4.0 Hydraulic Modelling

4.1 Overview

The dynamic hydraulic model MIKE FLOOD was used to model flood events. The model was constructed using topographic data for the study area and calibrated to surveyed flood levels for the January 2008 rainfall event. The calibrated model was then used to determine design flood behaviour.

4.2 MIKE FLOOD

MIKE FLOOD dynamically couples the two-dimensional (2D) surface water model, MIKE21, with the one-dimensional (1D) river hydraulics model, MIKE11. The MIKE21 2D model has been used to adequately represent the complex two dimensional hydraulics of the Alligator and Whites Creek floodplain. The 1D component of MIKE FLOOD (MIKE11) was required to provide a more accurate representation of the hydraulics of structures (such as culverts and bridges).

4.3 Model Setup

4.3.1 Topographic Data

The MIKE FLOOD topographic grid was developed consisting of 1000 x 1590 (10m) grid cells. Approximately 2 km of the downstream portion of the Alligator Creek catchment was not within the aerial survey area. This extends from approximately 250 m downstream of the confluence of Alligator and Whites Creeks. This section of the creek was represented by a MIKE11 branch using interpolated cross sections extracted from the MIKE21 grid. This area was given a uniform height of 60m AHD in the MIKE FLOOD topographic grid. The MIKE FLOOD topographic grid is shown in **Figure 4-1.** The main hydraulic controls in the study area are structures and embankments associated with the Bruce Highway and North Coast Railway. Approximate structure locations are shown in **Figure 4-2** and **Figure 4-3** respectively.

4.3.2 Model Boundaries

Total catchment flow hydrographs for sub-catchment AC-3-b and WC9 – from the Alligator Creek and Whites Creek catchment respectively – were applied as discharge boundaries in the MIKE FLOOD model. All other sub-catchment flow hydrographs within the hydraulic model extent were applied directly to the grid as source points at locations corresponding to the sub-catchment outlets.
The downstream boundary was set to a fixed tailwater level of RL 1.21 m AHD, which is the Mean High Water Spring (MHWS) tidal level. Source point and boundary locations are shown in **Figure 4-1.**

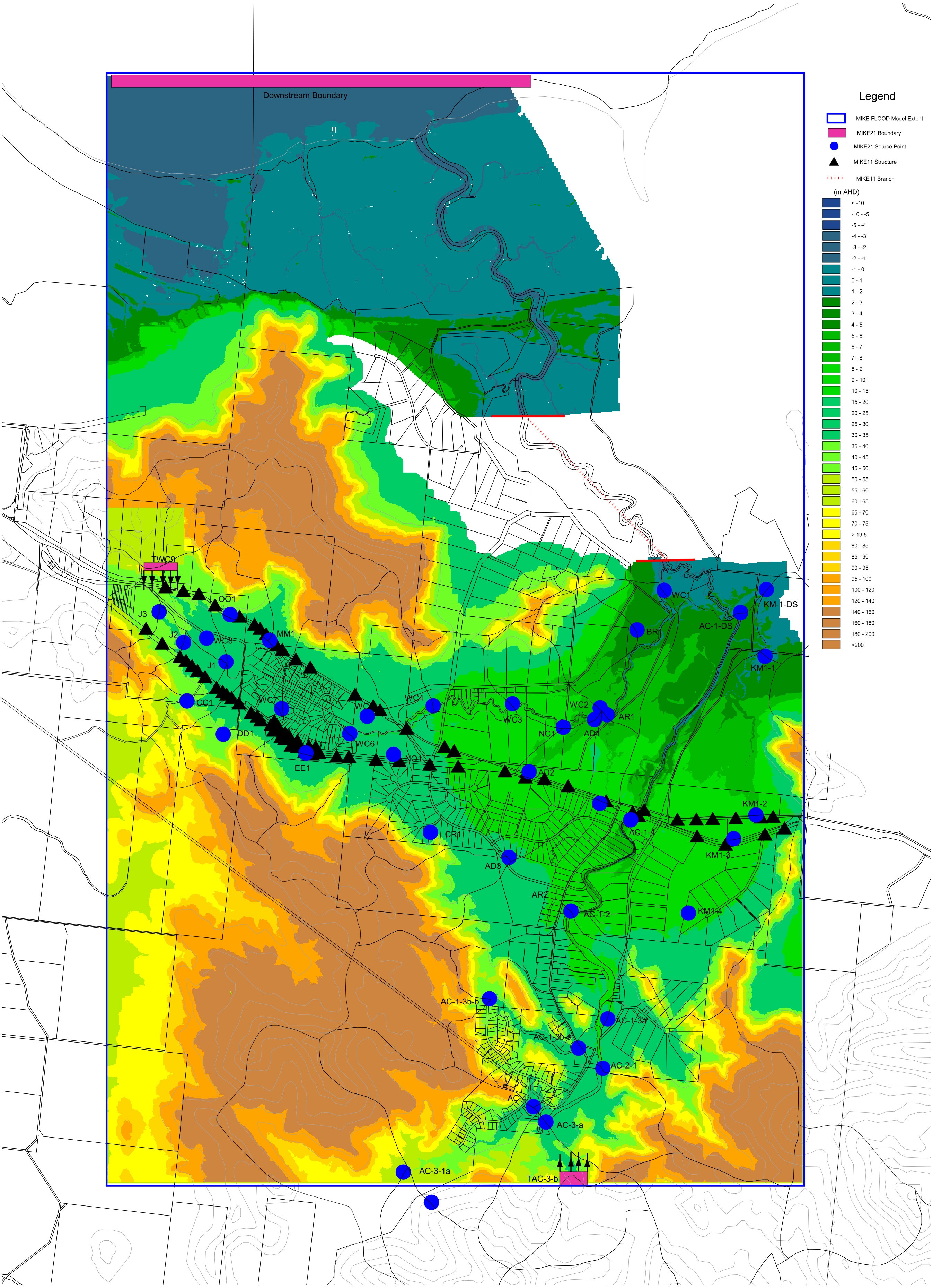
4.3.3 Roughness

Roughness values were defined for the MIKE21 grid based on site inspection and aerial photography. The adopted roughness values are given in **Table 4-1**. The distribution of these roughness values is shown in **Figure 4-4.** These values have been selected from calibration of the MIKE FLOOD model.

Table 4-1 - Representative Roughness Values

Land Cover Type	Manning's n value
Dense vegetation/mangroves	0.07
Medium dense vegetation	0.05
Long grasses / cultivated crops	0.05
Tidal flats	0.04
Roads	0.03
Waterways	0.025-0.035
Riparian zones	0.08

MAUNSELL | AECOM



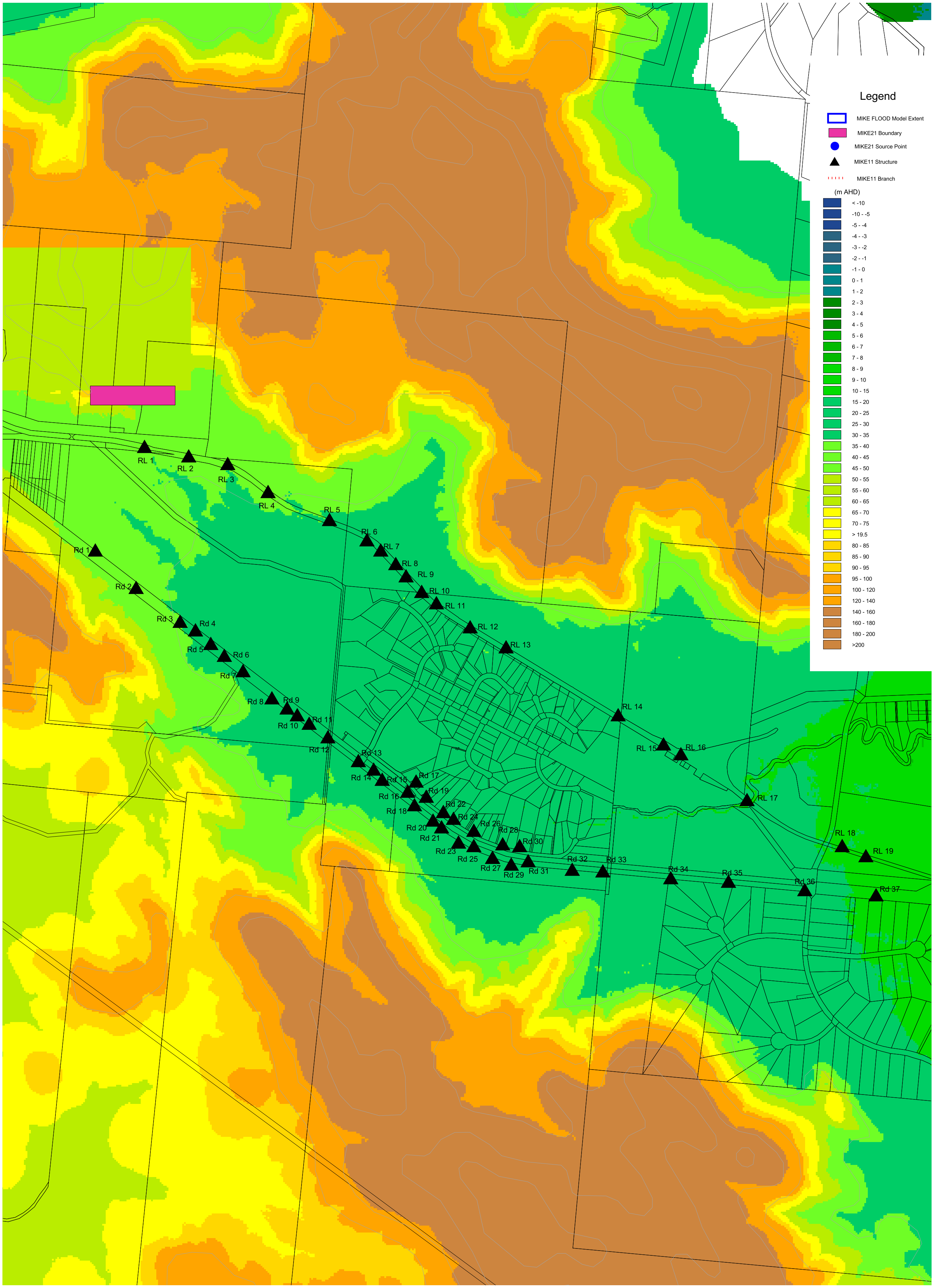
QUEENSLAND DEPARTMENT OF MAIN ROADS
80401406

0 1000m 1:25 000 (A1)

SOUTHERN ACCESS CORRIDOR HYDRAULIC MODELLING

MIKE FLOOD Model Setup

FIGURE 4.1



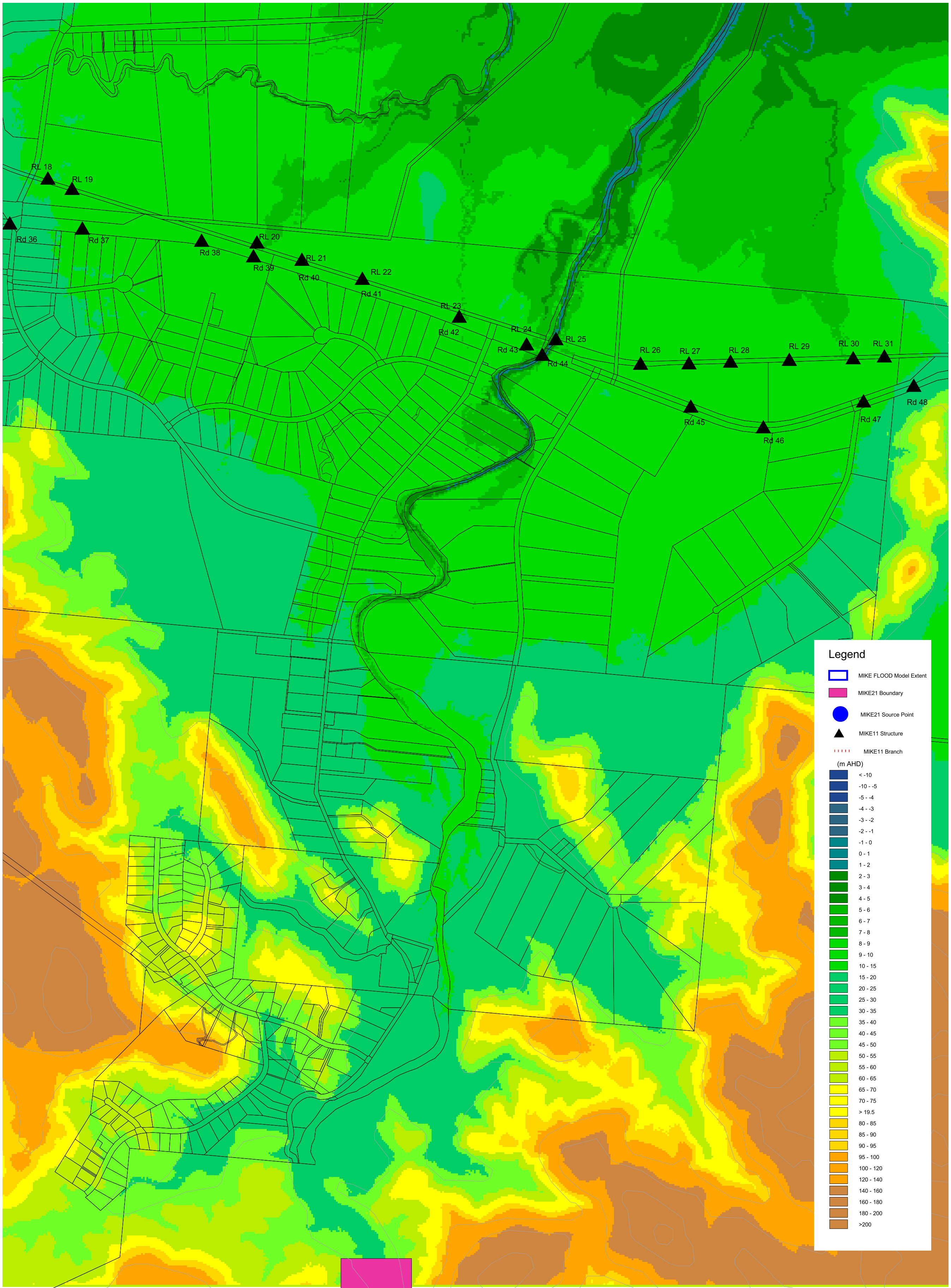
QUEENSLAND DEPARTMENT OF MAIN ROADS
80401406

0 1000m 1:10 000 (A1)

SOUTHERN ACCESS CORRIDOR HYDRAULIC MODELLING

MIKE FLOOD STRUCTURES

FIGURE 4.2



QUEENSLAND DEPARTMENT OF MAIN ROADS
80401406

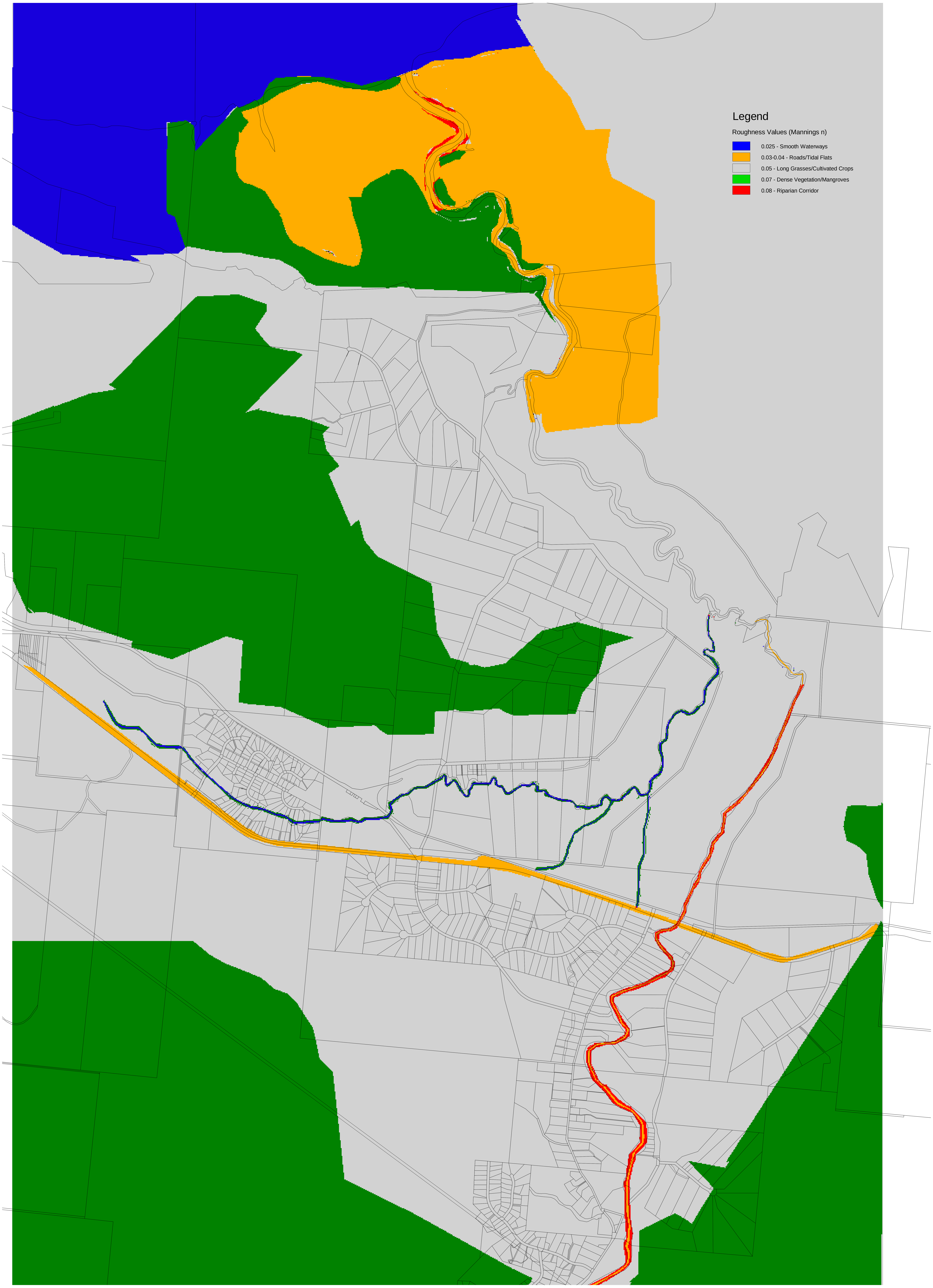
0 1000m 1:10 000 (A1)

SOUTHERN ACCESS CORRIDOR HYDRAULIC MODELLING

MIKE FLOOD STRUCTURES

FIGURE 4.3

MAUSELL | AECOM



QUEENSLAND DEPARTMENT OF MAIN ROADS
80401406

SOUTHERN ACCESS CORRIDOR HYDRAULIC MODELLING
MIKE21 ROUGHNESS GRID

FIGURE 4.4

4.3.4 Structures

Approximately 80 structures (bridges and culverts) exist within the study area. These are located along the Bruce Highway, North Coast Railway and existing access roads. Approximate structure locations within the MIKE FLOOD model are shown in **Figure 4-2** and **Figure 4-3**. All structures are represented as one-dimensional elements within the MIKE11 model, which are coupled to the MIKE21 model to ensure accurate representation of the structure hydraulics.

4.4 Model Calibration – January 2008 Event

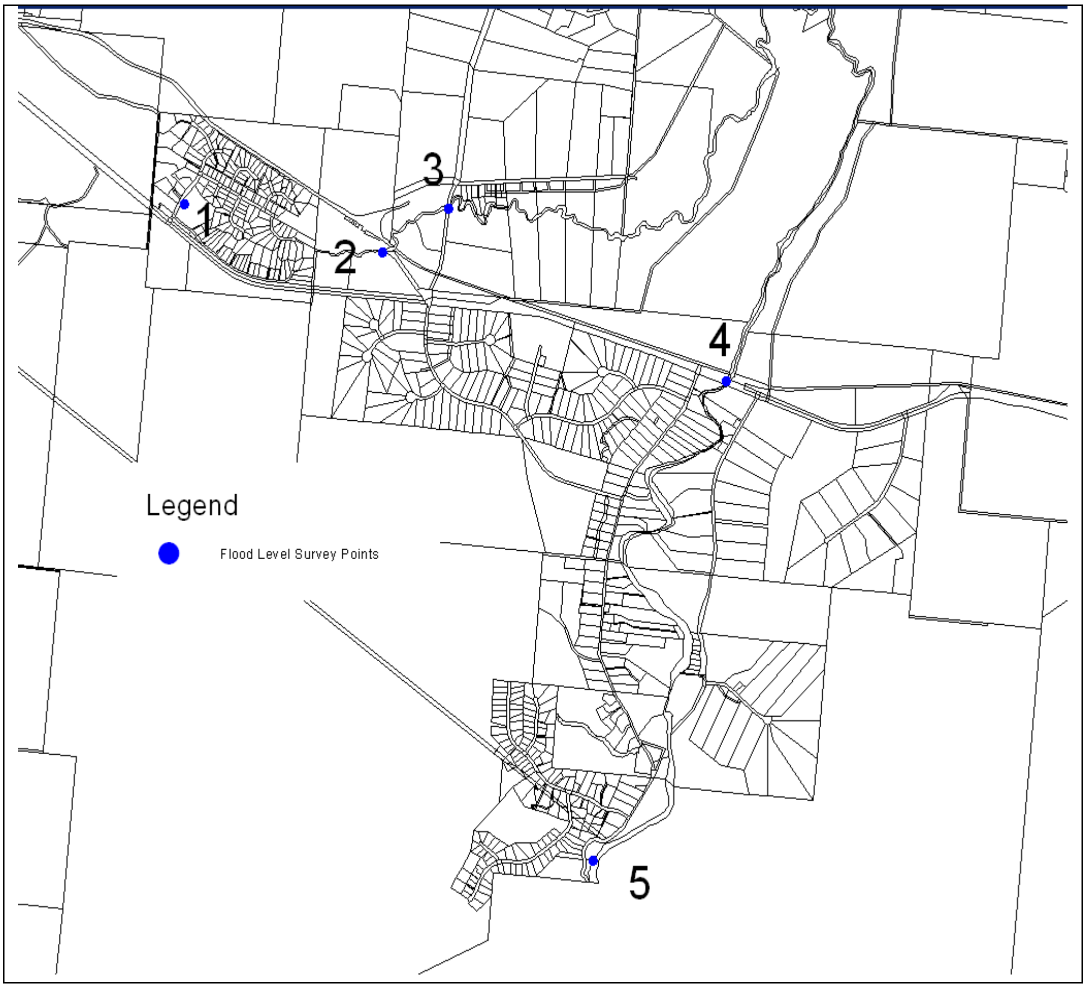
The MIKE FLOOD model was calibrated to surveyed flood levels for the flood event of 13-14 January 2008. Flood levels were surveyed at five points by DMR based on flood marks and flood debris levels. Survey levels are shown in **Table 4-2** and their locations in **Figure 4-5**. Calibration was only possible due to the availability of surveyed flood levels across the study area for the 2008 rainfall event, as such the MIKE FLOOD model cannot be calibrated accurately to any other recorded event.

Table 4-2 – Survey Flood Levels and Locations

Survey Point	Survey Location	Surveyed Levels (m AHD)	MIKE FLOOD Levels (m AHD)	Level Difference (m)
1	Muntalunga Drive road crossing over Whites Creek	23.81	23.84	0.03
2	North Coast Railway crossing over Whites Creek	16.63	16.67	0.04
3	Bentley Drive crossing over Whites Creek	14.41	14.47	0.06
4	Bruce Highway crossing of Alligator Creek	7.73	7.74	0.01
5	Alligator Creek Road crossing of Alligator Creek	26.18	26.19	0.01
			Average Difference	**0.03**

Flow hydrographs from the calibrated RAFTS-XP model were applied to the MIKE FLOOD model. Roughness values were varied to achieve a reasonable match between the modelled and surveyed flood levels. The comparison between surveyed flood levels and modelled flood levels shows good agreement between the recorded levels and those predicted by the MIKE FLOOD model. The calibration of the MIKE FLOOD confirms its suitability for determining design flood levels for Alligator and Whites Creek.

Figure 4-5 – Flood Survey Locations



4.5 Comparison to Previous HEC-RAS

The Alligator Creek and Whites Creek Flooding Report (2007) was prepared by UDP to determine 50 year flood levels and flows in Whites Creek in order to establish planning levels for TCC. This study used the rational method to establish flows, which were input to a 1D HEC-RAS hydraulic model of an approximately 1 km section of Whites Creek down stream of the rail bridge. The model used surveyed cross sections to represent floodplain and channel geometry. **Table 4-3** shows a comparison between flood levels for locations shown in **Drawing BRA009/01.**

There is a decrease in flood levels in the MIKE FLOOD model. The MIKE FLOOD model is based on extended flood plain geometry, allowing formation of secondary flows outside the main Whites Creek channel.

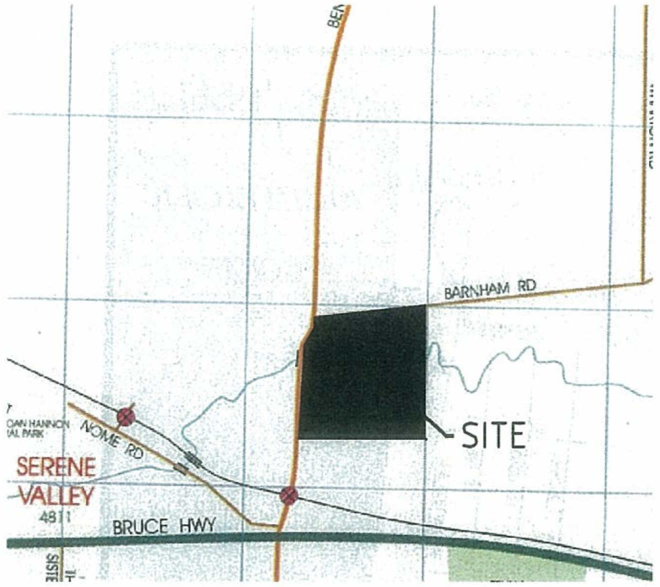
Table 4-4 shows a comparison of the flows within the HEC-RAS model to flows within the same cross-section extents in the MIKE FLOOD model. This shows flows in the MIKE FLOOD model are reduced as result of the secondary flow paths south of Whites Creek.

Table 4-3 – Whites Creek Flood Level Comparison

Chainage (m)	UDP Flood Levels (m AHD)	MIKE FLOOD Levels (m AHD)	Difference (m)
810	15.85	15.42	-0.43
1010	15.23	14.81	-0.42
1210	14.75	14.28	-0.47
1360	14.1	13.52	-0.58
1540	13.52	13.1	-0.42
1680	12.44	12.32	-0.12
		Average Difference	**-0.41**

Table 4-4- Whites Creek Flow Comparison

Chainage (m)	UDP Flow (m^3/s)	MIKE FLOOD Flow (m^3/s)	Difference (m^3/s)
810	315	217	-98
1010	315	156	-159
1210	315	142	-173
1360	315	184.8	-130.2
1540	315	164.7	-150.3
1680	315	164	-151
		Average Difference	**-143.6**



LOCALITY PLAN

NOT TO SCALE

LOT NUMBER	Q50 WATER SURFACE LEVEL (RL)	HABITABLE FLOOR LEVEL (RL)
1	15.50	15.80
2	15.20	15.50
3	15.00	15.30
4	14.90	15.20
5	14.80	15.10
6	14.50	14.80
7	14.50	14.80
8	13.90	14.20
9	13.80	14.10
10	13.50	13.80
11	13.00	13.30
12	12.90	13.20
13	12.60	12.90

REAL PROPERTY DESCRIPTION:

Former Lot 7 on RP739537 & Lot 8 on RP739537

Rv.	DATE	REVISIONS	REC.	APPR.
A	05/06/07	ISSUED FOR INFORMATION - FINAL		

DRAWN: J.STROGUSZ
DESIGNED: R.MCKENZIE
CHECKED: R.MCKENZIE
PROJECT MANAGER: R.MCKENZIE
DATUM: AHD(Derived)
PROJECT DIRECTOR: P.BRADY - RPEQ 7112
XREF: BRA009 X-REF-DESIGN

UDP Consulting Engineers
Urban Development Design Infrastructure Project Management
Suite 3, 62 Walker St
TOWNSVILLE QLD 4810
PO BOX 1110
TOWNSVILLE QLD 4810
Phone: (07) 4772 0666
Fax: (07) 4772 0566
Email: main@udpconsulting.com.au

B AND M CREEDY

WHITE'S CREEK HYDRAULIC STUDY
BENTLEY DRIVE & BARNHAM ROAD, NOME
FINISHED FLOOR LEVELS FOR HABITABLE STRUCTURES

DRAWING SIZE	SCALE	DRAWING No.	REV
A1	AS SHOWN	BRA009/01	A

5.0 Design Flood Assessment

The calibrated MIKE FLOOD model was used to simulate the 5, 10, 20, 50, and 100 Year design flood events. Catchment runoff hydrographs for the 24 hour design storm from the RAFTS-XP model were applied to the MIKE FLOOD model.

The MIKE FLOOD model was used to define:

- flood levels;
- water depths;
- flood extents; and
- flow velocities.

Flood maps showing water depth, flood levels and current velocities for each design event modelled are included in **Appendix A**. Long sections of flood levels along the four major watercourses within the study site are included in **Appendix B** and with chainages indicated in **Figure B-1.**

5.1 Road Corridors

A summary of flood levels for major road corridors within the study area is shown in **Table 5-1** with their locations shown in **Figure 5-1.** Road corridors within the study area inundated for all modelled flooding events (5 year ARI and greater) include:

- the Muntalunga Drive crossing of Whites Creek;
- the Nome Road crossing of Whites Creek;
- Bentley Drive for a significant length;
- Barnham Road for a significant length;
- Willing Drive at three locations;
- Allendale Drive at three locations;
- Duggan Drive at two locations;
- upper Alligator Creek Road at two locations;
- lower Alligator Creek Road adjacent to Duggan Drive; and
- Williams Road in its upper reaches adjacent to Alligator Creek.

A summary of the Bruce Highway inundation locations for the specific flood event is given below. The Bruce Highway is inundated:

- west of the Muntalunga Drive turnoff for flood events greater than the 20 year flood;
- adjacent to Country Road in the 50 year flood event;
- adjacent to Olivia Court in the 50 year flood event;
- in the area bordering Willing Drive for the 20 year event;
- adjacent to Alligator Creek Road for the 100 year flood;
- at the Alligator Creek road bridge for the 100 year flood event; and
- east of Williams Road in the 20 year flood.

5.2 Defined Flood Event

The 50 year ARI flood event has been adopted by TCC as the Defined Flood Event for planning and development purposes. The following section describes the inundation from the 50 year ARI event (refer **Appendix A**).

Within the Alligator Creek catchment properties bordered by Mount Panorama Drive and Alligator Creek Road are inundated to depths of 1.5 – 2 m adjacent to Slippery Rocks Creek. North of Mount Elliot Drive overbank flooding from Alligator Creek occurs to depths of 1 – 1.5 m on adjacent properties. Properties bordered by Williams Road and Alligator Creek Road south of the highway are inundated by flood depths above 3 m adjacent to Alligator Creek. Downstream of the highway there is extensive overbank flooding adjacent to Alligator Creek with depths generally above 3 m. Minor flooding occurs of depths up to 0.3 m on properties between Tindall Court and Williams Road.

Within the Whites Creek catchment extensive overbank flooding occurs both upstream and downstream of Muntlunga Drive, inundating properties to depths up to 0.75 m. Overflows occur to the south of the main channel downstream of the Nome Road crossing to depths up to 0.5 m. A series of secondary flow paths form adjacent to Whites Creek downstream of the Bentley Drive crossing inundating properties to depths up to 1 m. These follow Whites Creek before rejoining the main channel approximately 3 km downstream.

Within the flood plain bordered by Allendale Drive and Alligator Creek Road there is widespread inundation to depths of 0.5 m. This overland flow drains north of the highway into a small well defined channel which discharges into Whites Creek approximately 1.5 km downstream. A small drainage channel runs parallel to Alligator Creek inundating properties to depths of 0.5 m downstream of the highway.

Table 5-1: MIKE FLOOD Design Flood Levels

				MIKE FLOOD Design Flood Levels (m AHD)					
MIKE FLOOD Grid Co-ordinates	Location ID	Location	Road Level	5 Year ARI Event	10 Year ARI Event	20 Year ARI Event	50 Year ARI Event	100 Year ARI Event	Overtop Road
(55, 794)	1	West Bruce Highway	42.45	40.79	40.79	40.79	40.79	40.88	No
(167, 707)	2	West Bruce Highway	29.48	28.20	28.21	28.24	28.26	28.29	No
(193, 687)	3	Old Coast Road Crossing	28.19	27.91	28.15	28.39	28.49	28.70	20 Year ARI
(229, 706)	4	Muntalunga Road Crossing	23.44	24.90	25.24	25.61	25.78	26.01	< 5 Year ARI
(286, 622)	5	Nome Highway Region	23.15	23.06	23.10	23.14	23.15	23.18	50 Year ARI
(413, 610)	6	Nome Bruce Highway	20.50	20.29	20.40	20.5	20.53	20.61	50 Year ARI
(426, 645)	7	White Creek Rail Crossing	18.52	18.23	18.36	18.49	18.56	18.64	50 Year ARI
(485, 687)	8	Bentley Drive Crossing	14.30	14.58	14.61	14.63	14.65	14.68	< 5 Year ARI
(575, 591)	9	Central Bruce Highway	10.38	10.34	10.37	10.38	10.39	10.41	20 Year ARI
(609, 583)	10	Central Bruce Highway	9.21	9.12	9.15	9.19	9.20	9.23	100 Year ARI
(642, 572)	11	Central Bruce Highway	9.83	9.46	9.47	9.48	9.48	9.49	No
(720, 547)	12	West Alligator Creek Gully	10.23	10.00	10.09	10.18	10.22	10.26	100 Year ARI
(766, 527)	13	Alligator Creek Crossing	10.67	9.43	9.79	10.26	10.45	10.75	100 Year ARI
(848, 495)	14	East Bruce Highway	10.69	10.66	10.68	10.70	10.71	10.72	20 Year ARI
(884, 483)	15	East Bruce Highway	10.30	10.19	10.22	10.29	10.31	10.35	50 Year ARI
(912, 487)	16	East Bruce Highway	10.71	10.12	10.14	10.17	10.19	10.20	No

MAUNSELL | AECOM

QUEENSLAND DEPARTMENT OF MAIN ROADS
80401406

SOUTHERN ACCESS CORRIDOR HYDRAULIC MODELLING
MIKE FLOOD DESIGN FLOOD LEVEL LOCATIONS

FIGURE 5.1

6.0 Summary and Conclusions

The Alligator and Whites Creek Flooding Assessment was undertaken to establish baseline flood levels along the Bruce Highway as input for alignment options for the SAC project and to provide TCC with flood levels for development control.

RAFTS-XP hydrological models were used to produce flow hydrographs for the Alligator and Whites Creek catchments respectively. The RAFTS-XP model has been calibrated against the January 2008 rainfall event.

A MIKE FLOOD 2-D hydraulic model has been developed to represent the flooding of the Alligator and Whites Creek area. The MIKE FLOOD model was constructed using topographic survey data from a variety of sources. The MIKE FLOOD model was calibrated to surveyed flood levels for the January 2008 event supplied by DMR. The model matched recorded levels well with modelled flood levels 0.03 m higher on average compared to survey levels for the event.

The design flood event was modelled using the existing floodplain topography and MHWS tailwater level for the 5, 10, 20, 50 and 100 year rainfall events.

Design flood events show that a significant number of access roads are cut within the study area for all modelled flood events. The Bruce Highway is innundated for the specific flood event at the following locations:

- west of the Muntalunga Drive turnoff for flood events greater than the 20 year flood;
- adjacent to Country Road in the 50 year flood event;
- adjacent to Olivia Court in the 50 year flood event;
- in the area bordering Willing Drive for the 20 year event;
- adjacent to Alligator Creek Road for the 100 year flood;
- at the Alligator Creek road bridge for the 100 year flood event; and
- east of Williams Road in the 20 year flood.

The 50 ARI flood event is adopted by Townsville City Council as the Defined Flood Event for planning and design purposes in the study area. The 50 year flood shows inundation of properties adjacent to Alligator and Whites Creek due to overbank flooding and floodplain formation (refer **Appendix A)**.

7.0 References

Maunsell Australia (2007), Rocky Springs Integrated Water Cycle Management Study

UDP Consulting Engineers (2007), Alligator Creek and Whites Creek Flooding Report

DHI Software (2005), MIKE FLOOD 1D-2D Modelling User Manual

The Institution of Engineers, Australia (1998), Australian Rainfall and Runoff

WP Software (1994) RAFTS-XP User's Manual, Version 4.0