APPENDIX C

APPENDIX C

APPENDIX C: CALIBRATION AND VALIDATION REPORTS

A part of BMT in Energy and Environment

Calibration Feasibility Report Lower Pine River Catchment Regional Floodplain Database Stage 3

R.B18521.002.01.LPR_Calibration_Feasibility_Report

January 2013

Calibration Feasibility Report
Lower Pine River Catchment
Regional Floodplain Database
Stage 3

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Client Reference	Regional Floodplain Database

Title :	Calibration Feasibility Report for the Lower Pine River Catchment Regional Floodplain Database Stage 3
Author :	Anne Kolega / Richard Sharpe
Synopsis :	Calibration Feasibility Report including the review of available rainfall and river gauge data for the calibration of the combined hydrologic and hydraulic model developed for the Lower Pine River catchment for Moreton Bay Regional Councils RFD Stage 3.

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1 INTRODUCTION

1.1 Background

Moreton Bay Regional Council (MBRC) is currently undertaking Stage 3 of developing the Regional Floodplain Database (RFD). The RFD includes the development of coupled hydrologic and hydraulic models for the entire local government area (LGA) that are capable of seamless interaction with a spatial database to deliver detailed information about the existing flood behaviour across the region.

Stage 3 includes the detailed hydrologic and hydraulic modelling of 2 packages; the Lower Pine River (LPR) catchment and the rivers and creeks that are also part of Brisbane City Council's (BCC) Local Government Area. This *Calibration Feasibility Report* addresses the Lower Pine River catchment only and forms part of the hydrologic and hydraulic modelling for the LPR catchment.

The Lower Pine catchment includes the following Rivers and Creek:

- Parts of the North Pine River (from downstream of Lake Samsonvale, also called North Pine Dam) until it discharges into Pine River,
- Sideling Creek from downstream of Lake Kurwongbah where it discharges into North Pine River;
- The entire South Pine River catchment; and
- The entire Pine River, which is formed at the junction of the North Pine River and South Pine River (some 7 km upstream from the mouth), to the mouth, where the combined system forms an extensive coastal estuary.

The aim of this assessment is to investigate the feasibility of calibrating the Lower Pine River hydraulic model by considering the quantity and quality of rainfall gauge, river gauge and other information on flooding in the catchment.

1.2 Scope

The scope of this calibration feasibility assessment and report can be summarised as follows:

- Review available rainfall and river gauge information on historical flooding provided by MBRC;
- Collect river stream gauge data available from the Bureau of Meteorology (BoM) and the Queensland Department of Environment and Resource Management (DERM);
- Document available data for model calibration, such as rainfall and river levels; and
- Assess the feasibility of various historic flood events to be utilised for calibrating the Lower Pine River model.

2 HISTORIC FLOOD EVENTS

Based on the recorded flood levels in the South Pine River illustrated in Figure 2-1, significant flood events categorised as major floods by the Bureau of Meteorology (BoM) were reported in 1967, 1972, 1974, 1989, 1991, 2009, 2010 and, most recently, in January 2011. The three largest events on record are the 1974, 2011 and 1991 flood events.

The highest flood on record for the South Pine River at Drapers Crossing is the January 1974 flood with a height of 7.44mAHD, and the second highest record is in January 2011 with a flood height of 7.32mAHD.

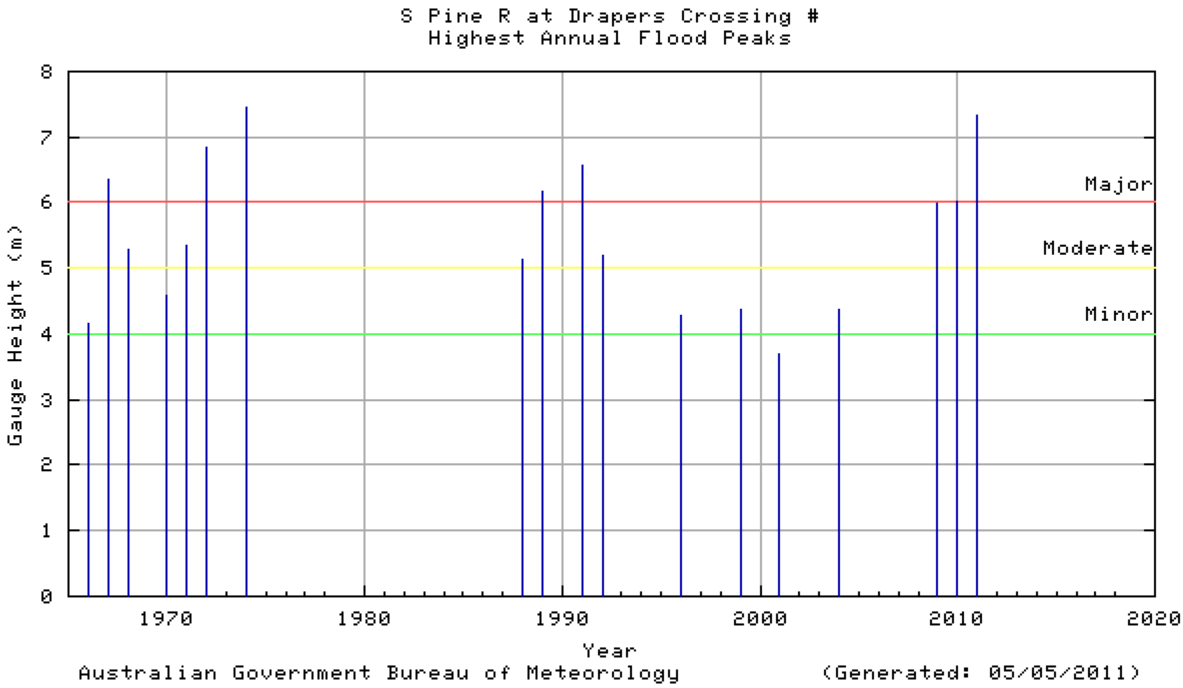


Figure 2-1 Historic Peak Flood Levels on the South Pine River at Draper Crossing

3 AVAILABLE DATA

3.1 Stream Gauge Data

A review of stream gauge data was undertaken based on data available from BoM and MBRC. Based on the water resource station catalogue provided by BoM, a total of 9 stream gauge stations were identified within the Lower Pine River catchment.

Table 3-1 summarises the available river gauge data obtained from MBRC, DERM and the BoM for the Lower Pine River catchment with the start and end date for the stream gauges. The information provided in Table 3-1 is based on the water resource station catalogue provided by BoM. Figure 3-1 illustrates the location of these gauges.

Table 3-1 Stream Gauge Summary[1]

ID	Stream Gauge	Station No	Owner	Start Date	End Date
1	Albany Ck	142201B	DERM	1/01/1917	1/01/1948
2	Cash's Crossing	142201A	DERM	1/01/1909	1/01/1917
	Cash's Crossing	142201D	DERM	1/01/1951	1/01/1964
3	Drapers Crossing	142202A	DERM	1/01/1965	
4	Drapers Crossing Alert	142804	BOM (Qld)	23/11/1994	
5	Fahey's Crossing	142201C	DERM	1/01/1947	1/01/1952
6	Petrie Alert	142802	BOM (Qld)	23/11/1994	
7	Samford Alert	142817	BOM (Qld)	12/04/1995	16/08/2004
8	The Y.M.C.A Camp	142102B	DERM	1/01/1969	1/01/1972
9	Young's Crossing	142101A	DERM	1/01/1915	1/01/1978

BoM also publishes information on their website on the *Flood Warning System for the Pine & Caboolture River Systems,* which is also provided in Appendix A. This information is somewhat contradictory to the water resource catalogue and information provided in Table 3-1. The stream gauge information has been requested and the availability of recorded data will be confirmed once this data is available.

The hydrograph for the Drapers Crossing gauge for the January 2011 and 1974 flood events are provided in Appendix B.

3.1.1 Flood Classification

Table 3-2 shows the flood classification levels of minor, moderate and major floods adopted by the BoM for selected river height stations in the Lower Pine River catchment[2].

[1] Source: http://www.bom.gov.au/hydro/wrsc
[2] Source: http://www.bom.gov.au/hydro/flood/qld/brochures/caboolture/caboolture.shtml

Table 3-2 Flood Level Classification of Selected Gauges

Stream Gauge	Minor Flood Level (m)	Moderate Flood Level (m)	Major Flood Level (m)
Cash's Crossing	6.3	6.7	8.1
Drapers Crossing	4.0	5.0	6.0
John Bray Park	3.4	3.7	4.3
Murrumba Downs	2.3	2.5	4.1
Petrie Alert	3.5	5.5	7.1
Samford Alert	4.8	5.3	5.8
Young's Crossing	6.0	7.5	9.5

Note: All heights are in metres relative to the stream gauge datum.

3.2 Rainfall Data

Rainfall gauge data was provided by MBRC, and comprised of the following three categories:

- Rainfall Daily;
- Rainfall Alert; and
- Pluviometer (6-minute interval records).

A review was undertaken to identify relevant rainfall data from stations that are located within the Lower Pine catchment and rainfall stations outside the Lower Pine catchment that can be utilised for the model calibration. Table 3-3 summarises the rainfall data for the Lower Pine River catchment and Figure 3-1 shows the gauge locations. In total, 18 rainfall alert gauges have been identified; 12 of these are located within the catchment, and the other 6 stations are nearby the catchment periphery, refer to Figure 3-1. MBRC has already consolidated and provided 5 minute interval data series for these 18 stations for the January 2011 event.

Figure 3-1 illustrates that these 18 gauge locations cover the catchment relatively well, except for the south-western portion of the catchment. Interpolation of rainfall depths across the south-west portion of the catchment will therefore be relatively coarse and uncertain. Radar data will be sourced from BoM to inspect rainfall intensity variations across the catchment, and thereby identify any inadequacies in the distribution of rainfall gauges.

Table 3-3 Rainfall Data Summary

ID	Sensor Name	Sensor Type	BoM Station	Easting	Northing
1	Cash's Crossing AL	Rainfall Alert	540415	496093	6975598
2	Cedar Creek AL	Rainfall Alert	540444	486608	6977170
3	Clear Mountain AL	Rainfall Alert	540418	488744	6979734
4	Deagon AL	Rainfall Alert	540124	505688	6976366
5	Drapers Crossing AL	Rainfall Alert	540205	492362	6974950
6	Ferny Hills AL	Rainfall Alert	540115	492997	6969719
7	John Bray Park AL	Rainfall Alert	540413	498524	6980705
8	Lake Kurwongbah AL	Rainfall Alert	540204	495050	6985873
9	Lawnton AL	Rainfall Alert	540439	499374	6982997
10	Mt Glorious Alert-P	Rainfall Alert	540138	474959	6978461
11	Murrumba Downs AL	Rainfall Alert	540417	501738	6981671
12	Normanby Way AL	Rainfall Alert	540414	499689	6979637
13	North Pine Dam AL-B	Rainfall Alert	540277	493401	6984027
14	Petrie AL	Rainfall Alert	540203	497526	6983659
15	Samford AL	Rainfall Alert	540060	488077	6973592
16	Samford Village AL	Rainfall Alert	540416	488991	6972560
17	Three Ways AL	Rainfall Alert	540110	482789	6964233
18	Youngs Crossing AL	Rainfall Alert	540412	495474	6984013
19	Amcor Cartonboard - Petrie Mill	Rainfall Daily	498406	6983748	498406
20	Highvale	Rainfall Daily	481845	6971617	481845
21	Strathpine Colonial Drive	Rainfall Daily	495873	6982208	495873
22	Bald Hills Post Office	Not Operational	500960	6977722	500960
23	Bracken Ridge Road Alert	Not Operational	502196	6979018	502196
24	Camp Mountain (Davison Road)	Not Operational	486792	6969685	486792
25	Clear Mountain Buranda Rd	Not Operational	490414	6977597	490414
26	Mt Glorious Fahey Rd	Not Operational	477416	6976527	477416
27	Samford CSIRO	Not Operational	488736	6973497	488736
28	Samford Kay Drive	Not Operational	487748	6972422	487748

3.3 Flood Marks Providing Historic Flood Levels

Historic flood level records were provided by MBRC. This data comprises in total 7 historic storm events ranging from 1966 through to 2011. The highest numbers of recorded levels were collected in 1974 and January 2011. A summary of the number of flood marks recorded for each year is provided in Table 3-4. The locations of the flood marks are shown in Figure 3-2.

It should be noted that most of the flood marks collected for the January 2011 flood event are located within the North Pine River catchment; only 4 flood marks were collected along Cedar Creek in the upper part of the South Pine River catchment. Therefore, the coverage of flood marks in this particular event is quite poor for the South Pine River.

Table 3-4 Flood Mark Summary

ID	Flood Mark Date	Number of Flood Marks
1	1974	73
2	January 2011	56
3	1967	46
4	1988	19
5	1989	13
6	1966	8
7	1976	3

3.4 Water Quality Event Monitoring and Maximum Height Indicators

Maximum height indicators were provided by MBRC. Ten maximum height indicators are located within the Lower Pine catchment; refer to Figure 3-1 for locations. These indicators are used for road safety and do not record levels. Therefore, these indicators are not suitable for model calibration and have been included in this report for documentation purposes only.

Water Quality Event Monitoring Gauges owned by MBRC were also reviewed, with the following five gauges located within the Lower Pine catchment:

- South Pine River Site ID: South Pine River PRSC012;
- South Pine River Site ID: South Pine River - PRSC013;
- Cedar Creek Site ID: Cedar Creek - PRSC011;
- Four Mile Creek Site ID: Four Mile Creek - 2PRSC014; and
- One Mile Creek Site ID: Hayward Avenue Reserve.

These gauges record water levels, rainfall and turbidity and were installed between the years 2007 and 2009. The flood levels from these records may be used as additional information for model calibration for the January 2011 event. The gauge locations are illustrated in Figure 3-1.

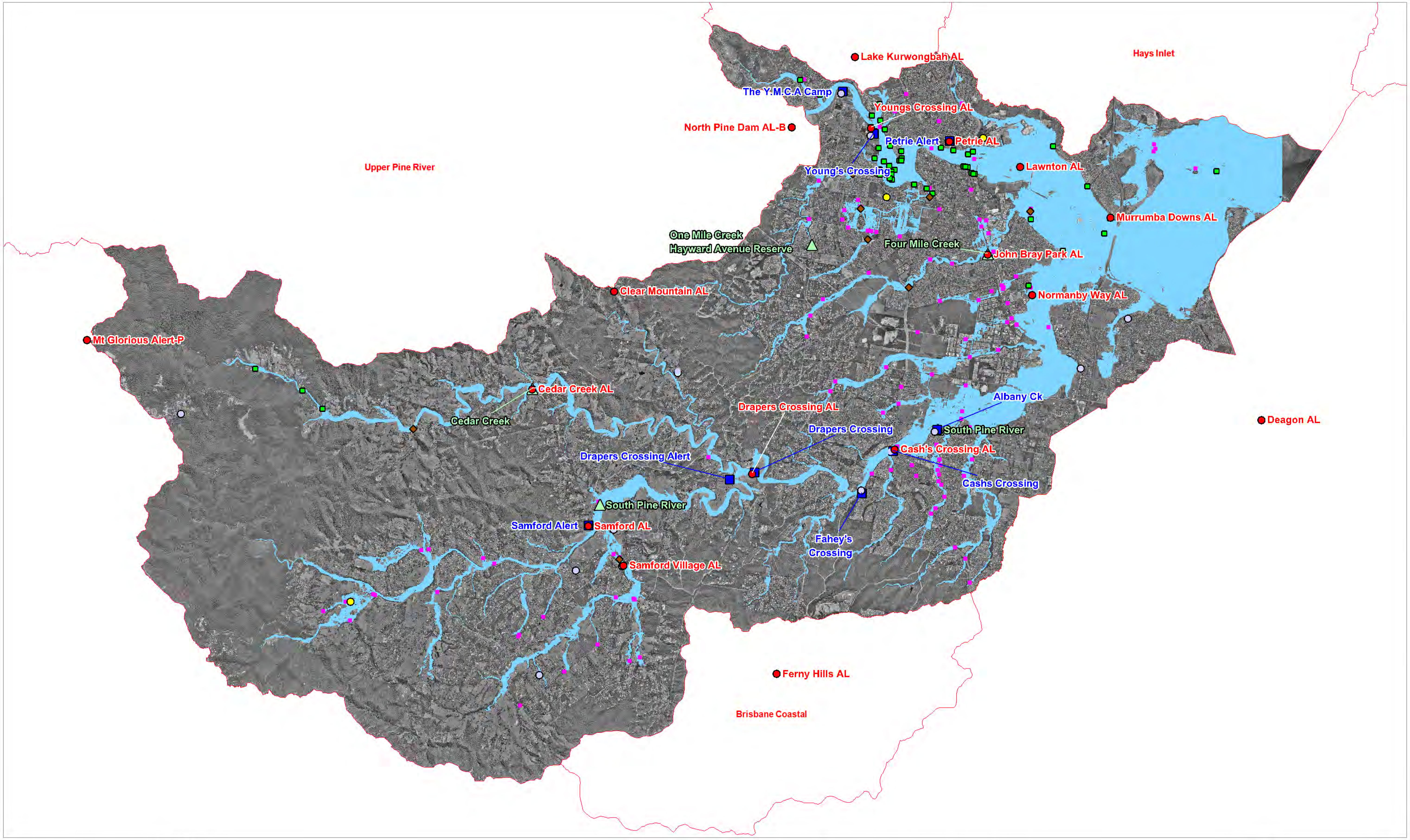
3.5 Resident Survey

MBRC have issued a questionnaire to residents to collate historical flood information, such as flood extents, levels (if available), flood marks and photos. This survey was first undertaken in 2010. In January 2011, MBRC issued another media release to the community through the local newspaper that asks for provision of any available flood information to MBRC. This data was collated by MBRC through the RFD project website. Information could have been provided via E-mail (flood@moretonbay.qld.gov.au or an on-line Flood Data Form (http://www.moretonbay.qld.gov.au/general.aspx?ekfrm=74810&libID=77442).

Where the community provided feedback and flood marks, MBRC has surveyed these flood marks. These marks were included in the flood mark layer (Section 3.3) and will be utilised for the model calibration in the respective storm event.

3.6 Floodmark and Photo Collection January 2011 Event

The January 2011 flood event in the Lower Pine River Catchment provided an excellent opportunity to collate an expansive and reliable set of flood data. MBRC were active in capturing this flood information, which includes flood levels, and photographs, primarily on the North Pine River catchment. It is anticipated that the January 2011 flood information will be a good resource for model calibration in parts of the catchment where the data is available; mainly for the North Pine River. In the South Pine River part of the catchment there are only 4 flood marks and 1 definite stream gauge recorded level for the 2011 flood, however this gauge at Drapers Crossing was the second highest on record and classified as a major flood.



LEGEND

- Lower Pine River Catchment
- Stage 1 Flood Extent (100 Year ARI)
- Rainfall Alert Gauges and Pluviometers
- Rainfall Gauges - Not Operational (in 2011)
- Rainfall Gauges Daily
- River Gauges
- Water Quality Monitoring Event Gauges
- Flood Marks collected in January 2011
- Flood Marks collected prior to 2011
- Maximum Height Indicators

Title:

Rainfall and Stream Gauge Locations
Lower Pine River Catchment

Figure: **3-1**

Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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Approx. Scale

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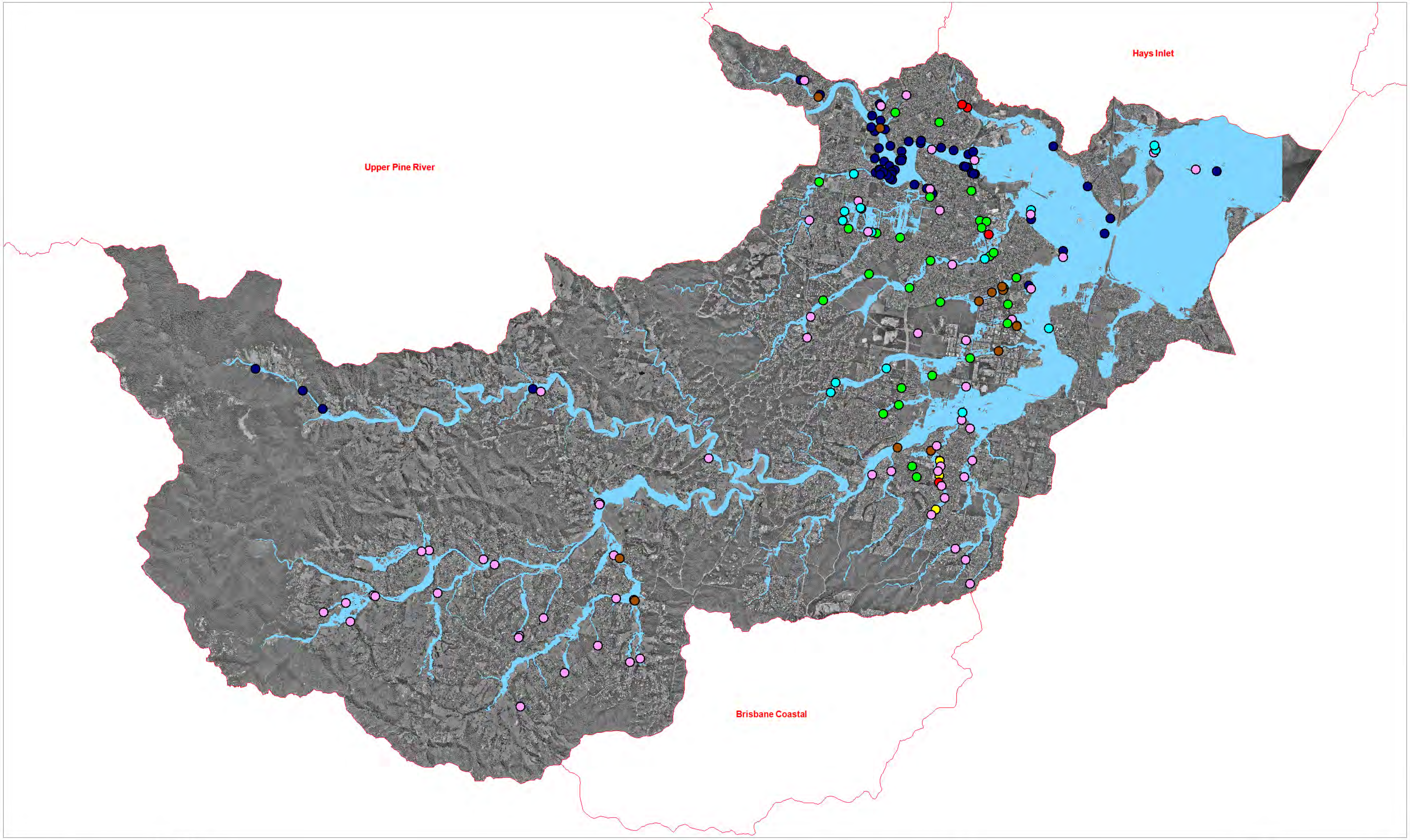

LEGEND

Lower Pine River Catchment

Stage 1 Flood Extent (100 Year ARI)

Historic Flood Marks

- 2011
- 1974
- 1989
- 1970
- 1988
- 1967
- 1976
- 1966

Title:

Flood Marks Categorised Per Year

Figure: **3-2**

Rev: **A**

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N 0 2.5 5km Approx. Scale

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4 CONCLUSION

Following on from the January 2011 event, MBRC has been active in collecting flood marks in a timely manner for the Lower Pine River and other catchments in the LGA. MBRC also invited the community to provide photos, flood marks and other relevant information via their RFD website. In total, 56 flood marks were collected in the LPR catchment. However, most of these are located within the North Pine River catchment (see Section 3.3). This recent January 2011 flood event is expected to improve flood awareness within the community, and may lead to improved acceptance of the RFD and, by calibrating the model to this flood event, the associated flood model results. However, since the coverage of the flood marks for the January 2011 flood event is limited, it is recommended that a second event is used to verify the model.

The 1974 flood was the largest on record and MBRC has recorded 73 flood marks for this event. The only negative aspect with use of this event for model verification is that it occurred nearly 40 years ago. During this time the catchment may have changed significantly in terms of its landuse, topography and number of structures within the creeks and rivers. All of these catchment characteristics will greatly affect the hydraulic behaviour and will have to be represented as best as possible in the model. Therefore, the suitability of the 1974 flood event for model verification will largely depend on whether information is available to replicate the LPR catchment in 1974.

River gauge data is crucial for a high quality model calibration due to the ability to not only calibrate to the peak flood level, but also to the flood volume and the timing. The number of available gauges across the catchment therefore influence the quality of the model calibration exercise; generally the more gauge data available the better, and a good spread of the gauges over various tributaries in the catchment is also advantageous. There will be at least one stream gauge on the South Pine River at Drapers Crossing that recorded flood levels for major storm events, including 1974 and 2011. The additional number of stream gauges data that recorded flood levels for the major storm events is yet to be confirmed, however it is likely that will be limited to a maximum of one more gauge at Petrie for the 1974 flood and two more gauges at Samford Village and Cashs' Crossing for the major event between 2009 and 2011 (based on information provided by BoM and provided in Appendix A).

More recent flood events are preferable for model calibration because it is less likely that the catchment's topography and landuse have changed significantly. The severity of the flood is also important. For this particular study a minor flood event (e.g. the 5 or 10 year ARI event) is less useful for calibration compared to larger flood events (e.g. 50 or 100 year ARI event). This is because the study includes modelling of large flood events, and calibrating to large flood events will test both in-bank and out-of-bank flow in the hydraulic model.

There are twelve alert rainfall and pluviometer gauges within the catchment and another 6 alert rainfall and pluviometer gauges outside but near the catchment. For model calibration the alert and pluviometer gauges are preferred compared to daily stations because the records are more detailed (5 to 6 minute interval data). The coverage of pluviometers is considered satisfactory, although it is also noted that there are certain areas, in particular in the south-west of the catchment, with a lack of rainfall data in the Lower Pine River. This will influence the accuracy and level of detail during the calibration process.

The January 2011 event had high rainfall at the western part of the Lower Pine catchment, but less rainfall was recorded towards the coast and Deception Bay. The neighbouring catchments to the north-east, Hays Inlet and Redcliffe, did not experience a major flood event in 2011.

The Lower Pine River model will receive inflows from two upstream catchments that have been modelled separately during Stage 2 of the RFD (the Upper Pine River (UPR) and Sideling Creek (SID)) for the design events. As such, inaccuracies in the upstream catchment models will be passed through into the Lower Pine River model. There are three approaches that could be used in the calibration modelling approach:

1. Utilise outflows from the UPR and SID models as upstream inflow boundary conditions in the UPR model. Model calibration has been undertaken for these two catchments for the January 2011 flood event, so the outflows are available for calibrating the LPR model.
2. Develop upstream inflow boundary conditions for the UPR calibration model based on recorded rain gauge data and the hydrology model. Again, this information is already available.
3. Use recorded stream gauge data at Young’s Crossing (including flows from the Upper Pine River and Sideling Creek catchment) to estimate an inflow into the model.

It is recommended that the first approach (point 1 above) is used, as this is consistent with the design flood event modelling approach. However, the other two approaches could be considered if the modelled and measured results are not comparing well.

Based on the severity of the flood events, the availability and frequency of rainfall and stream gauge data and flood mark information, model calibration is possible for the following events:

- January 2011;
- January 1974;
- February 1999; and
- May 2009.

5 RECOMMENDATIONS

As discussed in Section 4, there are sufficient historical flood records to undertake a calibration exercise on the LPR model; however, there are some limitations in the available data, so it is advisable that a second historical flood event is used to verify the model.

The most suitable flood event for calibration is the January 2011 flood event due to it being recent, large (second biggest flood on record) and having a sizeable and reliable data record relative to the other major flood events. However the quality of the calibration will be limited due to the following reason:

- Flood marks for the January 2011 flood event are concentrated around the Upper Pine River, and flows in this river will be largely controlled by the outflows of the UPR and SID models. As a result, the calibration will not cover much of the South Pine River catchment.

The most suitable flood event for the model verification is the 1974 flood event due to it being the largest flood on record and the availability of a large set of records relative to the other major floods. The quality of the verification will be limited due to the small number of stream gauges operational during the flood and because of potential changes to the catchment over the last 40 years.

In light of these limitations, it is still recommended to undertake a calibration and verification exercise on the LPR flood model, as this may provide a mechanism to improve and gain an understanding of the model performance.

6 REFERENCE

Bureau of Meteorology, 2011, *Water Resources Station Catalogue*, viewed 1 September 2011, <http://www.bom.gov.au/hydro/wrsc>

Bureau of Meteorology, 2011, *Flood Warning System of the Pine and Caboolture Rivers*, viewed 1 September 2011, <http://www.bom.gov.au/hydro/flood/qld/brochures/caboolture/caboolture.shtml>

Moreton Bay Regional Council, 2011, *Share your flood data*, viewed 1 September 2011, <http://www.moretonbay.qld.gov.au/general.aspx?ekfrm=74810&libID=77442>

APPENDIX A: FLOOD WARNING SYSTEM FOR THE PINE & CABOOLTURE RIVERS PROVIDED BY BOM

FLOOD WARNING SYSTEM for the PINE & CABOOLTURE RIVERS

This brochure describes the flood warning system operated by the Australian Government, Bureau of Meteorology for the Pine and Caboolture Rivers. It includes reference information which will be useful for understanding Flood Warnings and River Height Bulletins issued by the Bureau's Flood Warning Centre during periods of high rainfall and flooding.

Pine River at Murrumba Downs

Contained in this document is information about:
(Last updated May 2011)

Flood Risk

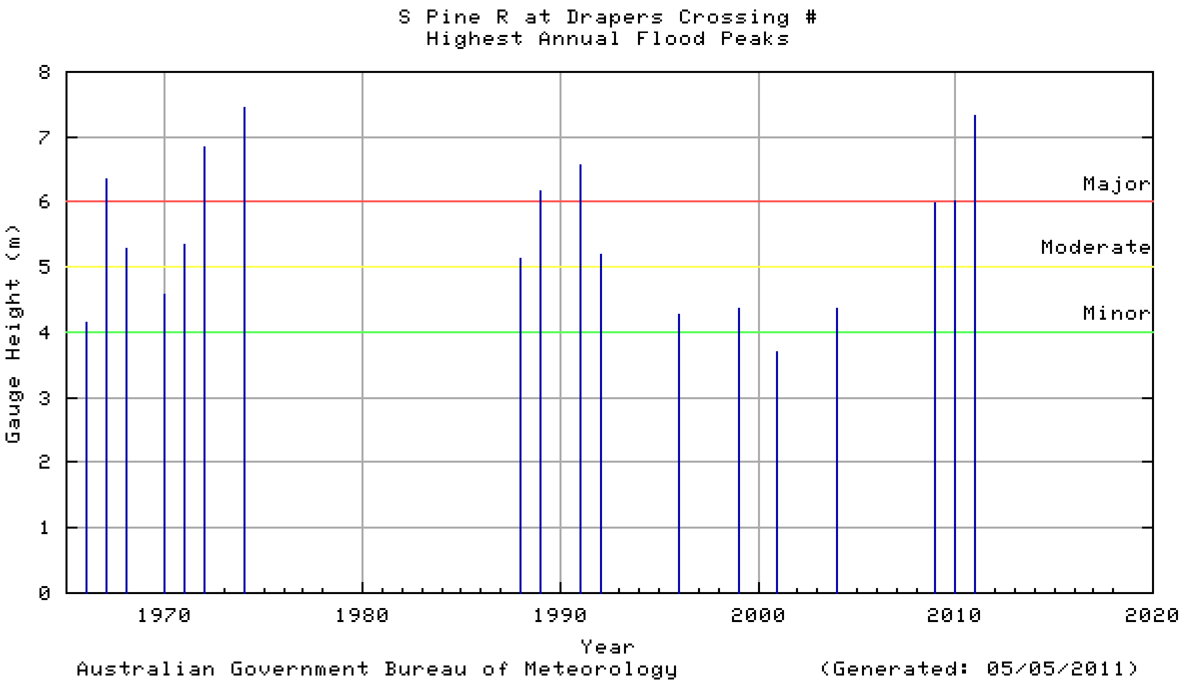
The Pine River catchment drains in a generally easterly direction from the relatively steep D'Aguilar Ranges towards the flat coastal plains of Bramble Bay between Sandgate and Redcliffe. The North Pine River and South Pine River join some 7 km upstream from the mouth,where the combined system forms an extensive coastal estuary. The North Pine Dam located in the middle of the catchment was completed in 1976. The Dam is operated by Seqwater.

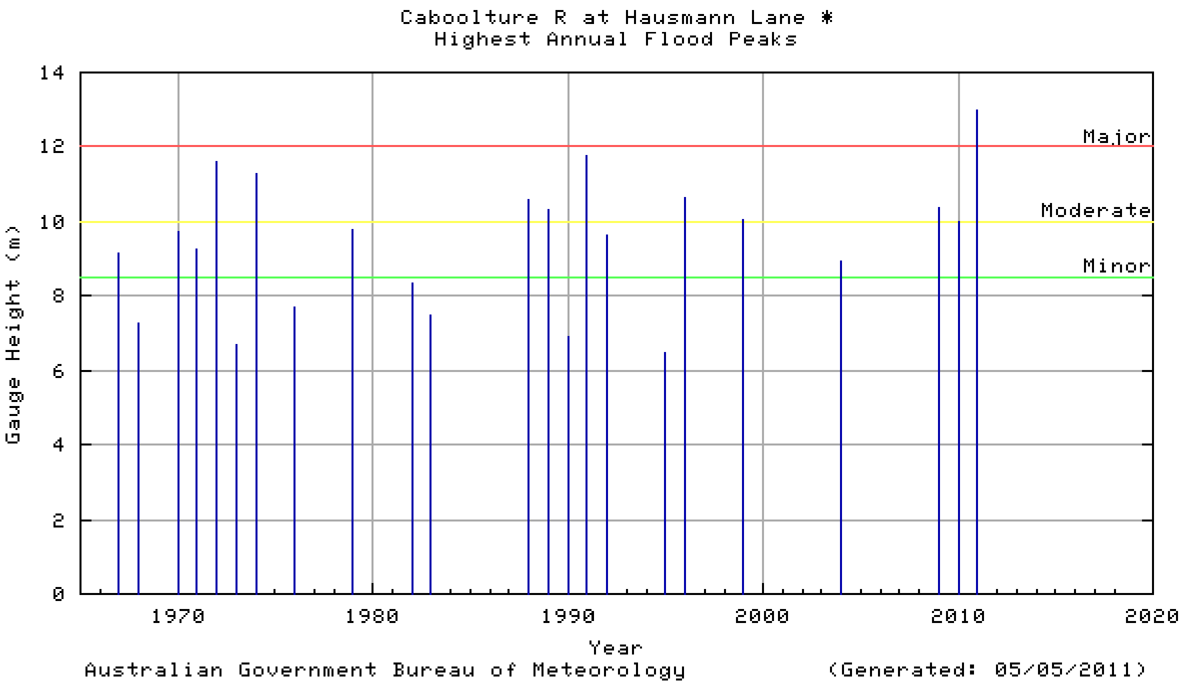
The Caboolture River is situated about 40 km north of Brisbane and has a total catchment area of 370 square kilometres. It rises in the D'Aguilar Ranges and flows in an easterly direction towards the coast, passing through Caboolture and entering Deception Bay (the northern part of Moreton Bay) near the township of Beachmere. Its major tributaries include Wararba, Sheep Station, King John and Lagoon Creeks.

The Pine and Caboolture system is susceptible to episodes of rapid flooding which can cause significant damage to public and private property throughout the catchment. Continuing increases in population have accentuated the potential flood risk to life and property, and this trend is unlikely to abate given the current growth in the area.

Previous Flooding

Records dating back to 1966 indicate a few major floods that have occurred in the Pine and Caboolture Rivers. Significant flood events with major flooding were reported in 1967, 1972, 1974, 1989, 1991, 2010 and 2011.





Flood Forecasting

In conjunction with the Moreton Bay Regional Council and Seqwater, the Bureau of Meteorology operates a flood warning system for the Pine and Caboolture Rivers, based on the network of rainfall and river height stations shown on the map.

The Bureau's Flood Warning Centre issues Flood Warnings and River Height Bulletins for the Pine and Caboolture River catchments during flood events.

Local Information

The Moreton Bay Regional Council is able to provide further information on flooding in your area of the Pine and Caboolture River catchments.

Flood ALERT System

Since the mid 1990's, an automated flood monitoring system in the Pine and Caboolture River catchments has been progressively developed by Seqwater and Councils.

The system is comprised of a network of rainfall and river height field stations located in the catchment which report via VHF radio to a base station computer located in the Moreton Bay Regional Council office at Strathpine and at Seqwater and Bureau offices. The field stations send reports for every 1 millimetre of rainfall and every 50 millimetre change in river height.

In consultation with the Moreton Bay Regional Council and Seqwater, the Bureau issues Flood Warnings for the Pine and Caboolture Rivers.

The base station computers located in the Moreton Bay Regional Council office collects the data and has software that displays it in graphical and tabular form. The data is also received by the Bureau's Flood Warning Centre where it is used in hydrologic models to produce river height predictions.

Flood Warnings and Bulletins

The Bureau of Meteorology issues Flood Warnings and River Height Bulletins for the Pine and Caboolture River catchment regularly during floods. They are sent to radio stations for broadcast, and to local Councils, emergency services and a large number of other agencies involved in managing flood response activities. Flood Warnings and River Height Bulletins are available via :

Radio

Radio stations, particularly the local ABC, and local commercial stations, broadcast Flood Warnings and River Height Bulletins soon after issue.

Local response organisations

These include the Councils, Police, and State Emergency Services in the local area.

Internet/World Wide Web

Flood Warnings, River Height Bulletins and other weather related data is available on the Bureau's Web page at http://www.bom.gov.au . The Queensland Flood Warning Centre website is http://www.bom.gov.au/qld/flood .

Telephone Weather

Flood Warnings are available through a recorded voice retrieval system, along with a wide range of other weather related and climate information.

Main Directory	Phone	1900 955 360
Flood Warnings	Phone	1300 659 219

Telephone Weather Services Call Charges:
1900 numbers: 77c per minute incl. GST; 1300 numbers: Low call cost - around 27.5c incl. GST.
(More from international, satellite, mobile or public phones)

Interpreting Flood Warnings and River Height Bulletins

Flood Warnings and River Height Bulletins contain observed river heights for a selection of the river height monitoring locations. The time at which the river reading has been taken is given together with its tendency (e.g. rising, falling, steady or at its peak). The Flood Warnings may also contain predictions in the form of minor, moderate or major flooding for a period in the future. River Height Bulletins also give the height above or below the road bridge or causeway for each river station located near a road crossing.

One of the simplest ways of understanding what the actual or predicted river height means is to compare the height given in the Warning or Bulletin with the height of previous floods at that location.

The table below summarises the flood history of the Pine and Caboolture River catchments - it contains the flood gauge heights of the more significant floods.

River height station	Feb 1972	Jan 1974	Apr 1989	Dec 1991	Apr 2009	May 2009	Oct 2010	Jan 2011
Baxters Creek	-	-	-	-	4.95	4.65	4.68	9.20
Dayboro	-	-	-	-	5.97	6.27	-	-
North Pine Dam	-	-	-	-	-	39.90	40.10	41.08
Lake Kurwongbah	-	-	-	-	21.84	22.19	21.16	-
Youngs Crossing	-	-	-	-	4.82	6.42	8.27	13.27
Petrie	-	5.10	-	-	3.04	4.79	-	-
Samford Village	-	-	-	-	2.40	4.70	5.00	4.60
Drapers Crossing	6.68	7.44	6.18	6.55	4.97	5.97	6.00	7.32
Cash's Crossing	-	-	-	-	4.00	4.80	5.10	5.60
Burpengary (Rowley Road)	20.30	20.00	20.00	20.20	20.15	20.02	18.25	-
Burpengary (Dale Street)	11.15	-	10.81	10.45	10.19	10.79	9.74	11.19
Upper Caboolture	11.58	11.30	10.29	11.76	10.64	10.29	9.44	13.01
Wamuran	30.61	-	30.11	30.26	29.37	29.02	28.67	30.67
Caboolture	9.91*	-	9.16*	9.54*	7.79	-	7.69	10.94

All heights are in metres on flood gauges. [*] These heights were obtained using surveyed flood marks.

Historical flood heights for all river stations in the Pine and Caboolture River Floodwarning networks, as shown on the map, are available from the Bureau of Meteorology upon request.

PINE AND CABOOLTURE CATCHMENTS - ASSESSMENT OF THE FLOOD POTENTIAL

Major flooding requires a large scale rainfall situation over the Pine and Caboolture River catchments. Once the North Pine Dam is at full capacity, overflowing occurs and inundation of the Petrie area begins. The following can be used as a rough guide to the likelihood of flooding in the catchment:

Average catchment rainfalls of in excess of 200mm in 12 hours causes minor to moderate flooding in both the Pine and Caboolture catchments. This flooding will cause minor traffic difficulties as well as inundation of low lying areas.

Average catchment rainfalls of in excess of 300mm in 12 hours causes serious major flooding to occur. Rises in stream height will serverly affect traffic capabilities and will affect houses and businesses on a widespread level. Releases from the North Pine Dam spillway during flood events causes the closure of Youngs Crossing Road.

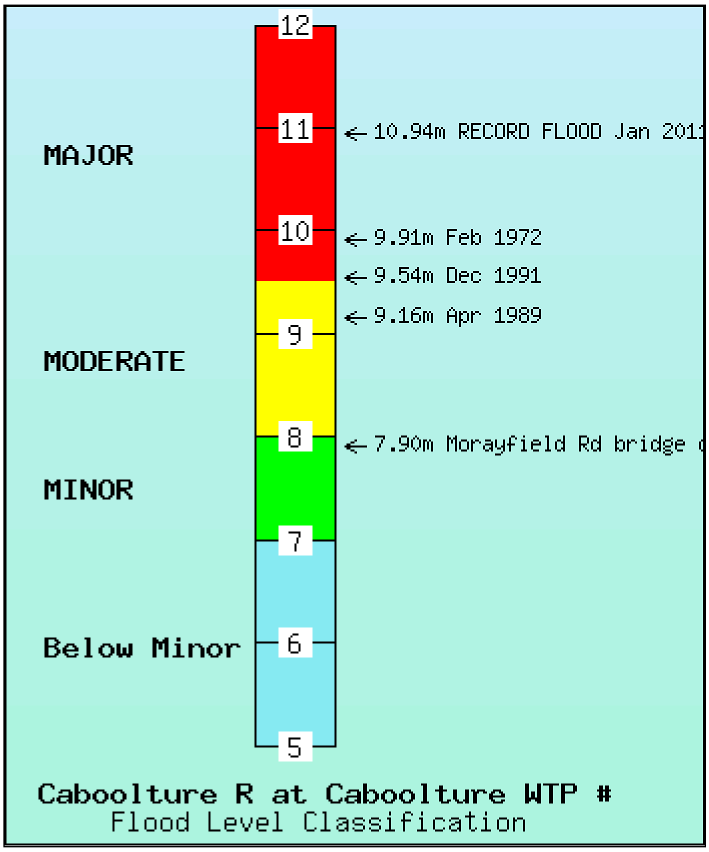
Flood Classifications

At each flood warning river height station, the severity of flooding is described as minor, moderate or major according to the effects caused in the local area or in nearby downstream areas. Terms used in Flood Warnings are based on the following definitions.

Major Flooding : This causes inundation of large areas, isolating towns and cities. Major disruptions occur to road and rail links. Evacuation of many houses and business premises may be required. In rural areas widespread flooding of farmland is likely.

Moderate Flooding : This causes the inundation of low lying areas requiring the removal of stock and/or the evacuation of some houses. Main traffic bridges may be closed by floodwaters.

Minor Flooding : This causes inconvenience such as closing of minor roads and the submergence of low level bridges and makes the removal of pumps located adjacent to the river necessary.



Each river height station has a pre-determined flood classification which details heights on gauges at which minor, moderate and major flooding commences. Other flood heights may also be defined which indicate at what height the local road crossing or town becomes affected by floodwaters.

The table below shows the flood classifications for selected river height stations in the Pine and Caboolture River catchments.

River Height Station	First Report Height	Crossing Height	Minor Flood Level	Crops & Grazing	Moderate Flood Level	Towns and Houses	Major Flood Level
North Pine Dam	-	39.6 (F)	-	-	-	-	-
Lake Kurwongbah	-	20.42 (S)	-	-	-	-	-
Youngs Crossing	-	3.49 (B)	6.0	-	7.5	-	9.5
Petrie	-	-	3.5	-	5.5	-	7.1
Samford Village	-	-	4.8	-	5.3	-	5.8
Drapers Crossing	-	-	4.0	-	5.0	-	6.0
Cash's Crossing	-	-	6.3	-	6.7	-	8.1
Normanby Way	-	-	3.7	-	3.9	-	4.6
John Bray Park	-	-	3.4	-	3.7	-	4.3
Murrumba Downs	-	-	2.3	-	2.5	-	4.1
Burpengary (Rowley Road)	-	20.0 (B)	15.0	-	20.0	-	20.5

Burpengary (Dale Sreet)	-	-	8.8	-	9.7	-	10.5
Upper Caboolture	-	-	8.5	-	10.0	-	12.0
Wamuran	-	30.60 (B)	29.0	-	30.0	-	30.5
Caboolture WTP	-	7.90 (B)	7.0	-	8.0	-	9.5

All heights are in metres on flood gauges. (B) = Bridge (F) = Full Supply Level (S) = Spillway

The above details are correct at the time of preparing this document. Up-to-date flood classifications and other details for all flood warning stations in the network are at:

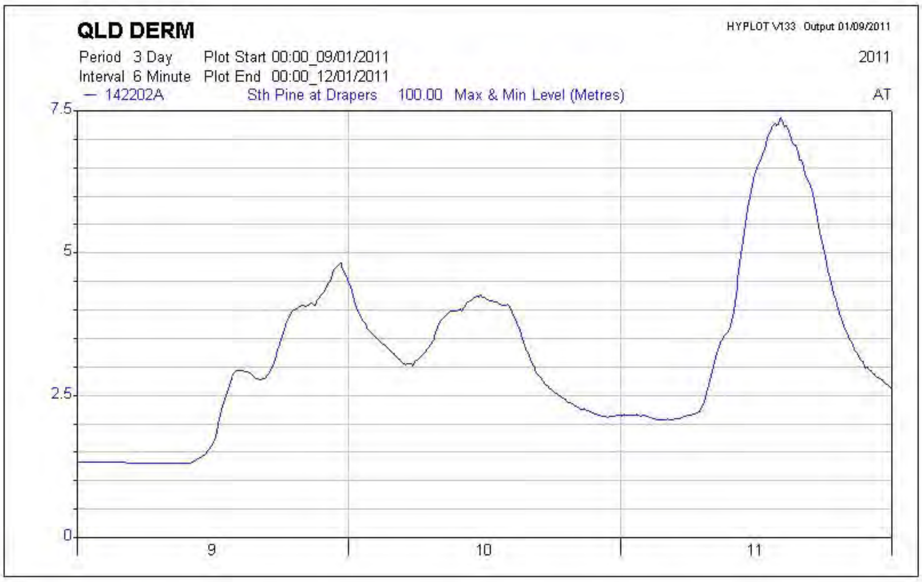
http://www.bom.gov.au/hydro/flood/qld/networks/index.shtml

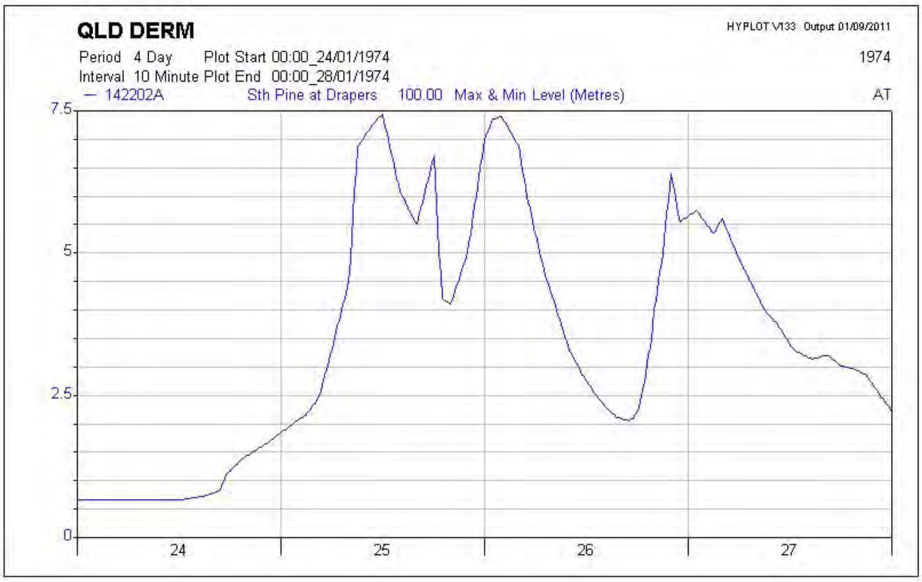
Catchment Map showing the Pine and Caboolture River flood warning network

Click here to view map as: PNG PDF (308K bytes)

For further information, contact:
The Regional Director, Bureau of Meteorology, GPO Box 413, Brisbane Q 4001

APPENDIX B: RECORDED HYDROGRAPH JANUARY 2011 AND 1974 EVENT


QLD DERM
HYPLOT V133 Output 01/09/2011
Period 3 Day Plot Start 00:00_09/01/2011
Interval 6 Minute Plot End 00:00_12/01/2011
2011
— 142202A Sth Pine at Drapers 100.00 Max & Min Level (Metres)
AT
7.5
5
2.5
0
9
10
11


QLD DERM
HYPLOT V133 Output 01/09/2011
Period 4 Day Plot Start 00:00_24/01/1974
Interval 10 Minute Plot End 00:00_28/01/1974
1974
— 142202A Sth Pine at Drapers 100.00 Max & Min Level (Metres)
AT
7.5
5
2.5
0
24
25
26
27

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Model Calibration Report Lower Pine River Catchment Regional Floodplain Database Stage 3

R.B18521.003.02.LPR_Model_Calibration_Report.docx

March 2013

Model Calibration Report
Lower Pine River Catchment
Regional Floodplain Database
Stage 3

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Brisbane
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Prepared For:	Moreton Bay Regional Council
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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Title :	Model Calibration Report Lower Pine River Catchment Regional Floodplain Database Stage 3
Author :	Richard Sharpe
Synopsis :	This report includes the details and findings of the combined hydrologic and hydraulic model calibration of the Lower Pine River for the January 2011 flood event. This report is part of Council's Regional Floodplain Database, Stage 3.

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE OF ISSUE	CHECKED BY		ISSUED BY	
0	20 December 2012	A Kolega		R Sharpe	
1	7 January 2013	A Kolega		R Sharpe	
2	1 March 2013	A Kolega		R Sharpe	

DISTRIBUTION

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BMT WBM Library	PDF	PDF	PDF	

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1 INTRODUCTION

As part of Stage 3 (Package 2) of the Regional Floodplain Database (RFD) project, Moreton Bay Regional Council (Council) has commissioned BMT WBM to develop a TUFLOW model of the Lower Pine River catchment. As part of the model development, the January 2011 flood event was simulated to calibrate the model to flood data that was recorded during this recent flood event. This report documents the calibration of the Lower Pine River TUFLOW model.

As recommended by Council and in the *Calibration Feasibility Report* (BMT WBM, 2011) the January 2011 event was utilised for the model calibration due it being both a recent event and the largest flood on record within the Lower Pine River catchment. The *Calibration Feasibility Report* also outlines limitations to the flood data collected for the January 2011 event and advantages of undertaking model calibration and verification to more than one historic event. It is recommended that the *Calibration Feasibility Report* is read in conjunction with this report.

Model calibration is an important part of developing a flood model, as it establishes confidence in the model performance and quantifies potential inaccuracies in the model results. Since the model results will ultimately be used to assess future development and for communication consultation, Council has promoted and been actively involved in the model calibration phase of the project.

Based on available rainfall, river gauge and flood mark data, model calibration was feasible and subsequently commissioned for the following six catchments as part of RFD:

- Burpengary Creek;
- Caboolture River;
- Sideling Creek;
- Upper Pine River;
- Lower Pine River; and
- Stanley River.

Council has an overarching understanding of calibration results for the models covering these catchments, with a view to adopting a consistent set of hydrologic and hydraulic parameters across the entire LGA.

This report outlines the data used, results and discussion of the model calibration for the Lower Pine River catchment.

2 AVAILABLE DATA

2.1 Rainfall Data

To represent the rainfall during the event, records from 17 rainfall gauges were utilised in the hydrologic model established for the January 2011 event. The recorded cumulative rainfall depths in millimetre (mm) for these rainfall gauges are illustrated in Figure 2-1. Note that the rainfall records from Ferny Hills gauge were not used as no rainfall was recorded during the event at this gauge.

These gauges provide a good spread of rainfall data across the catchment. Figure 2-2 presents the locations of the rainfall gauges used for the model calibration and the total rainfall depth over the four days from the 9th to the 12th of January 2011.

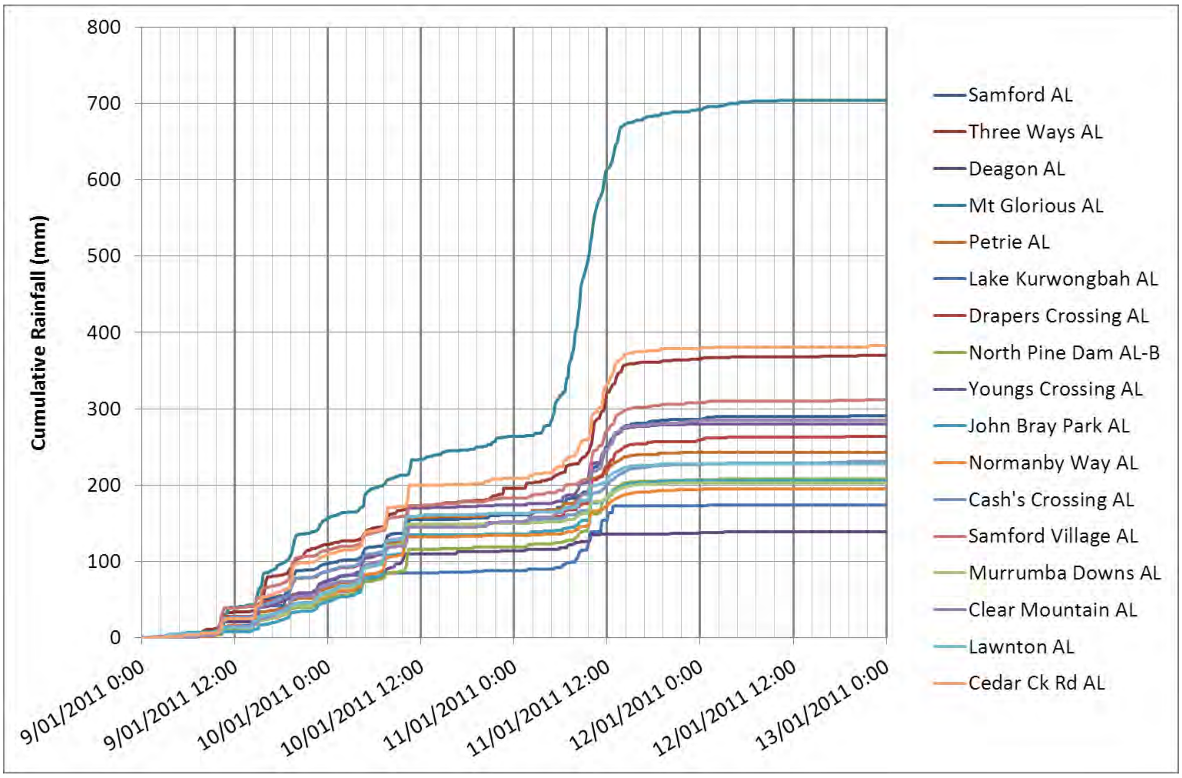


Figure 2-1 Cumulative Rainfall Depths (mm) for Lower Pine River Catchment during January 2011 Event

Analysis of the recorded rainfall data between the 9th and 12th of January 2011 suggest a similar trend in the timing of the rainfall bursts over the 4 day period. However, it is noted that the cumulative rainfall depth over 4 days results in significantly varied magnitudes across the Lower Pine River catchment. Cumulative rainfall depths range from approximately 140 to 280mm within the east of the catchment, whereas cumulative rainfall depths range from 280 to 700mm towards the west.

2.2 Stream Gauges

A number of stream gauges recorded water level data during the January 2011 flood event in the Lower Pine River catchment. The Gauge in Petrie did not record levels for this event. These gauges are spread throughout the catchment, as show in Figure 2-2.

The gauge level data for the gauges were obtained from Council and the Bureau of Meteorology's website. A list of the nine stream gauges and the gauge datum is provided in Table 2-1.

Table 2-1 List of Stream Gauges

Gauge Name	Gauge Datum (mAHD)
Cash's Crossing	6.525
Cedar Creek	62.248
Drapers Crossing	17.592
John Bray Park	9.006
Lawnton	0
Murrumba Downs	0
Normanby	-1.0
Samford Village	45.237
Young's Crossing	0

These gauges were used to compare time series water level results from the model with the recorded gauge data, enabling the performance of the model to be assessed in terms of both timing and magnitude of flooding. The Young's Crossing gauge malfunctioned during the peak of the flood event, so could only be used to compare water levels preceding the peak of the flood.

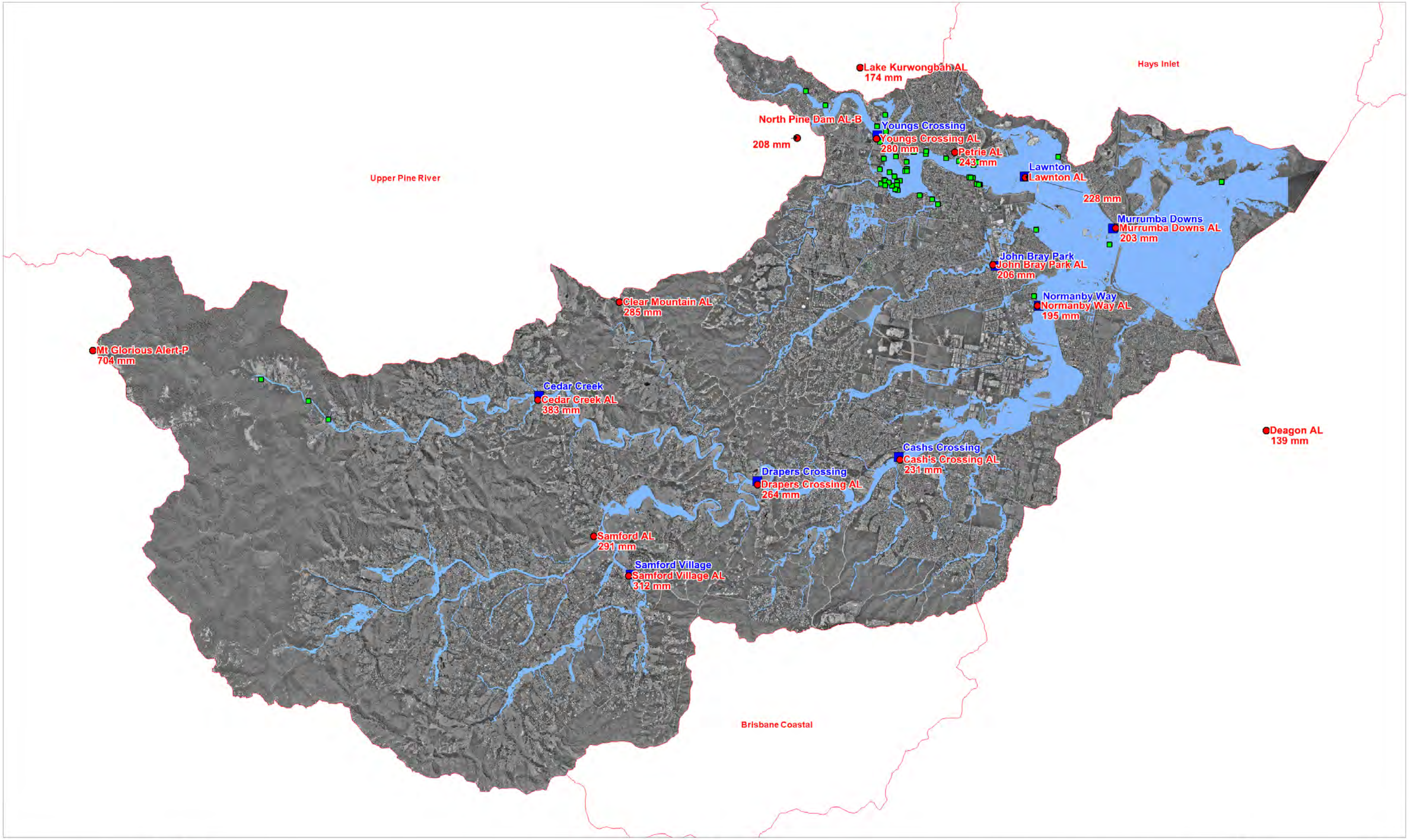
2.3 Surveyed Flood Marks

Council collected 57 surveyed flood marks for the January 2011 flood event; Figure 2-2 shows the locations. Of these flood marks:

- 49 were of medium quality derived from debris wrack marks; and
- 8 were of high quality derived from clearly defined wrack marks.

The majority of the flood marks were located on the North Pine River, and mostly between the Gympie Road and Young's Crossing bridges. There were only four flood marks in the South Pine catchment, with three in the upper reaches of Cedar Creek and one near the Normanby Way stream gauge.

These flood marks were compared against modelled peak flood level results during model calibration, thereby providing an indication of the model performance in terms of peak flood levels.



LEGEND

- Lower Pine River Catchment
- Modelled January 2011 Flood Extent (Adopted)
- Rainfall Gauges
  Total 4 day Rainfall Depth (mm) 9 to 12 January 2011
  (Except the Three Ways Gauge
  Located further outside the catchment)
- River Gauges
- Flood Marks January 2011 Event

Title:
Gauge Locations and Floodmarks utilised in the Model Calibration January 2011 Event Lower Pine River Catchment

Figure: **2-2**

Rev: **A**

N 0 2.5 5km
Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : I:\B18521_I_AK_MBRC_RFD_Stage_3\DRG\FLD_008_1212198_LPR_Rain_Stream_Gauges_Modelled.wor

3 HYDROLOGIC MODELLING

Council supplied a WBNM hydrologic model to BMT WBM, which was based on subcatchment delineation adopted by Council. The WBNM model was adapted to simulate the January 2011 flood event, by including 5 minute interval rainfall from the 17 rainfall gauges described in Section 2.1. The method used by WBNM to develop a hyetograph for each subcatchment is as follows:

i. For each subcatchment, the temporal pattern of the nearest rain gauge is adopted; and

ii. The total rainfall depth for each subcatchment is computed by applying a weighting to the depth of all surrounding rain gauges in the model. The weighting is based on the inverse square distance between each rain gauge and the centre of the subcatchment.

There is generally a reasonable spread of rainfall gauges around the catchment. However, there is a lack of rainfall data in the upper catchment of the South Pine River. This limitation in data availability is exacerbated in the upper Cedar Creek catchment, where rainfall depths change by 320mm over a gap of 11.5km (between the Mt Glorious and the Cedar Creek Gauges). The interpolation assumptions may produce modelled rainfall depths in the upper Cedar Creek catchment that deviate significantly from the actual rainfall that fell in the catchment.

The default values for the model setup were used for most of the WBNM parameters (i.e. nonlinearity exponent, stream routing). The adopted hydrological parameters are listed in Table 3-1.

Table 3-1 Hydrologic Model Parameters Calibration Event

Parameter	Value
Initial Loss	0mm
Continuing Loss	2.5mm/hr
Lag Factor	1.6

The WBNM model was simulated only once, with no further adjustment deemed necessary for calibration. The results of the WBNM model were then used as inflows in the hydraulic model.

4 HYDRAULIC MODELLING

A TUFLOW model was developed using various topographic, land use and structure data supplied by Council. The model was based on a 10m square computation grid. The AJ Wylie Bridge has undergone changes since the January 2011 flood event, so the dimensions of the bridge at the time of the flood event were used in the model.

The upstream boundary on the North Pine River is at the outflow of the North Pine Dam (Lake Samsonvale). The inflow for this boundary was extracted from the Seqwater report (Seqwater, 2011) on the North Pine Dam operation during the flood event.

Approximately 3km downstream of the North Pine Dam, outfalls from Lake Kurwongbah drain the Sidling Creek catchment into the North Pine River. Outflows from Council's Sidling Creek model for the January 2011 event were used as inflow boundaries in the model at the Lake Kurwongbah outfall.

For the remainder of the catchment, inflows for each subcatchment were derived from the Lower Pine River WBNM model. These inflows were applied at the lowest 2D grid cell (in terms of elevation) within each subcatchment at the first timestep in the simulation, and subsequently spread across all wet cells within the corresponding subcatchment (Source-Area approach in TUFLOW).

A head versus time downstream boundary was applied at the mouth of the Pine River. The downstream boundary conditions were based on predicted tide levels at the Brisbane Bar tidal gauge, which is 14km south of the Pine River mouth.

A number of alterations to the model setup were implemented to acquire a reasonable calibration. The model runs undertaken during the model calibration, the resolutions and remaining discrepancies are summarised in Table 4-1. Runs 4, 5, and 6 are the key runs with best model performance and detailed results of the flood marks and hydrograph comparisons for all gauges are provided in the Appendix D, E and F. These runs include the correct inflows to the South Pine River.

Runs 1, 2, 3, 7 and 8 were mainly undertaken to improve model calibration in the North Pine River. These model runs include incorrect (reduced) flows into the South Pine River, thus model results provided in the Appendices focus on the North Pine River area, the hydrograph comparison at the South Pine River gauges were not included in the Appendices.

There was no need to adjust the hydraulic roughness parameters that had previously been adopted by Council as part of Stage 2 of the RFD. A reasonable calibration was achieved by revising/updating topographic data, structure data and land use mapping.

Table 4-1 List of Hydraulic Model Runs

Adjustments	Resolutions	Residual Discrepancies/Issues
Run 1 – Results in Appendix A (LPR_002a_H _January_2011_047_10m.tcf)		
		• Considerable over prediction on the North Pine River between Young's Crossing and the Bruce Highway and on the lower reach of the South Pine River. This was primarily caused by too much backup of flow at the Bruce Highway Bridge. • Large head loss across some structures, such as the railway bridge on the North Pine River. This was attributed to incorrect bathymetry in the model under some structures, whereby the terrain modifiers in the model were creating small embankments under the structures. • Under prediction on Cedar Creek. At Cedar Creek gauge the river thalweg had a 'hump' of over 2m high controlling water levels. Council investigated this and did find some local silting up of the channel, but on a much smaller scale.
Run 2 – Results in Appendix B (LPR_002a_H _January_2011_048_10m.tcf)		
• Structure terrain modifiers were examined, and adjusted where necessary to ensure they did not inadvertently cause obstructions to flow. • The 2m high 'hump' in the Cedar Creek thalweg near Cedar Creek gauge was removed.	• Head loss across structures where terrain modifiers were adjusted had improved, but still looked too high in some instances. • Over prediction on the North Pine River reduced, but not enough.	• Considerable over prediction on the North Pine River between Young's Crossing and the Bruce Highway and on the lower reach of the South Pine River. This was primarily caused by too much backup of flow at the Bruce Highway Bridge. • Head loss across some structures, particularly the railway bridge on the North Pine River, were too large. • Large under prediction on Cedar Creek, leading to under prediction on the South Pine River at the confluence with Cedar Creek.

Adjustments	Resolutions	Residual Discrepancies/Issues
Run 3 – Results in Appendix C (LPR_002a_H _January_2011_050_10m.tcf)		
• Manning's n in the Pine River downstream of the confluence of the North and South Pine Rivers was reduced to 0.02. • Correction made to obvert level on Bruce Highway Bridge over the Pine River (raised by 0.88m). • Correction made at Gympie Road Bridge, the dimensions for the north and south bound lanes had been supplied the wrong way around. • Correction made to bridge form loss coefficients.	• Water levels upstream of the Bruce Highway Bridge on the Pine River dropped by over 2.5 meters, to within 70mm of recorded flood levels. Thus improving the calibration results along the North Pine River and lower South Pine River. • Head losses across the railway bridge on the North Pine River reduced to within realistic magnitudes. • Discrepancy on Cedar Creek was attributed to limitation in the rainfall data in the Cedar Creek catchment; discussed further in Section 5.2.	• Under prediction at Lawnton gauge. This could, in part, be attributed to crest levels of the river banks being 'missed' by the model resolution. A 0.5m head across the left bank into an adjacent lake was noted. • Peak flood levels upstream of a 'bottle neck' on the North Pine River near 122 Bray Road were over predicted in the model by up to 1m. The terrain in the 2D model in this area was based on LiDAR data. However, the river is relatively deep at the 'bottleneck'. Thus, the river bed levels inferred from the LiDAR data were too high, and the channel cross-sectional area significantly underestimated.
Run 4 – Results in Appendix D (LPR_002a_H _January_2011_072_10m.tcf)		
• Council supplied additional bathymetry data for the North Pine River to assist with resolving the issue raised in 'Run 3'. The bathymetry data includes elevations within the channel of -1 to -3mAHD (between Mungarra and Sweeney Reserves). • Breakline terrain modifiers representing riverbank crest levels near Lawnton gauge were added.	• Water levels in the vicinity of Mungarra Reserve and Ron Thomason Park reduced significantly, but were still over predicted. • Improved correlation between modelled and recorded levels at Lawnton gauge.	• Over prediction of peak flood levels of approximately 0.5m in the vicinity of Mungarra Reserve and Ron Thomason Park. This was believed to be attributed to morphological changes during the flood event. • Large over prediction of over 2m on a tributary to the North Pine River approximately 0.5km downstream of North Dine Dam (Floodmark LPR056).
Run 5 – Results in Appendix D (LPR_002a_H _January_2011_074_10m.tcf)		
• Council supplied an additional land use layer, to account for vegetation stripping during the flood event. This layer was exaggerated in order to gain an understanding of the sensitivity of the results to vegetation stripping.		• Rather than over predicting along the North Pine River, the model was now significantly under predicting flood levels on the North Pine River; by over 1m in the vicinity of Mungarra Reserve and Ron Thomason Park.

Adjustments	Resolutions	Residual Discrepancies/Issues
Run 6 – Results in Appendix E – *Adopted as the final calibration run* (LPR_002a_H _January_2011_075_10m.tcf)		
• Council supplied some revisions to the land use mapping. This included some slight changes to the creek waterbody extent, and conversion of dense vegetation to medium dense vegetation in some areas. • Manning's n reduced to 0.02 along the North Pine River downstream of the Gympie Road Bridge.	• Removed the over predictions of peak flood levels on the North Pine River in the vicinity of Mungarra Reserve and Ron Thomason Park. • Significantly reduced the over prediction of flood levels on a tributary to the North Pine River near Vores Road.	• 1.4m over prediction of flood levels on a tributary to the North Pine River approximately 0.5km downstream of North Dine Dam (Floodmark LPR056); discussed further in Section 5.3.
Run 7 – Results in Appendix F (LPR_002a_H _January_2011_056_10m.tcf)		
• Investigated sensitivity of results to 5m of vegetation stripping on each bank on the North Pine River, upstream of Murrumba Downs.	• Significantly reduced the over prediction of flood levels on a tributary to the North Pine River near North Dine Dam.	• 0.98m over prediction of flood levels on a tributary to the North Pine River approximately 0.5km downstream of North Dine Dam (Floodmark LPR056). • About 0.7m under prediction of flood levels in the Young's crossing area.
Run 8 – Results in Appendix G (LPR_002a_H _January_2011_057_10m.tcf)		
• Investigated sensitivity of results to 10m of vegetation stripping on each bank on the North Pine River, upstream of Murrumba Downs.	• Significantly reduced the over prediction of flood levels on a tributary to the North Pine River approximately 0.5km downstream of North Dine Dam.	• 0.46m over prediction of flood levels on a tributary to the North Pine River approximately 0.5km downstream of North Dine Dam (Floodmark LPR056). • About 1m under prediction of flood levels in the Young's crossing area.

5 DISCUSSION ON RESULTS

5.1 Overview

For each of the model runs listed in Table 4-1, the following result comparisons have been compiled:

1. Comparison of modelled water level hydrograph against recorded water level hydrograph at stream gauges in the catchment;
2. Histograms of the differences between the modelled peak flood level and surveyed flood marks; and
3. Maps of the flood marks showing differences between modelled peak flood levels and surveyed flood marks.

The results are included in the Appendices; Table 4-1 lists the Appendix number corresponding to each model run.

5.2 Stream Gauges

Young's Crossing – This gauge is located just 3km downstream of the North Pine Dam. The gauge malfunctioned at the peak of the flood. Therefore, it is not possible to infer the model performance in terms of peak levels at this gauge. Modelled levels match the recorded levels prior to the peak. This suggests that the model is accurately conveying flow in the upper reach of the North Pine River, and that the roughness parameters in the vicinity of the gauge are simulating flood levels well.

After the January 2011 event, Council had to move the location of the gauge, as it was relocated and buried in sedimentation. The changed location is of particular interest for any potential future flood events that may be used for calibration.

Lawnton – This gauge is located a further 6km downstream from Young's Crossing on the North Pine River. Initially the model was over predicting at this gauge, due to the issues at the Bruce Highway Bridge further downstream. After the bridge issues were resolved, water levels were under predicted at the Lawnton gauge. This under prediction was resolved in two ways:

i. Increasing the North Pine River conveyance upstream of Lawnton by including additional bathymetry; and
ii. A system of lakes lie on the right bank of the river in the vicinity of the gauge (north of Lawnton Pocket Road). The banks of the river control flows breaking out of bank and spilling into the lakes. A 0.5m head drop between the river and lake was noted during calibration. Due to the relatively coarse model resolution, the crest of the right bank was not consistently captured in the model topography. Thus, a breakline representing the bank crest levels was incorporated into the model.

After these modifications were included, the modelled peak flood level at the gauge was 0.23m below the recorded peak level. The general shapes of the modelled and recorded hydrographs also match well.

Murrumba Downs – This gauge is located upstream of the Bruce Highway Bridge across the Pine River, 4.5km downstream of Lawnton gauge. Initially, the obvert level and the way the form loss coefficients were being applied in the model were incorrect. As a result, the bridge was overly constrictive and the peak flood levels at the Murrumba Downs gauge was over predicted by more than 2.3m. After the bridge obvert was revised from 3.57mAHD to 4.45mAHD and the form loss coefficient application was corrected, the modelled peak flood level was similar to the recorded level. For the adopted calibration run, the modelled peak water level is 0.31m higher than recorded, and the general shapes of the modelled and recorded hydrographs match well.

John Bray Park – This gauge is located on a tributary of the South Pine River. Gympie Road and the Queensland railway cross this tributary immediately downstream of the gauge, and the tributary's confluence is 6.5km downstream of the gauge in close proximity to the North and South Pine River confluence and Bruce Highway Bridge. The flood behaviour at this gauge is driven by the local catchment conditions, and the modelled levels matched the recorded levels well throughout all model runs. For the final calibration run, the peak modelled flood level was 0.10m lower than recorded and the general shapes of the modelled and recorded hydrographs also match well.

Samford Village – This gauge is located at Samford Village in the upper South Pine River catchment. The peak flood level and timing of the peak is represented well in the model, with the model over predicting the peak flood level by 0.11m.

Cedar Creek – This gauge is located on Cedar Creek, a tributary of the South Pine River, approximately 200m upstream of the Mount Samson Road crossing. The model captures the lower water levels between peaks well, but the peak flood level is under predicted by 1.1m. This is believed to be due to insufficient rainfall being simulated in the hydrology model in the Cedar Creek catchment.

The total rainfall depth recorded (over the four days) at Cedar Creek gauge is 383mm. The next nearest gauge for the upper Cedar Creek catchment is 11.5km east, on the catchment divide at Mount Glorious, which recorded 704mm. Given this large change in rainfall depth, and the large under prediction in the peak flood levels, it appears that there is not enough rainfall in the upper Cedar Creek catchment in the hydrologic model. There is also a lack of rainfall gauges in the south-east of the catchment (no additional rainfall gauge to the east of the Samford gauge). It is likely that the interpolation procedure used by WBNM to assign rainfall depths to subcatchments between the rainfall gauges has significantly underestimated the rainfall that actually fell in the upper Cedar Creek catchment.

It is interesting to note that two of the three flood marks in the upper catchment, about halfway between the Cedar Creek and Mount Glorious gauges, indicate that the model is over predicting peak flood levels in the upper Cedar Creek catchment by 0.07m at floodmark LPR003 and 0.21m at floodmark LPR002, whereas the model is under predicting flood levels by about 0.41m at floodmark LPR001. This flood mark is located about 0.7km downstream of floodmark LPR002 and about 8.0km upstream of the Cedar Creek gauge. This demonstrates a discrepancy between the Cedar Creek gauge and the floodmarks.

It is concluded that the model calibration in the vicinity of Cedar Creek gauge is limited by a lack of rainfall data in the upper catchment. It is acknowledged that a better representation of rainfall could be developed by inspection of radar data. A similar approach was used for the Caboolture River model where a lack of rainfall data in the eastern part of the catchment occurred. For the Caboolture

River model radar data were obtained (from BoM) to further analyse the rainfall and model simulations were undertaken to “manually” increase the amount of rainfall in the eastern catchment; refer to the *Model Calibration Report Caboolture River Catchment* (BMT WBM, 2012). However, this process did not change the adopted calibration parameters; it focussed on a better representation of the rainfall during the flood event. Therefore, this approach was not repeated for the Lower Pine River model.

Drapers Crossing – This gauge is located at the confluence between Cedar Creek and the South Pine River. Apart from the peak flood level, the model simulates the recorded water levels well. The model under predicts the peak flood level by 0.28m. This under prediction during the peak of the flood (on 11th of January 2011) is linked to the under prediction in flow in the Cedar Creek catchment, as discussed above.

Cash’s Crossing – This gauge is located immediately upstream of the South Pine Road Bridge on the South Pine River, 6km downstream of Drapers Crossing gauge and about 7km upstream of the Normanby gauge. The flood level comparison between the modelled and the recorded levels match very well at the start of the flood event and at the onset of the peak. However, the recorded peak flood levels are about 1.1m lower than the modelled peak flood levels from the adopted calibration model run. It is noticeable that the gauge records show a drop in levels just before the peak (at about 1pm on 11 January). It is possible that this gauge was malfunctioning during the peak of the event. This theory is supported by the fact that the model under predicts the peak flood levels only by about 0.3m at the Drapers Crossing gauge (upstream), and by about 0.56m at the Normanby gauge (downstream) .

Consideration was also given to the constriction of the flood extent at the South Pine Road Bridge as a result of the elevated South Pine Road levels (about 15.5m) to the south of the bridge. The model representation of the South Pine Road Bridge was compared to design drawings and was considered acceptable. However, it would be beneficial to undertaken additional survey of the South Pine Road Bridge configuration and the road levels to the south of the bridge to confirm the drawings and river bank elevations (potential scouring during the flood event).

Normanby Way – Located 3.5km upstream of the North and South Pine River confluence, water levels at this gauge are influenced by tail water conditions at the confluence. At this location, flood levels match very well at the start of the flood event and the onset of the peak, however the model under predicts peak flood levels by about 0.56m, which is a significant difference. However, at the nearby flood mark (LPR054), the model under predicts peak flood levels only by 0.19m. Unfortunately, there were no additional flood marks available nearby along South Pine River.

5.3 Flood Marks

The following statistics are drawn from the differences in modelled and measured flood marks for the adopted calibration run:

- Of the 57 flood marks, three were more than 10m from the flood extent and were excluded from the flood mark comparison analysis.
- The maximum difference is an over prediction of 1.4m on a tributary 0.5km downstream of the North Pine Dam.

- The minimum difference is an under prediction of 1.4m at Hampstead Outlook, Murrumba Downs (LPR035), 1km upstream of the Murrumba Downs gauge. This appears spurious, as the modelled peak levels at this gauge is within 0.31m of recorded levels (the model is over predicting).
- The median difference is an under prediction of 0.04, and the mean difference is an under prediction of 0.06m.
- 46% of the flood marks are within 0.1m, 56% within 0.2m and 76% within 0.3m of the modelled peak flood levels.

This is considered to be a reasonably good overall agreement between modelled and measured peak flood levels at the flood marks.

There is one flood mark (ID LPR056) on a small tributary to the North Pine River at Vores Road in **Whiteside**, 0.5km downstream of the outfall of the North Pine Dam. The model is significantly over predicting the flood level at this point, by 1.4m (for run 6). Flooding at this point is from North Pine River backwater. Therefore, this indicates that flood levels in the upper reach of the North Pine River in the model are over predicted. The river banks are lined with dense vegetation. With nearly 3,000m^3/s released through this confined (150m wide) portion of the river, it is likely that significant vegetation stripping and morphological changes occurred during the flood. Run 8 considers modest bank vegetation stripped away by one grid cell (10m) on each bank. The results showed a large reduction in flood levels, with the flood level at the Vores Road flood mark reducing by 0.93m; resulting in an over prediction of 0.46m. Therefore, it considered that the over prediction at Vores Road in Whiteside is likely to be due to vegetation stripping (and possibly morphological changes) that occurred during the flood event.

Flood marks surrounding **Young's Crossing** gauge suggest that the model is under predicting peak flood levels in this area by approximately 0.4m to 0.5m. The gauged levels suggest that the model performs well subsequent to the flood peak. The under estimation at the peak of the flood may be due to a combination of an over estimate in upstream attenuation due to vegetation stripping and debris blockage at Young's Crossing.

There is a concentration of about 24 flood marks surrounding the **Mungarra Reserve and Ron Thomason Park area** up towards Young's Crossing. Initially the model was over predicting peak flood levels by approximately 1m in this area. Inspection of the results indicated that water levels in this area were controlled by a constriction in the floodplain near 122 Bray Road. Since the river channel and floodplain is incised at the constriction, Council provided additional bathymetry for this part of the North Pine River. Subsequent to including the bathymetry, the model was still over predicting levels by approximately 0.5m. This was attributed to some incorrect allocation of landuse types, whereby some areas of medium dense vegetation had been defined as dense vegetation. Correcting the land use definitions resulted in a good fit between modelled and measured flood levels, with the model over predicting by approximately 0.03m in average.

There are 10 flood marks surrounding **the Sweeney Reserve and Gympie Road Crossing area** on the North Pine River. At the western edge of Sweeney Reserve, one flood mark matched the modelled peak flood level to within 20mm. This flood mark is of high quality, and was provided by a local resident. A further 340m downstream another floodmark (medium quality) was 0.39m higher than the modelled peak flood level. And then a further 340m downstream, at the railway bridge, there are four flood marks where the model has under predicted flood levels by approximately 0.4m. At the Gympie Road Bridge (200m downstream of the railway bridge), the model is over predicting flood levels by 0.12m. The form loss coefficient at the railway bridge is relatively high (0.76), due to there being many piers spaced every 12m to 22m across the 300m span. It is likely that these piers trapped debris during the flood, and that the 0.4m under prediction is due to blockage at the structure.

In the vicinity of the Lawnton, Murrumba Downs and Normanby Way gauges (i.e. near the **confluence between the North and South Pine Rivers**) there are 8 flood marks. Some of these flood marks suggest that the model is significantly under predicting flood levels (by 0.1m to 1.4m), others indicate an over prediction of 0.1m to 0.6m. However, the more reliable gauged levels suggest the model is under predicting by 0.23m at Lawnton gauge, over predicting by 0.31m Murrumba Downs gauge and under predicting by 0.56m at Normanby Way gauge. Therefore, the quality of flood marks in this area is questionable, and discrepancies of more than 0.5m between modelled and measured levels at these flood marks have been disregarded.

6 CONCLUSION

The Lower Pine River WBNM hydrologic and TUFLOW hydraulic models were set up to simulate the January 2011 flood event. This historical event was used to calibrate the hydraulic model. Council provided historical flood data for the January 2011 flood event in the form of recorded water level hydrographs at nine stream gauges and 57 surveyed flood marks based on wrack marks identified shortly after the flood event. The availability of a large number of gauges, 17 rainfall and nine river gauges, and the location of these being well spread over the catchment provided a good data set for model calibration. The flood marks were mainly collected on the North Pine River, enabling a good calibration in this part of the model.

After making a number of revisions/adaptions to the TUFLOW model, a reasonable calibration has been achieved given the available data for the January 2011 flood event. Residual discrepancies between modelled and measured data do exist, but these have been justified as follows:

- Lack of rainfall data in the Upper Cedar Creek catchment;
- Vegetation stripping and possibly morphological changes on the upper North Pine River;
- Malfunctioning of the Young's Crossing and possibly at the Cash's Crossing gauge during the peak of the flood event; and
- Debris blockage at Young's Crossing and the North Pine River Railway Bridge.

Based on this calibration assessment, the model is deemed suitable for determining design flood levels across the Lower Pine River catchment, in particular in the North Pine River. The model under predicts flood levels in particular in the vicinity of the Normanby Way gauge, along South Pine River .

It is recommended that additional rainfall gauges are installed in the western part of the catchment along Cedar Creek to improve rainfall data capture and potential future model calibration.

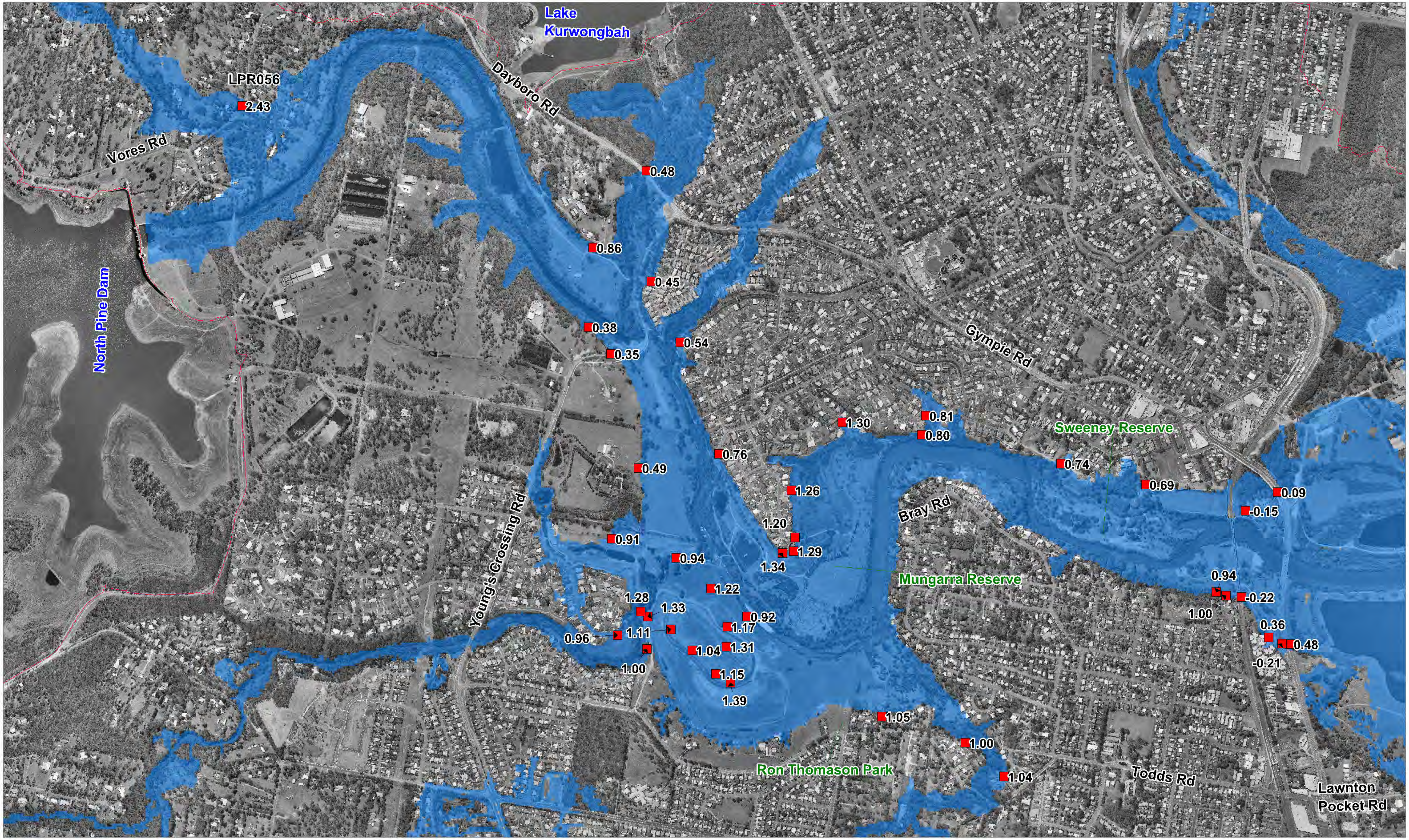
7 REFERENCES

BMT WBM (2011): *Calibration Feasibility Report, Lower Pine River Catchment, Regional Floodplain Database Stage 3, September 2011*

BMT WBM (2012): *Model Calibration Report Caboolture River Catchment, Regional Floodplain Database Stage 2, June 2012*

Seqwater (2011): *January 2011 Flood Event: Report on the operation of the North Pine Dam, 11 March 2011*

APPENDIX A: RUN 1 RESULTS



LEGEND

- Lower Pine River Catchment
- Modelled January 2011 Flood Extent
- Flood Marks January 2011 Event
  0.03 Difference in Peak Flood Levels in m (Modelled Minus Surveyed)

Title:

January 2011 Event Flood Mark Comparison
Run 1 Lower Pine River Catchment

Figure: **A-1**

Rev: **-**

N

0 250 500m
Approx. Scale

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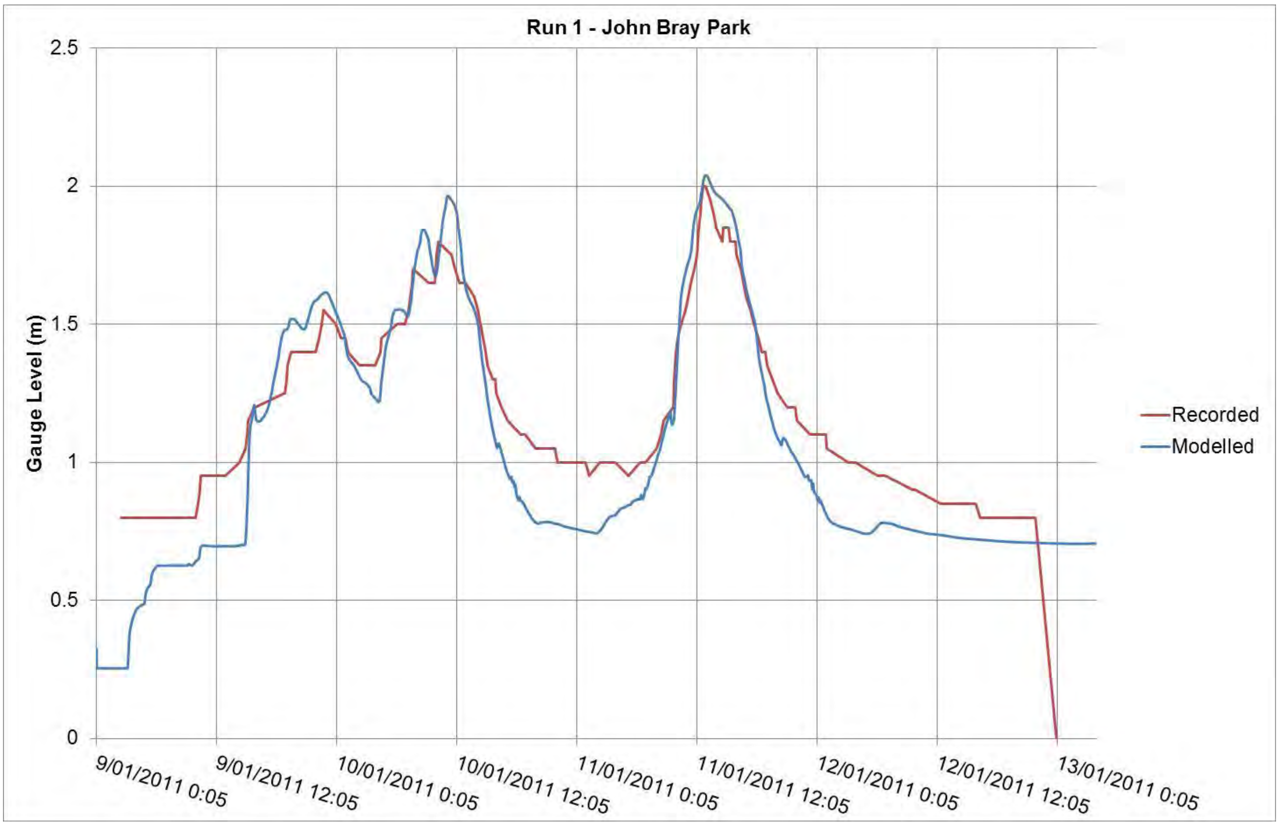
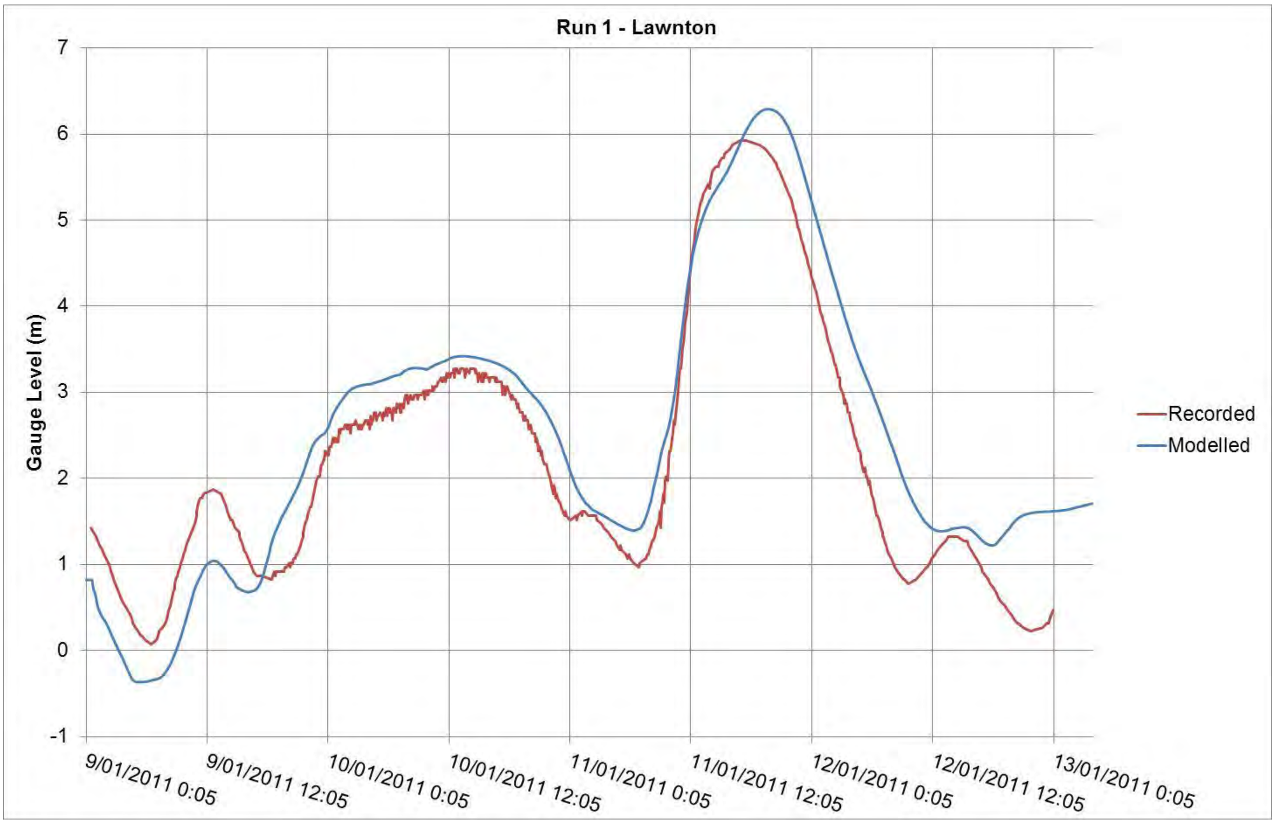
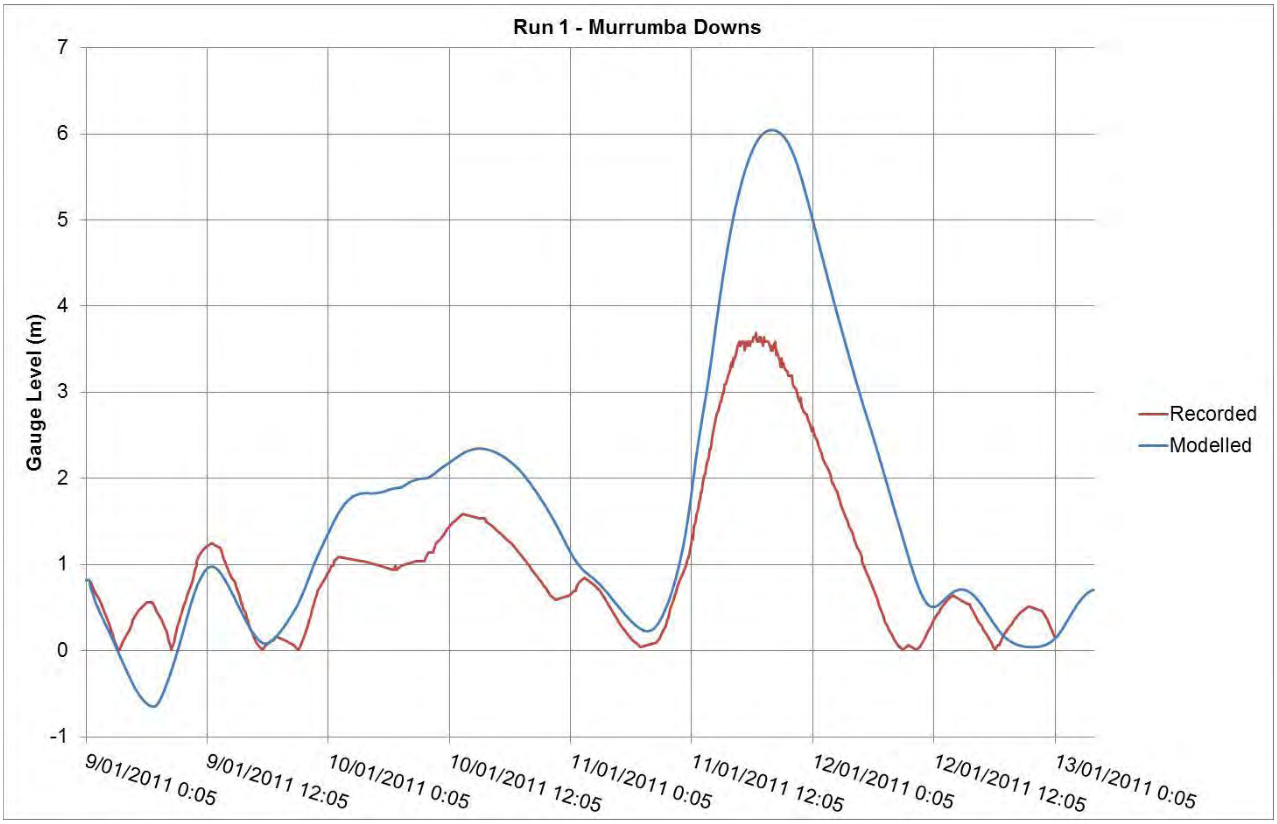
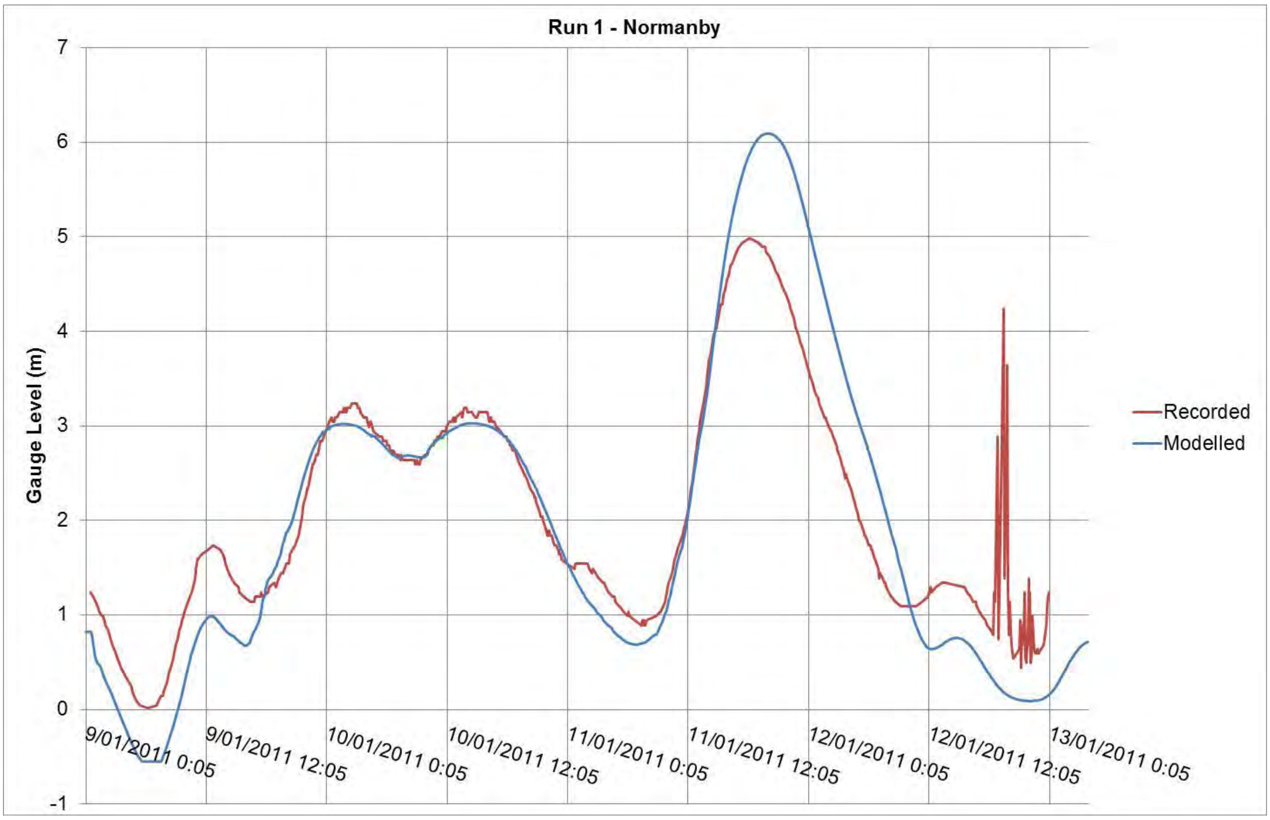
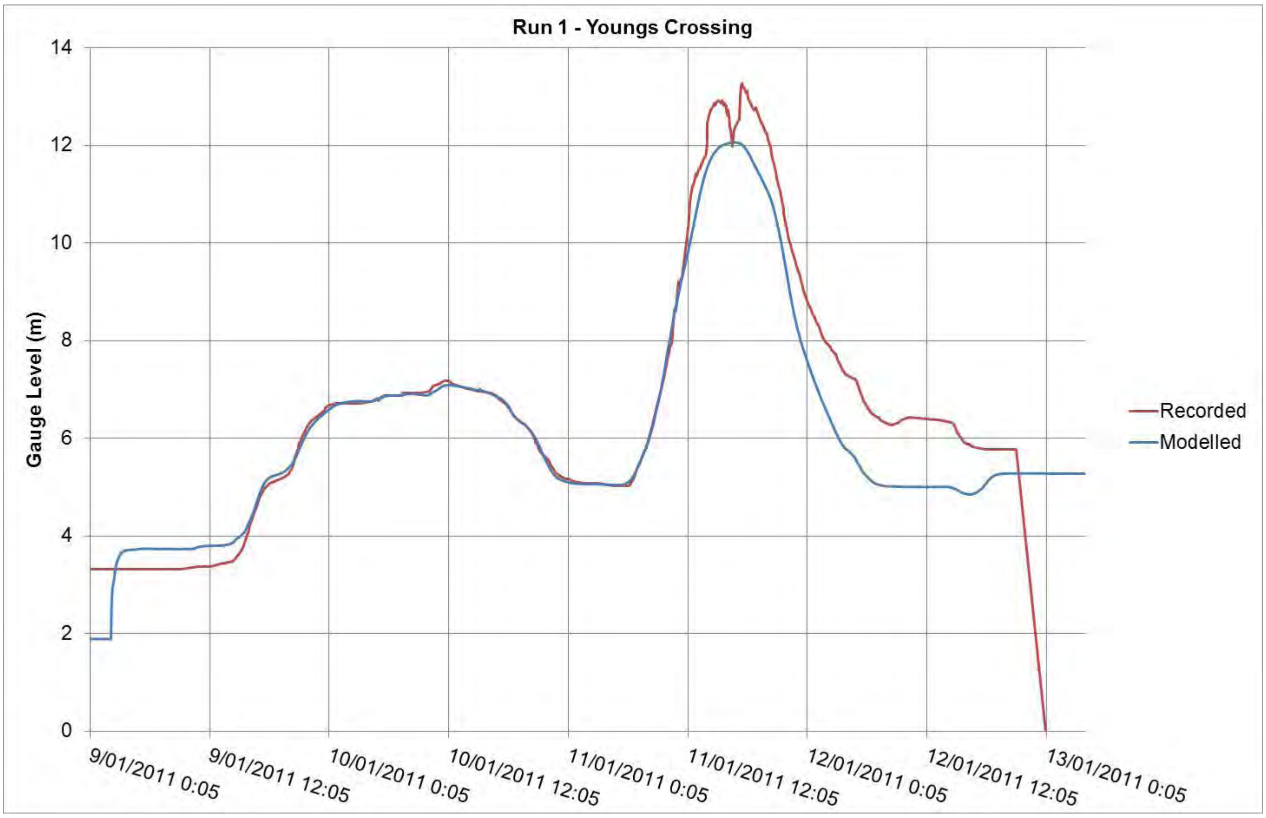
Filepath : I:\B18521_I_AK_MBRC_RFD_Stage_3\DRG\Calibration\FLD_010_121219_LPR_Calibration_Results_F1.WOR

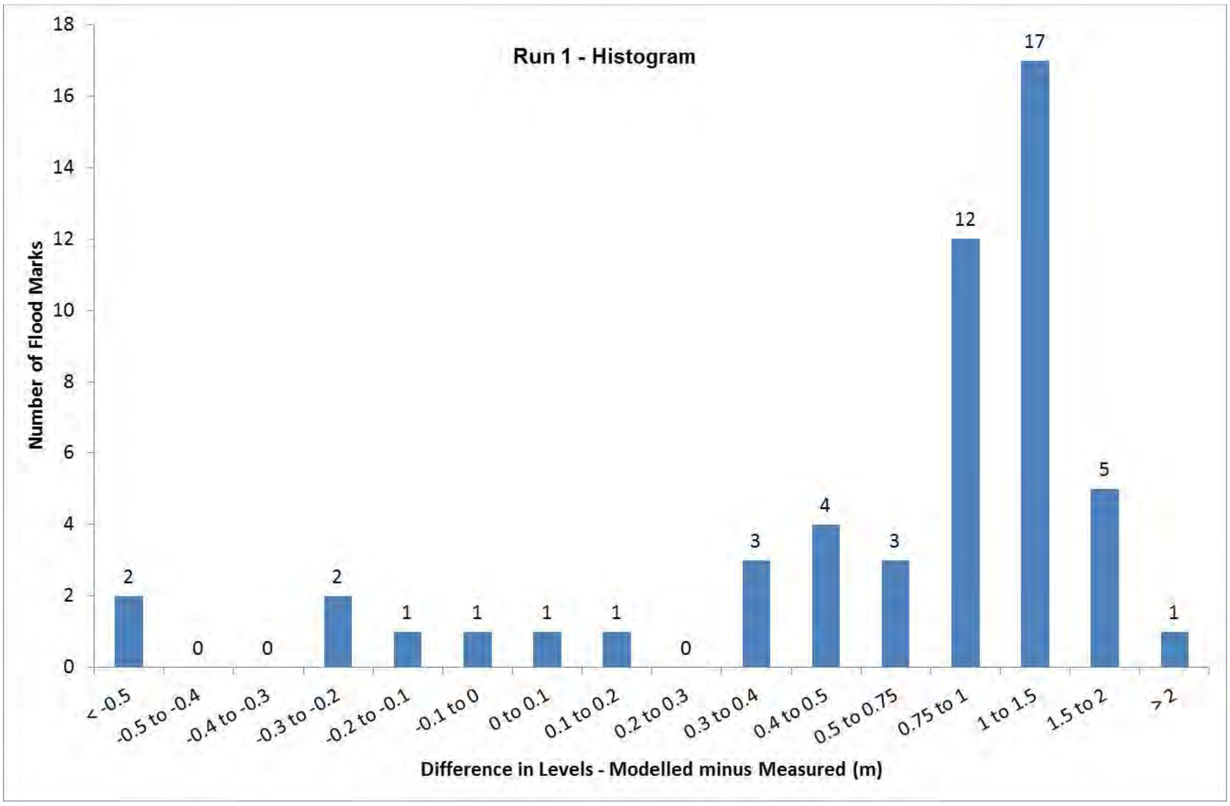

Run 1 - John Bray Park
Gauge Level (m)
2.5
2
1.5
1
0.5
0
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 1 - Lawnton
Gauge Level (m)
7
6
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

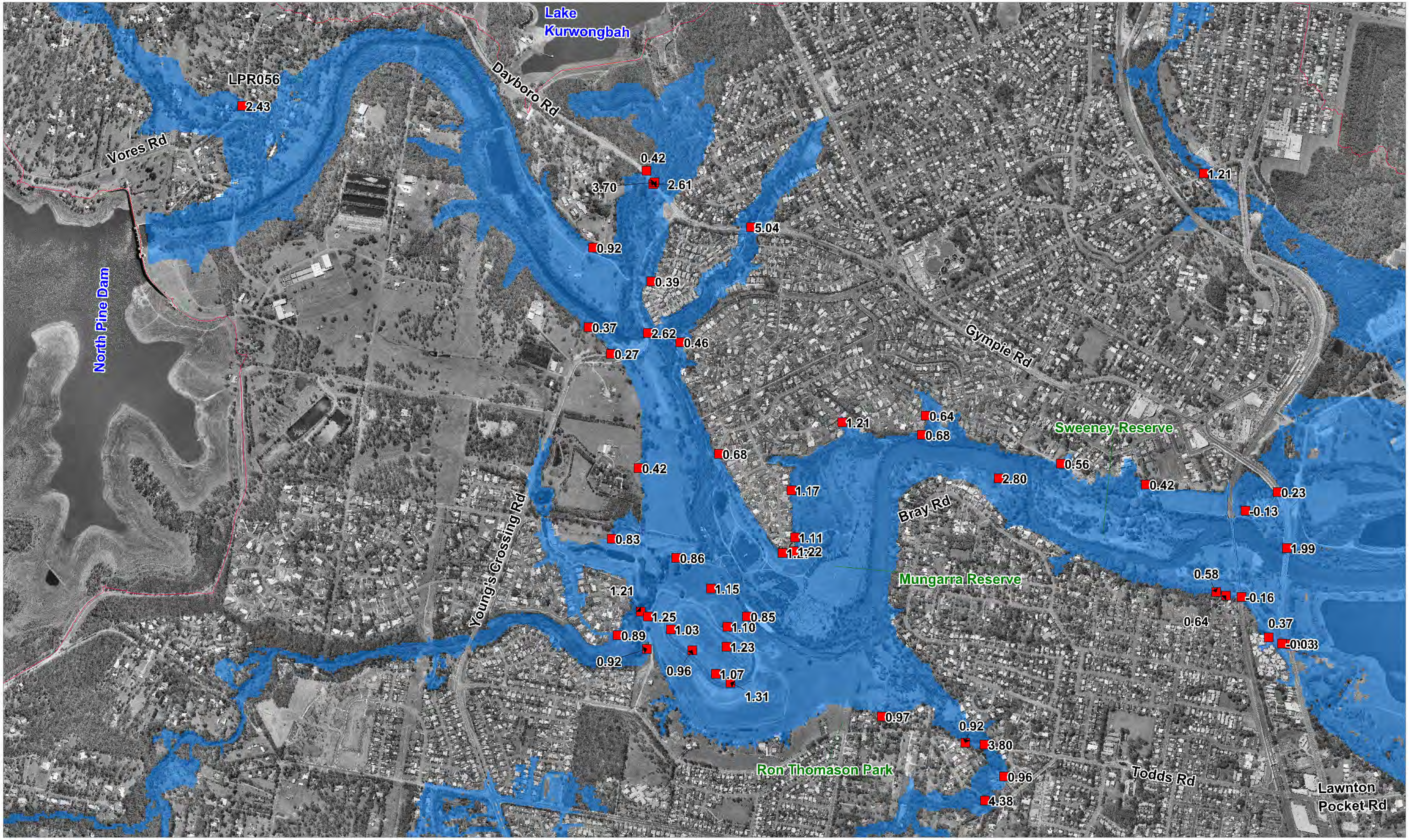

Run 1 - Murrumba Downs
Gauge Level (m)
7
6
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 1 - Normanby
Gauge Level (m)
7
6
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 1 - Youngs Crossing
Gauge Level (m)
14
12
10
8
6
4
2
0
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 1 - Histogram
Number of Flood Marks
Difference in Levels - Modelled minus Measured (m)
< -0.5: 2
-0.5 to -0.4: 0
-0.4 to -0.3: 0
-0.3 to -0.2: 2
-0.2 to -0.1: 1
-0.1 to 0: 1
0 to 0.1: 1
0.1 to 0.2: 1
0.2 to 0.3: 0
0.3 to 0.4: 3
0.4 to 0.5: 4
0.5 to 0.75: 3
0.75 to 1: 12
1 to 1.5: 17
1.5 to 2: 5
> 2: 1

APPENDIX B: RUN 2 RESULTS



LEGEND

Lower Pine River Catchment

Modelled January 2011 Flood Extent

Flood Marks January 2011 Event
0.03 Difference in Peak Flood Levels in m (Modelled Minus Surveyed)

Title:
January 2011 Event Flood Mark Comparison
Run 2 Lower Pine River Catchment

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 250 500m
Approx. Scale

Figure: **B-1**

Rev: **-**

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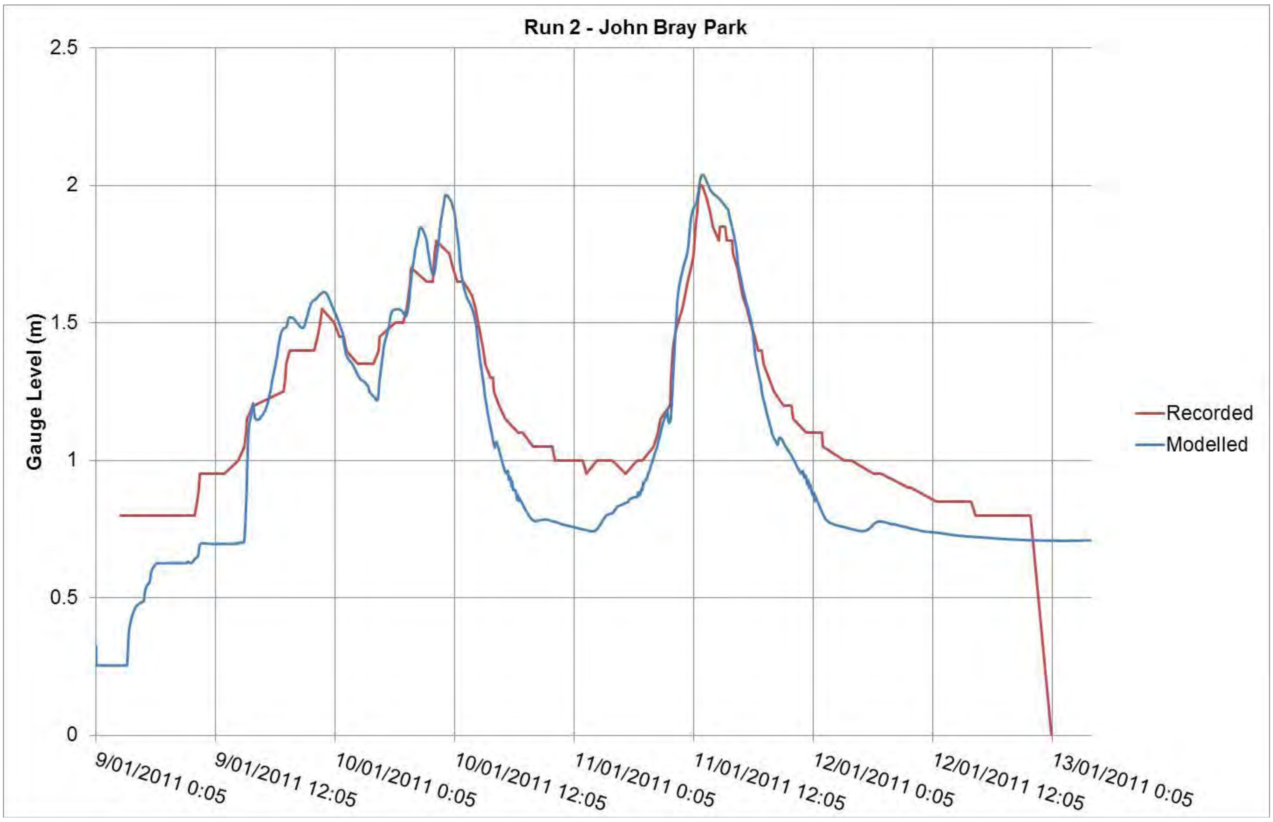
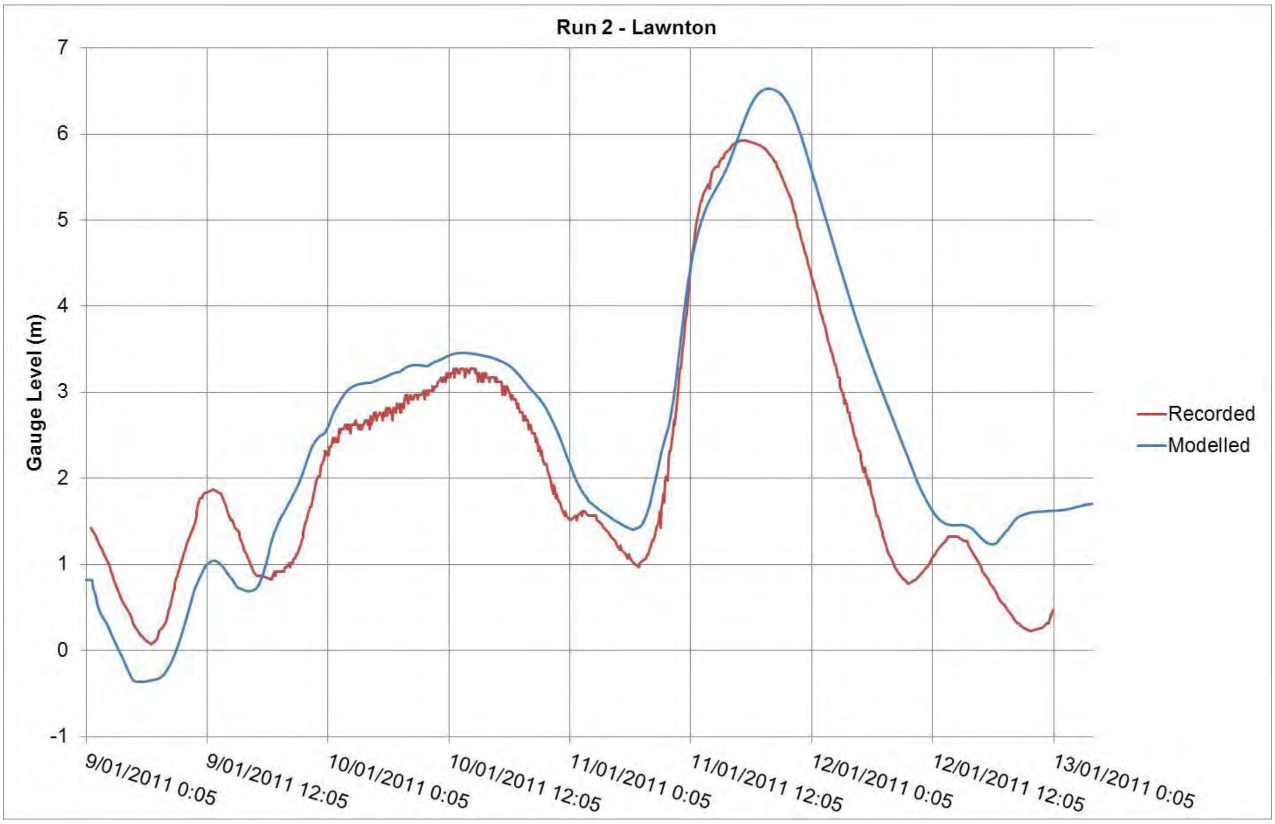
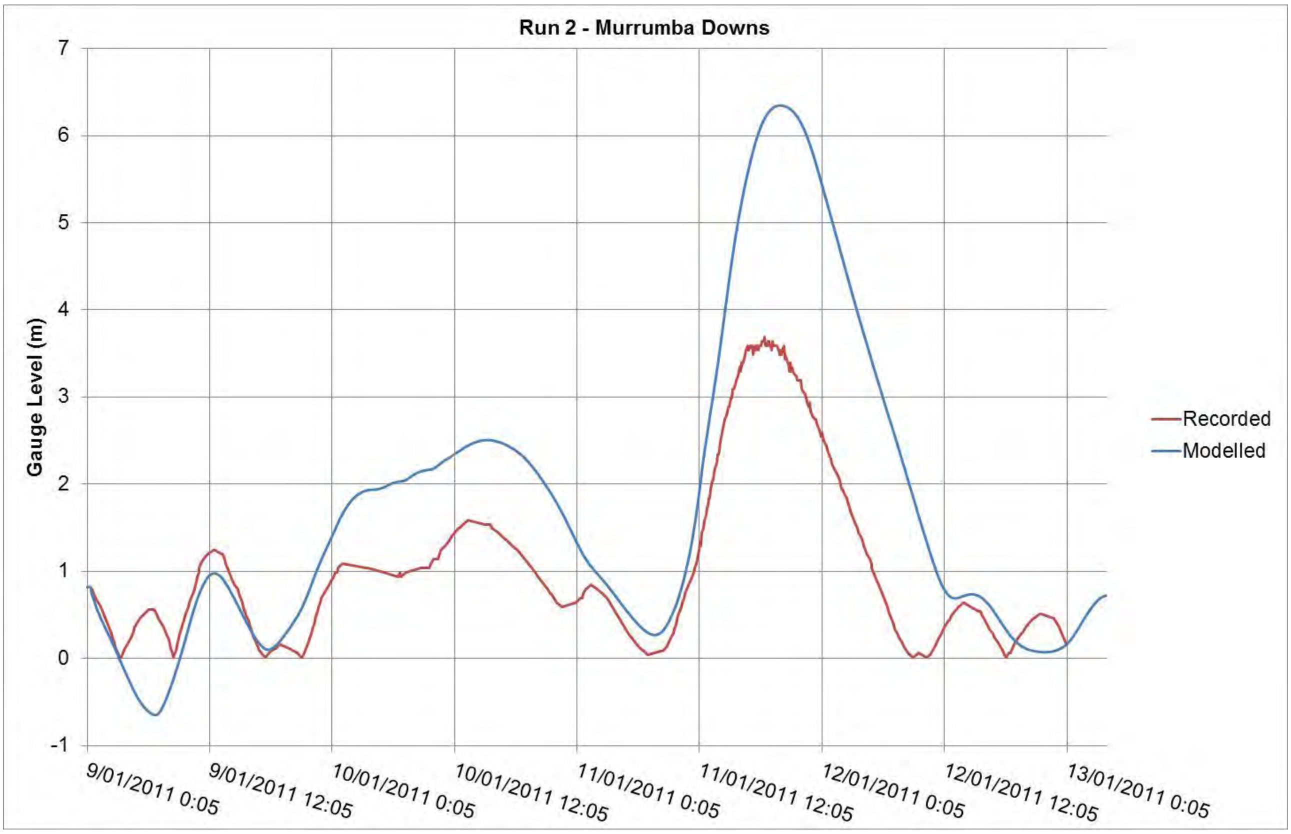
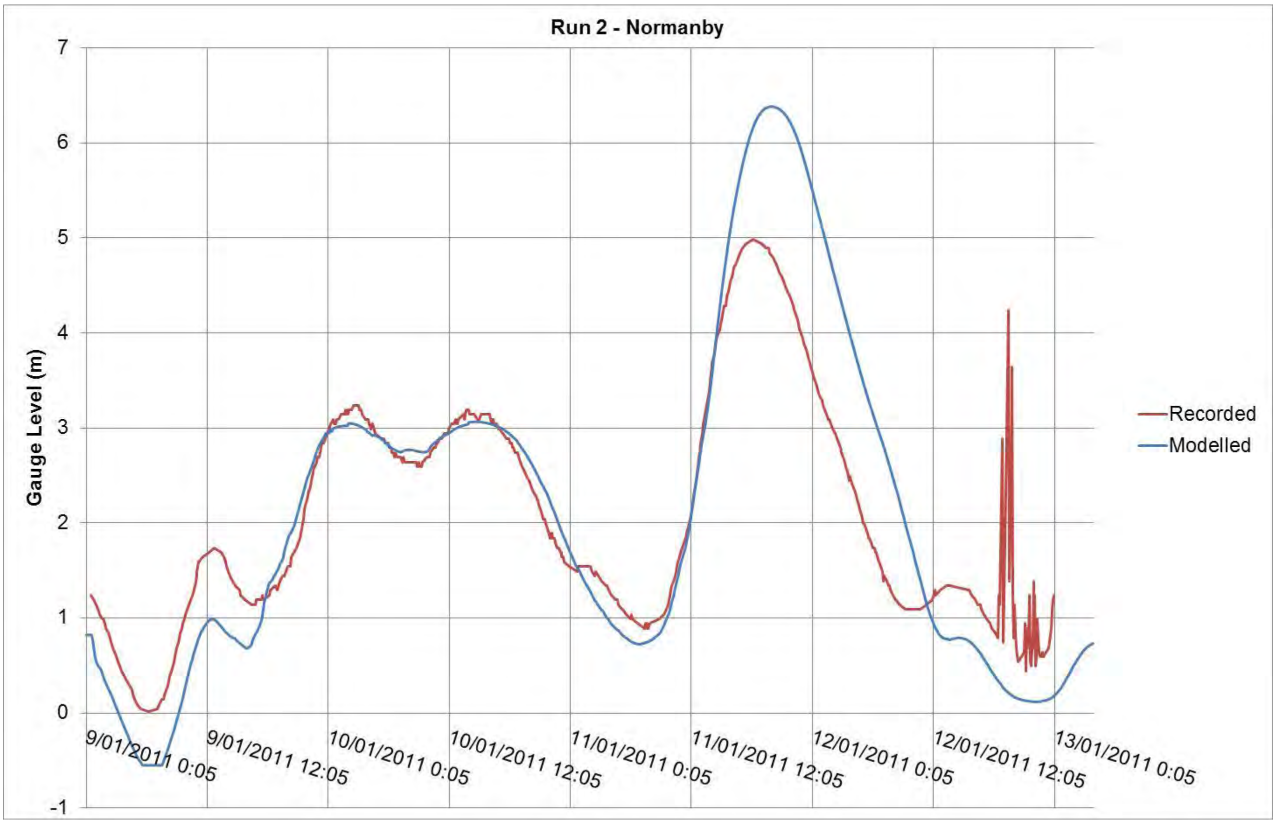
Filepath : I:\B18521_I_AK_MBRC_RFD_Stage_3\DRG\Calibration\FLD_011_121219_LPR_Calibration_Results_F2.WOR

B-3 Run 2 Results

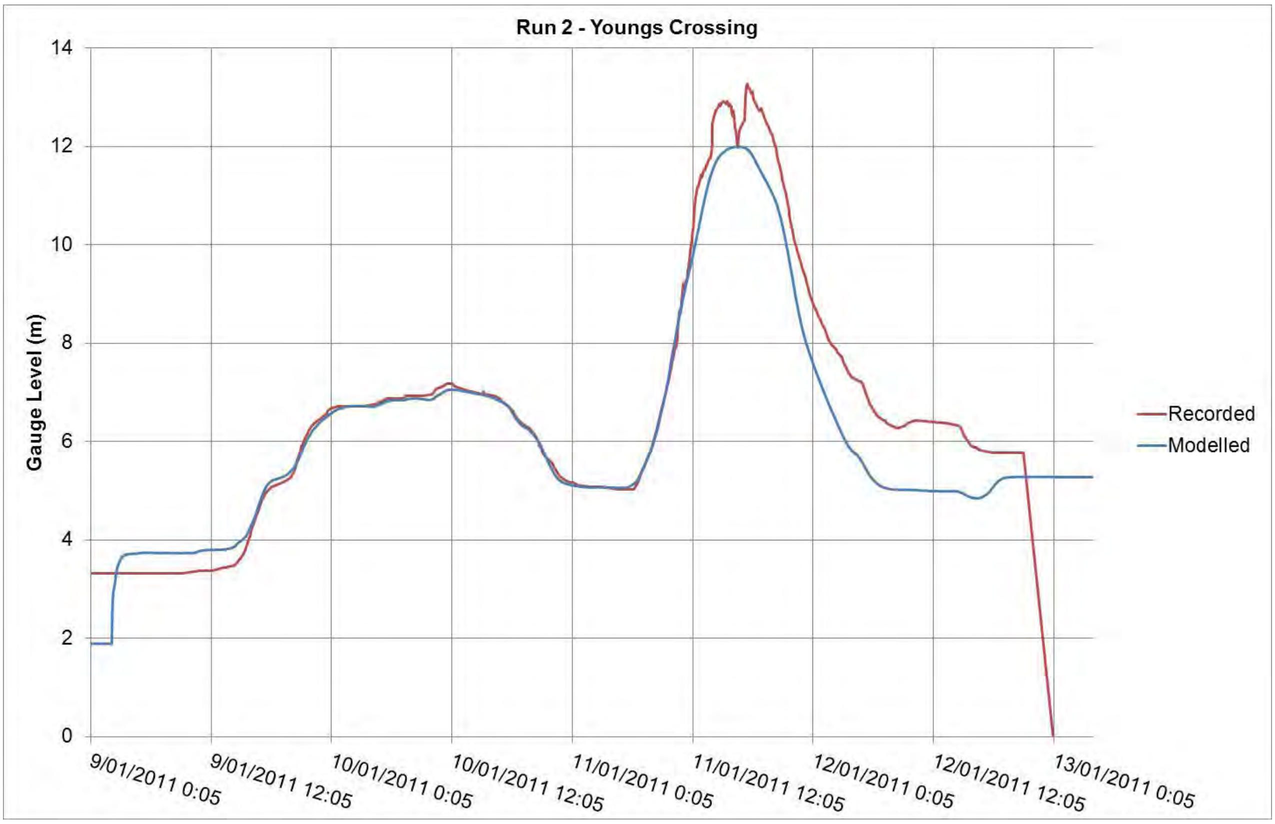


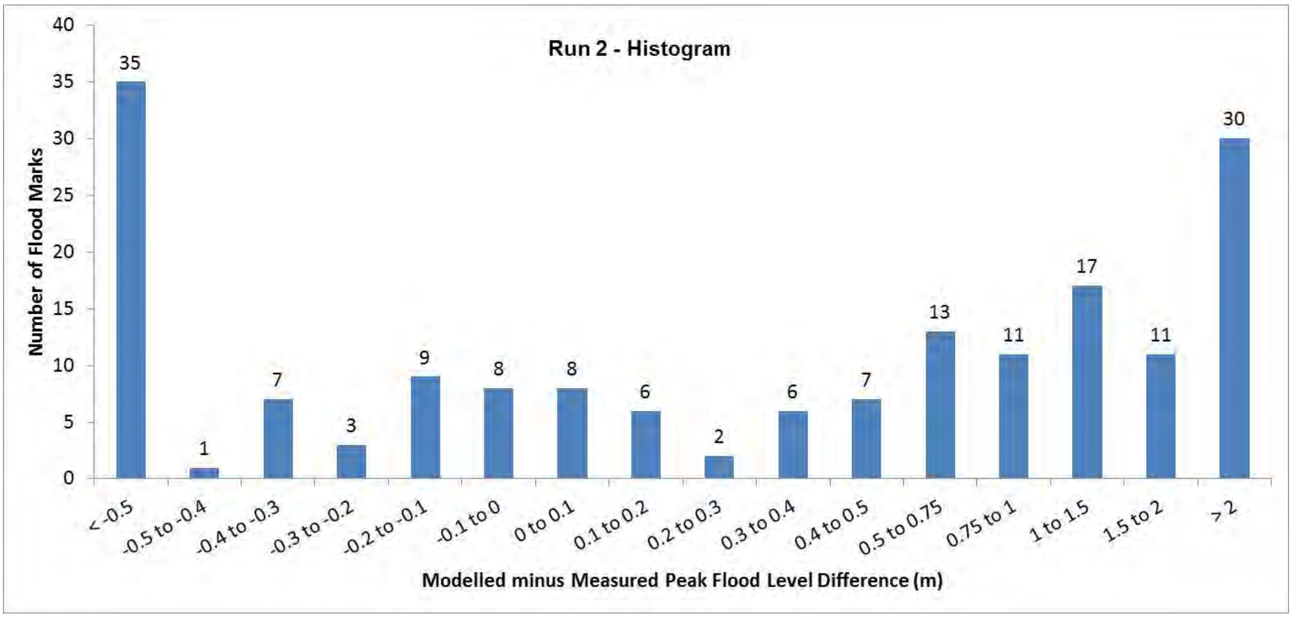



Run 2 - Murrumba Downs
Gauge Level (m)
7
6
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

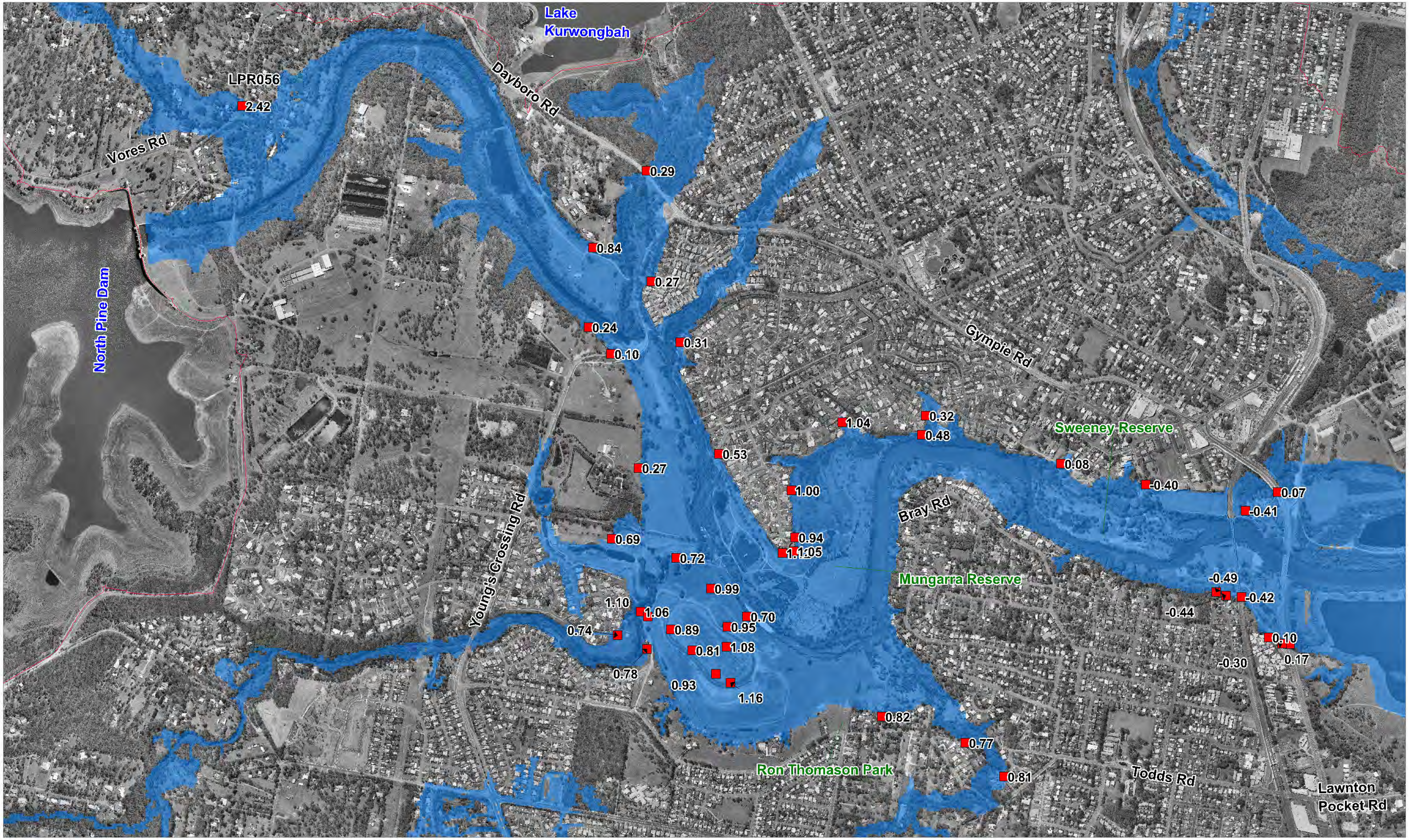

Run 2 - Normanby
Gauge Level (m)
7
6
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

B-5 RUN 2 RESULTS





APPENDIX C: RUN 3 RESULTS



LEGEND

Lower Pine River Catchment

Modelled January 2011 Flood Extent

0.03 Flood Marks January 2011 Event Difference in Peak Flood Levels in m (Modelled Minus Surveyed)

Title:

January 2011 Event Flood Mark Comparison
Run 3 Lower Pine River Catchment

N

0 250 500m
Approx. Scale

Figure: C-1

Rev: -

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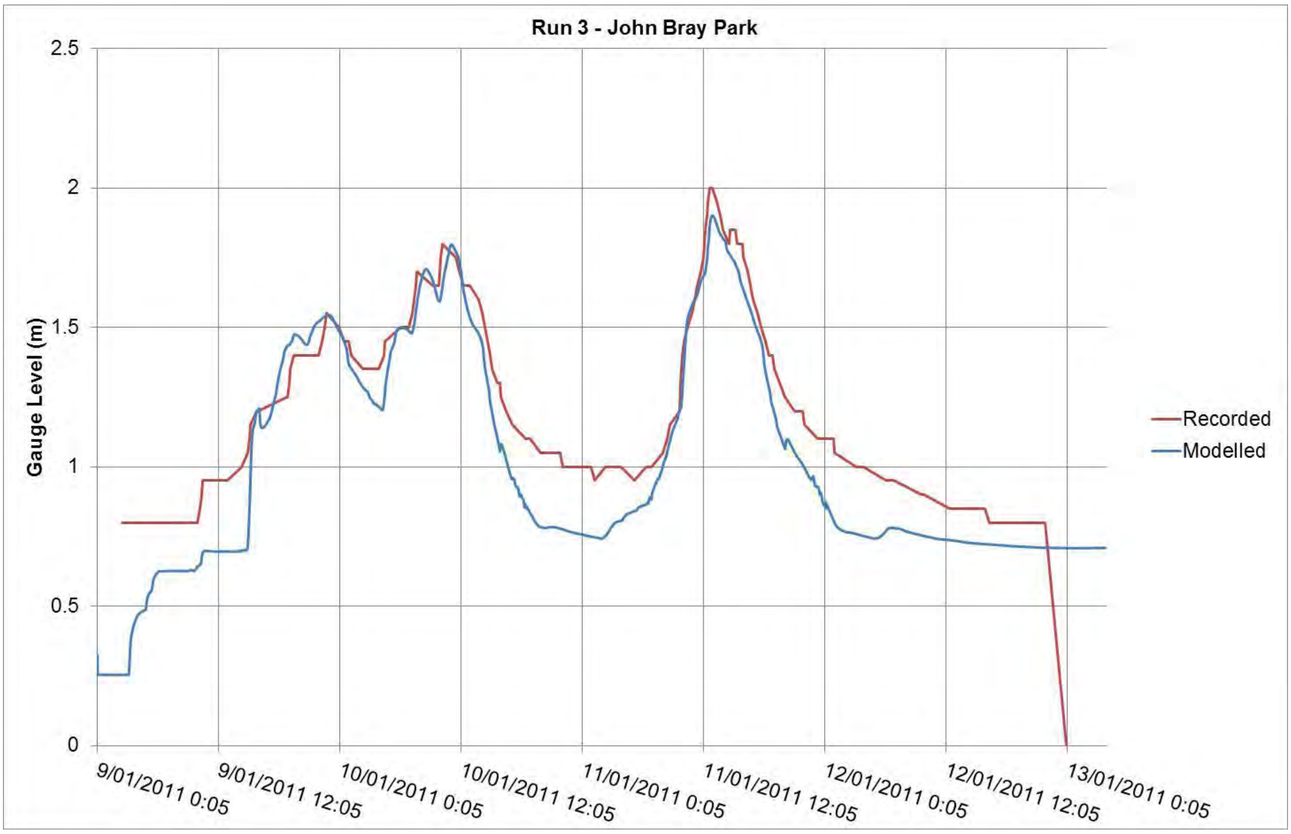
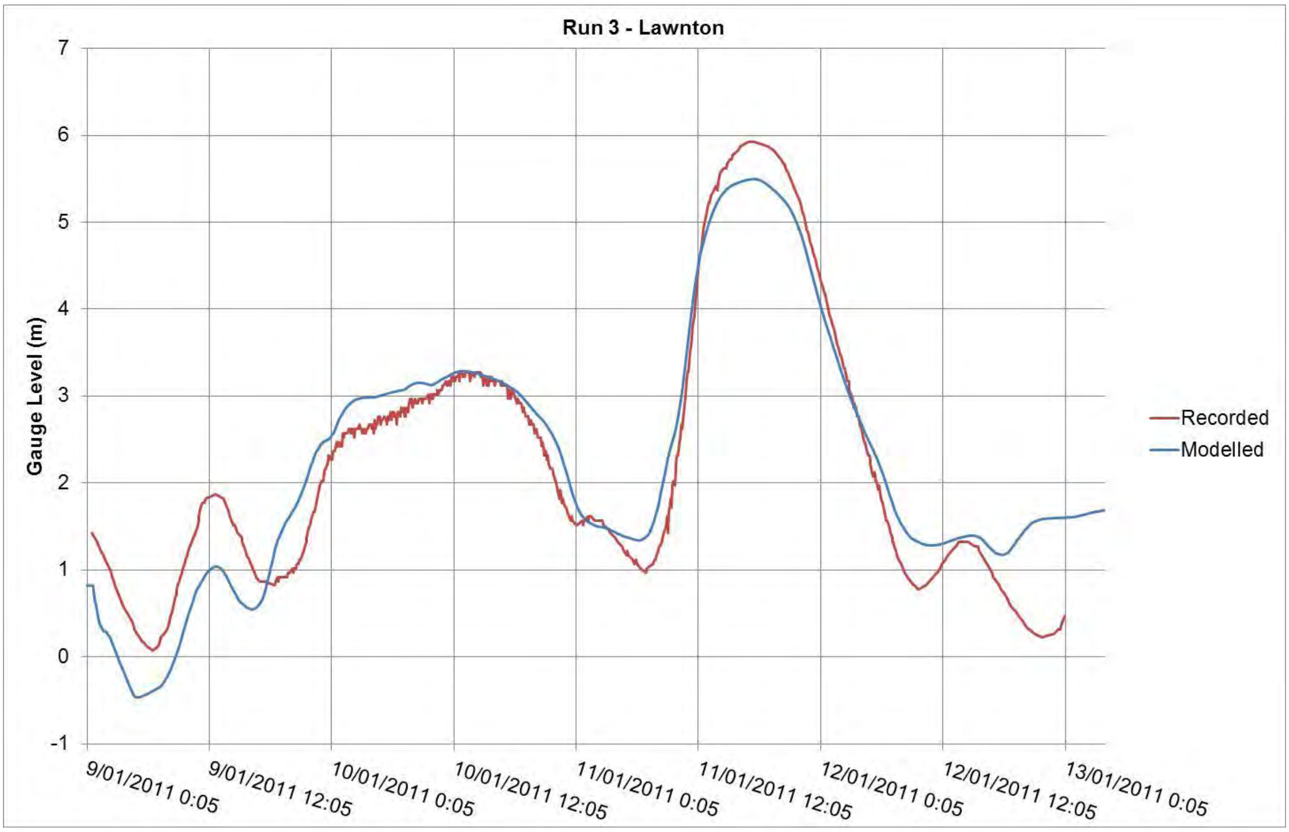
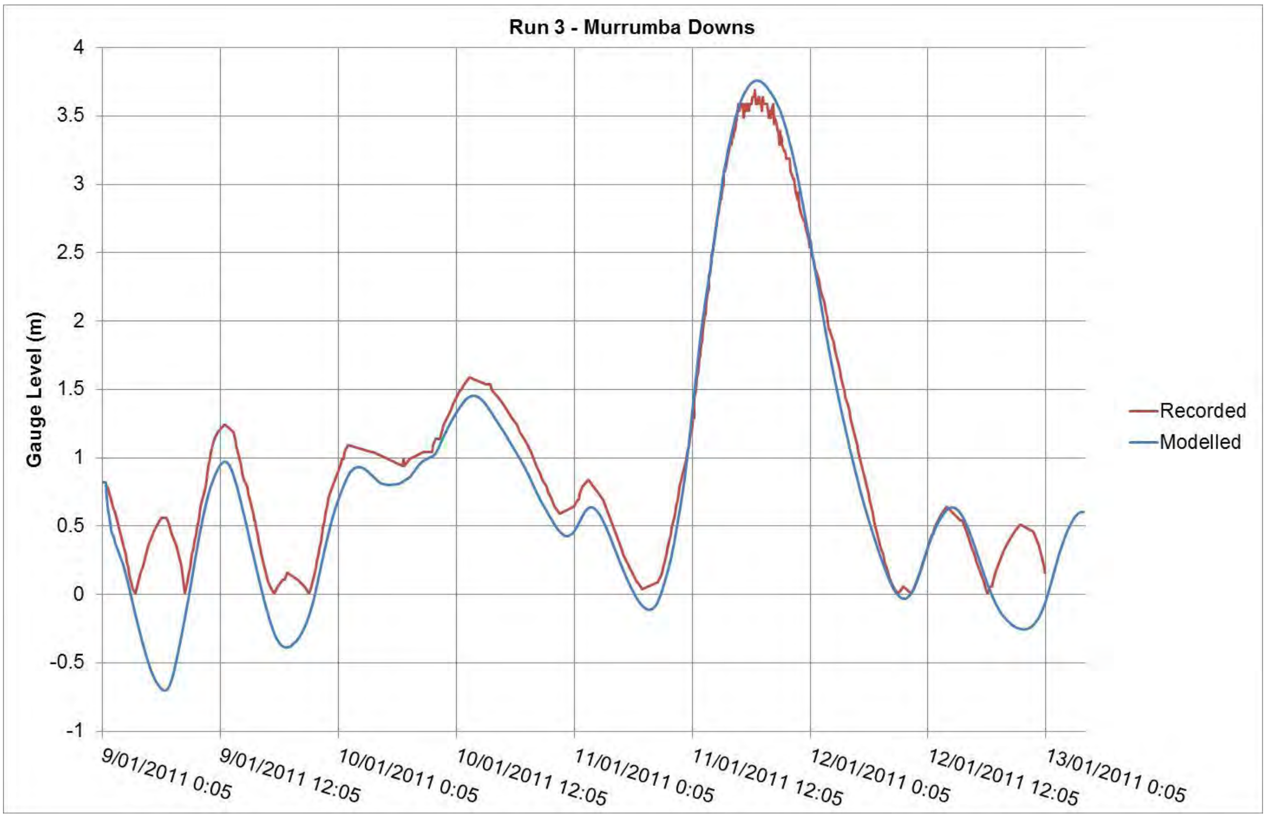
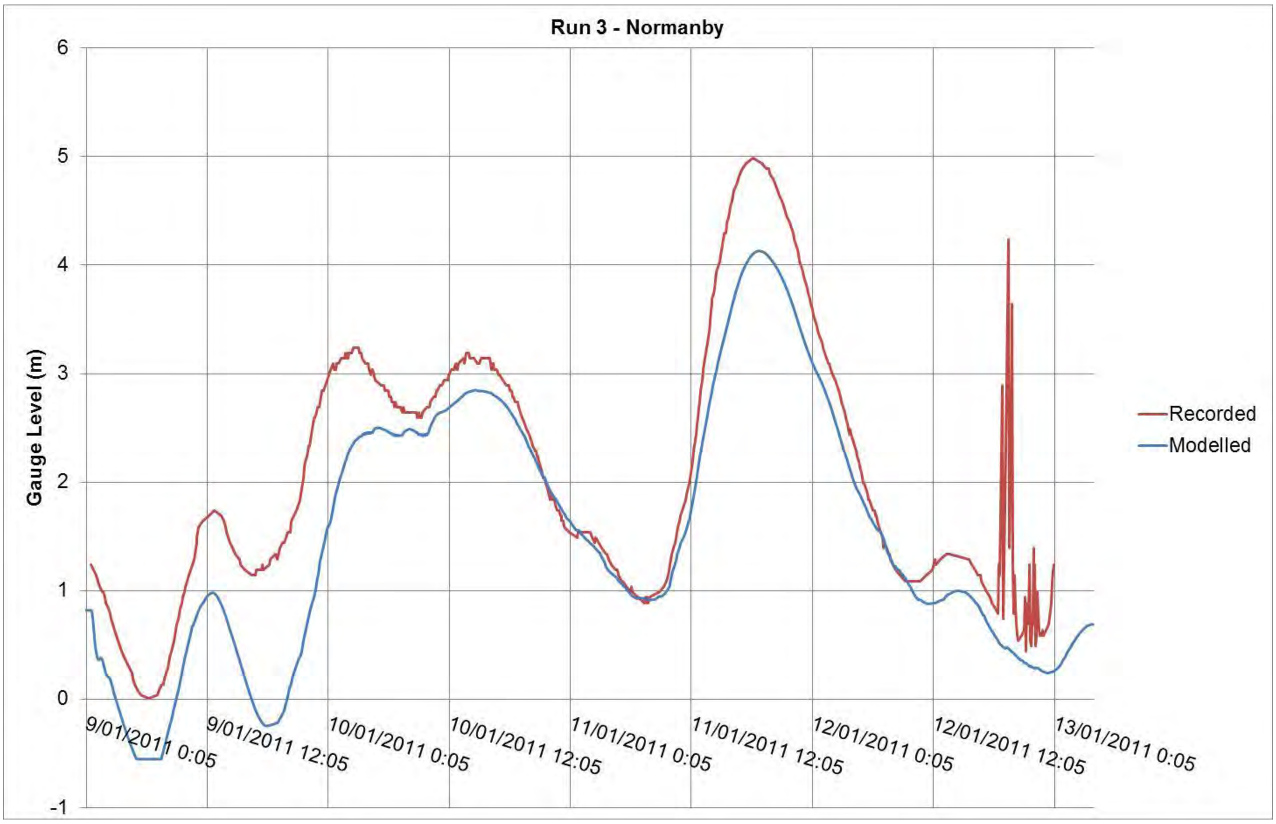
Filepath : I:\B18521_I_AK_MBRC_RFD_Stage_3\DRG\Calibration\FLD_012_121219_LPR_Calibration_Results_F3.WOR


Run 3 - John Bray Park
Gauge Level (m)
2.5
2
1.5
1
0.5
0
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

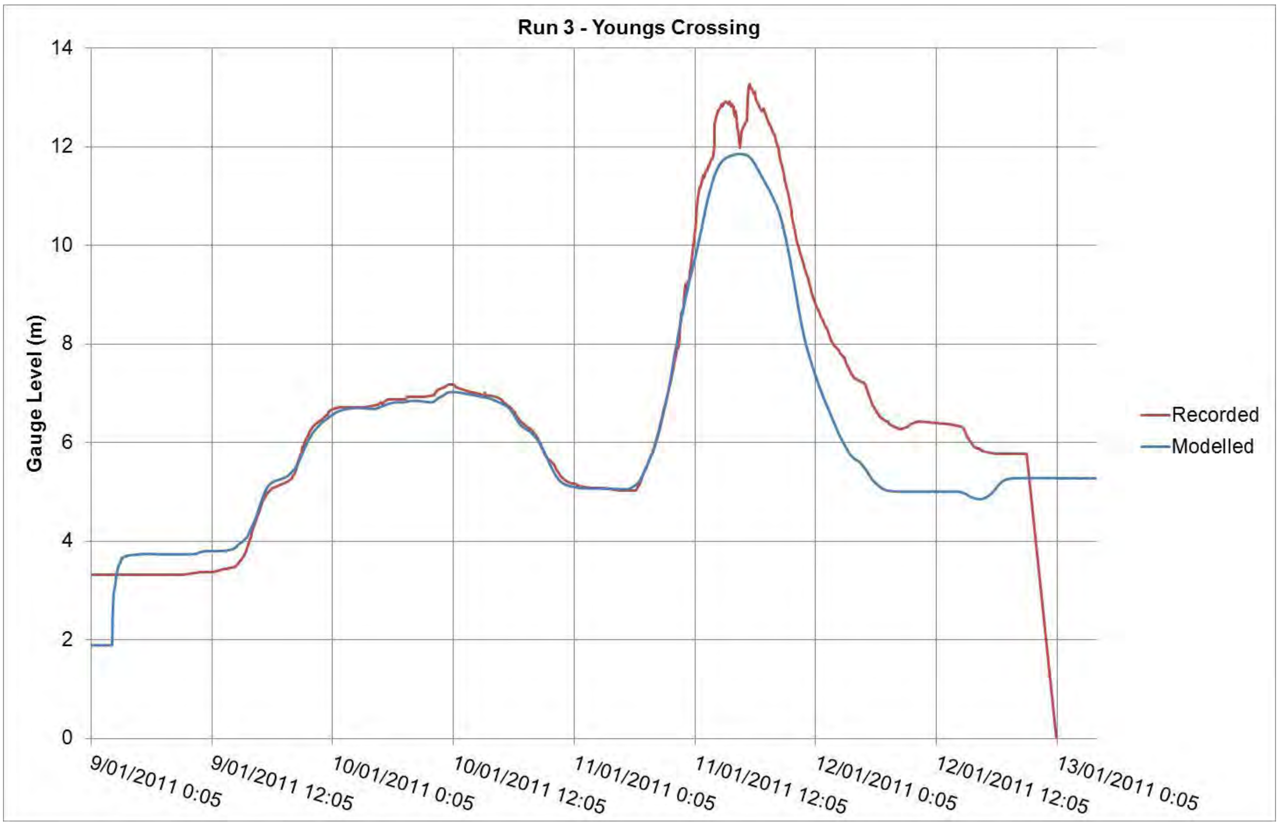

Run 3 - Lawnton
Gauge Level (m)
7
6
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

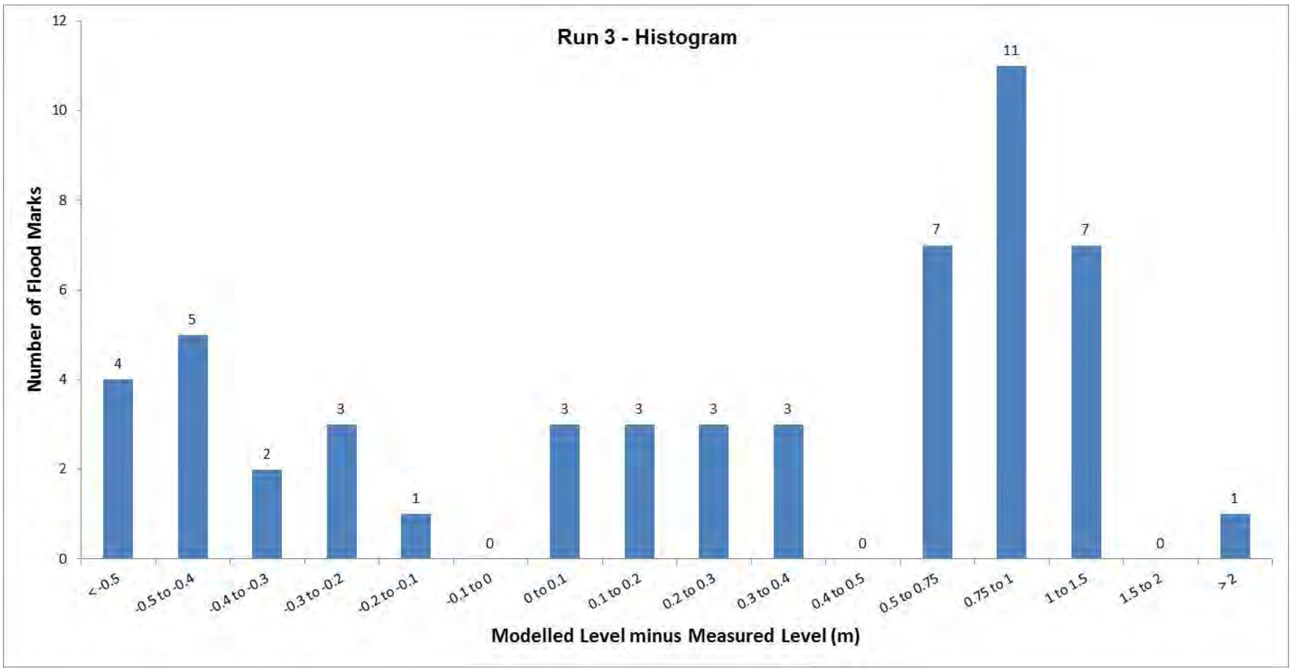


Run 3 - Murrumba Downs
Gauge Level (m)
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

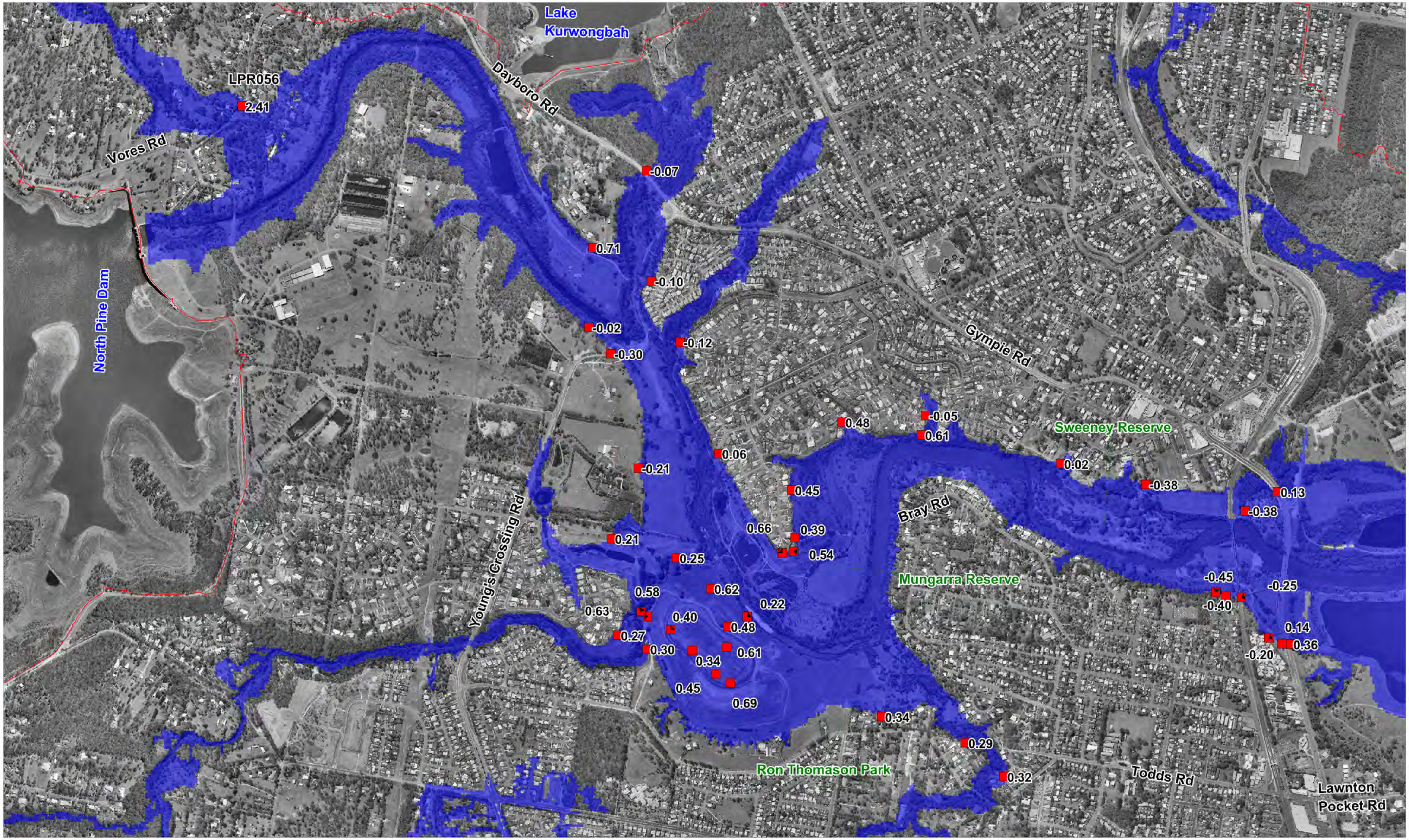


Run 3 - Normanby
Gauge Level (m)
6
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 3 - Youngs Crossing
Gauge Level (m)
14
12
10
8
6
4
2
0
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 3 - Histogram
Number of Flood Marks
12
10
8
6
4
2
0
4
5
2
3
1
0
3
3
3
3
0
7
11
7
0
1
< -0.5
-0.5 to -0.4
-0.4 to -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to 0
0 to 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.75
0.75 to 1
1 to 1.5
1.5 to 2
> 2
Modelled Level minus Measured Level (m)

APPENDIX D: RUN 4 RESULTS



LEGEND

Lower Pine River Catchment

Modelled January 2011 Flood Extent

Flood Marks January 2011 Event Difference in Peak Flood Levels in m (Modelled Minus Surveyed)
0.03

Title:
January 2011 Event Flood Mark Comparison
Run 4 Lower Pine River Catchment

Figure: D-1

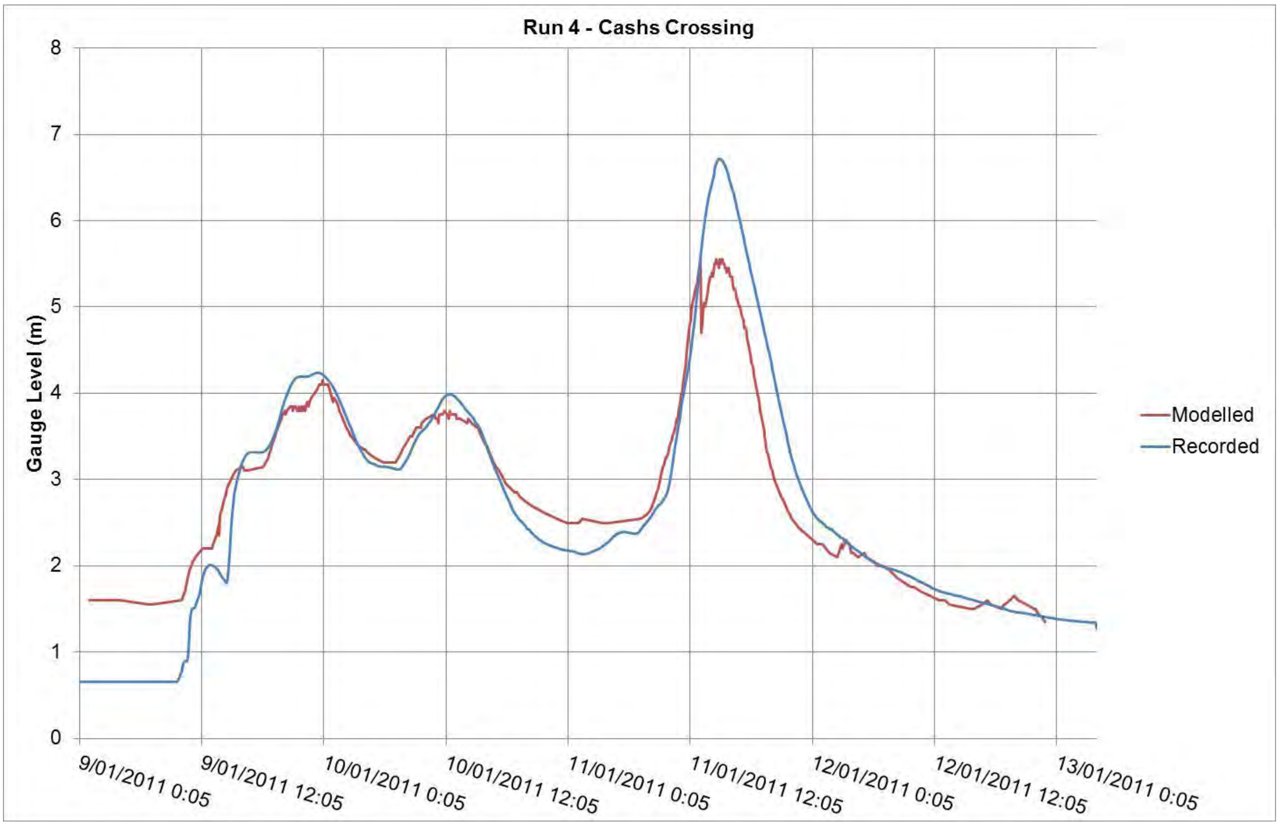
Rev: -

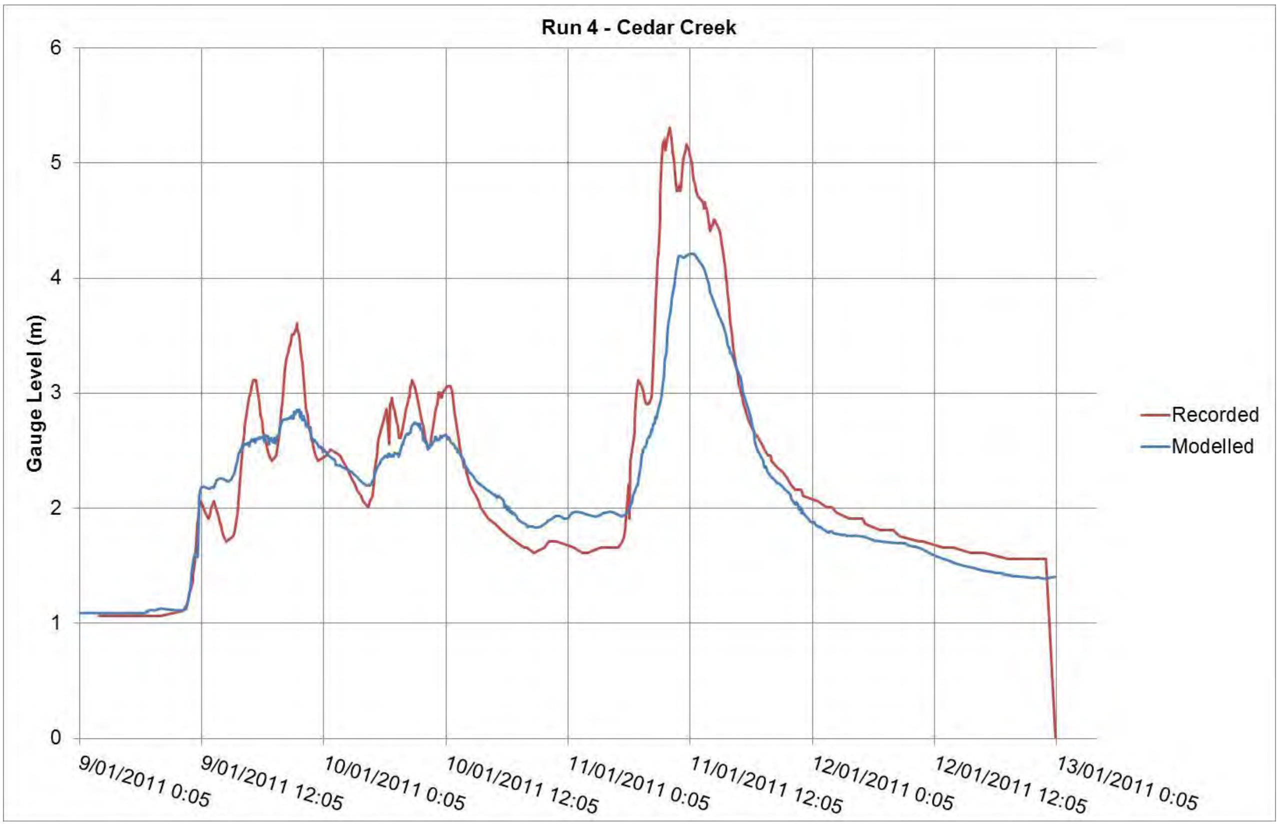
N

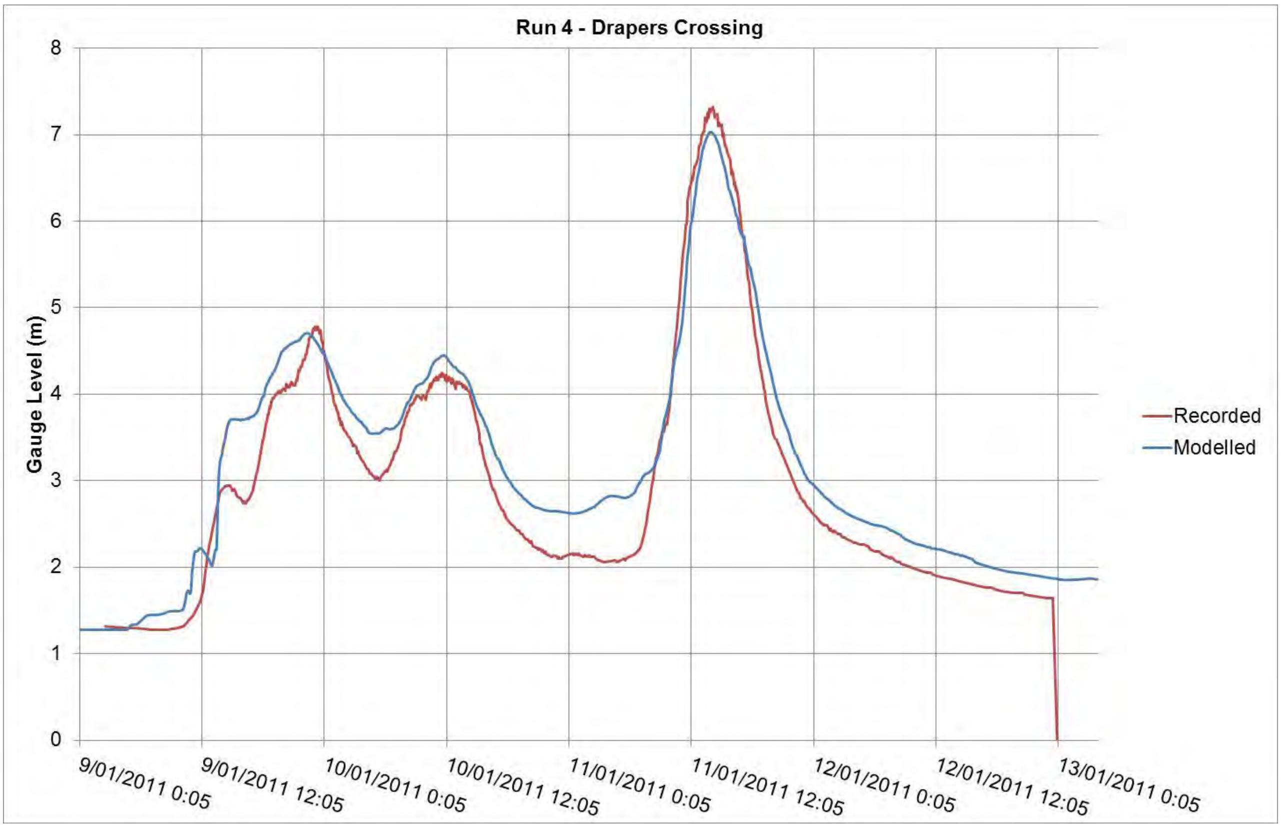
0 250 500m
Approx. Scale

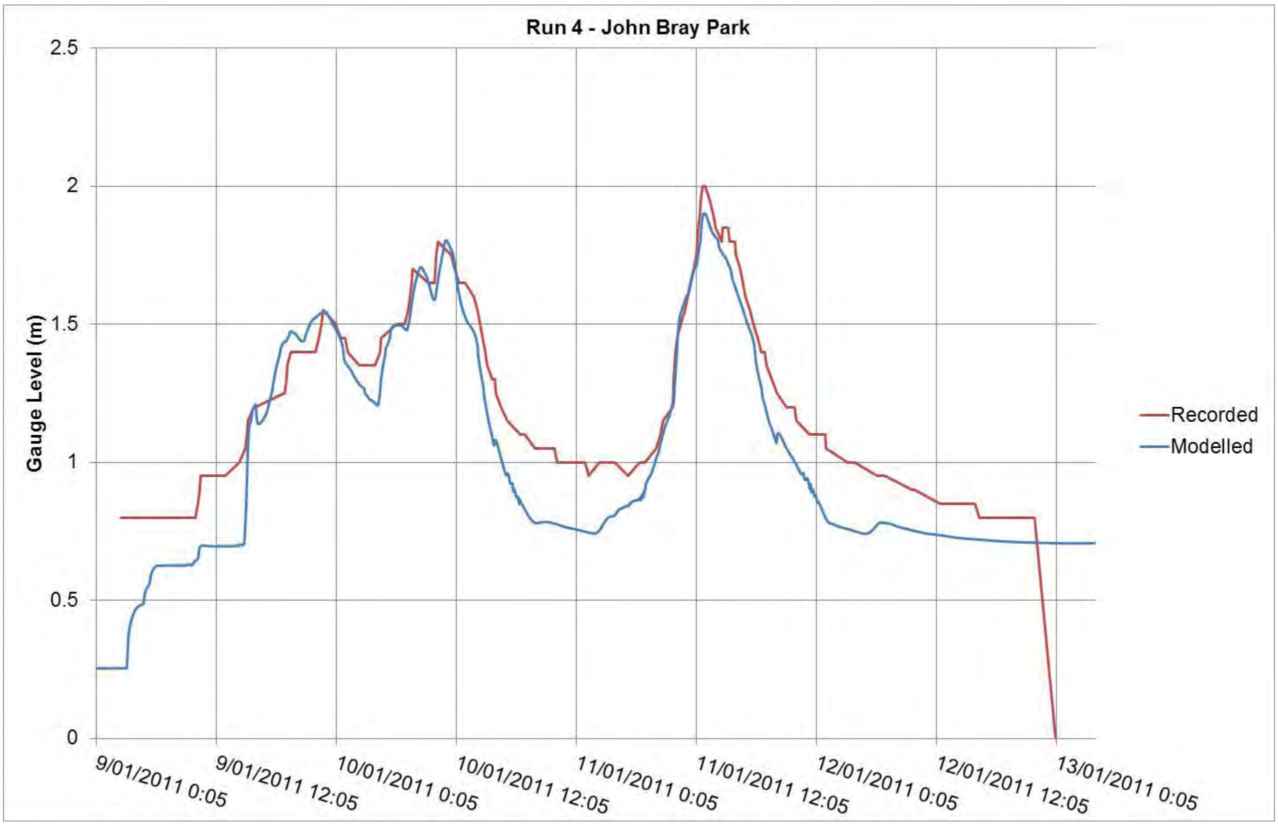
BMT WBM
www.bmtwbm.com.au

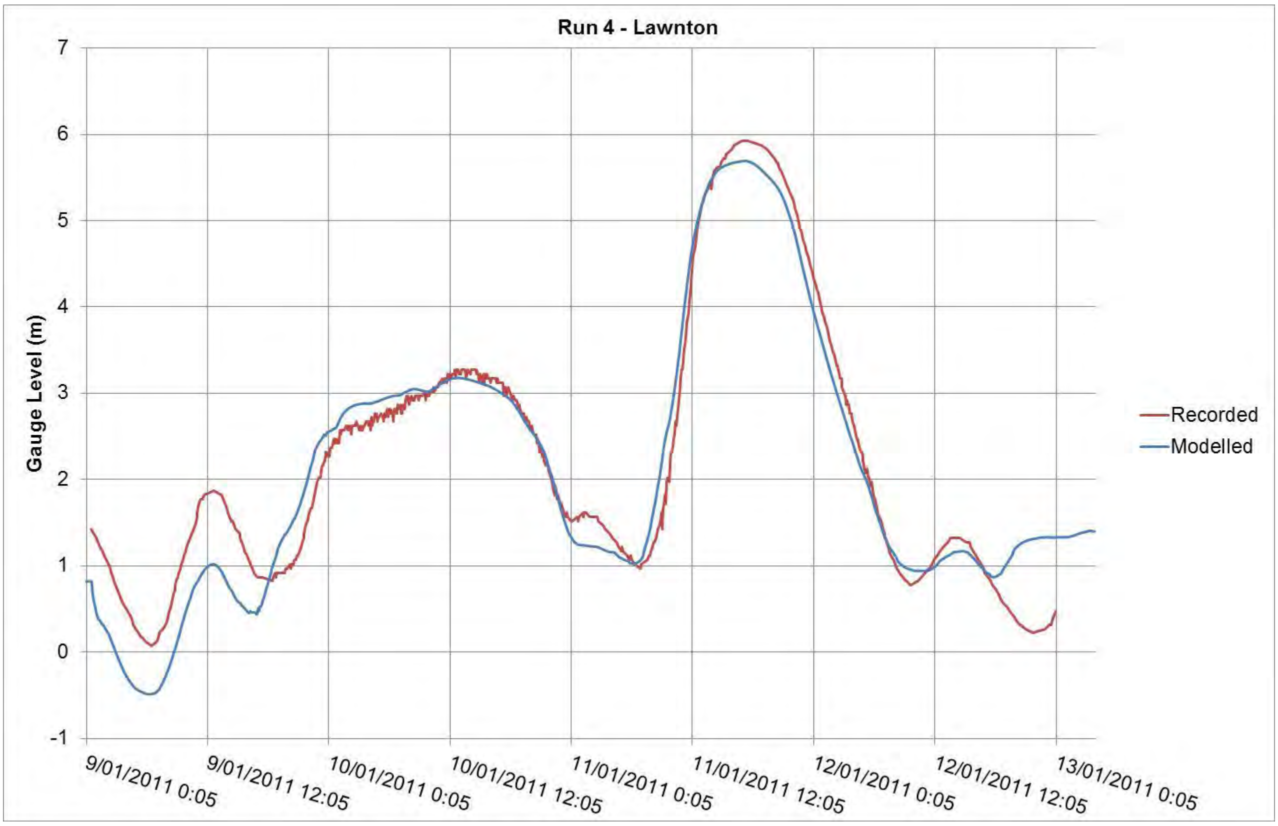
Filepath : I:\B18521_I_AK_MBRC_RFD_Stage_3\DRG\Calibration\FLD_018_130129_LPR_Calibration_Results_F4_revised.WOR

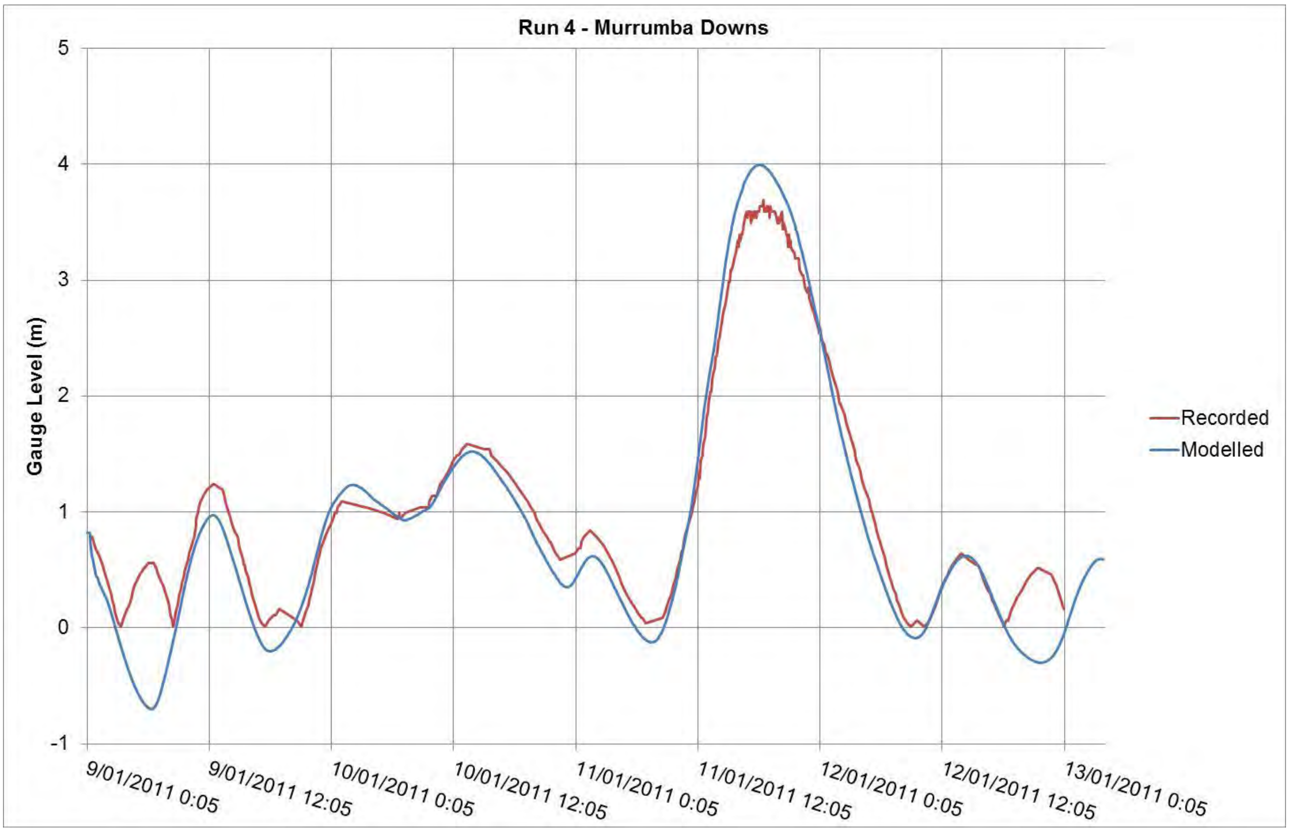

Run 4 - Cashs Crossing
Gauge Level (m)
0
1
2
3
4
5
6
7
8
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Modelled
Recorded

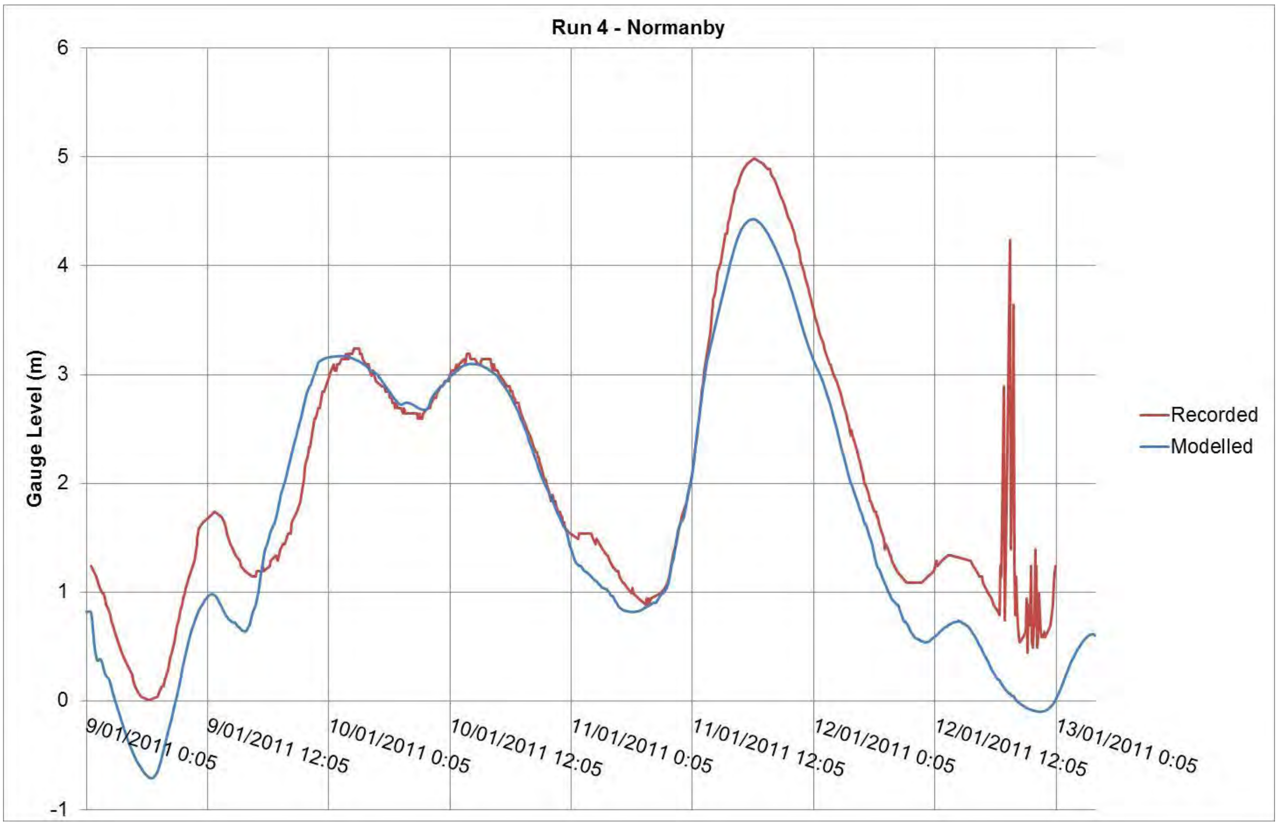

Run 4 - Cedar Creek
Gauge Level (m)
0
1
2
3
4
5
6
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

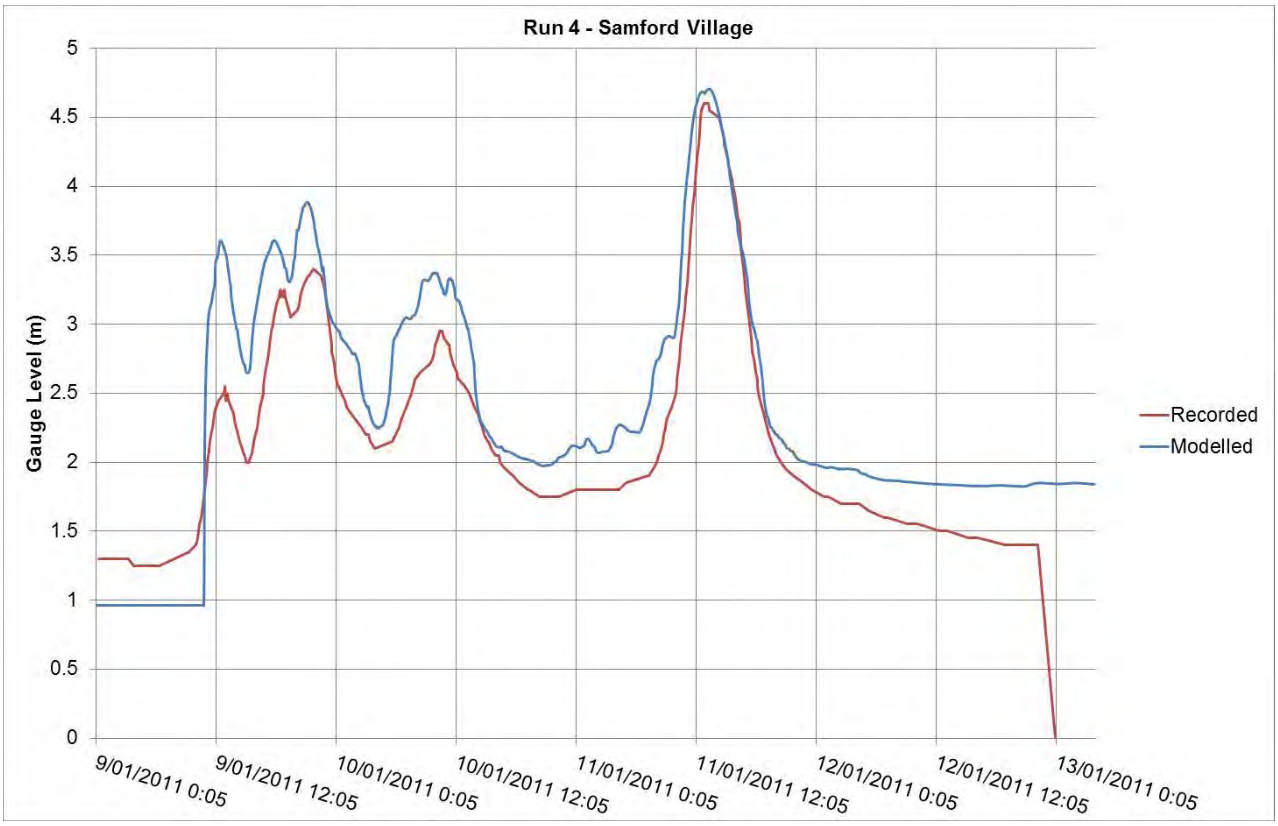

Run 4 - Drapers Crossing
Gauge Level (m)
0
1
2
3
4
5
6
7
8
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

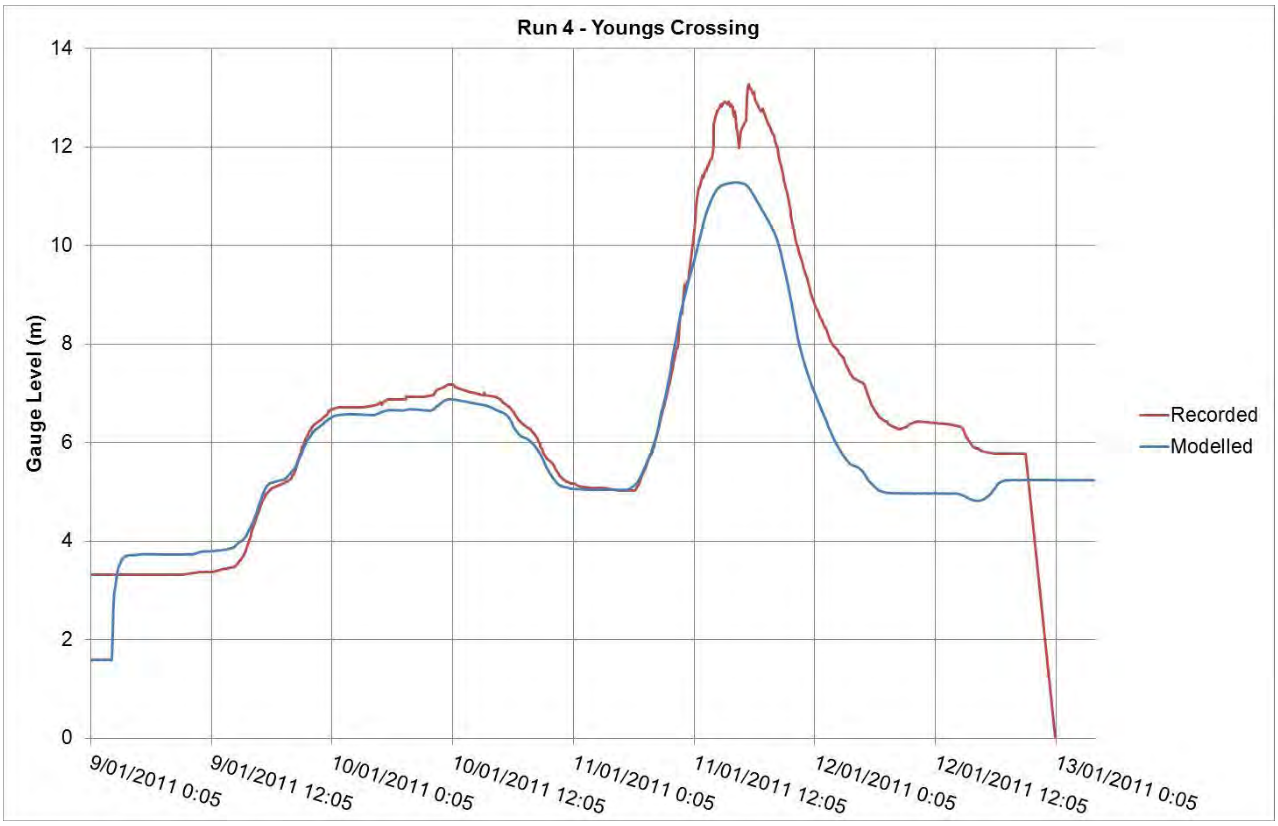

Run 4 - John Bray Park
Gauge Level (m)
0
0.5
1
1.5
2
2.5
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

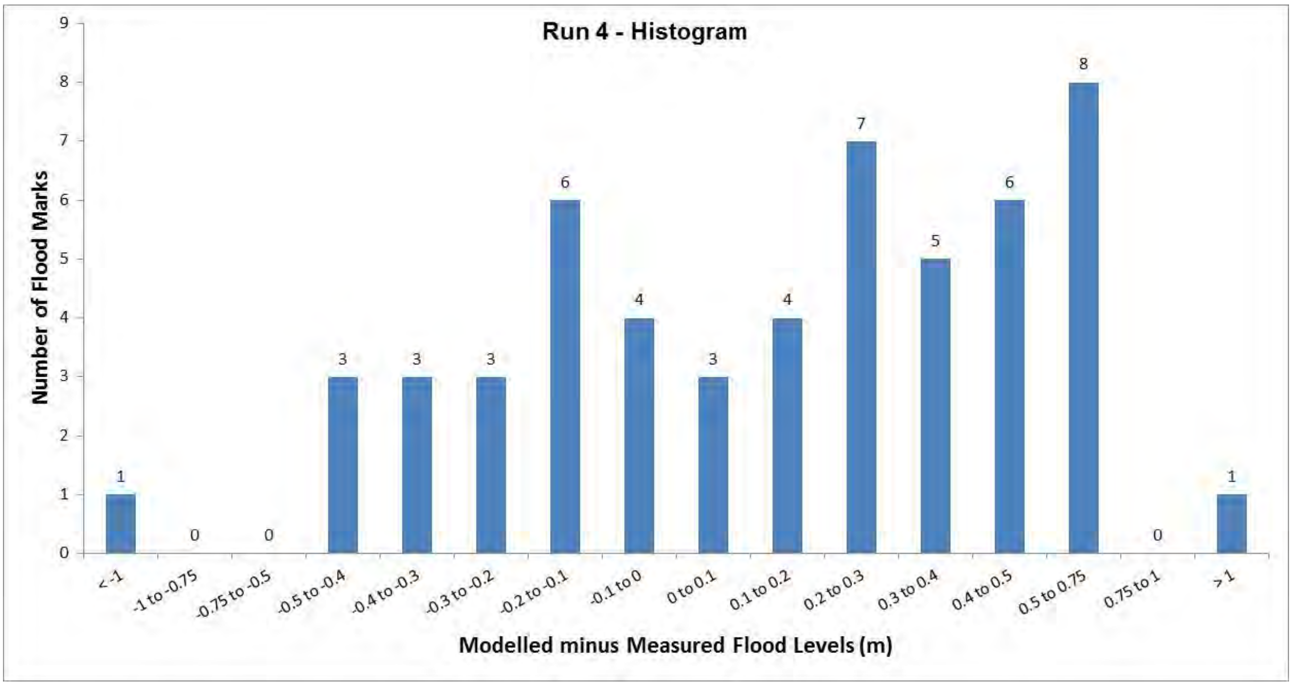

Run 4 - Lawnton
Gauge Level (m)
7
6
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 4 - Murrumba Downs
Gauge Level (m)
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

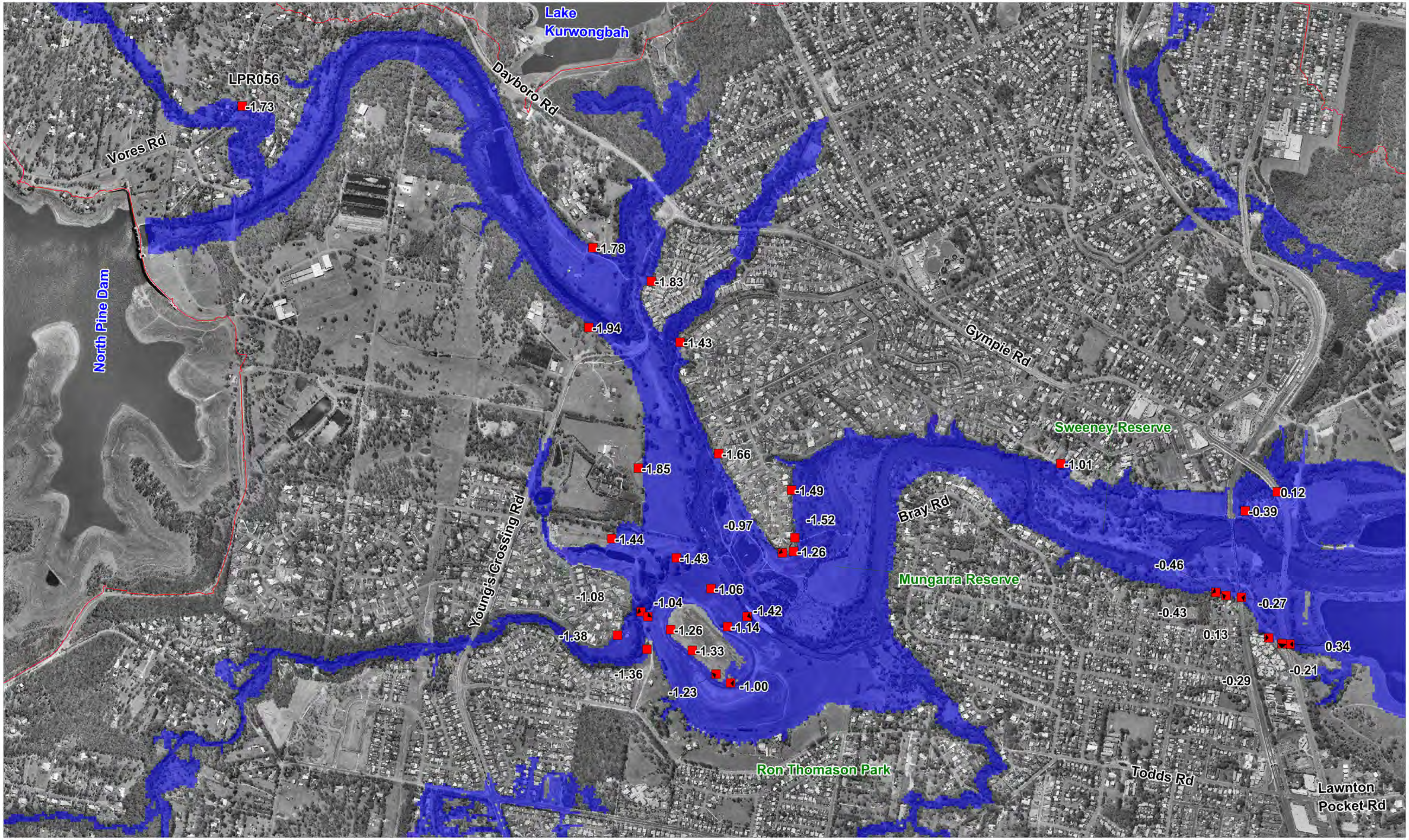

Run 4 - Normanby
Gauge Level (m)
6
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 4 - Samford Village
Gauge Level (m)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 4 - Youngs Crossing
Gauge Level (m)
14
12
10
8
6
4
2
0
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 4 - Histogram
Number of Flood Marks
Modelled minus Measured Flood Levels (m)
< -1
-1 to -0.75
-0.75 to -0.5
-0.5 to -0.4
-0.4 to -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to 0
0 to 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.75
0.75 to 1
> 1
1
0
0
3
3
3
6
4
3
4
7
5
6
8
0
1

APPENDIX E: RUN 5 RESULTS



LEGEND

Lower Pine River Catchment

Modelled January 2011 Flood Extent

0.03 Flood Marks January 2011 Event Difference in Peak Flood Levels in m (Modelled Minus Surveyed)

Title:

January 2011 Event Flood Mark Comparison
Run 5 Lower Pine River Catchment

Figure: **E-1**

Rev: **-**

N

0 250 500m
Approx. Scale

BMT WBM
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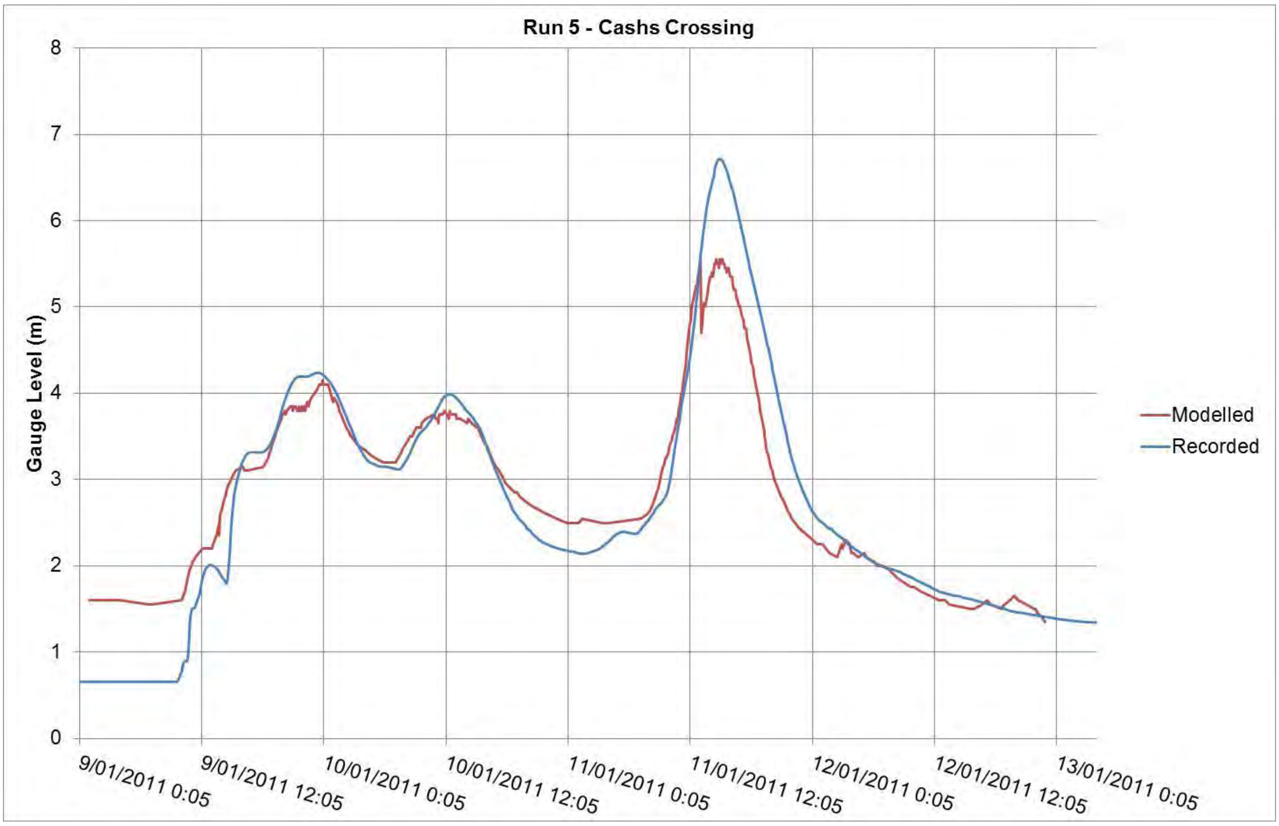
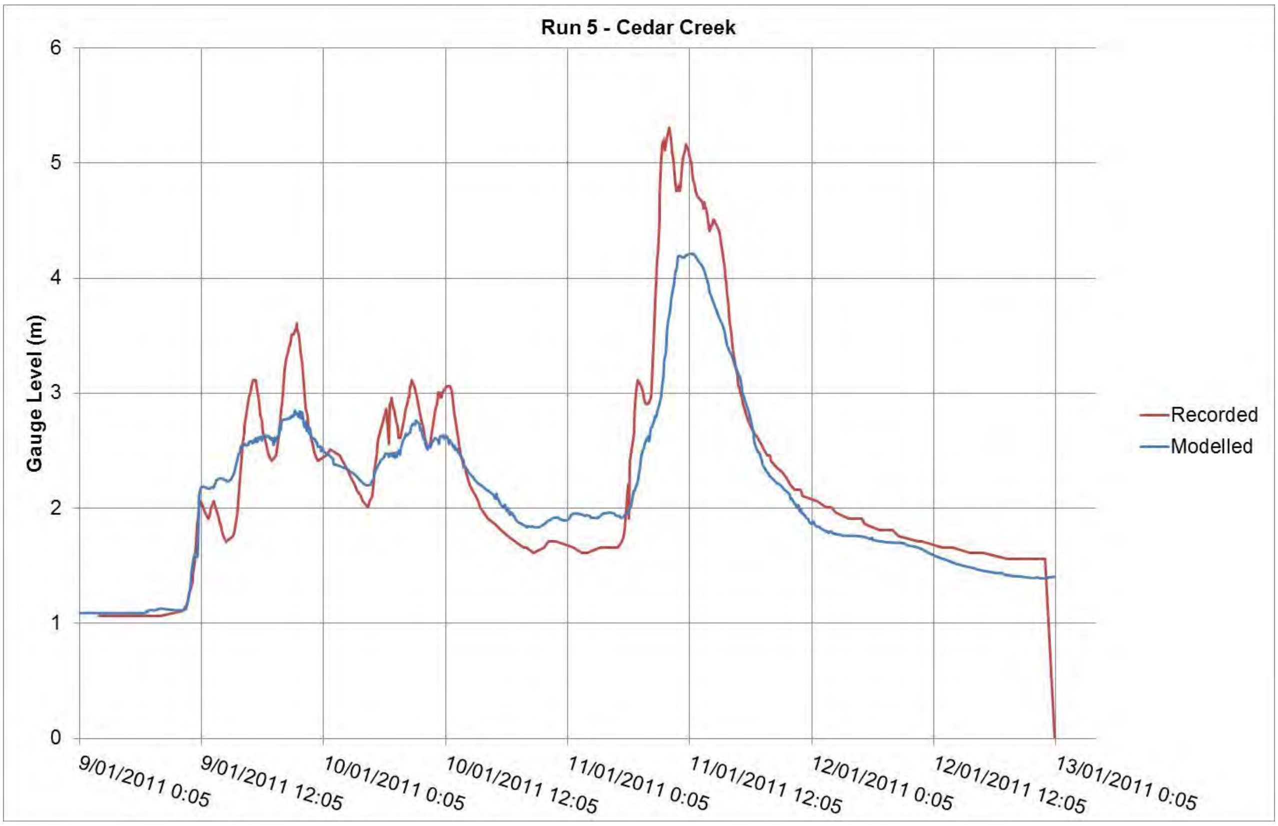
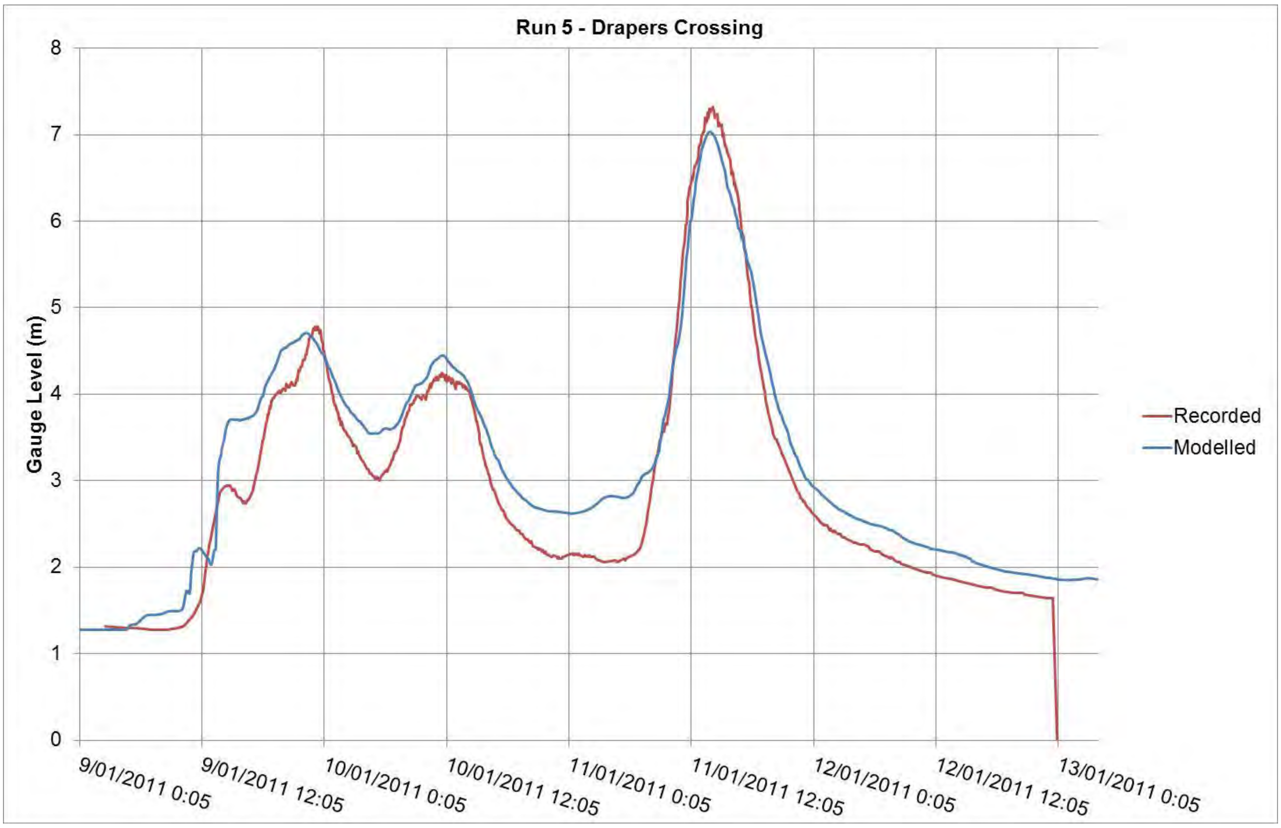
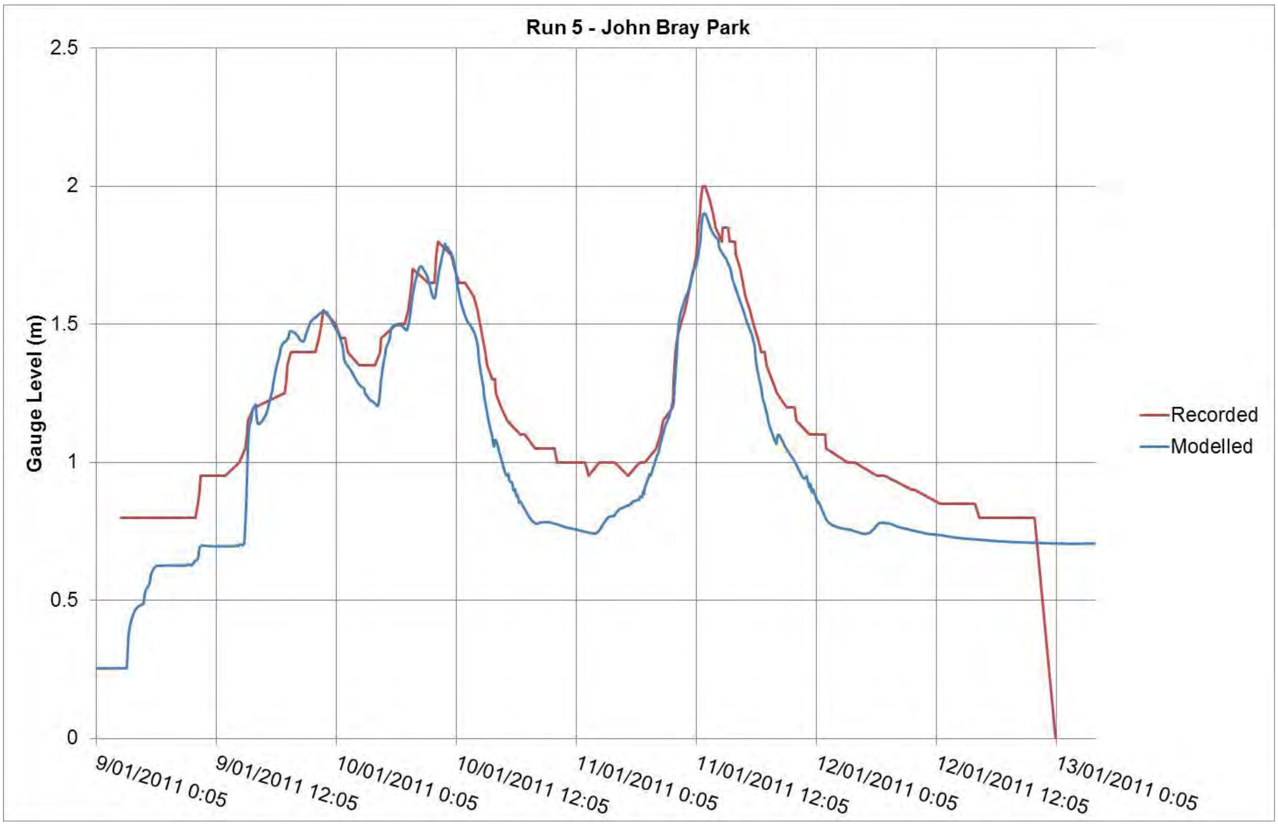
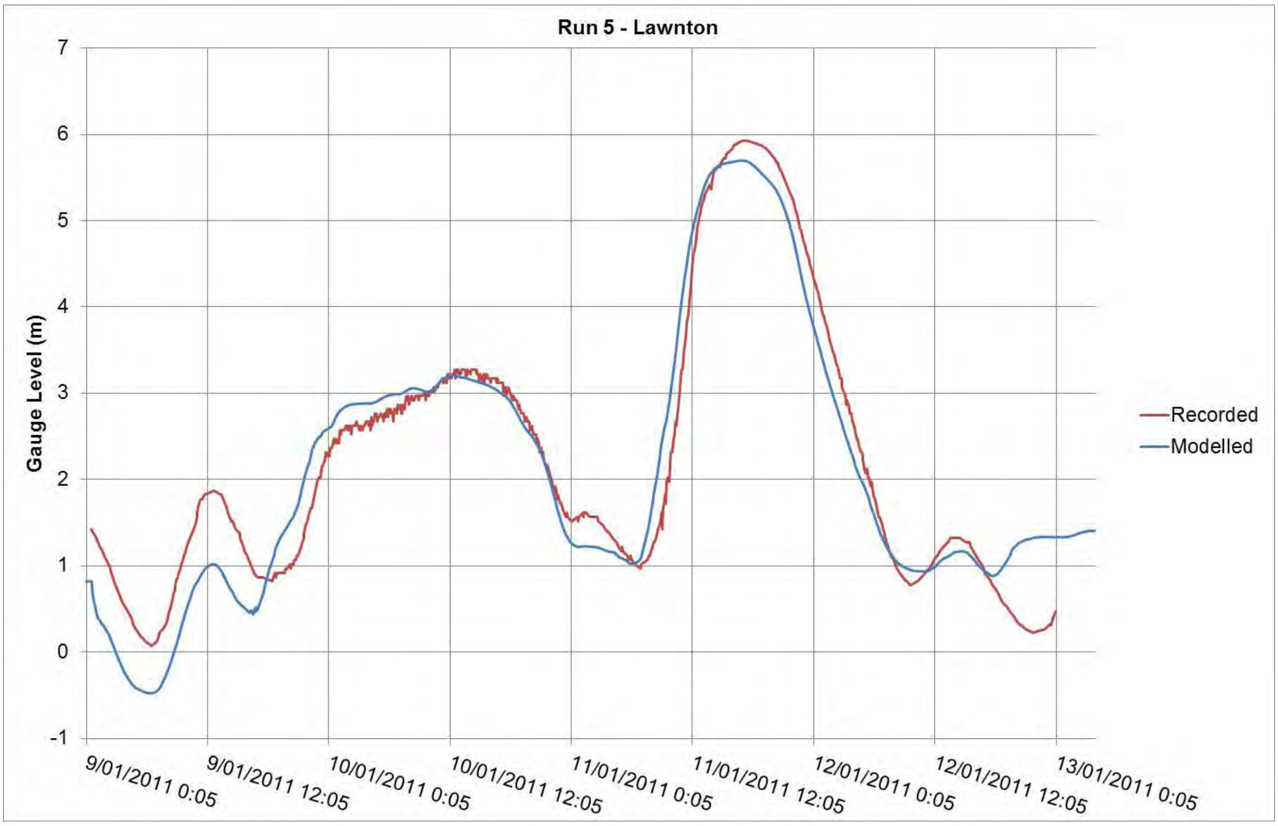
Filepath : I:\B18521_I_AK_MBRC_RFD_Stage_3\DRG\Calibration\FLD_019_130129_LPR_Calibration_Results_F5_revised.WOR

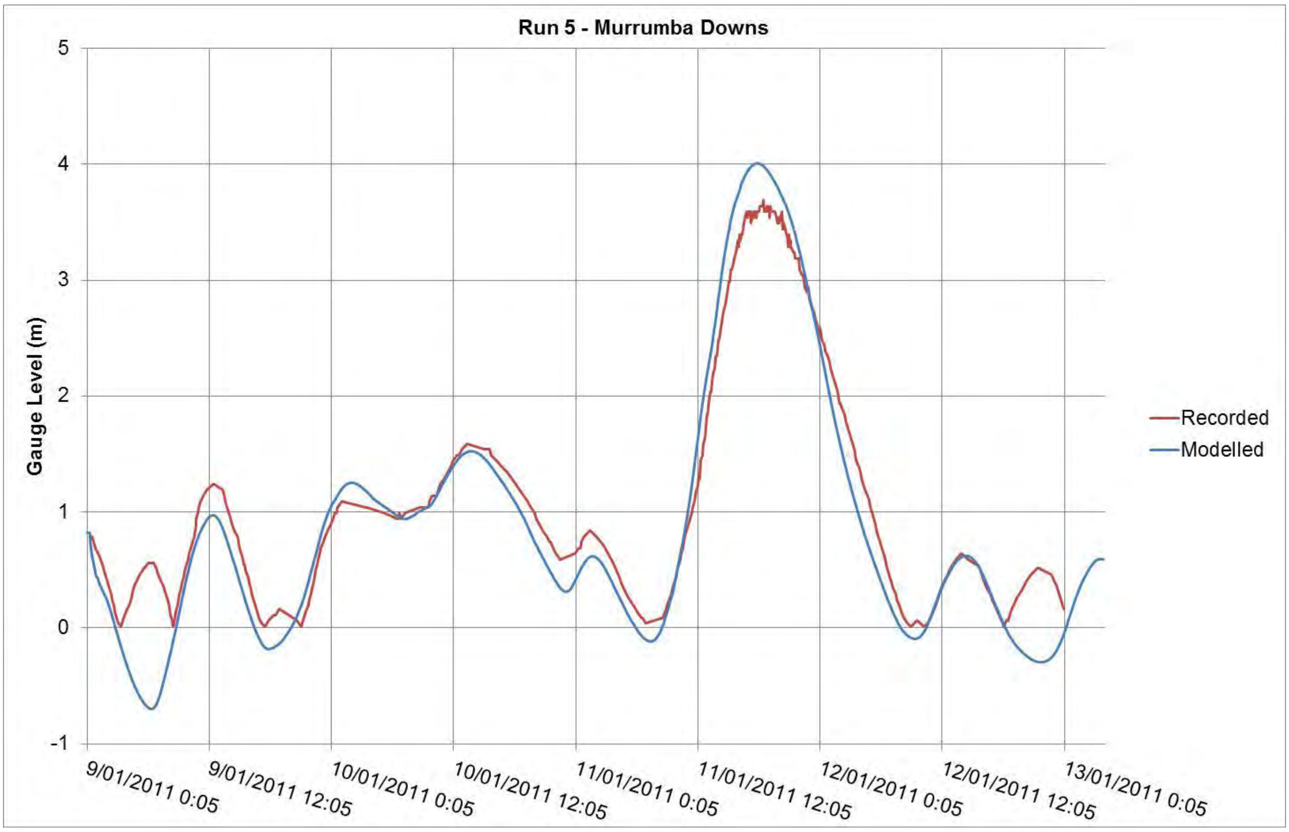

Run 5 - Cashs Crossing
Gauge Level (m)
0
1
2
3
4
5
6
7
8
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Modelled
Recorded

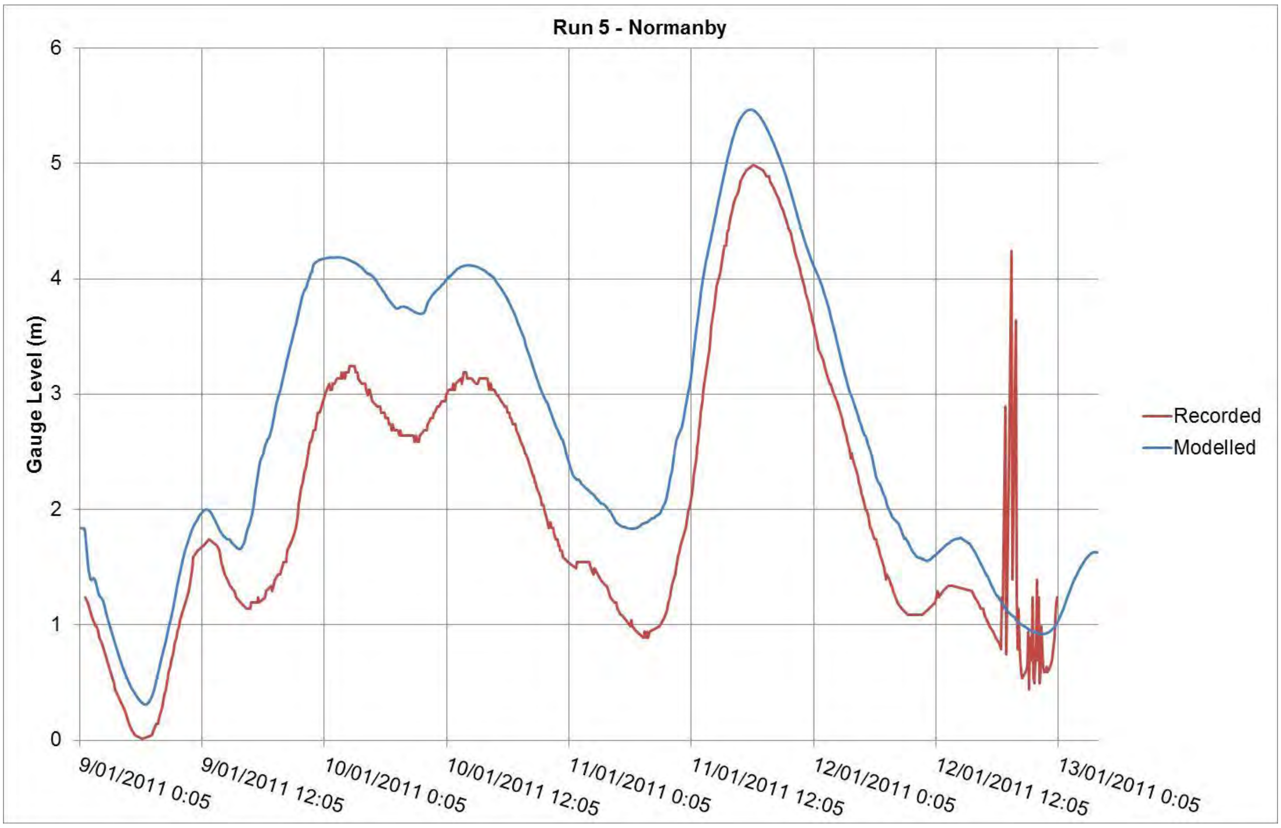

Run 5 - Cedar Creek
Gauge Level (m)
0
1
2
3
4
5
6
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

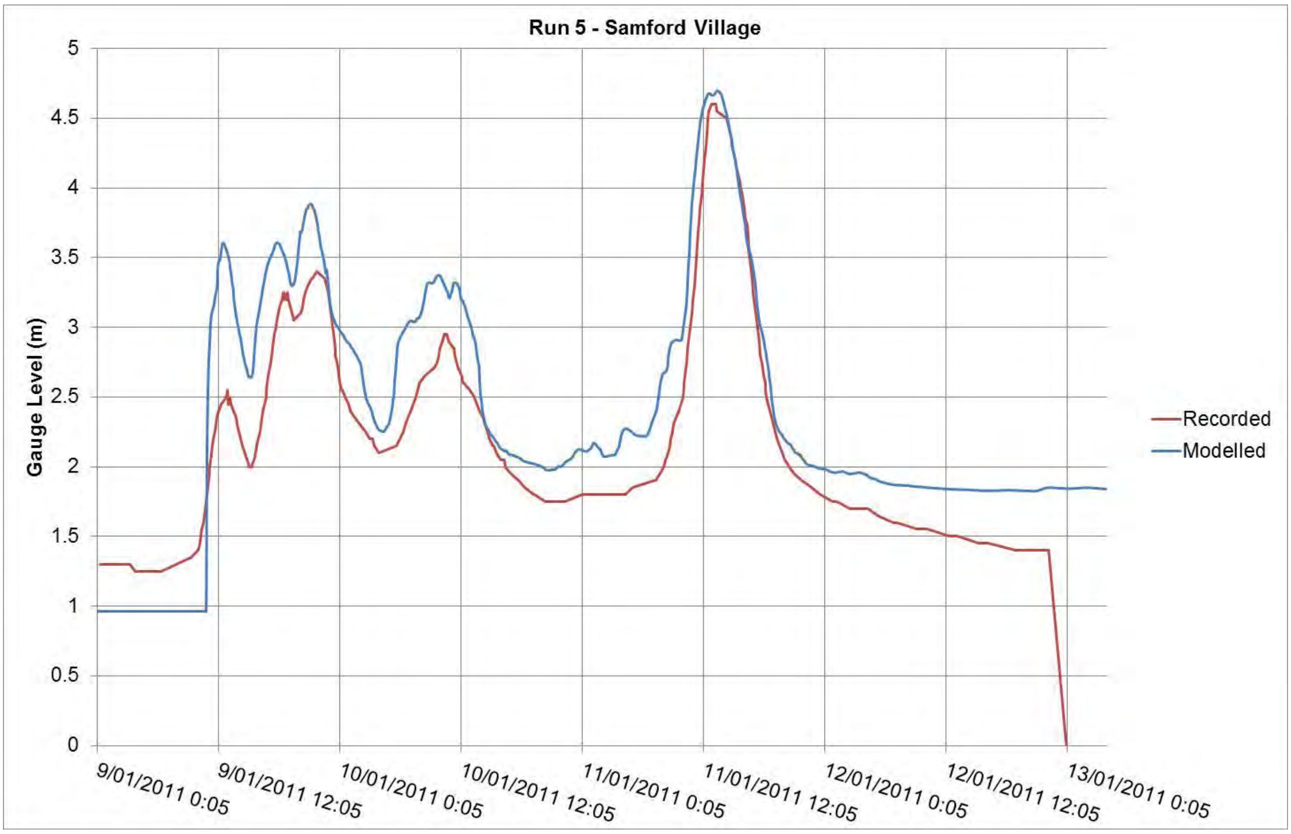

Run 5 - Drapers Crossing
Gauge Level (m)
0
1
2
3
4
5
6
7
8
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

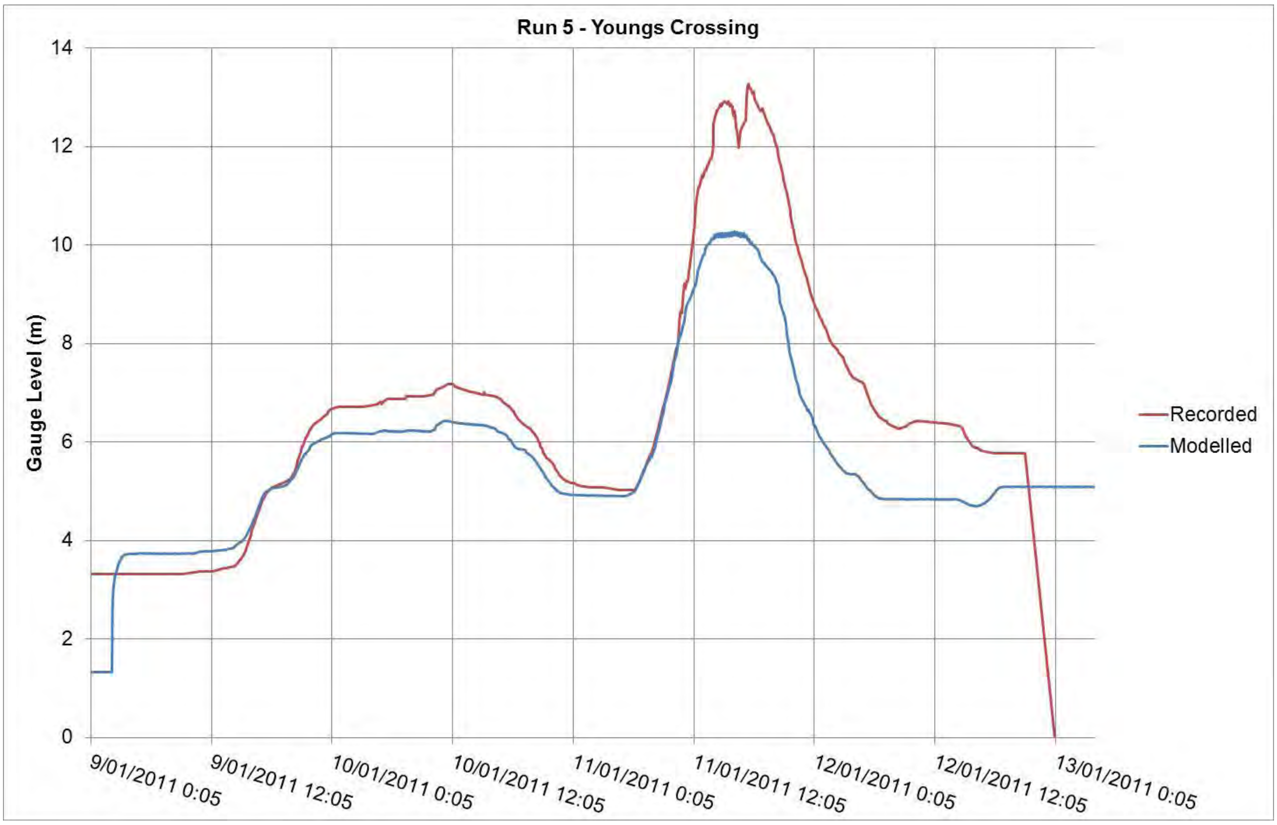

Run 5 - John Bray Park
Gauge Level (m)
0
0.5
1
1.5
2
2.5
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

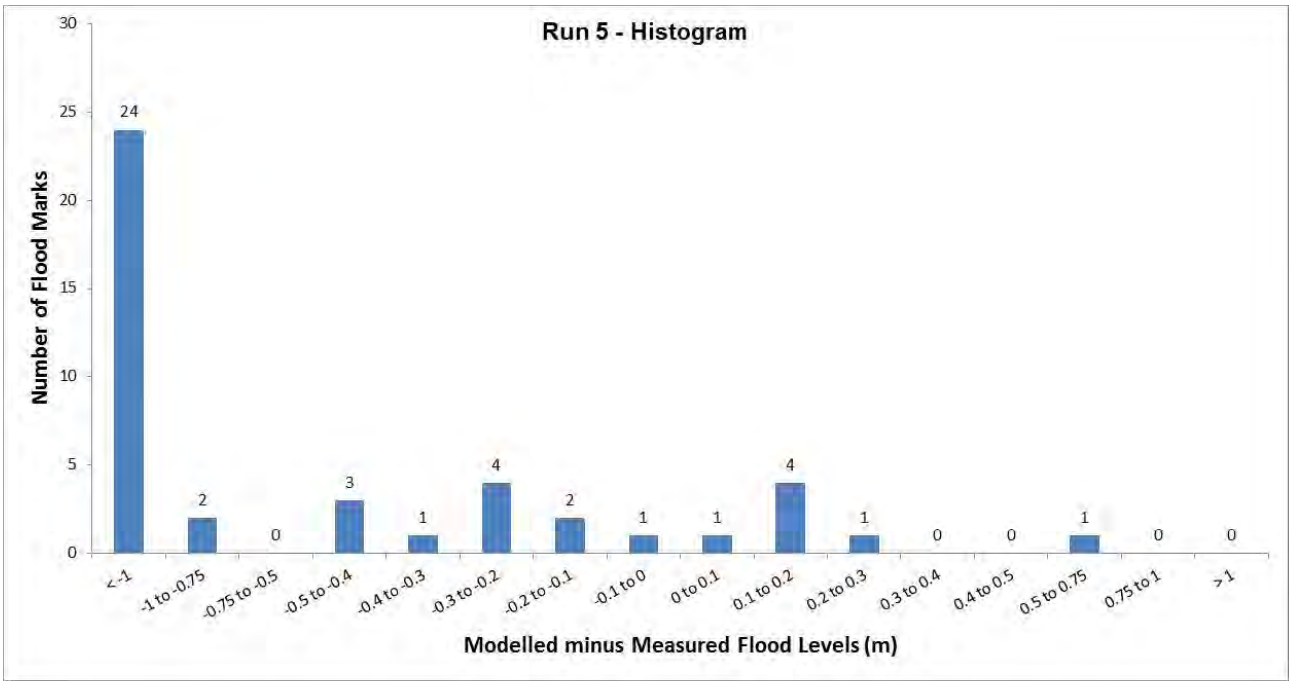

Run 5 - Lawnton
Gauge Level (m)
7
6
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 5 - Murrumba Downs
Gauge Level (m)
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

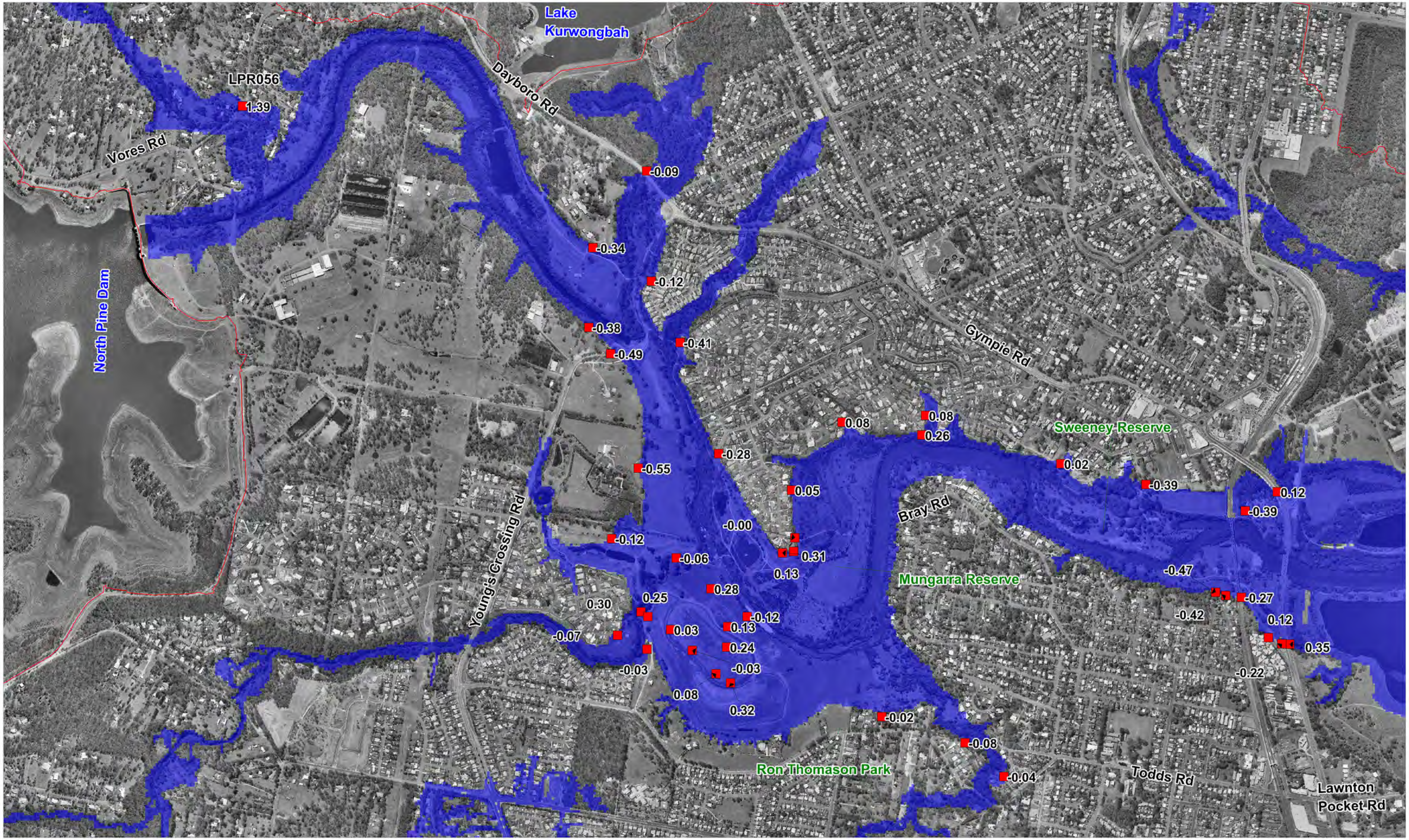

Run 5 - Normanby
Gauge Level (m)
0
1
2
3
4
5
6
Recorded
Modelled
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05


Run 5 - Samford Village
Gauge Level (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Recorded
Modelled
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05


Run 5 - Youngs Crossing
Gauge Level (m)
14
12
10
8
6
4
2
0
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 5 - Histogram
Number of Flood Marks
30
25
20
15
10
5
0
24
2
0
3
1
4
2
1
1
4
1
0
0
1
0
0
<-1
-1 to -0.75
-0.75 to -0.5
-0.5 to -0.4
-0.4 to -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to 0
0 to 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.75
0.75 to 1
>1
Modelled minus Measured Flood Levels (m)

APPENDIX F: RUN 6 RESULTS



LEGEND

Lower Pine River Catchment

Modelled January 2011 Flood Extent

Flood Marks January 2011 Event
0.03 Difference in Peak Flood Levels in m
(Modelled Minus Surveyed)

Title:
January 2011 Event Flood Mark Comparison
Run 6 Lower Pine River Catchment

Figure: **F-1**

Rev: **-**

N

0 250 500m
Approx. Scale

BMT WBM
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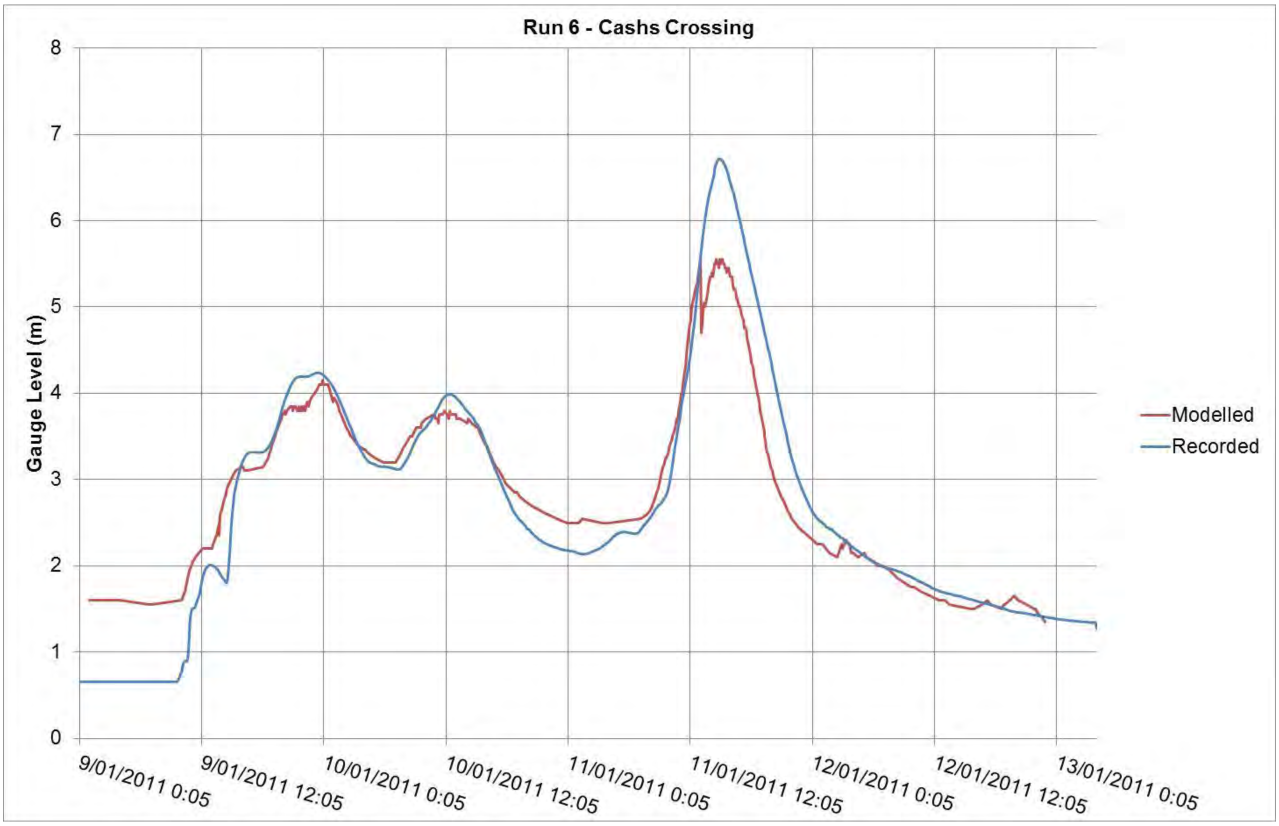
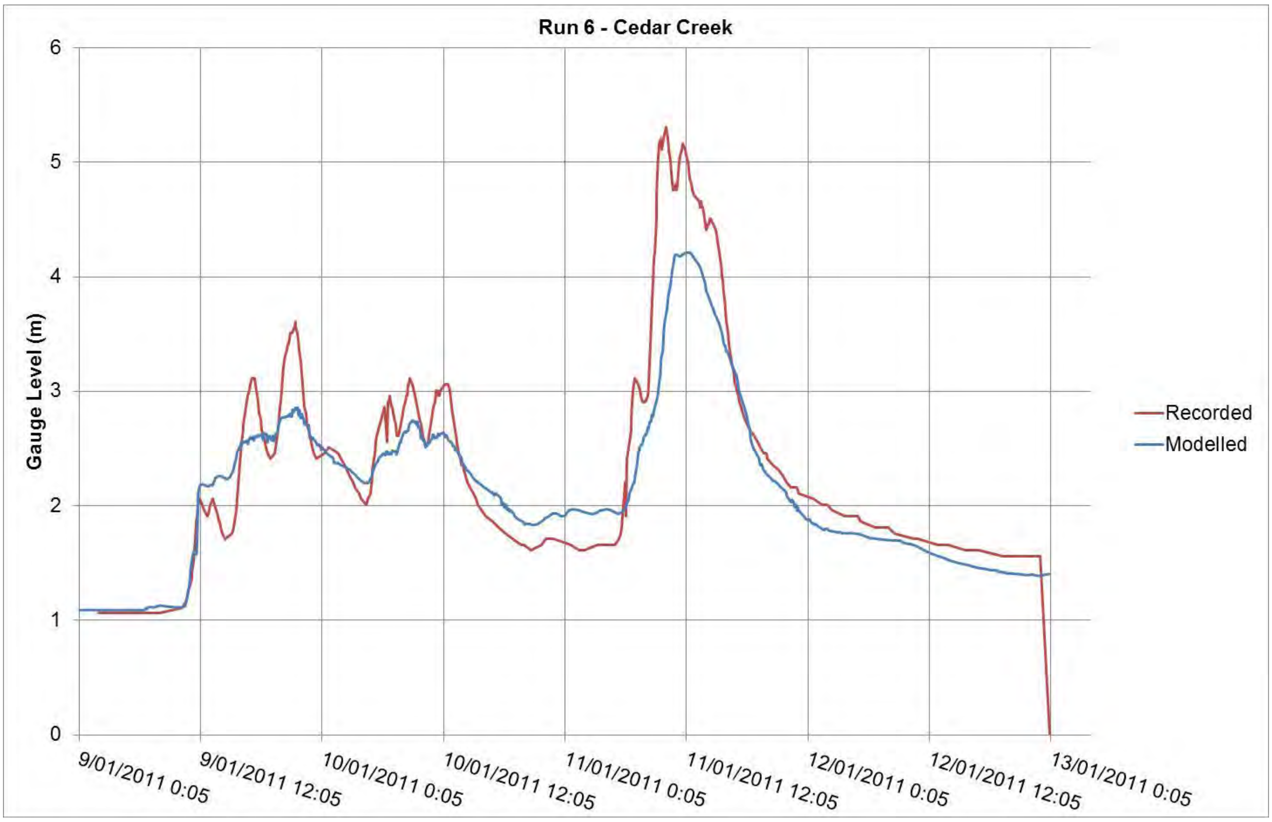
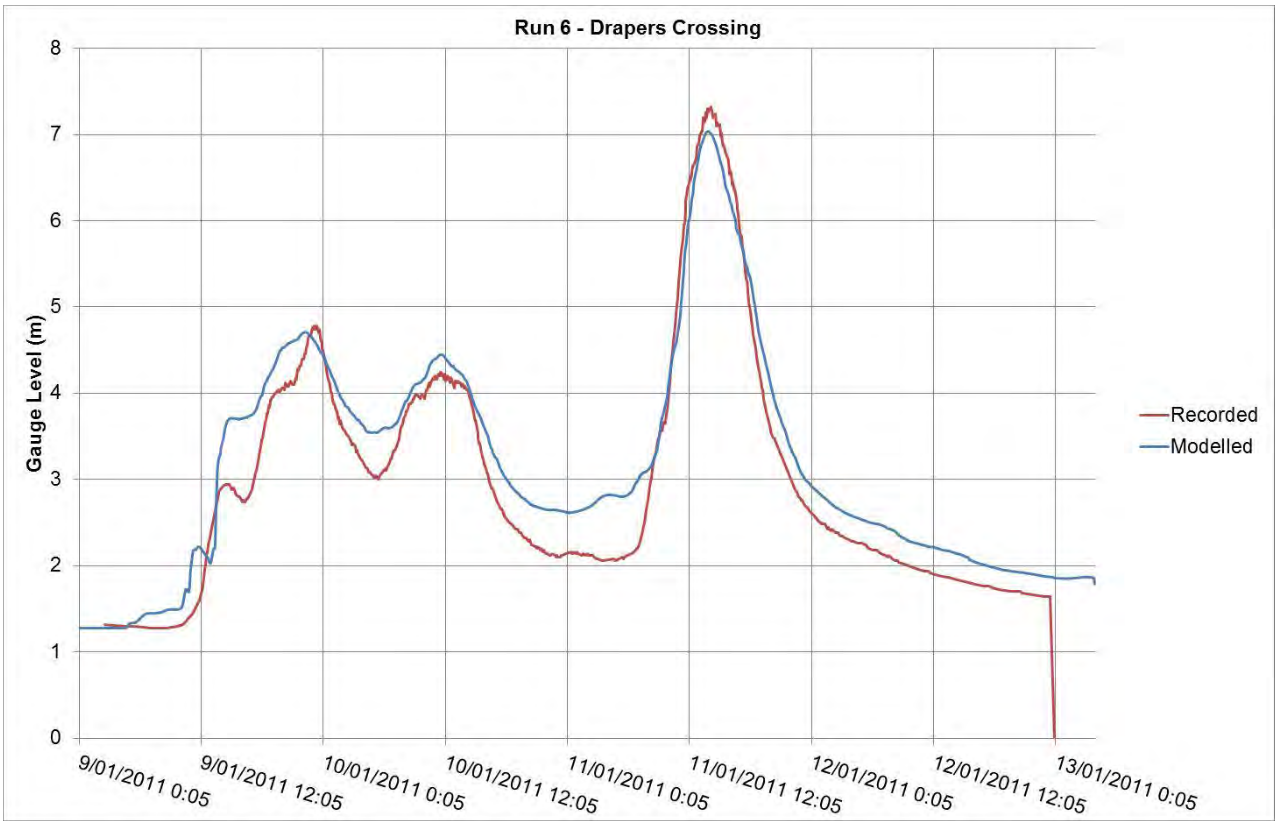
Filepath : I:\B18521_I_AK_MBRC_RFD_Stage_3\DRG\Calibration\FLD_020_130129_LPR_Calibration_Results_F6_revised.WOR

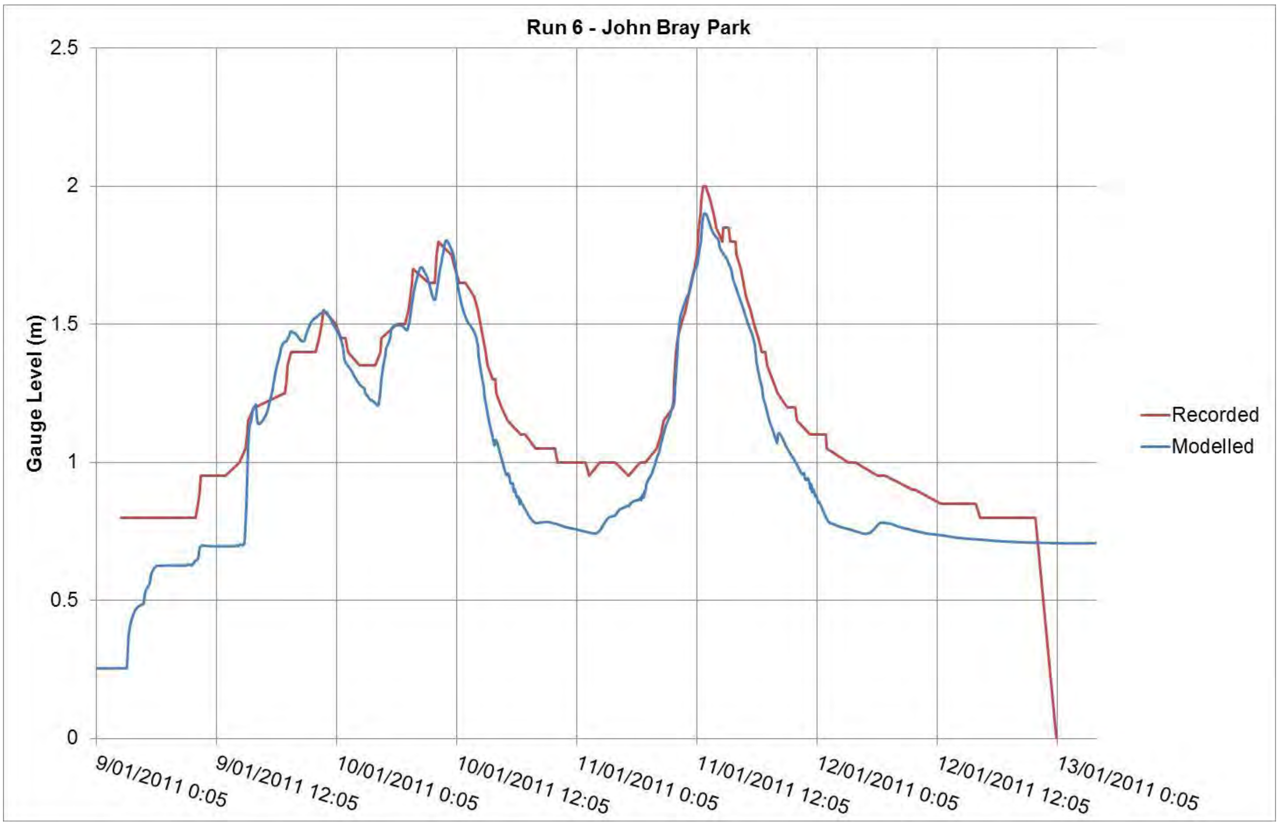


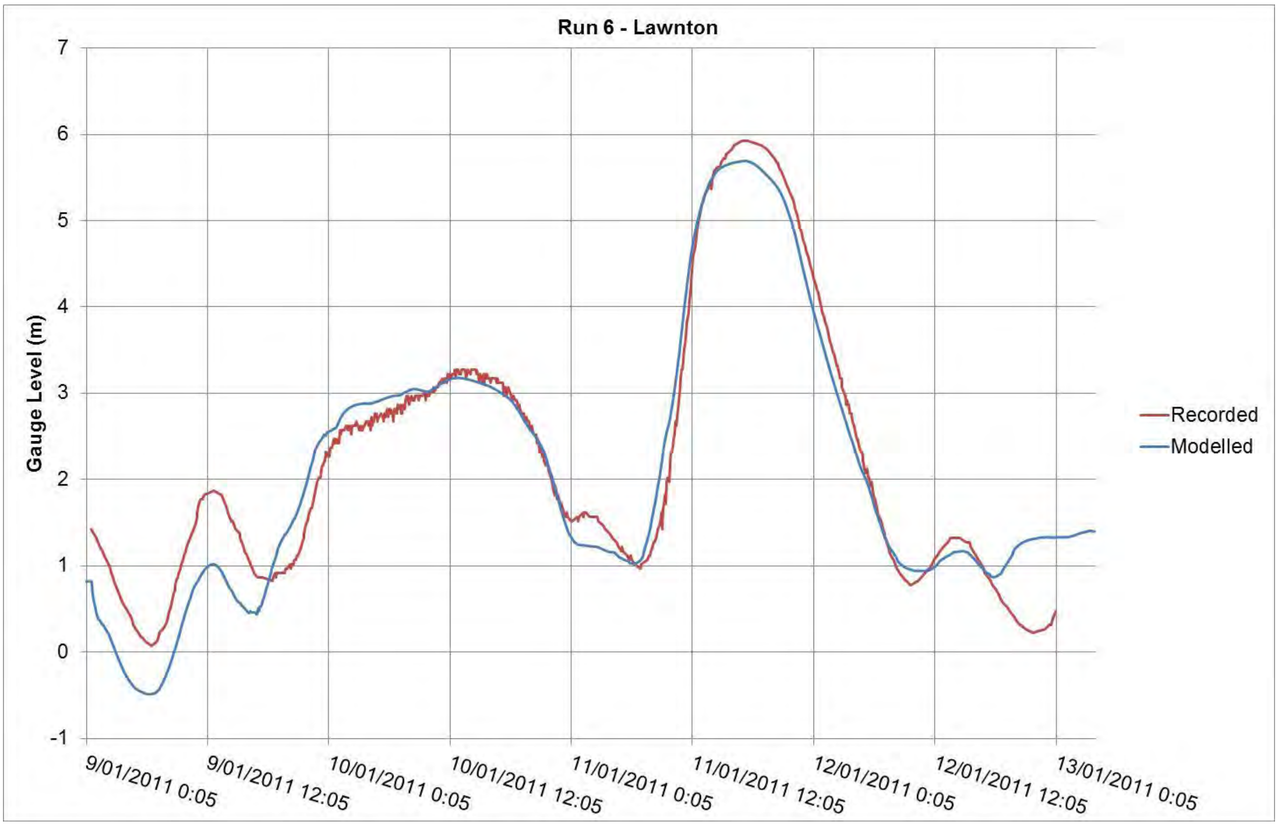
Run 6 - Cashs Crossing
Gauge Level (m)
0
1
2
3
4
5
6
7
8
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Modelled
Recorded

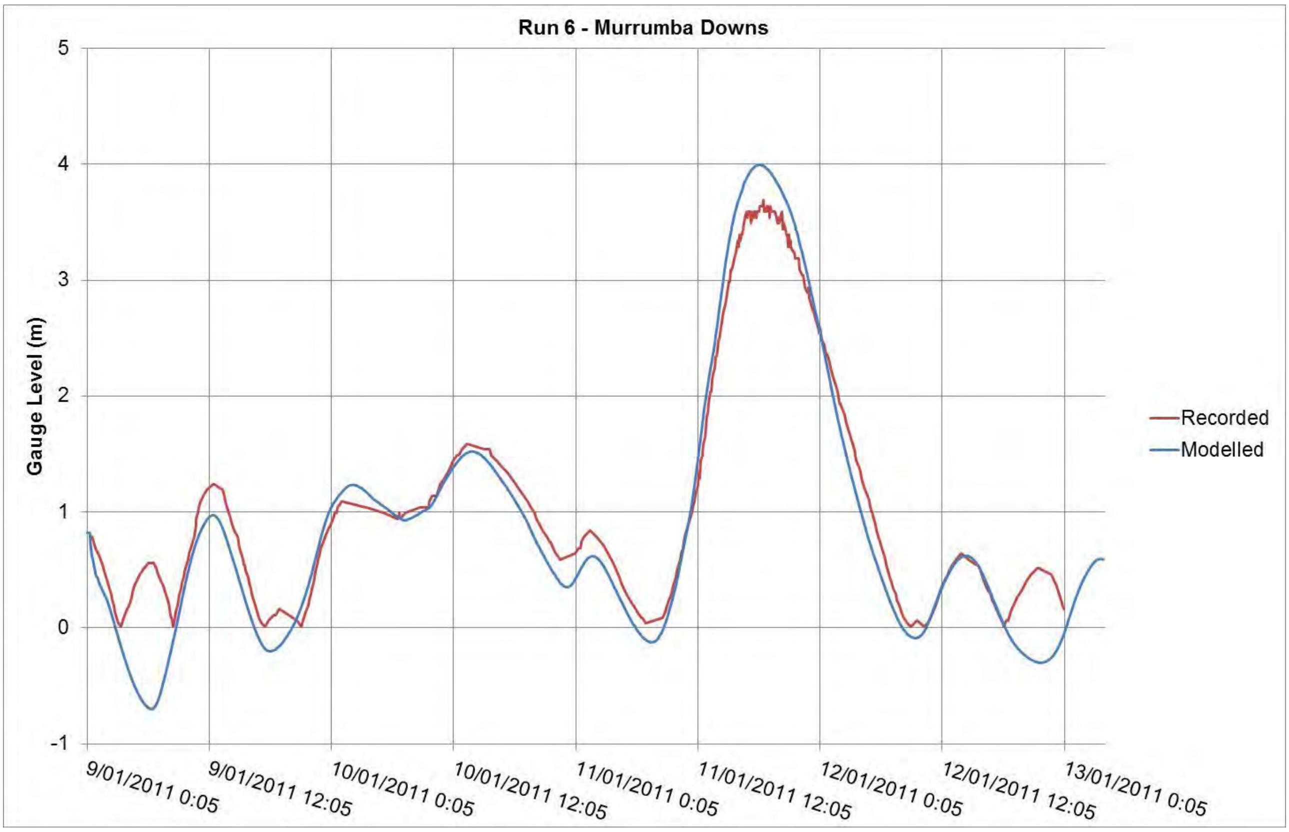


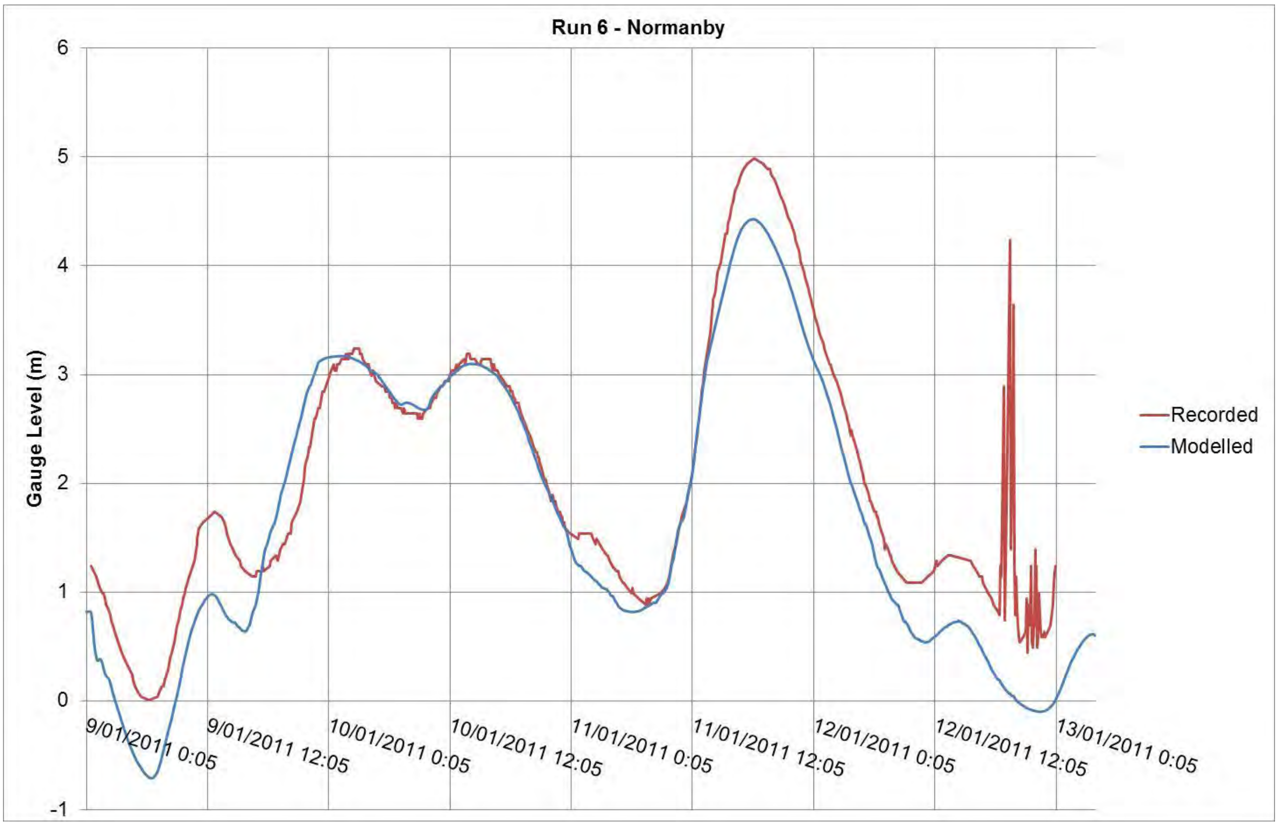
Run 6 - Cedar Creek
Gauge Level (m)
0
1
2
3
4
5
6
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

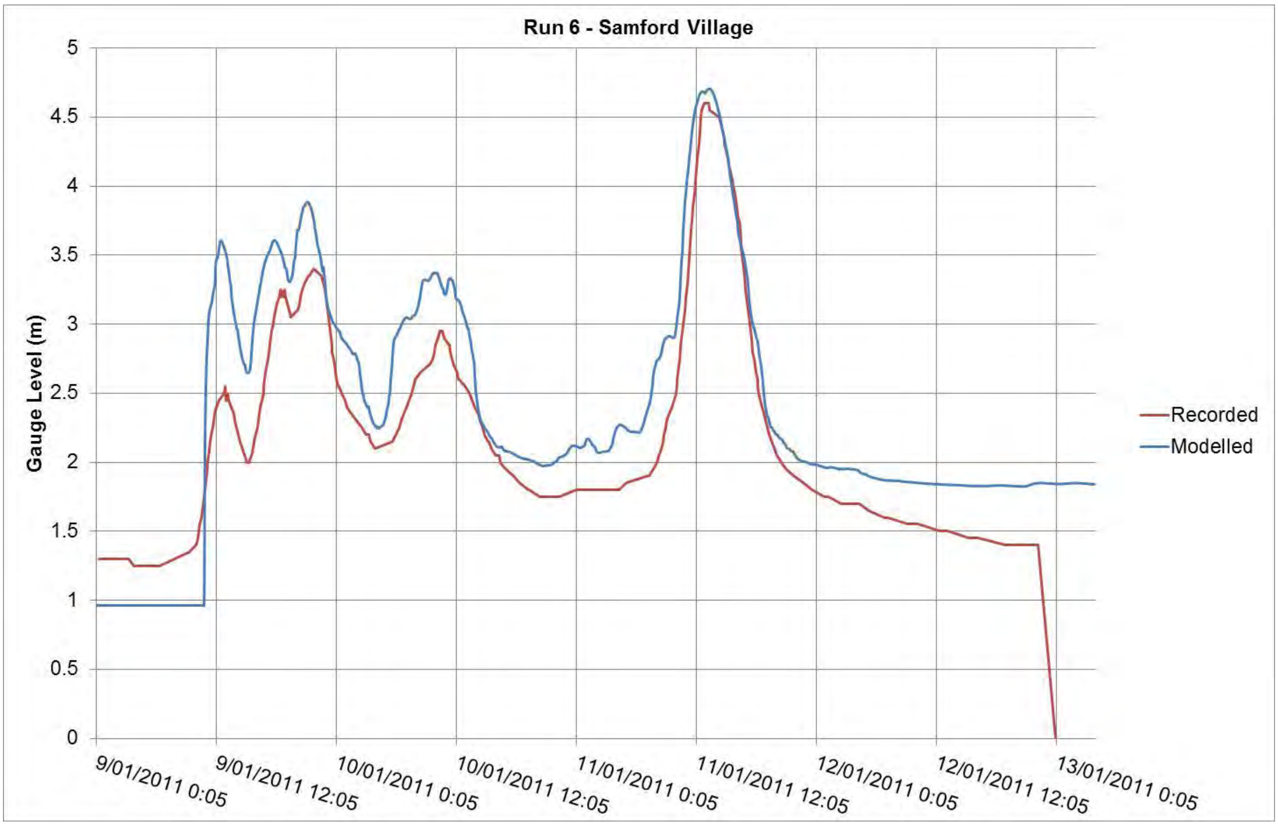

Run 6 - Drapers Crossing
Gauge Level (m)
0
1
2
3
4
5
6
7
8
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

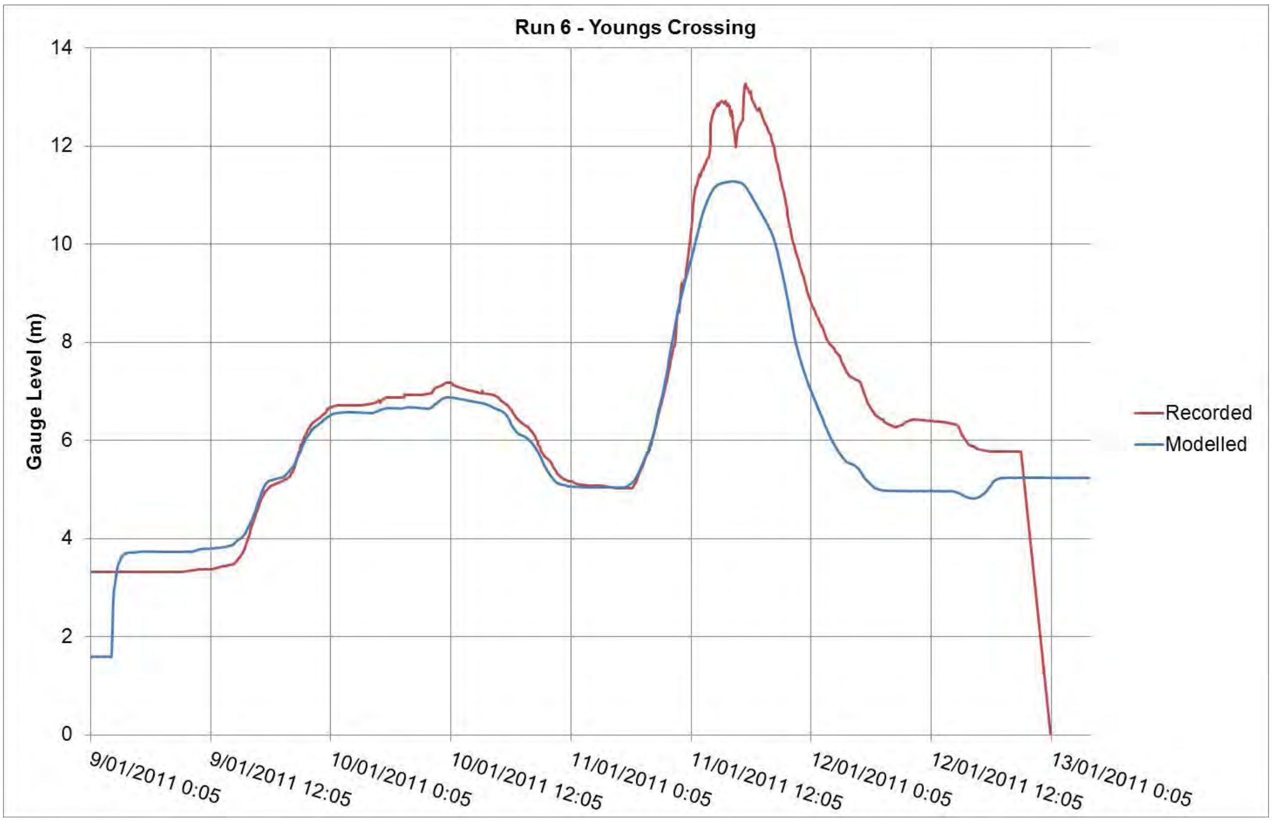

Run 6 - John Bray Park
Gauge Level (m)
0
0.5
1
1.5
2
2.5
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

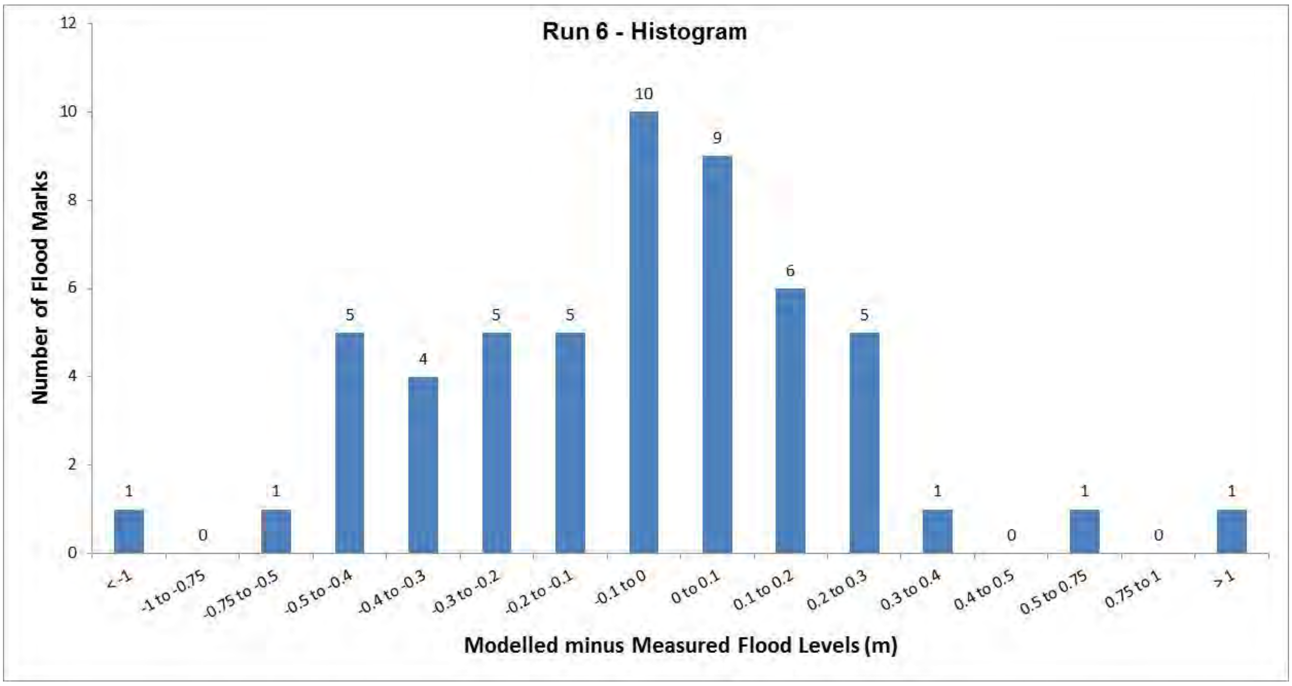

Run 6 - Lawnton
Gauge Level (m)
7
6
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 6 - Murrumba Downs
Gauge Level (m)
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

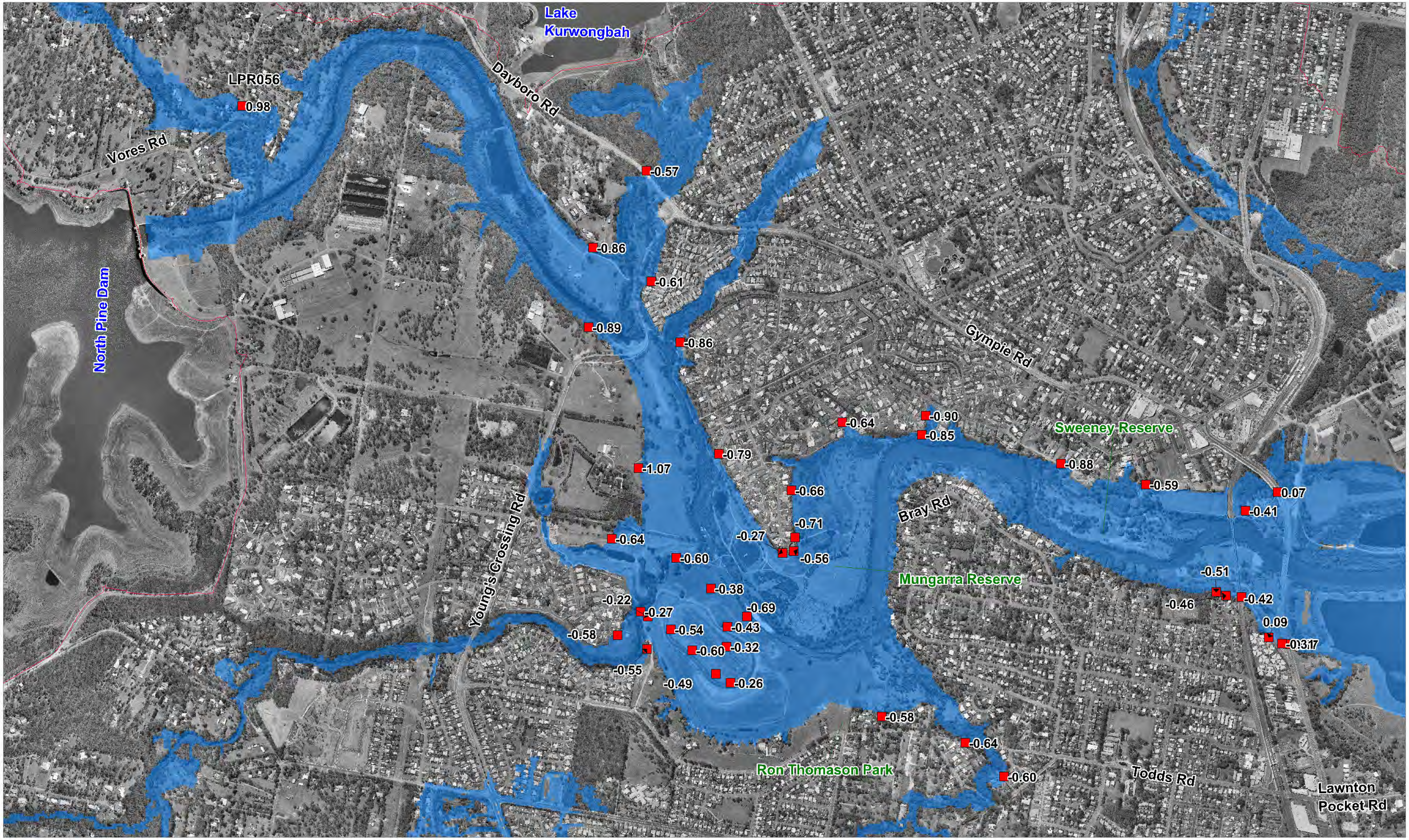

Run 6 - Normanby
Gauge Level (m)
6
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 6 - Samford Village
Gauge Level (m)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 6 - Youngs Crossing
Gauge Level (m)
14
12
10
8
6
4
2
0
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 6 - Histogram
Number of Flood Marks
12
10
8
6
4
2
0
1
0
1
5
4
5
5
10
9
6
5
1
0
1
0
1
<-1
-1 to -0.75
-0.75 to -0.5
-0.5 to -0.4
-0.4 to -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to 0
0 to 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.75
0.75 to 1
>1
Modelled minus Measured Flood Levels (m)

APPENDIX G: RUN 7 RESULTS



LEGEND

Lower Pine River Catchment

Modelled January 2011 Flood Extent

Flood Marks January 2011 Event
0.03 Difference in Peak Flood Levels in m (Modelled Minus Surveyed)

Title:

January 2011 Event Flood Mark Comparison
Run 7 Lower Pine River Catchment

Figure: **G-1**

Rev: **-**

N

0 250 500m
Approx. Scale

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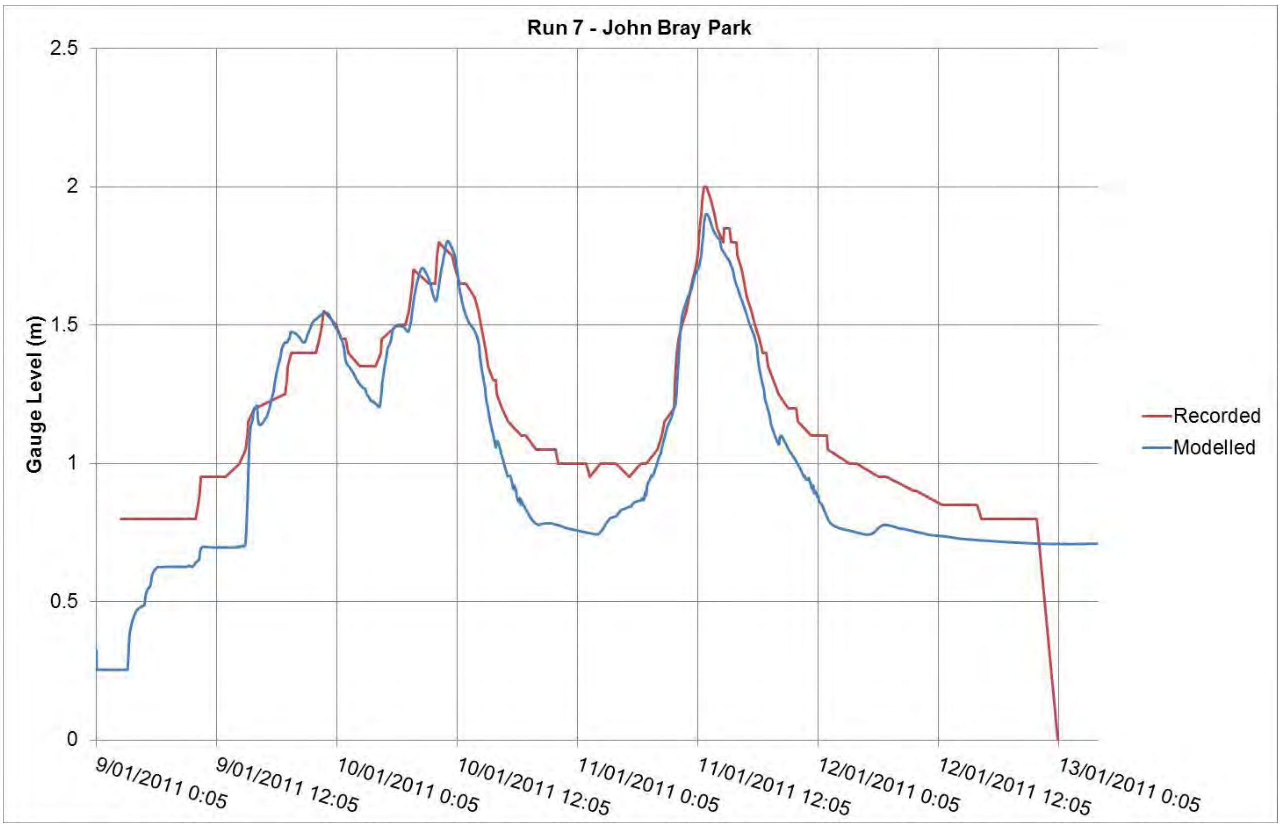
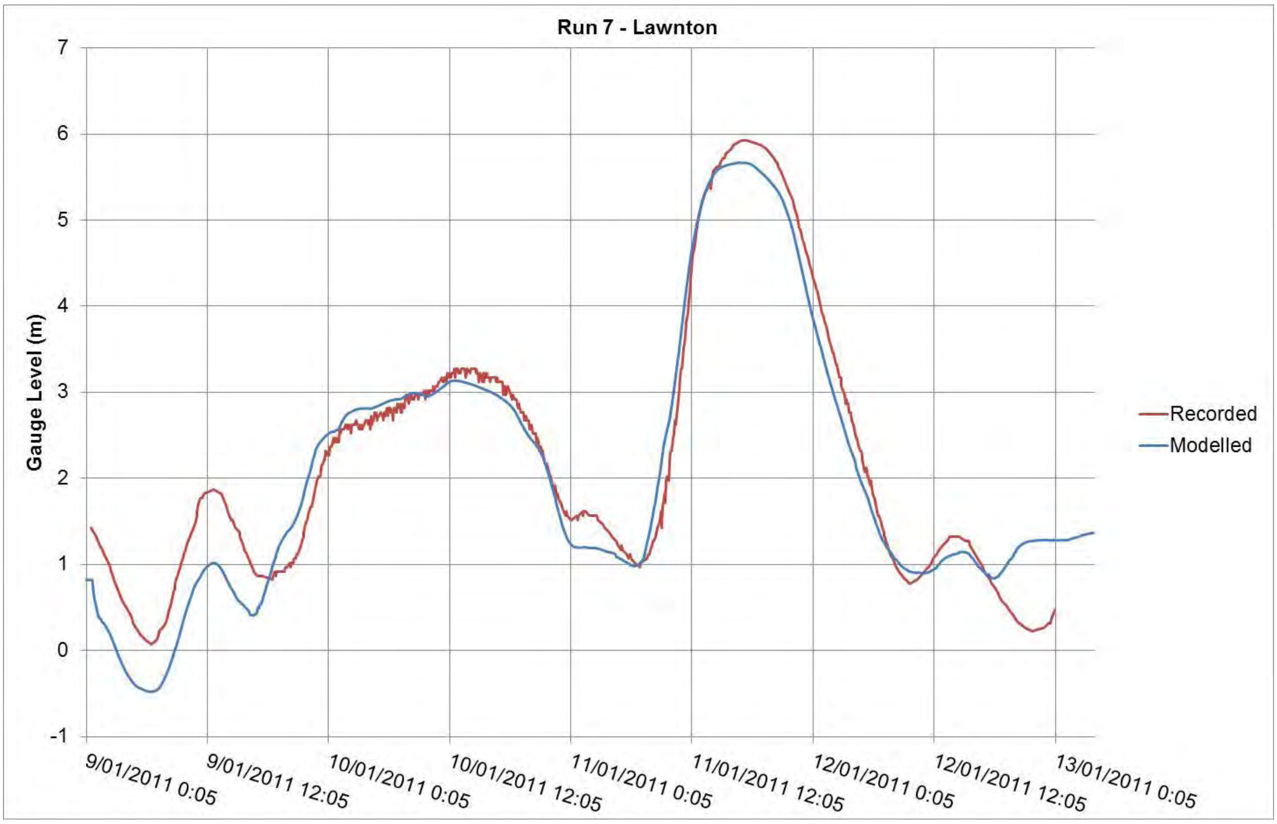
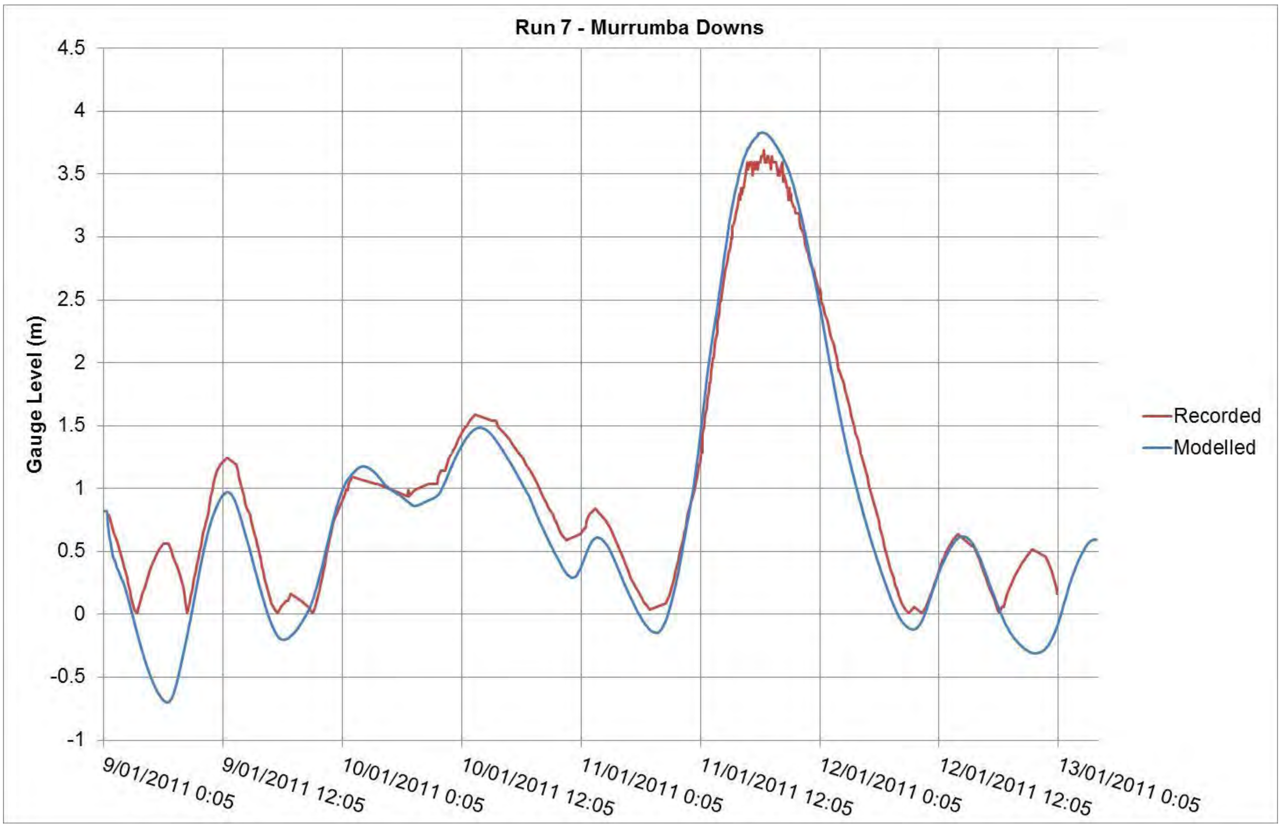
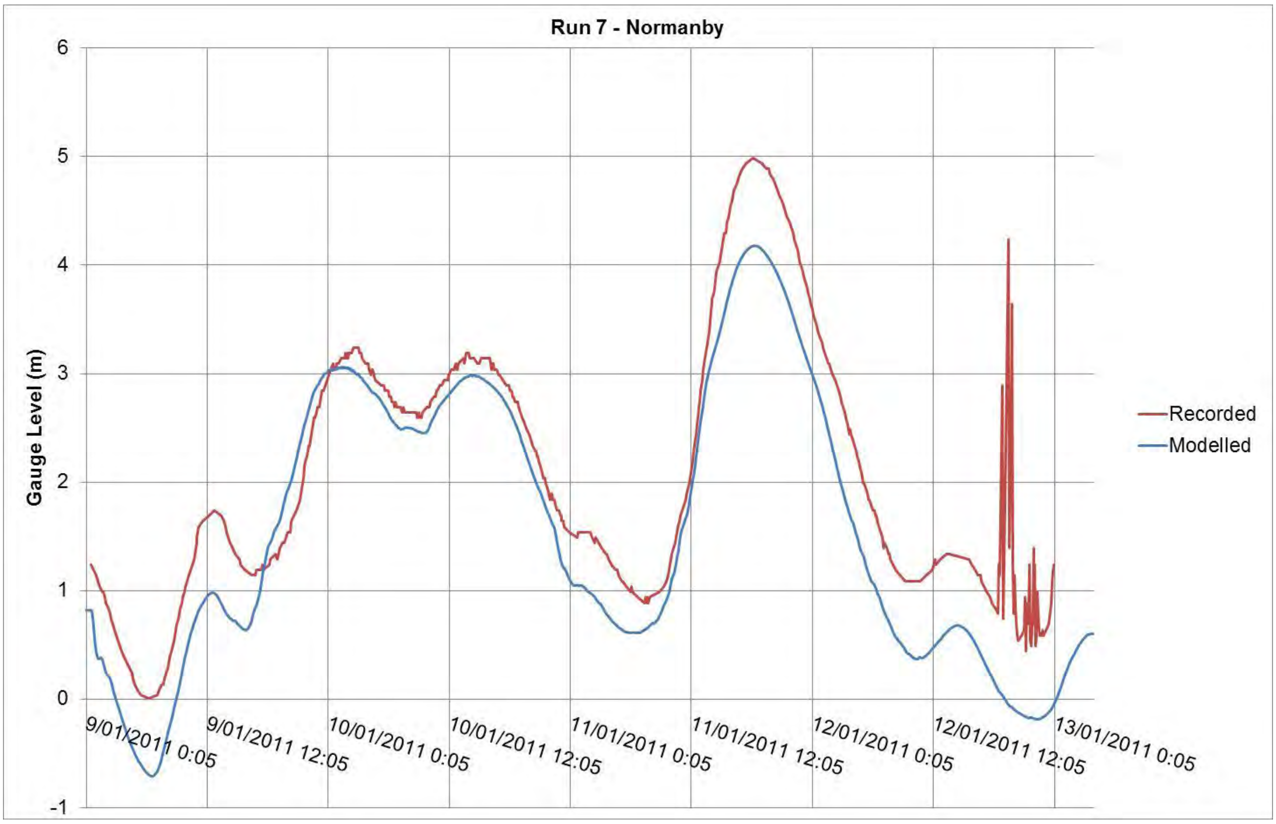
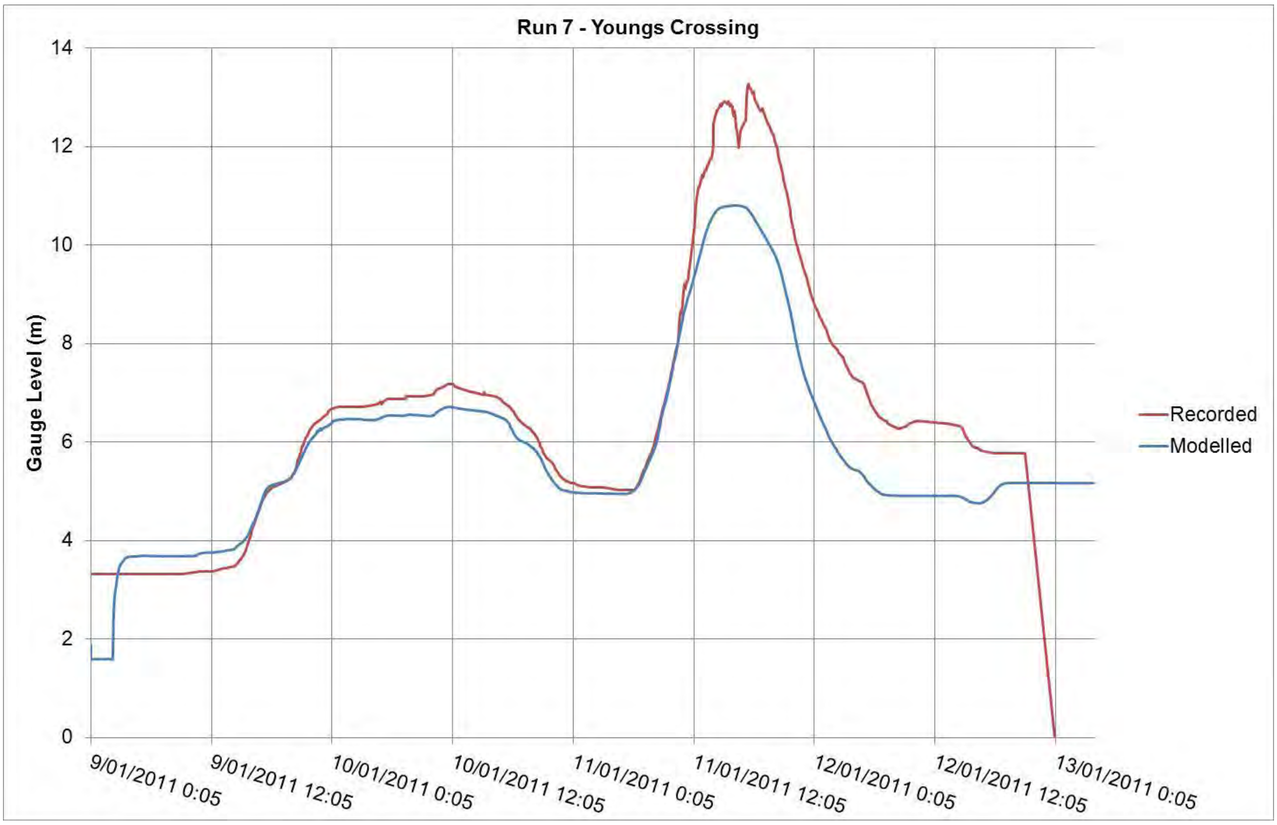
Filepath : I:\B18521_I_AK_MBRC_RFD_Stage_3\DRG\Calibration\FLD_016_121219_LPR_Calibration_Results_F7.WOR

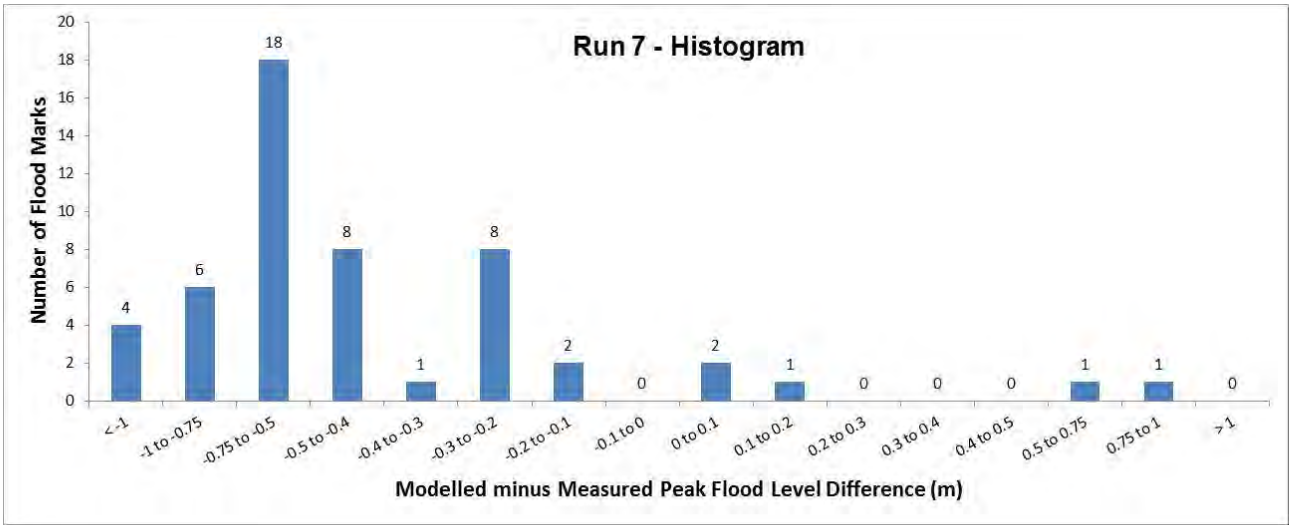

Run 7 - John Bray Park
Gauge Level (m)
2.5
2
1.5
1
0.5
0
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 7 - Lawnton
Gauge Level (m)
7
6
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

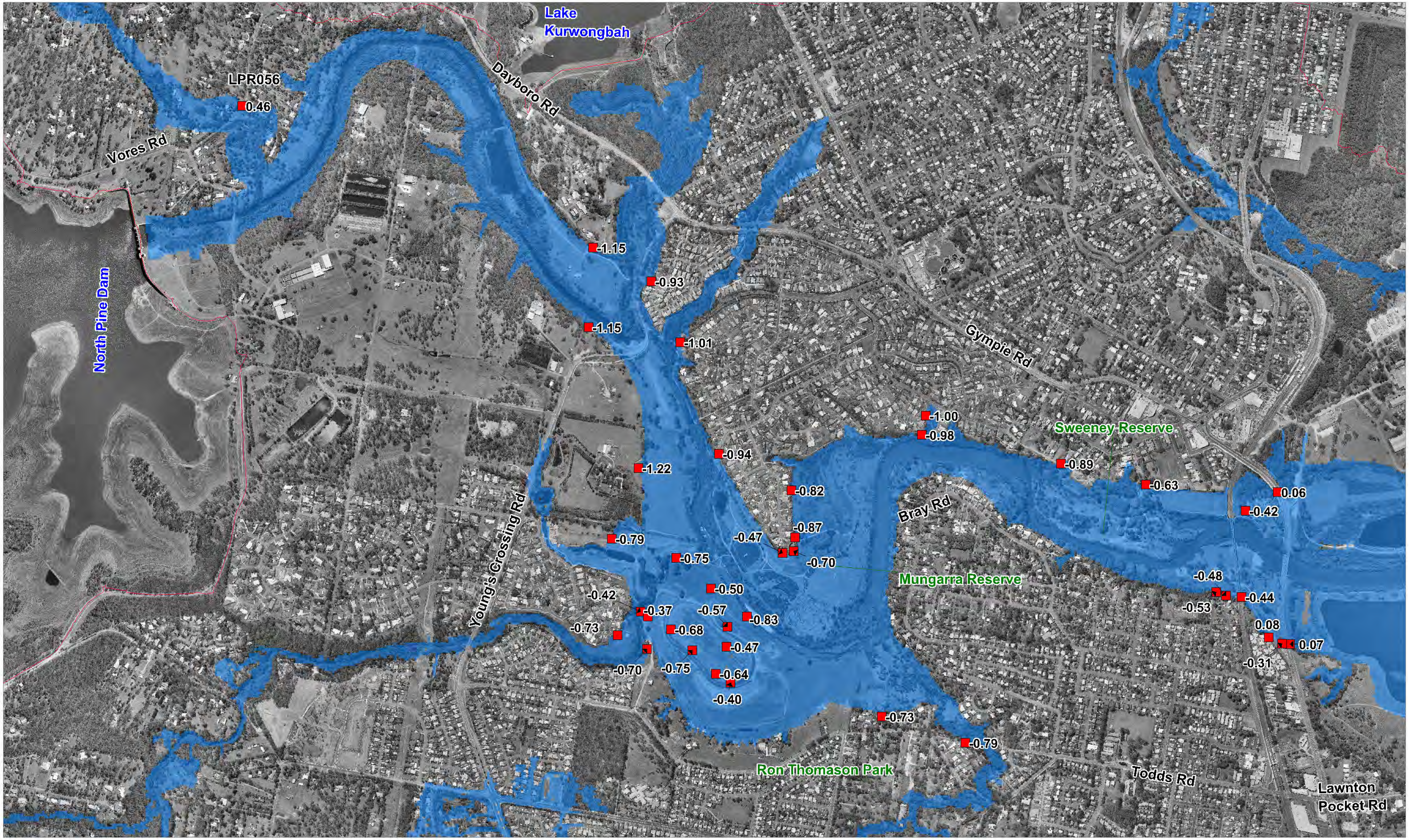

Run 7 - Murrumba Downs
Gauge Level (m)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 7 - Normanby
Gauge Level (m)
6
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 7 - Youngs Crossing
Gauge Level (m)
14
12
10
8
6
4
2
0
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 7 - Histogram
Number of Flood Marks
20
18
16
14
12
10
8
6
4
2
0
4
6
18
8
1
8
2
0
2
1
0
0
0
1
1
0
< -1
-1 to -0.75
-0.75 to -0.5
-0.5 to -0.4
-0.4 to -0.3
-0.3 to -0.2
-0.2 to -0.1
-0.1 to 0
0 to 0.1
0.1 to 0.2
0.2 to 0.3
0.3 to 0.4
0.4 to 0.5
0.5 to 0.75
0.75 to 1
> 1
Modelled minus Measured Peak Flood Level Difference (m)

APPENDIX H: RUN 8 RESULTS



LEGEND

Lower Pine River Catchment

Modelled January 2011 Flood Extent

0.03 Flood Marks January 2011 Event Difference in Peak Flood Levels in m (Modelled Minus Surveyed)

Title:

January 2011 Event Flood Mark Comparison
Run 8 Lower Pine River Catchment

N

0 250 500m
Approx. Scale

Figure: **H-1**

Rev: **-**

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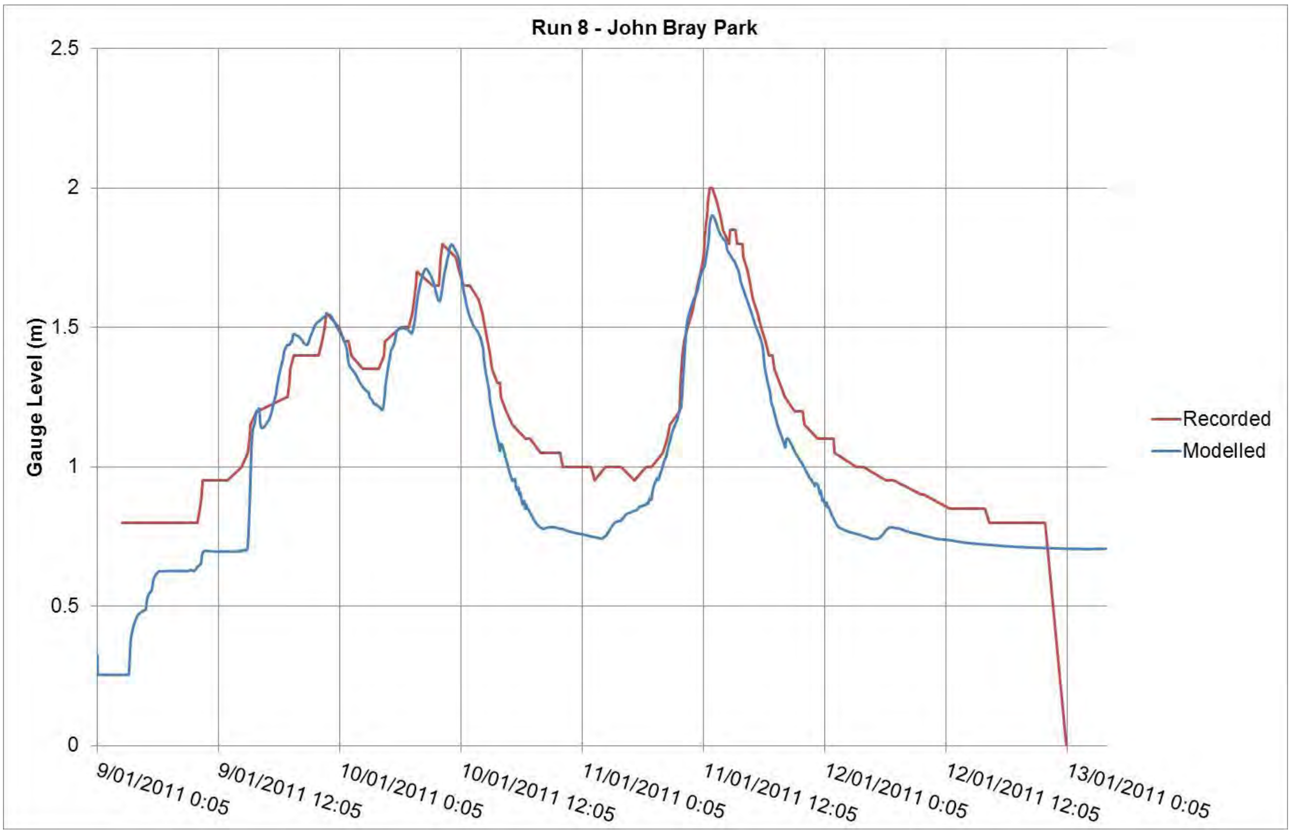
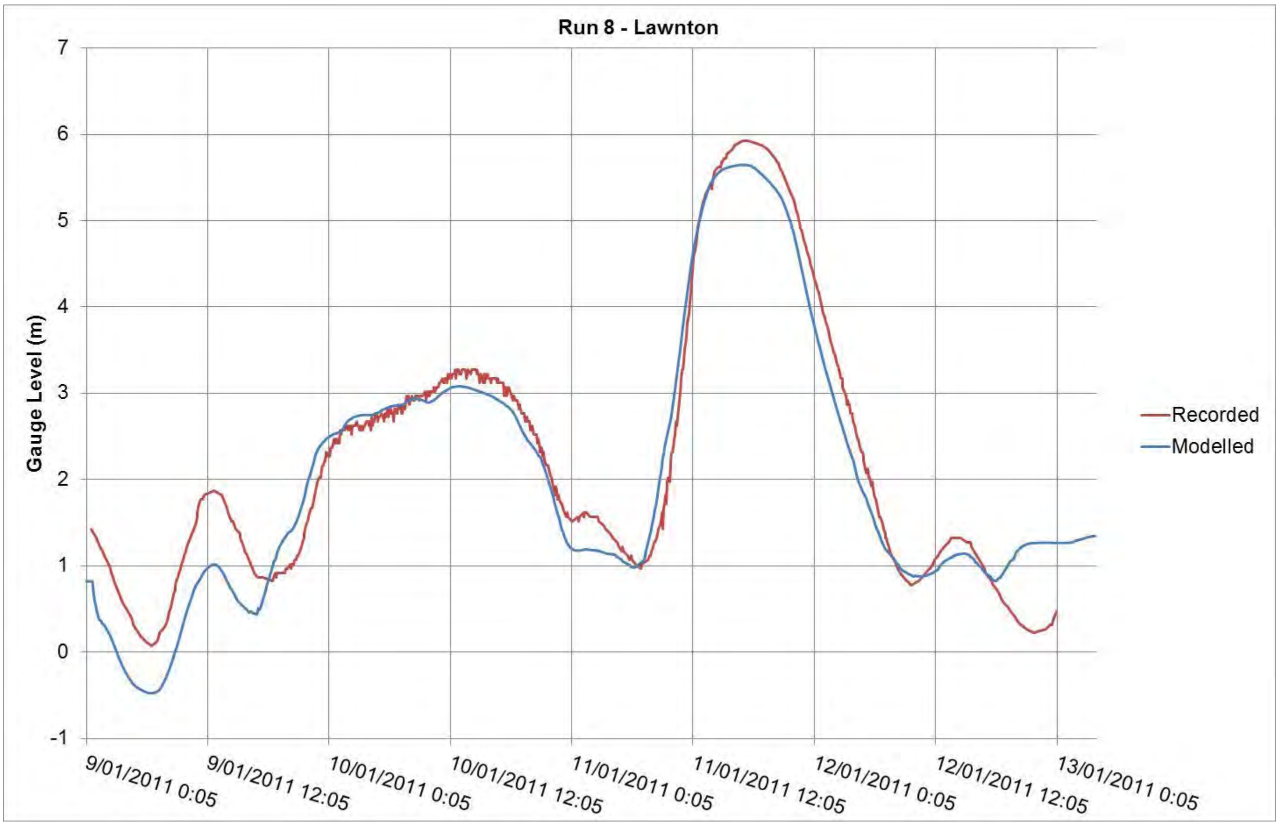
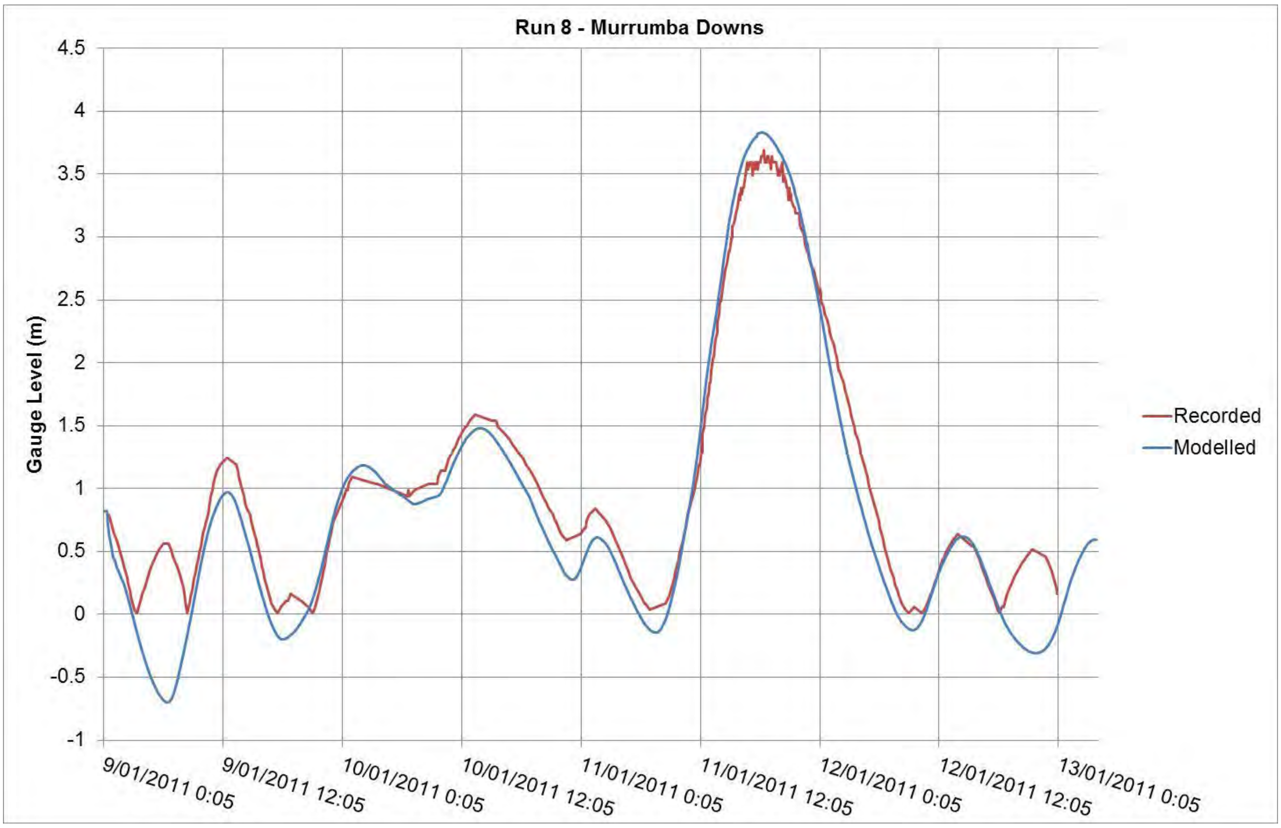
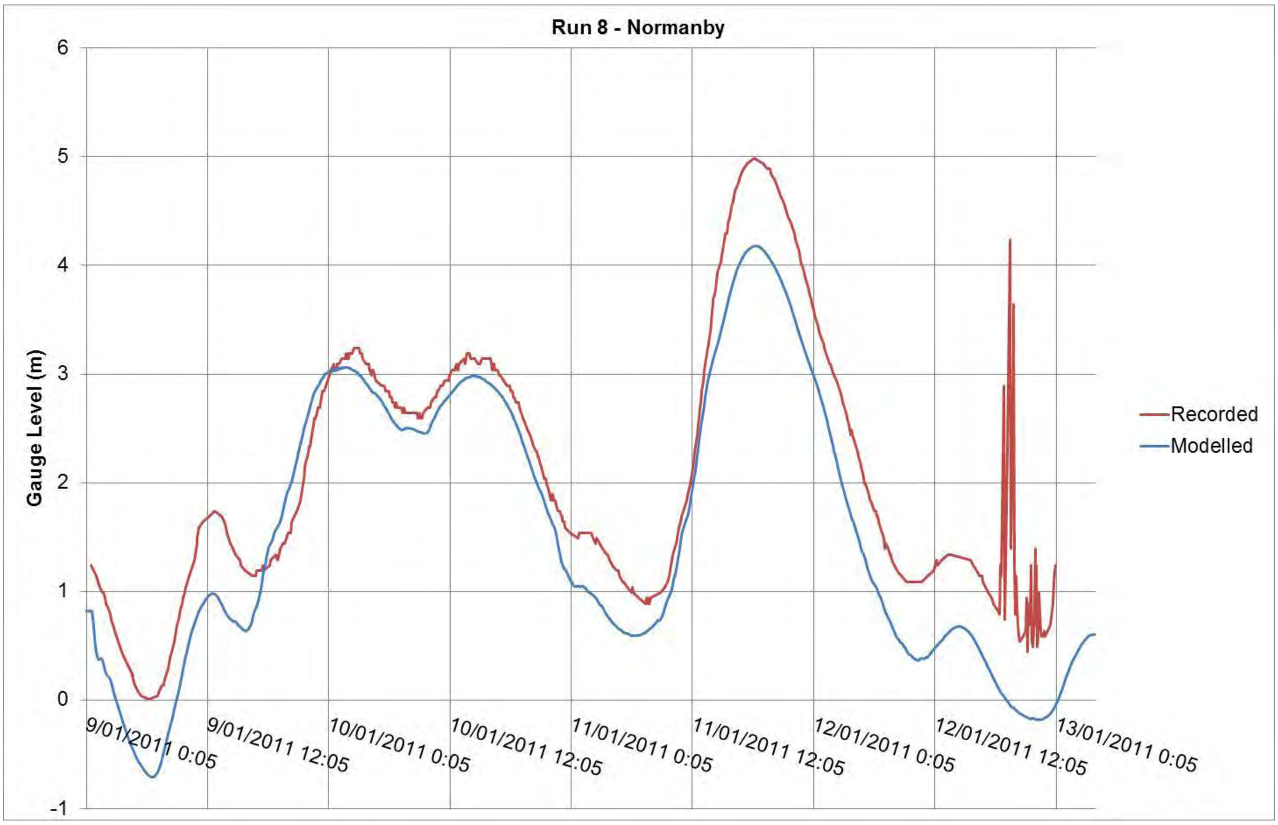
Filepath : I:\B18521_I_AK_MBRC_RFD_Stage_3\DRG\Calibration\FLD_017_121219_LPR_Calibration_Results_F8.WOR

H-3 RUN 8 RESULTS

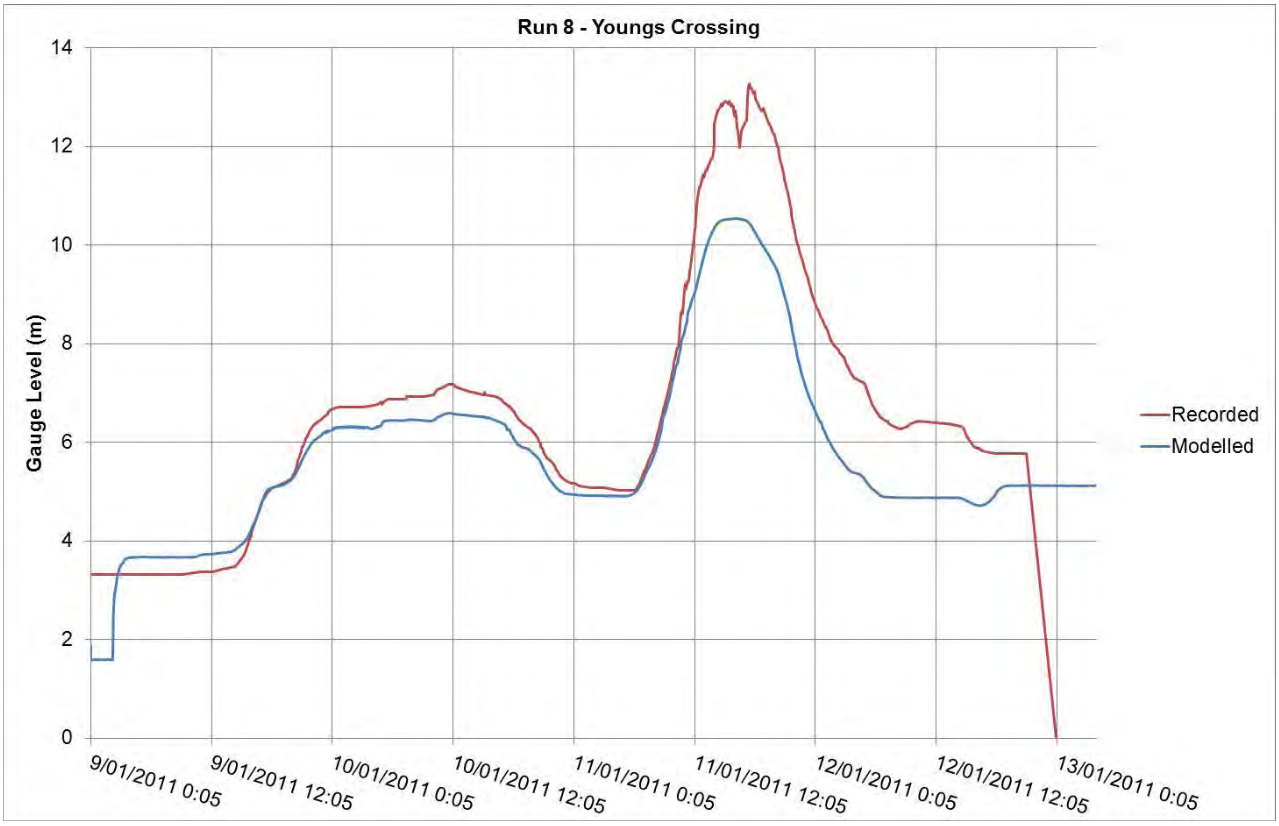


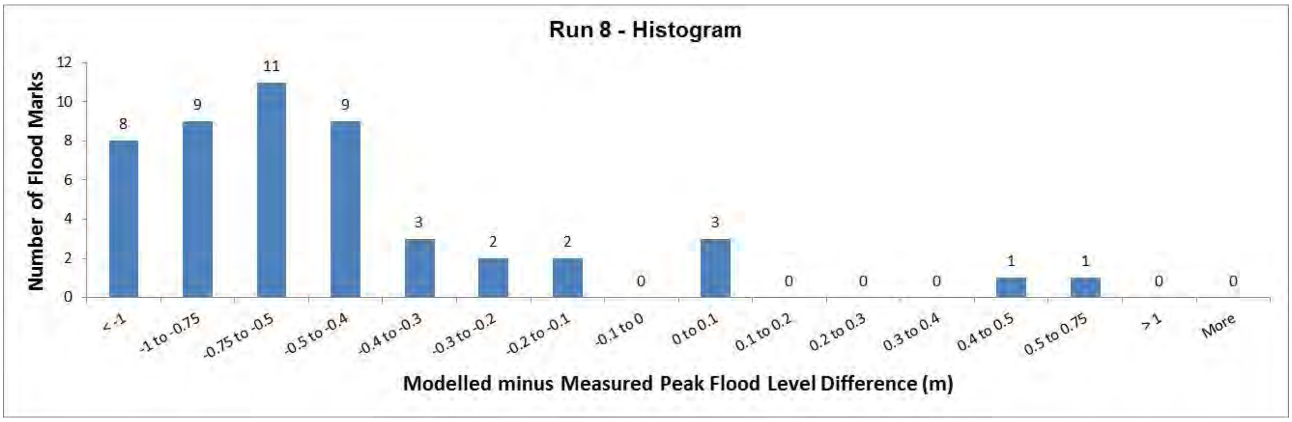



Run 8 - Murrumba Downs
Gauge Level (m)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled


Run 8 - Normanby
Gauge Level (m)
6
5
4
3
2
1
0
-1
9/01/2011 0:05
9/01/2011 12:05
10/01/2011 0:05
10/01/2011 12:05
11/01/2011 0:05
11/01/2011 12:05
12/01/2011 0:05
12/01/2011 12:05
13/01/2011 0:05
Recorded
Modelled

H-5 RUN 8 RESULTS





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