	AR&R 100 year, 2 hours storm, average 31.9 mm/h, Zone 2
Gully 2	26.717	2.83	AR&R 100 year, 2 hours storm, average 31.9 mm/h, Zone 2
Gully 1	26.694	2.83	AR&R 100 year, 2 hours storm, average 31.9 mm/h, Zone 2
Sect 5-4	721.227	4.29	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
Sect 4-3	721.016	2.34	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
Sect 3-2	719.585	2.02	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
Sect 2-C	717.82	3.71	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
Crk555	713.822	2.4	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
Sect 7-6	713.811	2.8	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
Sect 6-5	713.814	3.05	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2

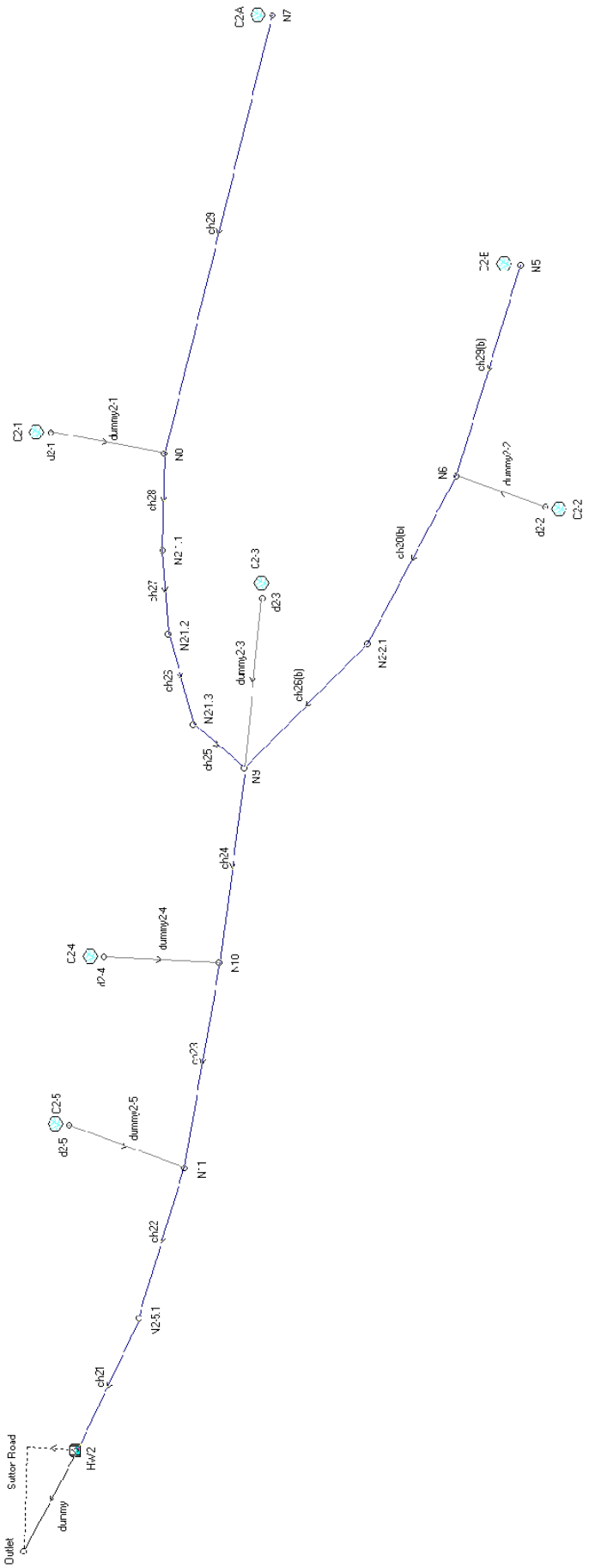
OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm

Critical channel D1	73.711	73.711	5.585	1.049	4.38	22.14	4.18	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2
Main channel H1	111.547	111.547	6.287	1.456	6.03	23.45	4.14	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Main channel L1	149.078	149.078	6.597	1.787	7.64	24.51	4.28	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Main channel M1	129.446	129.446	6.239	1.551	6.88	23.75	4.44	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Critical channel N1	64.444	64.444	6.963	1.259	3.63	22.82	2.88	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Critical channel O	31.695	31.695	7.344	0.956	1.94	21.85	2.03	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Critical channel A	13.278	13.278	4.915	0.473	1.16	20.3	2.45	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2
Critical channel B	81.866	81.866	5.186	1.041	4.88	22.12	4.68	AR&R 100 year, 2 hours storm, average 31.9 mm/h, Zone 2
Culvert O/Flow 2	0	0	6.671	0	0	0	0	
Sect 2 - Culvert	717.82	717.82	6.671	4.66	18.36	140.03	3.94	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
Critical channel R	9.748	9.748	5.664	0.461	0.87	20.26	1.88	AR&R 100 year, 2 hours storm, average 31.9 mm/h, Zone 2
Critical channel P	53.263	53.263	6.417	1.038	3.18	22.11	3.06	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2
Critical channel Q	40.019	40.019	5.014	0.738	2.7	21.15	3.67	AR&R 100 year, 2 hours storm, average 31.9 mm/h, Zone 2
Critical channel E1	65.721	65.721	6.963	1.271	3.69	22.86	2.9	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
Critical channel F1	99.863	99.863	6.202	1.34	5.52	23.07	4.12	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
Main channel G	90.029	90.029	6.276	1.296	5.02	22.93	3.88	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Critical channel S1	71.422	71.422	5.972	1.1	4.18	22.31	3.8	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2
Critical channel T1	142.014	142.014	5.388	1.422	7.73	23.34	5.43	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2
Critical channel K1	131.407	131.407	6.298	1.568	6.97	23.81	4.44	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Critical channel J1	115.79	115.79	6.697	1.603	6.1	23.92	3.81	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
Critical channel I1	84.597	84.597	5.446	1.109	4.94	22.34	4.45	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2
Critical channel D2	72.43	72.43	5.585	1.04	4.32	22.12	4.15	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2
Main channel H2	110.16	110.16	6.287	1.446	5.97	23.41	4.13	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Main channel I	109.13	109.13	6.443	1.48	5.87	23.52	3.97	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Main channel L2	147.239	147.239	6.597	1.775	7.56	24.47	4.26	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Main channel M2	127.575	127.575	6.239	1.539	6.8	23.71	4.42	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Main channel N	268.102	268.102	8.795	4.575	7.19	131.58	1.57	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Critical channel N2	62.855	62.855	6.963	1.243	3.55	22.76	2.86	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Main channel O	324.881	324.881	8.192	4.435	9.4	117.53	2.12	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Culvert O/Flow 1	0	0	6.671	0	0	0	0	
Main Channel A	1020.592	1020.592	7.409	5.387	17.89	200.62	3.32	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
Critical channel E2	65.373	65.373	6.963	1.268	3.67	22.84	2.9	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
Critical channel E3	64.999	64.999	6.963	1.264	3.65	22.83	2.89	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
Critical channel F2	98.233	98.233	6.202	1.328	5.45	23.04	4.1	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
Main channel F1	88.207	88.207	7.132	1.516	4.72	23.64	3.11	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Main channel F2	87.331	87.331	7.132	1.508	4.68	23.61	3.1	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Main channel E1	178.778	178.778	7.883	2.677	8.14	29.87	3.04	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Main channel E2	172.112	172.112	7.883	2.627	7.89	29.66	3	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Main channel Q	262.487	262.487	7.192	2.768	11.81	30.28	4.27	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
Critical channel S2	70.136	70.136	5.972	1.09	4.12	22.28	3.78	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2
Critical channel T2	140.771	140.771	5.388	1.416	7.67	23.32	5.42	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2
Critical channel K2	129.56	129.56	6.298	1.557	6.88	23.77	4.42	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Critical channel J2	113.665	113.665	6.697	1.587	6.01	23.87	3.78	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2
Critical channel I2	82.712	82.712	5.446	1.097	4.85	22.3	4.42	AR&R 100 year, 3 hours storm, average 24.2 mm/h, Zone 2
Main channel J	175.639	175.639	7.729	2.539	8.15	29.29	3.21	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Main channel K	276.746	276.746	8.389	4.34	8.43	107.94	1.94	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Main channel T	383.626	383.626	9.477	5.39	6.72	200.89	1.25	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Main channel S	394.563	394.563	8.878	5.06	8.12	175.48	1.6	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Main channel R	427.784	427.784	7.716	4.556	11.59	129.6	2.54	AR&R 100 year, 6 hours storm, average 14.9 mm/h, Zone 2
Main channel P	696.394	696.394	6.697	4.623	18.18	136.37	3.93	AR&R 100 year, 18 hours storm, average 7.0 mm/h, Zone 2

Run Log for 40446 run at 13:28:28 on 4/7/2014

Creek C2 DRAINS Model - Schematic



CREEK C2 SUB CATCHMENT DATA

PIT / NODE DETAILS *Version 1*

Name	Type	CAP1 or VCAP1	CAP2 or VCAP2	CAP3 or VCAP3	CAP4	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Base Inflow (cu.m/s)	Blocking Factor (0=clear)	x	y
N7	Node							640	0		884.458	-378.39
N8	Node							587.5	0		791.667	-355.556
N2-1.1	Node							586.5	0		770.987	-355.11
N2-1.2	Node							584	0		753.49	-356.344
N2-1.3	Node							582.3	0		734.311	-361.615
N9	Node							580.3	0		724.981	-372.454
N10	Node							577	0		683.752	-367.227
N11	Node							576	0		640.262	-359.785
N2-5.1	Node							575.4	0		608.4	-350.017
HW2	Headwall						0.5	573.3	0		580.492	-336.761
Outlet	Node							573.156	0		559.096	-325.597
N5	Node							600	0		831.433	-430.951
N6	Node							589.5	0		786.806	-417.361
N2-2.1	Node							587	0		751.243	-398.484
d2-3	Node							580.4	0		760.965	-376.297
d2-4	Node							577.1	0		684.915	-342.807
d2-5	Node							576.1	0		649.332	-335.365
d2-2	Node							589.6	0		780.268	-436.16
d2-1	Node							587.6	0		796.083	-331.412

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area	Impervious Area	Avg Slope(%)	Mannings n	Time lag (mins)	Rainfall Multiplier	Hydrological Model
C2-A	N7	35.7	0	3.7	0.03	0	1	Gundaroo RAFTS
C2-B	N5	1.8	0	3.3	0.03	0	1	Gundaroo RAFTS
C2-3	d2-3	0.9	0	3.5	0.03	0	1	Gundaroo RAFTS
C2-4	d2-4	2.1	0	1	0.03	0	1	Gundaroo RAFTS
C2-5	d2-5	3.8	0	1.2	0.03	0	1	Gundaroo RAFTS
C2-2	d2-2	4.7	0	2.3	0.03	0	1	Gundaroo RAFTS
C2-1	d2-1	5.6	0	2.1	0.03	0	1	Gundaroo RAFTS

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From
dummy	HW2	Outlet	15	573.2	573.156	0.29	Concrete	10	5	0.012	Existing	1	HW2

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Width (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed
ch29	N7	N8	Irregular	1600	640	587.5							
ch28	N8	N2-1.1	Irregular	123	587.5	586.5							
ch27	N2-1.1	N2-1.2	Irregular	134	586.5	584							
ch26	N2-1.2	N2-1.3	Irregular	83	584	582.3							
ch25	N2-1.3	N9	Irregular	70	582.3	580.3							
ch24	N9	N10	Irregular	120	580.3	577							
ch23	N10	N11	Irregular	50	577	576							
ch22	N11	N2-5.1	Irregular	80	576	575.4							
ch21	N2-5.1	HW2	Irregular	120	575.4	573.2							
ch29(b)	N5	N6	Irregular	300	600	589.5							
ch28(b)	N6	N2-2.1	Irregular	210	589.5	587							
ch26(b)	N2-2.1	N9	Irregular	260	587	580.3							
dummy2-3	d2-3	N9	Prismatic	10	580.4	580.3	1	10	0.1	0.1	0.03	10	No
dummy2-4	d2-4	N10	Prismatic	10	577.1	577	1	10	0.1	0.1	0.03	10	No
dummy2-5	d2-5	N11	Prismatic	10	576.1	576	1	10	0.1	0.1	0.03	10	No
dummy2-2	d2-2	N6	Prismatic	10	589.6	589.5	1	10	0.1	0.1	0.03	10	No
dummy2-1	d2-1	N8	Prismatic	10	587.6	587.5	1	10	0.1	0.1	0.03	10	No

OVERFLOW ROUTE DETAILS

Name	From	To	Length (m)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Storms (m)	SafeDepth Minor Storms (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %	id
Sutton Road	HW2	Outlet	15	573.3	60	1.7	Sutton Road	0.3	0.15	0.6	0.4	0	5420

100yr ARI Results

DRAINS results prepared 04 July, 2014 from Version 2014.07

PIT / NODE DETAILS *Version 8*

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N7	640.51		4.917				
N8	587.75		5.694				
N2-1.1	587.06		5.578				
N2-1.2	584.34		5.562				
N2-1.3	582.48		5.561				
N9	580.7		6.524				
N10	577.6		6.769				
N11	576.39		7.163				
N2-5.1	575.6		7.139				
HW2	573.47		7.133		-0.17	7.124	Headwall height/system capacity
Outlet	573.16		7.124				
N5	600.09		0.385				
N6	589.6		1.153				
N2-2.1	587.1		1.154				
d2-3	580.7		0.215				
d2-4	577.6		0.292				
d2-5	576.39		0.508				
d2-2	589.71		0.782				
d2-1	587.76		0.869				

SUB-CATCHMENT DETAILS

Name	Max Flow (cu.m/s)	Due to Storm
C2-A	4.917	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C2-B	0.385	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C2-3	0.215	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C2-4	0.292	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C2-5	0.508	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C2-2	0.782	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C2-1	0.869	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
dummy	0	0	573.352	573.161	AR&R 100 year, 5 minutes storm, average 194 mm/h, Zone 2

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm
ch29	4.912	9.84	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
ch28	5.578	1.16	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
ch27	5.562	5.11	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
ch26	5.561	5.25	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
ch25	5.558	1.17	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
ch24	6.533	2.4	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
ch23	6.747	6.7	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
ch22	7.139	3.36	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
ch21	7.133	1	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
ch29(b)	0.382	0.78	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
ch28(b)	1.154	0.73	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
ch26(b)	1.146	0.99	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
dummy2-3	0.215	0.07	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
dummy2-4	0.332	0.07	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
dummy2-5	0.657	0.23	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
dummy2-2	0.782	0.77	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
dummy2-1	0.867	0.53	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
Sutton Road	7.124	7.124	37.286	0.101	0.12	61.91	1.14	AR&R 100 year, 1 hour storm

Run Log for 2916 run at 11:23:48 on 4/7/2014
Flows were safe in all overflow routes.

PMP Results

DRAINS results prepared 04 July, 2014 from Version 2014.07

PIT / NODE DETAILS *Version 8*

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N7	641.26		42.477				
N8	588.45		48.786				
N2-1.1	587.75		48.313				
N2-1.2	584.75		48.77				
N2-1.3	582.43		48.882				
N9	581.28		57.482				
N10	577.92		58.181				
N11	576.91		62.156				
N2-5.1	575.87		61.903				
HW2	574.02		61.881		-0.72	61.896	Headwall height/system capacity
Outlet	573.16		61.896				
N5	600.19		3.081				
N6	589.81		8.814				
N2-2.1	587.29		8.87				
d2-3	581.28		1.677				
d2-4	577.92		2.508				
d2-5	576.91		4.461				
d2-2	589.94		5.952				
d2-1	588.46		6.891				

SUB-CATCHMENT DETAILS

Name	Max Flow (cu.m/s)	Due to Storm
C2-A	42.477	PMP - 45 Minute Duration
C2-B	3.081	PMP - 15 Minute Duration
C2-3	1.677	PMP - 15 Minute Duration
C2-4	2.508	PMP - 45 Minute Duration
C2-5	4.461	PMP - 45 Minute Duration
C2-2	5.952	PMP - 15 Minute Duration
C2-1	6.891	PMP - 45 Minute Duration

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
dummy	0	0	573.388	573.161	PMP - 15 Minute Duration

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm
ch29	42.412	6.72	PMP - 45 Minute Duration
ch28	48.313	2.17	PMP - 45 Minute Duration
ch27	48.77	9.01	PMP - 45 Minute Duration
ch26	48.882	7.81	PMP - 45 Minute Duration
ch25	49.147	2.22	PMP - 45 Minute Duration
ch24	56.1	4.39	PMP - 45 Minute Duration
ch23	58.195	2.36	PMP - 45 Minute Duration
ch22	61.903	5.87	PMP - 45 Minute Duration
ch21	61.881	2	PMP - 45 Minute Duration
ch29(b)	3.014	1.29	PMP - 15 Minute Duration
ch28(b)	8.87	1.44	PMP - 15 Minute Duration
ch26(b)	8.835	1.77	PMP - 15 Minute Duration
dummy2-3	1.677	0.21	PMP - 15 Minute Duration
dummy2-4	2.508	0.3	PMP - 45 Minute Duration
dummy2-5	4.453	0.55	PMP - 45 Minute Duration
dummy2-2	5.952	1.93	PMP - 15 Minute Duration
dummy2-1	6.892	0.79	PMP - 45 Minute Duration

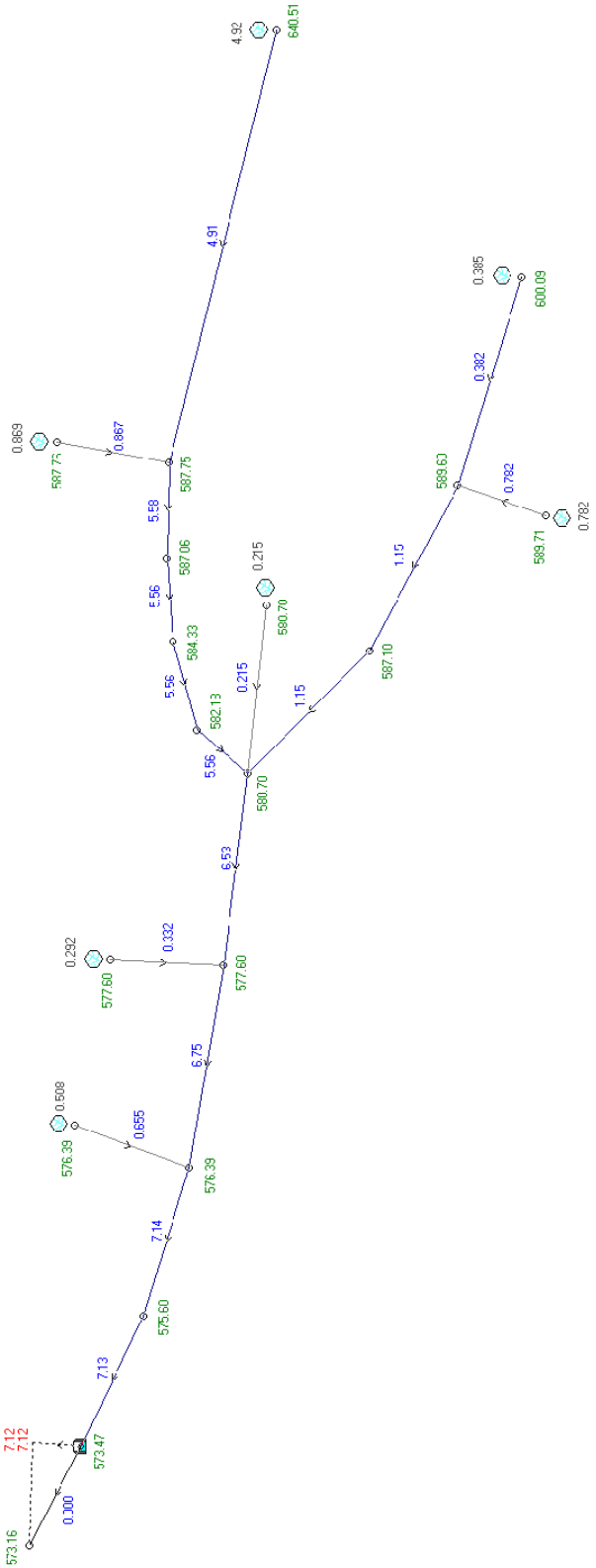
OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
Sutton Road	61.896	61.896	37.286	0.371	1	61.94	2.7	PMP - 45 Minute Duration

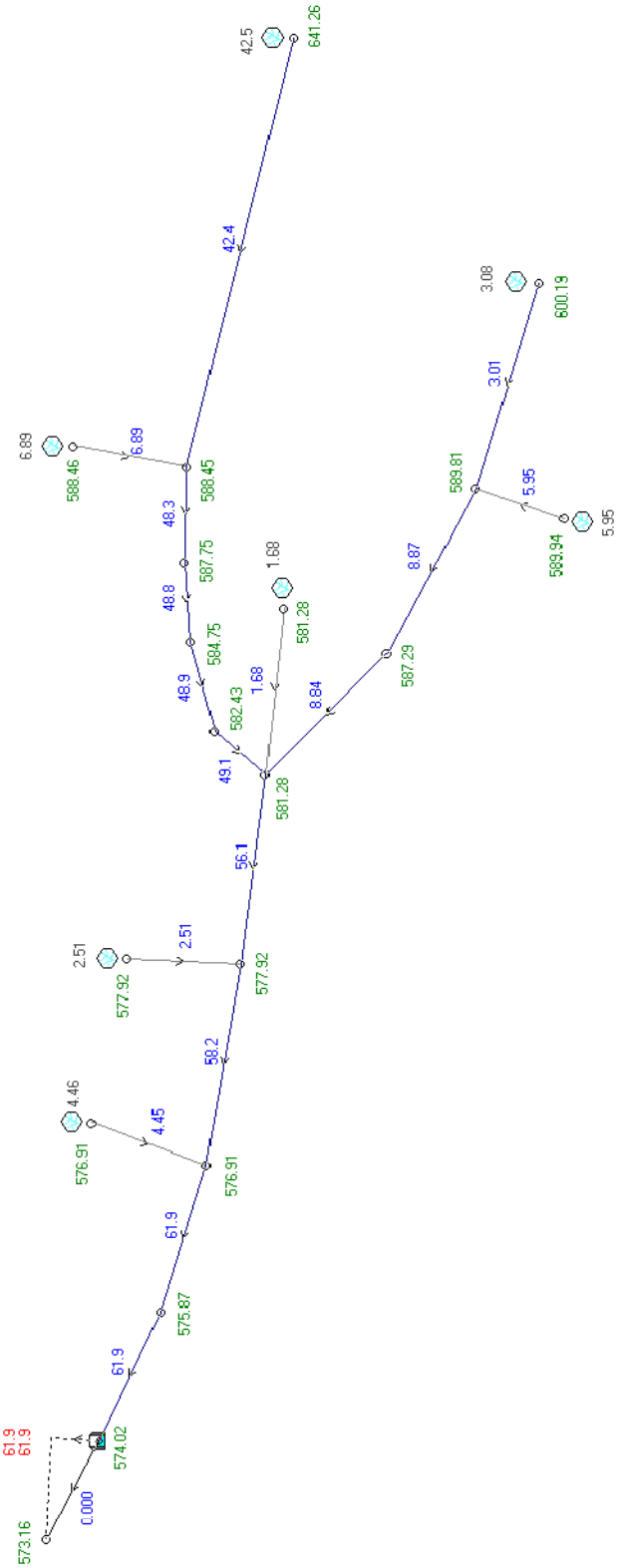
Run Log for 2916 run at 12:36:54 on 4/7/2014

The maximum flow exceeded the safe value in the following overflow routes: Sutton Road

100 yr ARI Results



PMP Results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641.26
42.4
3.08
600.19
3.01
6.89
6.89
588.46
588.45
48.3
589.81
5.95
5.95
589.94
587.75
48.8
1.68
581.28
8.87
584.75
48.9
1.68
582.43
587.29
8.84
49.1
581.28
56.1
2.51
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577.92
577.92
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4.46
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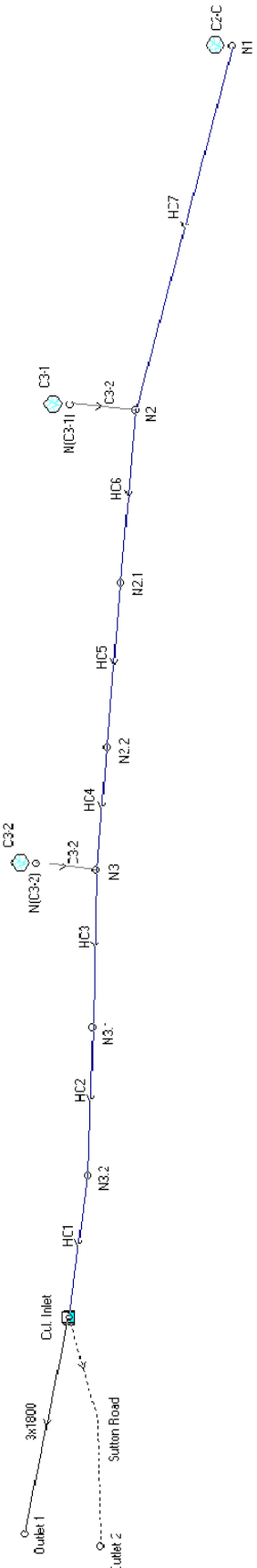
Harrow Creek DRAINS Model - Schematic



HARROW CREEK SUB CATCHMENT DATA

PIT / NODE DETAILS Version 1

Name	Type	CAP1 or VCAP1	CAP2 or VCAP2	CAP3 or VCAP3	CAP4	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Base Inflow (cu.m/s)	Blocking Factor (0=clear)	x	y
N1	Node							758	0		1127	-574
N2	Node							583.274	0		788	-527
N2.1	Node							581.292	0		724.167	-521.667
N2.2	Node							579.798	0		663.333	-516.667
N3	Node							578.48	0		618	-513
N3.1	Node							576.292	0		560	-511.667
N3.2	Node							575.095	0		505	-510
Cul. Inlet	Headwall						0.5	575.633	0		452.749	-502.984
Outlet 1	Node							573.1	0		329.051	-497.454
N(C3-1)	Node							583.3	0		790.315	-503.698
N(C3-2)	Node							578.5	0		620.633	-491.418
Outlet 2	Node							575.483	0		335.401	-515.844

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area	Impervious Area	Avg Slope(%)	Mannings n	Time lag (mins)	Rainfall Multiplier	Hydrological Model
C2-C	N1	244	0	4.6	0.03	0	1	Gundaroo RAFTS
C3-1	N(C3-1)	14.7	0	1.3	0.03	0	1	Gundaroo RAFTS
C3-2	N(C3-2)	15.7	0	1.3	0.03	0	1	Gundaroo RAFTS

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes
3x1800	Cul. Inlet	Outlet 1	15	573.116	573.1	0.11	crete Under Rc	1800	1800	0.012	Existing	3

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Width (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed
HC7	N1	N2	Irregular	3800	758	583.274							
HC6	N2	N2.1	Irregular	101.86	583.274	581.292							
HC5	N2.1	N2.2	Irregular	133.18	581.292	579.798							
HC4	N2.2	N3	Irregular	127.04	579.798	578.48							
HC3	N3	N3.1	Irregular	139.91	578.48	576.292							
HC2	N3.1	N3.2	Irregular	171.14	576.292	575.095							
HC1	N3.2	Cul. Inlet	Irregular	104.24	575.095	573.116							
C3-2	N(C3-1)	N2	Prismatic	10	583.374	583.274	1	10	0.1	0.1	0.03	10	No
C3-2	N(C3-2)	N3	Prismatic	10	578.58	578.48	1	10	0.1	0.1	0.03	10	No

OVERFLOW ROUTE DETAILS

Name	From	To	Length (m)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Storms (m)	SafeDepth Minor Storms (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %	id
Sutton Road	Cul. Inlet	Outlet 2	15	575.633	62	1.7	Sutton Road	0.3	0.15	0.6	1	0	141

100yr, 0% Blockage

DRAINS results prepared 03 July, 2014 from Version 2014.07

PIT / NODE DETAILS *Version 8*

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N1	759.59		24.846				
N2	585.28		26.61				
N2.1	583		26.512				
N2.2	581.02		26.519				
N3	579.52		27.953				
N3.1	577.08		27.899				
N3.2	575.87		27.78				
Cul. Inlet	575.67		27.203		-0.04	0.706	Headwall height/system capacity
Outlet 1	574.57		0				
N(C3-1)	585.29		1.538				
N(C3-2)	579.52		1.619				

SUB-CATCHMENT DETAILS

Name	Max Flow (cu.m/s)	Due to Storm
C2-C	24.846	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C3-1	1.538	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C3-2	1.619	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
3x1800	26.326	3.45	575.337	574.9	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm
HC7	24.887	5.59	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC6	26.512	5.48	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC5	26.519	5.82	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC4	26.487	3.47	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC3	27.899	4.74	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC2	27.78	1.63	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC1	27.203	2.53	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C3-2	1.807	0.09	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C3-2	1.657	0.18	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
Sutton Road	0.706	0.706	37.335	0.019	0.01	61.9	0.6	AR&R 100 year, 1 hour storm

Run Log for 2916 run at 16:56:08 on 3/7/2014
Flows were safe in all overflow routes.

100yr, 50% Blockage

DRAINS results prepared 03 July, 2014 from Version 2014.07

PIT / NODE DETAILS *Version 8*

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N1	759.59		24.846				
N2	585.28		26.611				
N2.1	583		26.499				
N2.2	581.02		26.505				
N3	579.52		27.941				
N3.1	577.08		27.884				
N3.2	576.02		27.781				
Cul. Inlet	575.9		27.747		-0.27	14.578	Headwall height/system capacity
Outlet 1	574.81		0				
N(C3-1)	585.29		1.538				
N(C3-2)	579.52		1.619				

SUB-CATCHMENT DETAILS

Name	Max Flow (cu.m/s)	Due to Storm
C2-C	24.846	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C3-1	1.538	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C3-2	1.619	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
3x1800	13.114	4.13	575.597	574.812	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm
HC7	24.882	5.59	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC6	26.499	5.48	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC5	26.505	5.82	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC4	26.476	3.47	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC3	27.884	4.74	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC2	27.781	1.59	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC1	27.747	2.08	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C3-2	1.784	0.09	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C3-2	1.666	0.18	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
Sutton Road	14.578	14.578	37.335	0.118	0.24	61.91	2	AR&R 100 year, 1 hour storm

Run Log for 2916 run at 16:56:08 on 3/7/2014
Flows were safe in all overflow routes.

100yr, 100% Blockage

DRAINS results prepared 03 July, 2014 from Version 2014.07

PIT / NODE DETAILS *Version 8*

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N1	759.59		24.846				
N2	585.28		26.54				
N2.1	583		26.505				
N2.2	581.02		26.508				
N3	579.52		27.952				
N3.1	577.08		27.892				
N3.2	576.12		27.784				
Cul. Inlet	576.04		27.758		-0.41	27.684	Headwall height/system capacity
Outlet 1	573.2		0				
N(C3-1)	585.28		1.538				
N(C3-2)	579.52		1.619				

SUB-CATCHMENT DETAILS

Name	Max Flow (cu.m/s)	Due to Storm
C2-C	24.846	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C3-1	1.538	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C3-2	1.619	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
3x1800	0.022	2.82	575.84	573.2	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm
HC7	24.888	5.59	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC6	26.505	5.48	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC5	26.508	5.82	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC4	26.48	3.47	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC3	27.892	4.73	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC2	27.784	1.58	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
HC1	27.758	1.81	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C3-2	1.797	0.09	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2
C3-2	1.672	0.18	AR&R 100 year, 1 hour storm, average 50.9 mm/h, Zone 2

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
Sutton Road	27.684	27.684	37.335	0.173	0.45	61.92	2.58	AR&R 100 year, 1 hour storm

Run Log for 2916 run at 16:43:10 on 3/7/2014
Flows were safe in all overflow routes.

PMP, 100% Blockage

DRAINS results prepared 03 July, 2014 from Version 2014.07

PIT / NODE DETAILS *Version 8*

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N1	761.67		253.67				
N2	587.79		274.313				
N2.1	585.31		325.858				
N2.2	583.15		318.122				
N3	581.35		311.081				
N3.1	578.52		301.77				
N3.2	577.87		294.683				
Cul. Inlet	577.59		293.371		-1.96	289.04	Headwall height/system capacity
Outlet 1	573.2		0				
N(C3-1)	587.8		15.512				
N(C3-2)	581.35		16.432				

SUB-CATCHMENT DETAILS

Name	Max Flow (cu.m/s)	Due to Storm
C2-C	253.67	PMP - 45 Minute Duration
C3-1	15.512	PMP - 45 Minute Duration
C3-2	16.432	PMP - 45 Minute Duration

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
3x1800	0.028	3.55	577.271	573.2	PMP - 45 Minute Duration

CHANNEL DETAILS

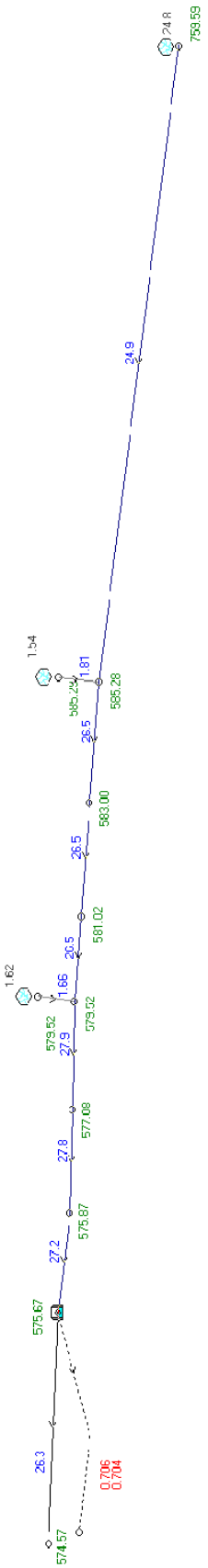
Name	Max Q (cu.m/s)	Max V (m/s)	Due to Storm
HC7	257.64	8.5	PMP - 45 Minute Duration
HC6	325.858	9.48	PMP - 45 Minute Duration
HC5	318.122	8.07	PMP - 45 Minute Duration
HC4	296.459	6.73	PMP - 45 Minute Duration
HC3	301.77	10.65	PMP - 45 Minute Duration
HC2	294.683	3.08	PMP - 45 Minute Duration
HC1	293.371	3.97	PMP - 45 Minute Duration
C3-2	16.706	0.36	PMP - 45 Minute Duration
C3-2	16.67	0.59	PMP - 45 Minute Duration

OVERFLOW ROUTE DETAILS

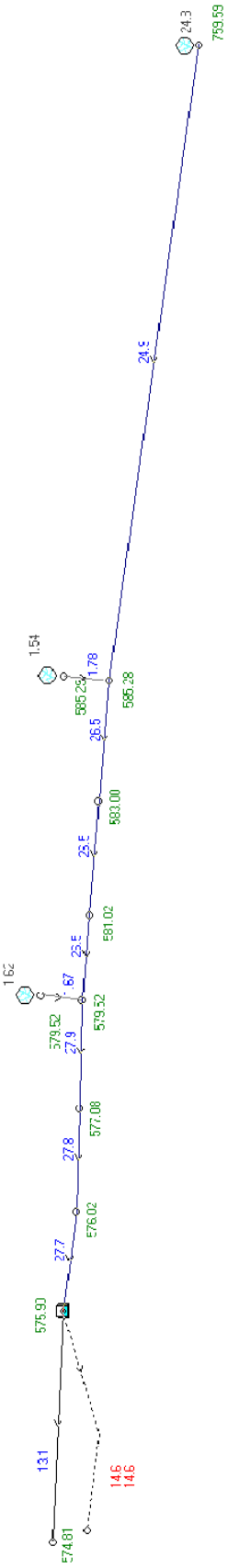
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
Sutton Road	289.04	289.04	0	0.712	4.67	61.97	6.55	PMP - 45 Minute Duration

Run Log for 2916 run at 16:33:04 on 3/7/2014
The maximum flow exceeded the safe value in the following overflow routes: Sutton Road

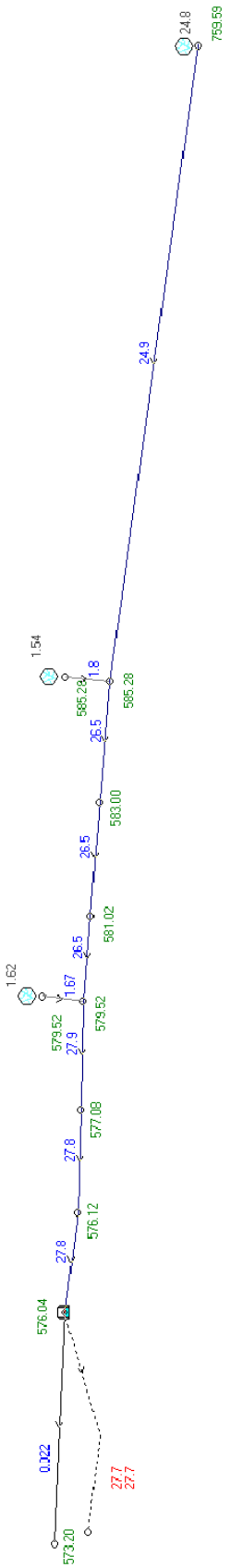
100 yr – 0% Blockage Results



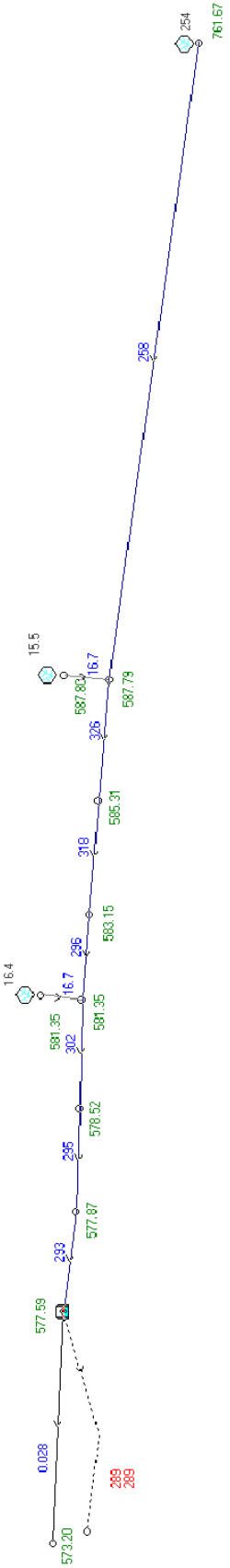
100 yr – 50% Blockage Results



100 yr – 100% Blockage Results



PMP – 100% Blockage Results



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