Lota Creek Flood Study
Volume 1 of 2

BRISBANE CITY

Dedicated to a better Brisbane

Lota Creek Flood Study

Volume 1 of 2

Prepared by Brisbane City Council's, City Projects Office

October 2014

BRISBANE CITY

Dedicated to a better Brisbane

Brisbane City Council

City Projects Office

Level 1, 505 St Pauls Terrace

Fortitude Valley QLD 4006

GPO Box 1434

Brisbane QLD 4000

Telephone: 07 3403 8888

Facsimile: 07 3334 0071

Notice

Document Control: CA14/944970

Issue No.	Date of Issue	Amdt	Prepared By (Author/s)		Supervised By		Approved for Issue (Project Director)
			Initials	RPEQ Number and Signature	Initials	RPEQ Number and Signature	Initials
Draft	28/06/13		HZ		EC		EC
Final Draft	29/07/13		HZ		EC		EC
Final	31/10/14		HZ	[signature]	EC	[signature] 10498	EC [signature]

Executive Summary

1.1 Introduction

Brisbane City Council (BCC) is in the process of updating all of its flood studies to reflect the current conditions of the catchment and best practice flood modelling techniques. The most recent flood study for the Lota Creek Catchment was undertaken in 1997 by Connell Wagner (now Aurecon). Following on from this study, the Lota Creek Stormwater Management Plan was undertaken by SKM in 1999 and BCC in 2000.

The Lota Creek Catchment is located within the south-eastern corner of the BCC area. It is bounded by the Tingalpa Creek Catchment to the east and Bulimba Creek Catchment to the west. The catchment is approximately 18 km^2 in area and contains the suburbs of Chandler, Gumdale, Ransome, Wakerley, Manly and Lota. The catchment is generally drained by poorly defined natural or constructed vegetated channels. Many of these waterways pass through private rural-residential parcels. Roadways are typically low lying with crossings consisting of small sized culverts that flood regularly. Road closures are common and since drainage is poor, residential dwellings are readily isolated.

1.2 Project Objectives

The primary objectives for this project are as follows:

- Update the Lota Creek Catchment hydrologic and hydraulic models to represent the current catchment conditions and best practice flood modelling techniques.
- Adequately calibrate and verify the models to historical storm events.
- Confirm that the hydrologic and hydraulic models are suitable to utilise for the purposes of design event modelling.
- Estimate design and extreme flood magnitudes.
- Determine design flood levels for the full range of design and extreme events up to the Probable Maximum Flood (PMF).
- Quantify the impacts of Minimum Riparian Corridor (MRC) and filling outside the Waterway Corridor (WC).
- Produce flood inundation, flood depth and depth-velocity mapping for the selected range of design and extreme events up to the PMF.
- Quantify the impacts of climate change on flooding within the catchment.

1.3 Project Elements

The Lota Creek Flood Study consists of the following components:

Calibration and Verification Modelling

Hydrologic and hydraulic models of the Lota Creek Catchment have been developed using the RAFTS and TUFLOW modelling software respectively. The RAFTS model covers the entire Lota Creek Catchment while the TUFLOW model covers approximately 85 % of the catchment area.

The hydrologic model simulates the catchment rainfall-runoff and runoff-routing processes. The hydrologic model also utilises high-level routing methodology to simulate the flow of floodwater in the major waterways within the catchment. The hydraulic model uses more sophisticated routing to simulate the movement of this floodwater through these waterways in order to predict flood levels, flood discharges and velocities. The hydraulic model takes into account the effects of the channel / floodplain topography; downstream tail water conditions and hydraulic structures.

Calibration is the process of refining the model parameters to achieve a good agreement between the modelled results and the historical / observed data. Model calibration is achieved when the model simulates the historical event to within specified tolerances. Verification is then undertaken on additional flooding events to confirm the calibrated model is suitable for use in simulating synthetic design storm events.

Calibration of the RAFTS and TUFLOW models was undertaken utilising two historical storms; namely 3rd February 2008 and the 20th May 2009. Verification of the RAFTS and TUFLOW models utilised the 11th October 2010 and 25th January 2012 historical storm events.

A good agreement was achieved between the simulated and historical records for both of the calibration events at the continuous recording stream gauge at Rickertt Road. At the Maximum Height Gauges (MHGs), the simulated peak levels were generally within the acceptable tolerance of ± 0.3 m.

Utilising the adopted parameters from the calibration process, the verification was undertaken. Similar to the calibration results, the verification achieved a good agreement between the simulated and historical records for both of the verification events.

Given the results of the calibration and verification process were quite reasonable, the RAFTS and TUFLOW models were considered acceptable for use in the second part of the flood study, in which design flood levels are estimated.

Design and Extreme Events and Climate Change Modelling

The calibrated hydrologic and hydraulic models were then used to simulate a range of design flood events. Design and extreme flood magnitudes were estimated for the full range of events from 2-yr ARI to PMF. These analyses assumed ultimate catchment development conditions in accordance with the current version of BCC City Plan.

Three waterway scenarios were considered follows:

- Scenario 1 – Existing Scenario: Based on the current waterway conditions. No further modifications were made to the TUFLOW model developed as part of the calibration / verification phase.
- Scenario 2 – Minimum Riparian Corridor (MRC) Scenario: Includes an allowance for a riparian corridor along the edge of the channel.
- Scenario 3 – Ultimate Scenario: Includes an allowance for the riparian corridor (as per Scenario 2) and also assumes filling to the WC boundary to simulate potential development outside the WC.

The results from the TUFLOW modelling were used to produce the following:

- Peak flood discharges
- Critical storm durations at selected locations
- Peak flood levels
- Peak flood extent mapping
- Peak flood depth mapping
- Peak depth-velocity mapping
- Hydraulic structure flood immunity

A climate change analysis was then undertaken to determine the impacts for two planning horizons; namely 2050 and 2100. This included making allowances for increased rainfall intensity and increased mean sea level rise. This analysis was undertaken for the 100-yr, 200-yr and 500-yr ARI events.

The results from the TUFLOW modelling were used to produce the following:

- Impacts to peak flood discharges
- Impacts to peak flood levels
- Flood afflux mapping

Table of Contents

List of Figures

List of Tables

List of Appendices

Glossary of Terms

Term	Definition
Annual Exceedance Probability (AEP)	The probability that a given rainfall total or flood flow will be exceeded in any one year. (see ARI/AEP conversion table)
Average Recurrence Interval (ARI)	The long-term average number of years between the occurrence of a flood as big as (or larger than) the selected event. For example, floods with a discharge as great as (or greater than) the 20 year ARI design flood will occur on average once every 20 years.
Brisbane Bar	Location at the mouth of the Brisbane River.
Catchment	The area of land draining through the main stream (as well as tributary streams) to a particular site. It always relates to an area above a specific location.
Digital Elevation Model (DEM)	A three-dimensional model of the ground surface elevation.
Design Event, Design Storm	A hypothetical flood/storm representing a specific likelihood of occurrence (for example the 100 year ARI).
Floodplain	Area of land subject to inundation by floods up to and including the Probable Maximum Flood (PMF) event
Flood Frequency Analysis (FFA)	Method of predicting flood flows at a particular location by fitting observed values at the location to a standard statistical distribution.
Flood Regulation Line (FRL)	Planning line used to denote extent of a waterway. The maximum encroachment of floodplain development. Superseded by the Waterway Corridor (see Waterway Corridor).
HEC-RAS	One-dimensional hydrodynamic modelling software package.
Hydrograph	A graph showing how the discharge or stage/flood level at any particular location varies with time during a flood.

Hydstra	File-based time-series data management system
Manning's 'n'	The Gauckler–Manning coefficient, used to represent roughness in 1D/2D flow equations.
Maximum Height Gauge (MHG)	An instrument for measuring a peak water level of a water body at a specific location during a specified time period.
MIKE11	One-dimensional hydrodynamic modelling software package.
MIKE21	Two-dimensional hydrodynamic modelling software package.
MIKEFLOOD	Software that dynamically couples a 1D MIKE11 and 2D MIKE21 model into a single model.
Minimum Riparian Corridor (MRC)	An area of (maximum) 15m width either side of the main flow channel, where future revegetation may occur.
Pluviograph	An instrument for measuring the amount of water that has fallen (ie. raingauge), with a feature to register the data in real time to demonstrate rainfall over a short period of time, often an automated graphing instrument.
Probable Maximum Flood (PMF)	An extreme flood deemed to be the largest flood that could conceivably occur at a specific location.
Probable Maximum Precipitation (PMP)	The PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year
Stream(flow) Gauge	An instrument for measuring the water level in a water body, with the ability to register the data in real time.
Thiessen Polygon method	A method of determining spatial rainfall distribution over a catchment
TUFLOW	Hydrodynamic modelling software package.
URBS	Hydrologic modelling software package.
Waterway Corridor (WC)	Planning line used to denote extent of a waterway.
XP-RAFTS	Hydrologic modelling software package.

ARI to AEP Conversion

ARI (years)	AEP (%)
2	50
5	20
10	10
20	5
50	2
100	1
200	0.5
500	0.2
2000	0.05

1.0 Introduction

1.1 Background

The Lota Creek Catchment is located within the south-eastern corner of Brisbane City Council (BCC) area. It is bounded by the Tingalpa Creek Catchment to the east and Bulimba Creek Catchment to the west. The entire catchment lies within the BCC jurisdiction. Figure 1.1 indicates the catchment locality.

Figure 1.1: Locality Plan

The most recent flood study for the catchment was undertaken in 1997 by Connell Wagner (now Aurecon). Following on from that flood study, the Lota Creek Stormwater Management Plan was undertaken by SKM in 1999.

BCC is in the process of updating all of its flood studies to reflect the current conditions of the catchment and best practice flood modelling techniques.

1.2 Study Objectives

The primary objectives for this part of the project are as follows:

- Update the Lota Creek Catchment hydrologic and hydraulic models to represent the current catchment conditions and best practice flood modelling techniques.
- Adequately calibrate and verify the models to historical storm events.
- Confirm that the hydrologic and hydraulic models are suitable to utilise for the purposes of design event modelling.
- Estimation of design and extreme flood magnitudes.
- Determine design flood levels for the full range of design and extreme events up to the Probable Maximum Flood (PMF).
- Quantify the impacts of Minimum Riparian Corridor (MRC) and filling outside the Waterway Corridor (WC).
- Produce flood inundation, flood depth and depth-velocity mapping for the selected range of design and extreme events up to the PMF.
- Quantify the impacts of climate change on flooding within the catchment.

1.3 Scope of Work

The following tasks were undertaken to achieve the project objectives outlined above:

- Develop / upgrade the RAFTS hydrologic model of the catchment, representing a refinement of the previous flood study.
- Develop a 2-dimensional TUFLOW model of the creek system to replace the existing 1-dimensional MIKE11 hydraulic model.
- Calibrate the RAFTS and TUFLOW models to the February 2008 and May 2009 historical flood events.
- Verify the RAFTS and TUFLOW models to the October 2010 and January 2012 historical flood events.
- Estimation of design and extreme flood magnitudes for the full range of events from 2-yr ARI to PMF.
- Simulate synthetic Australian Rainfall and Runoff (AR&R) design storms for multiple durations to determine the critical duration at various locations within the catchment.
- Utilise the calibrated RAFTS and TUFLOW models to determine peak design flood levels for the full range of design and extreme events up to the PMF.
- Make adjustments to the model to simulate the impacts of MRC and filling outside the WC.
- Combine the modelling results for the various storm durations to produce peak results throughout the catchment for each ARI.

- Produce peak mapping results for flood inundation, flood depth and depth-velocity for the selected range of design and extreme events up to the PMF.
- Undertake climate change modelling for the 100-yr, 200-yr and 500-yr ARI events to determine the impacts.

2.0 Catchment Details

2.1 Description of Catchment

The Lota Creek Catchment is approximately 18 km^2 in area and contains the suburbs of Chandler, Gumdale, Ransome, Wakerley, Manly and Lota. The major features of the catchment as well as the hydrometric stations are shown in Figure 2.1. Lota Creek is over 6.5 km long from Old Cleveland Road to the mouth at Moreton Bay.

Lota Creek originates in the suburb of Chandler as a number of tributaries upstream of Old Cleveland Road. The catchment elevation along the southern catchment boundary at Chandler is approximately 40 to 50 m AHD. Downstream of New Cleveland Road, the tributaries merge into the main creek and from there it flows through marshy areas and tidal wetlands before entering Moreton Bay at Fig Tree Point (near the boundary between BCC and Redland City Council).

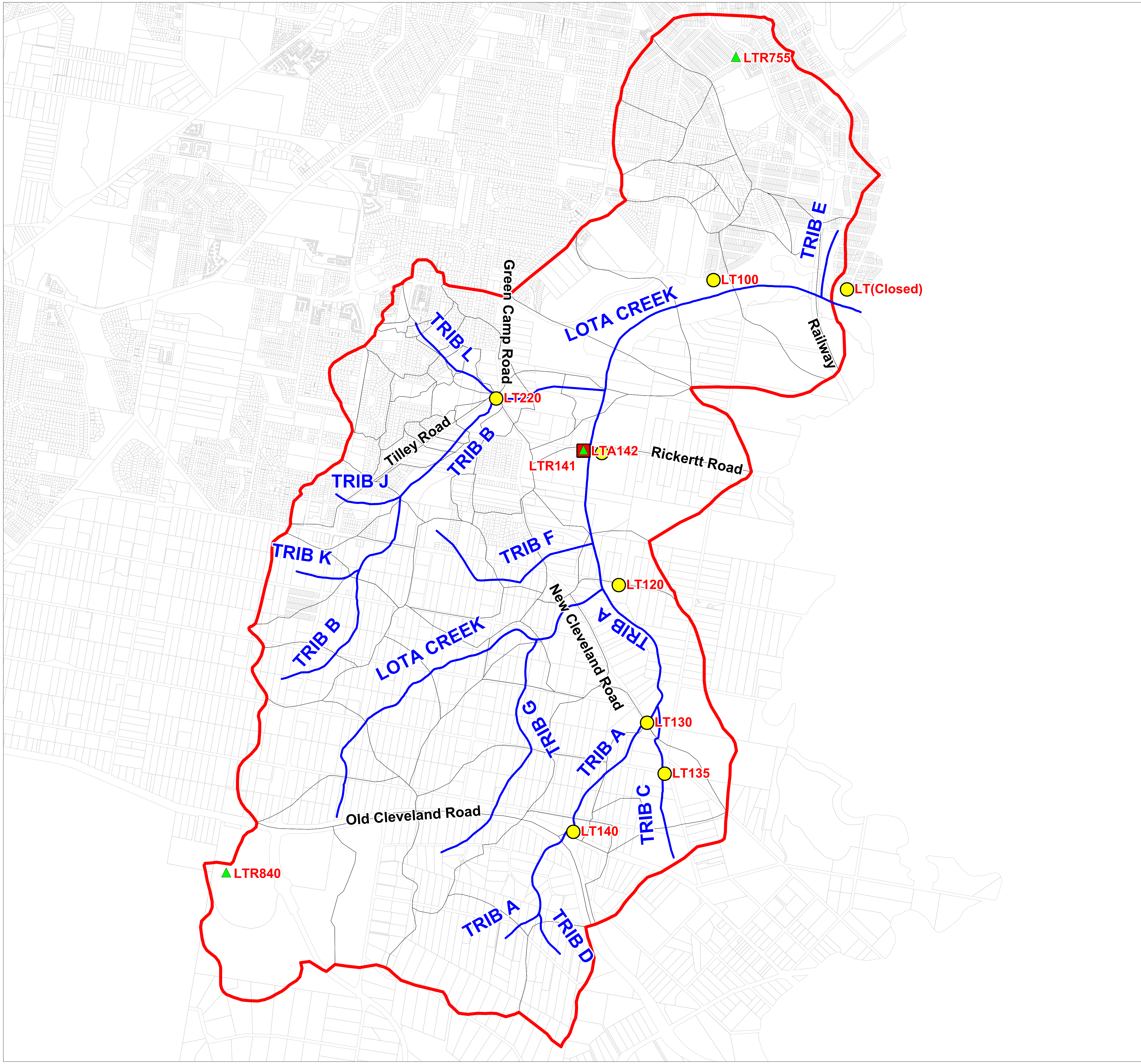
The catchment is drained by poorly defined natural or constructed vegetated channels. Many of these waterways pass through private rural-residential parcels. Roadways are typically low lying with crossings consisting of small sized culverts that flood regularly. Road closures are common and since drainage is poor, residential dwellings are readily isolated.

The majority of the Upper Lota Creek Catchment is rural residential, with the middle and lower areas comprising mainly of low density residential and environmental conservation areas. A review of the available aerial photography indicated that the catchment experienced only minor variations in the level of urbanisation from the early 1970s to around the year 2000. However, in recent years, the mid-catchment area has experienced considerable low density residential development and there is future planned development in this area.

2.2 Major Tributaries

2.2.1 Lota Creek (Old Cleveland Road to Molle Road)

This 3 km length of creek falls from approximately 17 m AHD at Old Cleveland Road to around 1 - 2 m AHD at Molle Road, an average longitudinal grade of approximately 0.5 %. The channel is well defined and flood flows tend to be contained. Through most of this reach, the creek flows through rural residential land and has fairly thick vegetation on the banks of the main channel and medium / thick trees on the overbanks. This reach of the creek includes five major road crossings as well as several crossings on private land.



MAILING ADDRESS:
GPO Box 1434
Brisbane Qld 4001

Green Square
South Tower
505 St. Paul's Terrace
Fortitude Valley Qld 4006

Telephone: (07) 3027 5550
Facsimile: (07) 3334 0225
E-mail: citydesign@brisbane.qld.gov.au

Dedicated to a better Brisbane

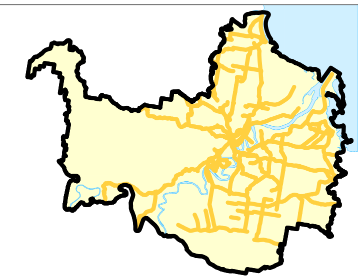
City Projects Office
Brisbane City Council

LEGEND

- Telemetry Gauge
- MHG Gauge
- Stream Gauge
- Waterways
- Lota Creek Sub-Catchment
- Lota Creek Catchment Boundary

N W E S

250 0 250 500 750
Metres



Printed 29 May 2013

Project Number CD130866 | Revision 1 | Prepared HZ | Checked HZ

Workspace G:\\130866\GIS\Workspaces\Figure 2.1.WOR

Project
Lota Creek Flood Study

Title
Lota Creek Catchment Map

Figure 2.1

2.2.2 Lota Creek (Molle Road to the Tidal Channel)

This section of Lota Creek is very flat and contains a wide floodplain. From downstream of Molle Road to downstream of Rickertt Road, the land is primarily a tea-tree swamp with rural residential properties on both sides. The lower parts of this reach flow through a very thick mangrove marshy area and for most of this section there is no defined main creek channel.

There are two major road crossings and some minor private property crossings within this section of Lota Creek.

2.2.3 Lota Creek (Tidal Channel)

From adjacent to Hardgreave Street to just upstream of the railway crossing, the very flat channel meanders through the mangrove areas. In the downstream reach, the creek is crossed by the Railway Bridge before it flows into Moreton Bay. Large head-losses are observed through the bridge as the bridge embankments appear to pose a significant restriction to the flow.

2.2.4 Tributary A

Tributary A is approximately 2.5 km in length and extends from upstream of Old Cleveland Road to the confluence with Lota Creek, just downstream of New Cleveland Road. In the upper reach above Old Cleveland Road, the main channel is well defined. Downstream of Old Cleveland Road the topography is flatter and the flow path is less defined. There are five major road crossings and some minor private property crossings along its length.

2.2.5 Tributary B

Tributary B is the largest tributary of Lota Creek, with a length of approximately 3.5 km. It extends from Tilley Road to the confluence with Lota Creek, downstream of Rickertt Road. Upstream of New Cleveland Road the main channel is well defined, however in the lower reach the topography is flatter and the flow path is less defined. There are five major road crossings and some minor private property crossings along its length.

2.2.6 Tributary E

Tributary E is approximately 1.5 km in length and extends from downstream of Whites Road to the confluence with Lota Creek, just downstream of the Railway Bridge. This tributary of Lota Creek is well defined along its length. There are four major road crossings along this tributary including the Railway Bridge at Alexander Street and some other minor crossings.

2.2.7 Tributary G

Tributary G is approximately 1.85 km in length and extends from upstream of Charleton Street to the confluence with Lota Creek, just upstream of Formosa Road. The majority of the flow within this section of the creek flows in the form of a wide extent overland flow path rather than flowing in a well-defined channel. There is no waterway corridor defined for the section of this tributary between Boston Road and Formosa Road. This tributary has three major road crossings along its length.

3.0 Hydrometric Data and Storm Selection

3.1 Hydrometric Stations

3.1.1 Continuous Recording Rainfall (Pluviograph) Stations

There are three BCC owned rainfall pluviograph stations located within the Lota Creek Catchment which were utilised for this study. These rainfall gauges are indicated in both Table 3.1 and Figure 2.1. These rainfall gauges are located within the upstream (LTR840), middle (LTR141) and lower (LTR755) catchment areas. The location of the three gauges would appear to adequately capture the spatial effects of rainfall within the catchment, without the need to utilise other rainfall gauges.

Table 3.1 – Pluviograph Stations utilised

Gauge ID	Location
LTR840	Sleeman Sports Complex, Chandler
LTR141	Lota Creek at Rickertt Road, Ransome
LTR755	Gannon Avenue, Manly

3.1.2 Continuous Recording Stream Gauge

There is only one stream gauge in existence (LTA142) within the catchment area. This gauge has been in commission since June 1999 and is located upstream of Rickertt Road on Lota Creek.

3.1.3 Maximum Height Gauge (MHG)

Table 3.2 indicates the MHGs within the catchment area, of which the majority of these gauges are located on Lota Creek and Tributary A as shown on Figure 2.1. Most of the gauges were installed in late 1977 and have been replaced at least once during their existence. New gauges on Tributaries B and C have recently been installed at Greencamp Road and London Road respectively.

Table 3.2 – Maximum Height Gauges

Gauge ID	Reach	Location	Period of Operation
LT001	Lota Creek	Lota Creek Mouth	September 1977 to March 2001
LT100	Lota Creek	Keyes Street	September 1977 to present
LT110	Lota Creek	Rickertt Road	September 1977 to present
LT120	Lota Creek	Molle Road	September 1977 to present
LT130	Tributary A	New Cleveland Road	September 1977 to present
LT135	Tributary A	London Road	May 2009 to present
LT140	Tributary A	Old Cleveland Road	September 1977 to present
LT220	Tributary B	Greencamp Road	August 2010 to present

3.2 Selection of Historical Storm Events

3.2.1 General

Selection of specific events for calibration and verification was based upon the event size, as well as the data availability and completeness. The previous modelling for the 1999 Stormwater Management Plan calibrated / verified the hydrologic / hydraulic model(s) to five events, of which the most recent was May 1996. Since this time, there have been several additional events, of which the latest was in January 2012.

Table 3.3 indicates the larger events that have occurred in Lota Creek (since 1967) for which there are records. The table also indicates the peak recorded flood level in the vicinity of Molle Road and ranks the events on this basis. Much of this earlier data is referenced from the 1997 Flood Study by Connell Wagner.

The largest events to have occurred were in June 1967 and January 1974, in which the flood level at Molle Road surpassed 4 m AHD. The third largest event occurred in May 2008 and the fourth in May 1996. It is apparent that there are generally more records available for the more recent events (2008 onwards) than the earlier events.

Table 3.3 – Historical Peak Levels at Molle Road

Event	Peak Flood Level (m AHD)	Rank for All Events	Rank for Selected Events	Number of MHGs and/or recorded levels
June 1967	4.25	1	-	1
January 1974	4.12	2	-	4
May 1980	3.19	9	-	2
December 1982	2.65	12	-	1
January 1983	2.51	13	-	2
June 1983	3.26	7	-	2
April 1988	3.27	6	-	4
April 1990	3.09	10	-	2
May 1996	3.42	4	-	3
February 2008	3.63	3	1	4
May 2009	3.36	5	2	5
October 2010	2.96	11	4	5
January 2012	3.25	8	3	6

After consideration, it was decided to use the most recent events in the calibration and verification process, as follows:

- Calibration
  - February 2008 (3rd ranked / 4 recorded levels)
  - May 2009 (5th ranked / 5 recorded levels)

- Verification
  - October 2010 (11th ranked / 5 recorded levels)
  - January 2012 (8th ranked / 6 recorded levels)

The predominant reason for selecting these events was the better data coverage when compared with the earlier events, especially the continuous recording stream gauge which has only been in operation since June 1999. Another factor was that a reasonable amount of development has occurred in recent years, which would only be captured in the four recent events selected.

3.2.2 Availability of Data for Selected Historical Storms

Tables 3.4 and 3.5 indicate the availability of historical pluviograph and MHG data for use with the calibration and verification events. These tables indicate that there is a good representation of historical data for all four events.

For all four events, data was available for the one continuous recording stream gauge (LTA142).

Table 3.4 – Availability of Rainfall Pluviograph Data

Gauge ID	Location	Calibration Events		Verification Events	
		Feb 2008	May 2009	Oct 2010	Jan 2012
LTR840	Sleeman Sports Complex, Chandler	✓	✓	✓	✓
LTR141	Lota Creek at Rickertt Road, Ransome	✓	✓	✓	✓
LTR755	Gannon Avenue, Manly	✓	✓	✓	✓

Table 3.5 – Availability of MHG Data

Gauge ID	Reach	Location	Calibration Events		Verification Events	
			Feb 2008	May 2009	Oct 2010	Jan 2012
LT001	Lota Creek	Lota Creek Mouth	×	×	×	×
LT100	Lota Creek	Keyes Street	×	✓	×	×
LT110	Lota Creek	Rickertt Road	✓	×	✓	✓
LT120	Lota Creek	Molle Road	✓	✓	✓	✓
LT130	Tributary A	New Cleveland Road	✓	✓	×	✓
LT135	Tributary A	London Road	×	✓	✓	✓
LT140	Tributary A	Old Cleveland Road	✓	✓	✓	✓
LT220	Tributary B	Greencamp Road	×	×	✓	✓

3.3 Characteristics of Calibration Events

3.3.1 3rd February 2008 Event

This event produced the 3rd highest flood level at Molle Road, since 1967. The storm was most intense in the east of Brisbane in the vicinity of the study area. Significant flooding occurred to private and public infrastructure. At Rickertt and Molle Roads on Lota Creek, the maximum depth of water over the road was approximately 0.5 m and 1.4 m respectively.

The majority of the rainfall for this event fell between 2 am and 10 am on the 3rd February, with the heaviest burst between 7:30 am and 10:30 am. The rainfall was more intense in the upper and middle sections of the catchment, with approximately 157 mm falling in this 8 hour period.

The pluviograph at Rickertt Road recorded the following design rainfall ARIs on the 3rd February:

- 2 hour design rainfall: 5-yr ARI
- 6 hour design rainfall: 17-yr ARI
- 12 hour design rainfall: 10-yr ARI

Figure 3.1 shows the IFD curves for the catchment, and the calibration event plotted for various durations for each pluvio gauge.

Figure 3.1: IFD Curves and February 2008 Event

Table 3.6 indicates the 4-day and 14-day antecedent rainfall as well as the total event rainfall at the three pluviographs. Further information on the event rainfall distribution is provided in Appendix A.

Table 3.6 – Rainfall characteristics (February 2008 Event)

Gauge ID	Location	Antecedent Rainfall (mm)		Event Rainfall (mm)	
		14-day	4-day	3rd Feb 2008	2nd Feb 2008 to 4th Feb 2008
LTR840	Sleeman Sports Complex, Chandler	71	51	157	163
LTR141	Lota Creek at Rickertt Road, Ransome	45	26	157	169
LTR755	Gannon Avenue, Manly	24	11	68	78

3.3.2 20th May 2009 Event

This event produced the 5th highest flood level at Molle Road, since 1967. The storm was most intense in the western suburbs of Brisbane. Some flooding occurred and many of the roads were overtopped. At Molle Road on Lota Creek, the maximum depth of water over the road was approximately 1.1 m.

The majority of the rainfall for this event fell steadily between 9 pm on the 19th May to midday on the 20th May. The rainfall was evenly distributed throughout the catchment, with approximately 100 to 120 mm falling in the 12-hour period between midnight and midday of the 20th May.

The pluviograph at Rickertt Road recorded the following design rainfall ARIs on the 20th May:

- 2 hour design rainfall: 1-yr ARI
- 6 hour design rainfall: 1-yr ARI
- 12 hour design rainfall: 4-yr ARI

Figure 3.2 shows the IFD curves for the catchment, and the calibration event plotted for various durations for each pluvio gauge.

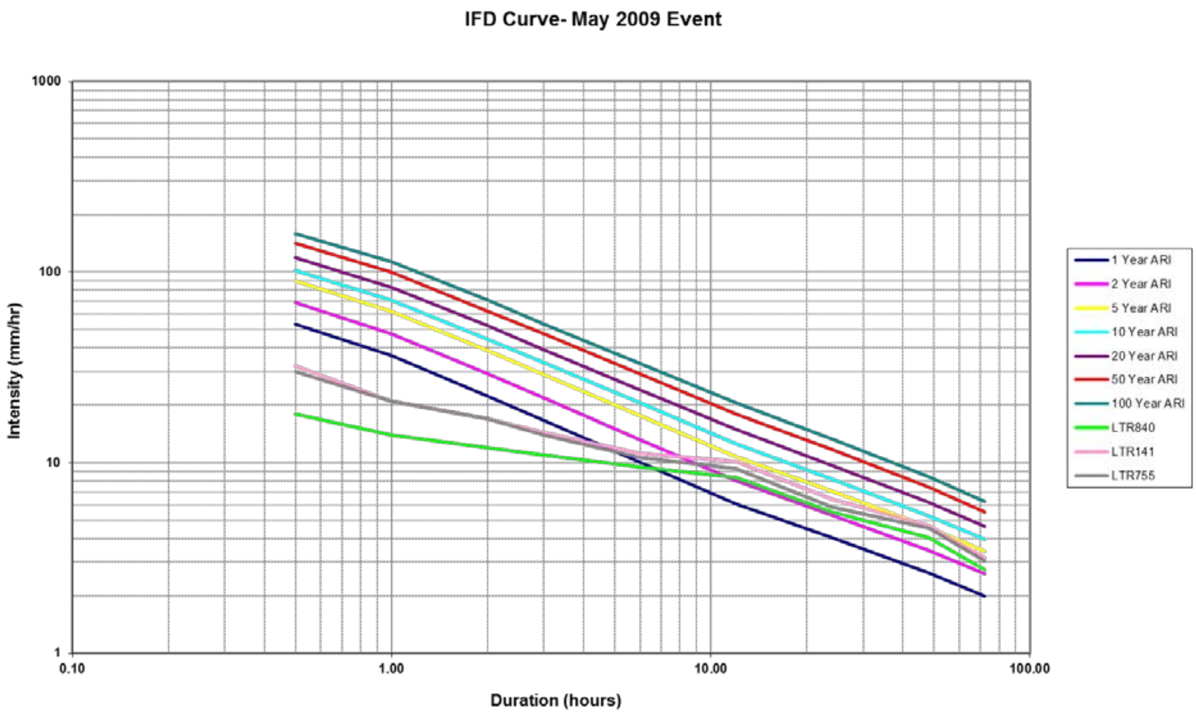


Figure 3.2: IFD Curves and May 2009 Event

Table 3.7 indicates the 4-day and 14-day antecedent rainfall as well as the total event rainfall at the three pluviographs. Further information on the event rainfall distribution is provided in Appendix A.

Table 3.7 – Rainfall characteristics (May 2009 Event)

Gauge ID	Location	Antecedent Rainfall (mm)		Event Rainfall (mm)	
		14-day	4-day	20th May 2009	18th May 2009 to 20th May 2009
LTR840	Sleeman Sports Complex, Chandler	85	82	116	198
LTR141	Lota Creek at Rickertt Road, Ransome	97	92	136	228
LTR755	Gannon Avenue, Manly	99	98	122	220

3.4 Characteristics of Verification Events

3.4.1 11th October 2010 Event

This event produced the 11th highest flood level at Molle Road, since 1967. The storm was most intense in the northern suburbs of Brisbane. At Rickertt Road, there was no overtopping of the road, whereas at Molle Road the maximum depth of water over the road was approximately 0.7 m.

The majority of the rainfall for this event fell steadily between midnight and 6 am on the 11th October. The rainfall was evenly distributed throughout the catchment, with approximately 45 to 55 mm falling in the 6-hour period between midnight and 6 am.

The pluviograph at Rickertt Road recorded the following design rainfall ARIs on the 11th October:

- 2 hour design rainfall: <1-yr ARI
- 6 hour design rainfall: 1-yr ARI
- 12 hour design rainfall: 1-yr ARI

Figure 3.3 shows the IFD curves for the catchment, and the calibration event plotted for various durations for each pluvio gauge.

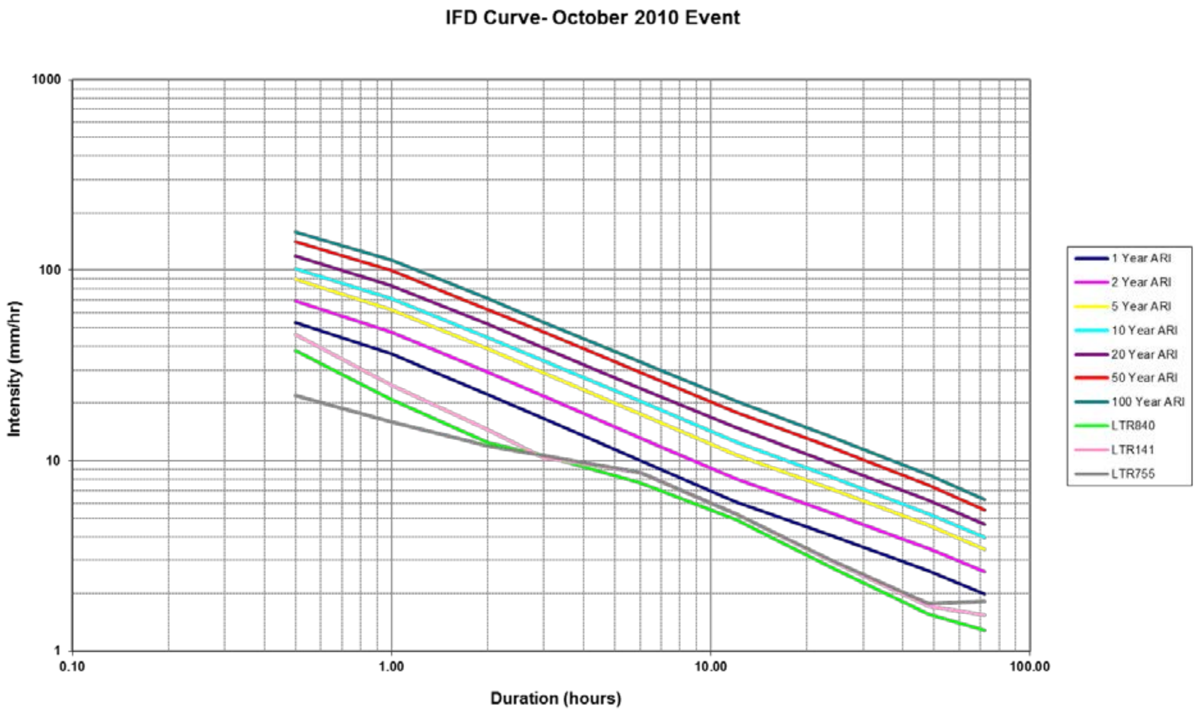


Figure 3.3: IFD Curves and October 2010 Event

Table 3.8 indicates the 4-day and 14-day antecedent rainfall as well as the total event rainfall at the three pluviographs. Further information on the event rainfall distribution is provided in Appendix A.

Table 3.8 – Rainfall characteristics (October 2010 Event)

Gauge ID	Location	Antecedent Rainfall (mm)		Event Rainfall (mm)	
		14-day	4-day	11th Oct 2010	8th Oct 2010 to 11th Oct 2010
LTR840	Sleeman Sports Complex, Chandler	108	69	54	123
LTR141	Lota Creek at Rickertt Road, Ransome	136	85	61	146
LTR755	Gannon Avenue, Manly	124	87	62	144

3.4.2 24th to 25th January 2012 Event

This event produced the 8th highest flood level at Molle Road, since 1967. The storm produced similar rainfall intensities across the BCC region. At Rickertt and Molle Roads, the maximum depth of water over the road was approximately 0.25 m and 1 m respectively.

The majority of the rainfall for this event fell steadily between 4 pm on the 24th January to 6 am on the 25th January. The rainfall was evenly distributed throughout the catchment, with approximately 60 to 70 mm falling in the 6-hour period between midnight and 6 am on the 25th January.

The pluviograph at Rickertt Road recorded the following design rainfall ARIs on the 25th January:

- 2 hour design rainfall: 1-yr ARI
- 6 hour design rainfall: 1-yr ARI
- 12 hour design rainfall: 2-yr ARI

Figure 3.4 shows the IFD curves for the catchment, and the calibration event plotted for various durations for each pluvio gauge.

Figure 3.4: IFD Curves and January 2012 Event

Table 3.9 indicates the 4-day and 14-day antecedent rainfall as well as the total event rainfall at the three pluviographs. Further information on the event rainfall distribution is provided in Appendix A.

Table 3.9 – Rainfall characteristics (January 2012 Event)

Gauge ID	Location	Antecedent Rainfall (mm)		Event Rainfall (mm)	
		14-day	4-day	24th Jan 2012 to 25th Jan 2012	23rd Jan 2012 to 25th Jan 2012
LTR840	Sleeman Sports Complex, Chandler	92	12	190	201
LTR141	Lota Creek at Rickertt Road, Ransome	127	33	255	288
LTR755	Gannon Avenue, Manly	108	26	247	272

4.0 RAFTS Model Set-up

4.1 Methodology

The RAFTS model for the Lota Creek Catchment was developed as part of the 1997 Flood Study and the 1999 Lota Creek Stormwater Management Plan. This model was previously calibrated / verified to historical storm events and is able to be used as a “standalone” hydrologic model, capable of accurately simulating catchment / reach routing and predicting discharges within the catchment area.

A number of modifications were made to the RAFTS model as part of this study as follows:

- The RAFTS model was updated to the latest version XPRAFTS 2009.
- To assist with better distribution of flows into the TUFLOW model, it was necessary to sub-divide a number of the RAFTS model sub-catchments.
- Catchment slopes were reviewed and updated as the result of better topographical data.
- The storage (reservoir) nodes were removed from the model. Refer to Section 6.1 for further details.

4.2 Sub-catchment Data

4.2.1 General

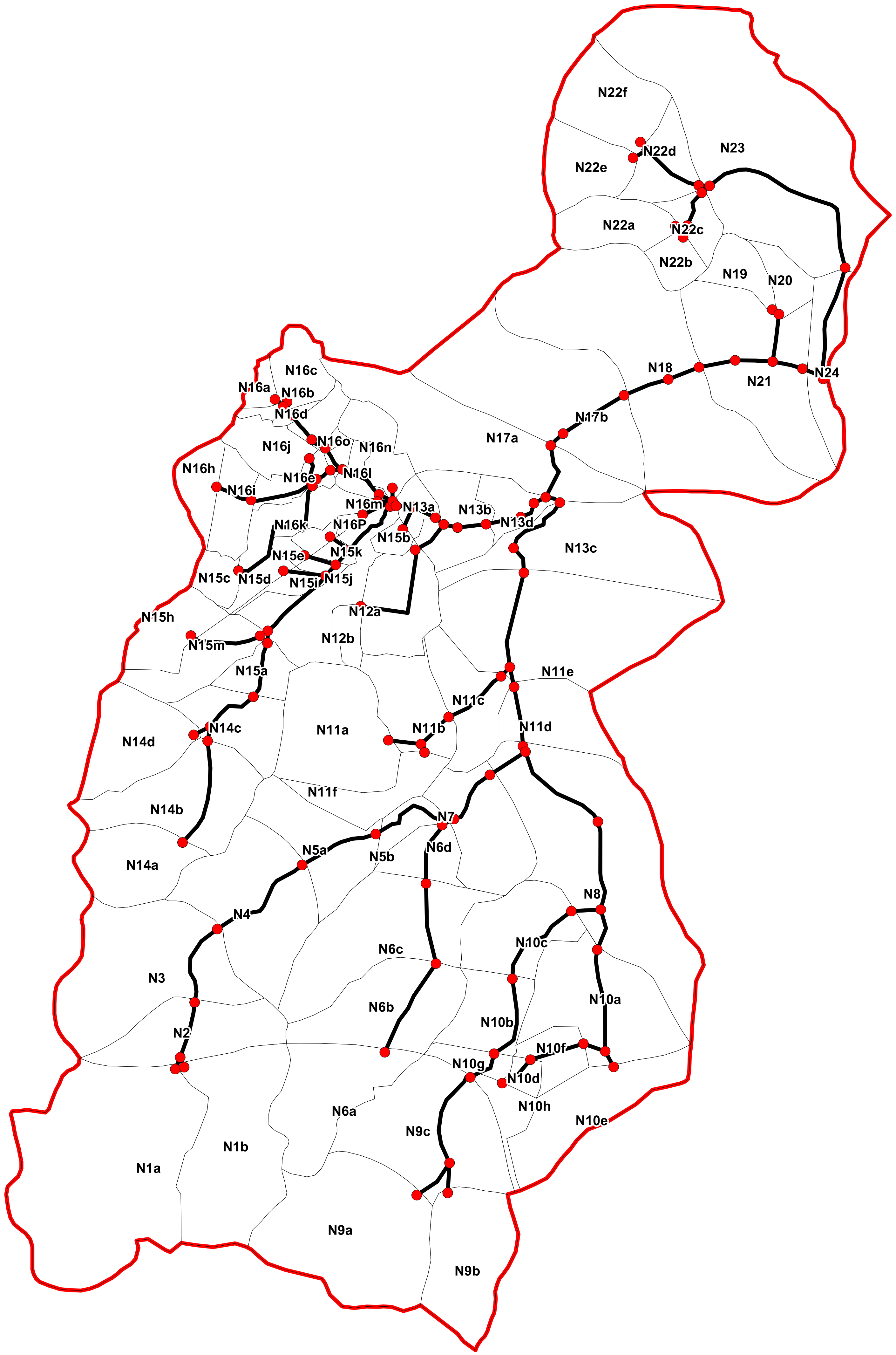
This section describes the derivation of the RAFTS sub-catchment parameters. The adopted sub-catchment parameters for the calibration / verification events are shown in Appendix B. Generally, as the calibration and verification events are all within 4 years, the same sub-catchment parameters have been used for each event.

4.2.2 Sub-catchment Delineation

The Lota Creek RAFTS model consists of 83 sub-catchments. Sub-catchment delineation was adjusted from the original model for a better representation of the flow into the TUFLOW hydraulic model. Figure 4.1 shows the sub-catchment delineation.

4.2.3 Sub-catchment Slope

Sub-catchment slopes have been calculated from the topography by identifying indicative flow paths and associated equal area slopes.



MAILING ADDRESS:
GPO Box 1434
Brisbane Qld 4001

Green Square
South Tower
505 St. Paul's Terrace
Fortitude Valley Qld 4006

Telephone: (07) 3027 5550
Facsimile: (07) 3334 0225
E-mail: citydesign@brisbane.qld.gov.au

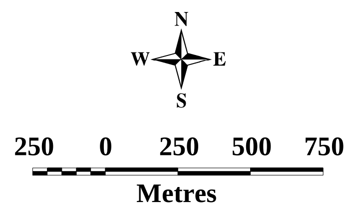
BRISBANE CITY

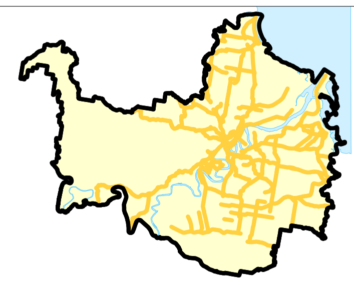
Dedicated to a better Brisbane

City Projects Office
Brisbane City Council

LEGEND

- RAFTS Node
- RAFTS Link
- RAFTS Sub-catchment
- RAFTS Catchment Boundary





Printed 29 May 2013

Project Number CD130866 | Revision 1 | Prepared HZ | Checked HZ

Workspace G:\\130866\GIS\Workspaces\Figure 4.1.WOR

Project
Lota Creek Flood Study

Title
RAFTS Sub-catchment Delineation

Figure 4.1

4.2.4 Percentage Impervious and Hydrologic Roughness (PERN)

The land-use and impervious area of the cadastral parcels have been identified using BCC aerial photography and the most recent version of BCC City Plan (as appropriate). The adopted land-use for the calibration / verification events is shown on a catchment map in Appendix E.

Table 4.1 indicates the percentage impervious values adopted for the various land-use types. Where RAFTS sub-catchments contained more than one type of land-use, weighted averages of the percentage imperviousness were applied for the sub-catchment characteristics.

Table 4.1 – Sub-catchment parameter by land-use

Land-use Type	% Impervious
Environmental Protection	20
Rural	20
Conservation	5
Park Land	5
Low Density Residential	65
Community Use Area Education Purposes	75
Sport And Recreation	50
Emerging Communities	70
Community Use Area Railway	90
Light Industry	90
Community Use Area Community Facilities	75
Community Use Area Health Care Purposes	75
Special Purpose Centre Major Sporting Stadium	75
Multi-Purpose Centre Convenience Centre	90
Community Use Area Utility Services	75
Road	90

The hydrologic roughness parameter (PERN) is input as a Manning's 'n' representation of the average sub-catchment roughness. A value of n = 0.025 was used for urbanised areas and a value of n = 0.05 was used for the remainder of the catchment.

4.3 Link Data

The link data is essentially the same as the previous RAFTS model, however the link representation in RAFTS is somewhat redundant as the channel routing is being undertaken by the TUFLOW model. Refer to Section 6.1 for further details.

4.4 Observed Rainfall Data

Each of the calibration and verification events were incorporated into the RAFTS model using a standard HYDSYS database format. This enabled the full rainfall period for each of the events to be modelled using a fast and reliable method.

Thiessen Polygons were drawn around each of the rainfall stations used to provide pluviograph information for each of the events. All of the sub-catchments that fell within each of the created polygons were then assigned the pluviograph information from the closest corresponding rainfall station. This method was considered appropriate based on the good spatial coverage of the pluviograph stations. The Thiessen Polygons diagrams are presented in Appendix C for reference.

5.0 TUFLOW Model Set-up

5.1 Methodology

The characteristics of the Lota Creek Catchment result in a 2-dimensional hydraulic model being more appropriate than a 1-dimensional hydraulic model for the majority of the catchment.

These characteristics include:

- Very flat and wide floodplain areas in the mid to lower catchment.
- Significantly more overbank flow compared with in-channel flow.
- Many wide and poorly defined flow paths, which have the potential to merge into one during higher flows.
- Numerous poorly defined break-out flow paths.
- A number of road crossings with very wide inundation widths.

As a result, the 2-dimensional TUFLOW hydrodynamic model (version 2012-05-AE) was selected for the hydraulic analysis of Lota Creek.

5.2 Available Data

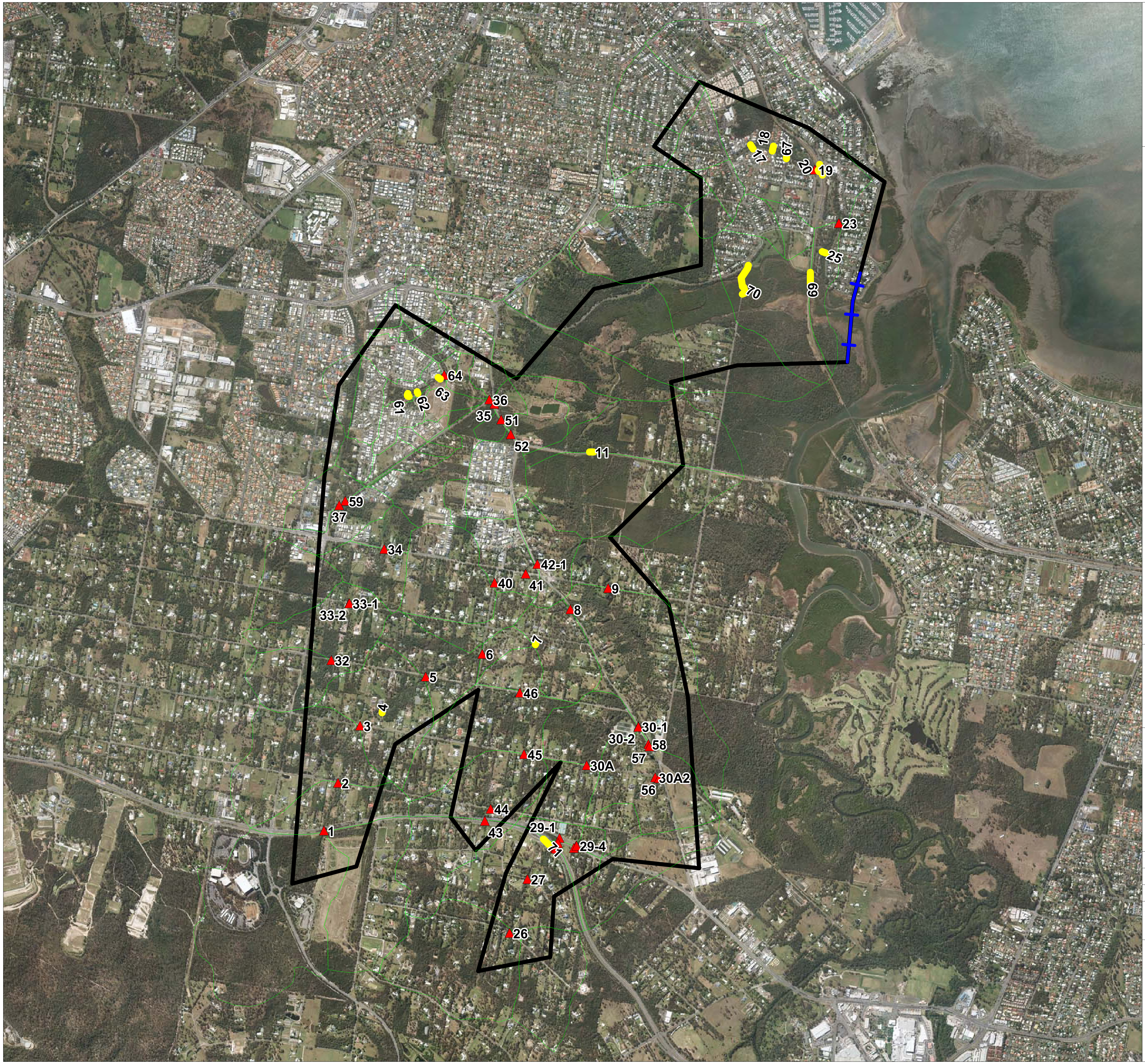
The following data was utilised in the development of the TUFLOW model:

- MIKE11 model - 1999 Stormwater Management Plan
- BCC 1997 and 1999 Survey Data
- BCC aerial photography – 2011, 2009, 2007, 2005, 2001, 1999, 1997 and 1995
- BCC 2009 Aerial Laser Scanning (ALS) data
- Current version of BCC City Plan
- Hydraulic structure drawings / reference sheets. Refer to Section 5.3.4 for further details.
- BCC Cadastre and GIS databases

5.3 Model Development

5.3.1 Model Extents

Figure 5.1 indicates the extents of the TUFLOW model as well as the inflow locations and the hydraulic structures included in the model. The model extends from south of Old Cleveland Road and incorporates the majority of the larger open channel systems within the catchment, including: Lota Creek, Tributary A, Tributary B, Tributary C, Tributary D, Tributary E, Tributary F, Tributary G, Tributary K, Tributary J and Tributary L.



MAILING ADDRESS:
GPO Box 1434
Brisbane Qld 4001

Green Square
South Tower
505 St. Paul's Terrace
Fortitude Valley Qld 4006

Telephone: (07) 3027 5550
Facsimile: (07) 3334 0225
E-mail: citydesign@brisbane.qld.gov.au

Dedicated to a better Brisbane

City Projects Office
Brisbane City Council

LEGEND

- 1D Structure
- 2D Structure
- Downstream Boundary
- SA Polygons (Inflows)
- 2D Domain

N W E S

250 0 250 500 750
Metres

Printed 29 May 2013

Project Number CD130866	Revision 1	Prepared HZ	Checked HZ

Workspace G:\\130866\GIS\Workspaces\Figure 5.1.WOR

Project
Lota Creek Flood Study

Title
TUFLOW Model Layout

Figure 5.1

5.3.2 Topography

The base topography was created using 2009 BCC ALS data. The triangulated ALS data was converted to a 5 m grid digital elevation model (MGA Zone 56) for use with the TUFLOW model. Detailed checks have not been undertaken on the accuracy of the ALS data, it is assumed that the data is representative of the topography and "fit for purpose."

The bathymetry of the creeks / channels was mostly represented using the ALS data; however, the existing surveyed cross sections data from 1997 and 1999 for the area west of Chelsea Road (north of lot 23, RP71076) up to the mouth were also incorporated into the digital elevation model. Generally, the ALS creek invert levels are higher than the actual level, however given that the majority of the flow is on the floodplain, this is not expected to significantly influence the results.

At the bridge / culvert crossing localised adjustments have been made to reflect the actual invert level of the creek, to ensure the structures are well represented.

5.3.3 Roughness

The Manning's 'n' values shown in Table 5.1 were adopted within the TUFLOW model. BCC aerial photography, BCC City Plan and site visits were utilised to identify the land-use and major topographical features within the model domain.

The selection of appropriate roughness values was based upon experience with similar studies and relevant hydraulic literature.

Table 5.1 – Adopted roughness parameters

Topographical feature / Land-use	Adopted Manning's 'n'
Environmental Protection	0.07
Rural	0.05
Conservation	0.12
Park Land	0.05
Low Density Residential	0.15
Community Use Area Education Purposes	0.1
Sport And Recreation	0.035
Emerging Communities	0.15
Community Use Area Railway	0.04
Light Industry	0.15
Community Use Area Community Facilities	0.1

Topographical feature / Land-use	Adopted Manning's 'n'
Community Use Area Health Care Purposes	0.1
Special Purpose Centre Major Sporting Stadium	0.1
Multi-Purpose Centre Convenience Centre	0.15
Community Use Area Utility Services	0.04
Road	0.02
Open Water	0.03
Mangroves	0.17
Minimum Riparian Corridor (MRC)	0.15

5.3.4 Hydraulic Structures

The major bridge and culvert structures within the model domain were represented in the TUFLOW model. These structures were generally at public road crossings and are indicated in Table 5.2. Each structure was modelled as either a 1D structure or a 2D structure depending on the most suitable modelling approach.

As many of the waterways pass through private rural-residential parcels, there are numerous private crossings within the catchment area. These crossings are generally minor and have not been included in the TUFLOW model.

5.3.5 Boundaries

Inflows to the TUFLOW model were represented using the "SA Polygon" method and taken from the RAFTS model results. The inflow locations to the TUFLOW model were taken from the RAFTS model sub-catchment schematisation.

A water level versus time (H-T) downstream boundary was used to represent the downstream boundary conditions at the mouth of the Lota Creek. For each event, tidal highs and lows were derived at the mouth and a tidal curve fitted. This information was based on the predicted Maritime Safety Queensland Tide Tables.

5.3.6 Assumptions

The following are major assumptions used in the development of the TUFLOW model:

- It is assumed that the fences along private properties don't have any impacts on flood behaviour and therefore they were not incorporated into the TUFLOW model.

- For the tail water Conditions, it is assumed that there were no storm surge effects within Moreton Bay.
- The cross sectional data used in the digital elevation model is assumed to be representative of current conditions even though it is acknowledged that the cross sections may have been modified by natural or unnatural processes since the survey was undertaken.

Table 5.2 – Hydraulic Structures represented in the TUFLOW Model

Reach	Structure ID	Structure Location	Structure Details	TUFLOW Structure	Origin of Data used for Coding the Structure
Lota Creek	1	Old Cleveland Road	4 / 2140 x 1240 RCBC	1d	MIKE11 Model
Lota Creek	2	Boston Road	4 / 600 RCP	1d	MIKE11 Model
Lota Creek	3	London Road	3 / 1500 RCP	1d	1999 Survey
Lota Creek	5	Grassdale Road	3 / 2700 x 1500 RCBC	1d	Drawing
Lota Creek	6	Archer Street	3 / 3000 x 1200 RCBC	1d	Drawing
Lota Creek	8	New Cleveland Road	6 / 1500 RCP	1d	Drawing
Lota Creek	9	Molle Road	1 / 400 RCP	1d	MIKE11 Model
Lota Creek	11	Rickertt Road	3 / 8740 x 1650 RCBC	2d	1999 Survey and Drawing
Lota Creek	69	Bayside United Soccer Club	Railway Bridge	2d	Aerial Photo and DEM
Lota Creek	7	Driveway-Formosa Road	5 / 1800 x 900 RCBC	2d	MIKE11 Model
Lota Creek	70	Chelsea Road	Footbridge	2d	Drawing
Trib A	26	Warriewood Street	2 / 1200 RCP	1d	MIKE11 Model
Trib A	27	Charleton Street	8 / 1800 x 750 RCBC	1d	Drawing
Trib A	28-1	Moreton Bay Road	4 / 1800 x 750 RCBC	1d	MIKE11 Model and Drawing
Trib A	28-2	Moreton Bay Road	2 / 1800 x 900 RCBC	1d	MIKE11 Model and Drawing
Trib A	28-3	Moreton Bay Road	2 / 1800 x 900 RCBC	1d	MIKE11 Model and Drawing
Trib A	28-4	Moreton Bay Road	2 / 1800 x 750 RCBC	1d	MIKE11 Model and Drawing
Trib A	29-1	Old Cleveland Road	5 / 1825 x 750 RCBC	1d	MIKE11 Model and Drawing
Trib A	29-2	Old Cleveland Road	6 / 1200 x 900 RCBC	1d	MIKE11 Model and Drawing
Trib A	29-3	Old Cleveland Road	2 / 900 RCP	1d	MIKE11 Model and Drawing
Trib A	29-4	Old Cleveland Road	6 / 1200 x 900 RCBC	1d	MIKE11 Model and Drawing
Trib A	29-5	Old Cleveland Road	5 / 1800 x 750 RCBC	1d	MIKE11 Model and Drawing

Reach	Structure ID	Structure Location	Structure Details	TUFLOW Structure	Origin of Data used for Coding the Structure
Trib A	30-1	New Cleveland Road	2 / 1200 x 900 RCBC	1d	MIKE11 Model and Drawing and 1999 Survey
Trib A	30-2	New Cleveland Road	2 / 1800 x 1200 RCBC	1d	MIKE11 Model and Drawing and 1999 Survey
Trib A	30A	London Road	1 / 1200 x 300 RCBC	1d	MIKE11 Model
Trib A	71	Moreton Bay Road	Bridge	2d	Drawing and DEM
Trib C	56	New Cleveland Road	2 / 300 RCP	1d	Spacial Data and DEM
Trib C	57	New Cleveland Road	2 / 450 RCP	1d	Spacial Data and DEM
Trib C	58	New Cleveland Road	3 / 1200 x 900 RCBC	1d	MIKE11 Model and Drawing
Trib C	30A2	London Road	2 / 1200 x 300 RCBC	1d	MIKE11 Model
Trib B	32	Grassdale Road	1 / 300 RCP	1d	MIKE11 Model and Drawing
Trib B	34	New Cleveland Road	2 / 1500 x 1200 RCBC	1d	MIKE11 Model and Drawing
Trib B	35	Green Camp Road	4 / 3350 x 1350 RCBC	1d	Drawing
Trib B	51	Green Camp Road	1 / 450 RCP	1d	Drawing and DEM
Trib B	52	Green Camp Road	1 / 1200 x 900 RCBC	1d	Drawing and DEM
Trib B	33-1	Formosa Road	1 / 600 RCP	1d	MIKE11 Model
Trib B	33-2	Formosa Road	2 / 375 RCP	1d	MIKE11 Model
Trib L	36	Tilley Road	3 / 3350 x 1350 RCBC	1d	Drawing
Trib L	65	Watervale Parade	Bridge	2d	Site Inspection and DEM
Trib J	37	Tilley Road	1 / 1200 RCP	1d	MIKE11 Model
Trib J	59	Tilley Road	1 / 450 RCP	1d	Drawing and DEM
Trib E	17	Bridgewater Place	10 / 2700 x 1500 RCBC	2d	Drawing
Trib E	18	Brookside Place	10 / 2700 x 2100 RCBC	2d	Drawing
Trib E	19	Alexander Street	3 / 2100 x 1200 RCBC	1d	Drawing
Trib E	23	Bowering Street	2 / 3300 x 1800 RCBC	1d	Drawing
Trib E	20	Alexander Street	Bridge	2d	Site Inspection and DEM

Reach	Structure ID	Structure Location	Structure Details	TUFLOW Structure	Origin of Data used for Coding the Structure
Trib E	25	Bowering Street	Bridge	2d	MIKE11 Model
Trib E	67	Hindes Street	Bridge	2d	Site Inspection and DEM
Trib E	68	Alexander Street	Railway Bridge	2d	Drawing
Trib F	40	Archer Street	3 / 750 RCP	1d	MIKE11 Model
Trib F	41	New Cleveland Road	2 / 900 RCP	1d	MIKE11 Model
Trib F	42-1	Green Camp Road	5 / 1200 x 900 RCBC	1d	Drawing
Trib G	43	Old Cleveland Road	7 / 1200 x 750 RCBC	1d	MIKE11 Model
Trib G	44	Boston Road	1 / 600 RCP	1d	MIKE11 Model
Trib G	45	London Road	2 / 1500 x 600 RCBC	1d	Drawing
Trib G	46	Grassdale Road	1 / 900 x 300 RCBC	1d	MIKE11 Model
NA	61	Torrens Crescent	Bridge	2d	Site Inspection and DEM
NA	64	Watervale Parade	Irregular Bridge	1d	Site Inspection and DEM
NA	62	Torrens Crescent	Bridge	2d	Site Inspection and DEM
NA	63	Torrens Crescent	Bridge	2d	Site Inspection and DEM

6.0 Calibration and Verification

6.1 Overall Methodology

The common approach adopted in BCC flood studies is to undertake separate calibration / verification of both the hydrologic model and the hydraulic model. This method has typically been adopted in Australia as most hydraulic river modelling software does not incorporate a rainfall-runoff (hydrologic) generator. Also, by separately calibrating / verifying the hydrologic model, it can then be used as a "standalone" model to accurately predict design discharges without the need to run the hydraulic model.

Some common difficulties with this approach are (i) trying to adequately calibrate the hydrologic model in areas where there is substantial floodplain storage / attenuation effects; (ii) the requirement to use rating curves to convert recorded stage to discharge.

Flood Management reviewed the set-up of the previous RAFTS model and it was found that the model was comprised of a number of storage (reservoir) nodes to enable the significant floodplain storage within the lower reaches to be routed hydrologically. The advent of 2-dimensional hydraulic modelling has resulted in the capability to more accurately simulate large, flat, floodplain areas, (such as mid to lower Lota Creek) when compared with 1-dimensional hydraulic models and hydrologic models.

Subsequently, it was decided that the most appropriate means to undertake the flood modelling was to calibrate the RAFTS model in combination with the TUFLOW model, rather than as separate models. The only limitation of this approach is that the RAFTS model cannot be then used as a "standalone" model and must be run together with the TUFLOW model to obtain discharge and flood level results.

6.2 Calibration

6.2.1 Methodology

The calibration events (February 2008 and May 2009) were firstly simulated in the RAFTS model. The RAFTS flow hydrograph for each sub-catchment was then used as an inflow for the TUFLOW model. The TUFLOW model was run and the simulated results compared against the historical / observed results. Adjustments were then made to the hydrologic and hydraulic parameters (as required) and the procedure was repeated. A number of iterations of this process were required until a reasonable calibration was achieved.

It should be noted that due to the significant de-siltation works since 2010, a low flow channel downstream of Green Camp Road and Rickertt Road was incorporated into the digital elevation model used for the Jan 2012 calibration model. This low flow channel was modelled based on the findings from site inspections and is not based on any survey information or design drawings.

6.2.2 Calibration to Stream Gauge (LTA142)

BCC flood studies aim to achieve a tolerance of ± 0.15 m for the calibration to continuous recording stream gauges. The hydrograph should also demonstrate a good replication of the timing of peaks / troughs and the rising limb.

Figures 6.1 and 6.2 indicate the simulated versus recorded hydrographs as extracted from the TUFLOW model results.

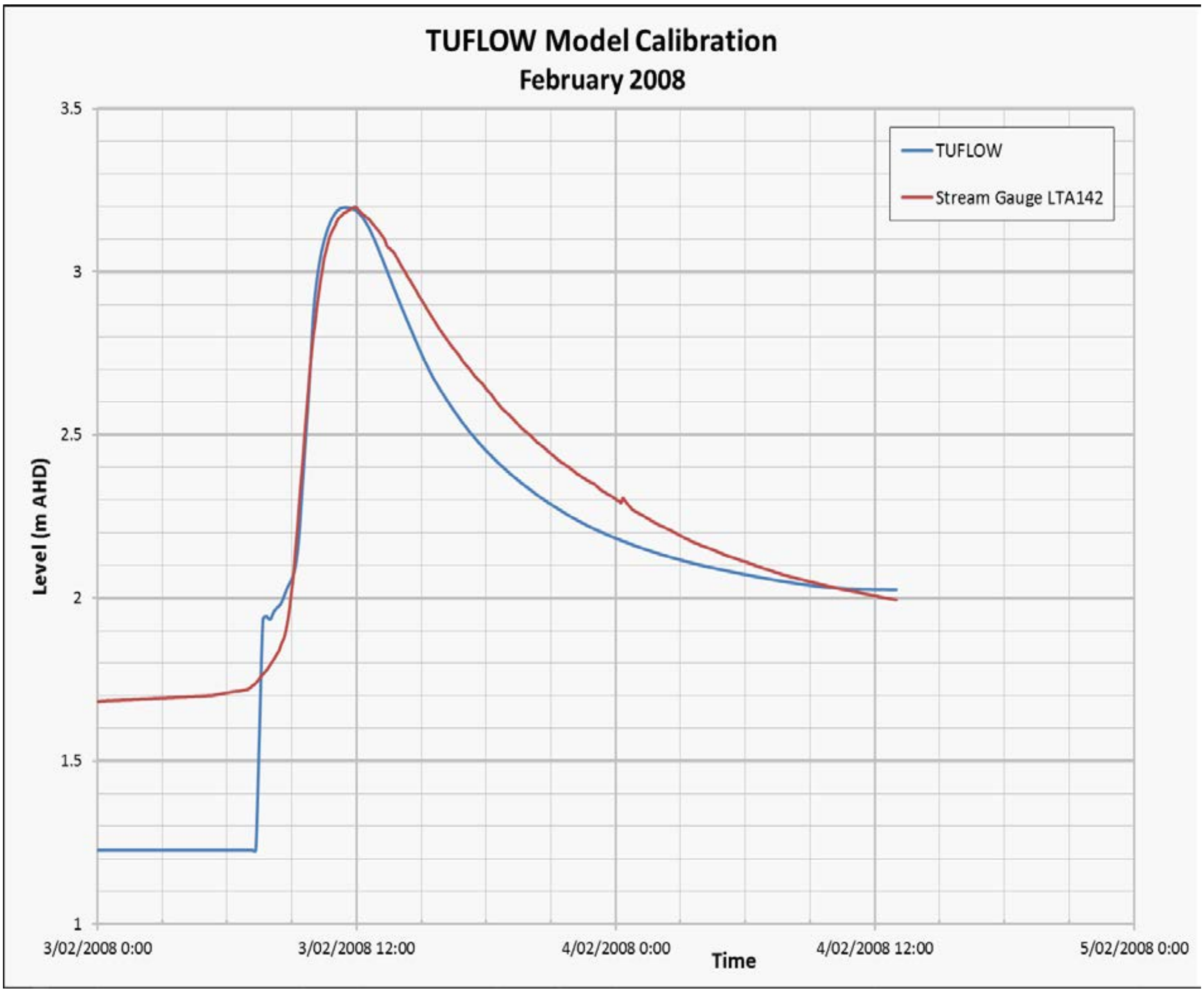


Figure 6.1: Stream Gauge LTA142 - simulated versus recorded (February 2008)

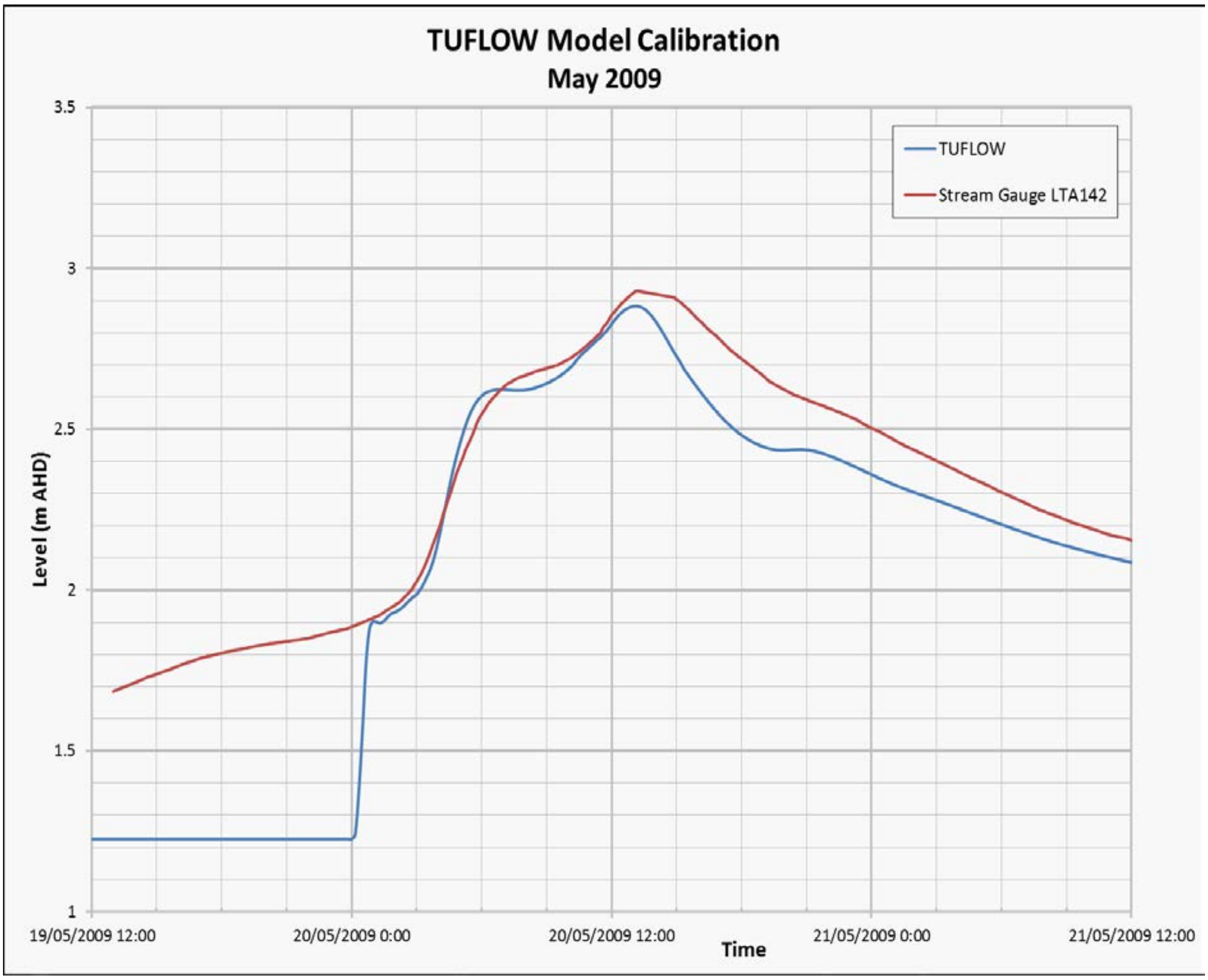


Figure 6.2: Stream Gauge LTA142 - simulated versus recorded (May 2009)

6.2.3 Calibration to Maximum Height Gauges

BCC flood studies aim to achieve a tolerance of ± 0.3 m for the calibration to Maximum Height Gauges. Tables 6.1 and 6.2 present a comparison of the recorded and simulated flood levels at the Maximum Height Gauges for the February 2008 and May 2009 events respectively.

Table 6.1 – Calibration to MHG Data (February 2008)

Gauge ID	Reach	Location	Recorded Peak WL (m AHD)	Simulated Peak WL (m AHD)	Difference (m)
LT100	Lota Creek	Keyes Street	-	2.50	-
LT110	Lota Creek	Rickertt Road	3.2	3.20	0.00
LT120	Lota Creek	Molle Road	3.63	3.74	-0.11
LT130	Tributary A	New Cleveland Road	6.8	6.90	-0.10

Gauge ID	Reach	Location	Recorded Peak WL (m AHD)	Simulated Peak WL (m AHD)	Difference (m)
LT135	Tributary A	London Road	-	8.48	-
LT140	Tributary A	Old Cleveland Road	15.17	15.01	0.16
LT220	Tributary B	Greencamp Road	-	4.10	-

Table 6.2 – Calibration to MHG Data (May 2009)

Gauge ID	Reach	Location	Recorded Peak WL (m AHD)	Simulated Peak WL (m AHD)	Difference (m)
LT100	Lota Creek	Keyes Street	2.44	2.23	0.21
LT110	Lota Creek	Rickertt Road	-	2.90	-
LT120	Lota Creek	Molle Road	3.36	3.33	0.03
LT130	Tributary A	New Cleveland Road	6.52	6.57	-0.05
LT135	Tributary A	London Road	8.22	8.31	-0.09
LT140	Tributary A	Old Cleveland Road	14.94	14.61	0.33
LT220	Tributary B	Greencamp Road	-	3.91	-

6.2.4 Calibrated RAFTS Parameters

The calibrated RAFTS parameters, determined as part of the calibration process for both the February 2008 and May 2009 events are shown in Table 6.3.

Table 6.3 – Calibrated RAFTS Parameters

Parameter	Description	Feb 2008	May 2009
n	Storage non-linearity exponent	-0.285	-0.285
Bx	Storage delay time coefficient multiplier	1.0	1.0
IL	Initial Loss (mm)	50	90
CL	Continuing Loss (mm / hr)	0	0

6.2.5 Major Hydraulic Structure Head-loss Checks

The TUFLOW manual recommends confirming the head-loss across hydraulic structures as follows:

It is strongly recommended that the losses through a structure be validated through:

- *Calibration to recorded information (if available).*
- *Cross-checked using desktop calculations based on theory and/or standard publications (e.g. Hydraulics of Bridge Waterways, US FHA 1973).*
- *Cross-checked with results using other hydraulic software.*

It is common practice in BCC flood studies to cross-check structure head-losses against results from the HEC-RAS hydraulic software. This methodology was undertaken for this flood study and the table in Appendix D show the head-loss comparisons.

Generally, the TUFLOW head-losses for the hydraulic structures (which were checked) were within ± 0.3 m of the HEC-RAS values for the full range of flows up to 300 m^3/s. This is considered reasonable and gives credence to the TUFLOW results.

6.3 Verification

6.3.1 Methodology

Table 6.4 indicates the RAFTS parameters which were taken forward into the verification process.

Table 6.4 – Adopted RAFTS Parameters

Parameter	Description	Adopted Value
n	Storage non-linearity exponent	-0.285
Bx	Storage delay time coefficient multiplier	1.0
CL	Continuing Loss (mm / hr)	0

The verification events (October 2010 and January 2012) were firstly simulated in the RAFTS model. The TUFLOW model was then run and the simulated results compared against the historical / observed results. Hydrologic Initial Loss (IL) values were then adjusted to better fit the shape of the hydrograph. A number of iterations of this process were required until a reasonable hydrograph shape was achieved. The Initial Loss (IL) values of 100mm and 85mm were adopted for October and January events respectively which provided the best results.

6.3.2 Verification to Stream Gauge (LTA142)

BCC flood studies aim to achieve a tolerance of ± 0.15 m for the verification to continuous recording stream gauges. The hydrograph should also demonstrate a good replication of the timing of peaks / troughs and the rising limb.

Figures 6.3 and 6.4 indicate the simulated versus recorded hydrographs as extracted from the TUFLOW model results.

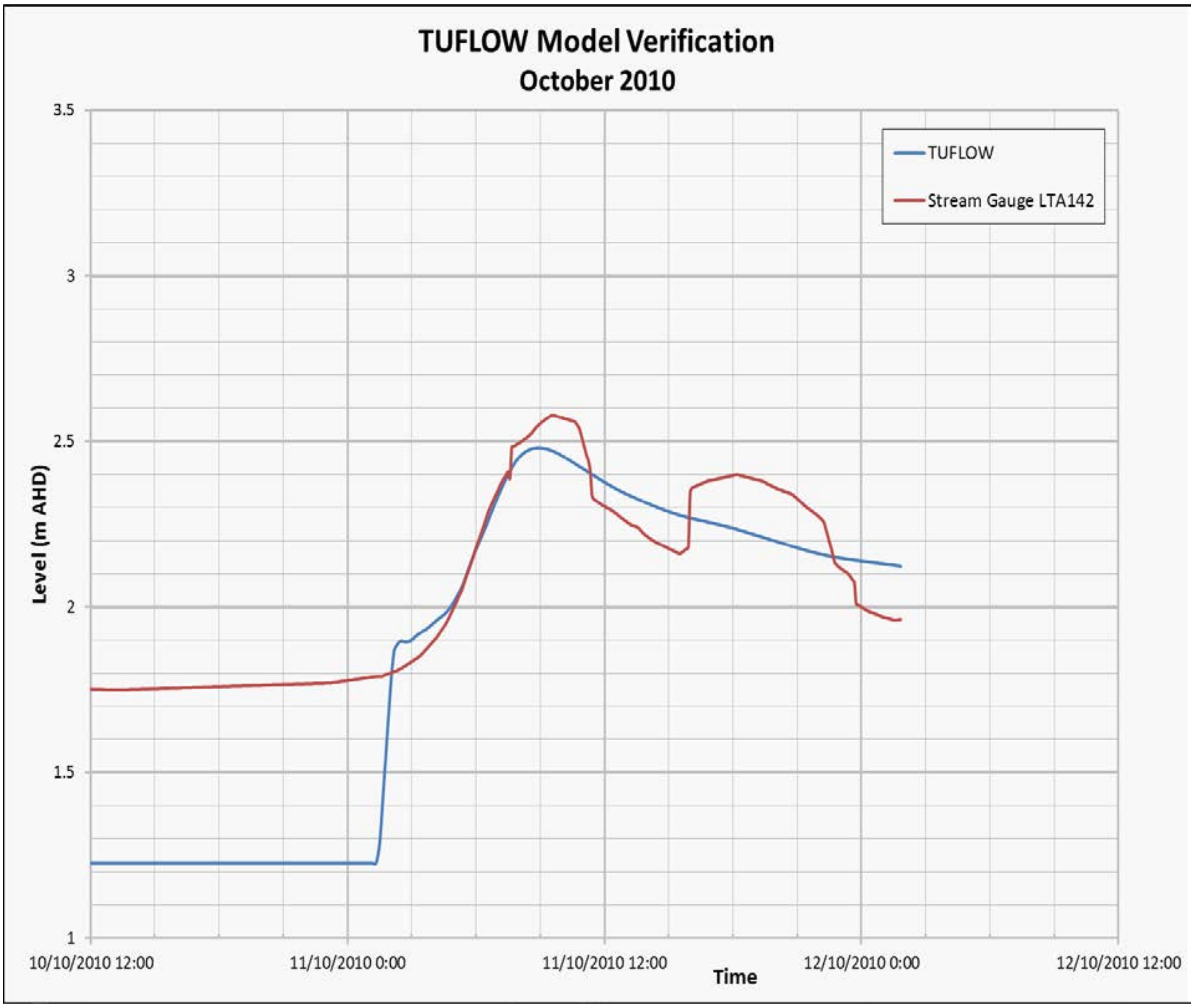


Figure 6.3: Stream Gauge LTA142 - simulated versus recorded (October 2010)

As shown in Figure 6.3, the rising limb has a good agreement with the recorded stream gauge data; however, the recorded data seems invalid from around the peak onwards.

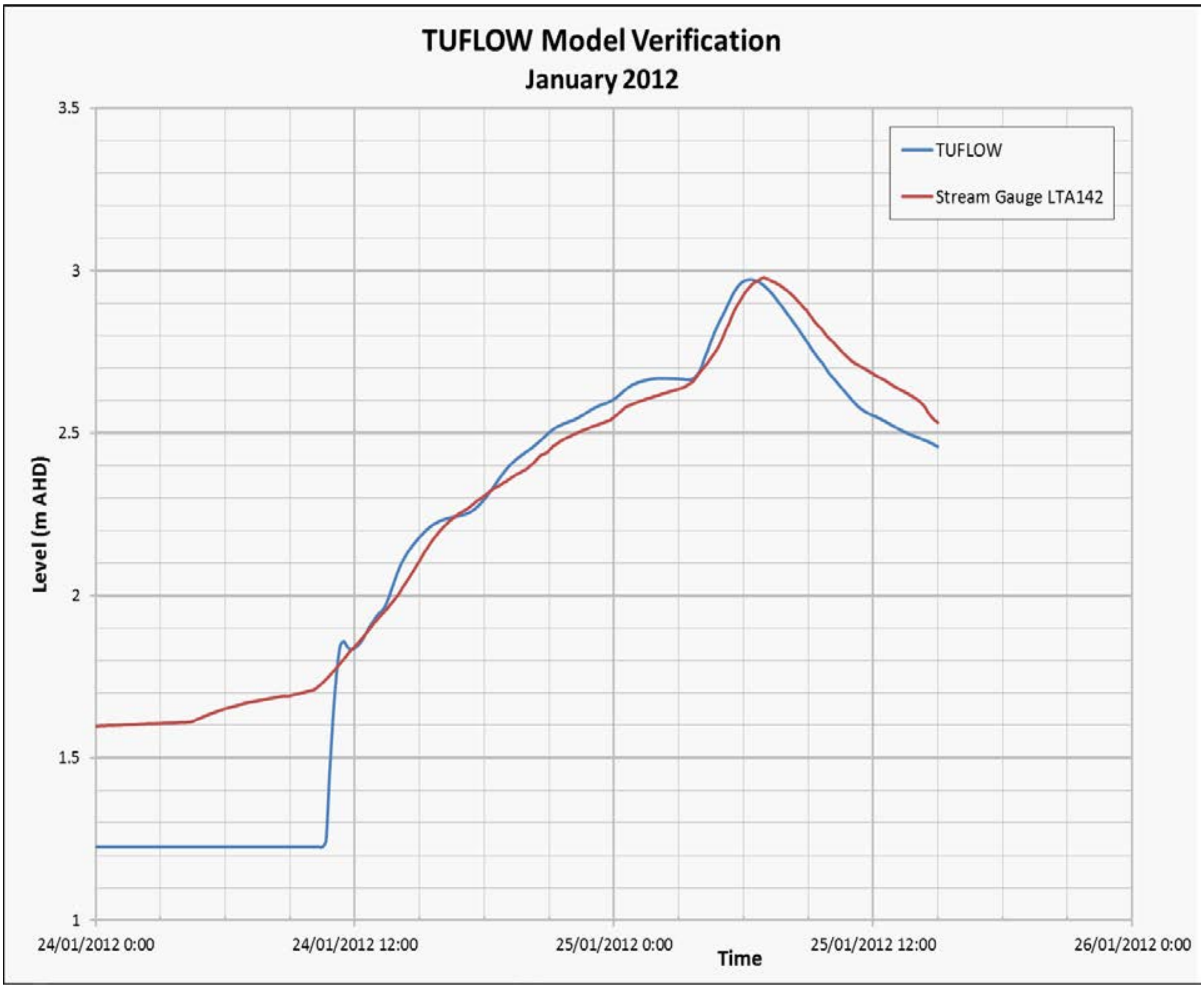


Figure 6.4: Stream Gauge LTA142 - simulated versus recorded (January 2012)

6.3.3 Verification to Maximum Height Gauges

BCC flood studies aim to achieve a tolerance of ± 0.3 m for the verification to Maximum Height Gauges. Table 6.5 and 6.6 present a comparison of the recorded and simulated flood levels at the Maximum Height Gauges.

Table 6.5 – Verification to MHG Data (October 2010)

Gauge ID	Reach	Location	Recorded Peak WL (m AHD)	Simulated Peak WL (m AHD)	Difference (m)
LT100	Lota Creek	Keyes Street	-	1.53	-
LT110	Lota Creek	Rickertt Road	2.53	2.55	-0.02
LT120	Lota Creek	Molle Road	2.96	2.95	0.01
LT130	Tributary A	New Cleveland Road	-	6.49	-
LT135	Tributary A	London Road	8.18	8.23	-0.05
LT140	Tributary A	Old Cleveland Road	14.64	14.60	0.04
LT220	Tributary B	Greencamp Road	3.37	3.69	-0.32

Table 6.6 – Verification to MHG Data (January 2012)

Gauge ID	Reach	Location	Recorded Peak WL (m AHD)	Simulated Peak WL (m AHD)	Difference (m)
LT100	Lota Creek	Keyes Street	-	2.34	-
LT110	Lota Creek	Rickertt Road	3.01	2.98	0.03
LT120	Lota Creek	Molle Road	3.25	3.45	-0.20
LT130	Tributary A	New Cleveland Road	6.58	6.70	-0.12
LT135	Tributary A	London Road	8.29	8.37	-0.08
LT140	Tributary A	Old Cleveland Road	14.90	14.70	0.20
LT220	Tributary B	Greencamp Road	3.03	3.86	-0.83

6.4 Discussion of Results

The calibration to the MHG gauges for all events are shown in Figure 6.5 to 6.8. Results show that the model has achieved a good calibration, across all flood events. The calibration to the stream gauge also provides good results compared to the peak flood levels from the TUFLOW model which are shown in Figure 6.1 to 6.4.

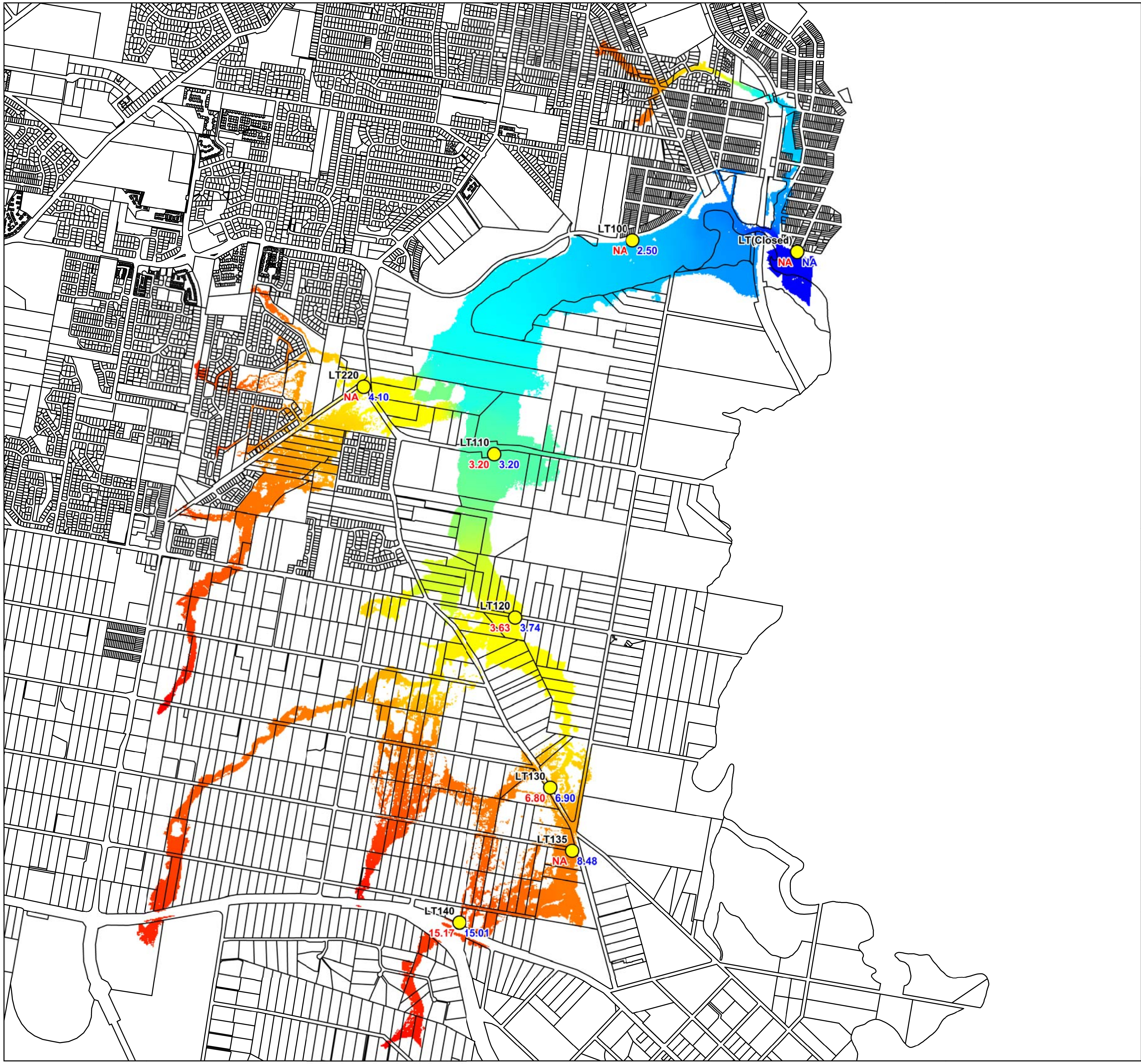
The model verification confirmed that the hydraulic model is producing consistent results.

The calibration to the January 2012 event was not achievable at the Gauge 220 due to the significant de-siltation works undertaken downstream of the Tilley Road, Green Camp Road and Rickertt Road at the recent years.

It also demonstrated the structure losses calculated by the TUFLOW model are reasonably consistent with the losses calculated by HEC-RAS. Thus, the structure losses are acceptable.

ALS survey data has been used to represent the topography of the catchment. While a significant portion of the catchment is densely vegetated and/or influenced by standing water level (tide), the verification of the ALS survey data within this area has not been undertaken.

Survey of the certain structures included in the model was not available. The structures were modelled based on the best available information and site inspection.



MAILING ADDRESS:
GPO Box 1434
Brisbane Qld 4001

Green Square
South Tower
505 St. Paul's Terrace
Fortitude Valley Qld 4006

Telephone: (07) 3027 5550
Facsimile: (07) 3334 0225
E-mail: citydesign@brisbane.qld.gov.au

Dedicated to a better Brisbane

City Projects Office
Brisbane City Council

LEGEND

Water Level (mAHD)

- 1.00 to 3.00
- 3.00 to 5.00
- 5.00 to 7.00
- 7.00 to 9.00
- 9.00 to 11.00
- 11.00 to 13.00
- 13.00 to 15.00
- 15.00 to 17.00
- 17.00 to 19.00
- 19.00 to 21.00
- 21.00 to 23.00

12.57 Modeled Levels

12.56 Recorded Levels

N W E S

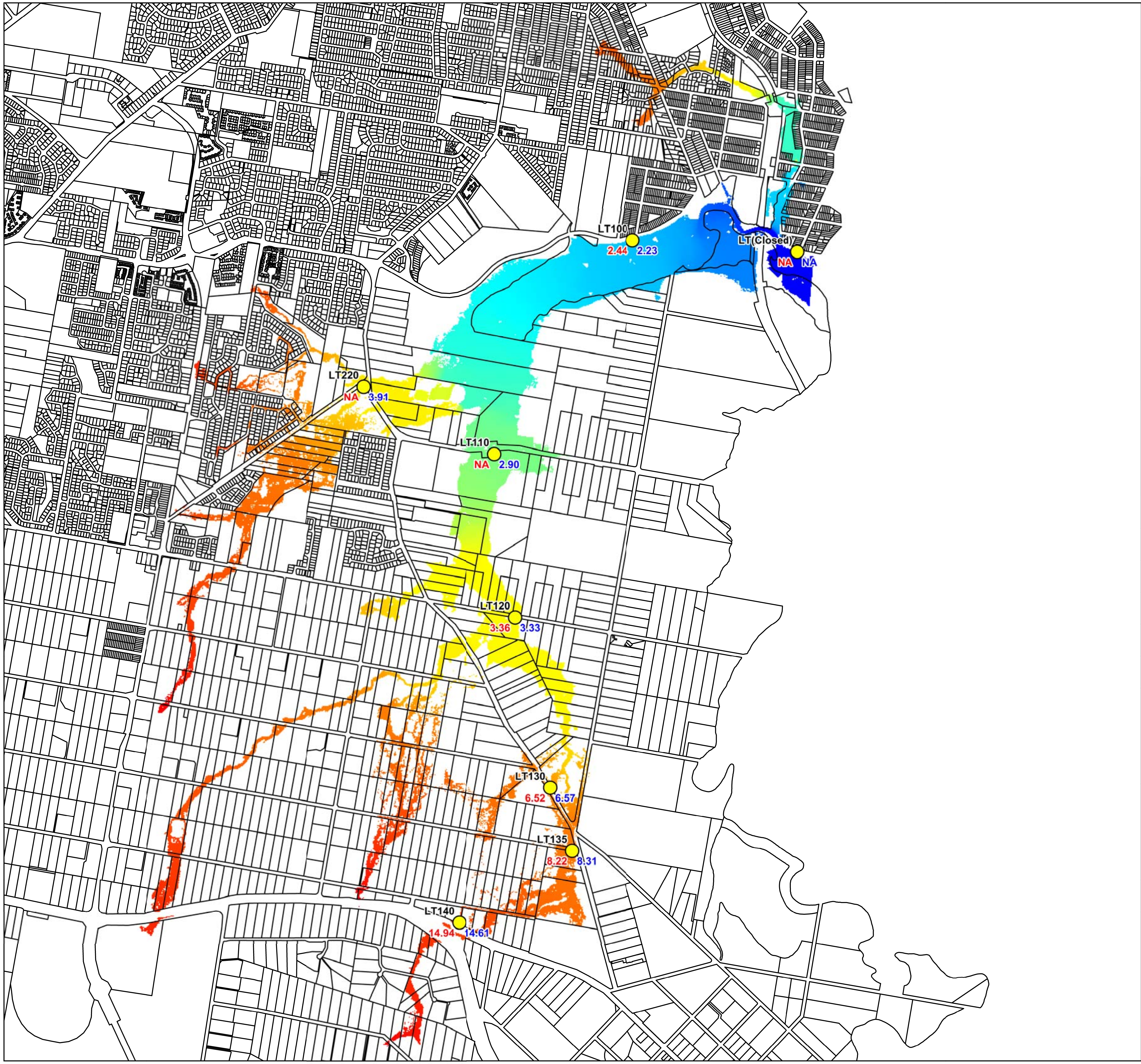
250 0 250 500 750
Metres

Printed 29 May 2013			
Project Number CD130866	Revision 1	Prepared HZ	Checked HZ
Workspace G:\\130866\GIS\Workspaces\Figure 6.5.WOR			

Project
Lota Creek Flood Study

Title
Feb 2008 Calibration Event

Figure 6.5



MAILING ADDRESS:
GPO Box 1434
Brisbane Qld 4001

Green Square
South Tower
505 St. Paul's Terrace
Fortitude Valley Qld 4006

Telephone: (07) 3027 5550
Facsimile: (07) 3334 0225
E-mail: citydesign@brisbane.qld.gov.au

BRISBANE CITY

Dedicated to a better Brisbane

City Projects Office
Brisbane City Council

LEGEND

Water Level (mAHD)

- 1.00 to 3.00
- 3.00 to 5.00
- 5.00 to 7.00
- 7.00 to 9.00
- 9.00 to 11.00
- 11.00 to 13.00
- 13.00 to 15.00
- 15.00 to 17.00
- 17.00 to 19.00
- 19.00 to 21.00
- 21.00 to 23.00

12.57 Modeled Levels

12.56 Recorded Levels

N
W E
S

250 0 250 500 750
Metres

Printed 29 May 2013

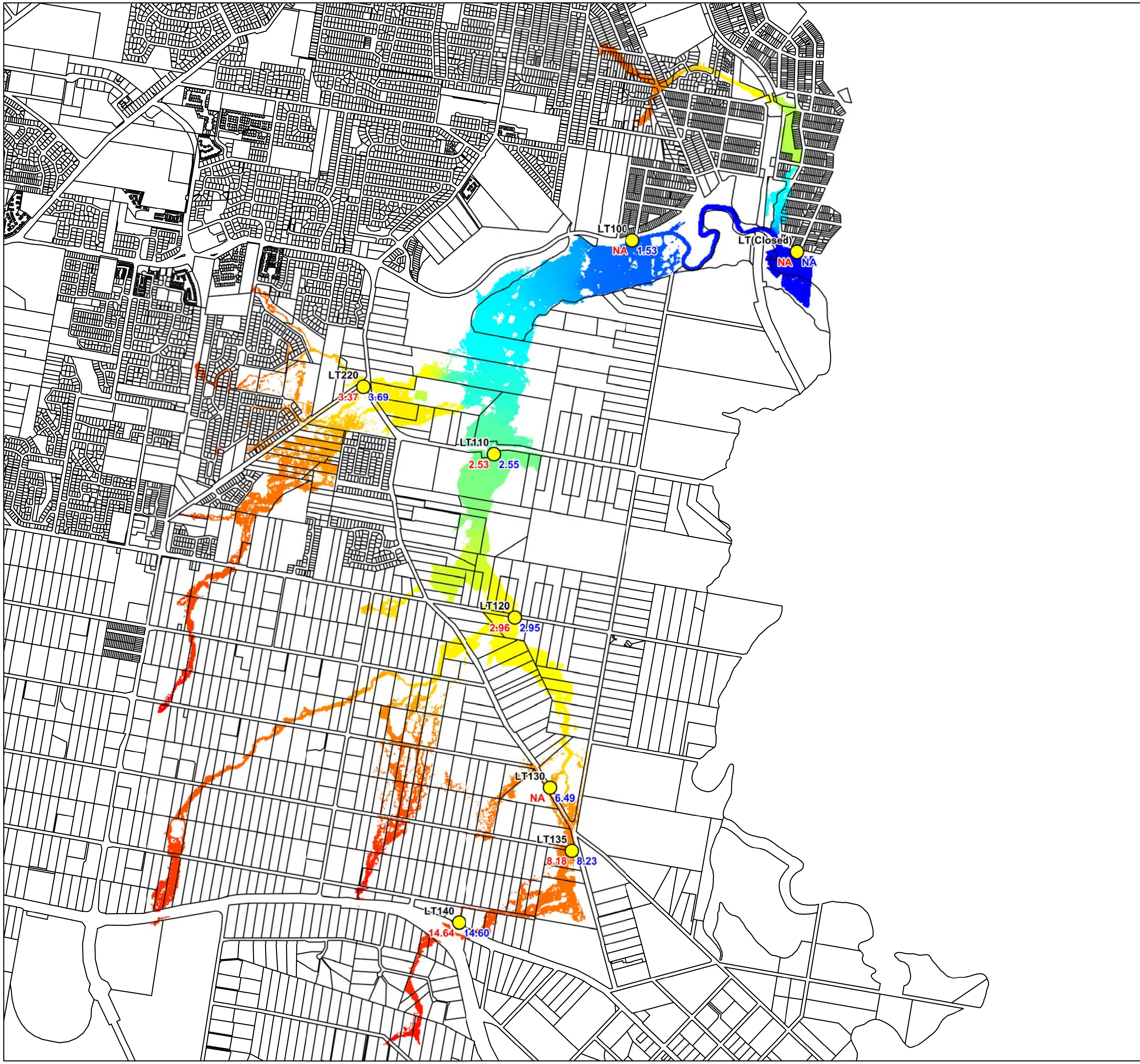
Project Number CD130866 | Revision 1 | Prepared HZ | Checked HZ

Workspace G:\\130866\GIS\Workspaces\Figure 6.6.WOR

Project
Lota Creek Flood Study

Title
May 2009 Calibration Event

Figure 6.6



MAILING ADDRESS:
GPO Box 1434
Brisbane Qld 4001

Green Square
South Tower
505 St. Paul's Terrace
Fortitude Valley Qld 4006

Telephone: (07) 3027 5550
Facsimile: (07) 3334 0225
E-mail: citydesign@brisbane.qld.gov.au

Dedicated to a better Brisbane

City Projects Office
Brisbane City Council

LEGEND

Water Level (mAHD)

- 1.00 to 3.00
- 3.00 to 5.00
- 5.00 to 7.00
- 7.00 to 9.00
- 9.00 to 11.00
- 11.00 to 13.00
- 13.00 to 15.00
- 15.00 to 17.00
- 17.00 to 19.00
- 19.00 to 21.00
- 21.00 to 23.00

12.57 Modeled Levels

12.56 Recorded Levels

N W E S

250 0 250 500 750

Metres

Printed 29 May 2013

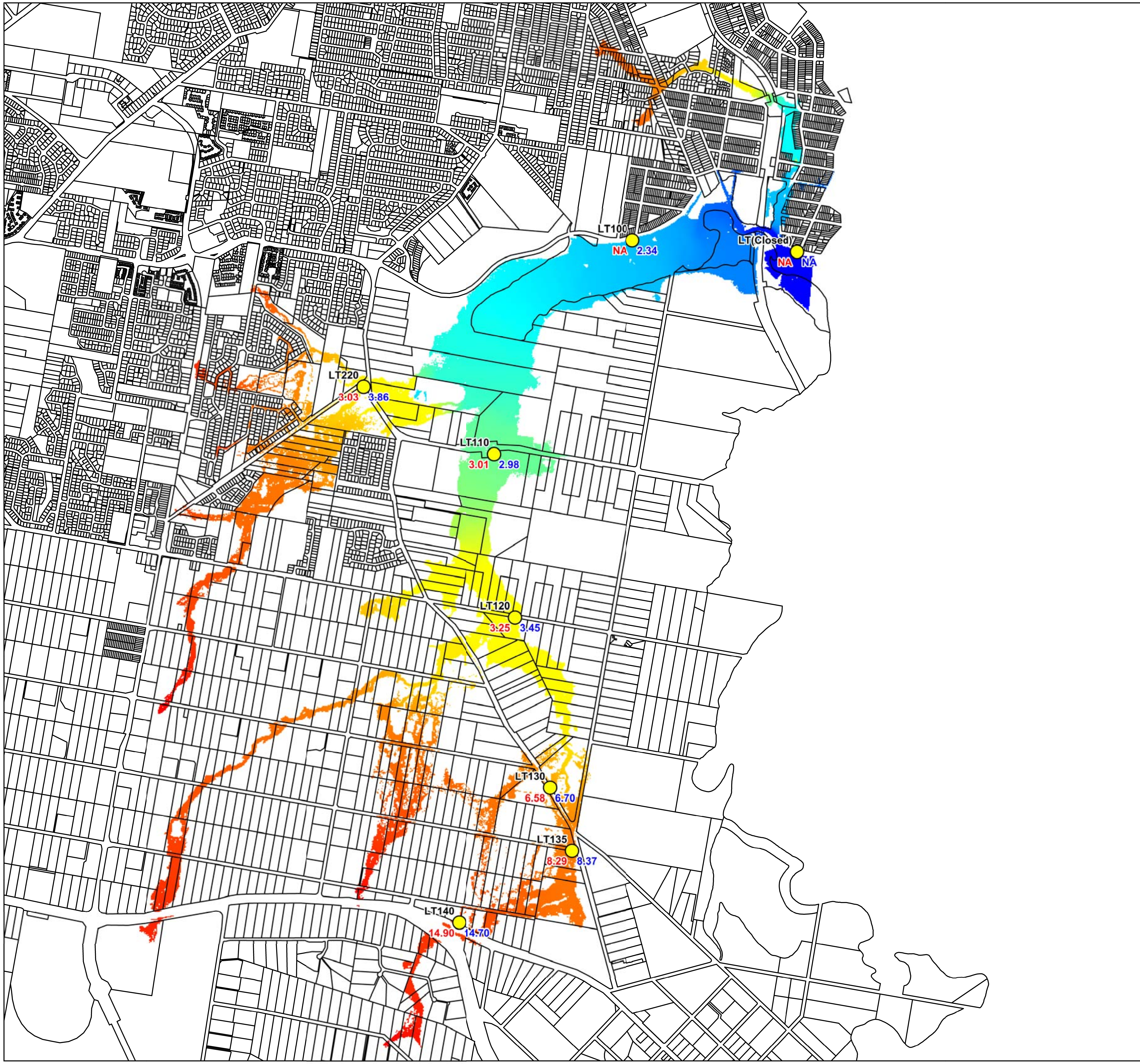
Project Number CD130866	Revision 1	Prepared HZ	Checked HZ

Workspace G:\\130866\GIS\Workspaces\Figure 6.7.WOR

Project
Lota Creek Flood Study

Title
Oct 2010 Calibration Event

Figure 6.7



MAILING ADDRESS:
GPO Box 1434
Brisbane Qld 4001

Green Square
South Tower
505 St. Paul's Terrace
Fortitude Valley Qld 4006

Telephone: (07) 3027 5550
Facsimile: (07) 3334 0225
E-mail: citydesign@brisbane.qld.gov.au

Dedicated to a better Brisbane

City Projects Office
Brisbane City Council

LEGEND

Water Level (mAHD)

- 1.00 to 3.00
- 3.00 to 5.00
- 5.00 to 7.00
- 7.00 to 9.00
- 9.00 to 11.00
- 11.00 to 13.00
- 13.00 to 15.00
- 15.00 to 17.00
- 17.00 to 19.00
- 19.00 to 21.00
- 21.00 to 23.00

12.57 **Modeled Levels**

12.56 **Recorded Levels**

N
W E
S

250 0 250 500 750
Metres

Printed 29 May 2013

Project Number CD130866 | Revision 1 | Prepared HZ | Checked HZ

Workspace G:\\130866\GIS\Workspaces\Figure 6.8.WOR

Project
Lota Creek Flood Study

Title
Jan 2012 Calibration Event

Figure 6.8

7.0 Design Event Modelling

7.1 Design Event Hydrology

7.1.1 General

For the purpose of this report, the term "design events" refers to those events with an Average Recurrence Interval (ARI) of 2 to 100 years. The term "extreme events" refers to those events with an ARI larger than 100 years. This Section 7 details the derivation of the design flood hydrology for the design events.

7.1.2 Available Data

The following data was available for use in the determination of the design flood levels:

- Calibrated 2013 RAFTS and TUFLOW models
- Australian Rainfall and Runoff (1987)
- 1997 Lota Creek Flood Study (Connell Wagner)
- 1999 Lota Creek Stormwater Management Plan (SKM)
- 2000 Lota Creek Catchment Stormwater Management Plan (BCC)
- MIKE11 model - 1999 Stormwater Management Plan
- BCC aerial photography
- Current version of BCC City Plan (2013 Draft City Plan)
- BCC Cadastre and GIS databases
- Latest BCC waterway corridor mapping (2013 Draft City Plan)

7.1.3 Methodology

Design flood estimation is best determined by undertaking flood frequency analysis of annual maximum and / or peak over threshold series from observed long-term stream flow records. However, in the Brisbane City Council region, the period of record is typically insufficient to enable sufficient confidence to warrant undertaking flood frequency methods. Table 7.1 [1] indicates some guidance for length of record versus expected error rate for flood frequency analysis.

[1] Flood Frequency Analysis - University Corporation for Atmospheric Research, USA (2010)

On the basis that the one continuous recording stream gauge on Lota Creek (LTA142) has only approximately 14 years of records it has been deemed unsuitable to undertake flood frequency analysis for this study.

Table 7.1 – Guidance for Length of Record versus Expected Error Rate

ARI (year)	Required Length of Record (years)	
	± 10% Error Level	± 25% Error Level
10	90	18
25	105	31
50	110	39
100	115	48

This study utilises the synthetic design storm concept from AR&R (1987) to estimate the design ARI flood in Lota Creek. This methodology was as follows:

- Design Intensity Frequency Duration (IFD) estimates are determined from AR&R for the full range of storm ARIs (2-yr to 100-yr) and durations (30 minute to 6-hr).
- Design temporal patterns are determined and design hyetographs produced for the full range of ARIs and durations.
- Appropriate design rainfall loss parameters are adopted.
- Using the calibrated models, design storms are simulated and the peak discharges and critical durations established within the model domain.

7.1.4 RAFTS Model Set-up

The calibrated RAFTS model was used to simulate the design storm rainfall-runoff and sub-catchment routing process. The following describes the adjustments made to the model in order to simulate the design events.

Catchment Development

The design events were modelled using ultimate catchment hydrological conditions. These conditions assume that the state of development within the catchment is at its ultimate condition, with reference to the current adopted planning scheme. Depending on the developed state of the catchment, an increase in development will generally affect the percentage impervious and the PERN hydrologic roughness values.

Appendix B indicates the RAFTS catchment parameters that were adopted for the design event modelling scenarios. The current adopted version of BCC City Plan was used to establish the ultimate catchment hydrological conditions. The adopted land-use for the ultimate catchment development is shown on a catchment map in Appendix E.

Rainfall Losses

The Initial Loss (IL) and Continuing Loss (CL) approach was used to simulate the rainfall losses in order to determine the rainfall excess. The IL is known to be the amount of rainfall that occurs before the start of surface runoff, while the CL is assumed to be the average loss rate throughout the remainder of the rainfall event.

The CL of 0 mm/hr was adopted for the calibration/verification events while the adopted initial losses were significantly high but variable for each event. Considering the land use within the Lota Creek catchment includes a significant amount of open space and to compensate for a portion of the IL, a CL of 2 mm/hr was adopted for the hydrology model. An IL of 0 mm was also selected for the design and extreme events modelling.

Design hyetographs

Design hyetographs were derived from the techniques in AR & R. Hyetographs were created for the 2-yr, 5-yr, 10-yr, 20-yr, 50-yr and 100-yr ARI events, considering durations of 30 minute, 1 hour, 1.5 hours, 2 hours, 3 hours, 4.5 hours and 6 hours.

7.2 Design Event Hydraulic Modelling

7.2.1 Modelled Scenarios

The TUFLOW model was used to determine both discharges and flood levels for the 2-yr, 5-yr, 10-yr, 20-yr, 50-yr and 100-yr ARI events. These events were simulated for durations from 30 minutes to 6 hours.

The following scenarios were simulated in the hydraulic model:

Scenario 1: Existing Waterway Conditions

Scenario 1 is based on the current waterway conditions. No further modifications were made to the TUFLOW model developed as part of the calibration / verification phase.

Scenario 2: Minimum Riparian Corridor (MRC)

Scenario 2 includes an allowance for a riparian corridor along the edge of the channel. This involved firstly reviewing the existing vegetation and land-use adjacent to the channel to determine an appropriate Manning's 'n' roughness value for the riparian corridor. In most locations the default value of n = 0.15 was used, however where the existing manning's 'n' is higher than n = 0.15, the manning's 'n' was left unchanged.

A 30 m wide corridor (15m wide each side from the centreline of the channel) was defined using a new materials layer within the TUFLOW model (6 grid cells wide). In areas where the 15 m width was not available, the MRC was set to the maximum possible width (ie less than 15 m).

Scenario 3: Ultimate Scenario

Scenario 3 assumes filling to the WC boundary to simulate potential development outside the WC. In the design events (2-yr to 100-yr ARI) the filling acts as a barrier and the WC can be modelled simplistically as a glass-wall of infinite height. For the modelling of events greater than 100-yr ARI, the fill height outside of the WC is set to the 100-yr flood level (Scenario 3) plus 0.3 m to allow the flood extents to spread laterally, should this level be exceeded?

This is a simple and conservative assumption used to develop design planning levels. It does not necessarily reflect allowable development assumptions under City Plan.

It should be noted, waterway corridors were marginally modified due to the recent development within the catchment and also to allow water flows into the waterway corridors from the upstream catchment where there is no waterway defined. Figure 7.1 shows the revised waterway corridor within Lota Creek catchment.

Table 7.2 indicates the three hydraulic scenarios utilised in the design modelling, noting that all design event scenarios were modelled using ultimate hydrological conditions. The following describes the hydraulic scenarios which were modelled.

Table 7.2 – Design Event Scenarios

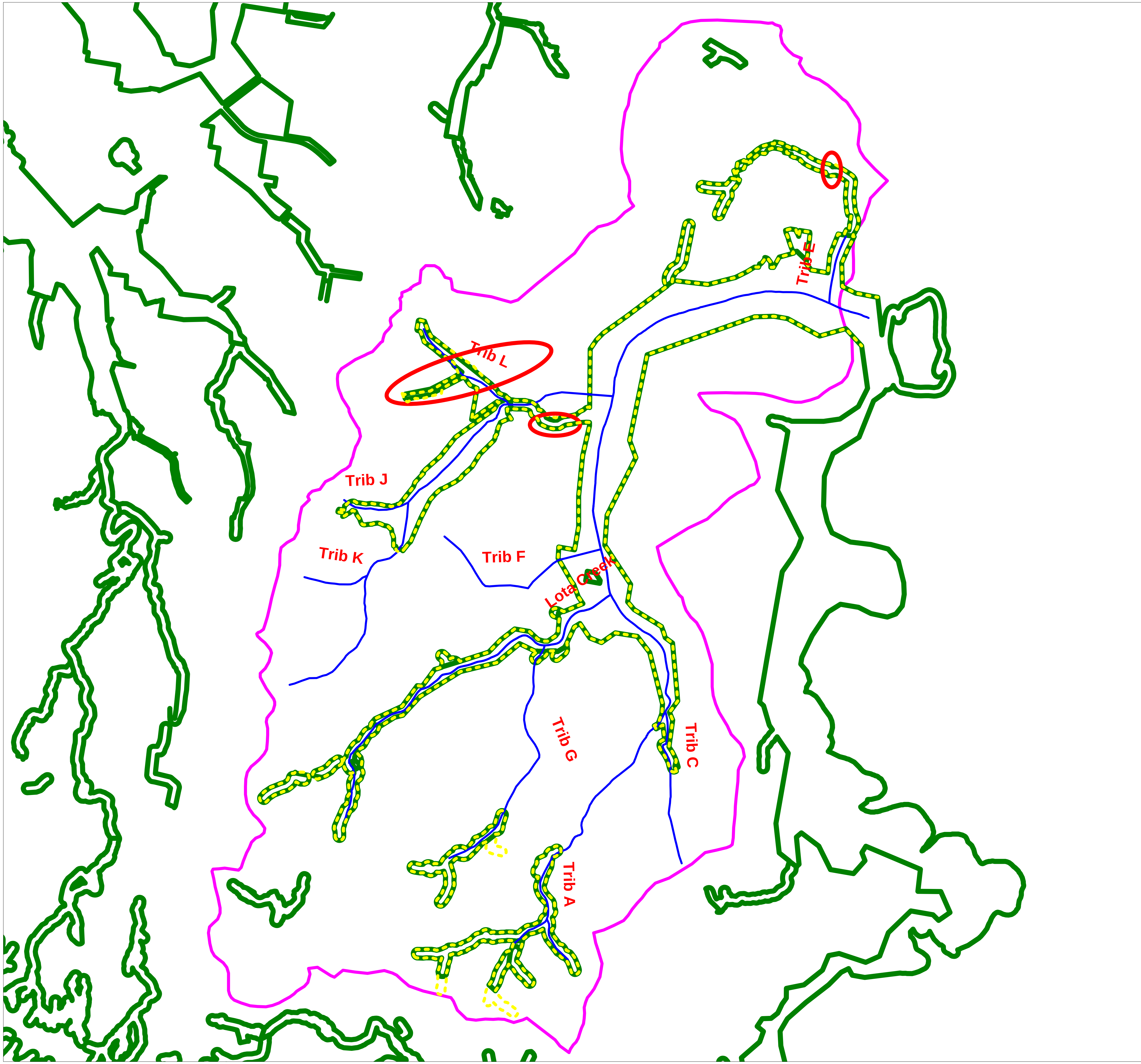
ARI (year)	Scenario 1	Scenario 2	Scenario 3
2	✓	✗	✓
5	✓	✗	✓
10	✓	✗	✓
20	✓	✗	✓
50	✓	✗	✓
100	✓	✓	✓

7.2.2 TUFLOW model roughness

The hydraulic roughness in the calibrated TUFLOW model was updated as required to represent the ultimate catchment conditions as per the current version of City Plan. This required some changes to areas where proposed development is planned, such as the "Emerging Community" land-use in the mid-catchment area.

7.2.3 TUFLOW model boundaries

The design inflow boundaries to the TUFLOW model were taken from the results of the RAFTS model for each ARI and duration. The inflow locations did not change from the calibrated TUFLOW model with the exception of 2 locations where the waterway corridor was included in the model.



MAILING ADDRESS:
GPO Box 1434
Brisbane Qld 4001

Green Square
South Tower
505 St. Paul's Terrace
Fortitude Valley Qld 4006

Telephone: (07) 3027 5550
Facsimile: (07) 3334 0225
E-mail: citydesign@brisbane.qld.gov.au

Dedicated to a better Brisbane

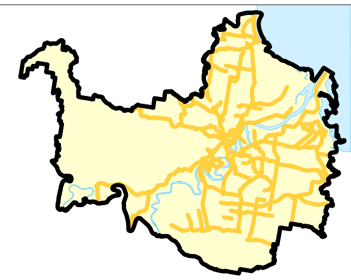
City Projects Office
Brisbane City Council

LEGEND

- Revised Waterway Corridor
- Areas of Change
- Waterways
- Existing Waterway Corridor
- Lota Creek Catchment Boundary

N W E S

250 0 250 500 750
Metres



Printed 29 May 2013

Project Number CD130866 | Revision 1 | Prepared HZ | Checked HZ

Workspace G:\\130866\GIS\Workspaces\Figure 7.1.WOR

Project
Lota Creek Flood Study

Title
Revised Waterway Corridor

Figure 7.1

The TUFLOW model utilised a fixed water level (H-T) boundary at its downstream extent (i.e. Moreton Bay). A Mean High Water Springs (MHWS) value of 0.95 m AHD was adopted for all design events.

It should be noted that the joint probability of fluvial and tidal events has not been considered in the modelling.

7.3 Modelling Results

7.3.1 Peak Discharge

Discharges predicted by the TUFLOW model were extracted at crossing locations. These discharges are presented in Table 7.3 and represent the total flow at that location, including discharge through all culverts / bridges and associated bypass flow.

Table 7.3 – TUFLOW Design Event Peak Discharge at Major Structures (Scenario 3)

Creek / Channel	Structure Location	Peak Discharge (m^3/s)					
		2-yr ARI	5-yr ARI	10-yr ARI	20-yr ARI	50-yr ARI	100-yr ARI
Lota Creek	Old Cleveland Road	31.6	47.2	55.1	66.0	76.0	86.5
	Boston Road	34.1	51.6	59.9	72.4	84.3	96.1
	London Road	35.5	53.4	62.7	75.8	90.4	104.3
	Grassdale Road	37.4	56.5	66.6	81.4	98.1	113.6
	Archer Street	36.2	54.9	65.0	79.9	97.9	114.1
	New Cleveland Road	41.4	64.6	77.9	96.4	121.0	140.1
	Molle Road	36.3*	56.2*	69.3*	87.8*	111.2*	131.1*
	Rickertt Road	34.9*	52.7*	62.9*	78.3*	96.4*	112.6*
	Railway	27.5*	46.2*	57.8*	73.0*	92.0*	108.1*
Tributary A	Charleton Street	12.8	19.9	23.6	28.6	34.4	39.6
	Old Cleveland Road	12.2	18.4	21.1	26.5	34.7	40.0
	London Road	3.1	5.0	5.9	7.3	8.9	10.6
	New Cleveland Road	3.1	5.0	6.4	8.3	10.3	12.1
Tributary B	Grassdale Road	4.8	7.1	8.4	9.8	11.6	13.2
	Formosa Road	4.4	6.9	8.1	9.8	11.1	12.6
	New Cleveland Road	13.5	20.8	25.1	30.9	37.8	43.8
	Green Camp Road	17.9	26.4	32.0	39.9	51.5	63.8
Tributary E	Bridgewater Place	19.7	26.6	32.1	32.3	36.8	47.5
	Brookside Place	16.3	23.1	26.5	31.8	36.1	40.6

Creek / Channel	Structure Location	Peak Discharge (m^3/s)					
		2-yr ARI	5-yr ARI	10-yr ARI	20-yr ARI	50-yr ARI	100-yr ARI
	Alexander Street	13.3	18.6	21.1	24.2	29.1	34.4
	Coolana Street	15.5	21.7	25.6	31.9	45.0	55.7
Tributary G	Boston Road	5.9	9.2	10.7	12.7	13.3	15.5
	London Road	10.6	16.8	19.8	23.5	26.3	29.4
	Grassdale Road	13.0	20.1	24.0	28.7	34.1	39.0
Tributary J	Tilley Road	5.2	6.9	7.8	8.3	9.6	11.3
Tributary C	New Cleveland Road	13.4	18.9	22.0	27.2	34.5	40.4
Tributary L	Watervale Parade	8.3	11.7	13.8	16.8	20.1	23.2
	Tilley Road	11.3	16.2	19.3	23.2	26.5	30.3
Tributary F	New Cleveland Road	10.3	15.2	17.5	20.6	23.8	27.1
	Green Camp Road	12.2	18.3	21.2	25.0	29.2	33.2

** The observed discharge reduction/flow attenuation from Molle Road to the Railway Bridge is due to the significant storage available within the floodplain along this section of the creek.*

7.3.2 Critical Durations

A full range of event durations (30 minute, 1 hour, 1.5 hours, 2 hours, 3 hours, 4.5 hours and 6 hours) were simulated within the TUFLOW model. Table 7.4 indicates the critical durations for the 2-yr to 100-yr ARI events at key locations within the catchment.

Table 7.4 – Critical Durations at Selected Locations (Scenario 3)

Creek / Channel	Structure Location	Critical Duration (hours)					
		2-yr ARI	5-yr ARI	10-yr ARI	20-yr ARI	50-yr ARI	100-yr ARI
Lota Creek	Old Cleveland Road	30	60	60	60	60	60
	Boston Road	60	60	60	60	60	60
	London Road	60	60	60	60	60	60
	Grassdale Road	60	60	60	60	60	60
	Archer Street	90	60	60	60	60	60
	New Cleveland Road	90	90	60	60	60	60
	Molle Road	120	120	120	120	120	120
	Rickertt Road	180	180	180	180	180	180
	Railway	270	360	360	360	360	360
Tributary A	Charleton Street	90	60	60	60	60	60
	Old Cleveland Road	60	60	60	60	60	60
	London Road	60	60	60	60	60	60

Creek / Channel	Structure Location	Critical Duration (hours)					
		2-yr ARI	5-yr ARI	10-yr ARI	20-yr ARI	50-yr ARI	100-yr ARI
	New Cleveland Road	90	90	90	90	90	90
Tributary B	Grassdale Road	30	60	60	60	60	60
	Formosa Road	60	60	60	60	60	60
	New Cleveland Road	90	60	60	60	60	60
	Green Camp Road	120	120	120	120	90	90
Tributary E	Bridgewater Place	60	60	60	60	60	30
	Brookside Place	60	60	60	60	60	60
	Alexander Street	60	60	60	60	60	60
	Coolana Street	90	90	60	60	60	60
Tributary G	Boston Road	30	60	60	60	60	60
	London Road	60	60	60	60	60	60
	Grassdale Road	60	60	60	60	60	60
Tributary J	Tilley Road	30	30	30	60	60	60
Tributary C	New Cleveland Road	90	90	90	90	90	90
Tributary L	Watervale Parade	60	60	60	60	60	60
	Tilley Road	120	120	120	120	90	90
Tributary F	New Cleveland Road	60	60	60	60	60	60
	Green Camp Road	60	60	60	120	120	120

7.3.3 Peak Flood Levels

Tabulated peak flood level results are provided in Appendix F for Lota Creek and all major tributaries. These results are presented for the 2-yr to 100-yr ARI events for both Scenario 1 and Scenario 3. The peak flood levels are referenced to the existing Adopted Middle Thread Distance (AMTD). Figure 7.2 shows the chainages along AMTD lines within Lota Creek catchment.

7.3.4 Flood Mapping Products

The flood mapping products are provided in the separate A3 booklet as Appendix J. These mapping products have been provided for Scenario 1 and Scenario 3 only and include 10-yr, 20-yr and 100-yr ARI for the following flood characteristics:

- Flood Extent Mapping
- Flood Depth Mapping

The maps which are not included in this report (Scenario 1, 2 and 3), were provided in a digital format as part of deliverables of this study.

Ultimate scenario planning level surfaces were required to be generated and mapped. Within the flood modelling context, the ultimate scenario involves modifying the flood model topography to represent a fully developed floodplain in accordance with City Plan and in most instances applying an allowance for a riparian corridor. This process generally results in design flood levels being increased. Council requires these increased levels to then be mapped against the current floodplain topography thus providing a flood extent that is conservative, extends beyond the “existing” flood extent and ‘flags’ the additional properties that could potentially be at flood risk in the future and should have development controls (planning levels) applied.

With the move to ‘two-dimensional’ flood models, the production of flood levels, extents and depth-velocity products is inherent in simulating a model, i.e. a flood map is a direct output from a model simulation removing the requirement to apply a separate process. For the “existing” case simulations, the model is run and the direct output is able to be mapped or referenced in a GIS environment. In order to simulate the “ultimate” scenario, the model topography must be modified to represent filling associated with development. This in turn affects the resulting flood mapping with the flood extent limited to the edge of the filled floodplain. Post processing of the model output is required to represent the modelled flood levels against the current floodplain conditions.

The Water Ride stretching tool was selected for the purpose of processing the “ultimate” case results and producing the planning flood levels and surfaces. The stretching calculation starts at the north-easterly corner where it identifies each “dry cell” which is located immediately adjacent to the “wet cells”. It then calculates a water level for the dry cell by interpolating the neighbouring flood levels. If the assigned flood level is higher than the ground level for that cell, then the cell will be identified as wet. If this condition is not met (ie water level is less than ground level) then this cell will be identified as dry. This is an iterative process and continues counter clockwise until there is no wet cell left in a single revolution. The better control the process a tolerance is adopted in the determination of a wet cell, being a water depth of 300mm.

From experience to date, it is known that the Water Ride stretching tool alone cannot provide robust surface and level information in all conditions. Therefore, a thorough review of each surface produced by the tool was undertaken and manual intervention applied to the process to ensure suitable outcomes. To help with the initial review process, a comparison of the stretched extent with calculated flood extents including existing scenarios and larger events was undertaken. To modify the stretched surface, break lines were used to limit the expansion of the surface and to stop the “leakage” (upstream higher water level projecting to the downstream lower area) of the surface in problematic areas. Applying break lines at the right place enhances the produced flood levels and surfaces and minimises the anomalies across the flood extent.

In general, the modified areas are mostly observed around tight bends, at structures with high head losses, steep areas where the water can leak, stream junctions where cross-flow is likely, parallel channels, secondary paths and breakout areas. Specific application of the break lines for this flood study is detailed in Figure 7.3 below.

Despite the review of the stretched surfaces and the inclusion of break lines to manipulate the stretching process, the process and outputs are still subject to limitations as follows:

- The application of break lines will result in significant steps in the generated surface in some locations
- The application of break lines is highly subjective in some locations
- The application of break lines will not necessarily be consistent across all design events (i.e. they will change in number and location depending on the magnitude of the design event considered)
- The stretching process may not be readily repeatable (i.e. the output has not come directly from a model simulation and if model outputs change, it cannot be guaranteed that the process will not need further refinement to produce acceptable results)

The short comings of the stretching or extrapolation process are discussed as follows.

Stretched structure head loss – When a waterway crossing produces significant head loss the upstream surface may be incorrectly stretched to downstream areas. This can be managed by placing a break-line along the road or rail line that crosses the creek however the level difference produced by the structure will be stretched out to areas of ineffective flow where no such level difference would exist in reality.

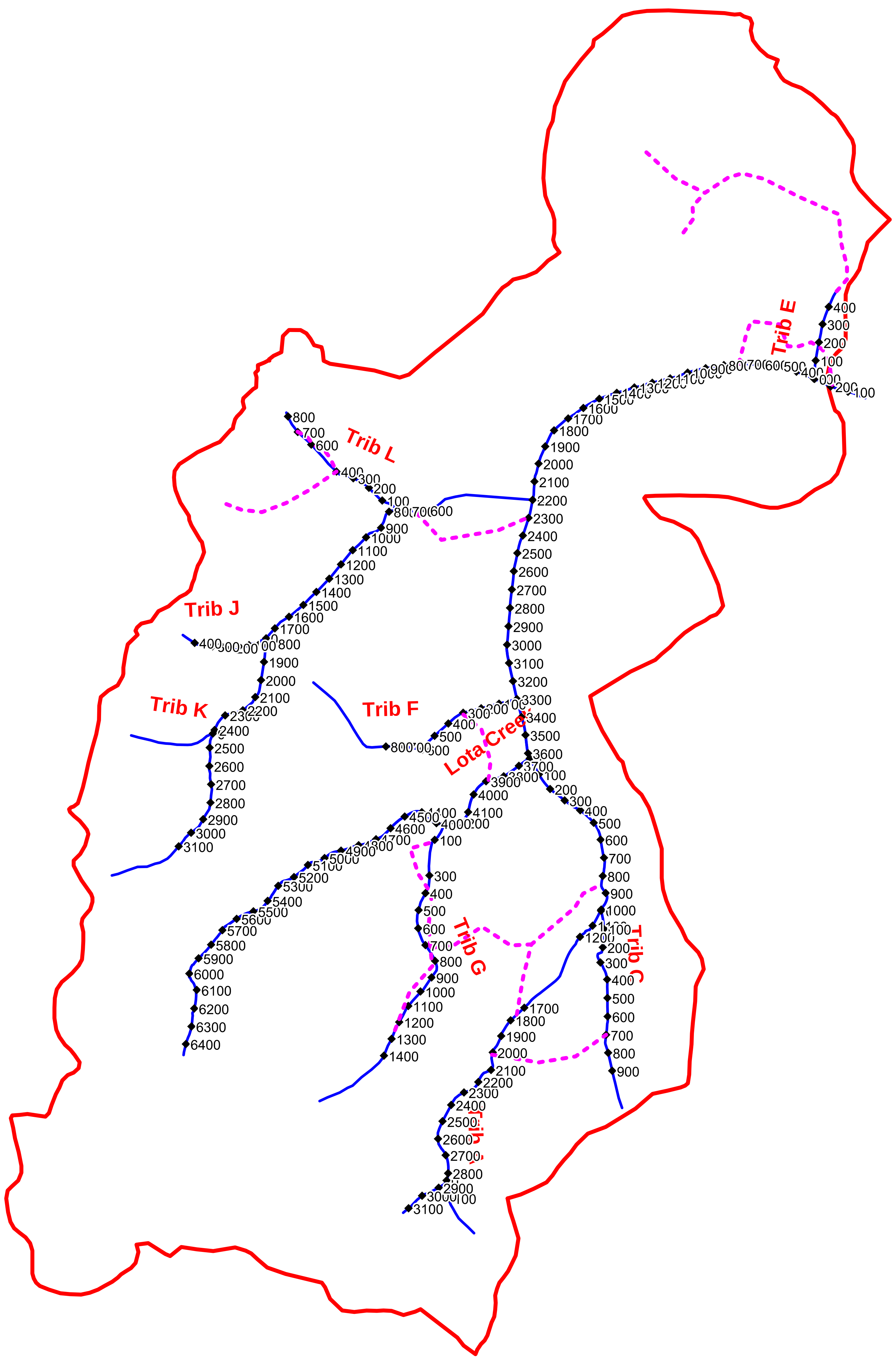
Stretching on sloping terrain – Water Ride will stretch a surface until the terrain comes to within the threshold depth. On flat or downward sloping terrain stretching will continue on a horizontal plain and break-lines need to be applied to restrict it. In these locations some overland flow may naturally occur in the Existing Case; however the equivalent stretched Ultimate Case will lead to over-estimates of flood level on downhill sloping terrain.

Tributaries merging – At the confluence of two tributaries, one tributary can stretch over the stretched surface of another. Between tributaries break-lines can be placed along ridgelines or other features if they exist but a drop in level may be apparent where the surface of one tributary meets that of another either side of the break-lines.

The stretching limitation locations identified in this project are shown in Appendix K and described briefly in Table 7.5 below.

Table 7.5 – Stretching Limitations

Map Location ID	Limitation Type	Comments
1	Sloping terrain	Overland flow occurs in Existing Scenario. Conservative food levels for Ultimate Case
2	Structure head loss	Structure head loss projected out laterally
3	Structure head loss	Structure head loss projected out laterally
4	Structure head loss	Structure head loss projected out laterally
5	Tributaries merging	Sudden flood surface drop between adjoining tributaries broken into steps
6	Sloping terrain	Overland flow occurs in Existing Scenario. Conservative food levels for Ultimate Case
7	Sloping terrain	Overland flow occurs in Existing Scenario. Conservative food levels for Ultimate Case
8	Sloping terrain	Overland flow occurs in Existing Scenario. Conservative food levels for Ultimate Case



MAILING ADDRESS:
GPO Box 1434
Brisbane Qld 4001

Green Square
South Tower
505 St. Paul's Terrace
Fortitude Valley Qld 4006

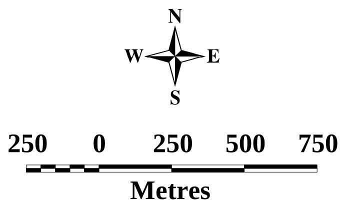
Telephone: (07) 3027 5550
Facsimile: (07) 3334 0225
E-mail: citydesign@brisbane.qld.gov.au

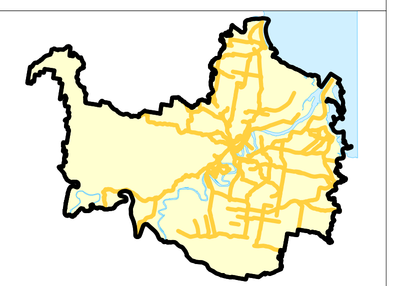
Dedicated to a better Brisbane

City Projects Office
Brisbane City Council

LEGEND

- ◆ Chainage
- AMTD Line
- Lota Creek Catchment
- Revised Overland Flow Path/ Waterway Centreline



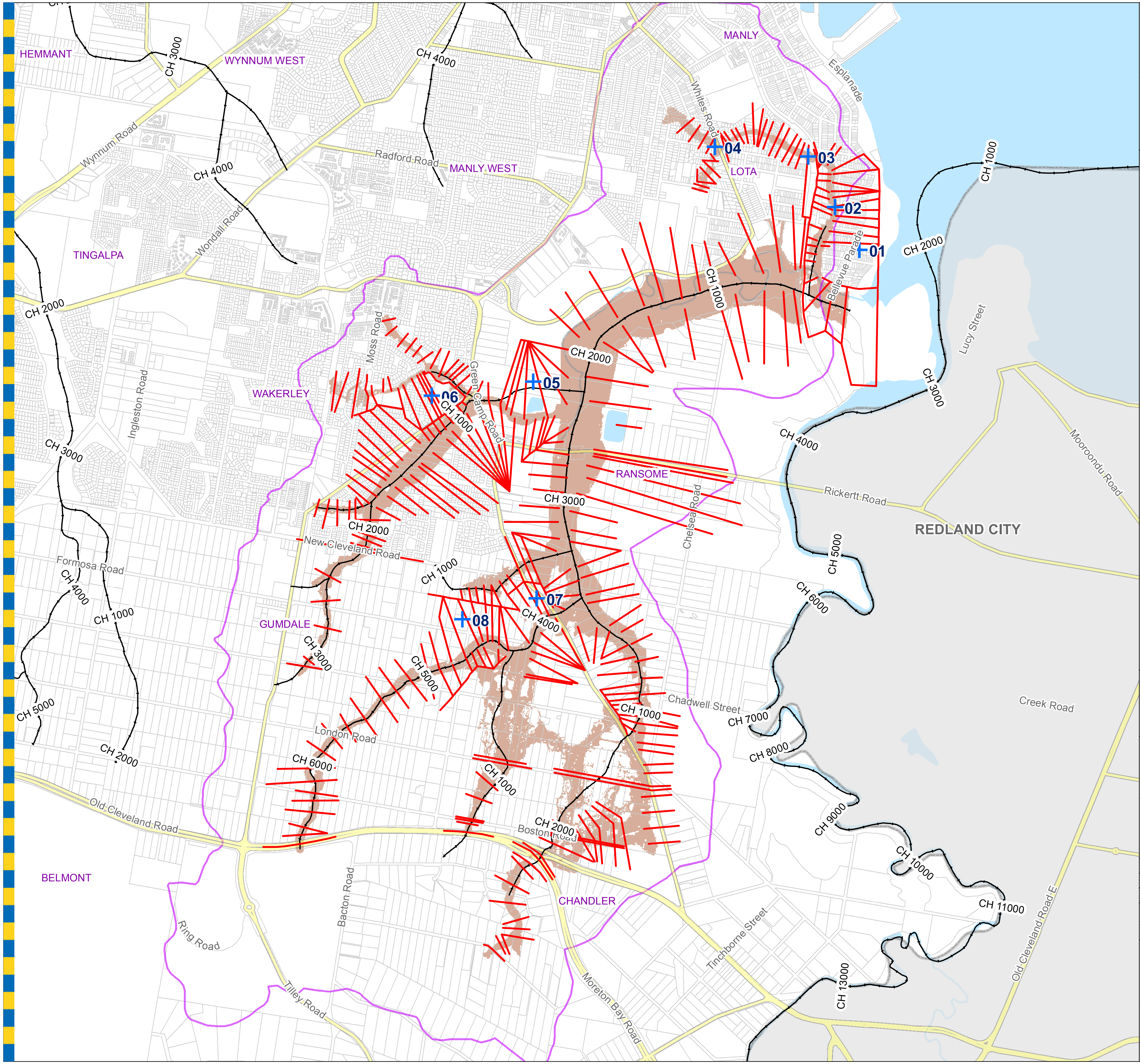


Printed 29 May 2013			
Project Number CD130866	Revision 1	Prepared HZ	Checked HZ
Workspace G:\\130866\GIS\Workspaces\Figure 7.2.WOR			

Project
Lota Creek Flood Study

Title
AMTD lines

Figure 7.2



Brisbane City Council
City Projects Office
GPO Box 1434
Brisbane Qld 4001

For more information
visit www.brisbane.qld.gov.au
or call (07) 3403 8888

BRISBANE CITY

Dedicated to a better Brisbane

City Projects Office
Brisbane City Council

Legend

- Stretched Area for
- WaterRide Break Line
- AMTD Line
- Major Roads
- Lota Creek Catchment boundary
- Property Holdings
- 1% AEP Ultimate Case Scenario Flood Inundation Extent
- Local Government boundary
- Waterway/Waterbody

For Information Only - Not Council Policy

N W E S

0 250 500 750
Metres

Scale 1:25000 on A3

Printed: 08 Oct 2014
Project No: 0390166
Revision: 0
Prepared: 097142
Checked: JS

GIM Ref: G:\BI\CD\Project\0390166_FRL_Review_-_Lota_Creek\ArcGIS\GIM_0390166_040.mxd

Project
Lota Creek Flood Study

Title
WaterRide Break Lines and Stretched Areas for Improvement

Figure 7.3

7.3.5 Flood Immunity of Hydraulic Structures

The flood immunity of the structures under Scenario 3 was determined for each crossing by comparing peak flood levels upstream of the crossing with the minimum overtopping levels. The estimated structure immunities are presented in Table 7.5, of which the minimum event considered, was the 2-yr ARI and the maximum was the 100-yr ARI. Hydraulic Structure Reference Sheets (HSRS) were also produced which outline the hydraulic characteristics of each structure. These are provided in Appendix H.

Table 7.6 – Existing Flood Immunity of Structures (Scenario 3)

Creek / Channel	Structure Location	Existing Immunity (ARI)
Lota Creek	Old Cleveland Road	2 year ARI
	Boston Road	Less than 2 year ARI
	London Road	Less than 2 year ARI
	Grassdale Road	Less than 2 year ARI
	Archer Street	Less than 2 year ARI
	New Cleveland Road	Less than 2 year ARI
	Molle Road	Less than 2 year ARI
	Rickertt Road	2 year ARI
	Railway	More than 100 year ARI
Tributary A	Charleton Street	Less than 2 year ARI
	Old Cleveland Road	5 year ARI
	London Road	Less than 2 year ARI
	New Cleveland Road	2 year ARI
Tributary B	Grassdale Road	Less than 2 year ARI
	Formosa Road	Less than 2 year ARI
	New Cleveland Road	Less than 2 year ARI
	Green Camp Road	Less than 2 year ARI
Tributary E	Bridgewater Place	More than 100 year ARI
	Brookside Place	More than 100 year ARI
	Alexander Street	Less than 2 year ARI
	Coolana Street	Less than 2 year ARI
Tributary G	Boston Road	Less than 2 year ARI
	London Road	Less than 2 year ARI
	Grassdale Road	Less than 2 year ARI

Creek / Channel	Structure Location	Existing Immunity (ARI)
Tributary J	Tilley Road	Less than 2 year ARI
Tributary C	New Cleveland Road	Less than 2 year ARI
Tributary L	Watervale Parade	Less than 2 year ARI
	Tilley Road	Less than 2 year ARI
Tributary F	New Cleveland Road	Less than 2 year ARI
	Green Camp Road	Less than 2 year ARI

As Table 7.5 indicates, the majority of the structures within Lota Creek catchment have a flood immunity of less than 2-yr ARI.

8.0 Extreme Event Modelling

8.1 Extreme Event Hydrology

8.1.1 General

This section details the derivation of the design flood hydrology for the following extreme events:

(i) 200-yr & 500-yr ARI events
(ii) 2000-yr ARI event, and
(iii) Probable Maximum Precipitation (PMP)

8.1.2 200-yr and 500-yr ARI Events

The IFD rainfall data for the 200-yr and 500-yr ARI events was obtained using the CRC-Forge method. During this process it was found that the 200-yr ARI CRC-Forge rainfall intensities were lower than the 100-yr ARI AR & R rainfall intensities. Therefore, adjustments were made to the 200-yr ARI rainfall intensity as follows:

$$\text{200-yr ARI intensity } (I) = (\text{500-yr } I_{\text{CRC-Forge}} - \text{100-yr } I_{\text{AR\&R}}) \times \{(\text{200-yr } I_{\text{CRC-Forge}} - \text{100-yr } I_{\text{CRC-Forge}}) / (\text{500-yr } I_{\text{CRC-Forge}} - \text{100-yr } I_{\text{CRC-Forge}})\} + \text{100-yr } I_{\text{AR\&R}}$$

Table 8.1 indicates the adopted 200-yr and 500-yr ARI design rainfall intensities with comparison to the adopted 100-yr ARI.

Table 8.1 – Adopted IFD (200-yr and 500-yr ARI)

Duration (hr)	Rainfall Intensity (mm/hr)		
	100-yr ARI	200-yr ARI	500-yr ARI
0.5	159	169	183
1	113	119	127
1.5	86	103.5	111
2	71	88	95
3	53	57	63
4.5	40.4	46.5	51.5
6	33.1	36	40

The AR & R 100-yr ARI design temporal pattern was adopted for both these events. Please refer to Appendix J for maps.

8.1.3 2000-yr ARI

To 2000-yr ARI IFD rainfall was determined using the CRC-Forge method. To avoid the need to simulate all of the different storm durations, a simplified super-storm method was used. This same methodology has also been used on other BCC flood studies currently being undertaken.

The rationale for adopting this approach is that world-wide research indicates that as storm rainfall depths increase during short duration storms, the rainfall intensity becomes more uniform. For this reason, the multi-peaked AR & R temporal pattern (as used for the 200-yr and 500-yr ARI) was not considered suitable for the analysis of this more extreme event.

A 6-hour super-storm was developed to represent all storm durations up to 6 hours. The super-storm was developed in 30 minute blocks and incorporates the 30 minute, 1 hour, 1.5 hours, 2 hours, and 3 hours storm bursts. Durations less than 30 minutes were not considered. The total rainfall depth of the super-storm was set equal to the 6 hour 2000-yr ARI CRC-Forge rainfall depth, which was determined as 340 mm. Please refer to Appendix J for maps.

8.1.4 PMP

For the PMP scenario, the 6 hour super-storm approach was also undertaken using the same temporal pattern as the 2000-yr ARI.

The total PMP depth was derived from the 6 hour storm duration using the Generalised Short Duration Method (GSDM). For the tropical and sub-tropical coastal areas it is recommended that this method is to be used to estimate the PMP over areas up to 520 km^2 and for durations up to 6 hours. To apply a consistent methodology across the majority of BCC an average catchment size of 60 km^2 and moisture adjustment factor of 0.85 were adopted.

The total rainfall depth of the super-storm was set equal to the 6 hour GSDM PMP rainfall depth, which was determined as 816 mm.

Table 8.2 indicates the adopted super-storm temporal pattern and hyetographs for the 2000-yr ARI and the PMP. Please refer to Appendix J for maps.

Table 8.2 – Adopted Super-storm Hyetographs

Time (hr)	Rainfall (%)	Rainfall (mm)		Time (hr)	Rainfall (%)	Rainfall (mm)	
		2000-yr	PMP			2000-yr	PMP
0.00	0	0.00	0.00	3.17	58	41.00	75.08
0.17	1	4.33	9.92	3.33	70	41.00	75.08
0.33	3	4.33	9.92	3.50	75	16.00	38.25
0.50	4	4.33	9.92	3.67	77	7.58	27.63
0.67	5	4.33	9.92	3.83	80	7.58	27.63
0.83	6	4.33	9.92	4.00	82	7.58	27.63
1.00	8	4.33	9.92	4.17	84	7.58	18.42
1.17	9	4.33	13.46	4.33	86	7.58	18.42
1.33	10	4.33	13.46	4.50	89	7.58	18.42
1.50	11	4.33	13.46	4.67	90	4.33	13.46
1.67	14	7.58	18.42	4.83	91	4.33	13.46
1.83	16	7.58	18.42	5.00	92	4.33	13.46
2.00	18	7.58	18.42	5.17	94	4.33	9.92
2.17	20	7.58	27.63	5.33	95	4.33	9.92
2.33	23	7.58	27.63	5.50	96	4.33	9.92
2.50	25	7.58	27.63	5.67	97	4.33	9.92
2.67	30	16.00	38.25	5.83	99	4.33	9.92
2.83	34	16.00	38.25	6.00	100	4.33	9.92
3.00	46	41.00	75.08				

8.2 Extreme Event Hydraulic Modelling

8.2.1 Modelled Scenarios

The TUFLOW model was used to determine both discharges and flood levels for the 200-yr ARI, 500-yr ARI, 2000-yr ARI and the PMF.

Table 8.3 indicates the three hydraulic scenarios considered in the extreme event modelling, noting that all extreme event scenarios were modelled using ultimate hydrological conditions. These scenarios have been previously described in Section 2.2.1.

Table 8.3 – Extreme Event Scenarios

ARI (year)	Scenario 1	Scenario 2	Scenario 3
200	✓	✗	✓
500	✓	✗	✓
2000	✓	✗	✗
PMF	✓	✗	✗

8.2.2 TUFLOW model roughness

No changes were made from the design event TUFLOW model(s).

8.2.3 TUFLOW model boundaries

The extreme event inflow boundaries to the TUFLOW model were taken from the results of the RAFTS model for each ARI and duration. The inflow locations did not change from the design event TUFLOW model.

The TUFLOW model utilised a fixed water level (H-T) boundary at its downstream extent (i.e. Moreton Bay). A Mean High Water Springs (MHWS) value of 0.95 m AHD was adopted for all extreme events. The flood level upstream of the Railway Bridge is not sensitive to the changes of the downstream boundary as it is strictly controlled by the Railway Bridge structure embankment.

8.2.4 Hydraulic Structures

All extreme event TUFLOW models incorporated the same hydraulic structures as the design event TUFLOW models.

8.3 Modelling Results

8.3.1 Peak Flood Levels

Tabulated peak flood level results are provided in Appendix G for Lota Creek and all major tributaries. These results are presented for the 200-yr & 500-yr ARI (Scenario 3) and 2000-yr ARI & PMF (Scenario 1).

8.3.2 Flood Mapping Products

The flood mapping products are provided in Appendix J. The flood extent maps have been provided for Scenario 1 (200-yr, 500-yr, 2000-yr ARI and PMF) and Scenario 1 and Scenario 3 (200-yr and 500-yr ARI).

8.3.3 Discussion of Results

A plot of flood profile is presented in Figure 8.1 to aid in the discussion of the results. In relation to the main branch of Lota Creek, the average increase in flood depth associated with the 200 and 500 year events when compared to the 100 year ARI (Scenario 3) flood profile is:

- 200 year ARI event: 0.18 m (Scenario3)
- 500 year ARI event: 0.25 m (Scenario3)

The flood profile for the 200 and 500 year ARI events are observed to follow a very similar trend with no significant areas of increased flood depth as compared to the 100 year ARI flood profile along main branch of Lota Creek.

The flood profiles for the 2000 year ARI and PMF events follow a similar trend upstream of New Cleveland Road. However, it is observed that downstream of New Cleveland Road significantly deeper flooding is predicted (up to 2.15m higher during PMF event) due to the Railway Bridge embankment which controls the upstream flood levels, as well as a flatter, less hydraulically efficient flood plain. The average increase in flood depth associated with both events when compared to the 100 year ARI (Scenario 3) flood profile is:

- 2000 year ARI event: 0.62 m (Scenario1)
- PMF event: 1.26 m (Scenario1)

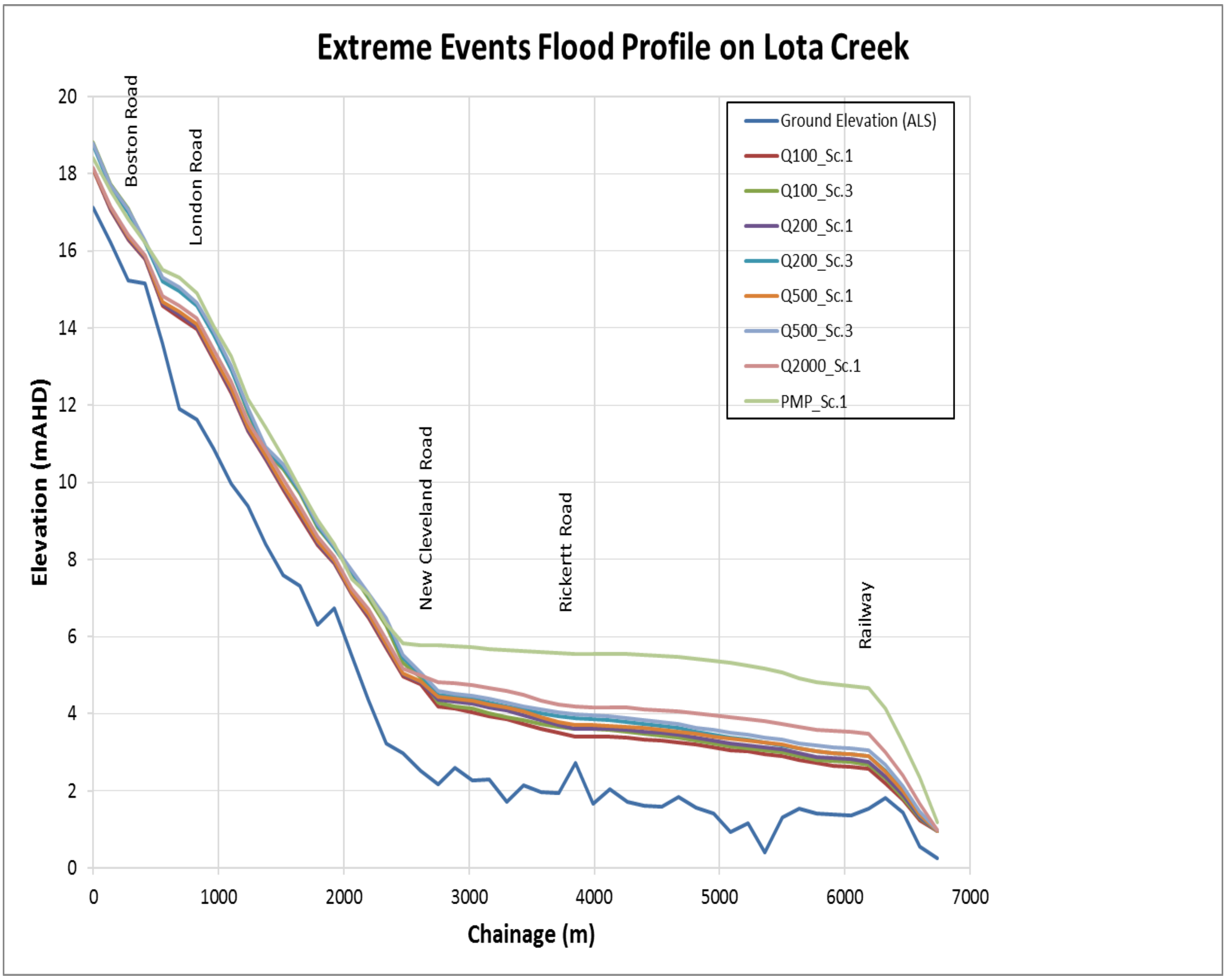


Figure 8.1: Extreme Event Flood Profile on Lota Creek

9.0 Climate Change Modelling

9.1 Background

Council's Natural Environment, Water and Sustainability (NEWS) Branch required longer term planning horizons to be considered in their program of flood studies by considering extreme flood events and potential climate change impacts. At this time, State Planning Policy 3/11 (now superseded by the Coastal Protection State Planning Regulatory Provision) and the Inland Flood Study (DERM, 2010) had provided guidance on assessing the potential impacts on communities and development of projected climate change effects, including sea level rise and increased rainfall intensities.

The SPP 3/11 outlined the following factors to be used by local government to determine planning levels for appropriate planning horizons (2050, 2070 and 2100):

- A sea-level rise factor of 0.8 metres;
- An increase in the maximum cyclone intensity by 10 per cent; and
- Where a relevant storm-tide inundation assessment has not been completed in relation to a proposed development, the coastal hazard area is taken to be all land between high water mark and a minimum default 100-year Design Storm Tide Event level of 1.5 metres above the level of Highest Astronomical Tide for all developments in SEQ.

The Inland Flooding Study outlines the rationale for adopting an interim methodology for assessing flooding risk in Queensland:

1. The proposed methodology is to factor a 5 per cent increase in rainfall intensity at Annual Exceedance Probabilities (AEP) of 1% (100 yr ARI), 0.5% (200 yr ARI) and 0.2% (500 yr ARI) per degree of global temperature increase for all rainfall events recommended in SPP 1/03 for the location and design of new development.
2. The following temperatures and timeframes should be used for the purposes of applying the climate change factor in Recommendation 1:
    a) 2C by 2050
    b) 3C by 2070
    c) 4C by 2100

To enable BCC to understand and plan for the impacts of climate change on flooding in the Lota Creek Catchment, an analysis was undertaken, which can be summarised as follows:

- 2050 Planning Horizon
    - 10 % increase in rainfall intensity
    - 0.3 m increase in mean sea level

- 2100 Planning Horizon
    - 20 % increase in rainfall intensity
    - 0.8 m increase in mean sea level

9.2 Modelled Scenarios

The TUFLOW model was used to determine climate change impacts for the 100-yr, 200-yr and 500-yr ARI events. Table 9.1 indicates the events modelled and the respective climate change modifications undertaken.

Table 9.1 – Climate Change Modelling Scenarios

Event	Scenario	Rainfall Condition	Adopted Tailwater	
			Condition	Level (m AHD)
100-yr ARI (2050)	1 and 3	+ 10 %	MHWS + 0.3 m	1.25
100-yr ARI (2100)	1 and 3	+ 20 %	MHWS + 0.8 m	1.75
200-yr ARI (2050)	3	+ 10 %	MHWS + 0.3 m	1.25
200-yr ARI (2100)	3	+ 20 %	MHWS + 0.8 m	1.75
500-yr ARI (2100)	3	+ 20 %	MHWS + 0.8 m	1.75

The rainfall intensity in the RAFTS model was increased by 10 % (or 20 %) and simulations undertaken to determine the climate change hydrographs. These hydrographs were then input into the Scenario 3 TUFLOW model and simulations undertaken for all climate change scenarios.

9.3 Climate Change Impacts

9.3.1 Impact on Flood Level

Tables 9.2 to 9.4 indicate the increase in peak flood level at selected locations for the 100-yr, 200-yr and 500-yr ARI events respectively.

Table 9.2 – 100-yr ARI Climate Change Impacts at Selected Locations (Scenario 3)

Creek / Channel	Structure Location	Flood Level (m AHD)		
		Existing	2050	2100
Lota Creek	Old Cleveland Road	18.95	18.97	19.01
	Grassdale Road	10.63	10.70	10.79
	New Cleveland Road	4.77	4.82	4.88

Creek / Channel	Structure Location	Flood Level (m AHD)		
		Existing	2050	2100
	Molle Road	4.18	4.30	4.40
	Rickertt Road	3.62	3.72	3.86
	Railway	2.28	2.44	2.65
Tributary A	Old Cleveland Road	15.87	15.91	15.95
	New Cleveland Road	7.23	7.23	7.24
Tributary B	New Cleveland Road	13.35	13.38	13.40
	Green Camp Road	5.15	5.12	5.18

Table 9.3 – 200-yr ARI Climate Change Impacts at Selected Locations (Scenario 3)

Creek / Channel	Structure Location	Flood Level (m AHD)		
		Existing	2050	2100
Lota Creek	Old Cleveland Road	18.95	18.99	19.04
	Grassdale Road	10.68	10.78	10.87
	New Cleveland Road	4.84	4.90	4.96
	Molle Road	4.43	4.54	4.63
	Rickertt Road	3.88	4.01	4.13
	Railway	2.48	2.64	2.83
Tributary A	Old Cleveland Road	15.93	15.96	15.99
	New Cleveland Road	7.24	7.28	7.31
Tributary B	New Cleveland Road	13.37	13.40	13.42
	Green Camp Road	5.19	5.30	5.43

Table 9.4 – 500-yr ARI Climate Change Impacts at Selected Locations (Scenario 3)

Creek / Channel	Structure Location	Flood Level (m AHD)	
		Existing	2100
Lota Creek	Old Cleveland Road	18.98	19.08
	Grassdale Road	10.75	10.91
	New Cleveland Road	4.89	4.99
	Molle Road	4.52	4.71
	Rickertt Road	3.98	4.21

Creek / Channel	Structure Location	Flood Level (m AHD)	
		Existing	2100
	Railway	2.63	2.94
Tributary A	Old Cleveland Road	15.95	16.01
	New Cleveland Road	7.27	7.35
Tributary B	New Cleveland Road	13.39	13.44
	Green Camp Road	5.28	5.55

The following indicates the average flood level increases for all climate change events:

- 100 year ARI C.C.2050 vs. 100 year ARI Scenario 3: 0.09 m increase
- 200 year ARI C.C.2050 vs. 200 year ARI Scenario 3: 0.24 m increase

- 100 year ARI C.C.2100 vs. 100 year ARI Scenario 3: 0.22 m increase
- 200 year ARI C.C.2100 vs. 200 year ARI Scenario 3: 0.36 m increase
- 500 year ARI C.C.2100 vs. 500 year ARI Scenario 3: 0.35 m increase

10.0 Conclusion

This report details the calibration and verification event, design event, extreme event and climate change modelling for the Lota Creek Catchment in the south-eastern area of the BCC region. Hydrologic and hydraulic models of the Lota Creek Catchment have been developed using the RAFTS and TUFLOW modelling software respectively. The RAFTS model covers the entire Lota Creek Catchment while the TUFLOW model covers approximately 85 percent of the catchment area.

Calibration of RAFTS and TUFLOW was undertaken utilising two historical storms; namely 3rd February 2008 and the 20th May 2009. Verification of RAFTS and TUFLOW was also undertaken utilising two historical storms; namely 11th October 2010 and 25th January 2012.

Hydrometric data for the four historical events was sourced and included the following:

- Pluviograph station data
- Stream gauge data, and
- Maximum Height Gauge data

During the calibration process both hydrologic and hydraulic parameters were adjusted to achieve a good agreement with the historical data. The hydrologic parameters which were adjusted were generally the rainfall losses (infiltration) parameters, as the sub-catchment routing parameters were kept at default values. The hydraulic parameters which were adjusted were generally Manning's 'n' roughness values and the hydraulic structure head-losses. Cross-checks of the TUFLOW structure head-losses were undertaken at the major structures using the HEC-RAS software, from which is was confirmed that the model was representing the structures adequately.

A good agreement was achieved between the simulated and historical records for both of the calibration events at the continuous recording stream gauge at Rickertt Road. At the MHGs, the simulated peak levels were generally within the acceptable tolerance of ± 0.3 m.

Utilising the adopted parameters from the calibration process, the verification was undertaken. Similar to the calibration results, the verification achieved a good agreement between the simulated and historical records for both of the verification events.

Given the results of the calibration and verification process were quite reasonable, the RAFTS and TUFLOW models would be considered acceptable for use in estimation of the design flood levels.

Design and extreme flood magnitudes were estimated for the full range of events from 2-yr ARI to PMF. These analyses assumed ultimate catchment development conditions in accordance with the current version of BCC City Plan.

Three waterway scenarios were considered as follows: Scenario 1 is based on the current waterway conditions. No further modifications were made to the TUFLOW model developed as part of the calibration / verification phase. Scenario 2 includes an allowance for a riparian corridor along the edge of the channel. Scenario 3 includes an allowance for the riparian corridor (as per Scenario 2) and also assumes filling to the WC boundary to simulate potential development outside the WC.

The results from the TUFLOW modelling were used to produce the following:

- Peak flood discharges
- Critical storm durations at selected locations
- Peak flood levels
- Peak flood extent mapping
- Peak flood depth mapping
- Peak depth-velocity mapping
- Hydraulic structure flood immunity

A climate change analysis was then undertaken to determine the impacts for two planning horizons; namely 2050 and 2100. This included making allowances for increased rainfall intensity and increased mean sea level rise. This analysis was undertaken for the 100-yr, 200-yr and 500-yr ARI events.

The results from the TUFLOW modelling were used to produce the flood inundation maps.

Hydraulic Structure Reference Sheets (HSRS) for all major crossings within the TUFLOW model area were also prepared. The HSRS provide data for each hydraulic structure and include data relating to the structure description, location, hydraulic performance and history.

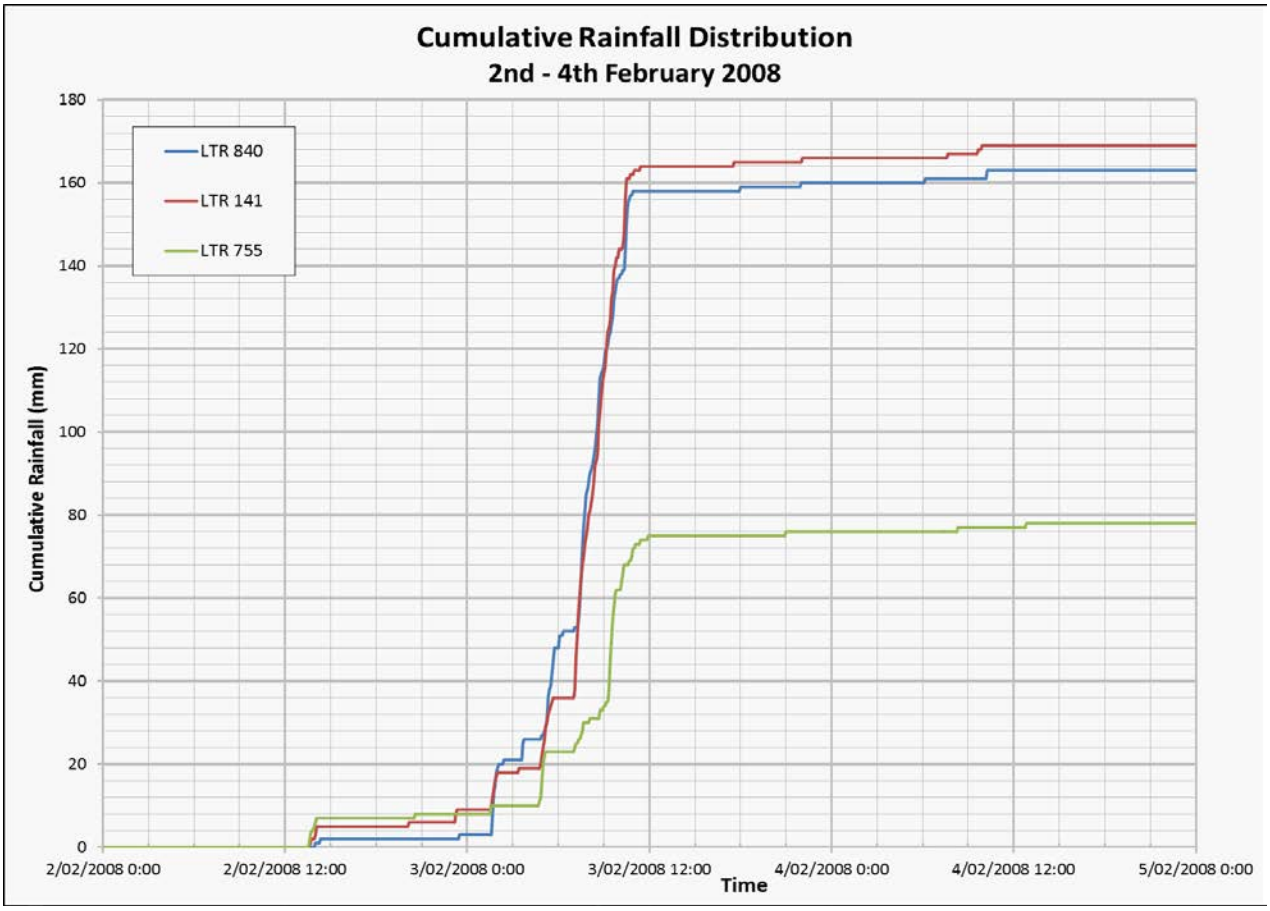
In utilising the models it is important to be aware of their limitations which can be summarised as follows:

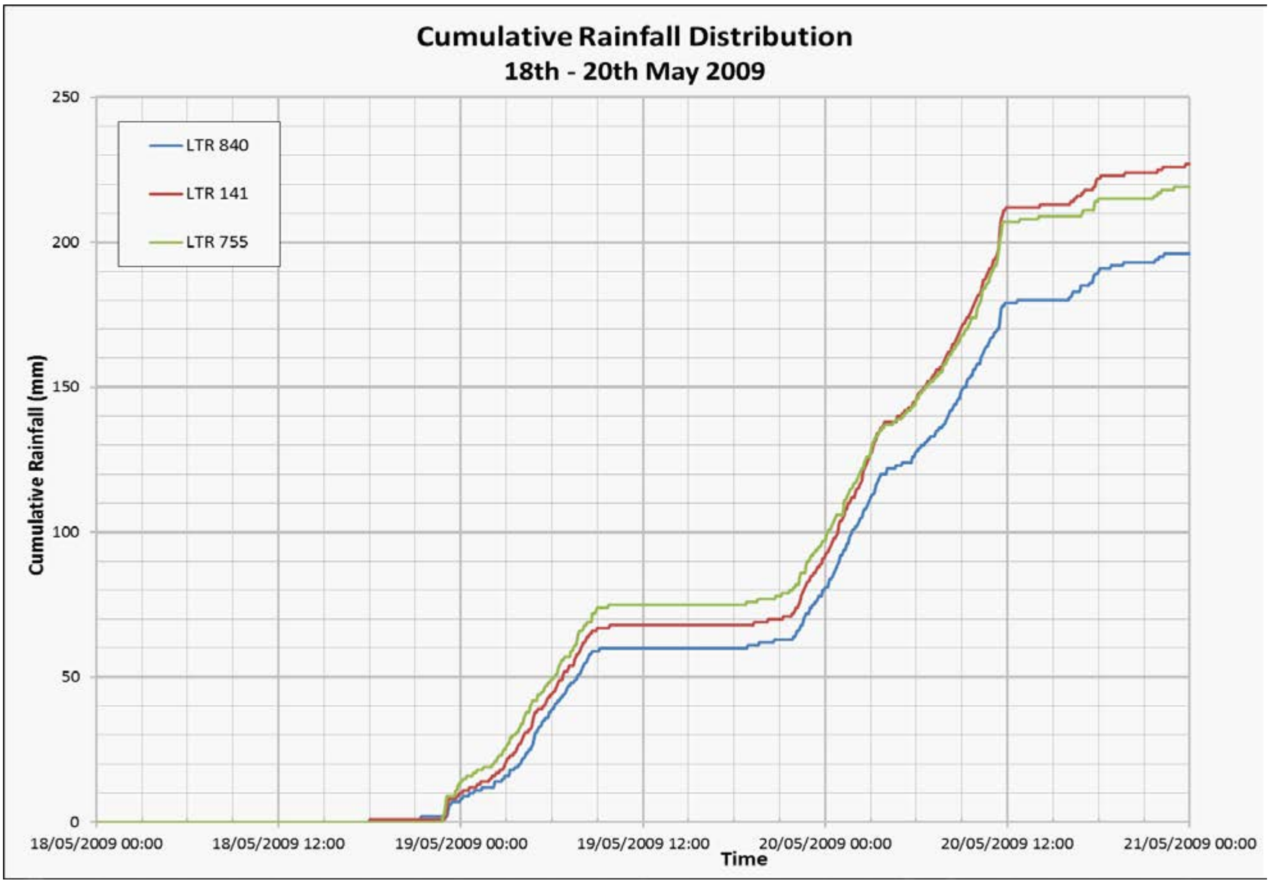
- The models have been only calibrated / verified at locations where stream gauge and MHG records exist. This should be taken into account when considering the accuracy of results outside the influence of the gauge locations.
- No calibration / verification was undertaken to survey debris marks, as there were no data available for those particular events.
- These models are catchment scale and have been developed to simulate the flooding characteristics at a broad scale. As a result, smaller more localised flooding characteristics may not be apparent in the results.
- The RAFTS and TUFLOW models must be used together to produce flooding results, as the RAFTS model has not been developed as a "standalone" model.
- BCC 2009 ALS data has been used as the basis for the TUFLOW model topography, with some minor modifications undertaken in places. Detailed checks have not been undertaken on the accuracy of the ALS data, it is assumed that the data is representative of the topography and "fit for purpose."
- The accuracy of the model results is directly linked to the following:
    - The accuracy limits of the data used to develop the model (e.g. ALS, survey information, bridge data, etc.).
    - The accuracy and quality of the hydrometric data used to calibrate / verify the models.
    - The number of historical stream gauge / MHG locations throughout the catchment.
    - The purpose of the study (i.e. catchment / broad-scale or detailed)

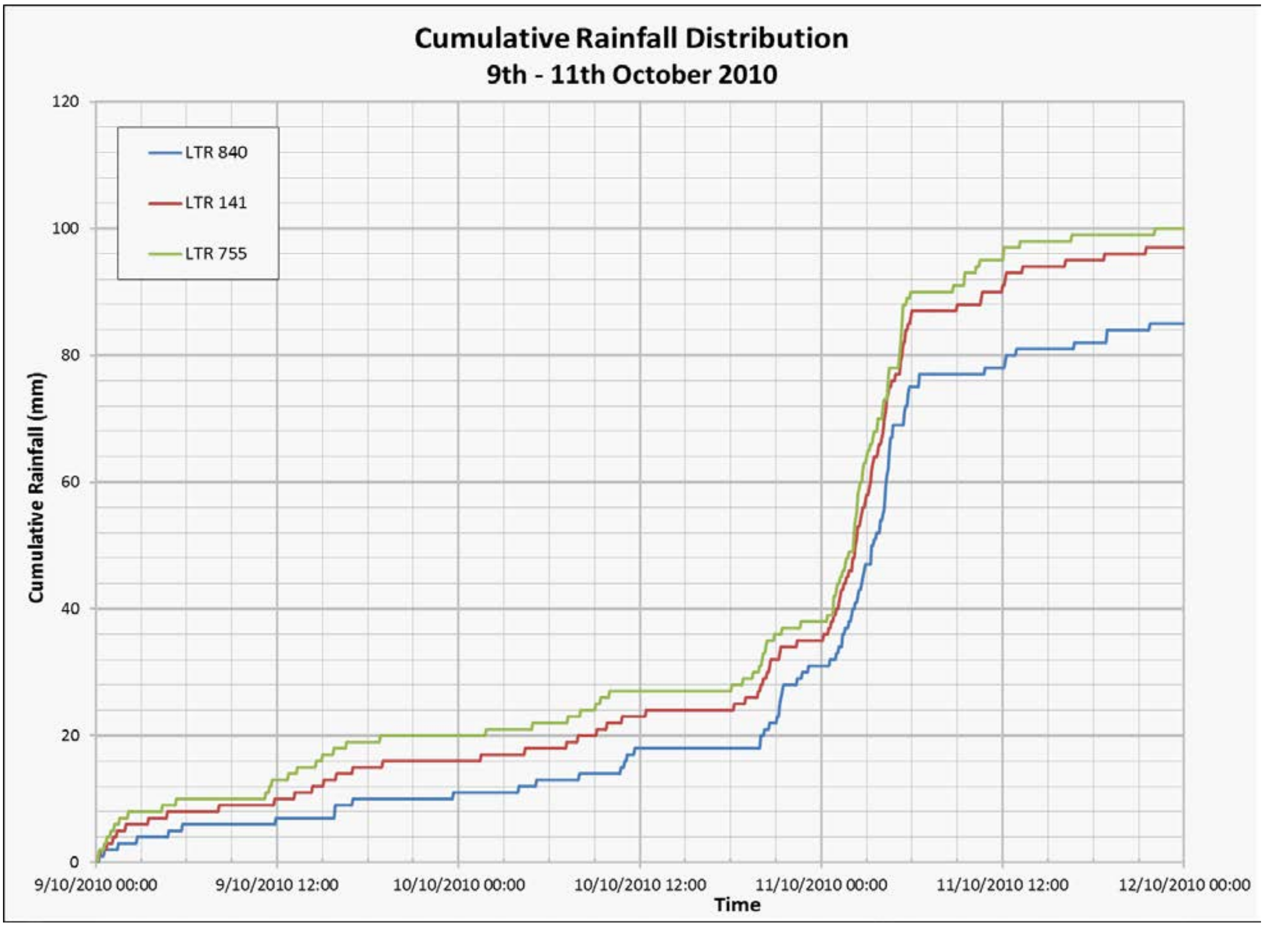
Page intentionally left blank

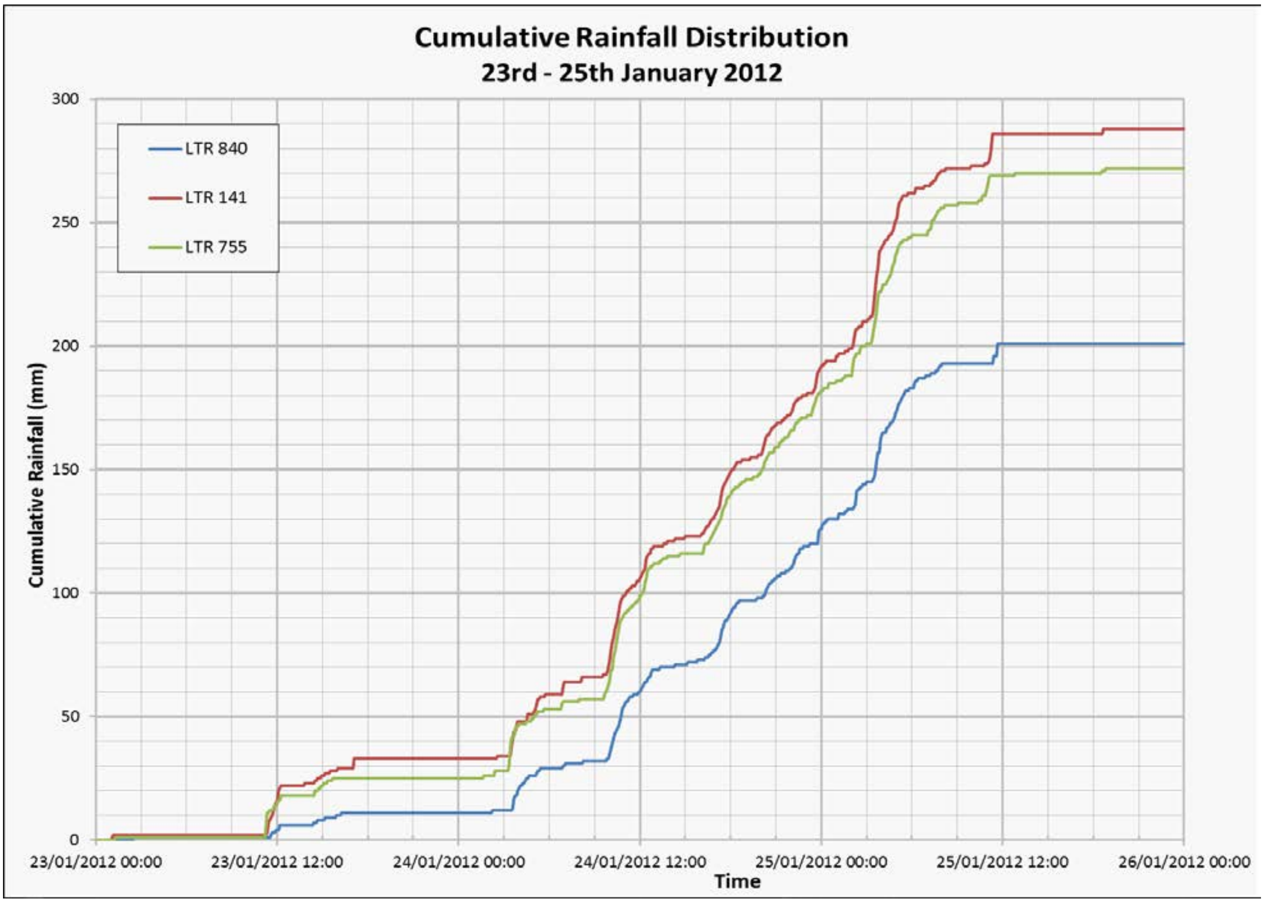
Appendix A: Cumulative Rainfall Distribution

Page intentionally left blank


Cumulative Rainfall Distribution
2nd - 4th February 2008
LTR 840
LTR 141
LTR 755
Cumulative Rainfall (mm)
180
160
140
120
100
80
60
40
20
0
2/02/2008 0:00
2/02/2008 12:00
3/02/2008 0:00
3/02/2008 12:00
4/02/2008 0:00
4/02/2008 12:00
5/02/2008 0:00
Time


Cumulative Rainfall Distribution
18th - 20th May 2009
LTR 840
LTR 141
LTR 755
Cumulative Rainfall (mm)
250
200
150
100
50
0
18/05/2009 00:00
18/05/2009 12:00
19/05/2009 00:00
19/05/2009 12:00
20/05/2009 00:00
20/05/2009 12:00
21/05/2009 00:00
Time


Cumulative Rainfall Distribution
9th - 11th October 2010
LTR 840
LTR 141
LTR 755
Cumulative Rainfall (mm)
0
20
40
60
80
100
120
9/10/2010 00:00
9/10/2010 12:00
10/10/2010 00:00
10/10/2010 12:00
11/10/2010 00:00
11/10/2010 12:00
12/10/2010 00:00
Time


Cumulative Rainfall Distribution
23rd - 25th January 2012
LTR 840
LTR 141
LTR 755
Cumulative Rainfall (mm)
0
50
100
150
200
250
300
23/01/2012 00:00
23/01/2012 12:00
24/01/2012 00:00
24/01/2012 12:00
25/01/2012 00:00
25/01/2012 12:00
26/01/2012 00:00
Time

Appendix B: RAFTS Sub-Catchment Parameters

Page intentionally left blank

RAFTS Sub-catchment Parameters for Calibration Events				
Catchment Name	Area (ha)	PERN	Percentage Impervious	Catchment Slope (%)
N9c	47.12	0.05	29.72	2.6
N9b	31.79	0.05	22.16	2.7
N9a	58.91	0.05	21.52	2
N8	81.06	0.05	20.51	0.5
N7	26.01	0.05	25.39	1.1
N6d	10.43	0.05	21.24	1.2
N6c	45.07	0.05	26.03	1.4
N6b	32.21	0.05	28.38	1.9
N6a	30.68	0.05	29.34	2.4
N5b	5.89	0.05	28.03	1.1
N5a	24.35	0.05	23.11	2.1
N4	44.41	0.05	22.84	2.1
N3	55.26	0.05	26.08	1.4
N24	14.87	0.05	25.82	1.1
N23	113.32	0.025	62.29	1.8
N22f	22.66	0.025	70.44	4.4
N22e	16.96	0.025	70.12	5
N22d	13.00	0.025	70.32	3
N22c	7.13	0.025	68.12	2.3
N22b	6.62	0.05	24.03	2.6
N22a	15.25	0.025	61.61	4.6
N21	48.97	0.05	24.40	0.8
N20	7.04	0.025	58.83	1
N2	26.10	0.05	33.13	1.9
N1b	50.57	0.05	20.32	1.6
N1a	96.73	0.05	51.40	1.6
N19	8.71	0.025	64.31	2.2
N18	95.82	0.05	19.15	1.4
N17b	59.37	0.05	14.48	1.1
N17a	47.12	0.05	22.21	1.4
N16q	2.39	0.025	52.11	2.6
N16p	1.12	0.025	7.04	0.8
N16o	1.02	0.025	43.11	6.4
N16n	11.11	0.025	63.51	4

RAFTS Sub-catchment Parameters for Calibration Events				
Catchment Name	Area (ha)	PERN	Percentage Impervious	Catchment Slope (%)
N16m	5.75	0.025	9.83	1.4
N16l	4.19	0.025	37.47	2.4
N16k	8.05	0.025	53.13	1.2
N16j	10.84	0.025	69.39	2.9
N16i	10.86	0.025	70.99	4.2
N16h	9.21	0.025	54.07	3.1
N16g	1.89	0.025	29.69	3.3
N16f	5.41	0.025	39.06	6.7
N16e	4.15	0.025	30.46	1.7
N16d	1.45	0.025	40.90	7
N16c	10.74	0.025	66.25	5
N16b	1.48	0.025	56.90	3.4
N16a	3.22	0.025	65.85	4.5
N15m	15.54	0.025	49.23	2.5
N15l	24.14	0.025	27.28	0.8
N15k	2.07	0.025	29.57	0.7
N15j	1.83	0.025	26.46	0.6
N15i	3.60	0.025	39.82	1.1
N15h	14.21	0.025	43.97	3.3
N15f	2.47	0.025	56.10	1.5
N15e	1.88	0.025	66.78	1.8
N15d	4.43	0.025	40.19	2.5
N15c	5.95	0.025	52.65	3.9
N15b	2.92	0.05	10.75	1.1
N15a	8.43	0.025	29.41	2.3
N14d	24.53	0.05	27.69	3
N14c	17.09	0.05	23.04	23
N14b	33.11	0.05	25.35	3
N14a	22.31	0.05	27.46	2.4
N13d	8.02	0.05	5.00	0.2
N13c	45.84	0.05	16.42	0.5
N13b	16.40	0.05	11.02	0.8
N13a	4.71	0.05	10.47	0.4
N12b	4.57	0.025	31.16	2.7
N12a	20.86	0.025	56.10	1.2
N11f	13.56	0.05	26.69	2

RAFTS Sub-catchment Parameters for Calibration Events				
Catchment Name	Area (ha)	PERN	Percentage Impervious	Catchment Slope (%)
N11e	66.64	0.05	14.05	0.4
N11d	19.43	0.05	17.59	0.6
N11c	18.90	0.05	24.81	0.9
N11b	19.20	0.025	42.48	1.7
N11a	36.65	0.05	27.86	3.1
N10h	6.90	0.05	52.87	1.8
N10g	5.28	0.05	49.45	2.1
N10f	8.52	0.05	24.62	1.1
N10e	28.68	0.05	37.21	1.9
N10d	3.19	0.05	35.14	1.5
N10c	23.92	0.05	24.42	0.8
N10b	16.18	0.05	24.51	2
N10a	39.37	0.05	24.19	0.9

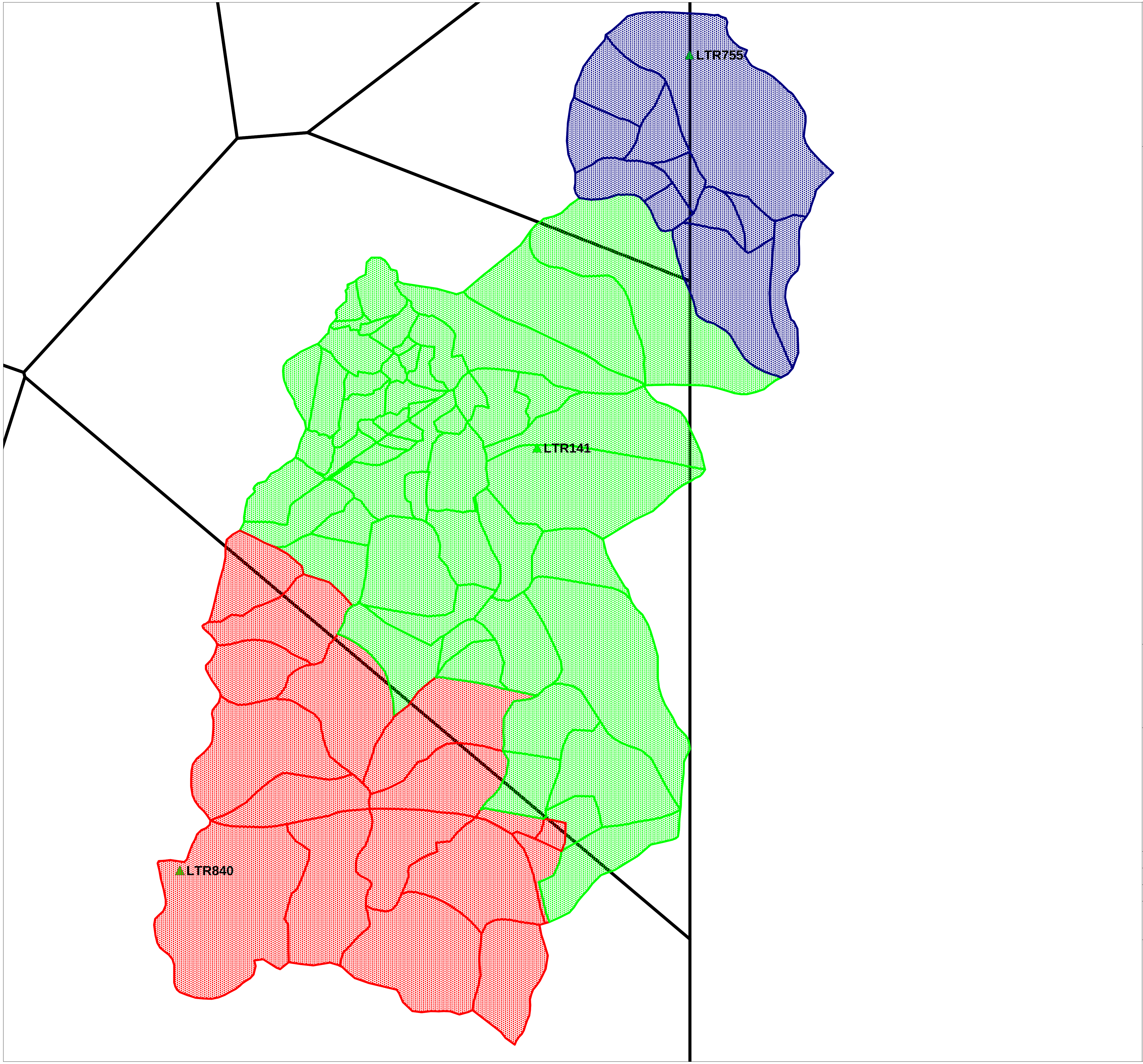
RAFTS Sub-catchment Parameters for Design and Extreme Events				
Catchment Name	Area (ha)	PERN	Percentage Impervious	Catchment Slope (%)
N9c	47.12	0.05	29.72	2.6
N9b	31.79	0.05	22.16	2.7
N9a	58.91	0.05	21.52	2
N8	81.06	0.05	20.80	0.5
N7	26.01	0.05	25.39	1.1
N6d	10.43	0.05	21.24	1.2
N6c	45.07	0.05	26.03	1.4
N6b	32.21	0.05	28.38	1.9
N6a	30.68	0.05	29.34	2.4
N5b	5.89	0.05	28.03	1.1
N5a	24.35	0.05	23.11	2.1
N4	44.41	0.05	22.84	2.1
N3	55.26	0.05	26.52	1.4
N24	14.87	0.05	26.56	1.1
N23	113.32	0.025	69.43	1.8
N22f	22.66	0.025	70.44	4.4
N22e	16.96	0.025	70.12	5
N22d	13.00	0.025	71.18	3
N22c	7.13	0.025	65.14	2.3
N22b	6.62	0.05	23.86	2.6
N22a	15.25	0.025	66.49	4.6
N21	48.97	0.05	24.78	0.8
N20	7.04	0.025	58.83	1
N2	26.10	0.05	33.13	1.9
N1b	50.57	0.05	50.85	1.6
N1a	96.73	0.05	69.65	1.6
N19	8.71	0.025	62.08	2.2
N18	95.82	0.05	23.60	1.4
N17b	59.37	0.05	23.52	1.1
N17a	47.12	0.05	22.57	1.4
N16q	2.39	0.025	69.06	2.6
N16p	1.12	0.025	70.16	0.8
N16o	1.02	0.025	68.49	6.4
N16n	11.11	0.025	65.12	4
N16m	5.75	0.025	68.22	1.4

RAFTS Sub-catchment Parameters for Design and Extreme Events				
Catchment Name	Area (ha)	PERN	Percentage Impervious	Catchment Slope (%)
N16l	4.19	0.025	69.64	2.4
N16k	8.05	0.025	72.57	1.2
N16j	10.84	0.025	74.14	2.9
N16i	10.86	0.025	71.93	4.2
N16h	9.21	0.025	76.82	3.1
N16g	1.89	0.025	68.58	3.3
N16f	5.41	0.025	69.99	6.7
N16e	4.15	0.025	69.87	1.7
N16d	1.45	0.025	71.33	7
N16c	10.74	0.025	73.25	5
N16b	1.48	0.025	72.43	3.4
N16a	3.22	0.025	70.69	4.5
N15m	15.54	0.025	68.92	2.5
N15l	24.14	0.025	62.10	0.8
N15k	2.07	0.025	66.90	0.7
N15j	1.83	0.025	71.85	0.6
N15i	3.60	0.025	73.85	1.1
N15h	14.21	0.025	74.48	3.3
N15f	2.47	0.025	67.89	1.5
N15e	1.88	0.025	70.37	1.8
N15d	4.43	0.025	72.18	2.5
N15c	5.95	0.025	71.51	3.9
N15b	2.92	0.05	10.75	1.1
N15a	8.43	0.025	71.68	2.3
N14d	24.53	0.05	38.53	3
N14c	17.09	0.05	23.72	23
N14b	33.11	0.05	25.87	3
N14a	22.31	0.05	31.92	2.4
N13d	8.02	0.05	31.39	0.2
N13c	45.84	0.05	33.08	0.5
N13b	16.40	0.05	28.79	0.8
N13a	4.71	0.05	40.13	0.4
N12b	4.57	0.025	71.02	2.7
N12a	20.86	0.025	66.39	1.2
N11f	13.56	0.05	26.69	2
N11e	66.64	0.05	17.23	0.4

RAFTS Sub-catchment Parameters for Design and Extreme Events				
Catchment Name	Area (ha)	PERN	Percentage Impervious	Catchment Slope (%)
N11d	19.43	0.05	20.38	0.6
N11c	18.90	0.05	25.89	0.9
N11b	19.20	0.025	61.11	1.7
N11a	36.65	0.05	39.02	3.1
N10h	6.90	0.05	57.50	1.8
N10g	5.28	0.05	49.45	2.1
N10f	8.52	0.05	25.04	1.1
N10e	28.68	0.05	30.59	1.9
N10d	3.19	0.05	35.14	1.5
N10c	23.92	0.05	24.42	0.8
N10b	16.18	0.05	24.51	2
N10a	39.37	0.05	26.01	0.9

Appendix C: Thiessen Polygons

Page intentionally left blank



MAILING ADDRESS:
GPO Box 1434
Brisbane Qld 4001

Green Square
South Tower
505 St. Paul's Terrace
Fortitude Valley Qld 4006

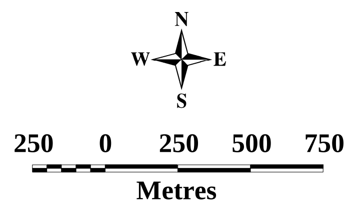
Telephone: (07) 3027 5550
Facsimile: (07) 3334 0225
E-mail: citydesign@brisbane.qld.gov.au

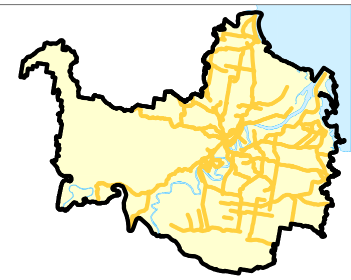
Dedicated to a better Brisbane

City Projects Office
Brisbane City Council

LEGEND

- Telemetry Gauge
- Gauge LTR141- Rainfall-Depth Gauge Application
- Gauge LTR840- Rainfall-Depth Gauge Application
- Gauge LTR755- Rainfall-Depth Gauge Application
- Thiessen Polygon





Printed 29 May 2013

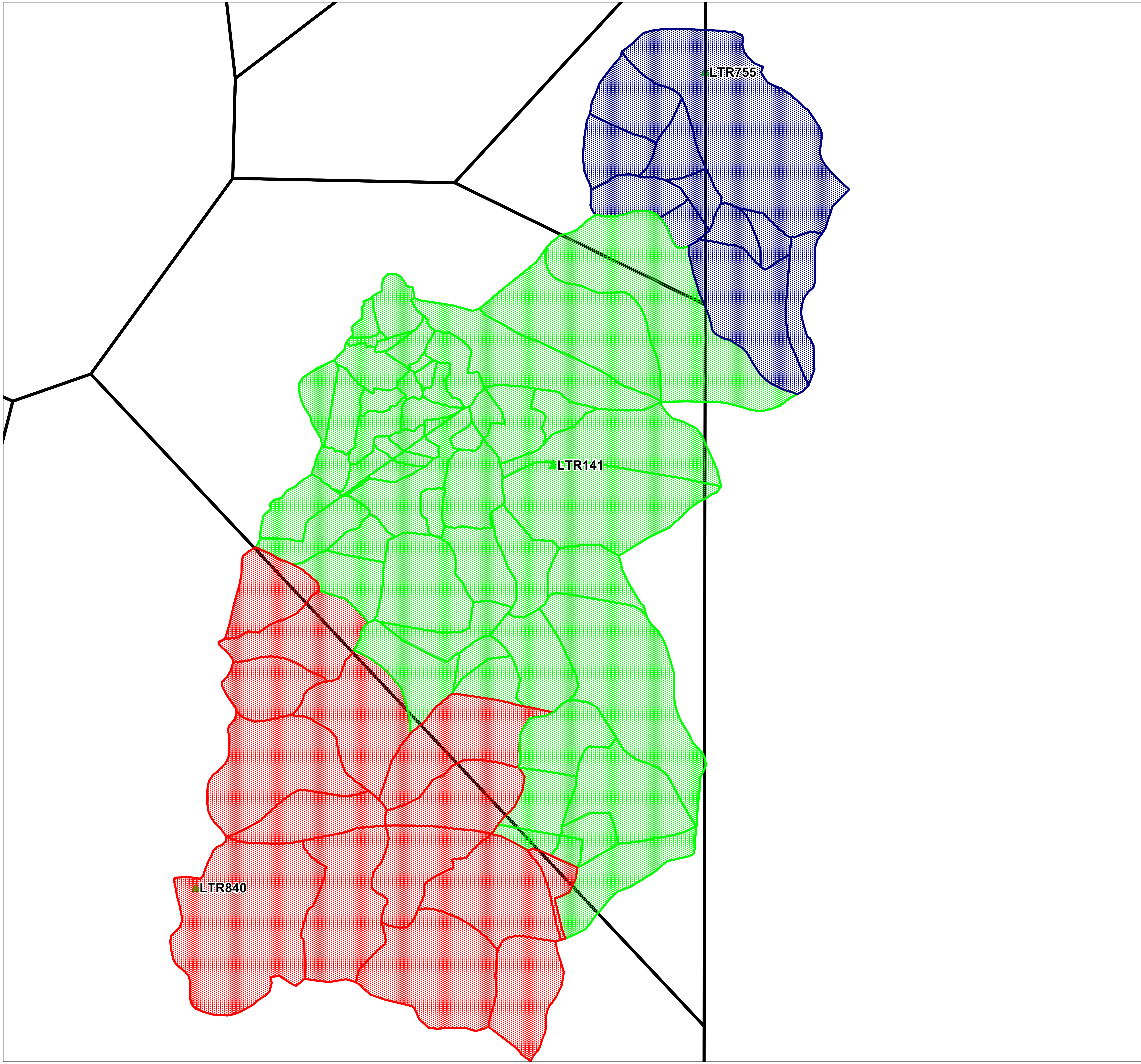
Project Number CD130866	Revision 1	Prepared HZ	Checked HZ

Workspace G:\\130866\GIS\Workspaces\Appendix C1.WOR

Project
Lota Creek Flood Study

Title
Thiessen Polygones for Feb08/May09/Oct2010

Appendix C1



MAILING ADDRESS:
GPO Box 1434
Brisbane Qld 4001

Green Square
South Tower
505 St. Paul's Terrace
Fortitude Valley Qld 4006

Telephone: (07) 3027 5550
Facsimile: (07) 3334 0225
E-mail: citydesign@brisbane.qld.gov.au

Dedicated to a better Brisbane

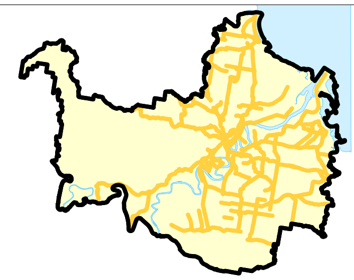
City Projects Office
Brisbane City Council

LEGEND

- Telemetry Gauge
- Thiessen Polygon
- Gauge LTR840- Rainfall-Depth Gauge Application
- Gauge LTR141- Rainfall-Depth Gauge Application
- Gauge LTR755- Rainfall-Depth Gauge Application

N
W E
S

250 0 250 500 750
Metres



Printed 29 May 2013

Project Number CD130866	Revision 1	Prepared HZ	Checked HZ

Workspace G:\\130866\GIS\Workspaces\Appendix C2.WOR

Project
Lota Creek Flood Study

Title
Thiessen Polygones for Jan12

Appendix C2

Appendix D: Structure Head-loss Comparison

Page intentionally left blank

Flow	TUFLOW Head-loss (m)	HEC-RAS Head-loss (m)	Difference (m)
Structure 1- Old Cleveland Road			
25	0.77	0.92	-0.15
50	0.98	1.33	-0.35
100	1.09	1.14	-0.05
150	0.95	1.02	-0.07
200	0.31	0.51	-0.2
300	-0.03	0.01	-0.04
Structure 5- Grassdale Road			
25	0.61	0.56	0.05
50	0.43	0.48	-0.05
100	0.4	0.59	-0.19
150	0.42	0.66	-0.24
200	0.42	0.68	-0.26
300	0.47	0.61	-0.14
Structure 8- New Cleveland Road			
25	0.33	0.59	-0.26
50	0.65	0.66	-0.01
100	0.6	0.46	0.14
150	0.53	0.31	0.22
200	0.56	0.28	0.28
300	0.62	0.22	0.4
Structure 11- Rickertt Road			
25	0.07	0.06	0.01
50	0	0	0
100	0.03	0.01	0.02
150	0.04	0	0.04
200	0.04	0.01	0.03
300	0.07	0.02	0.05

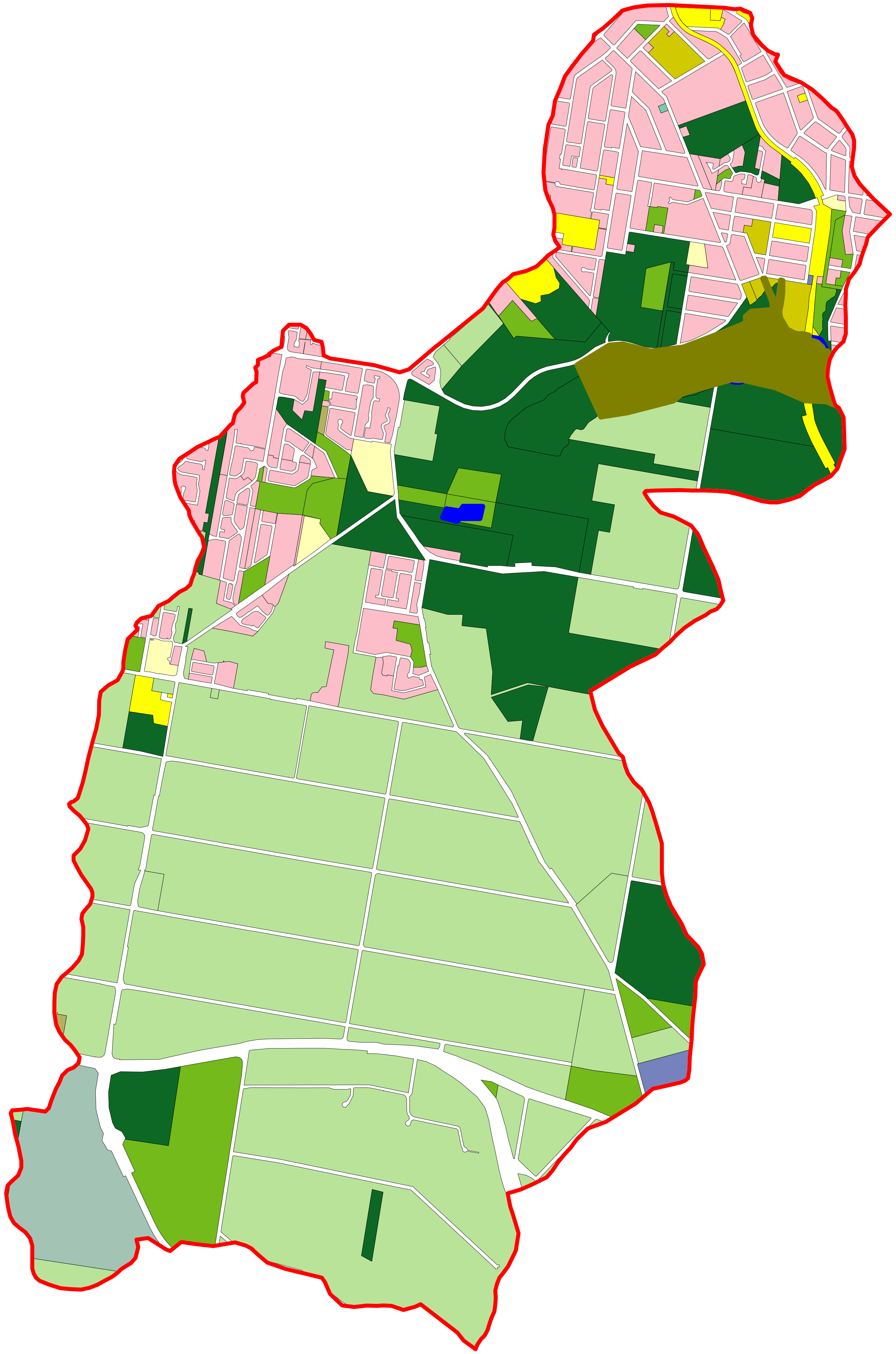
Flow	TUFLOW Head-loss (m)	HEC-RAS Head-loss (m)	Difference (m)
Structure 17&18- Bridgewater Place and Brookside Place			
25	0.12	0.08	0.04
50	0.54	0.2	0.34
100	0.74	0.75	-0.01
150	1.22	1.15	0.07
200	1.42	1.23	0.19
300	1.57	1.18	0.39
Structure 19- Alexander Street			
25	0.23	0.44	-0.21
50	0.28	0.32	-0.04
100	0.43	0.27	0.16
150	0.53	0.34	0.19
200	0.64	0.46	0.18
300	0.77	0.52	0.25
Structure 23- Bowering Street			
25	0.58	0.38	0.2
50	0.67	0.74	-0.07
100	0.73	0.92	-0.19
150	0.7	1.01	-0.31
200	0.69	1.04	-0.35
300	0.62	0.87	-0.25
Structure 25- Bowering Street			
25	0.17	0.01	0.16
50	0.19	0.02	0.17
100	0.12	0.01	0.11
150	0.16	0.02	0.14
200	0.17	0.02	0.15
300	0.18	0.03	0.15

Flow	TUFLOW Head-loss (m)	HEC-RAS Head-loss (m)	Difference (m)
Structure 30- New Cleveland Road			
25	0.51	0.57	-0.06
50	0.5	0.18	0.32
100	0.45	0.35	0.1
150	0.4	0.43	-0.03
200	0.29	0.49	-0.2
300	0.19	0.5	-0.31
Structure 43- Old Cleveland Road			
25	1.41	1.38	0.03
50	1.56	1.57	-0.01
100	1.66	1.84	-0.18
150	1.71	1.87	-0.16
200	1.66	1.9	-0.24
300	1.45	1.83	-0.38

Page intentionally left blank

Appendix E: Land-Use Maps

Page intentionally left blank



MAILING ADDRESS:
GPO Box 1434
Brisbane Qld 4001

Green Square
South Tower
505 St. Paul's Terrace
Fortitude Valley Qld 4006

Telephone: (07) 3027 5550
Facsimile: (07) 3334 0225
E-mail: citydesign@brisbane.qld.gov.au

Dedicated to a better Brisbane

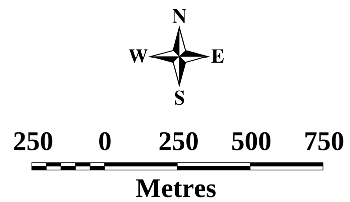
City Projects Office
Brisbane City Council

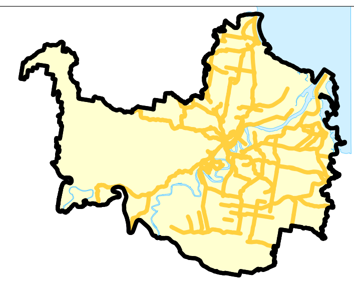
LEGEND

Lota Creek Catchment Boundary

Landuse Map Legend

- Open Water
- Mangroves
- Conservation
- Sport and Recreation
- Emerging Commiunities
- Low Density Residential
- Park Land
- Environmantal Protection
- Multi Purpose Centre/Convenience Centre
- Rural
- Special Purpose Centre
- Commiunity Use Area
- Light Industry





Printed 29 May 2013			
Project Number CD130866	Revision 1	Prepared HZ	Checked HZ
Workspace G:\\130866\GIS\Workspaces\Appendix E1.WOR			

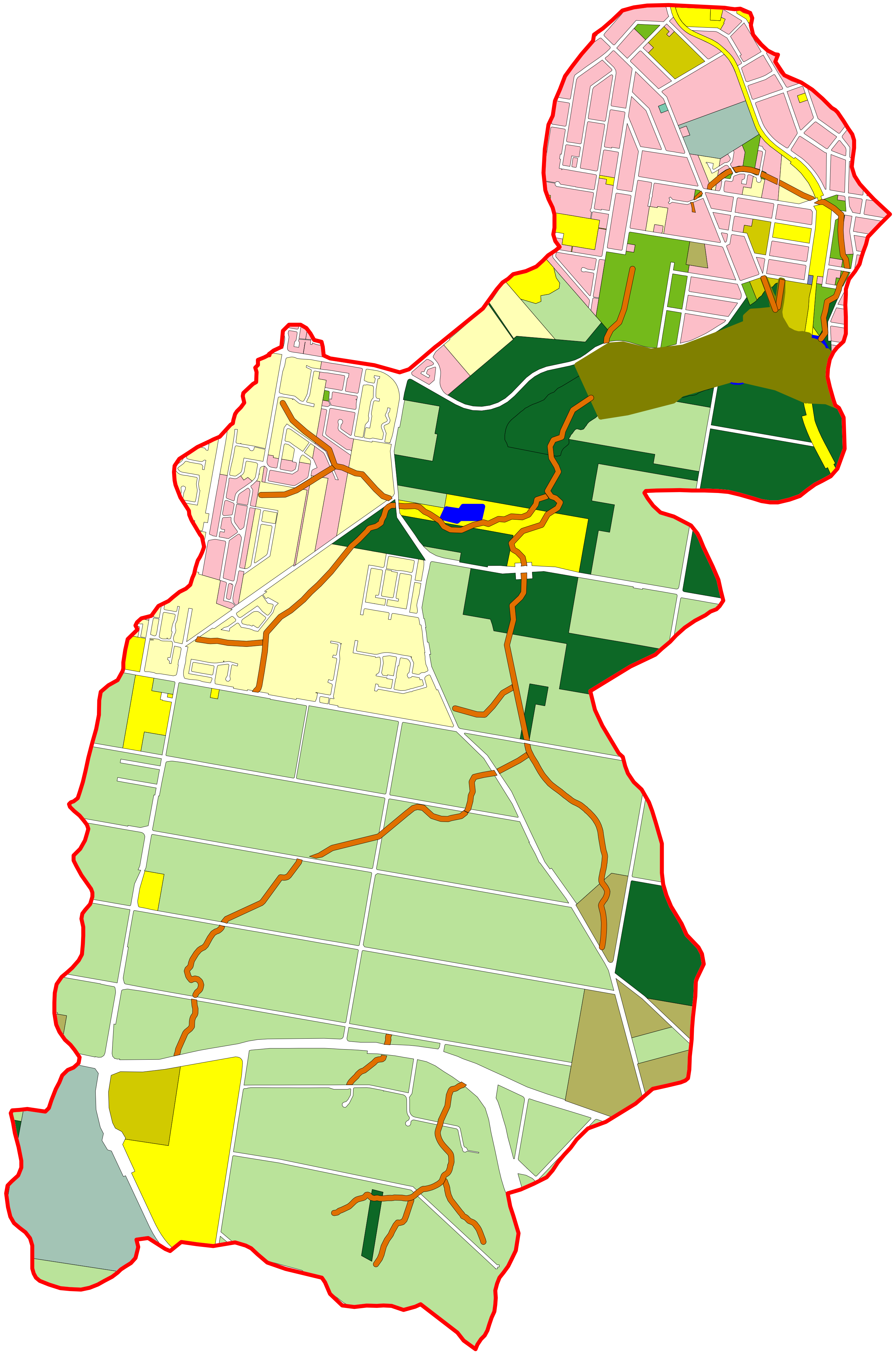
Project

Lota Creek Flood Study

Title

Exisitng Landuse Map

Appendix E1



MAILING ADDRESS:
GPO Box 1434
Brisbane Qld 4001

Green Square
South Tower
505 St. Paul's Terrace
Fortitude Valley Qld 4006

Telephone: (07) 3027 5550
Facsimile: (07) 3334 0225
E-mail: citydesign@brisbane.qld.gov.au

Dedicated to a better Brisbane

City Projects Office
Brisbane City Council

LEGEND

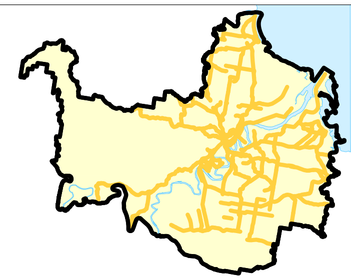
Lota Creek Catchment Boundary

Landuse Map Legend

- Open Water
- Mangroves
- Conservation
- Sport and Recreation
- Emerging Commiunities
- Low Density Residential
- Park Land
- Environmantal Protection
- Multi Purpose Centre/Convenience Centre
- Rural
- Special Purpose Centre
- Commiunity Use Area
- Light Industry
- Minimum Riparian Corridor (MRC)

N
W E
S

250 0 250 500 750
Metres



Printed 29 May 2013

Project Number CD130866 | Revision 1 | Prepared HZ | Checked HZ

Workspace G:\\130866\GIS\Workspaces\Appendix E2.WOR

Project
Lota Creek Flood Study

Title
Ultimate Landuse Map

Appendix E2

Appendix F: Design Event Peak Flood Levels

Page intentionally left blank

Creek / Channel	AMTD (m)	Design Flood Levels (Scenario 3) (m AHD)					
		2-yr ARI	5-yr ARI	10-yr ARI	20-yr ARI	50-yr ARI	100-yr ARI
Lota Creek	100	0.95	0.96	0.96	0.97	1.00	1.03
Lota Creek	200	1.00	1.09	1.17	1.27	1.41	1.52
Lota Creek	300	Null	Null	Null	Null	1.45	1.56
Lota Creek	400	1.72	2.01	2.16	2.35	2.57	2.75
Lota Creek	500	1.69	2.01	2.17	2.36	2.58	2.76
Lota Creek	600	1.70	2.03	2.19	2.39	2.62	2.79
Lota Creek	700	1.83	2.11	2.26	2.44	2.66	2.83
Lota Creek	800	1.94	2.20	2.34	2.52	2.72	2.89
Lota Creek	900	2.04	2.30	2.43	2.60	2.80	2.97
Lota Creek	1000	2.08	2.35	2.49	2.66	2.86	3.03
Lota Creek	1100	2.11	2.39	2.53	2.70	2.91	3.07
Lota Creek	1200	2.14	2.42	2.56	2.73	2.94	3.11
Lota Creek	1300	2.16	2.45	2.59	2.76	2.97	3.14
Lota Creek	1400	2.24	2.51	2.64	2.81	3.02	3.18
Lota Creek	1500	2.30	2.57	2.70	2.86	3.07	3.23
Lota Creek	1600	2.37	2.62	2.75	2.91	3.12	3.28
Lota Creek	1700	2.44	2.68	2.81	2.97	3.17	3.33
Lota Creek	1800	2.53	2.75	2.87	3.04	3.24	3.39
Lota Creek	1900	2.57	2.80	2.92	3.08	3.28	3.43
Lota Creek	2000	2.60	2.83	2.95	3.11	3.31	3.46
Lota Creek	2100	2.64	2.87	2.99	3.15	3.35	3.50
Lota Creek	2200	2.68	2.91	3.03	3.19	3.39	3.54
Lota Creek	2300	2.72	2.94	3.07	3.23	3.42	3.57
Lota Creek	2400	2.74	2.97	3.09	3.25	3.45	3.59
Lota Creek	2500	2.76	2.99	3.11	3.27	3.46	3.61
Lota Creek	2600	2.77	3.00	3.12	3.28	3.47	3.62
Lota Creek	2700	2.87	3.04	3.15	3.31	3.50	3.64
Lota Creek	2800	2.91	3.08	3.20	3.35	3.54	3.68
Lota Creek	2900	2.95	3.13	3.24	3.40	3.58	3.73
Lota Creek	3000	3.01	3.20	3.32	3.47	3.65	3.80
Lota Creek	3100	3.08	3.28	3.39	3.54	3.72	3.86
Lota Creek	3200	3.14	3.35	3.46	3.61	3.79	3.93
Lota Creek	3300	3.20	3.41	3.53	3.68	3.87	4.01
Lota Creek	3400	3.25	3.47	3.59	3.75	3.93	4.07
Lota Creek	3500	3.34	3.58	3.70	3.86	4.04	4.17

Creek / Channel	AMTD (m)	Design Flood Levels (Scenario 3) (m AHD)					
		2-yr ARI	5-yr ARI	10-yr ARI	20-yr ARI	50-yr ARI	100-yr ARI
Lota Creek	3600	3.36	3.60	3.73	3.89	4.07	4.19
Lota Creek	3700	3.43	3.66	3.79	3.94	4.11	4.24
Lota Creek	3800	3.89	4.06	4.14	4.24	4.35	4.42
Lota Creek	3900	4.41	4.55	4.63	4.73	4.85	4.95
Lota Creek	4000	4.50	4.68	4.77	4.89	5.02	5.13
Lota Creek	4100	5.18	5.45	5.58	5.73	5.91	6.04
Lota Creek	4200	5.70	5.98	6.09	6.21	6.36	6.47
Lota Creek	4300	6.19	6.47	6.59	6.72	6.86	6.97
Lota Creek	4400	6.81	7.04	7.15	7.29	7.44	7.56
Lota Creek	4500	7.15	7.36	7.46	7.59	7.74	7.86
Lota Creek	4600	7.68	7.89	7.99	8.11	8.25	8.37
Lota Creek	4700	7.92	8.16	8.26	8.40	8.55	8.67
Lota Creek	4800	8.47	8.78	8.92	9.08	9.24	9.37
Lota Creek	4900	9.11	9.39	9.51	9.67	9.84	9.97
Lota Creek	5000	9.42	9.73	9.86	10.02	10.20	10.34
Lota Creek	5100	9.94	10.14	10.23	10.36	10.51	10.63
Lota Creek	5200	10.24	10.48	10.60	10.73	10.88	11.01
Lota Creek	5300	11.03	11.34	11.47	11.62	11.79	11.93
Lota Creek	5400	11.80	12.14	12.29	12.47	12.66	12.81
Lota Creek	5500	12.51	12.83	12.97	13.16	13.35	13.52
Lota Creek	5600	13.08	13.40	13.56	13.76	13.96	14.15
Lota Creek	5700	13.53	13.87	14.03	14.22	14.42	14.60
Lota Creek	5800	13.78	14.13	14.29	14.49	14.69	14.87
Lota Creek	5900	14.01	14.35	14.51	14.71	14.91	15.09
Lota Creek	6000	14.32	14.61	14.75	14.93	15.12	15.29
Lota Creek	6100	15.80	16.00	16.08	16.18	16.27	16.35
Lota Creek	6200	16.23	16.50	16.62	16.77	16.90	17.03
Lota Creek	6300	16.54	16.82	16.95	17.11	17.25	17.39
Lota Creek	6400	17.39	17.61	17.71	17.84	17.96	18.08
Trib A	0	3.38	3.62	3.75	3.91	4.08	4.21
Trib A	100	3.39	3.63	3.76	3.92	4.10	4.24
Trib A	200	3.39	3.64	3.77	3.93	4.11	4.25
Trib A	300	3.40	3.64	3.77	3.94	4.12	4.26
Trib A	400	3.40	3.65	3.78	3.95	4.13	4.27
Trib A	500	3.41	3.66	3.79	3.95	4.14	4.28
Trib A	600	3.43	3.68	3.81	3.97	4.16	4.30

Creek / Channel	AMTD (m)	Design Flood Levels (Scenario 3) (m AHD)					
		2-yr ARI	5-yr ARI	10-yr ARI	20-yr ARI	50-yr ARI	100-yr ARI
Trib A	700	3.96	4.13	4.23	4.37	4.52	4.63
Trib A	800	4.32	4.55	4.66	4.79	4.96	5.07
Trib A	900	5.00	5.25	5.35	5.46	5.58	5.67
Trib A	1000	5.40	5.66	5.78	5.91	6.06	6.17
Trib A	1100	6.62	6.68	6.71	6.74	6.78	6.82
Trib A	1200	Null	Null	7.48	7.50	7.51	7.52
Trib A	1700	11.60	11.62	11.63	11.64	11.65	11.66
Trib A	1800	12.74	12.75	12.76	12.77	12.78	12.79
Trib A	1900	13.25	13.29	13.30	13.31	13.32	13.33
Trib A	2000	Null	13.98	13.99	14.01	14.04	14.07
Trib A	2100	14.92	15.00	15.02	15.04	15.06	15.08
Trib A	2200	16.28	16.28	16.28	16.29	16.30	16.31
Trib A	2300	17.34	17.62	17.74	17.91	18.10	18.25
Trib A	2400	17.38	17.67	17.80	17.97	18.16	18.32
Trib A	2500	17.93	18.09	18.15	18.23	18.34	18.45
Trib A	2600	18.43	18.59	18.67	18.77	18.88	18.97
Trib A	2700	18.83	18.99	19.06	19.16	19.26	19.35
Trib A	2800	19.84	20.00	20.08	20.17	20.26	20.34
Trib A	2900	20.74	20.84	20.88	20.94	21.00	21.05
Trib A	3000	21.97	22.09	22.14	22.21	22.27	22.33
Trib A	3100	Null	Null	Null	Null	23.00	23.07
Trib B	0	2.68	2.91	3.03	3.19	3.39	3.54
Trib B	600	3.97	4.23	4.37	4.55	4.77	4.95
Trib B	700	4.03	4.30	4.44	4.62	4.86	5.05
Trib B	800	4.13	4.39	4.53	4.72	4.96	5.13
Trib B	900	4.56	4.77	4.87	5.01	5.17	5.31
Trib B	1000	5.03	5.21	5.29	5.39	5.51	5.62
Trib B	1100	5.56	5.67	5.73	5.81	5.91	5.99
Trib B	1200	6.61	6.69	6.73	6.79	6.85	6.89
Trib B	1300	6.97	7.07	7.12	7.19	7.26	7.32
Trib B	1400	7.77	7.88	7.93	8.00	8.07	8.12
Trib B	1500	8.47	8.58	8.63	8.70	8.77	8.83
Trib B	1600	9.02	9.12	9.17	9.25	9.33	9.40
Trib B	1700	9.69	9.83	9.89	9.97	10.05	10.13
Trib B	1800	10.22	10.36	10.42	10.50	10.59	10.66
Trib B	1900	10.94	11.04	11.09	11.16	11.23	11.29

Creek / Channel	AMTD (m)	Design Flood Levels (Scenario 3) (m AHD)					
		2-yr ARI	5-yr ARI	10-yr ARI	20-yr ARI	50-yr ARI	100-yr ARI
Trib B	2000	11.66	11.81	11.88	11.97	12.07	12.15
Trib B	2100	12.69	12.80	12.87	12.95	13.05	13.12
Trib B	2200	13.13	13.25	13.30	13.37	13.44	13.50
Trib B	2300	13.89	13.98	14.02	14.09	14.14	14.18
Trib B	2400	14.44	14.52	14.56	14.62	14.69	14.74
Trib B	2500	15.14	15.20	15.24	15.29	15.33	15.38
Trib B	2600	16.22	16.25	16.27	16.30	16.31	16.32
Trib B	2700	17.25	17.35	17.38	17.42	17.46	17.50
Trib B	2800	18.23	18.30	18.33	18.37	18.40	18.43
Trib B	2900	19.48	19.54	19.57	19.60	19.63	19.65
Trib B	3000	20.96	21.04	21.07	21.11	21.14	21.18
Trib B	3100	22.72	22.78	22.81	22.84	22.87	22.90
Trib C	0	5.46	5.71	5.83	5.96	6.11	6.22
Trib C	100	6.04	6.27	6.37	6.48	6.61	6.71
Trib C	200	6.87	6.92	6.95	7.01	7.09	7.15
Trib C	300	7.52	7.60	7.62	7.70	7.76	7.80
Trib C	400	7.82	7.87	7.91	7.96	8.02	8.07
Trib C	500	8.40	8.47	8.50	8.55	8.61	8.65
Trib C	600	8.68	8.73	8.75	8.80	8.85	8.89
Trib C	700	9.00	9.06	9.09	9.14	9.19	9.23
Trib C	800	9.09	9.17	9.20	9.25	9.30	9.34
Trib C	900	9.30	9.36	9.38	9.40	9.43	9.45
Trib D	0	20.09	20.24	20.31	20.40	20.49	20.57
Trib D	100	20.69	20.81	20.86	20.92	20.99	21.05
Trib E	0	Null	Null	Null	1.30	1.44	1.56
Trib E	100	Null	Null	Null	Null	1.90	2.01
Trib E	200	1.70	1.77	1.82	1.90	2.07	2.23
Trib E	300	2.51	2.65	2.73	2.83	3.00	3.12
Trib E	400	2.59	2.75	2.83	2.93	3.10	3.22
Trib F	0	3.20	3.41	3.53	3.68	3.87	4.01
Trib F	100	3.21	3.42	3.54	3.70	3.88	4.02
Trib F	200	3.21	3.43	3.54	3.70	3.88	4.02
Trib F	300	3.21	3.43	3.54	3.70	3.88	4.03
Trib F	400	3.46	3.59	3.65	3.71	3.89	4.03
Trib F	500	4.06	4.15	4.19	4.24	4.29	4.35
Trib F	600	4.44	4.53	4.57	4.62	4.66	4.70

Creek / Channel	AMTD (m)	Design Flood Levels (Scenario 3) (m AHD)					
		2-yr ARI	5-yr ARI	10-yr ARI	20-yr ARI	50-yr ARI	100-yr ARI
Trib F	700	5.36	5.42	5.45	5.48	5.50	5.53
Trib F	800	5.57	5.65	5.68	5.72	5.76	5.80
Trib G	0	6.06	6.34	6.45	6.57	6.71	6.81
Trib G	100	6.15	6.42	6.53	6.65	6.79	6.89
Trib G	300	8.61	8.66	8.68	8.70	8.73	8.75
Trib G	400	Null	Null	Null	Null	9.10	9.12
Trib G	500	10.13	10.18	10.20	10.22	10.24	10.27
Trib G	600	Null	Null	Null	11.25	11.27	11.29
Trib G	700	12.37	12.43	12.45	12.48	12.49	12.51
Trib G	800	13.57	13.63	13.65	13.67	13.69	13.71
Trib G	900	14.41	14.45	14.47	14.48	14.49	14.51
Trib G	1000	Null	Null	15.62	15.63	15.63	15.66
Trib G	1100	17.48	17.54	17.56	17.58	17.58	17.61
Trib G	1200	19.38	19.41	19.43	19.46	19.46	19.49
Trib G	1300	21.30	21.32	21.33	21.34	21.35	21.36
Trib G	1400	Null	Null	Null	Null	23.37	23.63
Trib J	0	10.06	10.20	10.27	10.35	10.44	10.51
Trib J	100	10.95	11.01	11.04	11.06	11.09	11.13
Trib J	200	12.20	12.27	12.29	12.31	12.33	12.36
Trib J	300	13.94	13.98	14.01	14.02	14.06	14.09
Trib J	400	Null	16.22	16.24	16.26	16.27	16.29
Trib K	0	14.67	14.75	14.79	14.85	14.90	14.94
Trib L	0	4.08	4.35	4.50	4.69	4.96	5.15
Trib L	100	4.17	4.40	4.54	4.73	4.97	5.13
Trib L	200	5.16	5.33	5.40	5.47	5.55	5.63
Trib L	300	6.16	6.31	6.39	6.49	6.58	6.67
Trib L	400	7.05	7.23	7.32	7.42	7.52	7.61
Trib L	600	9.44	9.59	9.65	9.75	9.81	9.87
Trib L	700	10.98	11.07	11.13	11.19	11.23	11.28
Trib L	800	12.19	12.28	12.32	12.37	12.40	12.45

Creek / Channel	AMTD (m)	Design Flood Levels (Scenario 1) (m AHD)					
		2-yr ARI	5-yr ARI	10-yr ARI	20-yr ARI	50-yr ARI	100-yr ARI
Lota Creek	100	0.95	0.96	0.96	0.97	0.99	1.01
Lota Creek	200	1.00	1.09	1.15	1.24	1.37	1.46
Lota Creek	300	Null	Null	Null	Null	1.40	1.50
Lota Creek	400	1.72	1.99	2.13	2.30	2.50	2.65
Lota Creek	500	1.69	1.99	2.13	2.30	2.51	2.66
Lota Creek	600	1.70	2.01	2.16	2.33	2.54	2.69
Lota Creek	700	1.84	2.09	2.22	2.39	2.59	2.73
Lota Creek	800	1.95	2.19	2.31	2.47	2.65	2.80
Lota Creek	900	2.04	2.28	2.40	2.55	2.73	2.87
Lota Creek	1000	2.09	2.34	2.46	2.61	2.79	2.93
Lota Creek	1100	2.12	2.38	2.50	2.65	2.84	2.98
Lota Creek	1200	2.14	2.40	2.53	2.69	2.87	3.01
Lota Creek	1300	2.17	2.43	2.56	2.72	2.90	3.04
Lota Creek	1400	2.24	2.49	2.61	2.77	2.95	3.09
Lota Creek	1500	2.30	2.55	2.67	2.82	3.00	3.14
Lota Creek	1600	2.37	2.60	2.72	2.87	3.05	3.18
Lota Creek	1700	2.42	2.65	2.77	2.91	3.09	3.22
Lota Creek	1800	2.50	2.71	2.82	2.96	3.14	3.26
Lota Creek	1900	2.55	2.76	2.86	3.00	3.17	3.30
Lota Creek	2000	2.58	2.79	2.89	3.03	3.20	3.32
Lota Creek	2100	2.62	2.82	2.93	3.06	3.23	3.35
Lota Creek	2200	2.66	2.86	2.96	3.09	3.26	3.38
Lota Creek	2300	2.69	2.89	2.99	3.12	3.28	3.40
Lota Creek	2400	2.70	2.90	3.00	3.13	3.29	3.41
Lota Creek	2500	2.71	2.91	3.01	3.14	3.30	3.42
Lota Creek	2600	2.72	2.92	3.02	3.15	3.31	3.42
Lota Creek	2700	2.81	2.97	3.06	3.19	3.34	3.46
Lota Creek	2800	2.86	3.03	3.13	3.26	3.41	3.52
Lota Creek	2900	2.90	3.09	3.19	3.33	3.49	3.61
Lota Creek	3000	2.97	3.19	3.30	3.44	3.60	3.72
Lota Creek	3100	3.04	3.26	3.37	3.51	3.67	3.79
Lota Creek	3200	3.10	3.32	3.44	3.58	3.74	3.87
Lota Creek	3300	3.15	3.37	3.49	3.64	3.80	3.93
Lota Creek	3400	3.20	3.42	3.54	3.69	3.86	3.98
Lota Creek	3500	3.32	3.54	3.66	3.81	3.98	4.10

Creek / Channel	AMTD (m)	Design Flood Levels (Scenario 1) (m AHD)					
		2-yr ARI	5-yr ARI	10-yr ARI	20-yr ARI	50-yr ARI	100-yr ARI
Lota Creek	3600	3.34	3.57	3.69	3.84	4.01	4.13
Lota Creek	3700	3.38	3.61	3.73	3.88	4.05	4.17
Lota Creek	3800	3.79	3.92	3.99	4.06	4.16	4.26
Lota Creek	3900	4.42	4.53	4.59	4.65	4.73	4.78
Lota Creek	4000	4.47	4.60	4.67	4.74	4.83	4.88
Lota Creek	4100	4.88	5.10	5.19	5.30	5.40	5.46
Lota Creek	4200	5.31	5.52	5.62	5.75	5.87	5.95
Lota Creek	4300	5.81	6.04	6.14	6.27	6.39	6.47
Lota Creek	4400	6.61	6.76	6.82	6.89	6.95	7.00
Lota Creek	4500	6.97	7.13	7.20	7.27	7.35	7.40
Lota Creek	4600	7.50	7.66	7.73	7.81	7.89	7.96
Lota Creek	4700	7.72	7.90	7.98	8.08	8.18	8.25
Lota Creek	4800	8.12	8.36	8.47	8.61	8.74	8.84
Lota Creek	4900	8.80	9.00	9.10	9.21	9.31	9.40
Lota Creek	5000	9.10	9.33	9.43	9.57	9.70	9.80
Lota Creek	5100	9.87	9.99	10.06	10.15	10.25	10.34
Lota Creek	5200	10.11	10.28	10.40	10.51	10.63	10.74
Lota Creek	5300	10.62	10.85	10.98	11.15	11.30	11.42
Lota Creek	5400	11.41	11.63	11.80	11.95	12.10	12.23
Lota Creek	5500	12.08	12.30	12.43	12.57	12.70	12.82
Lota Creek	5600	12.67	12.85	12.95	13.07	13.23	13.33
Lota Creek	5700	13.15	13.37	13.51	13.66	13.82	13.94
Lota Creek	5800	13.38	13.60	13.72	13.87	14.02	14.15
Lota Creek	5900	13.59	13.82	13.94	14.10	14.26	14.39
Lota Creek	6000	14.20	14.41	14.51	14.62	14.75	14.82
Lota Creek	6100	15.45	15.56	15.63	15.71	15.79	15.85
Lota Creek	6200	15.80	15.92	15.99	16.08	16.16	16.23
Lota Creek	6300	16.17	16.31	16.39	16.49	16.59	16.67
Lota Creek	6400	16.90	16.99	17.05	17.13	17.20	17.26
Trib A	0	3.36	3.59	3.71	3.86	4.03	4.15
Trib A	100	3.37	3.60	3.72	3.87	4.04	4.17
Trib A	200	3.37	3.61	3.73	3.88	4.05	4.17
Trib A	300	3.37	3.61	3.73	3.88	4.06	4.18
Trib A	400	3.38	3.62	3.74	3.89	4.06	4.19
Trib A	500	3.39	3.63	3.75	3.90	4.07	4.20
Trib A	600	3.41	3.64	3.77	3.91	4.09	4.22

Creek / Channel	AMTD (m)	Design Flood Levels (Scenario 1) (m AHD)					
		2-yr ARI	5-yr ARI	10-yr ARI	20-yr ARI	50-yr ARI	100-yr ARI
Trib A	700	3.84	3.98	4.05	4.17	4.32	4.42
Trib A	800	4.13	4.31	4.41	4.55	4.70	4.82
Trib A	900	4.67	4.86	4.98	5.16	5.32	5.43
Trib A	1000	4.96	5.13	5.23	5.39	5.55	5.65
Trib A	1100	6.39	6.43	6.44	6.46	6.50	6.52
Trib A	1200	Null	7.48	7.49	7.50	7.52	7.53
Trib A	1700	11.60	11.62	11.63	11.64	11.66	11.67
Trib A	1800	12.74	12.75	12.76	12.77	12.78	12.79
Trib A	1900	13.26	13.29	13.30	13.31	13.32	13.34
Trib A	2000	Null	13.98	13.99	14.01	14.04	14.07
Trib A	2100	14.97	15.01	15.03	15.05	15.08	15.11
Trib A	2200	16.27	16.28	16.28	16.29	16.30	16.31
Trib A	2300	16.57	16.73	16.78	16.88	17.03	17.20
Trib A	2400	16.78	16.92	16.98	17.07	17.18	17.30
Trib A	2500	17.70	17.88	17.95	18.02	18.10	18.15
Trib A	2600	18.20	18.39	18.45	18.53	18.61	18.67
Trib A	2700	18.66	18.78	18.84	18.90	18.97	19.03
Trib A	2800	19.65	19.78	19.82	19.88	19.94	19.98
Trib A	2900	20.64	20.70	20.73	20.76	20.80	20.83
Trib A	3000	21.84	21.94	21.98	22.03	22.08	22.12
Trib A	3100	Null	Null	Null	Null	Null	Null
Trib B	0	2.66	2.86	2.96	3.09	3.26	3.38
Trib B	600	3.40	3.57	3.64	3.72	3.80	3.86
Trib B	700	3.41	3.58	3.66	3.74	3.83	3.90
Trib B	800	3.78	3.95	4.04	4.14	4.23	4.30
Trib B	900	4.32	4.53	4.62	4.72	4.80	4.86
Trib B	1000	4.82	5.02	5.10	5.20	5.29	5.36
Trib B	1100	5.44	5.55	5.60	5.67	5.75	5.81
Trib B	1200	6.57	6.62	6.65	6.68	6.72	6.75
Trib B	1300	6.92	6.98	7.01	7.06	7.11	7.15
Trib B	1400	7.71	7.79	7.83	7.87	7.92	7.96
Trib B	1500	8.44	8.53	8.58	8.64	8.70	8.74
Trib B	1600	8.97	9.08	9.12	9.18	9.25	9.31
Trib B	1700	9.66	9.80	9.85	9.92	10.00	10.06
Trib B	1800	10.22	10.34	10.40	10.47	10.55	10.61
Trib B	1900	10.95	11.04	11.09	11.16	11.22	11.28

Creek / Channel	AMTD (m)	Design Flood Levels (Scenario 1) (m AHD)					
		2-yr ARI	5-yr ARI	10-yr ARI	20-yr ARI	50-yr ARI	100-yr ARI
Trib B	2000	11.65	11.80	11.88	11.97	12.06	12.13
Trib B	2100	12.64	12.77	12.83	12.90	12.97	13.05
Trib B	2200	13.13	13.25	13.30	13.37	13.44	13.50
Trib B	2300	13.88	13.98	14.02	14.09	14.14	14.18
Trib B	2400	14.43	14.52	14.56	14.62	14.69	14.74
Trib B	2500	15.13	15.20	15.24	15.29	15.33	15.38
Trib B	2600	16.19	16.25	16.27	16.30	16.31	16.32
Trib B	2700	17.25	17.35	17.38	17.42	17.46	17.50
Trib B	2800	18.23	18.30	18.33	18.37	18.40	18.43
Trib B	2900	19.49	19.54	19.57	19.60	19.63	19.65
Trib B	3000	20.97	21.04	21.07	21.11	21.14	21.18
Trib B	3100	22.72	22.78	22.81	22.84	22.87	22.90
Trib C	0	5.01	5.17	5.27	5.42	5.58	5.68
Trib C	100	5.61	5.79	5.87	6.02	6.15	6.24
Trib C	200	Null	6.78	6.80	6.83	6.85	6.88
Trib C	300	7.49	7.52	7.54	7.58	7.61	7.64
Trib C	400	7.85	7.90	7.94	7.99	8.03	8.07
Trib C	500	8.44	8.51	8.55	8.61	8.67	8.71
Trib C	600	8.71	8.76	8.80	8.85	8.91	8.94
Trib C	700	9.04	9.10	9.14	9.20	9.25	9.29
Trib C	800	9.12	9.19	9.23	9.29	9.36	9.40
Trib C	900	9.30	9.36	9.38	9.40	9.43	9.45
Trib D	0	19.94	20.05	20.09	20.15	20.20	20.25
Trib D	100	20.56	20.66	20.70	20.76	20.81	20.85
Trib E	0	Null	Null	Null	1.27	1.40	1.50
Trib E	100	Null	Null	Null	Null	Null	1.94
Trib E	200	1.67	1.74	1.76	1.83	1.97	2.10
Trib E	300	2.44	2.53	2.57	2.60	2.64	2.67
Trib E	400	2.49	2.59	2.63	2.67	2.71	2.74
Trib F	0	3.15	3.37	3.49	3.64	3.80	3.93
Trib F	100	3.16	3.39	3.51	3.66	3.82	3.94
Trib F	200	3.16	3.39	3.51	3.66	3.82	3.95
Trib F	300	3.16	3.39	3.51	3.66	3.83	3.95
Trib F	400	3.43	3.56	3.61	3.68	3.83	3.96
Trib F	500	4.06	4.15	4.18	4.24	4.29	4.34
Trib F	600	4.44	4.53	4.57	4.62	4.66	4.70

Creek / Channel	AMTD (m)	Design Flood Levels (Scenario 1) (m AHD)					
		2-yr ARI	5-yr ARI	10-yr ARI	20-yr ARI	50-yr ARI	100-yr ARI
Trib F	700	5.37	5.42	5.45	5.48	5.50	5.53
Trib F	800	5.57	5.65	5.68	5.72	5.76	5.80
Trib G	0	5.63	5.89	5.99	6.14	6.27	6.36
Trib G	100	5.97	6.12	6.22	6.34	6.46	6.54
Trib G	300	8.61	8.66	8.68	8.70	8.73	8.75
Trib G	400	Null	Null	Null	Null	9.10	9.12
Trib G	500	10.13	10.18	10.20	10.23	10.25	10.26
Trib G	600	Null	Null	Null	11.26	11.28	11.28
Trib G	700	12.39	12.43	12.46	12.48	12.51	12.52
Trib G	800	13.58	13.63	13.65	13.67	13.70	13.71
Trib G	900	14.41	14.45	14.47	14.49	14.51	14.51
Trib G	1000	Null	Null	15.62	15.63	15.65	15.65
Trib G	1100	17.48	17.54	17.56	17.58	17.60	17.61
Trib G	1200	19.36	19.41	19.43	19.46	19.48	19.49
Trib G	1300	21.30	21.34	21.35	21.36	21.37	21.38
Trib G	1400	Null	Null	Null	Null	Null	23.36
Trib J	0	10.05	10.17	10.23	10.30	10.38	10.44
Trib J	100	10.94	10.99	11.02	11.03	11.06	11.09
Trib J	200	12.23	12.27	12.29	12.30	12.32	12.35
Trib J	300	13.93	13.98	14.01	14.02	14.05	14.09
Trib J	400	Null	16.22	16.24	16.26	16.27	16.29
Trib K	0	14.67	14.75	14.80	14.85	14.90	14.94
Trib L	0	Null	3.76	3.87	3.99	4.10	4.17
Trib L	100	4.00	4.15	4.23	4.33	4.42	4.49
Trib L	200	5.07	5.23	5.31	5.39	5.45	5.51
Trib L	300	6.06	6.22	6.30	6.39	6.47	6.54
Trib L	400	6.90	7.05	7.12	7.20	7.27	7.33
Trib L	600	9.44	9.58	9.64	9.75	9.81	9.87
Trib L	700	10.96	11.07	11.12	11.19	11.22	11.27
Trib L	800	12.19	12.27	12.31	12.37	12.39	12.44

**Null refers to the areas which are not wet during the specified events as AMTD line is not following the low flow chan*

Appendix G: Extreme Event Peak Flood Levels

Page intentionally left blank

Creek / Channel	AMTD (m)	Design Flood Levels (m AHD)			
		Scenario 3		Scenario 1	
		200-yr ARI	500-yr ARI	2000-yr ARI	PMF
Lota Creek	100	1.08	1.12	1.26	1.87
Lota Creek	200	1.64	1.74	1.97	2.70
Lota Creek	300	1.69	1.79	2.03	2.80
Lota Creek	400	2.95	3.10	3.52	4.73
Lota Creek	500	2.96	3.12	3.53	4.75
Lota Creek	600	3.00	3.15	3.57	4.79
Lota Creek	700	3.04	3.18	3.60	4.84
Lota Creek	800	3.09	3.24	3.65	4.91
Lota Creek	900	3.16	3.31	3.72	5.02
Lota Creek	1000	3.23	3.36	3.77	5.12
Lota Creek	1100	3.28	3.41	3.82	5.19
Lota Creek	1200	3.32	3.44	3.86	5.24
Lota Creek	1300	3.36	3.48	3.89	5.29
Lota Creek	1400	3.41	3.52	3.93	5.33
Lota Creek	1500	3.47	3.58	3.97	5.38
Lota Creek	1600	3.52	3.63	4.01	5.42
Lota Creek	1700	3.57	3.68	4.04	5.44
Lota Creek	1800	3.63	3.74	4.07	5.47
Lota Creek	1900	3.68	3.78	4.09	5.49
Lota Creek	2000	3.71	3.81	4.11	5.51
Lota Creek	2100	3.75	3.85	4.13	5.52
Lota Creek	2200	3.79	3.89	4.15	5.54
Lota Creek	2300	3.83	3.93	4.17	5.55
Lota Creek	2400	3.86	3.96	4.17	5.55
Lota Creek	2500	3.87	3.97	4.18	5.55
Lota Creek	2600	3.89	3.99	4.18	5.56
Lota Creek	2700	3.92	4.01	4.21	5.57
Lota Creek	2800	3.96	4.06	4.26	5.58
Lota Creek	2900	4.01	4.11	4.35	5.60
Lota Creek	3000	4.08	4.18	4.47	5.63
Lota Creek	3100	4.14	4.24	4.53	5.64
Lota Creek	3200	4.21	4.30	4.60	5.66
Lota Creek	3300	4.28	4.37	4.65	5.68
Lota Creek	3400	4.33	4.42	4.70	5.70
Lota Creek	3500	4.41	4.50	4.76	5.73

Creek / Channel	AMTD (m)	Design Flood Levels (m AHD)			
		Scenario 3		Scenario 1	
		200-yr ARI	500-yr ARI	2000-yr ARI	PMF
Lota Creek	3600	4.44	4.53	4.79	5.75
Lota Creek	3700	4.47	4.56	4.81	5.76
Lota Creek	3800	4.55	4.63	4.83	5.77
Lota Creek	3900	5.05	5.10	5.00	5.78
Lota Creek	4000	5.24	5.31	5.11	5.80
Lota Creek	4100	6.15	6.23	5.67	6.07
Lota Creek	4200	6.58	6.65	6.17	6.53
Lota Creek	4300	7.05	7.12	6.71	7.07
Lota Creek	4400	7.59	7.65	7.14	7.41
Lota Creek	4500	7.87	7.93	7.55	7.84
Lota Creek	4600	8.37	8.42	8.14	8.48
Lota Creek	4700	8.70	8.76	8.47	8.90
Lota Creek	4800	9.41	9.48	9.10	9.55
Lota Creek	4900	10.01	10.08	9.63	10.10
Lota Creek	5000	10.38	10.46	10.08	10.62
Lota Creek	5100	10.68	10.75	10.57	11.10
Lota Creek	5200	11.06	11.13	11.00	11.58
Lota Creek	5300	11.97	12.05	11.68	12.26
Lota Creek	5400	12.79	12.87	12.52	13.16
Lota Creek	5500	13.47	13.56	13.09	13.74
Lota Creek	5600	14.09	14.18	13.60	14.21
Lota Creek	5700	14.56	14.65	14.22	14.88
Lota Creek	5800	14.84	14.94	14.44	15.16
Lota Creek	5900	15.06	15.16	14.68	15.43
Lota Creek	6000	15.26	15.35	15.01	15.60
Lota Creek	6100	16.29	16.34	15.95	16.29
Lota Creek	6200	16.96	17.03	16.35	16.76
Lota Creek	6300	17.30	17.38	16.80	17.23
Lota Creek	6400	17.98	18.04	17.36	17.74
Trib A	0	4.45	4.54	4.80	5.76
Trib A	100	4.48	4.57	4.82	5.77
Trib A	200	4.49	4.58	4.83	5.78
Trib A	300	4.49	4.59	4.83	5.78
Trib A	400	4.50	4.60	4.84	5.79
Trib A	500	4.52	4.61	4.86	5.80

Creek / Channel	AMTD (m)	Design Flood Levels (m AHD)			
		Scenario 3		Scenario 1	
		200-yr ARI	500-yr ARI	2000-yr ARI	PMF
Trib A	600	4.54	4.63	4.88	5.82
Trib A	700	4.83	4.89	5.00	5.87
Trib A	800	5.26	5.31	5.34	6.03
Trib A	900	5.82	5.87	5.78	6.29
Trib A	1000	6.35	6.41	6.07	6.54
Trib A	1100	6.84	6.88	6.64	6.90
Trib A	1200	7.53	7.54	7.56	7.64
Trib A	1700	11.67	11.68	11.72	11.81
Trib A	1800	12.80	12.80	12.83	12.92
Trib A	1900	13.35	13.36	13.40	13.53
Trib A	2000	14.08	14.10	14.15	14.27
Trib A	2100	15.12	15.15	15.19	15.46
Trib A	2200	16.31	16.32	16.31	16.52
Trib A	2300	17.92	17.98	17.89	18.88
Trib A	2400	18.05	18.12	17.91	18.90
Trib A	2500	18.42	18.46	18.32	18.98
Trib A	2600	18.99	19.04	18.82	19.21
Trib A	2700	19.34	19.39	19.18	19.56
Trib A	2800	20.34	20.39	20.10	20.41
Trib A	2900	21.06	21.09	20.92	21.17
Trib A	3000	22.35	22.38	22.23	22.49
Trib A	3100	23.10	23.14	22.99	23.28
Trib B	0	3.79	3.89	4.15	5.54
Trib B	600	5.07	5.17	4.17	5.55
Trib B	700	5.15	5.25	4.20	5.55
Trib B	800	5.21	5.32	4.66	5.56
Trib B	900	5.42	5.50	5.08	5.58
Trib B	1000	5.71	5.78	5.60	5.98
Trib B	1100	6.07	6.12	6.07	6.48
Trib B	1200	6.93	6.96	6.88	7.16
Trib B	1300	7.37	7.41	7.30	7.61
Trib B	1400	8.16	8.20	8.09	8.34
Trib B	1500	8.87	8.90	8.89	9.17
Trib B	1600	9.44	9.48	9.49	9.85
Trib B	1700	10.16	10.20	10.26	10.64

Creek / Channel	AMTD (m)	Design Flood Levels (m AHD)			
		Scenario 3		Scenario 1	
		200-yr ARI	500-yr ARI	2000-yr ARI	PMF
Trib B	1800	10.71	10.76	10.83	11.25
Trib B	1900	11.32	11.35	11.45	11.86
Trib B	2000	12.18	12.23	12.32	12.75
Trib B	2100	13.13	13.18	13.21	13.63
Trib B	2200	13.53	13.56	13.63	13.99
Trib B	2300	14.20	14.23	14.27	14.56
Trib B	2400	14.77	14.80	14.86	15.19
Trib B	2500	15.40	15.42	15.46	15.77
Trib B	2600	16.33	16.35	16.34	16.48
Trib B	2700	17.51	17.53	17.54	17.74
Trib B	2800	18.45	18.47	18.48	18.66
Trib B	2900	19.66	19.68	19.68	19.84
Trib B	3000	21.20	21.22	21.22	21.41
Trib B	3100	22.91	22.93	22.93	23.09
Trib C	0	6.39	6.46	6.09	6.55
Trib C	100	6.87	6.94	6.54	6.92
Trib C	200	7.25	7.30	7.03	7.33
Trib C	300	7.87	7.90	7.73	7.97
Trib C	400	8.17	8.20	8.21	8.51
Trib C	500	8.74	8.76	8.86	9.13
Trib C	600	8.97	9.00	9.10	9.39
Trib C	700	9.31	9.34	9.45	9.73
Trib C	800	9.43	9.46	9.59	9.90
Trib C	900	9.47	9.50	9.65	9.97
Trib D	0	20.57	20.62	20.37	20.69
Trib D	100	21.06	21.10	20.96	21.28
Trib E	0	1.69	1.79	2.03	2.80
Trib E	100	2.15	2.25	2.48	3.24
Trib E	200	2.42	2.55	2.80	3.74
Trib E	300	3.22	3.27	2.79	3.72
Trib E	400	3.31	3.38	2.86	3.66
Trib F	0	4.28	4.37	4.65	5.68
Trib F	100	4.29	4.39	4.67	5.69
Trib F	200	4.30	4.40	4.68	5.70
Trib F	300	4.30	4.40	4.69	5.70

Creek / Channel	AMTD (m)	Design Flood Levels (m AHD)			
		Scenario 3		Scenario 1	
		200-yr ARI	500-yr ARI	2000-yr ARI	PMF
Trib F	400	4.30	4.40	4.70	5.71
Trib F	500	4.37	4.41	4.76	5.74
Trib F	600	4.72	4.74	4.97	5.78
Trib F	700	5.54	5.56	5.56	5.89
Trib F	800	5.82	5.84	5.85	6.22
Trib G	0	6.91	6.98	6.60	6.96
Trib G	100	7.00	7.07	6.78	7.17
Trib G	300	8.77	8.78	8.82	9.00
Trib G	400	9.14	9.16	9.20	9.40
Trib G	500	10.28	10.28	10.32	10.45
Trib G	600	11.29	11.30	11.32	11.43
Trib G	700	12.52	12.53	12.56	12.72
Trib G	800	13.71	13.73	13.75	13.91
Trib G	900	14.52	14.53	14.54	14.68
Trib G	1000	15.66	15.66	15.68	15.83
Trib G	1100	17.61	17.62	17.64	17.79
Trib G	1200	19.49	19.50	19.52	19.67
Trib G	1300	21.36	21.37	21.39	21.48
Trib G	1400	23.68	23.74	23.77	24.10
Trib J	0	10.56	10.60	10.66	11.09
Trib J	100	11.12	11.15	11.14	11.52
Trib J	200	12.37	12.39	12.34	12.49
Trib J	300	14.11	14.13	14.07	14.23
Trib J	400	16.30	16.31	16.27	16.37
Trib K	0	14.97	14.99	15.05	15.36
Trib L	0	5.19	5.28	4.50	5.55
Trib L	100	5.23	5.34	4.79	5.57
Trib L	200	5.61	5.65	5.63	5.87
Trib L	300	6.66	6.70	6.69	6.99
Trib L	400	7.60	7.65	7.45	7.77
Trib L	600	9.90	9.94	9.92	10.22
Trib L	700	11.30	11.33	11.25	11.47
Trib L	800	12.46	12.49	12.40	12.64

Page intentionally left blank

Appendix H: Hydraulic Structure Reference Sheet (HSRS)

Page intentionally left blank

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Old Cleveland Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 A9
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 1-OldClevelandRd	AMTD (m): LOTA_6490m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 4/2140*1240 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 16.78mAHD DOWNSTREAM INVERT LEVEL: 16.65mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 18.02mAHD DOWNSTREAM OBVERT LEVEL:17.89mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):38m LENGTH OF CULVERT BARREL AT OBVERT (m):38m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: PLAN NUMBER: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS: MAIN ROADS JOB NUMBER 140-U098-23	

CREEK		Lota Creek	
LOCATION		Old Cleveland Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	81.81	18.54	1098
50	70.67	18.45	1074
20	59.13	18.34	1038
10	47.63	18.24	1013
5	39.33	18.16	988
2	27.18	17.83	760

Old Cleveland Road Crossing, facing upstream

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Boston Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 A7
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 2-Boston Rd	AMTD (m): LOTA_6185m
STRUCTURE DESCRIPTION: PIPE CULVERT	
STRUCTURE SIZE 4*600 RCP For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 14.32mAHD DOWNSTREAM INVERT LEVEL: 14.26mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 14.92mAHD DOWNSTREAM OBVERT LEVEL:14.86mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):10m LENGTH OF CULVERT BARREL AT OBVERT (m):10m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

CREEK		Lota Creek	
LOCATION		Boston Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	91.78	16.00	91
50	79.24	15.94	92
20	65.88	15.87	92
10	53.14	15.80	94
5	44.07	15.75	96
2	31.13	15.64	98


Boston Road crossing, looking downstream

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	London Road

DATE OF SURVEY:**1999 Survey**	UBD REF: Map 183 A5
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 3-London Rd	AMTD (m): LOTA_5700m

STRUCTURE DESCRIPTION: PIPE CULVERT

STRUCTURE SIZE 3*1500 RCP
For Culverts: Number of cells/pipes & sizes
For Bridges: Number of Spans and their lengths

UPSTREAM INVERT LEVEL: 10.35mAHD UPSTREAM OBVERT LEVEL: 11.85mAHD

DOWNSTREAM INVERT LEVEL: 10.35mAHD DOWNSTREAM OBVERT LEVEL:11.85mAHD
For culverts give floor level For bridges give bed level

For Culverts
LENGTH OF CULVERT BARREL AT INVERT (m):6m

LENGTH OF CULVERT BARREL AT OBVERT (m):6m

TYPE OF LINING: Concrete
(e.g. concrete, stones, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No
If yes give details ie. Plan number and/or survey book number.
Note: This section should be at the highest part of the road
eg crown, kerb, hand rails guard rails whichever is higher.

WEIR WIDTH (m):N/A LOWEST POINT OF WEIR (m AHD):N/A

(In direction of flow, ie. distance from u/s face to d/s face)

HEIGHT OF GUARDRAILS: Handrail: N/A

DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:

The following should also be provided.
Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels.
For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: PLAN NUMBER:

HAS THE STRUCTURE BEEN UPGRADED?
If yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

CREEK		Lota Creek	
LOCATION		London Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	104.39	13.97	40
50	90.39	13.84	30
20	75.03	13.69	30
10	61.46	13.54	30
5	51.56	13.40	40
2	36.91	13.18	60

London Road crossing, facing downstream

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Grassdale Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 C4
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 5-Grassdale Rd	AMTD (m): LOTA_5100m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 3/2700*1500 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 7.42mAHD DOWNSTREAM INVERT LEVEL: 7.25mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 8.92mAHD DOWNSTREAM OBVERT LEVEL: 8.75mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):12m LENGTH OF CULVERT BARREL AT OBVERT (m):12m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER: W10765

CREEK		Lota Creek	
LOCATION		Grassdale Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	115.50	10.30	211
50	99.10	10.22	216
20	82.05	10.10	219
10	67.06	9.99	221
5	56.77	9.89	204
2	40.68	9.70	170

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Archer Street

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 E4
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 6-Archer St	AMTD (m): LOTA_4665m

STRUCTURE DESCRIPTION: BOX CULVERT

STRUCTURE SIZE 3/3000*1200 RCBC
For Culverts: Number of cells/pipes & sizes
For Bridges: Number of Spans and their lengths

UPSTREAM INVERT LEVEL: 4.77mAHD

UPSTREAM OBVERT LEVEL: 5.97mAHD

DOWNSTREAM INVERT LEVEL: 4.62mAHD
For culverts give floor level

DOWNSTREAM OBVERT LEVEL: 5.82mAHD
For bridges give bed level

For Culverts
LENGTH OF CULVERT BARREL AT INVERT (m):12m

LENGTH OF CULVERT BARREL AT OBVERT (m):12m

TYPE OF LINING: Concrete
(e.g. concrete, stones, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No
If yes give details ie. Plan number and/or survey book number.
Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.

WEIR WIDTH (m):N/A

(In direction of flow, ie. distance from u/s face to d/s face)

LOWEST POINT OF WEIR (m AHD):N/A

HEIGHT OF GUARDRAILS: Handrail: N/A

DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:

The following should also be provided.
Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels.
For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE:

PLAN NUMBER: W10761

HAS THE STRUCTURE BEEN UPGRADED?
If yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

CREEK		Lota Creek	
LOCATION		Archer Street	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	116.60	8.38	140
50	100.60	8.30	140
20	83.00	8.20	130
10	67.50	8.09	120
5	57.20	8.00	110
2	40.10	7.80	90

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	New Cleveland Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 H3
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 8-New Cleveland Rd	AMTD (m): LOTA_3850m
STRUCTURE DESCRIPTION: PIPE CULVERT	
STRUCTURE SIZE 6/1500 RCP For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 1.29mAHD DOWNSTREAM INVERT LEVEL: 1.26mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 2.79mAHD DOWNSTREAM OBVERT LEVEL: 2.76mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):10m LENGTH OF CULVERT BARREL AT OBVERT (m):10m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: 1m DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER: W1351

CREEK		Lota Creek	
LOCATION		New Cleveland Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	123.30	5.26	490
50	108.20	5.25	530
20	95.70	5.16	520
10	79.80	5.11	530
5	67.10	5.04	520
2	49.70	4.94	530

Culverts at New Cleveland Road, facing upstream

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Molle Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 J2
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 9-Molle Rd	AMTD (m): LOTA_3600m
STRUCTURE DESCRIPTION: PIPE CULVERT	
STRUCTURE SIZE 1/400 RCP For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 1.528mAHD DOWNSTREAM INVERT LEVEL: 1.528mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 1.928mAHD DOWNSTREAM OBVERT LEVEL: 1.928mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):10m LENGTH OF CULVERT BARREL AT OBVERT (m):10m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: 0.5m DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

CREEK		Lota Creek	
LOCATION		Molle Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	142.84	4.17	20
50	120.34	4.06	30
20	97.84	3.88	20
10	77.94	3.73	20
5	64.54	3.62	30
2	43.64	3.37	20

Culvert at Molle Road

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Rickertt Road

DATE OF SURVEY: **1999 survey**	UBD REF: Map 163 H18
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 11	AMTD (m): LOTA_2615m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 3/8740*1350 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 1.118mAHD DOWNSTREAM INVERT LEVEL: 1.108mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 2.468mAHD DOWNSTREAM OBVERT LEVEL: 2.458mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):35m LENGTH OF CULVERT BARREL AT OBVERT (m):35m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

CREEK		Lota Creek	
LOCATION		Rickertt Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	122.63	3.32	15
50	105.14	3.21	14
20	85.92	3.15	15
10	68.94	3.15	17
5	58.39	3.15	20
2	36.58	3.19	62

Culverts at Rickertt Road, facing downstream

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Bridgewater Place

DATE OF SURVEY: **No Survey**	UBD REF: Map 163 N9
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 17-Bridgewater Pl	AMTD (m):LOTA_TribE_1570m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 10/2700*1500 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 4.42mAHD DOWNSTREAM INVERT LEVEL: 4.34mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 5.92mAHD DOWNSTREAM OBVERT LEVEL: 5.84mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):14m LENGTH OF CULVERT BARREL AT OBVERT (m):14m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: 1.1m DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: PLAN NUMBER: 1229-CO7; WP4589 HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	

CREEK		Lota Creek	
LOCATION		Bridgewater Place	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	47.02	5.90	399
50	34.62	5.90	571
20	29.23	5.86	596
10	28.13	5.76	533
5	28.35	5.82	586
2	21.04	5.58	502

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Brookside Place

DATE OF SURVEY: **No Survey**	UBD REF: Map 163 N10
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 18-Brookside Pl	AMTD (m): LOTA_TribE_1415m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 10/2700*2100 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 3.42mAHD DOWNSTREAM INVERT LEVEL: 3.32mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 5.52mAHD DOWNSTREAM OBVERT LEVEL: 5.42mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):11m LENGTH OF CULVERT BARREL AT OBVERT (m):11m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: 1.1m DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: PLAN NUMBER: 1229-CO7; WP4589 HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	

CREEK		Lota Creek	
LOCATION		Brookside Place	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	44.11	5.25	88
50	38.87	5.14	79
20	33.61	5.03	89
10	28.42	4.90	81
5	24.80	4.79	83
2	18.20	4.57	104

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Alexander Street

DATE OF SURVEY: **No Survey**	UBD REF: Map 163 P10
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 19-Hindes St	AMTD (m): LOTA_TribE_1085m

STRUCTURE DESCRIPTION: BOX CULVERT

STRUCTURE SIZE 3/2100*1200 RCBC
For Culverts: Number of cells/pipes & sizes
For Bridges: Number of Spans and their lengths

UPSTREAM INVERT LEVEL: 1mAHD
DOWNSTREAM INVERT LEVEL: 0.8mAHD
For culverts give floor level

UPSTREAM OBVERT LEVEL: 2.2mAHD
DOWNSTREAM OBVERT LEVEL: 2mAHD
For bridges give bed level

For Culverts
LENGTH OF CULVERT BARREL AT INVERT (m):16.8m

LENGTH OF CULVERT BARREL AT OBVERT (m):16.8m

TYPE OF LINING: Concrete
(e.g. concrete, stones, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No
If yes give details ie. Plan number and/or survey book number.
Note: This section should be at the highest part of the road
eg crown, kerb, hand rails guard rails whichever is higher.

WEIR WIDTH (m):N/A
(In direction of flow, ie. distance from u/s face to d/s face)

LOWEST POINT OF WEIR (m AHD):N/A

HEIGHT OF GUARDRAILS: Handrail: 1m

DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:

The following should also be provided.
Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels.
For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: PLAN NUMBER: W11296_2

HAS THE STRUCTURE BEEN UPGRADED?
If yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

CREEK		Lota Creek	
LOCATION		Hindes Street	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	40.00	3.76	256
50	34.93	3.66	252
20	29.67	3.55	269
10	24.77	3.44	273
5	21.23	3.32	259
2	14.97	3.09	243

Culverts at Alexander Street, facing upstream

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Bowering Street

DATE OF SURVEY: **No Survey**	UBD REF: Map 163 Q12
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 23-Bowering St	AMTD (m): LOTA_TribE_609m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 2/3300*1800 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 0.195mAHD DOWNSTREAM INVERT LEVEL: 0.169mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 1.995mAHD DOWNSTREAM OBVERT LEVEL:1.969mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):N/A LENGTH OF CULVERT BARREL AT OBVERT (m):N/A TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: 1.1m DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER: W6625

CREEK		Lota Creek	
LOCATION		Bowering Street	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	-29.20	3.93	500
50	-27.20	3.83	470
20	-24.70	3.64	400
10	-22.10	3.52	370
5	-19.80	3.38	320
2	15	3.05	230

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Bowering Street

DATE OF SURVEY: **No Survey**	UBD REF: Map 163 Q12
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 25-Bowering St	AMTD (m): LOTA_TribE_360m
STRUCTURE DESCRIPTION: TIMBER FOOTBRIDGE	
STRUCTURE SIZE 3spans 19.2m long timber footbridge For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: -0.74mAHD DOWNSTREAM INVERT LEVEL: -0.74mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 1.41mAHD DOWNSTREAM OBVERT LEVEL: 1.41mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):5m LENGTH OF CULVERT BARREL AT OBVERT (m):5m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE:	PLAN NUMBER:
HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	

CREEK		Lota Creek	
LOCATION		Bowering Street	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	27.54	2.73	16
50	25.95	2.70	16
20	23.74	2.66	15
10	21.60	2.62	14
5	19.55	2.58	13
2	15.05	2.48	12

Foot bridge at Bowering Street, facing upstream

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Warriewood Rd

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 F2
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 26-Warriewood Rd	AMTD (m): LOTA_TribA_3050m
STRUCTURE DESCRIPTION: PIPE CULVERT	
STRUCTURE SIZE 2/1200 RCP For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 20.44mAHD DOWNSTREAM INVERT LEVEL: 20.36mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 21.64mAHD DOWNSTREAM OBVERT LEVEL: 21.56mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):7.4m LENGTH OF CULVERT BARREL AT OBVERT (m):7.4m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER: W1858

CREEK		Lota Creek	
LOCATION		Warriewood Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	25.93	22.77	470
50	22.55	22.71	445
20	18.62	22.64	424
10	15.57	22.58	397
5	13.24	22.54	390
2	8.60	22.35	364

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Charleton Street

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 C9
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 27-Charleton St	AMTD (m): LOTA_TribA_2550m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 8/1800*750 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 16.5mAHD DOWNSTREAM INVERT LEVEL: 16.45mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 17.25mAHD DOWNSTREAM OBVERT LEVEL: 17.2mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):10m LENGTH OF CULVERT BARREL AT OBVERT (m):10m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: 1 m DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER: WP3597

CREEK		Lota Creek	
LOCATION		Charleton Street	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	40.37	18.51	272
50	34.96	18.44	272
20	28.89	18.36	262
10	23.59	18.28	248
5	20.19	18.18	228
2	12.72	18.01	246

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Moreton Bay Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 G9
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 28-1Moreton Bay Rd	AMTD (m): LOTA_TribA_2275m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 4/1800*750 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 14.68mAHD DOWNSTREAM INVERT LEVEL: 14.52mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 15.58mAHD DOWNSTREAM OBVERT LEVEL:15.42mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):N/A LENGTH OF CULVERT BARREL AT OBVERT (m):N/A TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: 1.1m DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER: MAIN ROADS

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Moreton Bay Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 G9
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID:28-2Moreton Bay Rd	AMTD (m): LOTA_TribA_2275m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 2/1800*900 RCBC For Culverts: Number of cells/pipes & size For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 14.68mAHD DOWNSTREAM INVERT LEVEL: 14.52mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 15.58mAHD DOWNSTREAM OBVERT LEVEL:15.42mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):68.5m LENGTH OF CULVERT BARREL AT OBVERT (m):68.5m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: 1.1m DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER: MAIN ROADS

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Moreton Bay Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 G9
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 28-3Moreton Bay Rd	AMTD (m): LOTA_TribA_2275m

STRUCTURE DESCRIPTION: BOX CULVERT

STRUCTURE SIZE 2/1800*900 RCBC
For Culverts: Number of cells/pipes & sizes
For Bridges: Number of Spans and their lengths

UPSTREAM INVERT LEVEL: 14.68mAHD UPSTREAM OBVERT LEVEL: 15.58mAHD

DOWNSTREAM INVERT LEVEL: 14.52mAHD DOWNSTREAM OBVERT LEVEL:15.42mAHD
For culverts give floor level For bridges give bed level

For Culverts
LENGTH OF CULVERT BARREL AT INVERT (m):68.5m

LENGTH OF CULVERT BARREL AT OBVERT (m):68.5m

TYPE OF LINING: Concrete
(e.g. concrete, stones, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No
If yes give details ie. Plan number and/or survey book number.
Note: This section should be at the highest part of the road
eg crown, kerb, hand rails guard rails whichever is higher.

WEIR WIDTH (m):N/A LOWEST POINT OF WEIR (m AHD):N/A

(In direction of flow, ie. distance from u/s face to d/s face)

HEIGHT OF GUARDRAILS: Handrail: 1.1m

DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:

The following should also be provided.
Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels.
For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: PLAN NUMBER: MAIN ROADS

HAS THE STRUCTURE BEEN UPGRADED?
If yes, explain type and date of upgrade. Include plan number and location if applicable.
ADDITIONAL COMMENTS:

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Moreton Bay Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 G9
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 28-4Moreton Bay Rd	AMTD (m): LOTA_TribA_2275m

STRUCTURE DESCRIPTION: BOX CULVERT

STRUCTURE SIZE 2/1800*750 RCBC
For Culverts: Number of cells/pipes & sizes
For Bridges: Number of Spans and their lengths

UPSTREAM INVERT LEVEL: 14.68mAHD
UPSTREAM OBVERT LEVEL: 15.58mAHD

DOWNSTREAM INVERT LEVEL: 14.52mAHD
DOWNSTREAM OBVERT LEVEL:15.42mAHD
For culverts give floor level
For bridges give bed level

For Culverts
LENGTH OF CULVERT BARREL AT INVERT (m):68.5m

LENGTH OF CULVERT BARREL AT OBVERT (m):68.5m

TYPE OF LINING: Concrete
(e.g. concrete, stones, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No
If yes give details ie. Plan number and/or survey book number.
Note: This section should be at the highest part of the road
eg crown, kerb, hand rails guard rails whichever is higher.

WEIR WIDTH (m):N/A
LOWEST POINT OF WEIR (m AHD):N/A

(In direction of flow, ie. distance from u/s face to d/s face)

HEIGHT OF GUARDRAILS: Handrail: 1.1m

DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:

The following should also be provided.
Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels.
For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE:
PLAN NUMBER: MAIN ROADS

HAS THE STRUCTURE BEEN UPGRADED?
If yes, explain type and date of upgrade. Include plan number and location if applicable.
ADDITIONAL COMMENTS:

CREEK		Lota Creek	
LOCATION		Moreton Bay Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	35.80	18.02	910
50	32.50	17.65	750
20	27.50	17.15	530
10	22.60	16.73	360
5	19.00	16.43	240
2	14.60	16.09	100

Culverts at Moreton Bay Road, facing downstream

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Old Cleveland Road Inbound

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 G9
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 29-1-inbound	AMTD (m): LOTA_TribA_2200m

STRUCTURE DESCRIPTION: BOX CULVERT

STRUCTURE SIZE 5/1800*750 RCBC
For Culverts: Number of cells/pipes & sizes
For Bridges: Number of Spans and their lengths

UPSTREAM INVERT LEVEL: 14.51mAHD
UPSTREAM OBVERT LEVEL: 15.26mAHD

DOWNSTREAM INVERT LEVEL: 14.48mAHD
For culverts give floor level
DOWNSTREAM OBVERT LEVEL:15.23mAHD
For bridges give bed level

For Culverts
LENGTH OF CULVERT BARREL AT INVERT (m): 14.8m

LENGTH OF CULVERT BARREL AT OBVERT (m):14.8m

TYPE OF LINING: Concrete
(e.g. concrete, stones, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No
If yes give details ie. Plan number and/or survey book number.
Note: This section should be at the highest part of the road
eg crown, kerb, hand rails guard rails whichever is higher.

WEIR WIDTH (m):N/A
(In direction of flow, ie. distance from u/s face to d/s face)
LOWEST POINT OF WEIR (m AHD):N/A

HEIGHT OF GUARDRAILS: Handrail: 1.1m

DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:

The following should also be provided.
Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels.
For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE:
PLAN NUMBER: Main Roads Plan

HAS THE STRUCTURE BEEN UPGRADED?
If yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

CREEK		Lota Creek	
LOCATION		Old Cleveland Road Inbound	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	50.16	16.01	1192
50	44.74	15.95	1189
20	36.56	15.86	1156
10	28.93	15.77	1085
5	21.61	15.70	1036
2	16.79	15.34	800

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Old Cleveland Road Inbound

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 G9
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 29-2-inbound	AMTD (m): LOTA_TribA_2200m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 6/1200*900 RCBC (29-2-inbound, east bound) For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 14.51mAHD DOWNSTREAM INVERT LEVEL: 14.48mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 15.41mAHD DOWNSTREAM OBVERT LEVEL:15.38mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):12m LENGTH OF CULVERT BARREL AT OBVERT (m):12m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER: Main Roads Plan

CREEK		Lota Creek	
LOCATION		Old Cleveland Road Inbound	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	50.16	16.01	1192
50	44.74	15.95	1189
20	36.56	15.86	1156
10	28.93	15.77	1085
5	21.61	15.70	1036
2	16.79	15.34	800

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Old Cleveland Road Outbound

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 H9
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 29-1-Outband	AMTD (m): LOTA_TribA_2159m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 5/1825*750 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 14.399m AHD DOWNSTREAM INVERT LEVEL: 14.35mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 15.149mAHD DOWNSTREAM OBVERT LEVEL: 15.1mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):21.9 m LENGTH OF CULVERT BARREL AT OBVERT (m): 21.9 m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: 0.5m DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER: Main Roads Plan

CREEK		Lota Creek	
LOCATION		Old Cleveland Road Outbound	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	50.16	16.01	1192
50	44.74	15.95	1189
20	36.56	15.86	1156
10	28.93	15.77	1085
5	21.61	15.70	1036
2	16.79	15.34	800

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Old Cleveland Road Outbound

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 H9
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID:29-2-Outband	AMTD (m): LOTA_TribA_2159m

STRUCTURE DESCRIPTION: BOX CULVERT

STRUCTURE SIZE 6/1200*900 RCBC
For Culverts: Number of cells/pipes & sizes
For Bridges: Number of Spans and their lengths

UPSTREAM INVERT LEVEL: 13.73mAHD
UPSTREAM OBVERT LEVEL: 14.63mAHD

DOWNSTREAM INVERT LEVEL: 13.65mAHD
For culverts give floor level
DOWNSTREAM OBVERT LEVEL: 14.55mAHD
For bridges give bed level

For Culverts
LENGTH OF CULVERT BARREL AT INVERT (m): 13.73m

LENGTH OF CULVERT BARREL AT OBVERT (m): 13.73m

TYPE OF LINING: Concrete
(e.g. concrete, stones, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No
If yes give details ie. Plan number and/or survey book number.
Note: This section should be at the highest part of the road
eg crown, kerb, hand rails guard rails whichever is higher.

WEIR WIDTH (m):N/A
(In direction of flow, ie. distance from u/s face to d/s face)

LOWEST POINT OF WEIR (m AHD):N/A

HEIGHT OF GUARDRAILS: Handrail: N/A

DESCRIPTION OF ALL HAND AND GUARD RAILS AND
HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:

The following should also be provided.
Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels.
For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE:
PLAN NUMBER: Main Roads Plan

HAS THE STRUCTURE BEEN UPGRADED?
If yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Old Cleveland Road Outbound

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 H9
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 29-3-Outband	AMTD (m): LOTA_TribA_2159m
STRUCTURE DESCRIPTION: PIPE CULVERT	
STRUCTURE SIZE 2/900 RCP For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 13.73mAHD DOWNSTREAM INVERT LEVEL: 13.65mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 14.63mAHD DOWNSTREAM OBVERT LEVEL: 14.55mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m): 13.73m LENGTH OF CULVERT BARREL AT OBVERT (m): 13.73m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER: Main Roads Plan

CREEK		Lota Creek	
LOCATION		Old Cleveland Road Outbound	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	50.16	16.01	1192
50	44.74	15.95	1189
20	36.56	15.86	1156
10	28.93	15.77	1085
5	21.61	15.70	1036
2	16.79	15.34	800

Culverts at Old Cleveland Road, facing upstream

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	London Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 H7
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 30A-London Rd	AMTD (m): LOTA_TribA_1500m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 1/1200*300 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 9.926mAHD DOWNSTREAM INVERT LEVEL: 9.897mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 10.226mAHD DOWNSTREAM OBVERT LEVEL:10.197mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):8.6m LENGTH OF CULVERT BARREL AT OBVERT (m):8.6m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

CREEK		Lota Creek	
LOCATION		838 or 831 London Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	10.77	10.25	129
50	9.17	10.23	126
20	6.75	10.23	130
10	6.11	10.20	133
5	4.78	10.19	138
2	3.31	10.18	148

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	London Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 J7
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID:30A2-London Rd	AMTD (m): LOTA_TribA_1500m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 2/1200*300 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 7.33mAHD DOWNSTREAM INVERT LEVEL: 7.293mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL:7.63mAHD DOWNSTREAM OBVERT LEVEL:7.593mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):8.7m LENGTH OF CULVERT BARREL AT OBVERT (m):8.7m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE:	PLAN NUMBER:
HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	London Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 J7
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 56	AMTD (m): LOTA_TribA_1500m
STRUCTURE DESCRIPTION: PIPE CULVERT	
STRUCTURE SIZE 2/300 RCP For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 7.98mAHD DOWNSTREAM INVERT LEVEL: 7.98mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL:8.28mAHD DOWNSTREAM OBVERT LEVEL: 8.28mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m): N/A LENGTH OF CULVERT BARREL AT OBVERT (m):N/A TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

CREEK		Lota Creek	
LOCATION		886 or 1323 London Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	50.33	7.98	37
50	43.63	7.87	36
20	34.51	7.79	35
10	26.91	7.71	35
5	22.63	7.59	34
2	16.74	7.54	32

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	New Cleveland Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 K6
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 30-1New Cleveland Rd	AMTD (m): LOTA_TribA_1150m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 2/1200*900 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 5.476mAHD DOWNSTREAM INVERT LEVEL: 5.544mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 6.376mAHD DOWNSTREAM OBVERT LEVEL:6.444mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):8.5m LENGTH OF CULVERT BARREL AT OBVERT (m):8.5m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	New Cleveland Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 K6
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 30-2New Cleveland Rd	AMTD (m): LOTA_TribA_1150m

STRUCTURE DESCRIPTION: BOX CULVERT

STRUCTURE SIZE 2/1800*1200 RCBC
For Culverts: Number of cells/pipes & sizes
For Bridges: Number of Spans and their lengths

UPSTREAM INVERT LEVEL: 5.176mAHD UPSTREAM OBVERT LEVEL: 6.376mAHD

DOWNSTREAM INVERT LEVEL: 5.244mAHD DOWNSTREAM OBVERT LEVEL:6.444mAHD
For culverts give floor level For bridges give bed level

For Culverts
LENGTH OF CULVERT BARREL AT INVERT (m):8.5m
LENGTH OF CULVERT BARREL AT OBVERT (m):8.5m
TYPE OF LINING: Concrete
(e.g. concrete, stones, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No
If yes give details ie. Plan number and/or survey book number.
Note: This section should be at the highest part of the road
eg crown, kerb, hand rails guard rails whichever is higher.

WEIR WIDTH (m):N/A LOWEST POINT OF WEIR (m AHD):N/A
(In direction of flow, ie. distance from u/s face to d/s face)

HEIGHT OF GUARDRAILS: Handrail: N/A
DESCRIPTION OF ALL HAND AND GUARD RAILS AND
HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:

The following should also be provided.
Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels.
For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: PLAN NUMBER:
HAS THE STRUCTURE BEEN UPGRADED?
If yes, explain type and date of upgrade. Include plan number and location if applicable.
ADDITIONAL COMMENTS:

CREEK		Lota Creek	
LOCATION		1237 or 1204 New Cleveland Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	73.56	7.39	343
50	62.60	7.34	331
20	50.30	7.31	329
10	39.09	7.30	327
5	32.24	7.27	316
2	24.01	7.15	272

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Grassdale Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 A4
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 32-Grassdale Rd	AMTD (m): LOTA_TribB_3080m

STRUCTURE DESCRIPTION: PIPE CULVERT

STRUCTURE SIZE 1/300 RCP
For Culverts: Number of cells/pipes & sizes
For Bridges: Number of Spans and their lengths

UPSTREAM INVERT LEVEL: 21.82mAHD UPSTREAM OBVERT LEVEL: 22.12mAHD

DOWNSTREAM INVERT LEVEL: 21.69mAHD DOWNSTREAM OBVERT LEVEL: 21.99mAHD
For culverts give floor level. For bridges give bed level

For Culverts
LENGTH OF CULVERT BARREL AT INVERT (m):15.7m

LENGTH OF CULVERT BARREL AT OBVERT (m):15.7m

TYPE OF LINING: Concrete
(e.g. concrete, stones, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No
If yes give details ie. Plan number and/or survey book number.
Note: This section should be at the highest part of the road
eg crown, kerb, hand rails guard rails whichever is higher.

WEIR WIDTH (m):N/A LOWEST POINT OF WEIR (m AHD):N/A

(In direction of flow, ie. distance from u/s face to d/s face)

HEIGHT OF GUARDRAILS: Handrail: N/A

DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:

The following should also be provided.
Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels.
For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: PLAN NUMBER:

HAS THE STRUCTURE BEEN UPGRADED?
If yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

CREEK		Lota Creek	
LOCATION		457 Grassdale Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	13.16	22.26	188
50	11.56	22.24	185
20	9.89	22.20	179
10	8.35	22.16	171
5	7.12	22.14	169
2	4.78	22.05	150

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Formosa Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 B2
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 33-1Formosa Rd	AMTD (m): LOTA_TribB_2625m
STRUCTURE DESCRIPTION: PIPE CULVERT	
STRUCTURE SIZE 1/600 RCP For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 15.82mAHD DOWNSTREAM INVERT LEVEL:15.63mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL:16.42mAHD DOWNSTREAM OBVERT LEVEL: 16.23mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):9.9m LENGTH OF CULVERT BARREL AT OBVERT (m):9.9m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER: W13079

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Formosa Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 B2
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 33-2Formosa Rd	AMTD (m): LOTA_TribB_2625m
STRUCTURE DESCRIPTION: PIPE CULVERT	
STRUCTURE SIZE 2/375 RCP For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 16.09mAHD DOWNSTREAM INVERT LEVEL: 15.98mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL:16.465mAHD DOWNSTREAM OBVERT LEVEL: 16.355mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):9.9m LENGTH OF CULVERT BARREL AT OBVERT (m):9.9m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER: W13079

CREEK		Lota Creek	
LOCATION		419 Formosa Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	12.80	16.44	395
50	11.15	16.37	360
20	9.68	16.33	349
10	8.13	16.29	342
5	6.94	16.25	332
2	4.50	16.04	185

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	New Cleveland Rd

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 B1
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 34-New Cleveland Rd	AMTD (m): LOTA_TribB_2170m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 2/1500*1200 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 10.96mAHD DOWNSTREAM INVERT LEVEL: 10.88mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 12.16mAHD DOWNSTREAM OBVERT LEVEL:12.08mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):9.9m LENGTH OF CULVERT BARREL AT OBVERT (m):9.9m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER: W4101

CREEK		Lota Creek	
LOCATION		787 New Cleveland Rd	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	44.01	13.29	360
50	37.79	13.23	372
20	30.89	13.17	388
10	25.09	13.12	412
5	20.83	13.07	431
2	13.53	13.01	475

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Green Camp Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 A1
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 35-Green Camp Rd	AMTD (m): LOTA_TribB_750m

STRUCTURE DESCRIPTION: BOX CULVERT

STRUCTURE SIZE 4/3350*1350 RCBC
For Culverts: Number of cells/pipes & sizes
For Bridges: Number of Spans and their lengths

UPSTREAM INVERT LEVEL: 1.45mAHD UPSTREAM OBVERT LEVEL: 2.8mAHD

DOWNSTREAM INVERT LEVEL: 1.4mAHD DOWNSTREAM OBVERT LEVEL: 2.75mAHD
For culverts give floor level For bridges give bed level

For Culverts
LENGTH OF CULVERT BARREL AT INVERT (m):14m

LENGTH OF CULVERT BARREL AT OBVERT (m):14m

TYPE OF LINING: Concrete
(e.g. concrete, stones, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No
If yes give details ie. Plan number and/or survey book number.
Note: This section should be at the highest part of the road
eg crown, kerb, hand rails guard rails whichever is higher.

WEIR WIDTH (m):N/A LOWEST POINT OF WEIR (m AHD):N/A

(In direction of flow, ie. distance from u/s face to d/s face)

HEIGHT OF GUARDRAILS: Handrail: 1.1m

DESCRIPTION OF ALL HAND AND GUARD RAILS AND
HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:

The following should also be provided.
Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels.
For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: PLAN NUMBER: W11968

HAS THE STRUCTURE BEEN UPGRADED?
If yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

CREEK		Lota Creek	
LOCATION		128 Green Camp Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	52.24	4.16	284
50	44.51	4.09	266
20	35.16	3.96	242
10	28.54	3.82	202
5	23.45	3.73	178
2	14.47	3.64	122

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Tilley Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 163 E17
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 36-Tilley Rd	AMTD (m): LOTA_TribL_50m

STRUCTURE DESCRIPTION: BOX CULVERT

STRUCTURE SIZE 3/3350*1350 RCBC
For Culverts: Number of cells/pipes & sizes
For Bridges: Number of Spans and their lengths

UPSTREAM INVERT LEVEL: 1.55mAHD
UPSTREAM OBVERT LEVEL: 2.9mAHD

DOWNSTREAM INVERT LEVEL: 1.5mAHD
DOWNSTREAM OBVERT LEVEL: 2.85mAHD

For culverts give floor level
For bridges give bed level

For Culverts
LENGTH OF CULVERT BARREL AT INVERT (m):12m

LENGTH OF CULVERT BARREL AT OBVERT (m):12m

TYPE OF LINING: Concrete
(e.g. concrete, stones, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No
If yes give details ie. Plan number and/or survey book number.
Note: This section should be at the highest part of the road
eg crown, kerb, hand rails guard rails whichever is higher.

WEIR WIDTH (m):N/A
LOWEST POINT OF WEIR (m AHD):N/A

(In direction of flow, ie. distance from u/s face to d/s face)

HEIGHT OF GUARDRAILS: Handrail: 1.1m

DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:

The following should also be provided.
Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels.
For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: PLAN NUMBER:

HAS THE STRUCTURE BEEN UPGRADED?
If yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

CREEK		Lota Creek	
LOCATION		115 Tilley Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	25.50	4.37	80
50	19.98	4.49	70
20	15.20	4.15	60
10	11.80	4.01	50
5	9.30	3.86	30
2	4.70	3.63	20

Culverts at Tilley Road, facing downstream

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Tilley Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 A3
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID:37-Tilley Rd	AMTD (m): LOTA_TribJ_388m
STRUCTURE DESCRIPTION: PIPE CULVERT	
STRUCTURE SIZE 1/1200 RCP For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 14.22mAHD DOWNSTREAM INVERT LEVEL: 14.01mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL:15.42mAHD DOWNSTREAM OBVERT LEVEL:15.21mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):9.9m LENGTH OF CULVERT BARREL AT OBVERT (m):9.9m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Tilley Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 A3
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 59	AMTD (m): LOTA_TribJ_388m
STRUCTURE DESCRIPTION: PIPE CULVERT	
STRUCTURE SIZE 1/450 RCP For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 6.61mAHD DOWNSTREAM INVERT LEVEL: 6.61mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL:15.94mAHD DOWNSTREAM OBVERT LEVEL:15.94mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m): 9.8m LENGTH OF CULVERT BARREL AT OBVERT (m):9.8m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

CREEK		Lota Creek	
LOCATION		256 or 233 Tilley Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	11.22	15.36	388
50	9.51	15.40	418
20	8.26	15.41	451
10	7.81	15.42	460
5	6.80	15.41	470
2	5.08	15.33	467

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Old Cleveland Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 E8
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 43-Old Cleveland Rd	AMTD (m): LOTA_TribG_1400m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 7/1200*750 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 21.65mAHD DOWNSTREAM INVERT LEVEL: 21.59mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 22.35mAHD DOWNSTREAM OBVERT LEVEL: 22.29mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):32.5m LENGTH OF CULVERT BARREL AT OBVERT (m):32.5m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: 1.1m DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER: Main Roads plan

CREEK		Lota Creek	
LOCATION		2667 Old Cleveland Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	15.78	23.10	886
50	14.98	23.01	814
20	12.96	22.83	650
10	10.81	22.64	479
5	9.29	22.53	400
2	5.93	22.35	273


Culverts at Old Cleveland Road, facing upstream

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Boston Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 E8
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 44-Boston Rd	AMTD (m): LOTA_TribG_1300m
STRUCTURE DESCRIPTION: PIPE CULVERT	
STRUCTURE SIZE 1/600 RCP For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 20.42mAHD DOWNSTREAM INVERT LEVEL: 20.23mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 21.02 mAHD DOWNSTREAM OBVERT LEVEL: 20.83 mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):9.3m LENGTH OF CULVERT BARREL AT OBVERT (m):9.3m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

CREEK		Lota Creek	
LOCATION		1900 Boston Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	15.55	21.01	159
50	14.84	20.98	144
20	12.87	20.96	151
10	10.73	20.95	158
5	9.21	20.91	163
2	5.90	20.89	194

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	London Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 G7
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 45-London Rd	AMTD (m): LOTA_TribG_845m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 2/1500*600 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 12.9mAHD DOWNSTREAM INVERT LEVEL: 12.85mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 13.5 mAHD DOWNSTREAM OBVERT LEVEL:13.45mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):12m LENGTH OF CULVERT BARREL AT OBVERT (m):12m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

CREEK		Lota Creek	
LOCATION		767 or 758 London Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	30.69	14.30	444
50	27.89	14.27	417
20	23.87	14.24	407
10	19.83	14.21	394
5	16.93	14.19	383
2	10.77	14.12	364

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Grassdale Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 F5
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 46-Grassdale Rd	AMTD (m): LOTA_TribG_364m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 1/900*300RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 7.81 mAHD DOWNSTREAM INVERT LEVEL: 7.6mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 8.11mAHD DOWNSTREAM OBVERT LEVEL: 7.9mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):9.9m LENGTH OF CULVERT BARREL AT OBVERT (m):9.9m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

CREEK		Lota Creek	
LOCATION		694 or 715 Grassdale Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	39.30	8.77	36
50	34.97	8.75	38
20	29.33	8.73	37
10	24.26	8.70	37
5	20.25	8.68	39
2	13.14	8.62	49

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Archer Street

DATE OF SURVEY: **No Survey**	UBD REF: Map183 E3
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 40-Archer St	AMTD (m): LOTA_TribF_750m
STRUCTURE DESCRIPTION: PIPE CULVERT	
STRUCTURE SIZE 3/750 RCP For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 3.86mAHD DOWNSTREAM INVERT LEVEL: 3.81mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 4.61mAHD DOWNSTREAM OBVERT LEVEL: 4.56mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):8m LENGTH OF CULVERT BARREL AT OBVERT (m):8m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

CREEK		Lota Creek	
LOCATION		933 or 945Archer Street	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	21.30	5.45	11
50	18.47	5.41	14
20	16.06	5.39	15
10	13.59	5.36	14
5	11.75	5.33	14
2	8.12	5.28	11

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	New Cleveland Road

DATE OF SURVEY: **No Survey**	UBD REF: Map 183 F2
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 41-New Cleveland Rd	AMTD (m): LOTA_TribF_480m
STRUCTURE DESCRIPTION: PIPE CULVERT	
STRUCTURE SIZE 2/900 RCP For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 2.5mAHD DOWNSTREAM INVERT LEVEL: 2.44mAHD For culverts give floor level.	UPSTREAM OBVERT LEVEL: 3.4mAHD DOWNSTREAM OBVERT LEVEL: 3.34mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):11m LENGTH OF CULVERT BARREL AT OBVERT (m):11m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

CREEK		Lota Creek	
LOCATION		972 or 985 New Cleveland Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	20.55	3.80	108
50	18.15	3.75	111
20	17.45	3.72	112
10	17.57	3.74	123
5	15.23	3.70	132
2	10.36	3.59	147

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Green Camp Road

DATE OF SURVEY: **No Survey**	UBD REF: Map183 G1
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 42-1 Green Camp Rd	AMTD (m): LOTA_TribF_400m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 5/1200*900 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 2mAHD DOWNSTREAM INVERT LEVEL: 1.8mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 2.9mAHD DOWNSTREAM OBVERT LEVEL: 2.7mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):51m LENGTH OF CULVERT BARREL AT OBVERT (m):51m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: PLAN NUMBER: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	

CREEK		Lota Creek	
LOCATION		980 or 352 Green Camp Road	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	33.30	3.97	10
50	29.20	3.84	10
20	25.15	3.68	10
10	21.23	3.67	80
5	18.20	3.71	160
2	12.20	3.67	250

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Green Camp Road

DATE OF SURVEY: **No survey**	UBD REF: Map 163 E16
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 51	AMTD (m):
STRUCTURE DESCRIPTION: PIPE CULVERT	
STRUCTURE SIZE 1/450 RCP For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 2.75mAHD DOWNSTREAM INVERT LEVEL: 2.61mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 3.2mAHD DOWNSTREAM OBVERT LEVEL: 3.06mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):10m LENGTH OF CULVERT BARREL AT OBVERT (m):10m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

CREEK		Lota Creek	
LOCATION		Green Camp Road 1	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	7.10	3.90	20
50	4.84	3.83	24
20	2.55	3.79	62
10	1.57	3.76	120
5	1.27	3.74	171
2	0.84	3.72	312

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Green Camp Road

DATE OF SURVEY: **No survey**	UBD REF: Map 163 E16
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 52	AMTD (m):
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 1/1200*900 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 3.06mAHD DOWNSTREAM INVERT LEVEL: 2.96mAHD For culverts give floor level.	UPSTREAM OBVERT LEVEL: 3.96mAHD DOWNSTREAM OBVERT LEVEL: 3.86mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):15m LENGTH OF CULVERT BARREL AT OBVERT (m):15m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

CREEK		Lota Creek	
LOCATION		Green Camp Road 2	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	0.19	3.84	0
50	0.13	3.79	0
20	0.10	3.71	0
10	0.07	3.62	0
5	0.02	3.56	0
2	0.01	3.39	0

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	New Cleveland Road

DATE OF SURVEY: **No survey**	UBD REF: Map 183 K6
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 57	AMTD (m): LOTA_TribC_250m
STRUCTURE DESCRIPTION: PIPE CULVERT	
STRUCTURE SIZE 1/450 RCP For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 6.61mAHD DOWNSTREAM INVERT LEVEL: 6.61mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 7.06mAHD DOWNSTREAM OBVERT LEVEL: 7.06mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m):10m LENGTH OF CULVERT BARREL AT OBVERT (m): 10m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: 0.5m DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	New Cleveland Road

DATE OF SURVEY: **No survey**	UBD REF: Map 183 K6
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 58	AMTD (m): LOTA_TribC_250m
STRUCTURE DESCRIPTION: BOX CULVERT	
STRUCTURE SIZE 3/1200*900 RCBC For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL: 5.92mAHD DOWNSTREAM INVERT LEVEL: 5.92mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 6.82mAHD DOWNSTREAM OBVERT LEVEL: 6.82mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m): 9.4m LENGTH OF CULVERT BARREL AT OBVERT (m): 9.4m TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: 0.5m DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	PLAN NUMBER:

CREEK		Lota Creek	
LOCATION		New Cleveland Road 1	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	73.56	7.39	343
50	62.60	7.34	331
20	50.33	7.31	329
10	39.40	7.30	327
5	33.04	7.27	316
2	24.01	7.15	272

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Watervale Parade

DATE OF SURVEY: **No survey**	UBD REF: Map 163 C16
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID: 64	AMTD (m):

STRUCTURE DESCRIPTION: BRIDGE

STRUCTURE SIZE 1 span 8m arch shape bridge
For Culverts: Number of cells/pipes & sizes
For Bridges: Number of Spans and their lengths

UPSTREAM INVERT LEVEL: 5.4mAHD
UPSTREAM OBVERT LEVEL: 6.9mAHD

DOWNSTREAM INVERT LEVEL: 5.4mAHD
For culverts give floor level
DOWNSTREAM OBVERT LEVEL: 6.9mAHD
For bridges give bed level

For Culverts
LENGTH OF CULVERT BARREL AT INVERT (m):N/A

LENGTH OF CULVERT BARREL AT OBVERT (m):N/A

TYPE OF LINING: Concrete
(e.g. concrete, stones, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No
If yes give details ie. Plan number and/or survey book number.
Note: This section should be at the highest part of the road
eg crown, kerb, hand rails guard rails whichever is higher.

WEIR WIDTH (m):N/A
(In direction of flow, ie. distance from u/s face to d/s face)

LOWEST POINT OF WEIR (m AHD):N/A

HEIGHT OF GUARDRAILS: Handrail: 1.3m

DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:

The following should also be provided.
Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels.
For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE:
PLAN NUMBER:

HAS THE STRUCTURE BEEN UPGRADED?
If yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

CREEK		Lota Creek	
LOCATION		Watervale Parade	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	16.8	8.34	500
50	14.6	8.28	500
20	12.4	8.23	510
10	10.1	8.17	520
5	8.2	8.12	530
2	4.5	8.09	590

Bridge at Watervale Parade, facing downstream

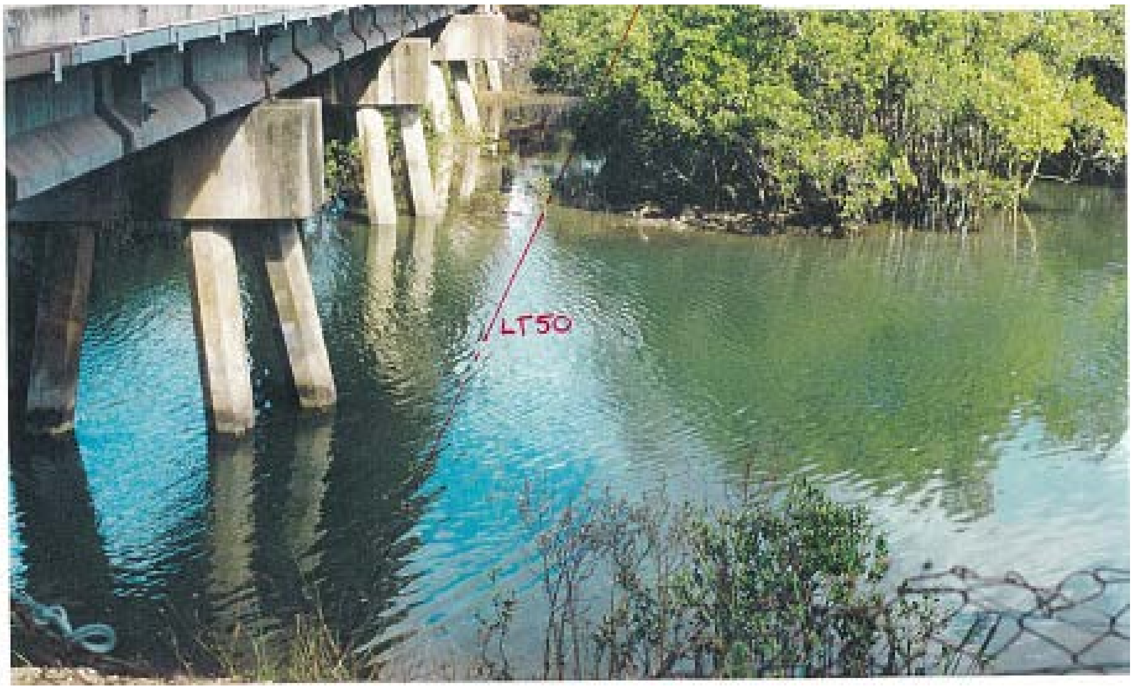
Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

HYDRAULIC STRUCTURE REFERENCE SHEET

CREEK	**Lota Creek**
LOCATION	Railway

DATE OF SURVEY: **No survey**	UBD REF: Map 163 Q13
AERIAL PHOTO No:	STRUCTURE ID: N/A
TUFLOW ID:	AMTD (m): LOTA _350m
STRUCTURE DESCRIPTION: RAILWAY BRIDGE	
STRUCTURE SIZE 5 spans with 15m long span For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths	
UPSTREAM INVERT LEVEL:-1.35mAHD DOWNSTREAM INVERT LEVEL: -1.35mAHD For culverts give floor level	UPSTREAM OBVERT LEVEL: 4.15mAHD DOWNSTREAM OBVERT LEVEL: 4.15mAHD For bridges give bed level
For Culverts LENGTH OF CULVERT BARREL AT INVERT (m): N/A LENGTH OF CULVERT BARREL AT OBVERT (m): N/A TYPE OF LINING: Concrete (e.g. concrete, stones, brick, corrugated iron)	
IS THERE A SURVEYED WEIR PROFILE? No If yes give details ie. Plan number and/or survey book number. Note: This section should be at the highest part of the road eg crown, kerb, hand rails guard rails whichever is higher.	
WEIR WIDTH (m):N/A (In direction of flow, ie. distance from u/s face to d/s face)	LOWEST POINT OF WEIR (m AHD):N/A
HEIGHT OF GUARDRAILS: Handrail: N/A DESCRIPTION OF ALL HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERSIDE OF GUARD RAILS:	
The following should also be provided. Wing wall/Headwall details, entrance details eg. Pipe flush with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specify Survey Book No.	
CONSTRUCTION DATE OF CURRENT STRUCTURE: PLAN NUMBER: HAS THE STRUCTURE BEEN UPGRADED? If yes, explain type and date of upgrade. Include plan number and location if applicable. ADDITIONAL COMMENTS:	

CREEK		Lota Creek	
LOCATION		Railway	
ARI (years)	DISCHARGE (m^3/s)	U/S WATER LEVEL (m AHD)	AFFLUX AT MAX FLOW (mm)
100	100.06	2.32	197
50	86.26	2.13	172
20	69.37	1.90	155
10	55.46	1.72	135
5	45.59	1.59	104
2	27.70	1.16	33



Railway Bridge, facing upstream

Note: Hydraulic structure reference sheet is based on the best available information from previous survey information, flood models, flood studies and site inspection. No ground survey was undertaken as part of 2013 Lota Creek Flood Study.

Page intentionally left blank

Appendix I: Hydrologic and Hydraulic Models Peer Review

Page intentionally left blank

Dedicated to a better Brisbane

MEMORANDUM

Brisbane City Council

To:	**Natural Environment Water and Sustainability Branch (NEWS)**	Date:	**27/10/2014**
Attn:	**Niloo Tara -** Project Manager, NEWS		
CC:	**Suba Subasing -** Project Owner, NEWS		
From:	**Hanieh Zolfaghari –** Hanieh Zolfaghari, Flood Mgmt **Evan Caswell** - Principal Engineer, Flood Mgmt		
Re:	**Lota Creek Hydrologic/Hydraulic Model Review**		

Planning & Design Branch
Flood Management

Green Square South Tower
505 St Pauls Tce
Fortitude Valley Qld 4006
GPO Box 1434
Brisbane Qld 4001

Phone: 07 3027 4686
Facsimile: 07 3334 0071
Email: hanieh.zolfaghari@brisbane.qld.gov.au
Internet: www.brisbane.qld.gov.au

1.0 Introduction and Background

The Flood Management team have developed XP-RAFTS hydrologic and TUFLOW hydraulic models of the Lota Creek catchment as part of the Lota Creek Flood Study. BMT WBM has provided technical advice throughout the development of the hydraulic model up to the final review of both hydrologic and hydraulic models.

A number of assumptions have been made during the development of the hydraulic and hydrologic models, of which some of the assumptions are specifically described below. Acknowledging the results of the review undertaken by BMT WBM (referred to as the “Lota Creek Flood Study Peer Review” (LCFSPR)) in this memorandum, the following clarification should be considered in conjunction with the findings of their model review. This memorandum summarises the concerns listed in the LCFSPR and provides a response based on the adopted methodology.

2.0 Hydrologic Model assumptions and clarification

LCFSPR Section 1.3 No.1.a:
Different initial losses (IL) and continuing losses (CL) were tested during the calibration process of the Lota Creek Flood Study. The initial losses and continuing losses were predominantly adopted to achieve a good calibration with the recorded historical data for the selected events within the Lota Creek catchment. The adopted losses provide the best agreement with the recorded data in terms of the timing and peak levels. It should be noted that high initial losses compensate for the lost storage within the catchment as a result of using ALS data rather than proper ground survey data which was the best available data at the time the flood study was undertaken. In general, the continuing loss value of 0mm/hr is consistent with the continuing loss values adopted in some of the other flood studies undertaken by BCC.

LCFSPR Section 1.3 No.1.d:
The adopted continuing loss value of 2mm/hr for design events is within the acceptable range in accordance with the industry standard practice. Considering the landuse within the Lota Creek catchment includes a significant amount of open space and to compensate for a portion of the IL, a CL of 2 mm/hr was adopted for the design event modelling in the hydrologic model.

3.0 Hydrologic Model assumptions and clarification

LCFSPR Section 2.1 No.6:
During the site inspection at the early stage of the flood study, it was recognised that aerial photos do not properly represent the current vegetation within the catchment in certain areas, specifically the areas downstream of Rickertt Road. The manning's n value was adopted based on the site inspection.

LCFSPR Section 2.3 No.4:
Structure 17-Bridgewater Place has been changed from 1D to 2D to avoid the instability observed within the 1D link structure.

4.0 Summary and Conclusions

The advice from LCFSPR was incorporated in the hydrologic and hydraulic models when deemed valid for the purpose of this study.

The LCFSPR states that overall, the Lota Creek XP-RAFTS/TUFLOW models appear to have been developed using sound techniques and diligent application and is suitable for the purpose of this study.

Prepared by:

Hanieh

Hanieh Zolfaghari
Hydraulic Engineer – Flood Management
Planning and Design Branch
City Projects Office, Brisbane Infrastructure

Reviewed by:

E R Caswell

Evan Caswell (CPEng RPEQ) 10498
Principal Engineer – Flood Management
Planning and Design Branch
City Projects Office, Brisbane Infrastructure

BMT WBM Pty Ltd
Level 8, 200 Creek Street
Brisbane 4000
Queensland Australia
PO Box 203 Spring Hill 4004

Tel: +61 7 3831 6744
Fax: + 61 7 3832 3627

ABN 54 010 830 421

www.bmtwbm.com.au

Our Ref: CDH: L.B20311.003.Modelling_Review_RPEQ

27 October 2014

Brisbane City Council
City Projects Office
Hanieh.Zolfaghari@brisbane.qld.gov.au

Attention: Hanieh Zolfaghari

Dear Hanieh

RE: LOTA CREEK HYDROLOGY/HYDRAULIC MODEL REVIEW

Brisbane City Council (BCC) have developed XP-RAFTS hydrologic and TUFLOW hydraulic models of the Lota Creek catchment as part of the Lota Creek Flood Study (BCC, 2013). BMT WBM have completed an audit/review of these models. The results of the review are presented below.

1 Hydrologic Model Review

The Lota Creek hydrologic model review has been completed following assessment of the following datasets which were supplied by BCC:

1. RAFTS model input and output files:
    a. Calibration Event: Cal_Feb08_Rev017.xp; and
    b. Design Event: Q100_90min_Ultimate_Rev03.xp
2. Lota Creek Flood Study Report 2013 – Final Draft (BCC, 2013)

It has been assumed that model parameters which have been adopted within the above listed RAFTS models also have been applied to the models which have been used to define the catchment runoff associated with the other calibration/design flood events.

The findings of the hydrologic model review are presented in this section and are structured around the following main areas of review: sub-catchment details, link details and rainfall parameters.

1.1 Sub-catchment Details

Review of the model sub-catchment details found the following:

1. The sub-catchment delineation has been completed to a sufficient scale of resolution for a regional scale flood study (83 sub-catchments).
2. The sub-catchment delineation appropriately aligns with topographic features within the catchment.
3. Sub-catchment slope and size inputs appear to have been applied correctly.

4. Spatial distribution of fraction impervious has not been reviewed. The values which have been adopted do compare to industry standard values defined within the Queensland Urban Drainage Manual (NRW, 2007)[1], shown in Figure 1-1.

Land-use Type	% Impervious
Environmental Protection	20
Rural	20
Conservation	5
Park Land	5
Low Density Residential	65
Community Use Area Education Purposes	75
Sport And Recreation	50
Emerging Communities	70
Community Use Area Railway	90
Light Industry	90
Community Use Area Community Facilities	75
Community Use Area Health Care Purposes	75
Special Purpose Centre Major Sporting Stadium	75
Multi-Purpose Centre Convenience Centre	90
Community Use Area Utility Services	75
Road	90

Lota Creek Flood Study (BCC, 2013)

Development Category	Fraction Impervious (f_i)
Central Business	1.00
Commercial, Local Business, Neighbouring Facilities, Service Industry, General Industry, Home Industry	0.90
Significant Paved Areas e.g. roads and car parks	0.90
Urban Residential – High Density	0.70 to 0.90
Urban Residential – Low Density (including roads)	0.45 to 0.85
Urban Residential – Low Density (excluding roads)	0.40 to 0.75
Rural Residential	0.10 to 0.20
Open Space & Parks etc.	0.00

QUDM (NRW, 2007)

Figure 1-1 Fraction Imperviousness Comparison

1.2 Link Details

Links have not been reviewed. Outflows from the RAFTS model are being applied to the TUFLOW hydraulic model as local flows, originating from the outlet of each of the 83 sub catchments. As such, all flood routing from the sub-catchment outlet is occurring within the hydraulic model, not within the hydrologic link channels.

This type of hydrologic /hydraulic model configuration is considered appropriate for the purposes of this study.

1.3 Rainfall Parameters

Review of the model rainfall parameters found the following:

Calibration/Verification Event Modelling

1. It appears the distribution of rainfall across the catchment has been applied appropriately, accounting for spatial variability within the recorded pluviograph datasets.

    a. The modelled initial and continuing loss assumptions which have been adopted during the model calibration do not represent industry standard values (refer to A continuing loss of 0mm/h has been adopted for all calibration/verification events. This value assumes no infiltration of rainfall occurs during an event. This assumption does not represent an industry standard value for pervious areas within a catchment.

    b. Acknowledging the above irregularities, the hydrologic/hydraulic model calibration results do match the recorded datasets relatively well. It is possible that the modelled high initial loss value is partially compensating for the low continuing loss value, though even if the total losses and therefore runoff volumes are similar it is expected that there would be differences in the runoff timing due to differences in the temporal distribution of the losses.

[1] Natural Resources and Water (2007), *Queensland Urban Drainage Manual, Volume 1*, Queensland Government.

c. A continuing loss value of 2.5mm/h has been adopted for pervious areas during the design flood event assessment. Sensitivity testing using this continuing loss value is recommended.

2. Table 1-1):

   a. The antecedent catchment conditions preceding each flood event highlight that the Lota Creek catchment was 'wet' prior to all the modelled calibration/verification periods. Based on this information, it would be expected that modelled initial losses should be low. This has not been reflected in the modelling.

   b. A continuing loss of 0mm/h has been adopted for all calibration/verification events. This value assumes no infiltration of rainfall occurs during an event. This assumption does not represent an industry standard value for pervious areas within a catchment.

   c. Acknowledging the above irregularities, the hydrologic/hydraulic model calibration results do match the recorded datasets relatively well. It is possible that the modelled high initial loss value is partially compensating for the low continuing loss value, though even if the total losses and therefore runoff volumes are similar it is expected that there would be differences in the runoff timing due to differences in the temporal distribution of the losses.

   d. A continuing loss value of 2.5mm/h has been adopted for pervious areas during the design flood event assessment. Sensitivity testing using this continuing loss value is recommended.

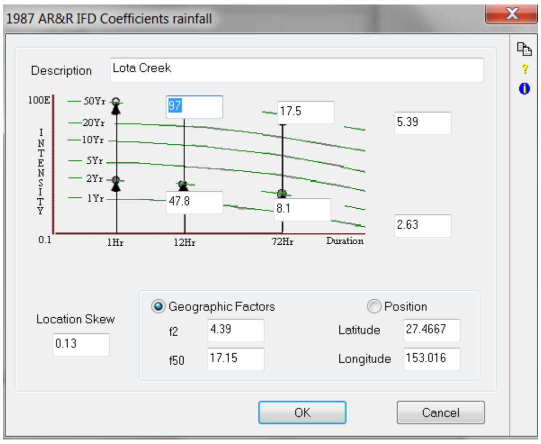
Table 1-1 Event Antecedent Conditions and Modelled Rainfall Losses

		Calibration/Verification Flood Event			
		February 2008	***May 2009***	***October 2010***	***January 2012***
Antecedent Conditions	Catchment Conditions	Wet	Wet	Wet	Wet
	4 day Antecedent Rainfall total	11mm to 51mm	82mm to 98mm	69mm to 87mm	12mm to 33mm
Modelled Losses	Initial Loss	50mm	90mm	100mm	85mm
	Continuing Loss	0mm/h	0mm/h	0mm/h	0mm/h

Design Events Event Modelling

Australian Rainfall and Runoff 1987 Intensity Frequency Duration (IFD) data has been used to define the design event rainfall within the Lota Creek catchment. The IFD parameters which have been adopted are consistent with values specified on the Bureau of Metrology IFD database[2]

[2] http://www.bom.gov.au/water/designRainfalls/ifd-arr87/index.shtml



Lota Creek Flood Study (BCC, 2013)

Location: 27.475S 153.025E Issued: 5/7/2013

Rainfall intensity in mm/h for various durations and Average Recurrence Interval

Average Recurrence Interval

Duration	1 YEAR	2 YEARS	5 YEARS	10 YEARS	20 YEARS	50 YEARS	100 YEARS
5Mins	118	151	192	216	248	292	325
6Mins	110	141	179	202	232	273	304
10Mins	89.9	116	148	167	193	227	254
20Mins	66.1	85.4	110	125	145	172	193
30Mins	53.8	69.7	90.5	103	120	142	160
1Hr	36.0	46.7	61.2	70.0	81.7	97.5	110
2Hrs	22.6	29.4	38.8	44.6	52.2	62.6	70.7
3Hrs	16.8	22.0	29.1	33.6	39.4	47.3	53.5
6Hrs	10.1	13.3	17.7	20.4	24.0	29.0	32.9
12Hrs	6.25	8.20	11.0	12.7	15.0	18.1	20.5
24Hrs	4.06	5.32	7.09	8.20	9.65	11.6	13.2
48Hrs	2.67	3.49	4.61	5.32	6.24	7.48	8.47
72Hrs	1.99	2.60	3.43	3.94	4.62	5.53	6.25

(Raw data: 47.85, 8.21, 2.63, 96.64, 17.48, 5.39, skew=0.13, F2=4.4, F50=17.24) © Australian Government, Bureau of Meteorology

BoM (2013)

Figure 1-2 Rainfall IFD Input Comparison

2 Hydraulic Model Review

The Lota Creek hydraulic model review has been completed following assessment of the following datasets which were supplied by BCC:

1. TUFLOW model input and output files:
    a. Calibration Event: Lck_Cal_Feb08_5m_022.tcf; and
    b. Design Event: Lck_Ult_5m_005_Q100_90min.tcf
2. Lota Creek Flood Study Report 2013 – Final Draft (BCC, 2013)

It has been assumed that model parameters which have been adopted within the above listed TUFLOW models have also been applied to the models which have been used to define the floodplain hydraulic behaviour associated with the other calibration/design flood events.

The findings of the hydraulic model review are presented in this section and are structured around the following main areas of review: model topography and resolution, model boundaries and model stability.

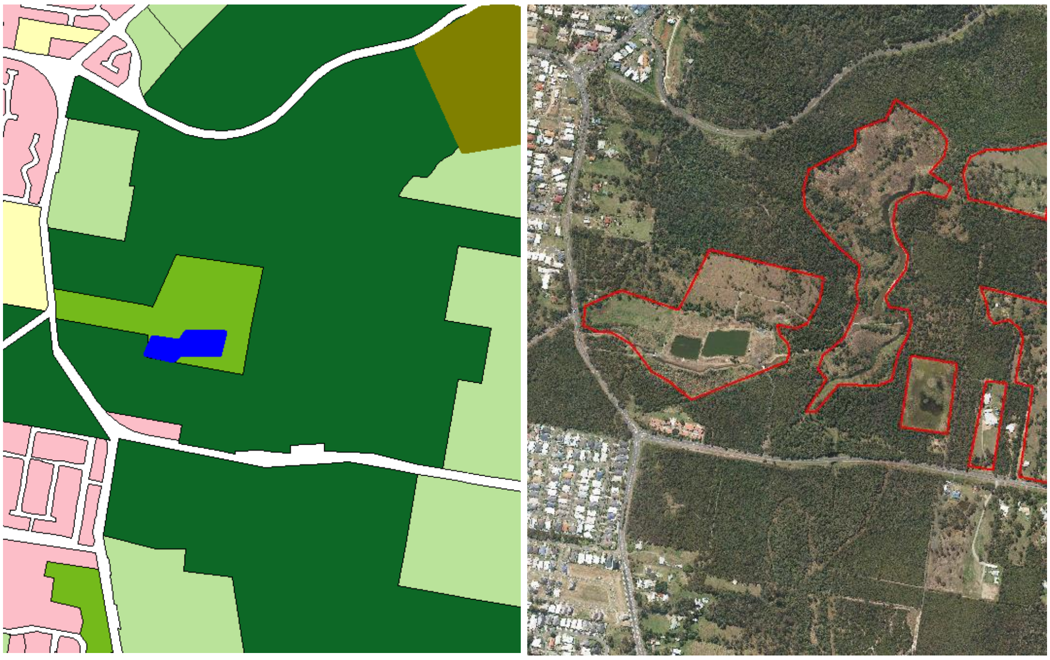
2.1 Model Topography and Resolution

Review of the TUFLOW model topography found the following:

1. The model uses a grid resolution of 5 metres which is considered to be an appropriate balance between model resolution and run times for the purpose of this study.
2. Linear features that potentially influence the flow behaviour, such as gullies and levees have appropriately been incorporated into the topography using 'breaklines' to ensure that these important features are contained within the model grid and represented in the hydraulic model.
3. Significant hydraulic structures such as culverts and bridges have been represented within the model using appropriate techniques. Large structures are represented in two-dimension (2D), whereas sub grid scale structures have been modelled in one-dimension (1D).
4. Creek and channel bathymetry within the model has mostly been represented using ALS data. ALS is typically not suitable for this purpose. As such, creek/channel cross-sections aligned with locations where ALS data has been used as the primary data source may be misrepresented. This misrepresentation may impact the modelled flood behaviour. It is not known to what extent this data gap may be impacting the assessment results. BCC comment that the impacts are not expected to be significant (report Section 5.3.2). The good model calibration results suggest that this comment may be valid, though it is noted this may also be inter-related with the need to adopt higher than expected initial loss values in the hydrologic model.
5. Adopted Manning's n parameter values (report Table 5.1) are within the range of industry standard values.

6. It appears that the spatial definition of vegetation largely reflects landuse planning zones, rather than actual land use including the presence and type of vegetation. In some locations, particularly along main flowpaths in the mid to upper catchment, this misrepresentation may result in the local modelled flood behaviour not representing reality. Regionally, this misrepresentation of vegetation is not expected to alter the flood results significantly apart from in particularly sensitive areas (e.g. at key hydraulic constraints).

   Figure 2-1 compares the modelled vegetation representation against an aerial photograph of the floodplain downstream of Rickertt Road. Many areas which represent cleared land have been modelled as dense vegetation (dark green).



Modelled Vegetation (report Appendix E-1) Aerial Photography

Figure 2-1 Modelled Vegetation Spatial Distribution

2.2 Model Boundaries

Review of the TUFLOW model boundaries found the following:

1. Model inflows derived from the RAFTS hydrology modelling are being applied appropriately and to a sufficient scale of resolution for a regional scale flood study.

   Note: Local catchment overland flow within the most upstream hydrologic sub-catchments will not be modelled hydraulically using the current model configuration.

2.3 Model Simulation

Review of the TUFLOW model simulation found the following:

1. The model calibration results generally match recorded levels reasonably well (within ±300mm).
2. The model uses an appropriate timestep for the adopted model grid resolution.
3. Simulation mass error is within appropriate bounds (<±1%).
4. Some 1D elements show instabilities, as shown in Figure 2-2. Reviews of the modelling results indicate these instabilities may impact flood levels within 50m of the hydraulic structure.

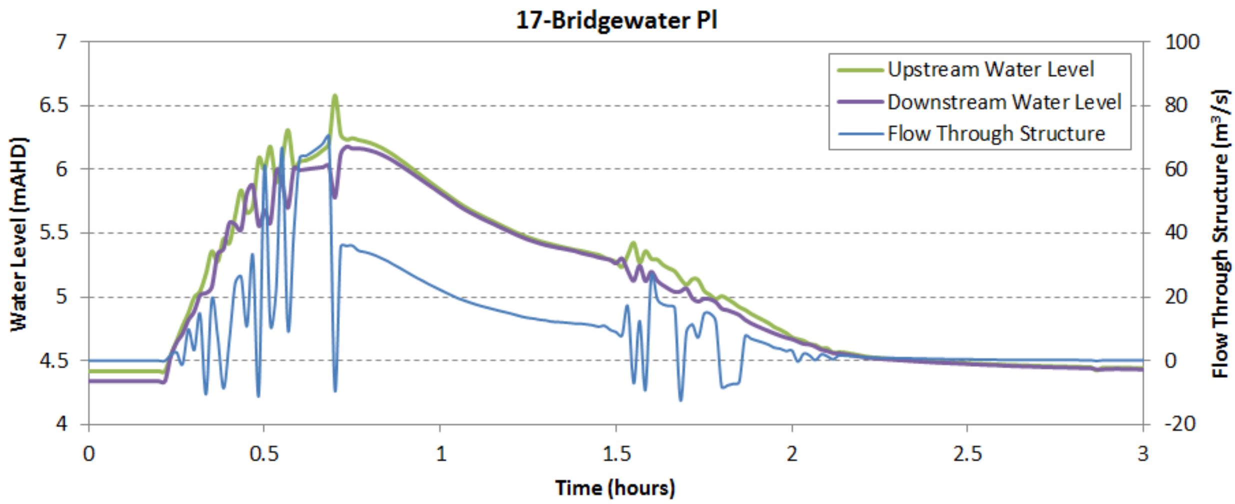


Figure 2-2 1D Bridge Structure Model Instability

3 Summary and Conclusions

Overall, the Lota Creek RAFTS/TUFLOW models appear to have been developed using sound techniques and diligent application. We recommend that the issues raised in this review are investigated and addressed as appropriate. However, overall it is expected that these issues are unlikely to significantly change the broader / regional flood behaviour results.[3] Our earlier letter of 2 July 2013 (L.B20311.002) contained details of key findings of the peer review, Council's response and our RPEQ signoff comment.

This sign-off endorses the peer review which was completed for the Lota Creek Flood Study. As such BMT WBM or Jo Tinnion is not liable for any errors or inaccuracies that may be present within the Lota Creek flood models. That responsibility rests with the model developers within Council.

Yours faithfully,

BMT WBM Pty Ltd

Chris Huxley

Senior Flood Engineer

Jo Tinnion CPEng RPEQ (11395)

Supervising Engineer[4]

[3] This third party review has been commissioned by BCC, the primary party responsible for the Lota Creek Flood Study. BMT WBM is not is not liable for any errors or inaccuracies that may be present within the Lota Creek flood models.

[4] Supervising Engineer signoff is based on information provided by Chris Huxley, and trust has been placed in the validity of the provided information and his ability to undertake the review.