MOOLARBEN COAL PROJECT

APPENDIX 7

Flood Impact Assessment

MOOLARBEN COAL MINES PTY LTD

MOOLARBEN COAL PROJECT

FLOOD IMPACT ASSESSMENT

Issue No. 3
MAY 2006

MOOLARBEN COAL MINES PTY LTD

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Issue No. 3
MAY 2006

Document Amendment and Approval Record

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1 INTRODUCTION

Moolarben Coal Mines Proprietary Limited proposes to develop a series of coal mines at a site located 40 kilometres north-east of Mudgee. The proposed mines are referred to as the Moolarben Coal Project and are located immediately east and south of the existing Ulan Colliery near the village of Ulan (*refer* **Figure 1**).

The Exploration License (*Reference No. 6288*) covers an area of about 11,000 hectares. However, mining operations are only expected to extend across an area of about 3,450 hectares (*refer* **Figure 2**). The mining operations will involve the extraction of 12 million tonnes per annum (*Mtpa*) of run-of-mine coal, of which 8 Mtpa is to be extracted from open cut operations and 4 Mtpa from underground operations.

The Moolarben Coal Project will comprise the staged development of three open cut mines, an underground mine as well as associated mine infrastructure and services. The open cut operations will occupy a total land area of about 1,120 hectares and will be situated in the central and southern sections of the Exploration License (*refer* **Figure 2**). The extent of the open cut operations are defined by a number of economic and physical constraints such as roads, railways and watercourses.

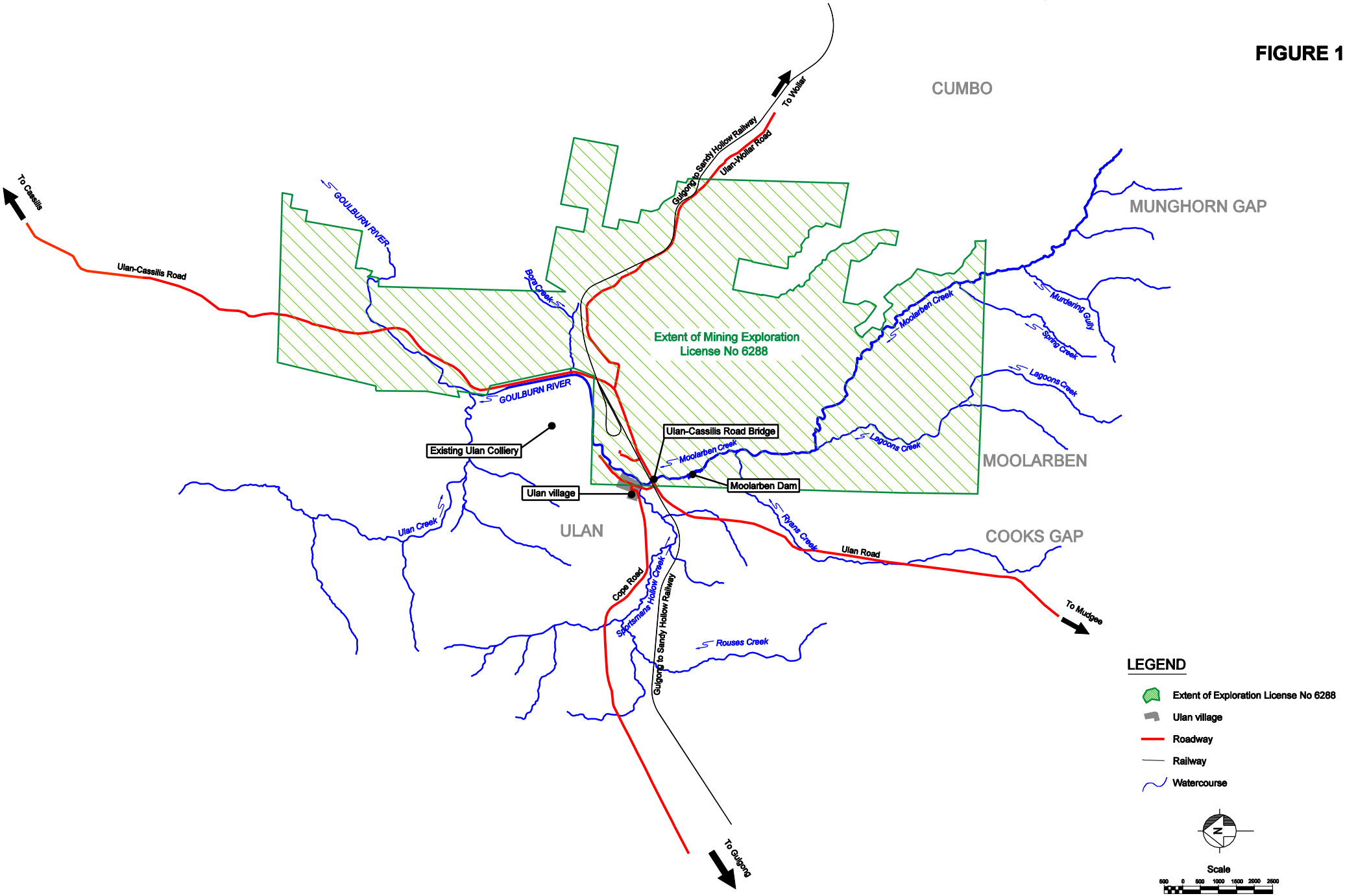
The underground operations will be located in the northern section of the Exploration License (*refer* **Figure 2**). The coal will be extracted from the underground mine using longwall mining methods. Mine infrastructure areas are also proposed between Open Cut No. 1 and the underground mine area adjacent to the Gulgong to Sandy Hollow Railway. The mine infrastructure will comprise coal stockpiling, a washing plant and rail loading facilities.

As shown in **Figure 2**, Moolarben Creek extends through and adjacent to the proposed open cut operations. The Goulburn River is also located within close proximity to the western boundary of the proposed underground mine area. A number of tributaries also join Moolarben Creek and the Goulburn River within the Exploration License. These include Ryans, Lagoons, Spring and Bora Creeks (*refer* **Figure 2**).

There is potential for inundation of the open cut mines when Moolarben Creek and the Goulburn River overtop their banks. There is also potential for the earthworks associated with the proposed mine development to impact on existing flood behaviour along each of the watercourses that drain through the Exploration License.

Accordingly, Moolarben Coal Mines Proprietary Limited commissioned Patterson Britton & Partners to investigate the potential for inundation of the proposed mine sites from Moolarben Creek and the Goulburn River during a range of design floods. This report documents the findings of those investigations and defines predicted peak flood levels and velocities along Moolarben Creek, the Goulburn River and their tributaries, for existing catchment conditions. The investigation also considers the potential impact that the mine development may have on existing flood behaviour.

FIGURE 1



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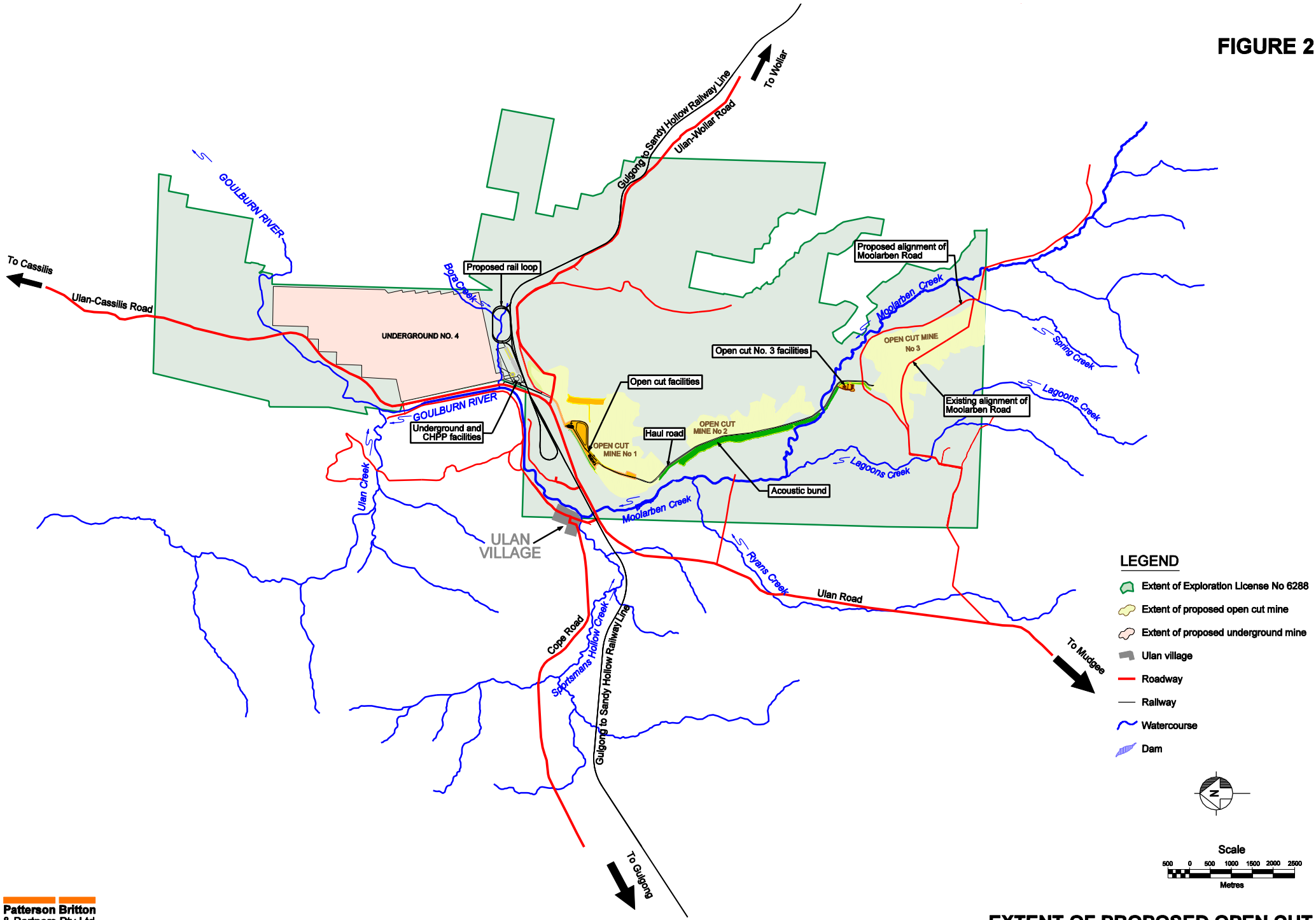
LOCATION OF PROPOSED MOOLARBEN COAL MINE PROJECT

FIGURE 2



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EXTENT OF PROPOSED OPEN CUT AND UNDERGROUND MINE ACTIVITIES

2 CATCHMENT AND STREAM CHARACTERISTICS

2.1 CATCHMENT CHARACTERISTICS

The Exploration License for the Moolarben Coal Project is drained by two major watercourses, namely Moolarben Creek and the Goulburn River. Moolarben Creek generally flows in a southerly direction from the Munghorn Gap Nature Reserve through the Exploration License until it crosses the Ulan-Cassilis Road and the Gulgong to Sandy Hollow Railway near Ulan (*refer* **Figure 2**). At this point Moolarben Creek becomes the Goulburn River.

The Goulburn River is a major tributary of the Hunter River and flows in a southerly direction along the eastern boundary of the existing Ulan Colliery (*refer* **Figure 2**).

Vegetation coverage across the Moolarben Creek and Goulburn River catchment varies considerably. The floodplain areas adjoining Moolarben Creek and the Goulburn River are generally cleared with only occasional scattered trees which are generally in close proximity to the creek lines (*refer* **Plate 1**). The steeper sections of the catchment are generally densely vegetated and uncleared, although the valley walls are typically defined by rocky outcrops.

Plate 1 VIEW LOOKING SOUTH-EAST FROM LAGOONS ROAD SHOWING CLEARED PASTURES AND SCATTERED TREES ACROSS FLOODPLAIN

With the exception of the existing Ulan Colliery, land use across the catchment is predominately low density grazing. Dwellings are generally sparsely distributed throughout the catchment. The village of Ulan is the only concentrated urban settlement in the area. A small airstrip is also located near the intersection of the Ulan-Cassilis Road and Wollar Road (*refer* **Figure 2**).

Topographic relief across the Exploration License is considerable. Ground surface elevations vary from less then 400 mAHD to over 550 mAHD. Numerous intermittent streams extend across the lower-lying sections of the catchment and drain to Moolarben Creek and the Goulburn River. These include a number of unnamed watercourses as well as Spring, Lagoons and Ryans Creeks (*refer* **Figure 2**).

2.2 STREAM CHARACTERISTICS

2.2.1 Moolarben Creek

Moolarben Creek is located in the headwaters of the Hunter River catchment. It drains a catchment of about 126 km^2 to the Ulan-Cassilis Road at Ulan.

Moolarben Creek generally has a well defined low flow channel. However, the channel and immediate floodplain are generally covered by low level vegetation which often obscures the channel banks (*refer* **Plate 2**). The low flow channel of Moolarben Creek is generally less than 10 metres in width.

Plate 2 VIEW LOOKING DOWNSTREAM ALONG MOOLARBEN CREEK FROM MOOLARBEN ROAD SHOWING DENSE VEGETATION ALONG CREEKLINE

The longitudinal grade of Moolarben Creek is typically about 1 vertical in 200 horizontal, although some sections approach grades of 1 in 100. These sections where steeper grades are evident indicate that high velocity flows are likely to occur during floods. This is substantiated by evidence of severe erosion in the upper sections of the catchment as shown in **Plate 3**.

Plate 3 VIEW LOOKING EAST FROM ULAN ROAD SHOWING SEVERE EROSION ALONG THE UPPER REACHES OF RYANS CREEK

Several roadways within the Exploration License cross Moolarben Creek. These crossings include a low level causeway crossing along Moolarben Road and a low level causeway and pipe culvert crossing along Lagoons Road (*refer* **Figure 2**). Two bridge crossings for the Ulan-Cassilis Road and Gulgong to Sandy Hollow Railway are also located at the downstream end of Moolarben Creek.

2.2.2 Goulburn River

The Goulburn River commences downstream of the Gulgong to Sandy Hollow Railway Bridge. The river meanders past the village of Ulan and generally comprises a channel that is about 20 metres wide. The river extends into the existing Ulan Colliery where it has been permanently diverted to the eastern boundary of the colliery (*located immediately west of the Ulan-Cassilis Road*).

The diverted channel is typically trapezoidal in shape with a base width of 15 to 20 metres and a longitudinal grade of 0.25%. It has been designed to contain the peak 100 year recurrence flood with a freeboard of 2 metres. It is suggested that this freeboard would afford protection during floods up to and including the 1,000 year recurrence event (*Department of Environment & Planning, 1981*).

Downstream of Ulan Colliery, the diverted section of the Goulburn River rejoins its original alignment. In this area, the river is largely incised with heavy flanking vegetation and limited overbank storage.

Three bridge crossings extend across the Goulburn River in the vicinity of the Moolarben Mine Project. These include:

- a single span bridge located along the service road within Ulan Colliery which provides access across the diverted section of the Goulburn River;
- a two span bridge located along the Ulan Colliery access road which is located upstream of the confluence of the Goulburn River with Ulan Creek; and,
- a three span bridge located along the Ulan-Cassilis Road near "The Drip" picnic area (*refer* **Figure 2**).

2.2.3 Bora Creek

Bora Creek is a small intermittent watercourse that drains through the proposed underground mine area and discharges to the diverted section of the Goulburn River. It drains a catchment area of about 670 hectares and flows in a westerly direction toward the Ulan-Cassilis Road (*refer* **Figure 2**).

In the vicinity of its headwaters, Bora Creek is a relatively narrow and incised tree lined channel. The grade of the creek within the upper reaches is generally about 2%. Due to this hydraulically steep grade, it is likely that flows carried by the stream would be characterised by high velocities.

The grade of Bora Creek flattens as it approaches the Ulan-Cassilis Road and is typically about 0.9% in the lower reaches. The channel is more well defined along the lower reaches of the creek with a channel width generally in excess of 20 metres (*refer* **Appendix B**). Vegetation coverage along the lower reaches of Bora Creek is generally more sparse with tree coverage typically limited to the immediate vicinity of the creek line (*refer* **Plate 3**).

Bora Creek drains beneath the Ulan-Cassilis Road via three 1500 mm diameter pipe culverts. The Ulan-Cassilis roadway embankment is generally elevated 4 to 5 metres above the adjoining floodplain. Accordingly, the embankment would afford a significant impediment to the free flow of water along Bora Creek during floods in excess of the capacity of the pipe culverts.

2.2.4 Moolarben Dam

Moolarben Dam is located along the lower reaches of Moolarben Creek (*refer* **Figure 2**). It was constructed by Ulan County Council in 1957 to provide general purpose and cooling tower water to the Ulan Power Station (*Ulan Coal Mines, 1981*). The power station was decommissioned in 1968.

The water surface area of the dam at full supply level is about 60,000 m^2. The dam comprises a 30 metre wide concrete spillway outlet. It is considered that the dam would provide only limited attenuation during a large flood.

Plate 3 VIEW LOOKING EAST FROM ULAN-CASSILIS ROAD TOWARDS BORA CREEK

3 ASSESSMENT OF EXISTING FLOOD BEHAVIOUR

3.1 GENERAL

The Moolarben Coal Project is to comprise the staged developed of three open cut mines and an underground mine. As shown in **Figure 2**, the proposed open cut mines are located within close proximity to Moolarben Creek and it's tributaries. The Goulburn River and Bora Creek are also located in close proximity to the proposed underground mine area.

Accordingly, there is potential for the open cut mines to be inundated during large floods along Moolarben and Bora Creek, and the Goulburn River.

Inundation of the mine areas would have a significant adverse impact on the mine as operations would be halted while floodwaters were pumped out of the mine pit and treated. This may sterilise the mine areas for a substantial period of time, resulting in associated production downtime.

In recognition of this issue, investigations were undertaken to assess the susceptibility of the Exploration License to flooding from Moolarben Creek, the Goulburn River and their tributaries. The methodology and results of this analysis are described in the following sections.

3.2 PREVIOUS INVESTIGATIONS

Several investigations have been previously undertaken to quantify and define design flood behaviour along Moolarben Creek and the Goulburn River. However, the majority of the investigations were prepared for the existing Ulan Colliery and did not consider those sections of Moolarben Creek upstream of the Gulgong to Sandy Hollow Railway Bridge.

Notwithstanding, a preliminary design report was prepared for a new dam along Moolarben Creek. A brief synopsis of this report is provided below.

***'Moolarben Creek Dam Preliminary Design Report'* (*July 1981*)**

This report was prepared by Sinclair Knight & Partners Pty Ltd for Ulan Coal Mines Limited. The report summarised the results of preliminary design investigations for a new dam along Moolarben Creek The new dam was required to augment the existing water supply to the Ulan Mine site and thereby accommodate a proposed expansion to the open cut and underground mine operations. The new dam was to be located immediately upstream of the existing Moolarben Creek Dam (*i.e., between the proposed Moolarben Open Cut No. 1 and Open Cut No. 2*).

The investigations undertaken for this study included an assessment of the design 100 year recurrence and Probable Maximum Flood (*PMF*) flows into the proposed dam. The design flood hydrographs were derived using the Unit Hydrograph Method and temporal patterns based on available gauging information for a stream gauge located at Ulan and daily read rainfall records at Dunedoo, Gulgong, Mudgee, Cassilis and Wollar.

The investigations determined that the critical duration for the catchment draining to the proposed dam was approximately 18 hours. The peak 100 year recurrence flood and PMF discharges were determined to be about 400 m^3/s and 2,000 m^3/s, respectively.

The PMF estimate was derived using procedures outlined in *'Australian Rainfall and Runoff – Flood Analysis and Design'* (*1977*) and the "Myers Maximum" flood method. Both of these methodologies have since been superseded.

It is understood that approval was granted for Ulan Coal Mines Limited to construct the proposed dam. This work was not undertaken, but as the expansion approval for the Ulan Mine is still valid, it is possible that the dam could be constructed in the future.

If constructed, the dam would have a full supply level of 442 mAHD and would provide approximately 7,300 megalitres of water storage.

3.3 HYDROLOGIC ANALYSIS

A hydrologic analysis of the Moolarben Creek and Goulburn River catchment was undertaken to quantify peak design flood discharges throughout the Exploration License. The peak discharges derived from the hydrologic analysis are used as the upstream boundary conditions for the hydraulic model. The hydraulic model is then used to quantify and define flood behaviour through the study area.

3.3.1 Model Development

Sub-Catchment Parameters

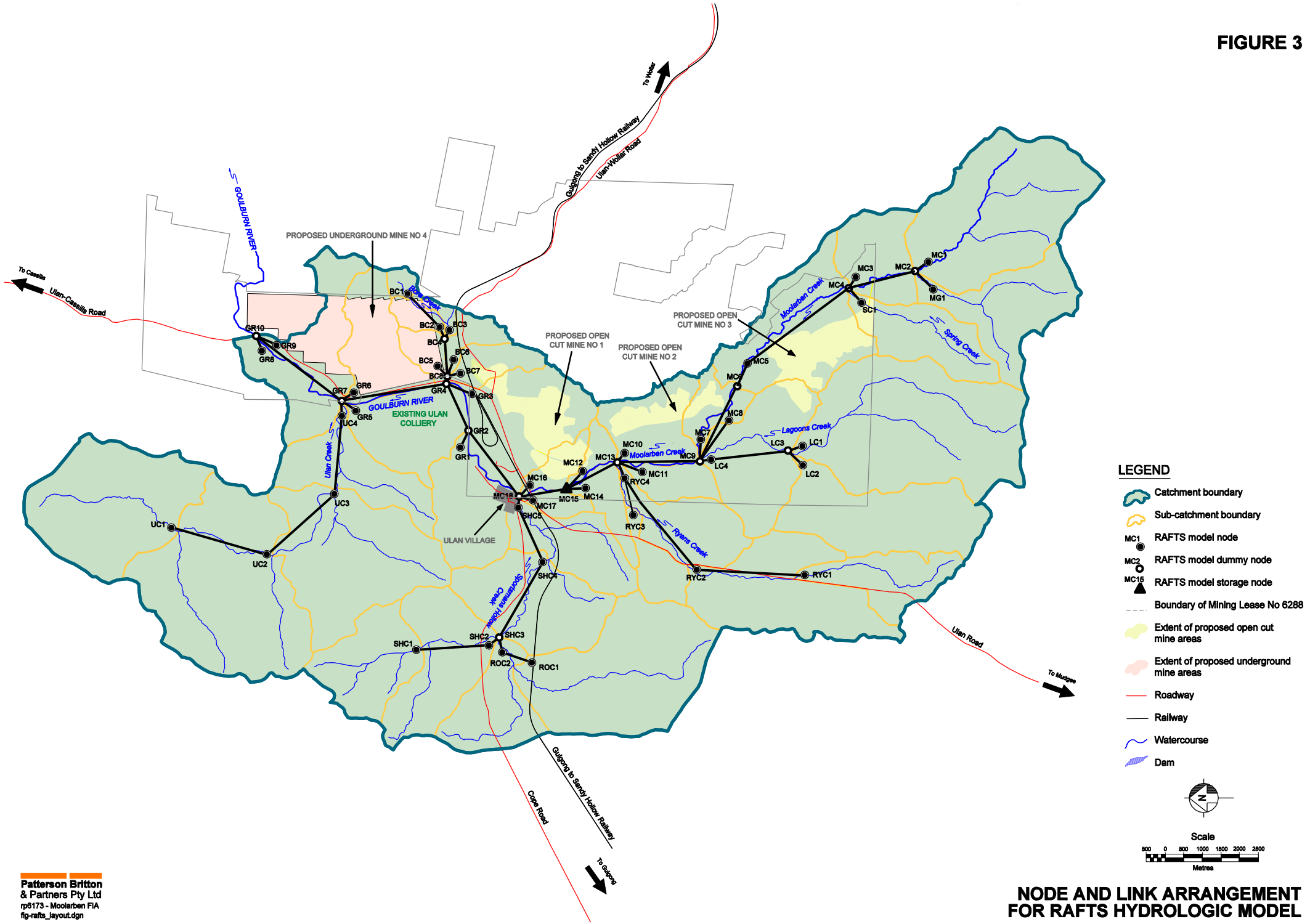
The Runoff Analysis and Flow Training Simulation (*RAFTS-XP*) software was employed to quantify flood discharges along Moolarben Creek and the Goulburn River for existing catchment conditions. RAFTS-XP is a deterministic runoff routing model that simulates catchment runoff processes. It is recognised in *'Australian Rainfall and Runoff – A Guideline to Flood Estimation'* (*1987*) as one of the available tools for use in flood routing within Australian catchments.

The Goulburn River catchment was subdivided into 40 smaller sub-catchments to better define the runoff processes across the catchment. Each of the sub-catchments is identified in **Figure 3**. The location of each sub-catchment outlet was based on consideration of the boundaries of the Exploration License, the location of significant storages (*e.g., Moolarben Dam*), and the probable extent of the hydraulic model used to simulate flood behaviour along the watercourses.

The RAFTS-XP model was developed using the physical characteristics of the catchment including catchment area, slope, roughness and percentage impervious area. The physical characteristics of each sub-catchment were defined using available ground surface contours presented in 1:25,000 topographic maps of the catchment, aerial photography as well as a visual inspection of the catchment.

Adopted parameter values for all sub-catchments are included in **Appendix A**.

FIGURE 3



LEGEND

- Catchment boundary
- Sub-catchment boundary
- MC1 RAFTS model node
- MC2 RAFTS model dummy node
- MC15 RAFTS model storage node
- Boundary of Mining Lease No 6288
- Extent of proposed open cut mine areas
- Extent of proposed underground mine areas
- Roadway
- Railway
- Watercourse
- Dam

Scale

500 0 500 1000 1500 2000 2500

Metres

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NODE AND LINK ARRANGEMENT FOR RAFTS HYDROLOGIC MODEL

After sub-catchment delineation was completed and suitable parameters were determined for each sub-catchment, the data was input into the RAFTS-XP software package. The node and link arrangement for the RAFTS-XP model is presented in **Figure 3**.

Moolarben Dam

The Moolarben Creek Dam has the potential to 'store' a proportion of the total storm runoff volume. This may alter flooding characteristics along Moolarben Creek and the Goulburn River downstream of the dam. Accordingly, the Moolarben Creek Dam was also incorporated into the RAFTS model.

The representation of a flood storage basin such as Moolarben Dam in RAFTS requires the storage and outflow characteristics of the storage to be defined. The storage characteristics are specified as a stage-storage relationship and the outflow characteristics are specified as a stage-discharge relationship.

The spillway of the dam was surveyed as part of the project by Pegasus Technical. A long section of the spillway crest is reproduced in **Appendix B** as Section M21 and was used to derive a stage-discharge relationship for the spillway by assuming it approximated a broad-crested weir.

The stage-storage relationship was developed using 0.2 metre contours that were derived from photogrammetry by Pegasus Technical.

It was assumed that no storage was provided by the dam below the level of the spillway. That is, it was assumed that the dam would be full prior to the commencement of the design storms that would generate significant flooding of the creek system. This assumption was made as it provides the most conservative peak discharge estimate downstream of the dam and the most conservative water level estimate upstream of the dam.

Rainfall Loss Model

In a typical storm event, not all of the rainfall that falls onto the catchment is converted to runoff. Some of the rainfall may be lost to the groundwater system through infiltration into the soil, or may be intercepted by vegetation and stored. This component of the overall rainfall is considered to be "lost" from the system and does not contribute to the estimated catchment runoff.

To account for rainfall losses of this nature, a rainfall loss model can be included within the RAFTS-XP model. For this study, the *Initial-Continuing Loss Model* was used to simulate rainfall losses across the catchment. This model assumes that a specified amount of rainfall (*e.g., 10 mm*) is lost from the system at the beginning of the storm being considered, and that further losses occur at a specified rate per hour (*e.g., 1.5 mm/hr*). These rainfall losses are effectively deducted from the total rainfall over the catchment, thereby leaving the remaining rainfall to be distributed through the catchment as runoff.

Continuing loss rates for the Hunter River catchment are documented in Table 3.1 of *'Australian Rainfall and Runoff'* (*1987*). However, these loss rates are not necessarily representative of loss rates within the upper sections of the Hunter River catchment.

Moreover these loss rates are significantly larger than the loss rates suggested in *'Australian Rainfall and Runoff'* (*1987*) for design flood estimation.

In recognition of the significant impact that inundation of the open cut mines may have, it was considered that the most conservative loss rates should be adopted for the design flood estimation. Accordingly, standard design rainfall losses outlined in Table 3.2 of *'Australian Rainfall and Runoff'* (*1987*), comprising an initial loss of 20 mm and a continuing loss of 2.5 mm/hour were adopted for the design storm simulations.

3.3.2 Model Calibration

Flood routing models such as RAFTS should be calibrated and verified using rainfall and stream flow data from specific flood events. Rainfall records from a major storm that caused flooding are routed through the model and discharge hydrographs are generated at locations where stream flow records for the flood corresponding to the storm have been gathered. Calibration is completed by modifying model parameters to achieve the best match between recorded and model generated discharge hydrographs.

Continuous stream flow data for historic floods is required for the calibration and verification process. A review of the Department of Natural Resources' PINEENA database (*Version 8*) indicates that a stream flow gauge was operational along the Goulburn River at Ulan for the period 1956 to 1982. However, the stream gauge only provides monthly stream flow readings. Accordingly, there is insufficient continuous stream flow information available to reliably calibrate the hydrologic model.

In the absence of suitable calibration data, RAFTS model parameter values were based on recommendations outlined in the RAFTS User Manual and documented in *'Australian Rainfall and Runoff'* (*1987*). A RAFTS model storage delay parameter (*Bx*) value of 1.0 was adopted for all design simulations.

3.3.3 Results

The RAFTS-XP model was used to simulate the 5, 20 and 100 year recurrence floods using rainfall intensities and temporal patterns for the study area, which were derived from standard procedures outlined in *'Australian Rainfall and Runoff – A Guide to Flood Estimation'* (*1987*).

A range of different storm durations were considered to establish the critical storm duration for the Goulburn River catchment, as well as for the Bora Creek sub-catchment. The critical duration for the Goulburn River catchment was defined as the storm duration that produced the highest peak discharge at 'The Drip' picnic area which is located near the northern limit of the Exploration License. The critical duration for the Bora Creek catchment was defined as the storm duration that generated the highest peak discharge at the Ulan-Cassilis Road crossing of Bora Creek.

A critical storm duration of 9 hours was determined for the Goulburn River catchment for all of the design storms. A critical duration of 2 hours was determined for the Bora Creek catchment for the 100 year recurrence storm and a critical duration of 9 hours was determined for the 5 and 20 year recurrence storms. A summary of peak discharges for the

5, 20 and 100 year recurrence events is presented in **Table 1** at key locations within the study area.

Table 1 PEAK DESIGN FLOWS FOR EXISTING CATCHMENT CONDITIONS

DESCRIPTION OF LOCATION	RAFTS MODEL NODE NUMBER (*refer Figure 3*)	PEAK DISCHARGE (m^3/s)		
		5 Year ARI	20 Year ARI	100 Year ARI
Moolarben Creek flow into Exploration License	MC2	43	71	107
Spring Creek flow into Exploration License	SC1	17	26	36
Junction of Moolarben Creek & Spring Creek	MC4	69	110	160
Moolarben Creek between Open Cut No.1 and Open Cut No.2	MC6	82	128	184
Junction of Moolarben Creek & lagoons Creek	MC9	141	217	314
Upstream of Moolarben Creek Dam	MC13	173	279	418
Peak Stage in Moolarben Creek Dam	*MC15*	*429.1**	*429.5**	*430.0**
Outflow from Moolarben Creek Dam	MC15	176	283	423
Ulan-Cassilis Road crossing of Moolarben Creek	MC18	248	398	596
Goulburn River near start of river diversion	GR2	251	403	603
Junction of Goulburn River & Bora Creek	GR4	258	412	618
Junction of Goulburn River & Ulan Creek	GR7	314	499	754
"The Drip" picnic area	GR10	316	502	758
Bora Creek flow into underground mine area	BC1	2.3	3.3	4.8
	BC2	4.7	6.4	12.3
Unnamed creek flow into Bora Creek	BC3	1.4	2.2	2.9
Junction of Bora & unnamed Creeks	BC4	7.7	11.0	15.0
Ulan-Cassilis Road crossing of Bora Creek	BC8	26	37	50
Ryans Creek flow into Exploration License	RYC4	59	87	120

**stage (metres relative AHD) specified at this node, not flow*

The results provided in **Table 1** show that the peak discharge for the Goulburn River catchment at "The Drip" picnic area is predicted to be about 760 m^3/s during the 100 year recurrence event. **Table 1** also shows that the existing Moolarben Creek Dam affords only limited attenuation of the peak flow during each of the design floods.

As outlined in **Section 3.2.1**, the *'Moolarben Creek Dam Preliminary Design Report'* (*Ulan Coal Mines Limited, 1981*) estimated the peak 100 year recurrence discharge in the vicinity of the Moolarben Creek Dam to be 400 m^3/s. The RAFTS model developed for this study predicts a peak discharge of 418 m^3/s upstream of the Moolarben Creek Dam. This indicates the RAFTS model generates similar peak design discharge estimates for Moolarben Creek to those estimated by the previous investigation.

3.4 HYDRAULIC ANALYSIS

A HEC-RAS hydraulic model was developed to define design flood behaviour along Moolarben Creek, the Goulburn River and their tributaries, for the 5, 20 and 100 year recurrence floods.

The HEC-RAS software can be used to perform one-dimensional water surface profile calculations for steady state and gradually varied flow in natural or constructed channels. It was developed by the US Army Corp of Engineers and is based on solution of the Energy Equation using an iterative procedure known as the Standard Step method. It is the successor to the steady-flow *HEC-2 Water Surface Profiles* software, which has been used widely to simulate flood behaviour in river and channel systems, particularly where structures (*e.g., bridges*) constrain free surface flow.

3.4.1 HEC-RAS Model Development

To facilitate development of the HEC-RAS hydraulic model, cross-sections of Moolarben, Spring, Lagoons, Ryans and Bora Creeks, and the Goulburn River, were gathered. The cross-sections were surveyed by Pegasus Technical during December 2005 and January 2006. Representative photographs of the watercourses were also taken as part of the survey for each cross-section to assist in defining suitable Manning's 'n' roughness values in the HEC-RAS model.

The location and extent of cross-sections used to develop the HEC-RAS model are shown in **Figures 4** to **8**. Plots of each cross-section are also enclosed within **Appendix B**.

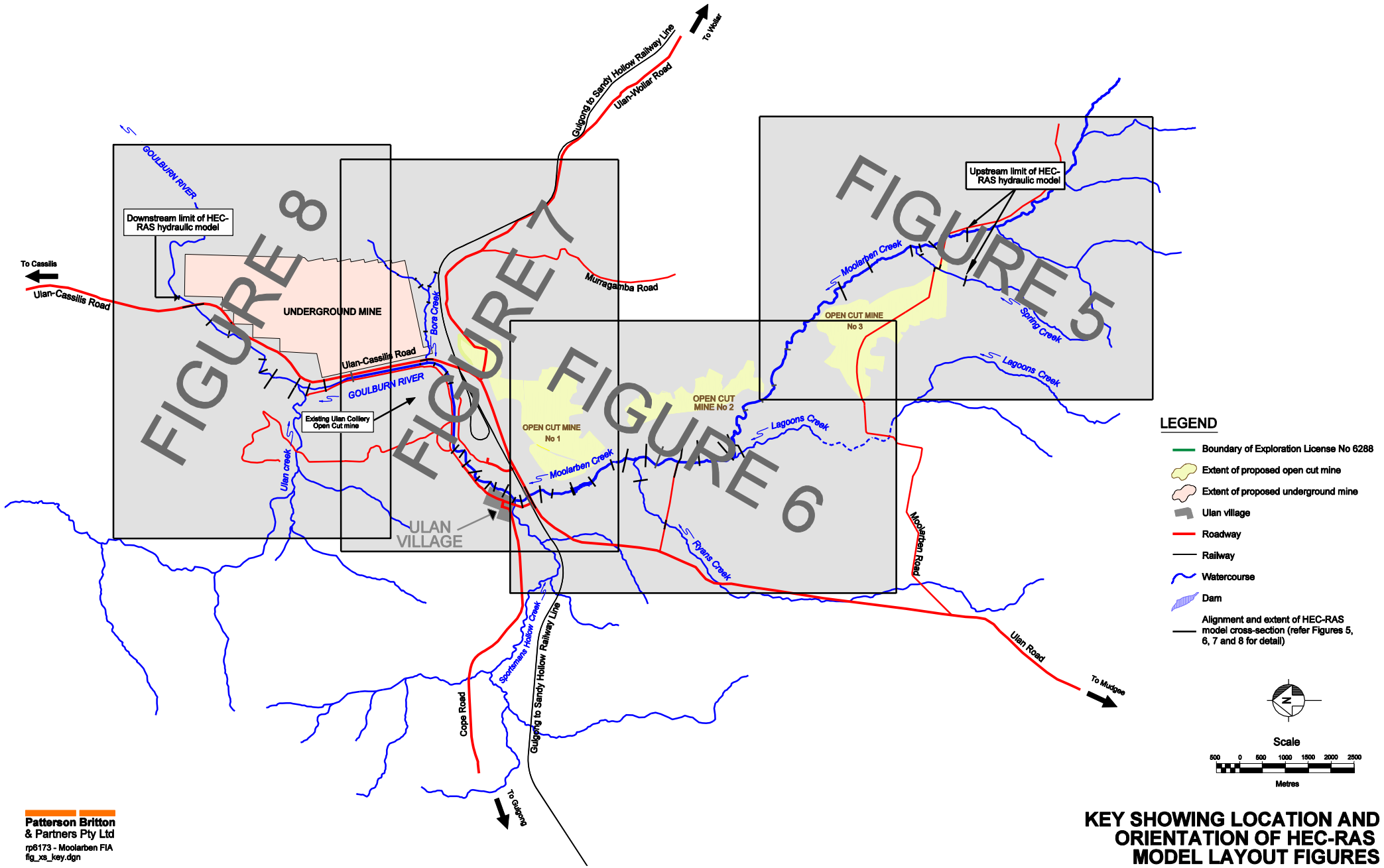
Ground surface contours of the Exploration License were also provided by Pegasus Technical and are also shown in **Figures 4** to **8**. The contours were provided at 0.2 metre intervals and were used in conjunction with peak flood level estimates to map the extent of flood liable land. The contours were derived using photogrammetric survey techniques and are considered to be provide a vertical accuracy of 500 mm.

The surveyed cross-sections were used to develop two separate HEC-RAS models for the investigation. The first model extended upstream along Moolarben Creek from the existing Moolarben Creek Dam to the southern boundary of the Exploration License. The second model extended downstream from the Moolarben Creek Dam to 'The Drip' picnic area (*located downstream of the Ulan-Cassilis Road bridge crossing of the Goulburn River*).

Channel and Floodplain Roughness

Main channel and overbank roughnesses were determined for each model cross-section based on the photographs gathered during the topographic survey and from field observations undertaken to assess channel and floodplain vegetation density.

FIGURE 4



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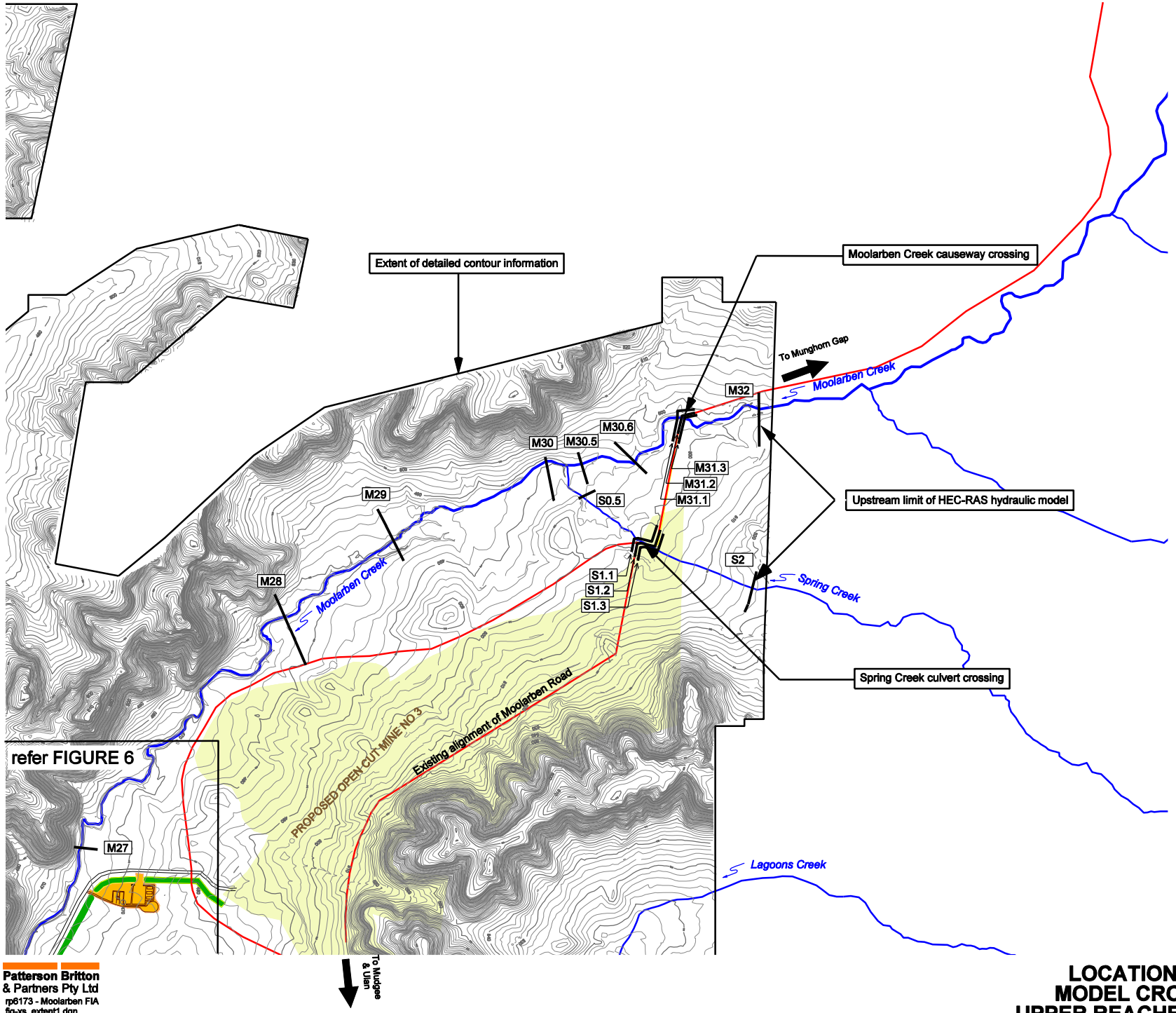
KEY SHOWING LOCATION AND ORIENTATION OF HEC-RAS MODEL LAYOUT FIGURES

FIGURE 5



LEGEND

- M32 — Alignment and extent of cross-section of Moolarben Creek
- S2 — Alignment and extent of cross-section of Spring Creek
- Boundary of Exploration License No 6288
- Extent of proposed open cut mine
- Contour of natural surface relative to mAHD
- Roadway
- Watercourse

N

Scale

200 0 200 400 600 800 1000

Metres

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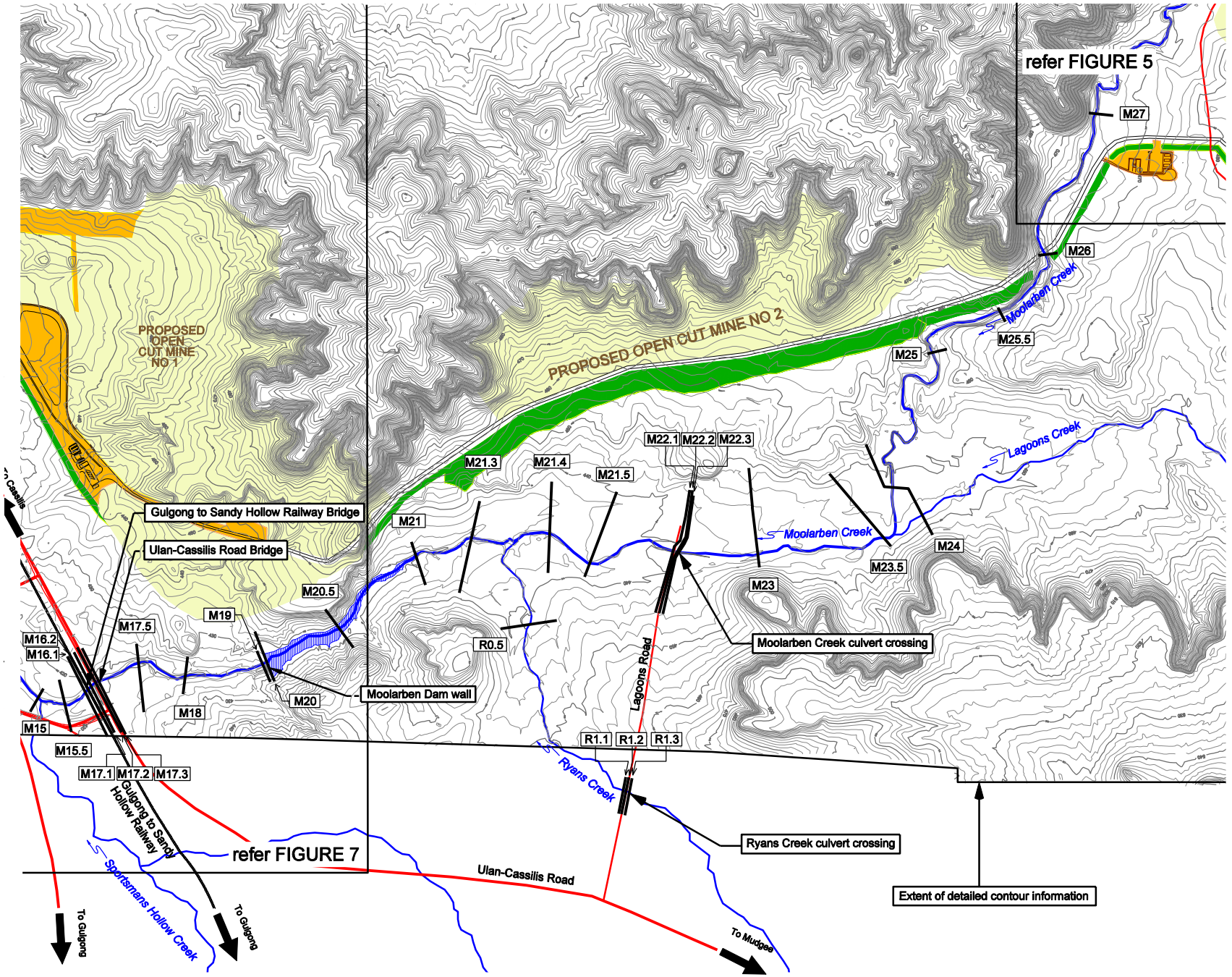
LOCATION AND EXTENT OF HEC-RAS MODEL CROSS-SECTIONS ALONG THE UPPER REACHES OF MOOLARBEN CREEK

FIGURE 6



LEGEND

- M27 — Alignment and extent of cross-section of Moolarben Creek/Goulburn River
- R1.3 — Alignment and extent of cross-section of Ryans Creek
- Boundary of Exploration License No 6288
- Extent of proposed open cut mine
- Contour of natural surface relative to mAHD
- Roadway
- Railway
- Watercourse
- Dam

N

Scale

200 0 200 400 600 800 1000

Metres

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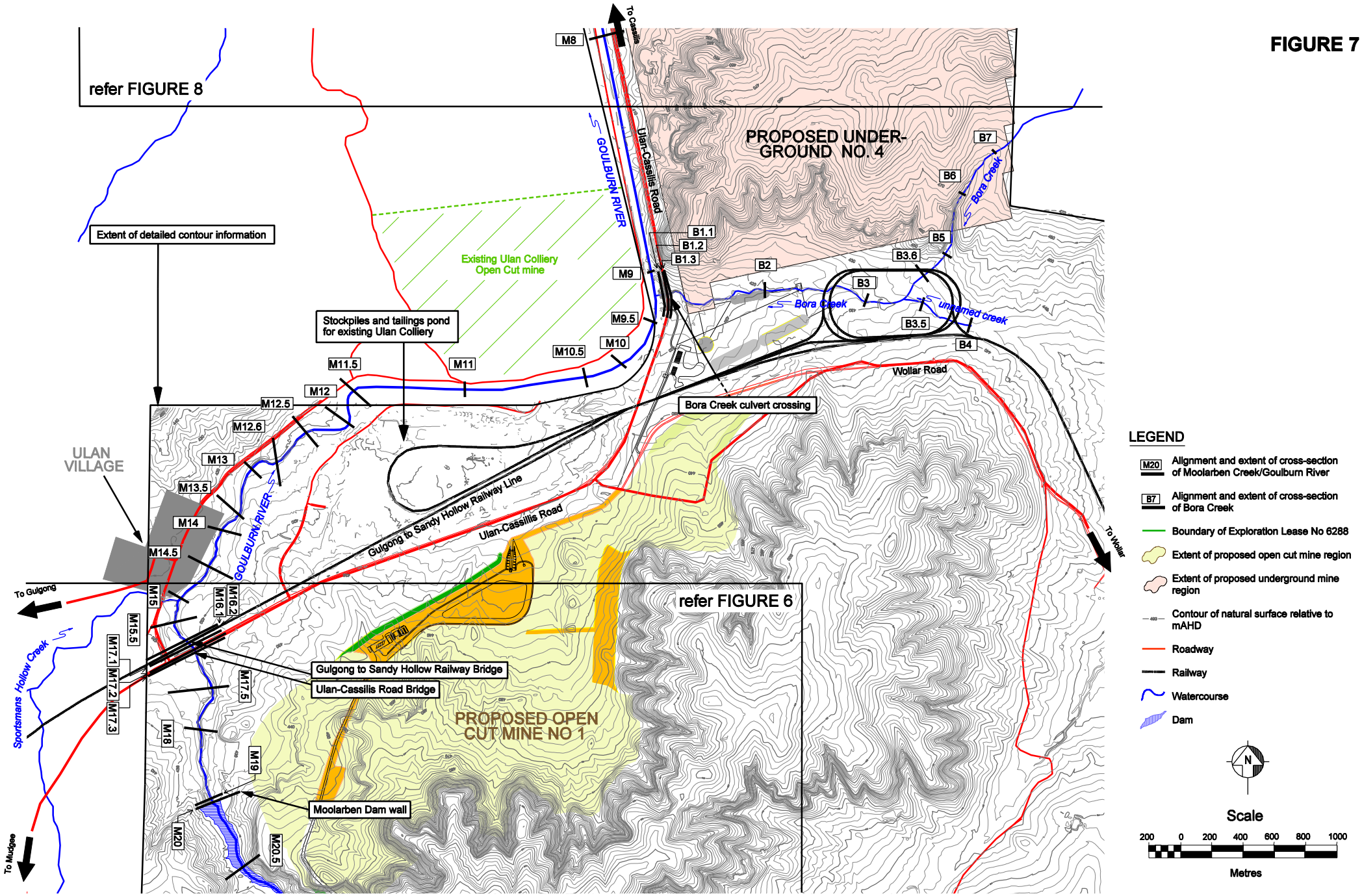
LOCATION AND EXTENT OF HEC-RAS MODEL CROSS-SECTIONS ALONG THE LOWER REACHES OF MOOLARBEN CREEK

FIGURE 7



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LOCATION AND EXTENT OF HEC-RAS MODEL CROSS-SECTIONS ALONG THE UPPER REACHES OF THE GOULBURN RIVER

FIGURE 8

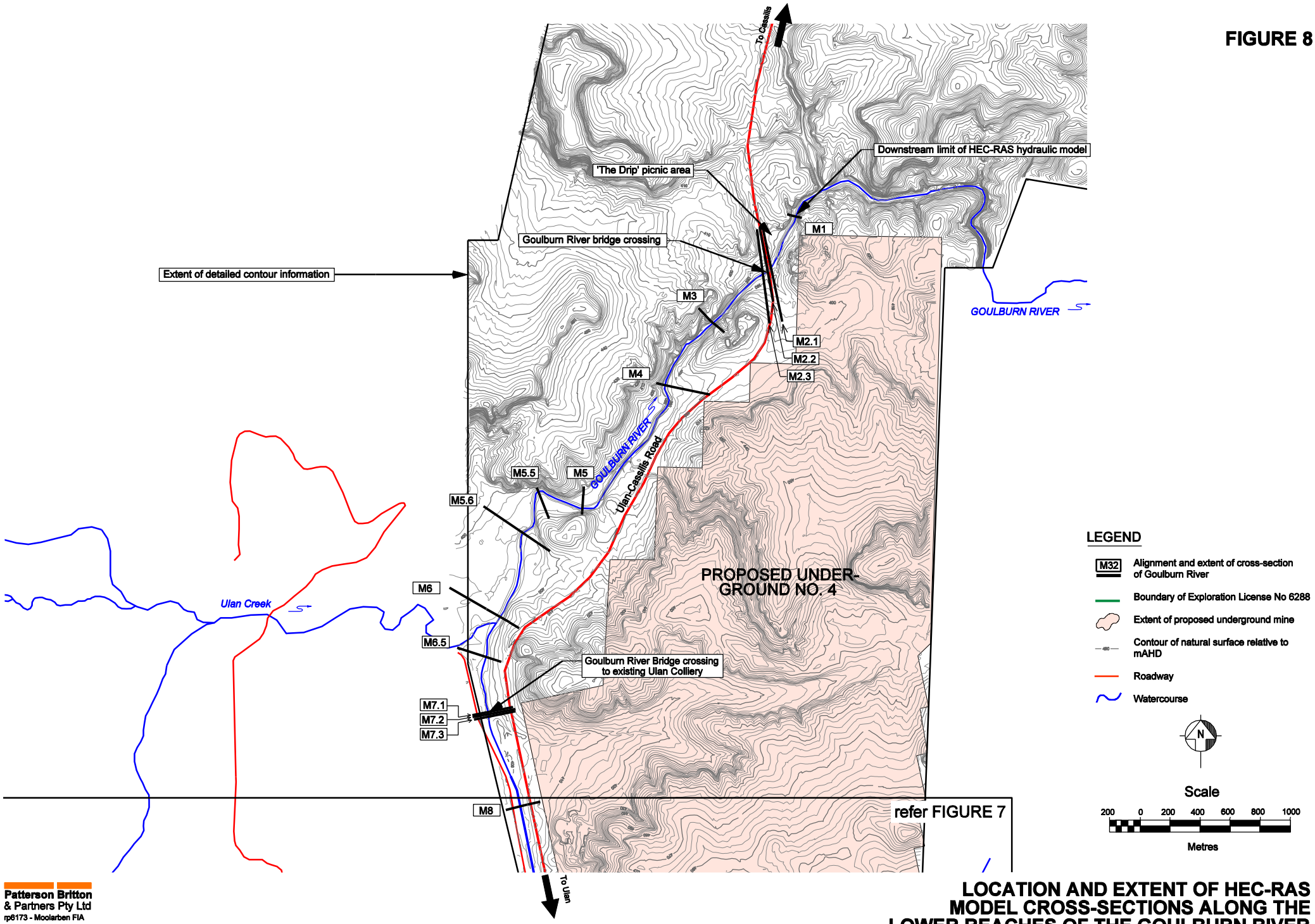

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fig-xs_extent4.dgn

LOCATION AND EXTENT OF HEC-RAS MODEL CROSS-SECTIONS ALONG THE LOWER REACHES OF THE GOULBURN RIVER

The adopted Manning's 'n' roughness values were determined by comparing observed vegetation density and soil types with standard photographic records of stream and floodplain condition for which Manning's 'n' values have been calculated.

Typical roughness values adopted in the model are summarised as follows:

- Dense Reeds/Trees - 0.100
- Medium to long grass - 0.050
- Short grass - 0.035

Boundary Conditions

Upstream Model

The upstream boundary conditions for the hydraulic model of the upstream section of Moolarben Creek were based on peak discharges determined from the RAFTS hydrologic model (*refer* **Table 1**). Separate boundary conditions were extracted for each of the 100, 20 and 5 year recurrence floods.

The downstream boundary condition for the "upstream hydraulic model" of Moolarben Creek was specified as a fixed water level. The water level was based on the predicted stage in the Moolarben Creek Dam which was extracted from the RAFTS hydrologic model (*refer* **Table 1**).

Downstream Model

The upstream boundary conditions for the "downstream hydraulic model" were based on the peak outflow from the Moolarben Creek Dam which was extracted from the RAFTS hydrologic model (*refer node MC15 in* **Table 1**).

The downstream boundary condition for the "downstream hydraulic model" was specified using normal depth calculations.

As the energy slope was not known, the slope of the channel bed was determined based on thalweg elevations for the three most downstream cross-sections. A slope of 0.32% was determined and adopted for modelling purposes.

Bridge and Culvert Modelling

The details of all bridge, culvert and causeway crossings were also collected as part of the project and incorporated into the HEC-RAS model. This information is reproduced in **Appendix C**.

There is potential for any culvert or bridge crossing to become partially blocked by debris during a flood, thereby reducing its conveyance capacity. This may generate increases in peak flood levels upstream of each bridge/culvert crossing. Accordingly, simulations were undertaken using the HEC-RAS model assuming 0% and 50% blockage of all culvert and bridge crossings to assess the potential impact that blockage may have on flood behaviour through the study area.

3.4.2 Results

No Blockage of Culverts and Bridges

The HEC-RAS models of the Goulburn River and Moolarben Creek were used to simulate the 100, 20 and 5 year recurrence floods. Simulations were initially undertaken assuming no blockage of bridge or culvert crossings. Peak flood levels and velocities for each model cross-section are summarised in **Tables 2**, **3** and **4** for Moolarben Creek, the Goulburn River and Bora Creek, respectively.

Design water surface profiles for the 100 year recurrence flood are provided in **Figures 9**, **10**, **11** and **12** for Moolarben Creek, the Goulburn River and Bora Creek.

HEC-RAS model output for the 5, 20 and 100 year recurrence floods is provided in **Appendix E**.

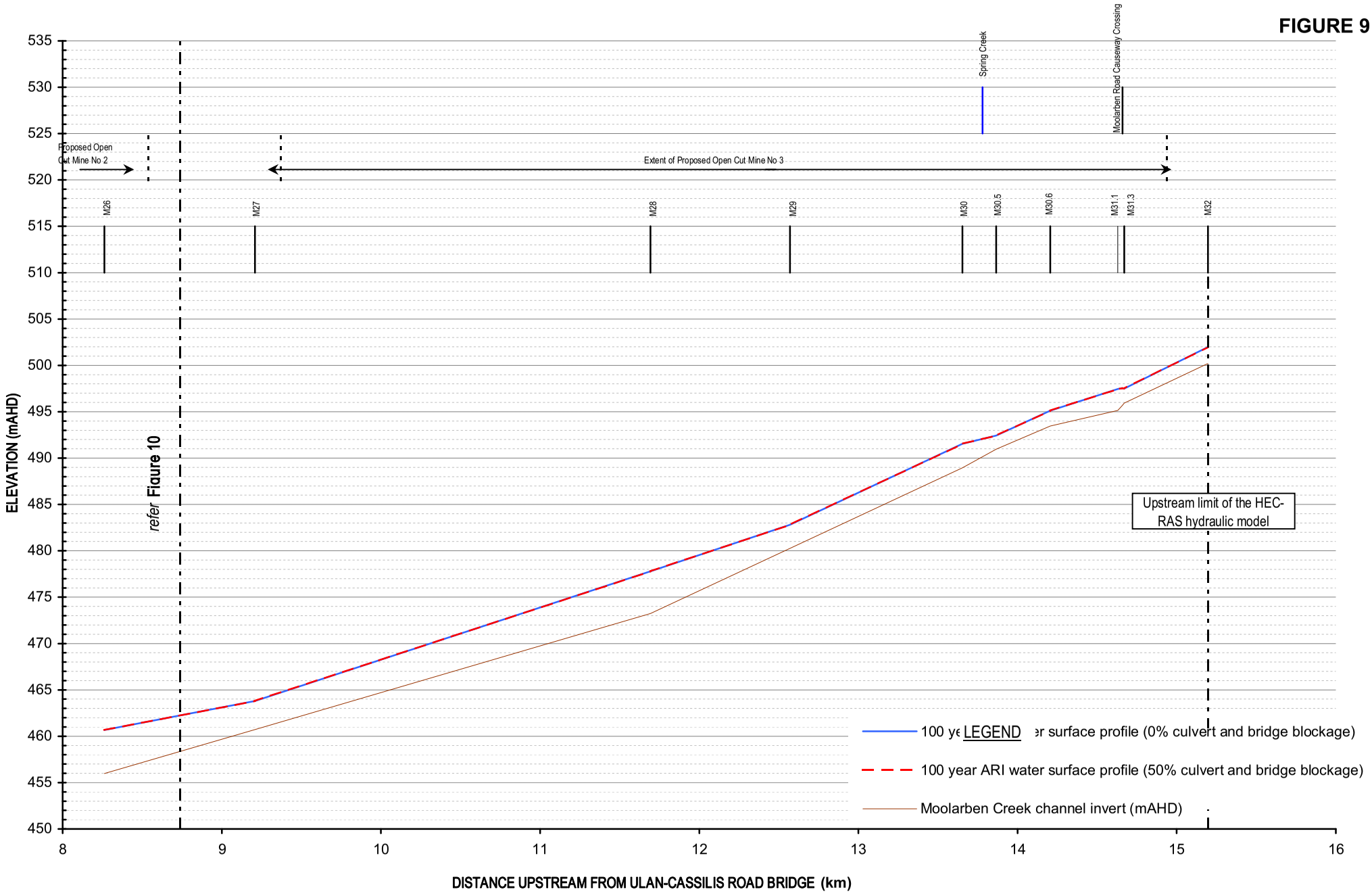
50% Blockage of Culverts and Bridges

The HEC-RAS models of Moolarben Creek and the Goulburn River were also used to simulate the 100, 20 and 5 year recurrence floods assuming 50% blockage of all culvert and bridge crossings. Peak flood levels and velocities are summarised in **Tables 5**, **6**, and **7** for Moolarben Creek, the Goulburn River and Bora Creek respectively. Design water surface profiles for the 100 year recurrence flood are provided in **Figures 9**, **10**, **11** and **12**.

The peak design flood levels listed in **Tables 5**, **6**, and **7**, were also "mapped" to the available contour information for the Exploration License to determine the predicted extent of inundation for each design flood.

The predicted extent of inundation for the 100 year recurrence flood with 50% culvert and bridge blockage is shown in **Figures 13**, **14**, **15**, **16** and **17**. HEC-RAS model output for scenario is also provided in **Appendix E** for the 5, 20 and 100 year recurrence floods.

FIGURE 9



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...n Creek FIA

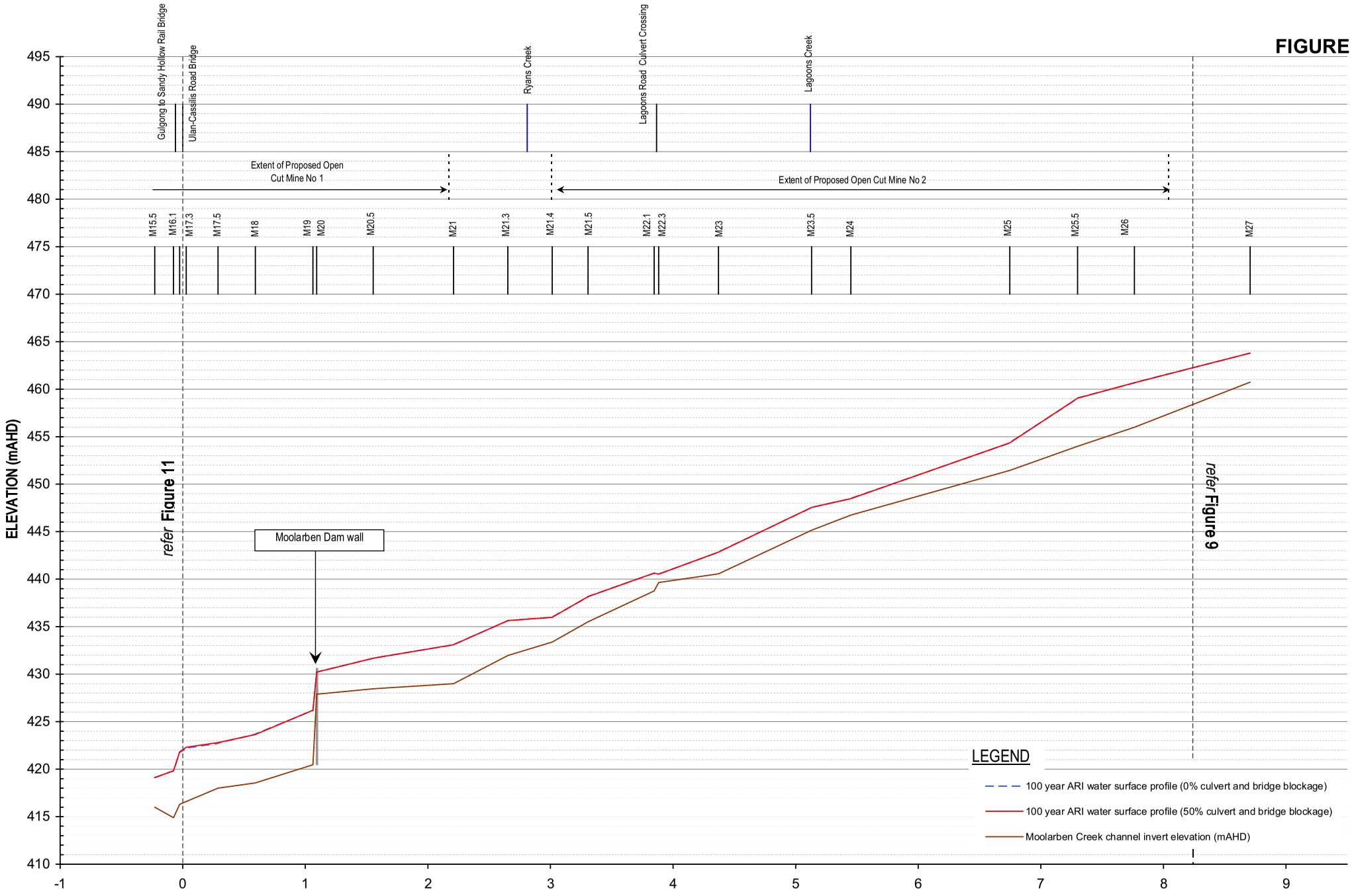
fg6173_djt060321-WSP.xls

Fig-WSP MC upper 100

PROFILES FOR THE UPPER REACHES OF MOOLARBEN CREEK

MOOLARBEN CREEK

FIGURE 10

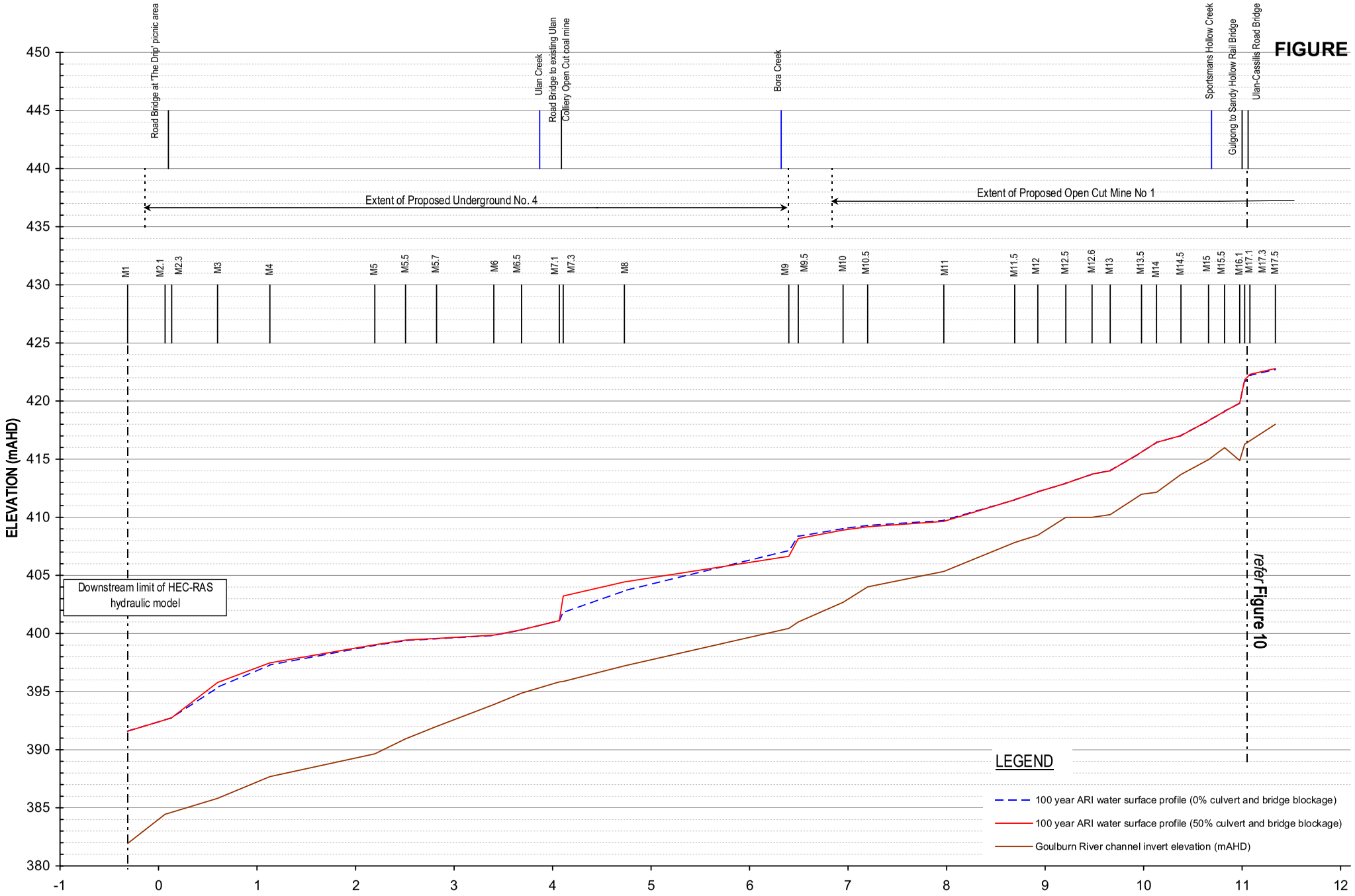


Patterson Britton & Partners Pty Ltd

rp6173.00_Moolarben Creek FIA
fg6173_djt060321-WSP.xls
Fig-WSP MC lower 100

PREDICTED DESIGN FLOODWATER SURFACE PROFILES FOR THE LOWER REACHES OF MOOLARBEN CREEK

FIGURE 11

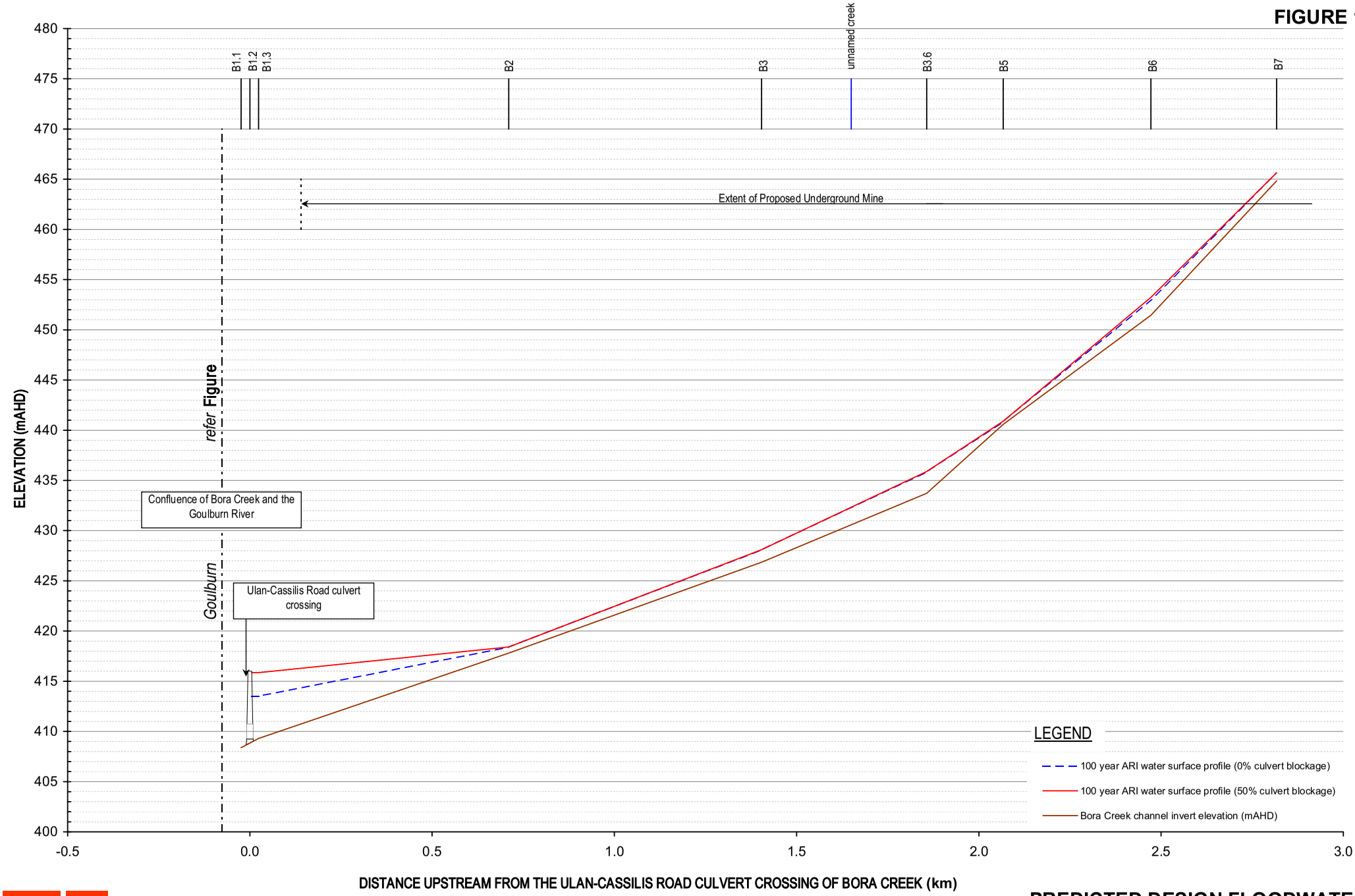


Patterson Britton & Partners Pty Ltd

rp6173.00 Moolarben FIA
fg6173_djt060321-WSP.xls
Fig-WSP GR 100

PREDICTED DESIGN FLOODWATER SURFACE PROFILES FOR THE GOULBURN RIVER

FIGURE 12

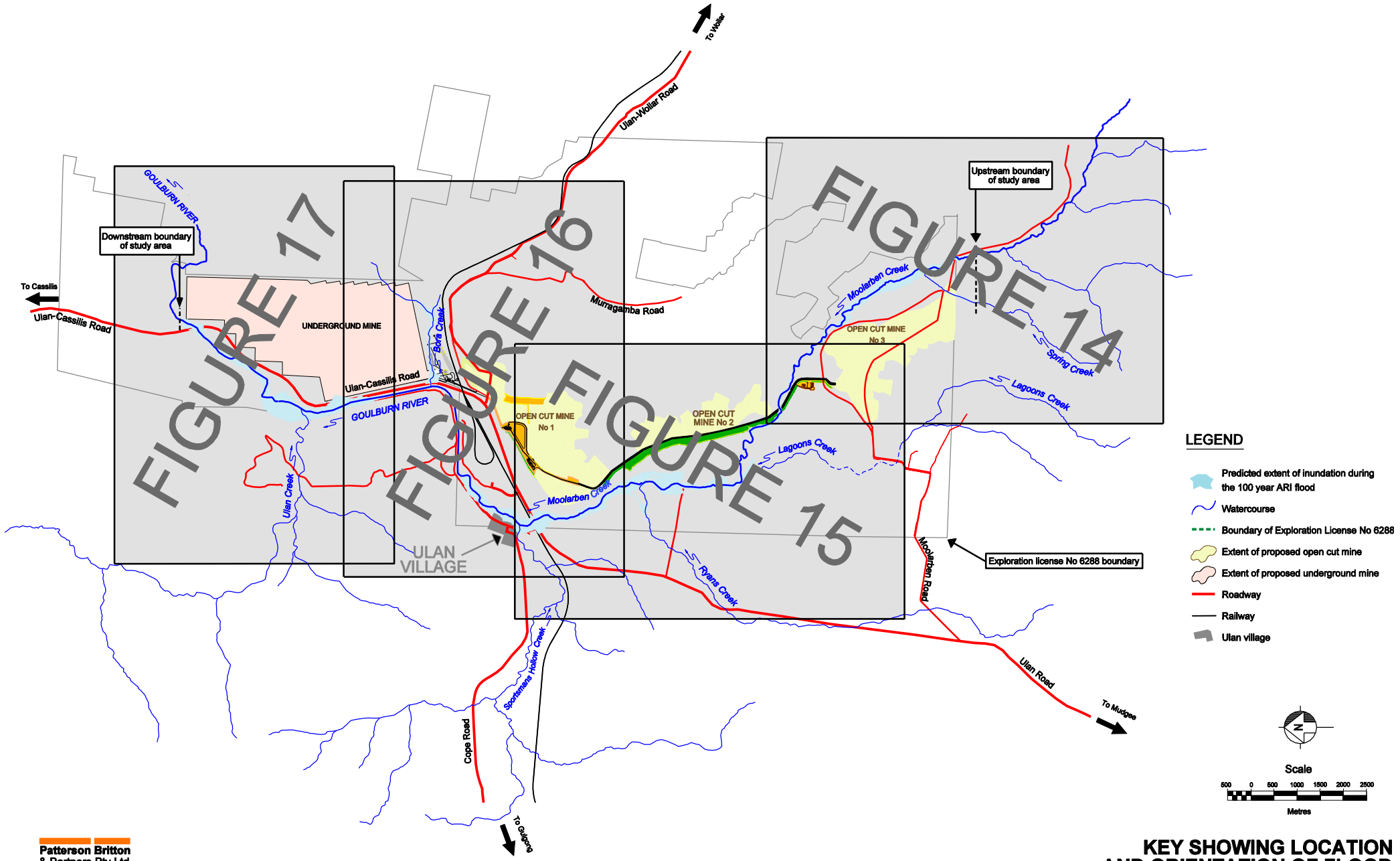


Patterson Britton & Partners Pty Ltd

rp6173.00 Moolarben FIA
fg6173_djt060321-WSP.xls
Fig-WSP BC 100

PREDICTED DESIGN FLOODWATER SURFACE PROFILES FOR BORA CREEK

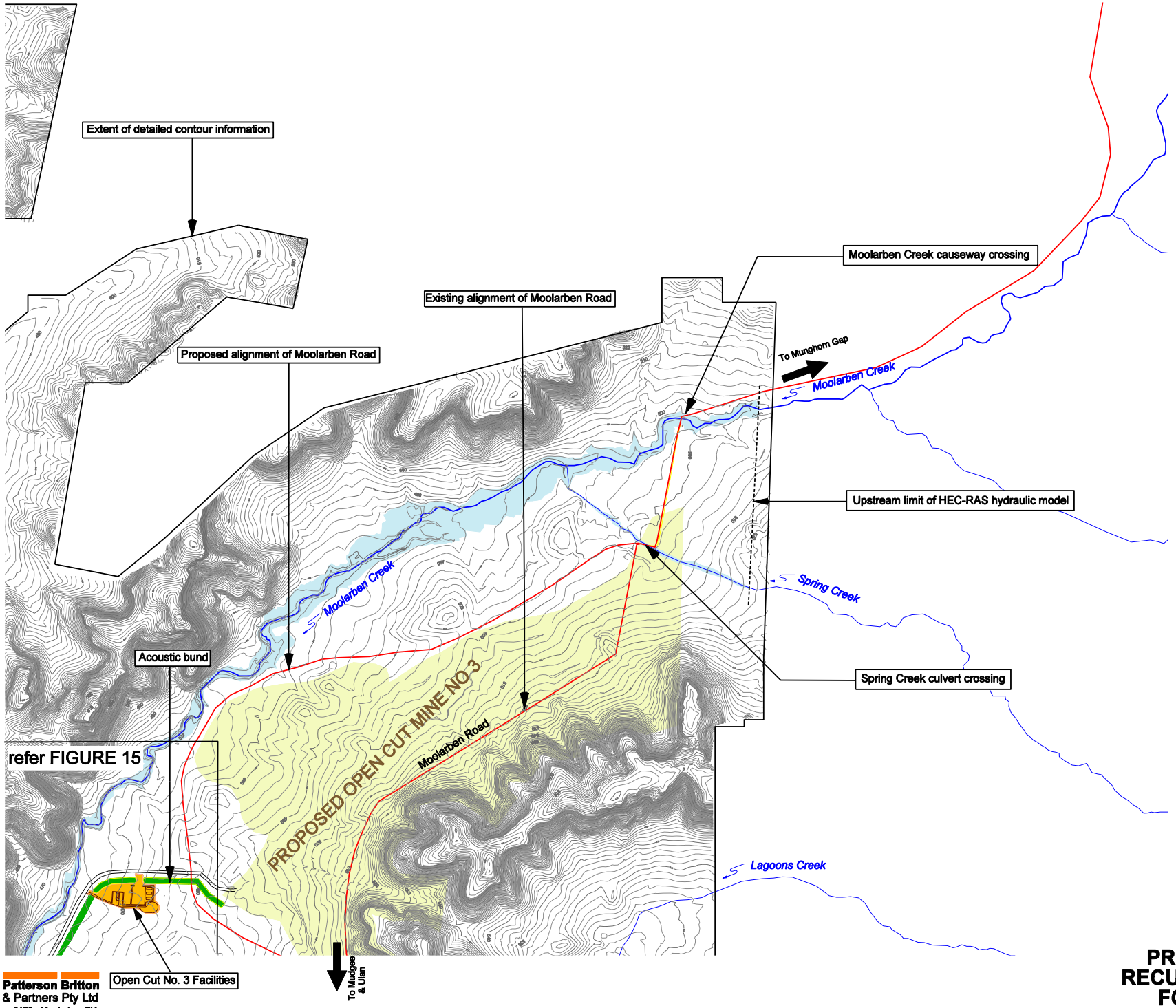
FIGURE 13



Patterson Britton & Partners Pty Ltd
rp6173 - Moolarben FIA
fig-floodextent_key.dgn

KEY SHOWING LOCATION AND ORIENTATION OF FLOOD EXTENT MAPPING FIGURES

FIGURE 14



LEGEND

- Predicted extent of inundation at the peak of the 100 year recurrence flood
- Watercourse
- Boundary of Mining License No 6288
- Extent of proposed Open Cut mine
- Contours of existing ground surface relative to mAHD
- Roadway

Scale

200 0 200 400 600 800 1000

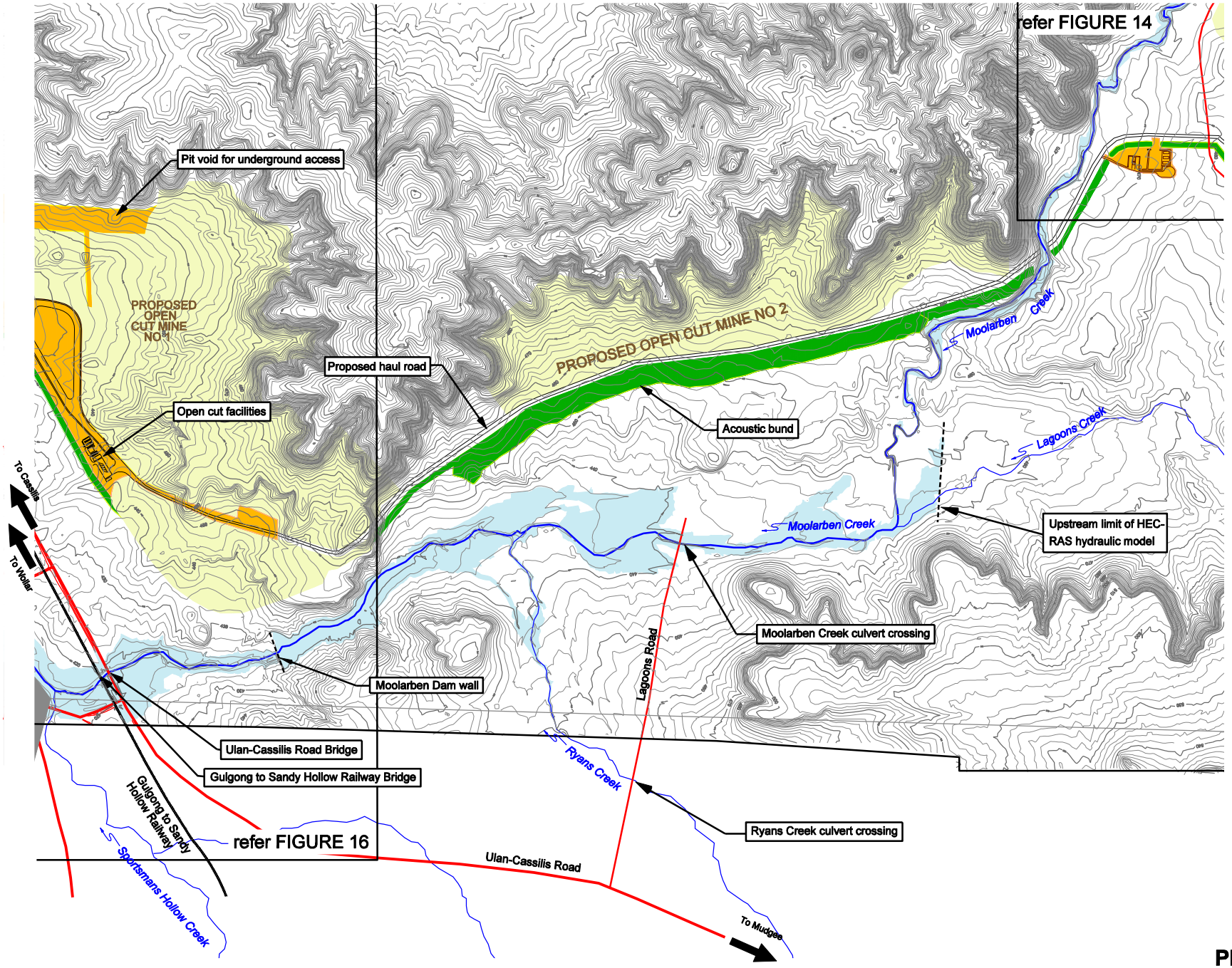
Metres

PREDICTED PEAK 100 YEAR RECURRENCE FLOOD EXTENT FOR THE UPPER REACHES OF MOOLARBEN CREEK

Patterson Britton & Partners Pty Ltd

rp6173 - Moolarben FIA
fig-floodextent1.dgn

FIGURE 15



LEGEND

- Predicted extent of inundation at the peak of the 100 year recurrence flood
- Watercourse
- Boundary of Exploration License No 6288
- Extent of proposed open cut mine
- Contours of existing ground surface elevation relative to mAHD
- Roadway
- Railway
- Ulan village

Scale

200 0 200 400 600 800 1000

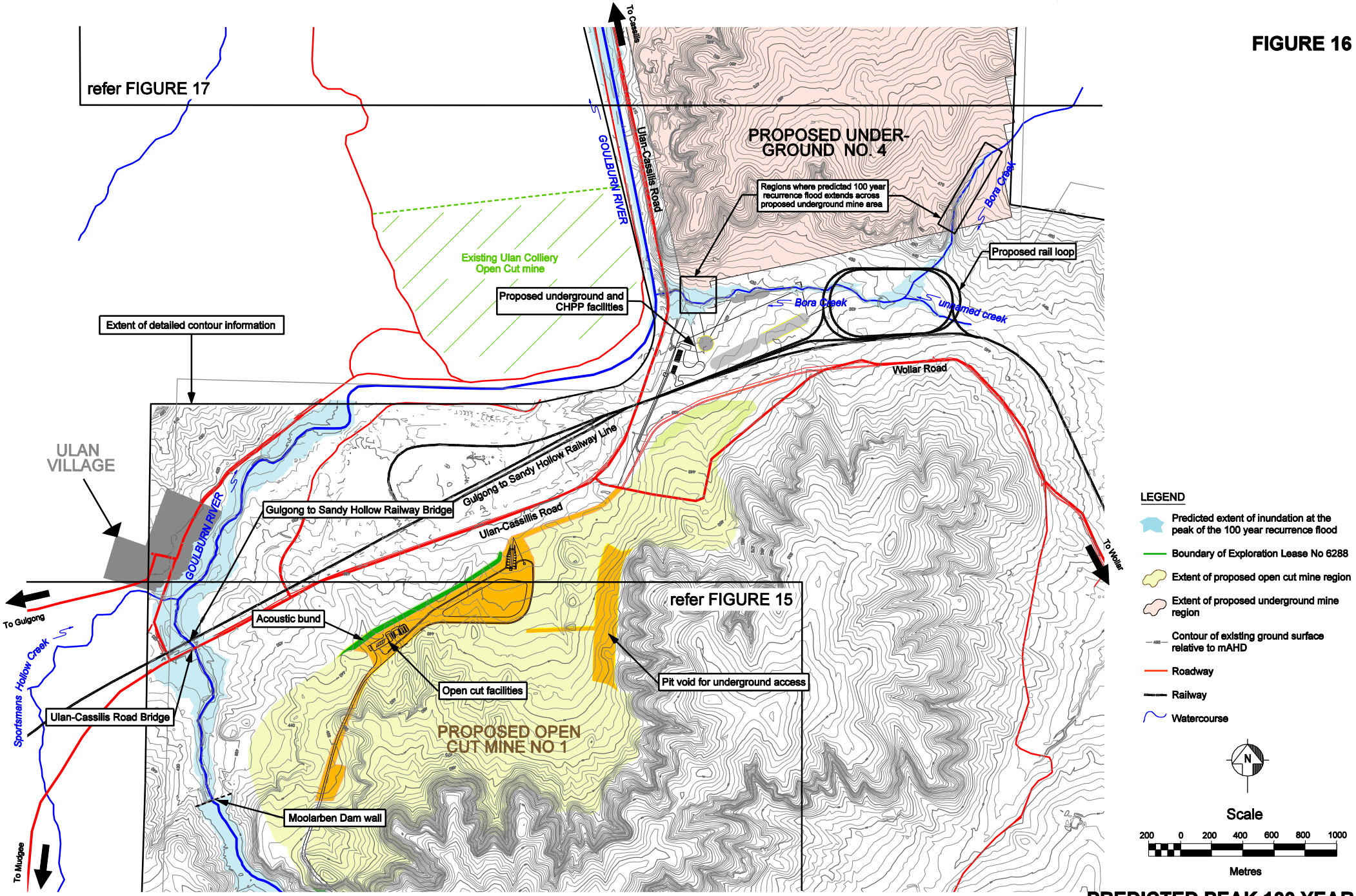
Metres

PREDICTED PEAK 100 YEAR RECURRENCE FLOOD EXTENT FOR THE LOWER REACHES OF MOOLARBEN CREEK

Patterson Britton & Partners Pty Ltd

rp6173 - Moolarben FIA
fig-floodextent2.dgn

FIGURE 16



LEGEND

- Predicted extent of inundation at the peak of the 100 year recurrence flood
- Boundary of Exploration Lease No 6288
- Extent of proposed open cut mine region
- Extent of proposed underground mine region
- Contour of existing ground surface relative to mAHD
- Roadway
- Railway
- Watercourse

N

Scale

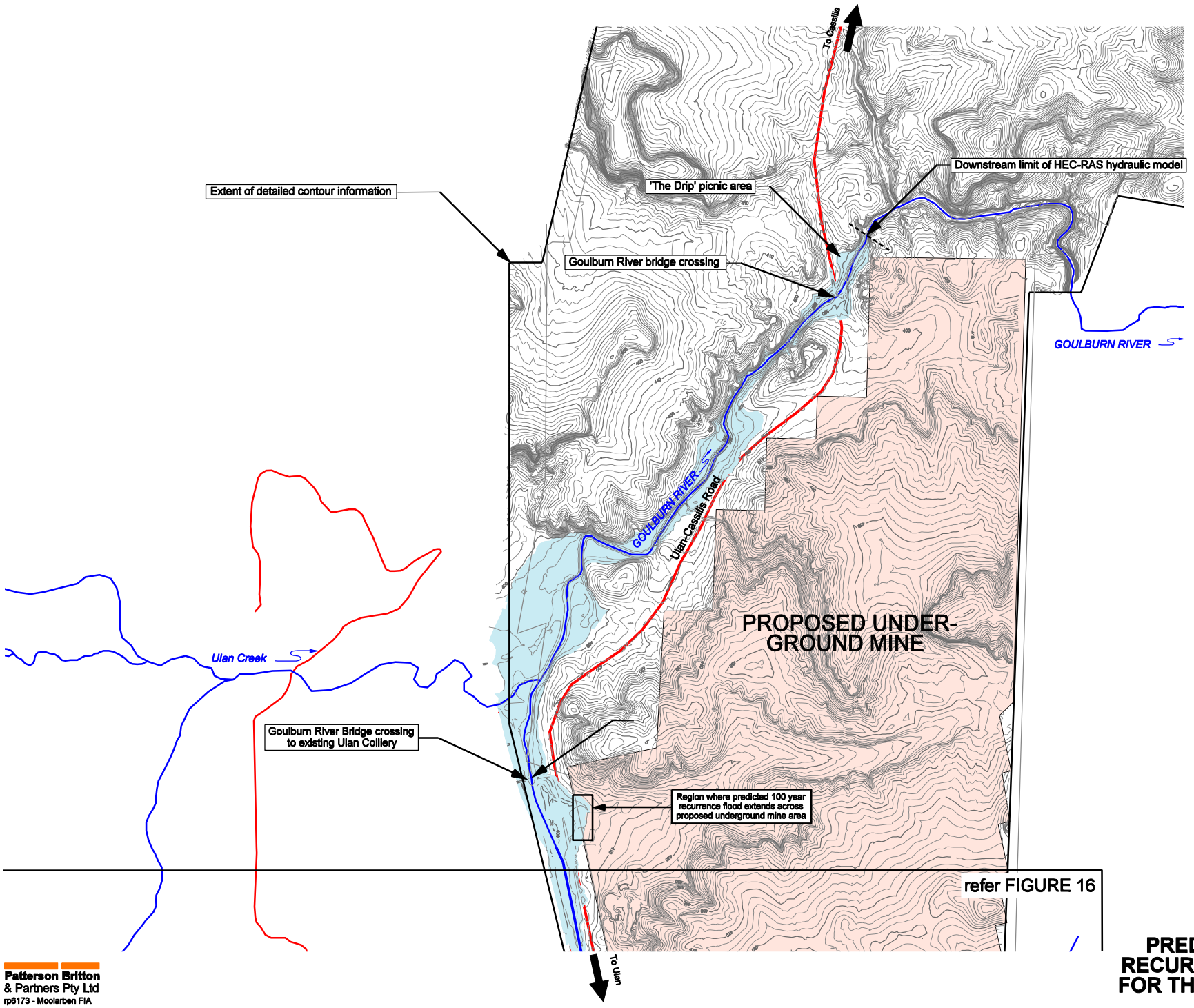
200 0 200 400 600 800 1000

Metres

Patterson Britton & Partners Pty Ltd
rp6173 - Moolarben FIA
fig-floodextent3.dgn

PREDICTED PEAK 100 YEAR RECURRENCE FLOOD EXTENT FOR THE UPPER REACHES OF THE GOULBURN RIVER

FIGURE 17



LEGEND

- Predicted extent of inundation at the peak of the 100 year recurrence flood
- Boundary of Exploration License No 6288
- Extent of proposed underground mine
- Contour of existing ground surface relative to mAHD
- Roadway
- Watercourse

N

Scale

200 0 200 400 600 800 1000

Metres

PREDICTED PEAK 100 YEAR RECURRENCE FLOOD EXTENT FOR THE LOWER REACHES OF THE GOULBURN RIVER

Patterson Britton & Partners Pty Ltd
rp6173 - Moolarben FIA
fig-floodextent4.dgn

Table 2 DESIGN FLOOD LEVELS AND VELOCITIES FOR MOOLARBEN CREEK WITH NO CULVERT/BRIDGE BLOCKAGE

HEC-RAS MODEL CROSS-SECTION*	100 YEAR RECURRENCE EVENT				20 YEAR RECURRENCE EVENT				5 YEAR RECURRENCE EVENT			
	Peak Level (mAHD)	Peak Velocity (m/s)			Peak Level (mAHD)	Peak Velocity (m/s)			Peak Level (mAHD)	Peak Velocity (m/s)		
		Left	Chann	Right		Left	Chann	Right		Left	Chann	Right
M32	502.0	2.3	1.1	2.1	501.8	1.8	0.9	1.7	501.7	1.4	0.7	1.2
M31.3	497.5	1.0	2.3	0.3	497.2	0.7	2.3	N/A	496.8	N/A	2.4	N/A
M31.2	497.6	N/A	1.6	N/A	497.2	N/A	1.7	N/A	496.8	N/A	2.0	N/A
M31.1	497.4	N/A	1.7	N/A	497.1	N/A	1.5	N/A	496.7	N/A	1.4	N/A
M30.6	495.1	N/A	0.9	0.7	494.9	N/A	0.8	0.4	494.8	N/A	0.6	0.1
M30.5	492.4	1.3	1.1	1.5	492.2	1.3	1.1	1.4	491.9	1.4	1.1	1.3
M30	491.6	1.5	1.3	N/A	491.3	1.4	1.2	N/A	491.0	1.3	1.0	N/A
M29	482.8	N/A	0.9	1.3	482.7	N/A	0.9	1.2	482.5	N/A	0.9	1.1
M28	477.8	0.8	1.4	0.7	477.4	0.8	1.2	0.5	476.8	0.4	1.1	N/A
M27	463.8	N/A	3.0	N/A	463.4	N/A	2.7	N/A	462.9	N/A	2.3	N/A
M26	460.7	1.3	1.2	1.3	460.1	1.1	1.1	1.1	459.5	0.9	1.0	0.8
M25.5	459.1	N/A	1.3	N/A	458.5	N/A	1.2	N/A	458.0	N/A	1.0	N/A
M25	454.3	1.6	3.7	0.4	454.1	1.3	3.3	N/A	453.7	0.8	3.0	N/A
M24	448.5	0.6	0.5	N/A	448.5	0.4	0.4	N/A	448.5	0.3	0.2	N/A
M23.5	447.5	1.0	2.8	0.9	447.3	0.8	2.6	0.5	446.7	N/A	3.6	N/A
M23	442.9	0.9	2.2	1.2	442.6	0.8	2.0	1.0	442.4	0.7	1.8	0.9
M22.3	440.5	1.6	2.1	1.4	440.4	1.3	1.7	1.5	440.2	1.1	1.5	1.3
M22.1	440.6	1.1	1.2	0.7	440.4	1.1	1.1	0.7	440.3	1.0	1.1	0.6
M21.5	438.2	N/A	3.4	0.5	437.9	N/A	3.1	N/A	437.4	N/A	3.1	N/A
M21.4	436.0	0.2	1.1	0.3	435.6	0.2	1.0	0.2	435.2	0.1	0.9	0.2
M21.3	435.6	0.6	1.4	0.9	435.2	0.5	1.3	0.8	434.8	0.4	1.2	0.8
M21	433.1	1.0	1.9	0.5	432.6	0.8	1.7	0.5	432.2	0.6	1.5	0.4
M20.5	431.7	N/A	1.6	N/A	431.0	N/A	1.4	N/A	430.5	N/A	1.3	N/A
M20	430.2	0.4	4.8	0.5	429.7	0.4	4.2	0.4	429.3	0.3	3.5	0.3
M19	426.2	1.1	1.9	0.7	425.5	1.0	1.7	0.3	424.7	0.8	1.4	N/A
M18	423.7	0.5	1.7	0.8	423.2	0.4	1.4	0.6	422.7	0.2	1.1	0.4
M17.5	422.7	1.0	1.2	0.7	422.4	0.8	1.1	0.6	422.0	0.7	0.9	0.4
M17.3	422.2	1.1	1.2	1.1	421.9	0.8	1.1	1.4	421.6	0.6	1.1	1.5
M17.1	421.7	1.4	0.9	0.6	421.5	1.2	0.8	0.5	421.3	0.9	0.7	0.4

Table 3 DESIGN FLOOD LEVELS AND VELOCITIES FOR THE GOULBURN RIVER WITH NO CULVERT/BRIDGE BLOCKAGE

HEC-RAS MODEL CROSS-SECTION*	100 YEAR RECURRENCE EVENT				20 YEAR RECURRENCE EVENT				5 YEAR RECURRENCE EVENT			
	Peak Level (mAHD)	Peak Velocity (m/s)			Peak Level (mAHD)	Peak Velocity (m/s)			Peak Level (mAHD)	Peak Velocity (m/s)		
		Left	Chann	Right		Left	Chann	Right		Left	Chann	Right
M16.1	419.8	2.1	1.5	1.2	419.5	1.8	1.3	1.4	419.1	1.5	1.2	1.5
M15.5	419.1	2.5	1.4	1.4	418.8	2.4	1.4	1.1	418.4	2.0	1.4	0.9
M15	418.3	2.2	1.3	1.0	418.0	1.7	1.1	0.7	417.8	1.3	0.9	0.4
M14.5	417.0	1.7	1.2	2.0	416.5	1.6	1.4	2.0	416.1	0.6	1.8	1.6
M14	416.4	1.5	0.9	1.8	415.9	1.3	0.8	1.5	415.4	1.2	0.7	1.2
M13.5	415.6	3.5	2.0	N/A	415.3	2.9	1.7	N/A	414.9	2.3	1.5	N/A
M13	414.0	1.8	1.3	2.2	413.5	1.8	1.3	2.1	413.0	2.0	1.3	1.9
M12.6	413.7	1.6	0.9	1.1	413.2	1.5	0.8	1.1	412.7	1.3	0.7	1.1
M12.5	412.9	N/A	1.6	N/A	412.4	N/A	1.4	N/A	411.9	N/A	1.2	N/A
M12	412.2	1.6	0.8	N/A	411.6	1.4	0.7	N/A	411.0	1.3	0.6	N/A
M11.5	411.5	2.6	1.8	N/A	410.9	2.3	1.7	N/A	410.2	1.9	1.6	N/A
M11	409.7	N/A	2.3	N/A	408.6	N/A	2.2	N/A	407.9	N/A	1.8	N/A
M10.5	409.3	1.5	1.7	1.2	407.9	1.7	1.8	1.1	406.6	2.1	2.0	1.0
M10	409.0	N/A	2.1	N/A	407.6	N/A	2.0	N/A	406.2	N/A	1.9	N/A
M9.5	408.4	N/A	3.2	N/A	407.1	N/A	2.7	N/A	405.7	N/A	2.2	N/A
M9	407.1	N/A	4.4	N/A	406.2	N/A	3.5	N/A	405.0	N/A	2.9	N/A
M8	403.7	1.6	1.4	1.4	402.7	0.9	1.3	1.0	401.8	N/A	1.1	0.3
M7.3	401.8	0.4	1.8	0.4	400.6	N/A	1.6	N/A	399.9	N/A	1.2	N/A
M7.1	401.1	0.3	1.1	0.6	400.4	0.3	1.0	0.4	399.7	0.1	0.8	0.2
M6.5	400.3	0.8	1.1	0.6	399.5	0.7	1.1	0.6	398.9	0.6	1.0	0.5
M6	399.8	0.6	0.9	N/A	398.8	0.6	1.2	N/A	397.9	0.4	1.4	N/A
M5.6	399.6	0.3	0.5	0.4	398.4	0.3	0.5	0.4	397.2	0.3	0.5	0.4
M5.5	399.4	0.4	0.9	0.6	398.2	0.3	0.8	0.6	396.9	0.3	0.8	0.5
M5	399.0	1.0	1.5	0.5	397.8	0.8	1.3	0.3	396.5	0.7	1.1	N/A
M4	397.3	0.9	1.4	0.7	396.0	0.9	1.4	0.6	394.6	0.8	1.4	0.6
M3	395.4	0.9	3.0	0.3	394.2	0.5	2.3	N/A	392.9	N/A	1.8	N/A
M2.3	392.7	0.9	2.0	1.0	391.6	0.7	1.9	0.8	390.6	0.5	1.7	0.7
M2.1	392.6	0.6	1.4	0.8	391.3	0.7	1.5	0.7	390.1	0.5	1.4	0.8
M1	391.6	1.5	2.1	1.2	390.2	1.3	1.9	1.1	388.9	1.0	1.6	0.9

Table 4 DESIGN FLOOD LEVELS AND VELOCITIES FOR BORA CREEK WITH NO CULVERT/BRIDGE BLOCKAGE

HEC-RAS MODEL CROSS-SECTION*	100 YEAR RECURRENCE EVENT				20 YEAR RECURRENCE EVENT				5 YEAR RECURRENCE EVENT			
	Peak Level (mAHD)	Peak Velocity (m/s)			Peak Level (mAHD)	Peak Velocity (m/s)			Peak Level (mAHD)	Peak Velocity (m/s)		
		Left	Chann	Right		Left	Chann	Right		Left	Chann	Right
B7	465.6	N/A	0.8	N/A	465.5	N/A	0.7	N/A	465.4	N/A	0.6	N/A
B6	453.0	N/A	1.7	N/A	452.9	N/A	1.6	N/A	452.7	N/A	1.5	N/A
B5	440.9	N/A	1.2	N/A	440.8	N/A	1.1	N/A	440.8	N/A	1.0	N/A
B4	437.1	N/A	0.6	N/A	437.1	N/A	0.5	N/A	437.1	N/A	0.4	N/A
B3.6	435.8	N/A	1.2	N/A	435.8	N/A	1.2	N/A	435.8	N/A	1.1	N/A
B3.5	432.7	N/A	1.1	N/A	432.7	N/A	1.1	N/A	432.6	N/A	1.0	N/A
B3	428.1	0.3	0.6	0.3	428.0	0.2	0.5	0.2	427.9	N/A	0.5	0.1
B2	418.4	N/A	2.0	N/A	418.3	N/A	1.8	N/A	418.2	N/A	1.7	N/A
B1.3	413.5	0.1	0.4	0.1	412.5	N/A	0.5	N/A	411.3	N/A	1.0	N/A
B1.1	409.7	N/A	3.0	N/A	409.6	N/A	2.8	N/A	409.4	N/A	2.6	N/A

NB: 'N/A' denotes that the design flows are contained to the creek or river channel. Therefore an overbank velocity cannot be defined.

** Refer to* **Figures *4 to 8*** *for model cross-section locations.*

Table 5 DESIGN FLOOD LEVELS AND VELOCITIES FOR MOOLARBEN CREEK WITH 50% CULVERT/BRIDGE BLOCKAGE

HEC-RAS MODEL CROSS-SECTION*	100 YEAR RECURRENCE EVENT				20 YEAR RECURRENCE EVENT				5 YEAR RECURRENCE EVENT			
	Peak Level (mAHD)	Peak Velocity (m/s)			Peak Level (mAHD)	Peak Velocity (m/s)			Peak Level (mAHD)	Peak Velocity (m/s)		
		Left	Chann	Right		Left	Chann	Right		Left	Chann	Right
M32	502.0	2.3	1.1	2.1	501.8	1.8	0.9	1.7	501.7	1.4	0.7	1.2
M31.3	497.6	1.0	2.3	0.3	497.2	0.7	2.3	N/A	496.8	N/A	2.4	N/A
M31.2	497.6	N/A	1.6	N/A	497.2	N/A	1.7	N/A	496.8	N/A	2.0	N/A
M31.1	497.4	N/A	1.7	N/A	497.1	N/A	1.5	N/A	496.7	N/A	1.4	N/A
M30.6	495.1	N/A	0.9	0.7	494.9	N/A	0.8	0.4	494.8	N/A	0.6	0.1
M30.5	492.4	1.3	1.1	1.5	492.2	1.3	1.1	1.4	491.9	1.4	1.1	1.3
M30	491.6	1.5	1.3	N/A	491.3	1.4	1.2	N/A	491.0	1.3	1.0	N/A
M29	482.8	N/A	0.9	1.3	482.7	N/A	0.9	1.2	482.5	N/A	0.9	1.1
M28	477.8	0.8	1.4	0.7	477.4	0.8	1.2	0.5	476.8	0.4	1.1	N/A
M27	463.8	N/A	3.0	N/A	463.4	N/A	2.7	N/A	462.9	N/A	2.3	N/A
M26	460.7	1.3	1.2	1.3	460.1	1.1	1.1	1.1	459.5	0.9	1.0	0.8
M25.5	459.1	N/A	1.3	N/A	458.5	N/A	1.2	N/A	458.0	N/A	1.0	N/A
M25	454.3	1.6	3.7	0.4	454.1	1.3	3.3	N/A	453.7	0.8	3.0	N/A
M24	448.5	0.6	0.5	N/A	448.5	0.4	0.4	N/A	448.5	0.3	0.2	N/A
M23.5	447.5	1.0	2.8	0.9	447.3	0.8	2.6	0.5	447.0	0.2	2.7	N/A
M23	442.9	0.9	2.2	1.2	442.6	0.8	2.0	1.0	442.4	0.7	1.9	0.9
M22.3	440.5	1.6	2.1	1.4	440.4	1.3	1.7	1.5	440.3	1.0	1.4	1.3
M22.1	440.6	1.1	1.2	0.7	440.4	1.1	1.1	0.7	440.3	1.0	1.1	0.6
M21.5	438.2	N/A	3.4	0.5	437.9	N/A	3.1	N/A	437.4	N/A	3.1	N/A
M21.4	436.0	0.2	1.1	0.3	435.6	0.2	1.0	0.2	435.2	0.1	0.9	0.2
M21.3	435.6	0.6	1.4	0.9	435.2	0.5	1.3	0.8	434.8	0.4	1.2	0.8
M21	433.1	1.0	1.9	0.5	432.6	0.8	1.7	0.5	432.2	0.6	1.5	0.4
M20.5	431.7	N/A	1.6	N/A	431.0	N/A	1.4	N/A	430.5	N/A	1.3	N/A
M20	430.2	0.4	4.8	0.5	429.7	0.4	4.2	0.4	429.3	0.3	3.5	0.3
M19	426.2	1.1	1.9	0.7	425.5	1.0	1.7	0.3	424.7	0.8	1.5	N/A
M18	423.7	0.5	1.7	0.8	423.2	0.4	1.4	0.6	422.7	0.2	1.1	0.4
M17.5	422.8	0.9	1.1	0.6	422.5	0.7	1.0	0.5	422.2	0.6	0.8	0.4
M17.3	422.3	1.2	1.0	1.1	422.1	0.9	0.8	1.2	421.8	0.7	0.7	1.2
M17.1	421.8	1.5	0.7	0.7	421.6	1.2	0.6	0.5	421.4	1.0	0.5	0.4

Table 6 DESIGN FLOOD LEVELS AND VELOCITIES FOR THE GOULBURN RIVER WITH 50% CULVERT/BRIDGE BLOCKAGE

HEC-RAS MODEL CROSS-SECTION*	100 YEAR RECURRENCE EVENT				20 YEAR RECURRENCE EVENT				5 YEAR RECURRENCE EVENT			
	Peak Level (mAHD)	Peak Velocity (m/s)			Peak Level (mAHD)	Peak Velocity (m/s)			Peak Level (mAHD)	Peak Velocity (m/s)		
		Left	Chann	Right		Left	Chann	Right		Left	Chann	Right
M16.1	419.8	2.1	1.5	1.2	419.5	1.8	1.3	1.4	419.1	1.5	1.2	1.5
M15.5	419.1	2.5	1.4	1.4	418.8	2.4	1.4	1.1	418.4	2.0	1.4	0.9
M15	418.3	2.2	1.3	1.0	418.0	1.7	1.1	0.7	417.8	1.3	0.9	0.4
M14.5	417.0	1.7	1.2	2.0	416.5	1.6	1.4	2.0	416.1	0.6	1.8	1.6
M14	416.4	1.5	0.9	1.8	415.9	1.3	0.8	1.5	415.4	1.2	0.7	1.2
M13.5	415.6	3.5	2.0	N/A	415.3	2.9	1.7	N/A	414.9	2.3	1.5	N/A
M13	414.0	1.8	1.3	2.2	413.5	1.8	1.3	2.1	413.0	2.0	1.3	1.9
M12.6	413.7	1.6	0.9	1.1	413.2	1.5	0.8	1.1	412.7	1.3	0.7	1.1
M12.5	412.9	N/A	1.6	N/A	412.4	N/A	1.4	N/A	411.9	N/A	1.2	N/A
M12	412.2	1.6	0.8	N/A	411.6	1.4	0.7	N/A	411.0	1.3	0.6	N/A
M11.5	411.5	2.6	1.7	N/A	410.9	2.3	1.7	N/A	410.2	1.9	1.6	N/A
M11	409.7	N/A	2.4	N/A	408.6	N/A	2.2	N/A	407.9	N/A	1.8	N/A
M10.5	409.2	1.6	1.8	1.3	407.8	1.7	1.8	1.1	406.6	2.1	2.1	1.0
M10	408.9	N/A	2.2	N/A	407.5	N/A	2.1	N/A	406.2	N/A	2.0	N/A
M9.5	408.2	N/A	3.3	N/A	406.9	N/A	2.8	N/A	405.6	N/A	2.3	N/A
M9	406.6	N/A	4.8	N/A	405.9	N/A	3.8	N/A	404.9	N/A	3.1	N/A
M8	404.4	1.5	1.1	1.2	403.3	1.1	1.1	1.0	402.4	0.4	0.9	0.6
M7.3	403.2	0.8	1.3	0.7	401.2	0.3	2.0	0.4	400.5	N/A	1.6	N/A
M7.1	401.1	0.3	1.1	0.6	400.4	0.3	1.0	0.4	399.7	0.1	0.8	0.2
M6.5	400.3	0.8	1.1	0.6	399.5	0.7	1.1	0.6	398.9	0.6	1.0	0.5
M6	399.9	0.6	0.9	N/A	398.8	0.6	1.1	N/A	397.9	0.4	1.4	N/A
M5.6	399.6	0.3	0.5	0.4	398.4	0.3	0.5	0.4	397.2	0.3	0.5	0.4
M5.5	399.4	0.4	0.9	0.6	398.2	0.3	0.8	0.5	397.0	0.3	0.8	0.5
M5	399.0	1.0	1.5	0.5	397.8	0.8	1.3	0.3	396.5	0.7	1.1	N/A
M4	397.5	0.9	1.4	0.7	396.2	0.8	1.3	0.6	394.8	0.8	1.3	0.6
M3	395.8	0.9	2.8	0.4	394.7	0.5	2.2	0.1	393.4	0.2	1.7	N/A
M2.3	392.8	1.0	2.2	1.2	391.7	0.9	2.2	1.1	390.7	0.7	2.0	1.0
M2.1	392.6	0.6	1.4	0.8	391.3	0.7	1.5	0.7	390.1	0.5	1.4	0.8
M1	391.6	1.5	2.1	1.2	390.2	1.3	1.9	1.1	388.9	1.0	1.6	0.9

Table 7 DESIGN FLOOD LEVELS AND VELOCITIES FOR BORA CREEK WITH 50% CULVERT/BRIDGE BLOCKAGE

HEC-RAS MODEL CROSS-SECTION*	100 YEAR RECURRENCE EVENT				20 YEAR RECURRENCE EVENT				5 YEAR RECURRENCE EVENT			
	Peak Level (mAHD)	Peak Velocity (m/s)			Peak Level (mAHD)	Peak Velocity (m/s)			Peak Level (mAHD)	Peak Velocity (m/s)		
		Left	Chann	Right		Left	Chann	Right		Left	Chann	Right
B7	465.7	N/A	0.7	N/A	465.5	N/A	0.7	N/A	465.4	N/A	0.6	N/A
B6	453.2	N/A	2.0	N/A	452.9	N/A	1.6	N/A	452.7	N/A	1.5	N/A
B5	440.9	N/A	1.3	N/A	440.8	N/A	1.1	N/A	440.8	N/A	1.0	N/A
B4	437.1	N/A	0.6	N/A	437.1	N/A	0.5	N/A	437.1	N/A	0.4	N/A
B3.6	435.9	N/A	1.3	N/A	435.8	N/A	1.2	N/A	435.8	N/A	1.1	N/A
B3.5	432.7	N/A	1.1	N/A	432.7	N/A	1.1	N/A	432.6	N/A	1.0	N/A
B3	428.1	0.3	0.6	0.4	428.0	0.2	0.5	0.2	427.9	N/A	0.5	0.1
B2	418.4	N/A	2.0	N/A	418.3	N/A	1.8	N/A	418.2	N/A	1.7	N/A
B1.3	415.9	0.1	0.1	0.1	415.7	0.0	0.1	0.1	414.0	0.1	0.1	0.1
B1.1	409.8	N/A	3.0	N/A	409.6	N/A	2.8	N/A	409.4	N/A	2.6	N/A

NB: 'N/A' denotes that the design flows are contained to the creek or river channel. Therefore an overbank velocity cannot be defined.

** Refer to* **Figures *4 to 8*** *for model cross-section locations.*

3.5 DISCUSSION

Figure 9 shows that 50% blockage of all bridge and culvert crossings within the study area will have only a minimal impact on flood behaviour along the upper reaches of Moolarben Creek. This is because the culvert crossings along this section of the creek only have a limited capacity. Accordingly, during large floods, the majority of the flow passes over the top of the roadways.

Figures 10 and **11** show that larger increases in peak 100 year recurrence water levels are predicted in the vicinity of major bridge crossings such as the Ulan-Cassilis Road bridge and Gulgong to Sandy Hollow Railway bridge. An afflux of about 100 mm is predicted at this location. The most significant increase in peak flood level occurs at the Ulan-Cassilis culvert crossing of Bora Creek where 50% blockage of the culverts is predicted to increase peak 100 year recurrence flood levels by over 2 metres.

As shown in **Plate 4**, the Ulan-Cassilis Road forms a significant embankment. Accordingly, during large floods, water will effectively "build up" behind the embankment until it is able to pass through the culverts. If the capacity of the culverts is compromised, then floodwaters will continue to build up behind the embankment, generating higher peak flood levels.

Plate 4 VIEW SHOWING CULVERTS DRAINING RUNOFF FROM BORA CREEK BENEATH THE ULAN – CASSILIS ROAD

Figures 9 to **12** also show that the hydraulic gradient along each of the watercourses is generally steep. This indicates that flood behaviour along the watercourses is typically characterised by relatively shallow fast moving water. This is confirmed by the results provided in **Tables 2** to **7** which indicate that flow velocities along each of the watercourses are generally in excess of 1 m/s during the 5, 20 and 100 year recurrence floods.

As shown in **Figures 14** to **17**, Open Cut No.1 and Open Cut No.2 are located well outside of the predicted peak 100 year recurrence flood extent. **Figure 14** indicates that Open Cut No.3 will be within the 100 year recurrence flood extent. However, it is understood that mining activities will be excluded from those areas predicted to be inundated at the peak of the 100 year recurrence flood.

As shown in **Figures 16** and **17**, the 100 year recurrence flood extent is predicted to extend across the lower lying sections of the area proposed for underground mining. However, the inundation is predicted to be restricted to small sections near the south-west and south-east corners of the underground mine area.

A small section of land near the eastern edge of the underground mine is also predicted to be inundated at the peak of the 100 year recurrence flood (*refer* **Figure 17**).

4 FLOOD IMPACT ASSESSMENT

4.1 DESCRIPTION OF DEVELOPMENT PROPOSAL AND POTENTIAL IMPACTS

The proposed Moolarben Coal Mine Project is to comprise the staged development of three open cut mines (*Open Cuts No. 1, 2 and 3*) and an underground mine (*Underground No. 4*) (*refer* **Figure 2**). Mine infrastructure, surface facilities and coal handling and preparation facilities will also be constructed between Open Cut No. 1 and Underground No. 4 (*refer* **Figure 2**).

4.1.1 Potential Flood Impacts along Moolarben and Bora Creek

As shown in **Figures 15** and **16**, Open Cuts No 1 and No 2 are located well outside the predicted 100 year recurrence flood extent. Accordingly, all earthworks associated with the construction and operation of Open Cut No 1 and Open Cut No 2 are unlikely to impact on existing flood behaviour along the lower reaches of Moolarben Creek and sections of the Goulburn River adjacent to the Exploration License.

As shown in **Figure 14**, Open Cut No.3 is predicted to be located within the 100 year recurrence flood extent. However, it is understood that mining activities will be excluded from those section of the mine area where inundation is predicted during the 100 year recurrence flood. This will reduce the potential for inundation of the open cut area and subsequent disruption to mining activities following heavy rainfall in the catchment.

Accordingly, it is understood that no alteration to the topography of Moolarben Creek or its floodplain will be undertaken across areas that are currently inundated during floods up to and including the 100 year recurrence event. Therefore, works associated with Open Cut No. 3 will have no measurable impact on flood behaviour along Moolarben Creek during events up to and including the 100 year recurrence flood.

As shown in **Figure 16**, inundation of small sections of the underground mine area could occur as a result of flooding of Bora Creek. However, as mining activities in this area will be underground, inundation across the surface of these areas is not expected to present any impediment to mine operations.

Notwithstanding, there is potential for subsidence and surface cracks to provide a passage for surface water into the underground mine. However, it has been determined that '*..surface drainage patterns are likely to function with minimal changes after subsidence trough development*' (*Moolarben Coal Mines Pty Ltd, May 2006*). That is, the proposed mine is note predicted to alter existing drainage behaviour.

Moreover, it should be recognised that no permanent watercourses extend across the land surface above the proposed underground mine. That is, those sections of the underground mine that are predicted to be inundated will generally only be subject to inundation during relatively rare rainfall events.

4.1.2 Proposed Moolarben Creek Dam

As outlined in **Section 3.2.1**, Ulan Coal Mines Limited has approval for the construction of a new water supply dam immediately upstream of the existing Moolarben Creek Dam. The proposed dam is to be located between Open Cut No.1 and Open Cut No.2. Therefore, the open cut operations will not directly impact on the proposed dam.

However, Moolarben Coal Mines Pty Ltd does propose to construct a haul road between Open Cut No.1 and Open Cut No.2 to form a bund along the eastern bank of the proposed dam. The alignment of the proposed haul road is shown in **Figure 2**.

Available topographic survey along the alignment of the haul road indicates that the roadway would have a minimum elevation of about 448 mAHD. As discussed in **Section 3.2.1**, the proposed Moolarben Dam is to have a full storage level of 442 mAHD. Therefore, the proposed haul road will be located 6 metres above the full supply level of the dam. That is, the haul road will not encroach into the dam and therefore will not compromise the capacity of the proposed dam.

5 CONCLUSIONS

Moolarben Coal Mines Pty Limited plans to develop a series of coal mines across an Exploration License located adjacent to Moolarben Creek and the Goulburn River near Ulan. Investigations carried out for the proposed mine have defined existing flood behaviour along each of the watercourses that drain through the mining Exploration License. These investigations have also considered the potential for mining operations to adversely impact on existing flood behaviour along each of the watercourses.

Existing flood behaviour along each of the watercourse has been defined using hydrologic and hydraulic computer models developed specifically for the Moolarben Mine Project. The hydrologic model has been used to define design flood flows at various locations across the Exploration License. The hydraulic model has been applied to predict flood characteristics such as peak water levels and flow velocities along each of the primary watercourses.

The results of the modelling indicate that flood behaviour across the Exploration License is generally characterised by shallow, high velocity flood flows. As shown in **Figures 14 to 17**, the open cut and underground mining operations are generally located well outside of the predicted 100 year recurrence flood extent. Accordingly, the majority of the proposed mine areas will not be inundated during all floods up to and including the 100 year recurrence event.

A small intermittent watercourse, known as Bora Creek, currently extends across sections of the proposed underground mine. However, results documented in the *'Mine Subsidence Impact Assessment for the Proposed Longwall Panels LWs 1 to 14, Approved No. 4 Underground Area, Moolarben Coal Project'* (*May 2006*), indicate that mine subsidence is not predicted to adversely impact on existing drainage behaviour.

Therefore, the proposed mine operations will generally be located outside of the predicted 100 year recurrence flood extent. Accordingly, any earthworks associated with the proposed mine development are not predicted to adversely impact on existing flood behaviour across or outside of the Exploration License.

Overall, the Moolarben Coal Project is not predicted to be impacted by floodwaters inundating the mine site during all events up to and including the 100 year recurrence flood. Moreover, any proposed earthworks are not predicted to adversely impact on existing flood behaviour along each of the watercourses that currently drain through the Exploration License.

6 REFERENCES

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(5) Institution of Engineers Australia (1977), *'Australian Rainfall and Runoff – Flood Analysis and Design'*.

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(7) Moolarben Coal Project (*February 2006*) '*Soil, Rural Land Capability and Agricultural Suitability Assessment – Underground, Infrastructure Area & Open Cuts 1, 2,3* ', prepared by JAMMEL Environmental & Planning Services Pty Ltd.

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(9) US Army Corp of Engineers, Hydrologic Engineering Centre (*April, 1997*), *'HEC-RAS River Analysis System – Hydraulic Reference Manual'*; also incorporating HEC-RAS software.

(10) Moolarben Coal Mines Pty Ltd (*May 2006*) *'Mine Subsidence Impact Assessment for the Proposed Longwall Panels LWs 1 to 14, Approved No. 4 Underground Area, Moolarben Coal Project'*, prepared by Strata Engineering.

(11) WP Software (1992), *'Runoff Analysis & Flow Training Simulation, RAFTS-XP Manual, Version 2.80'*

APPENDIX A
ADOPTED RAFTS MODEL SUB-CATCHMENT PARAMETERS

RAFTS Data - Existing Conditions

Sub-Catchment Area and Slope Data

	Pasture / Grassed Area	Timbered Area		*Notes*
% Impervious	5	10		*Higher impervious area set for timbered areas to account for numerous rock outcrops*
% Pervious	95	90		
Initial Loss (mm)	20	20		
Continuing Loss (mm/hr)	2.5	2.5		*Continuing loss taken from Table 3.1 in Book Two of AR&R 1998 for the Hunter River catchment*
Manning's 'n'	0.04	0.08		
Manning's 'n' description	pasture - no brush - high grass - "normal - maximum" value	trees - heavy stand of timber, few down trees, little undergrowth - "minimum" value		

Watercourse Catchment	Receiving Watercourse	RAFTS Node No.	Node Type	Sub-catchment Area (m2)	Sub-catchment Area (ha)	Description	Total Flowpath Length (m)	20% of length (m)	Elevation at 20% (mAHD)	Elevation at outlet (mAHD)	Vectored Slope	Pasture / Grassed Area (m^2)	Pastured / Grassed Area (ha)	Proportion Pasture / Grassed Area	Timbered Area (m^2)	Timbered Area (ha)	Proportion Timbered Area
Moolarben Creek	Moolarben Creek		catchment	14,270,499	1,427	forested area at top of Moolarben Creek	6,300	#REF!	620	508	#REF!	4,512,994	451	32%	9,757,505	976	68%
		MC2	dummy														
		MC3	catchment	4,587,536	459	rural area; top of Open Cut 3	2,000	#REF!	605	498	#REF!	1,772,576	177	39%	2,814,960	281	61%
		MC4	dummy														
		MC5	catchment	9,576,528	958	rural area; covers majority of Open Cut 3	1,900	#REF!	550	487	#REF!	5,574,965	557	58%	4,001,563	400	42%
		MC6	dummy														
		MC7	catchment	1,486,455	149	top of Open Cut 2	1,500	#REF!	532	455	#REF!	1,025,283	103	69%	461,172	46	31%
		MC8	catchment	749,373	75		430	#REF!	475	458	#REF!	339,255	34	45%	410,118	41	55%
		MC9	dummy														
		MC10	catchment	4,577,491	458		2,600	#REF!	500	442	#REF!	3,062,916	306	67%	1,514,575	151	33%
		MC11	catchment	2,098,862	210		1,300	#REF!	515	447	#REF!	1,281,928	128	61%	816,934	82	39%
		MC12	dummy														
		MC13	catchment	962,825	96		1,300	#REF!	536	430	8%	543,184	54	56%	419,641	42	44%
		MC16	catchment	1,527,010	153		2,100	#REF!	492	420	8%	636,492	64	42%	890,518	89	58%
		MC14	catchment	1,994,111	199		3,000	#REF!	470	432	#REF!	1,495,761	150	75%	498,350	50	25%
		MC17	catchment	1,046,582	105		1,000	#REF!	450	422	#REF!	980,781	98	94%	65,801	7	6%
		MC15	dummy														
		MC18	dummy														
				41,830,690	**4,183**												
Murdering Gully	Moolarben Creek	catchment		6,900,249	690	all rural	5,000	#REF!	640	508	#REF!	1,130,023	113	16%	5,770,226	577	84%
				6,900,249	**690**												
Spring Creek	Moorlaben Creek	catchment		5,267,372	527	predominantly rural, contains top of part of Open Cut 3	5,200	#REF!	620	490	#REF!	3,063,632	306	58%	2,203,740	220	42%
				5,267,372	**527**												
Lagoon Creek	Moorlaben Creek	LC2	catchment	9,556,459	956	rural	6,100	#REF!	580	471	#REF!	7,943,479	794	83%	1,612,980	161	17%
		LC1	catchment	17,967,698	1,797	rural	7,700	#REF!	580	471	#REF!	10,436,643	1,044	58%	7,531,055	753	42%
		LC4	catchment	7,807,141	781	rural	2,700	#REF!	548	453	#REF!	5,965,223	597	76%	1,841,918	184	24%
		LC3	dummy														
				35,331,298	**3,533**												
Ryans Creek	Moorlaben Creek	RYC1	catchment	4,476,069	448	rural residential	5,100	#REF!	617	538	#REF!	4,225,872	423	94%	250,197	25	6%
		RYC2	catchment	10,265,343	1,027	rural residential	1,800	#REF!	592	538	#REF!	9,160,796	916	89%	1,104,547	110	11%
		RYC3	catchment	2,121,975	212	rural residential	3,000	#REF!	510	450	#REF!	1,205,769	121	57%	916,206	92	43%
		RYC4	catchment	4,826,641	483	rural	2,300	#REF!	575	478	#REF!	1,990,260	199	41%	2,836,381	284	59%
				21,690,028	**2,169**												
Sportsmans Hollow Creek	Goulburn River	SHC1	catchment	6,018,881	602	forest and some rural	3,400	#REF!	534	476	#REF!	858,241	86	14%	5,160,640	516	86%
		SHC2	catchment	7,506,569	751	forest and rural	3,300	#REF!	540	475	#REF!	3,559,990	356	47%	3,946,579	395	53%
		SHC3	dummy														
		SHC4	catchment	8,086,018	809		2,600	#REF!	530	433	#REF!	5,395,826	540	67%	2,690,192	269	33%
		SHC5	catchment	5,070,777	507		3,600	#REF!	490	426	#REF!	1,980,493	198	39%	3,090,284	309	61%
				26,682,245	**2,668**												
Rouses Creek	Sportsmans Hollow Creek	ROC1	catchment	13,704,451	1,370	predominantly rural	6,600	#REF!	530	460	#REF!	3,589,530	359	26%	10,114,921	1,011	74%
		ROC2	catchment	4,907,498	491	rural residential & forest	5,000	#REF!	510	450	#REF!	2,996,924	300	61%	1,910,574	191	39%
				18,611,949	**1,861**												
Goulburn River	Goulburn River	GR1	catchment	5,598,613	560		2,900	#REF!	488	413	#REF!	2,916,914	292	52%	2,681,699	268	48%
		GR2	dummy														
		GR3	catchment	7,947,345	795		3,600	#REF!	478	410	#REF!	4,350,017	435	55%	3,597,328	360	45%
		GR4	dummy														
		GR6	catchment	5,150,213	515		4,100	#REF!	463	398	#REF!	1,565,982	157	30%	3,584,231	358	70%
		GR5	catchment	5,867,127	587		2,800	#REF!	480	410	#REF!	3,632,880	363	62%	2,234,247	223	38%
		GR7	dummy														
		GR9	catchment	4,637,428	464		4,400	#REF!	469	390	#REF!	0	0	0%	4,637,428	464	100%
		GR8	catchment	3,359,759	336		1,500	#REF!	440	392	#REF!	689,718	69	21%	2,670,041	267	79%
		GR10	dummy														
				32,560,485	**3,256**												
Bora Creek	Goulburn River	BC1	catchment	579,480	58		1,000	#REF!	500	470	#REF!	0	0	0%	579,480	58	100%
		BC2	catchment	1,022,363	102		1,600	#REF!	481	424	#REF!	700,143	70	68%	322,220	32	32%
		BC3	catchment	444,704	44		940	#REF!	435	424	#REF!	444,704	44	100%	0	0	0%
		BC4	dummy														
		BC5	catchment	1,347,186	135		1,600	#REF!	476	418	#REF!	767,114	77	57%	580,072	58	43%
		BC6	catchment	1,361,874	136		2,000	#REF!	490	420	#REF!	800,584	80	59%	561,290	56	41%
		BC7	catchment	1,996,758	200		2,800	#REF!	490	412	#REF!	1,203,618	120	60%	793,140	79	40%
		BC8	dummy														
				6,752,365	**675**												
Ulan Creek	Goulburn River	UC1	catchment	12,496,463	1,250		4,900	#REF!	498	454	#REF!	6,418,752	642	51%	6,077,711	608	49%
		UC2	catchment	17,762,604	1,776		4,300	#REF!	520	454	#REF!	0	0	0%	17,762,604	1,776	100%
		UC3	catchment	12,915,207	1,292		3,600	#REF!	487	418	#REF!	3,835,036	384	30%	9,080,171	908	70%
		UC4	catchment	5,708,303	571		3,100	#REF!	470	407	#REF!	2,286,503	229	40%	3,421,800	342	60%
				48,882,577	**4,888**												
TOTAL CATCHMENT				**244,509,258**	**24,451**							**114,340,801**	**11,434**	**47%**	**131,215,039**	**13,122**	**54%**

RAFTS Link Data

Lag times are based on an assumed channel velocity
Times of concentration derived from the Probabilistic Rational Method formula given in Equation 1.4.in Section 1.4.1 of Book 4 of AR7R 1998 have been used as confirmation of the estimated lag times
Note that stream slope is not the equal area slope; however the two are assumed to be equal in this instance due to the short link lengths relative to the total combined length of the Goulburn River and Moolarben Creek

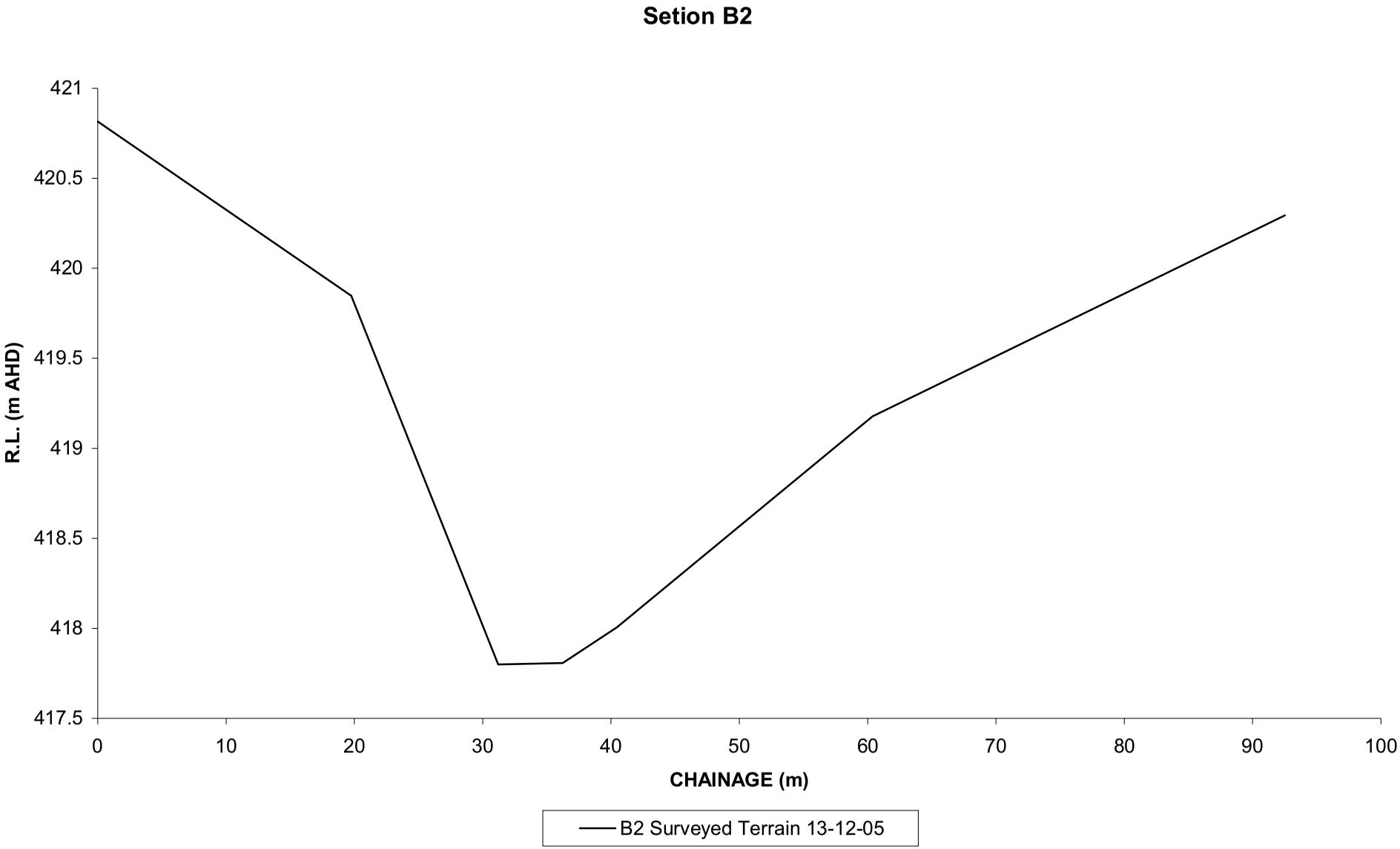
	Assumed flow velocity		
For catchment slopes <1.5%	0.3	m/s	*Based on Table 5.05.4 in Queensland Urban Drainage Manual*
For catchment slopes >1.5%	0.7	m/s	*Based on Table 5.05.4 in Queensland Urban Drainage Manual*
	1	m/s	*From HEC-RAS modelling*

Reduction Factor for Probabilistic Rational Method tc	1

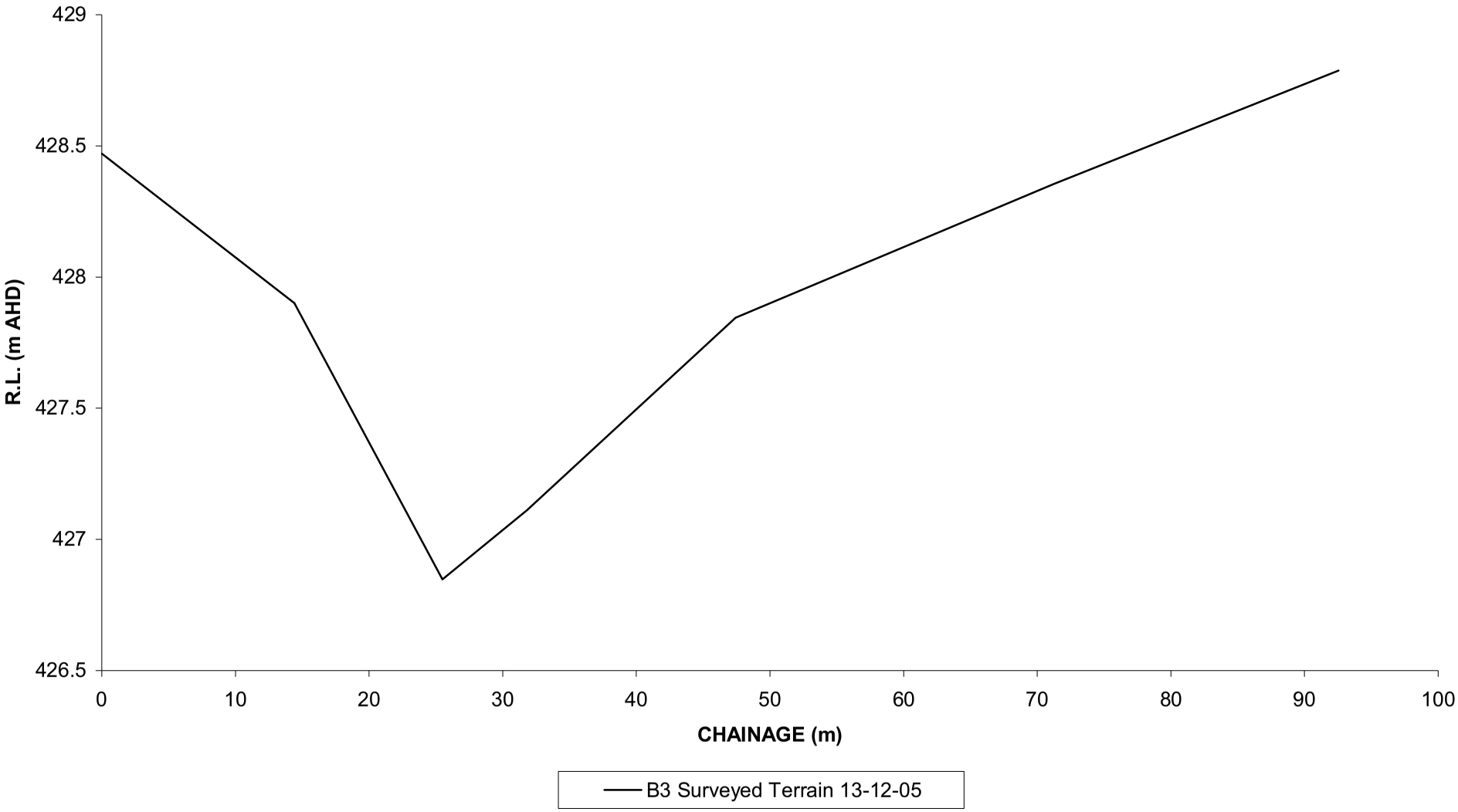
	Link Data				Catchment and Stream Data						Probabilistic Rational Method		HEC-RAS Velocity	QUDM Assumed Velocity	HEC-RAS		
Watercourse Catchment	**Old RAFTS Link No.**	**New RAFTS Link No.**	**U/S Node No.**	**D/S Node No.**	**Total catchment area draining to D/S node (ha)**	**Stream Length (m)**	**Max Stream Elevation (mAHD)**	**Min Stream Elevation (mAHD)**	**Stream Slope**	**Stream Slope (m/km)**	**Overall tc for Contributing Catchment (mins)**	**tc for link (mins)**	**Travel Time for Link (mins)**	**Travel Time for Link (mins)**	**HEC-RAS Velocity for Link (m/s)**	**Travel Time for Link (mins)**	**Final Adopted Lag (mins)**
Murdering Gully																	
	1.00	2.00	MG1	MC1	690	0											
Moolarben Creek																	
		1.00	MC1	MC2	2,117						145						
	1.01	1.01	MC2	MC4	2,576	2,048	508	490	0.9%	8.8	157	11	34	114			34
	1.02	1.02	MC4	MC6	3,533	4,672	490	460	0.6%	6.4	177	20	78	260			78
	1.03	1.03	MC6	MC9	3,757	2,973	460	447	0.4%	4.4	181	4	50	165			50
	1.04	1.04	MC9	MC12	7,958	2,335	447	434	0.6%	5.6	241	60	39	130			39
	1.05	1.05	MC12	MC15	10,423	1,642	434	428	0.4%	3.7	267	26	27	91			27
		1.06	MC15	MC18		1,400	428	416	0.9%	8.6			23	78			23
	3.00	3.00	MC3	MC4		0								0			0
	5.00	5.00	MC5	MC6		0								0			0
	7.00	6.00	MC7	MC9		0								0			0
		7.00	MC8	MC9		0								0			0
		10.00	MC10	MC12		0								0			0
		11.00	MC11	MC12		0								0			0
		13.00	MC13	MC15		0								0			0
		14.00	MC14	MC15		0								0			0
		15.00	MC16	MC18										0			0
		16.00	MC17	MC18										0			0
Spring Creek																	0
	2.00	4.00	SC1	MC4		0								0			0
Lagoon Creek																	
		8.00	LC1	LC3													
	4.00	9.00	LC2	LC3							0						
	4.01	8.01	LC3	LC4	3,533	2,972	580	447	4.5%	44.8	177	177	50	71			50
	4.02	8.02	LC4	MC9		0											
Ryans Creek																	
				RYC1	448						81						
	6.00	12.00	RYC1	RYC2	1,474	3,072	538	495	1.4%	14.0	127	46	51	171			51
	6.01	12.01	RYC2	RYC3	1,686	2,339	495	450	1.9%	19.2	133	7	39	56			39
	6.02	12.02	RYC3	RYC4	2,169	1,336	450	434	1.2%	12.0	147	13	22	74			22
	6.03	12.03	RYC4	MC12		0								0			0
Sportsmans Hollow Creek																	
				SHC1	602						90						
	8.00	17.00	SHC1	SHC3	1,353	2,309	476	450	1.1%	11.3	123	32	38	128			38
		18.00	SHC2	SHC3										0			0
	8.01	17.01	SHC3	SHC4	2,161	3,086	450	433	0.6%	5.5	147	24	51	171			51
	8.02	17.02	SHC4	SHC5	2,668	2,415	433	416	0.7%	7.0	159	12	40	134			40
	8.03	17.03	SHC5	MC15		0								0			0
Rouses Creek																	
				ROC1	1,370						123						
	9.00	19.00	ROC1	ROC2	1,861	1,090	460	450	0.9%	9.2	139	15	18	61			18
	9.01	19.01	ROC2	SHC3		0								0			0
Goulburn River																	
				MC9	14,952						306						
	1.06	1.07	MC18	GR2	15,512	2,638	416	410	0.2%	2.3	310	4	44	147			44
	1.07	1.08	GR2	GR4	16,307	1,607	410	406	0.2%	2.5	316	6	27	89			27
	1.08	1.09	GR4	GR7	17,497	2,986	406	394	0.4%	4.0	325	9	49	165			49
	1.09	1.10	GR7	GR10	23,185	3,361	394	386	0.2%	2.4	**361**	37	56	187			56
		20.00	GR1	GR2		0								0			0
	10.00	21.00	GR3	GR4		0								0			0
		29.00	GR5	GR7		0								0			0
	16.00	28.00	GR6	GR7		0								0			0
		32.00	GR8	GR10		0								0			0
	17.00	31.00	GR9	GR10		0								0			0
Bora Creek																	
				BC1	58						37						
	11.00	22.00	BC1	BC4	205	1,630	470	424	2.8%	28.2	60	23	27	39			27
	11.01	22.01	BC4	BC8	675	1,342	424	406	1.3%	13.4	94	34	22	75			22
	11.02	22.02	BC8	GR4		0								0			0
		23.00	BC2	BC4		0								0			0
	12.00	24.00	BC3	BC4		0								0			0
		25.00	BC5	BC8		0								0			0
	13.00	26.00	BC6	BC8		0								0			0
	14.00	27.00	BC7	BC8		0								0			0
						0											
Ulan Creek																	
				UC1	1,250						119						
	15.00	30.00	UC1	UC2	3,026	2,936	454	432	0.7%	7.5	167	48	49	163			49
	15.01	30.01	UC2	UC3	4,317	3,041	432	409	0.8%	7.6	191	24	51	169			51
	15.02	30.02	UC3	UC4	4,888	2,910	409	394	0.5%	5.2	200	9	49	162			49
	15.03	30.03	UC4	GR5		0								0			0

APPENDIX B

SURVEYED CROSS-SECTIONS OF MOOLARBEN, SPRING, RYANS AND BORA CREEKS AND THE GOULBURN RIVER


Setion B2
421
420.5
420
419.5
419
418.5
418
417.5
R.L. (m AHD)
0
10
20
30
40
50
60
70
80
90
100
CHAINAGE (m)
B2 Surveyed Terrain 13-12-05

Section B3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428
427.5
427
426.5
R.L. (m AHD)
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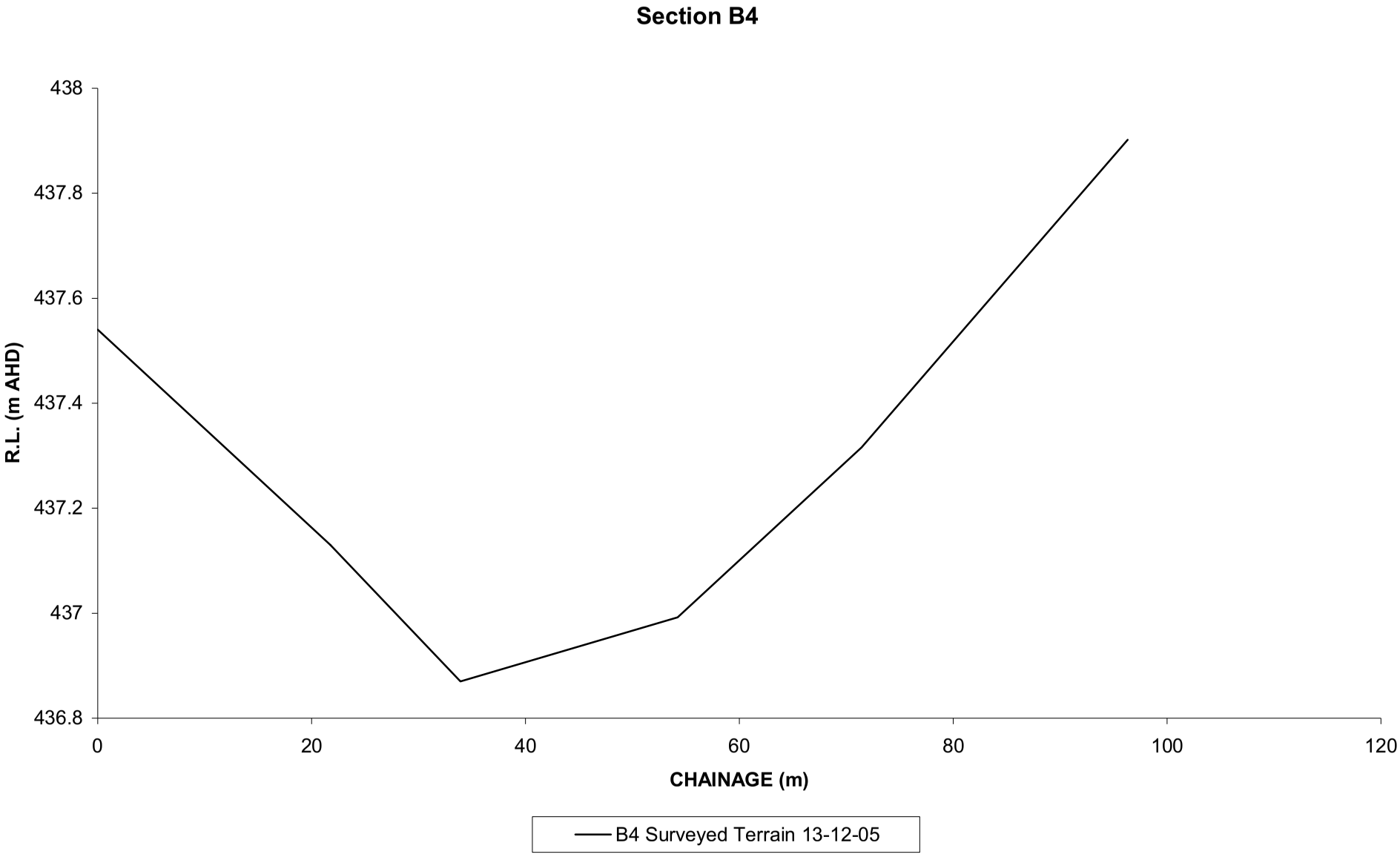
20
30
40
50
60
70
80
90
100
CHAINAGE (m)
B3 Surveyed Terrain 13-12-05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437.8
437.6
437.4
437.2
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436.8
R.L. (m AHD)
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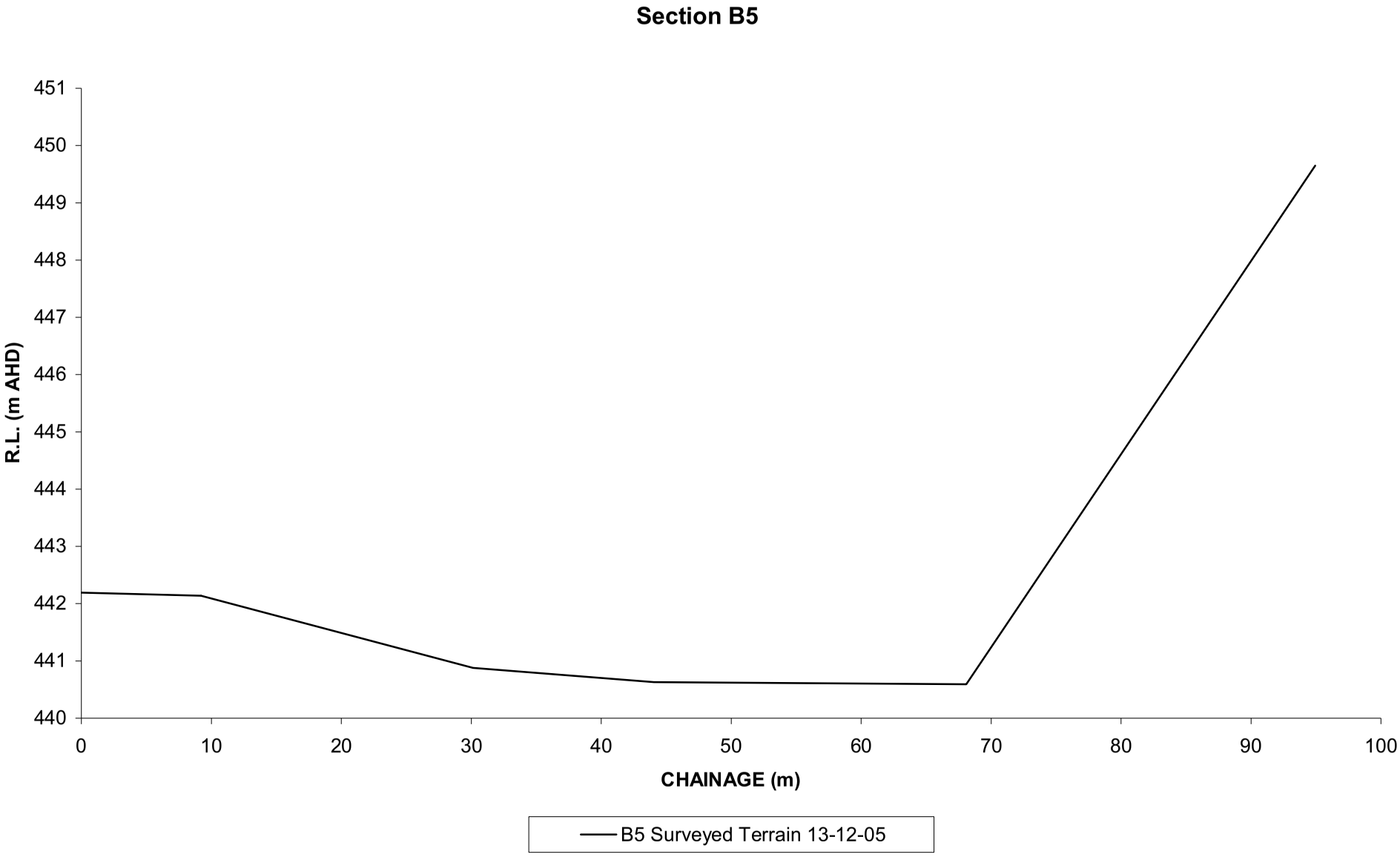
40
60
80
100
120
CHAINAGE (m)
B4 Surveyed Terrain 13-12-05


Section B5
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449
448
447
446
445
444
443
442
441
440
R.L. (m AHD)
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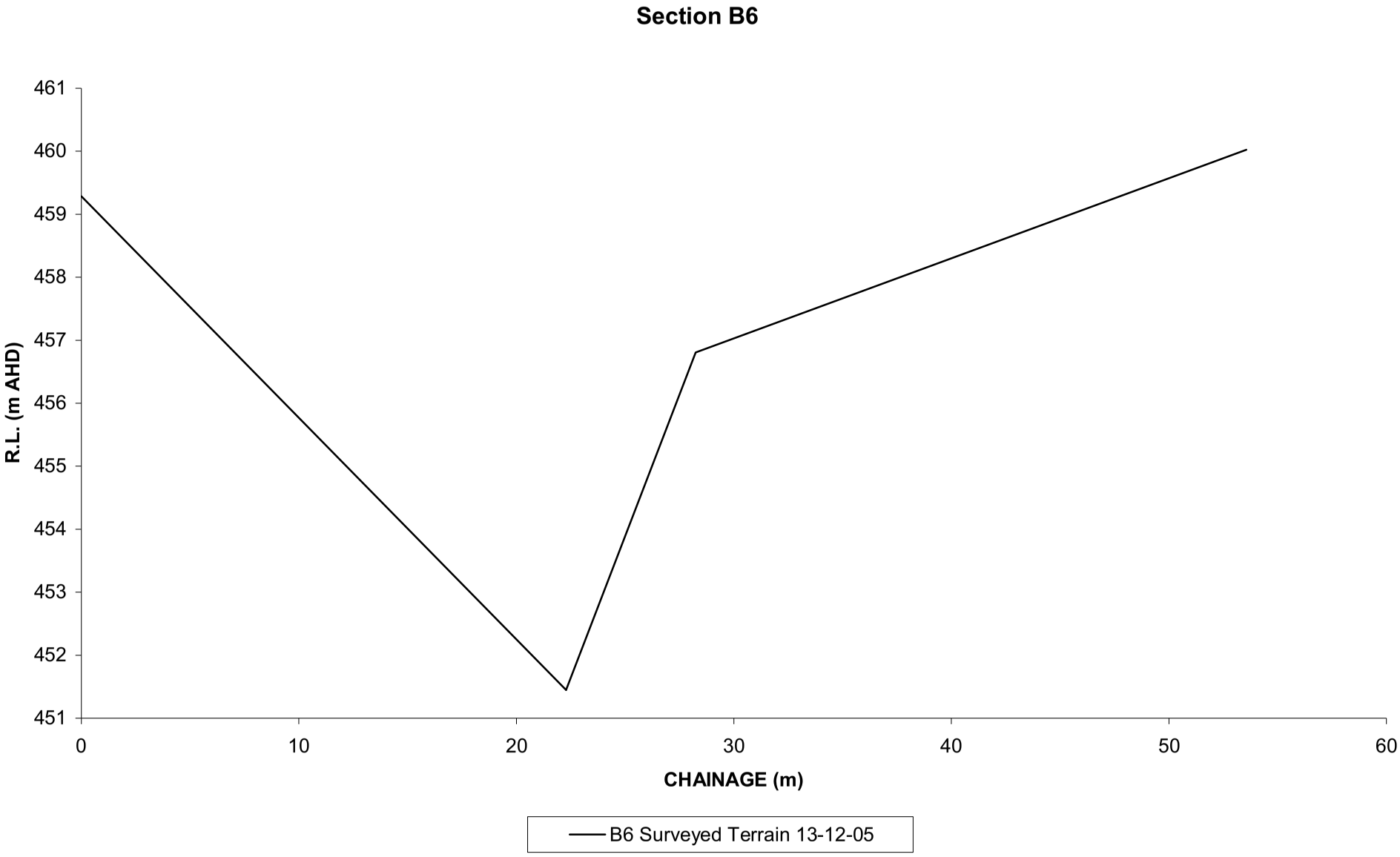
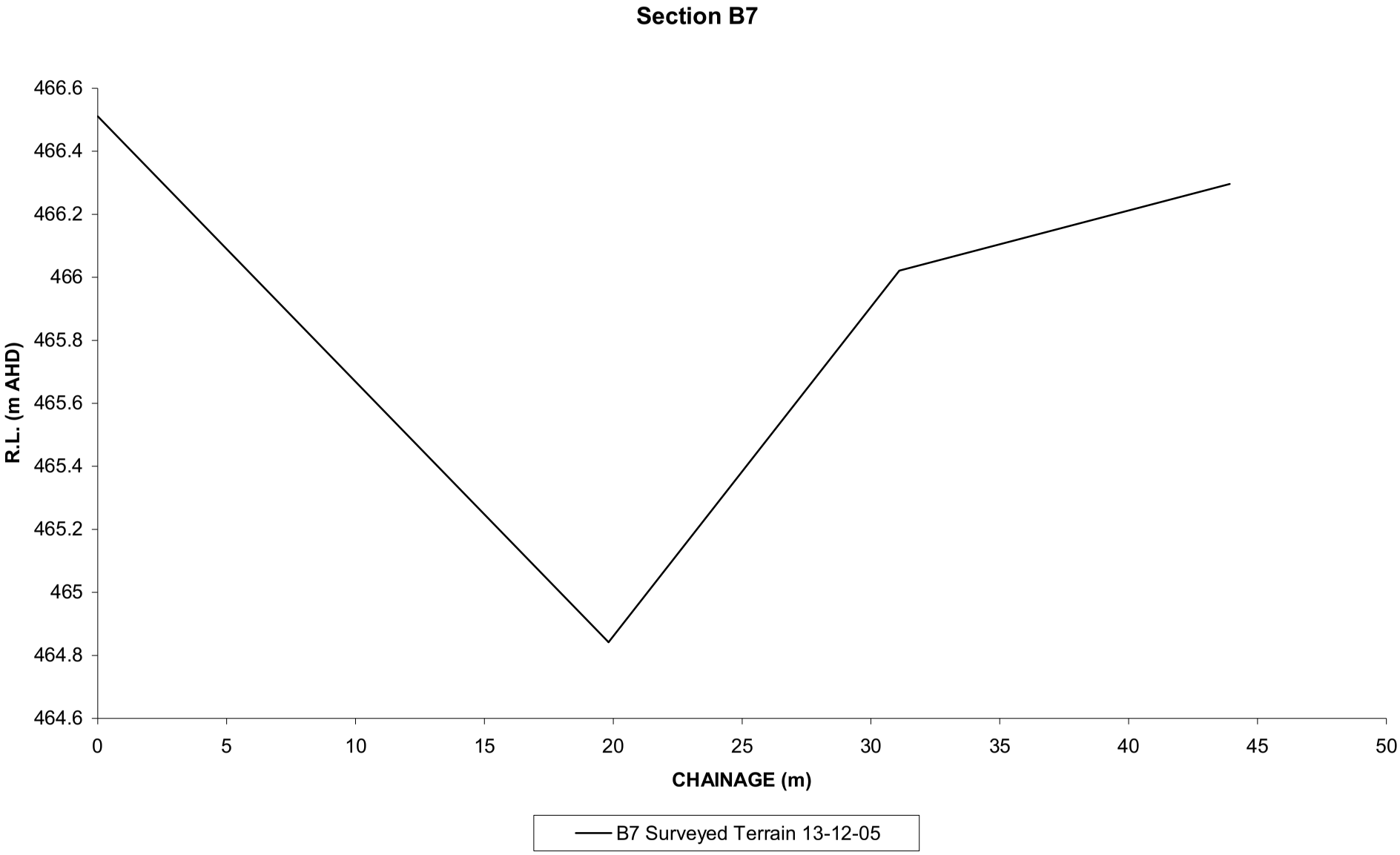
10
20
30
40
50
60
70
80
90
100
CHAINAGE (m)
B5 Surveyed Terrain 13-12-05


Section B6
461
460
459
458
457
456
455
454
453
452
451
R.L. (m AHD)
0
10
20
30
40
50
60
CHAINAGE (m)
B6 Surveyed Terrain 13-12-05


Section B7
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466.4
466.2
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465.8
465.6
465.4
465.2
465
464.8
464.6
R.L. (m AHD)
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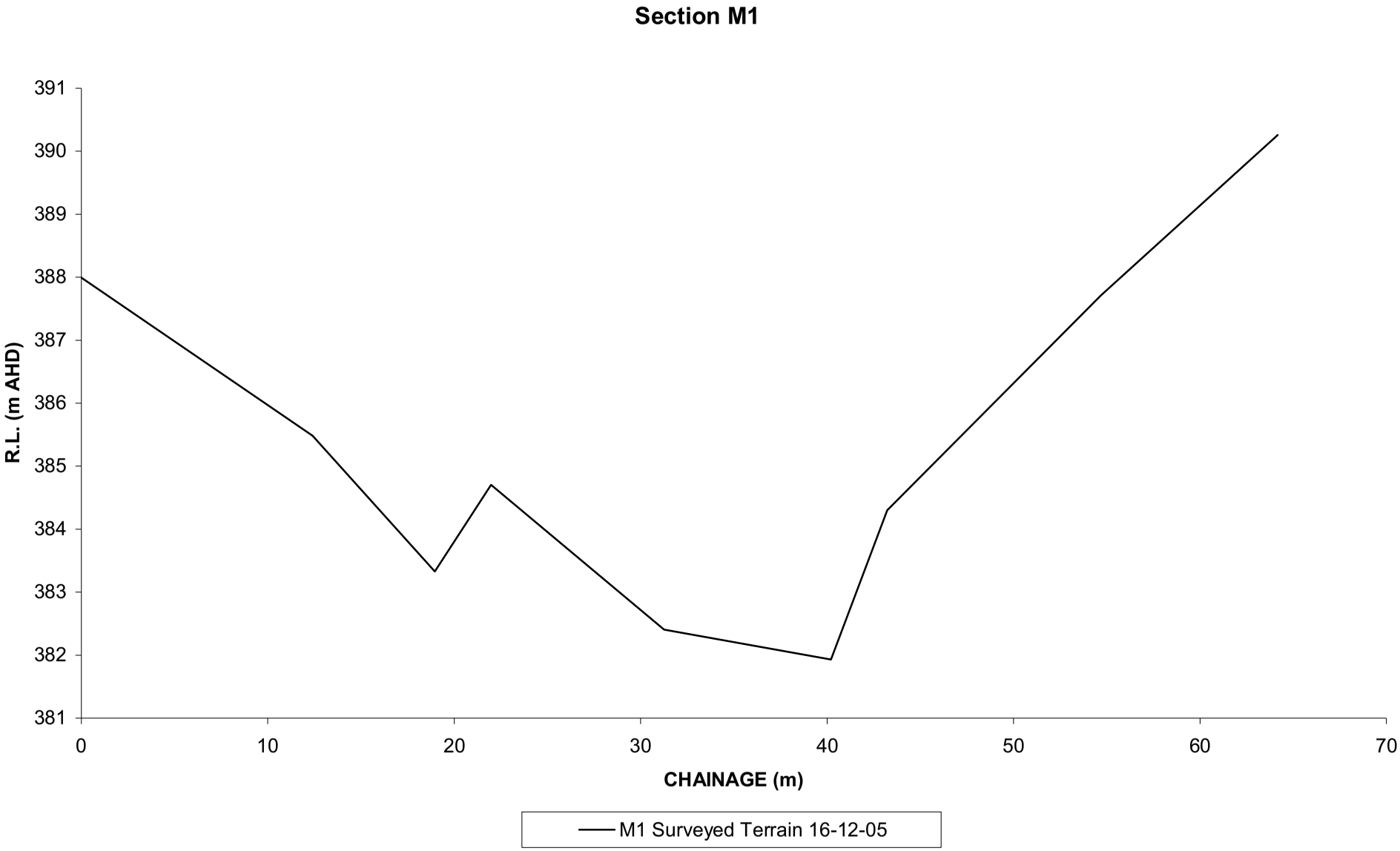
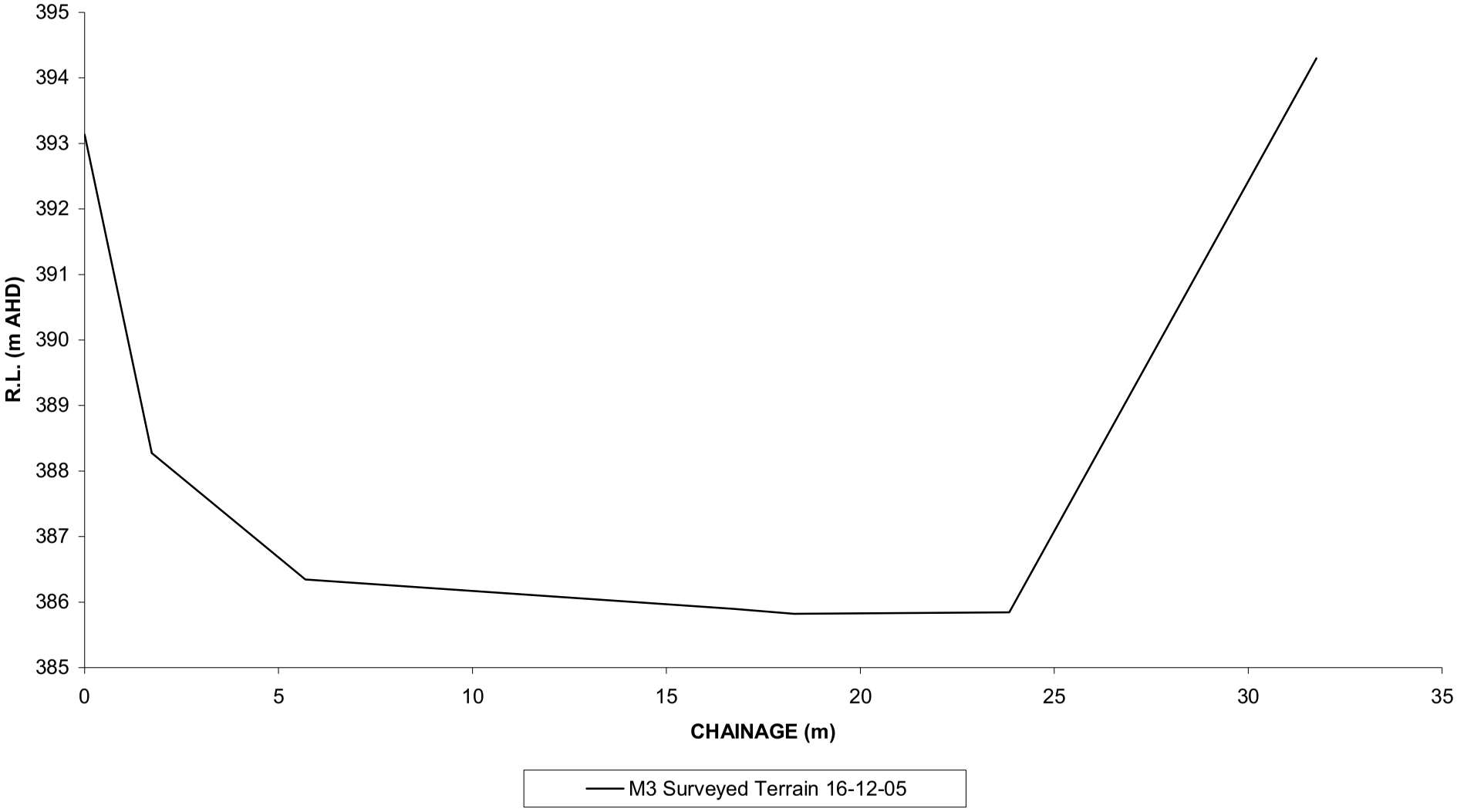
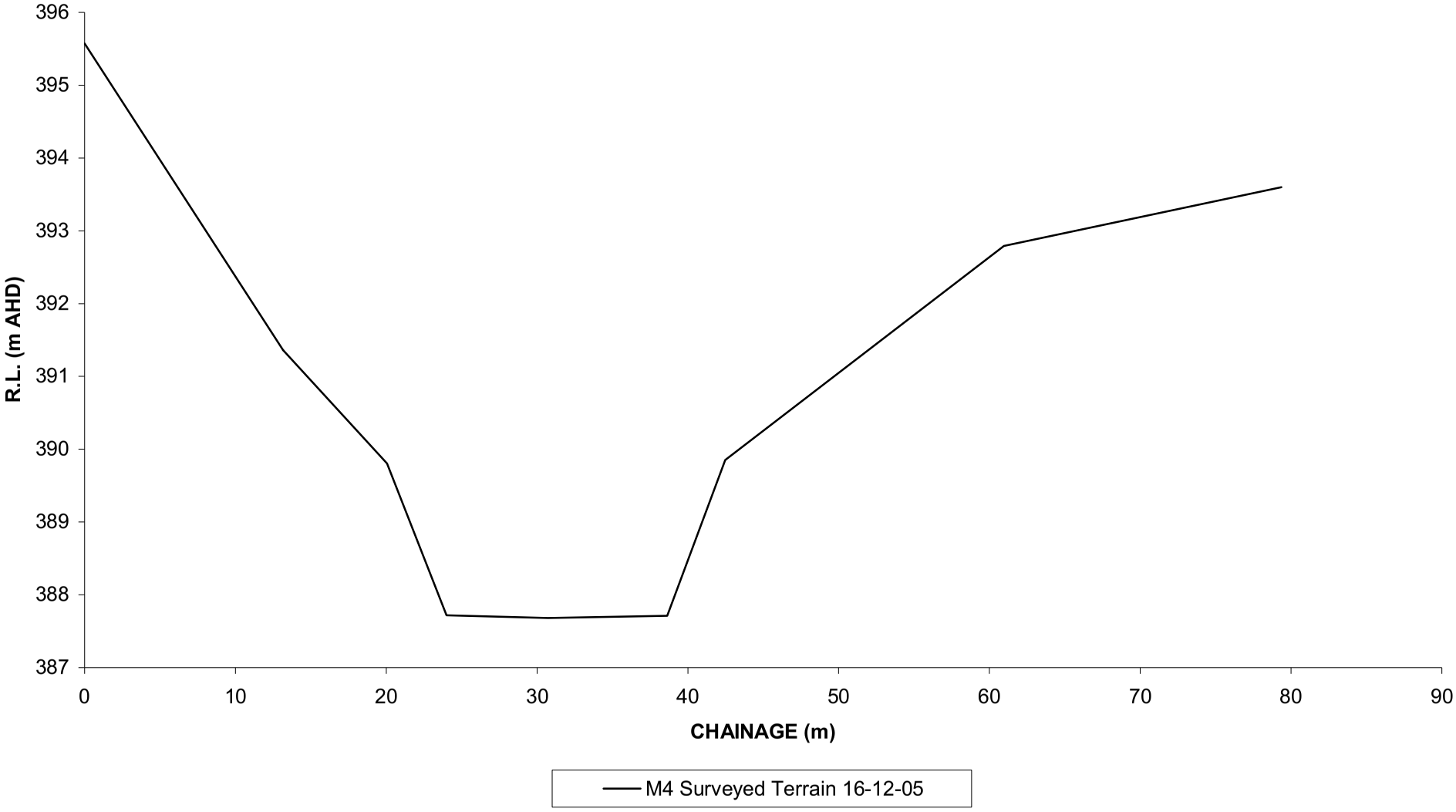
5
10
15
20
25
30
35
40
45
50
CHAINAGE (m)
B7 Surveyed Terrain 13-12-05


Section M1
391
390
389
388
387
386
385
384
383
382
381
R.L. (m AHD)
0
10
20
30
40
50
60
70
CHAINAGE (m)
M1 Surveyed Terrain 16-12-05

Section M3


395
394
393
392
391
390
389
388
387
386
385
R.L. (m AHD)
0
5
10
15
20
25
30
35
CHAINAGE (m)
M3 Surveyed Terrain 16-12-05

Section M4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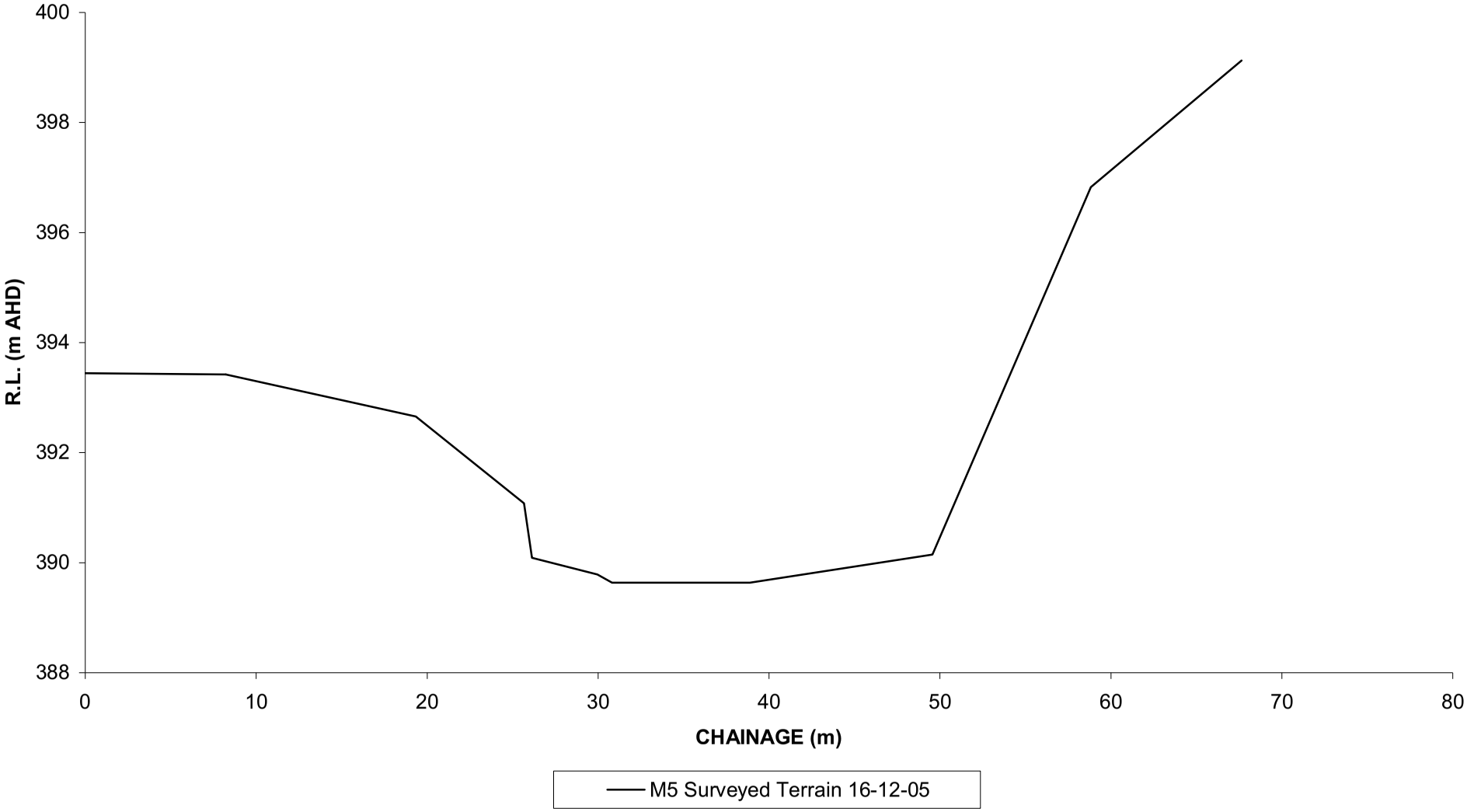
394
393
392
391
390
389
388
387
R.L. (m AHD)
0
10
20
30
40
50
60
70
80
90
CHAINAGE (m)
M4 Surveyed Terrain 16-12-05

Section M5


400
398
396
394
392
390
388
R.L. (m AHD)
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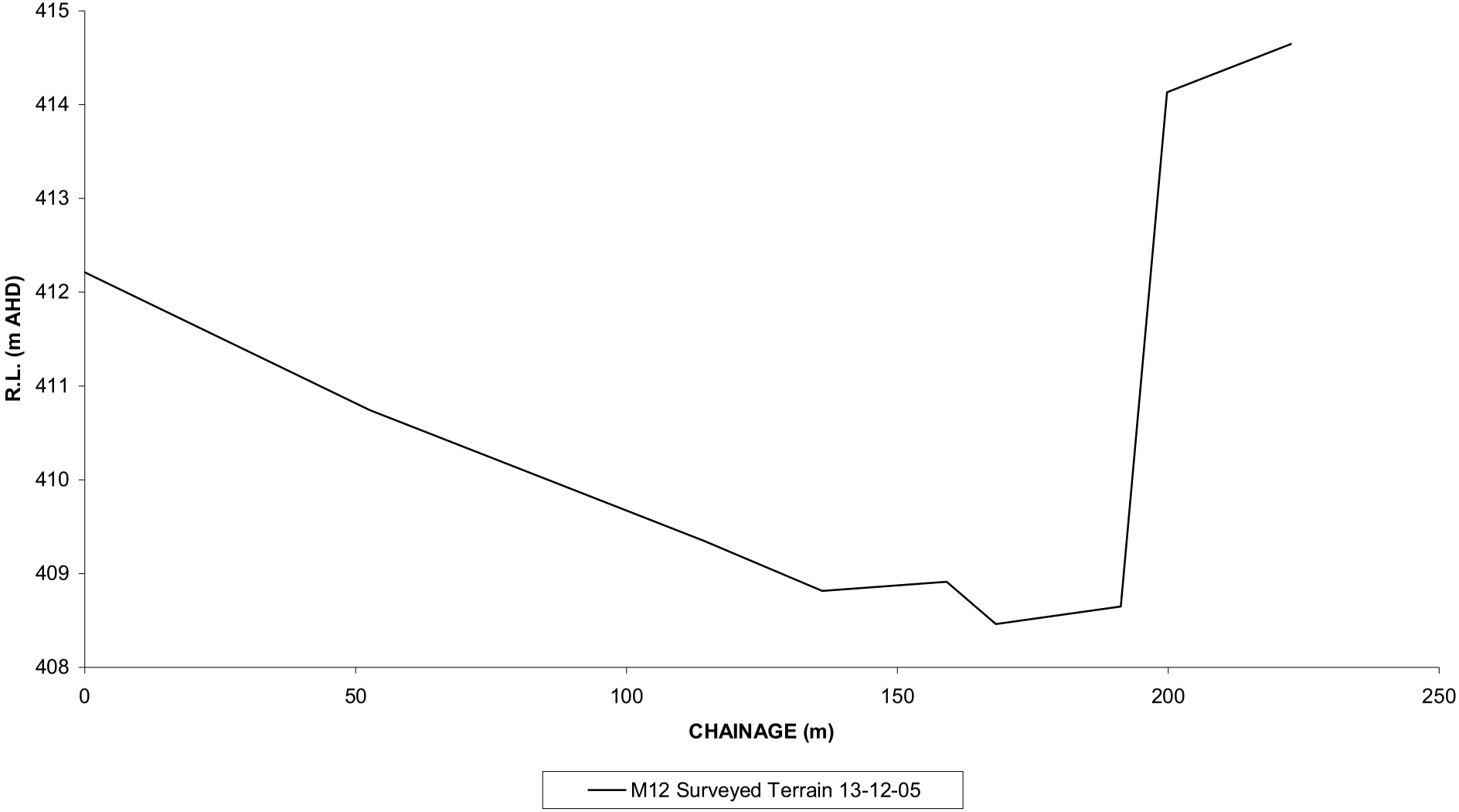
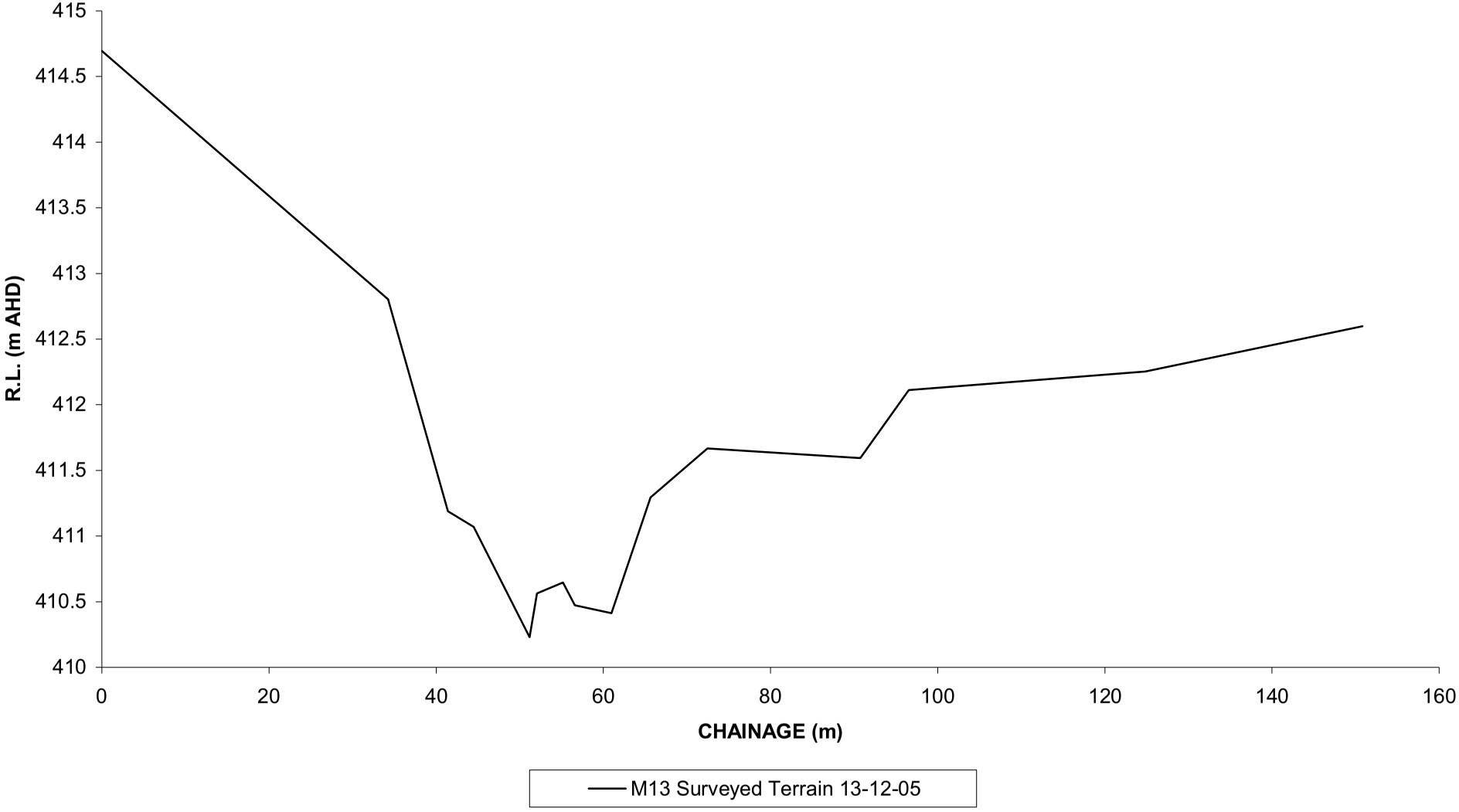
10
20
30
40
50
60
70
80
CHAINAGE (m)
M5 Surveyed Terrain 16-12-05

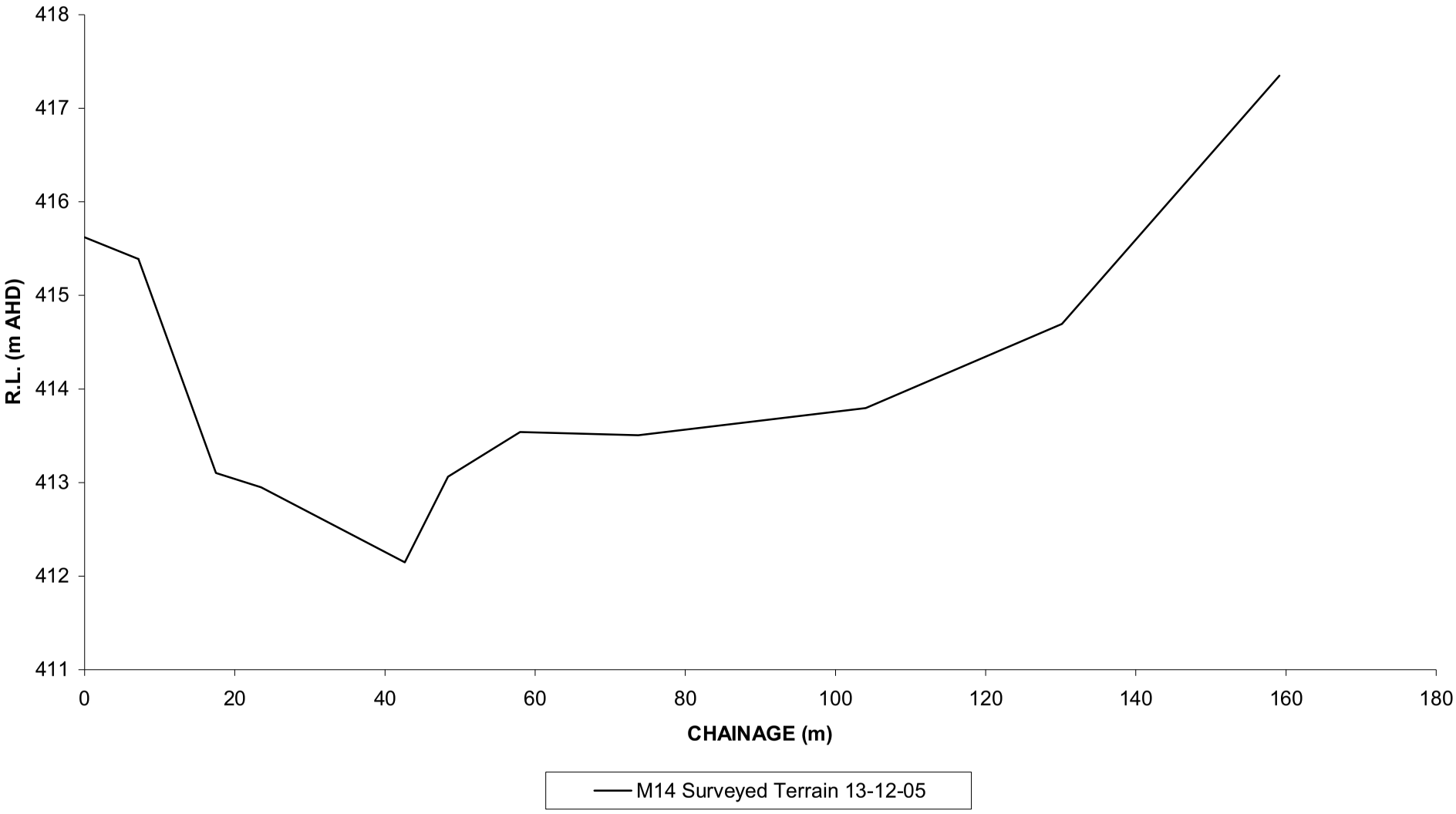
Section M12


415
414
413
412
411
410
409
408
R.L. (m AHD)
0
50
100
150
200
250
CHAINAGE (m)
M12 Surveyed Terrain 13-12-05

Section M13


415
414.5
414
413.5
413
412.5
412
411.5
411
410.5
410
R.L. (m AHD)
0
20
40
60
80
100
120
140
160
CHAINAGE (m)
M13 Surveyed Terrain 13-12-05

Section M14


418
417
416
415
414
413
412
411
R.L. (m AHD)
0
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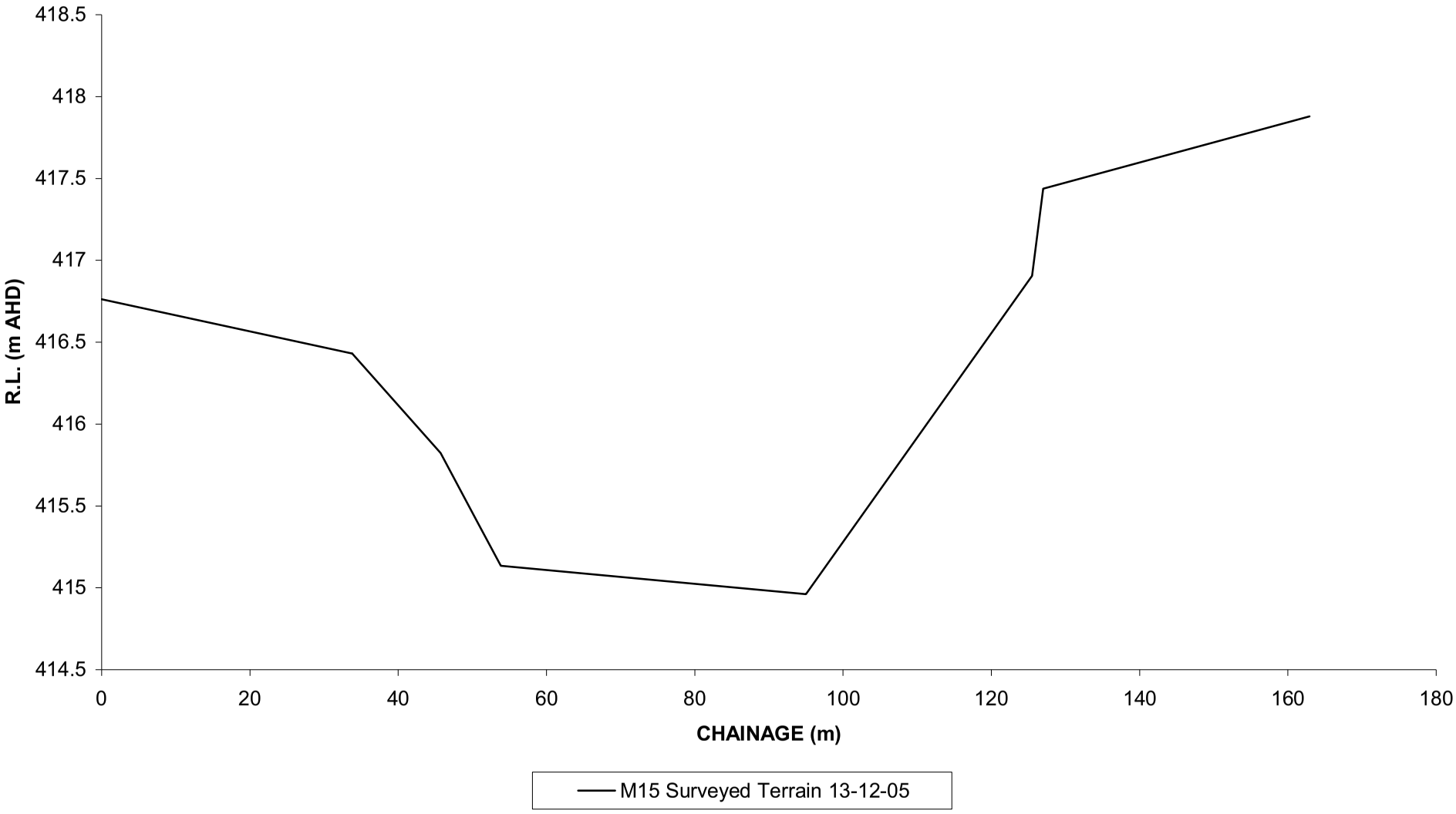
40
60
80
100
120
140
160
180
CHAINAGE (m)
M14 Surveyed Terrain 13-12-05

Section M15


418.5
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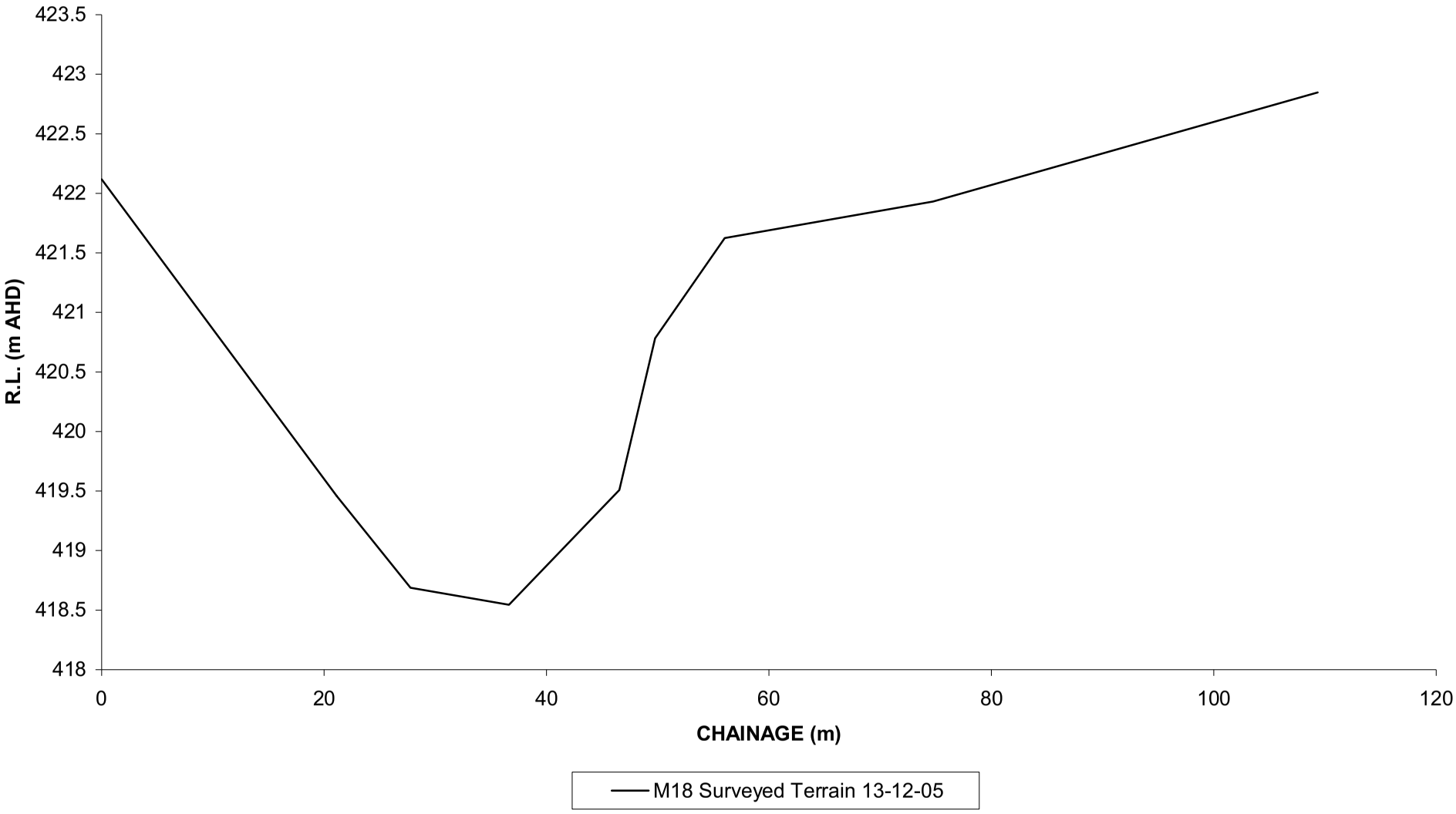
417.5
417
416.5
416
415.5
415
414.5
R.L. (m AHD)
0
20
40
60
80
100
120
140
160
180
CHAINAGE (m)
M15 Surveyed Terrain 13-12-05

Section M18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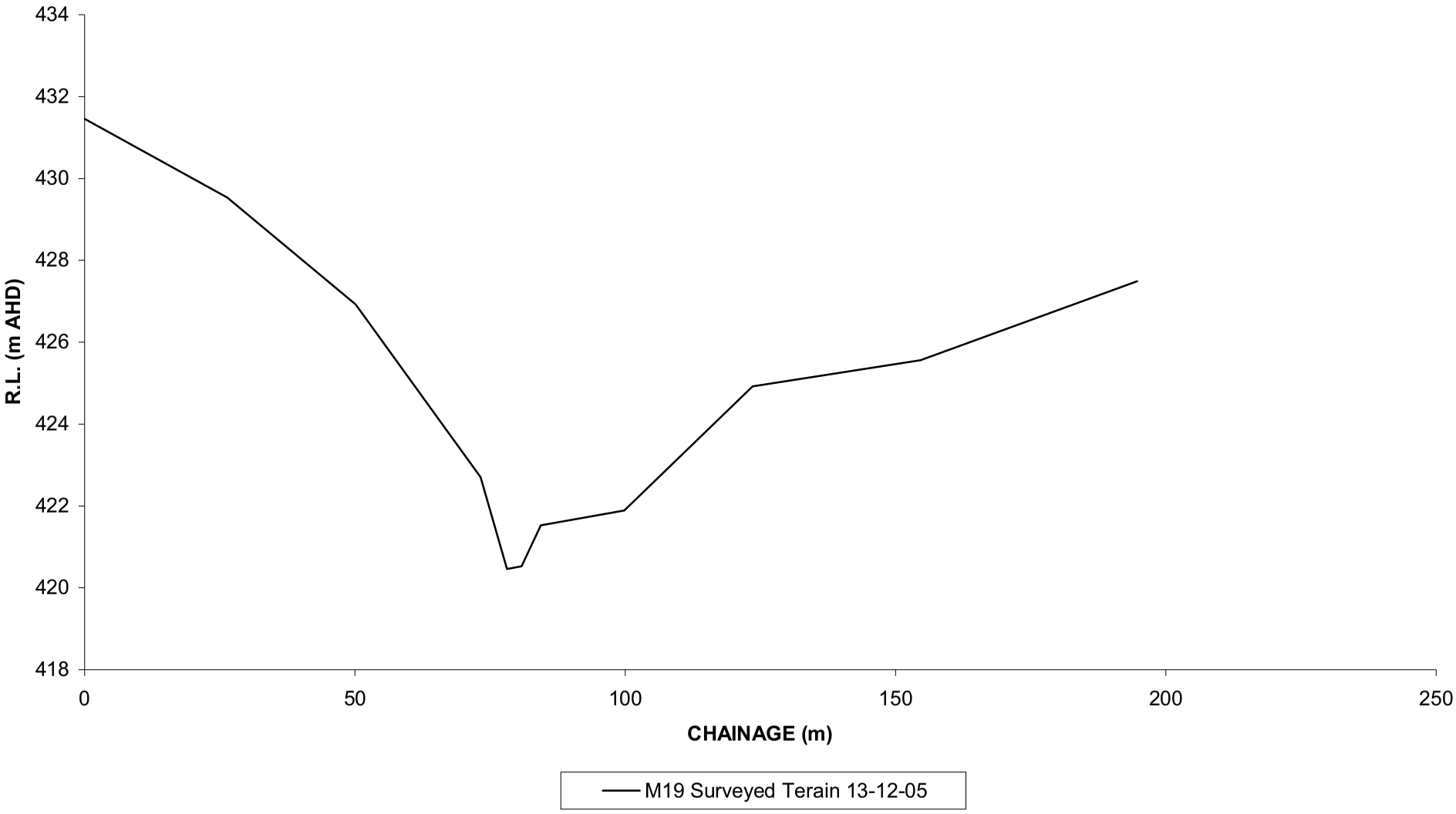
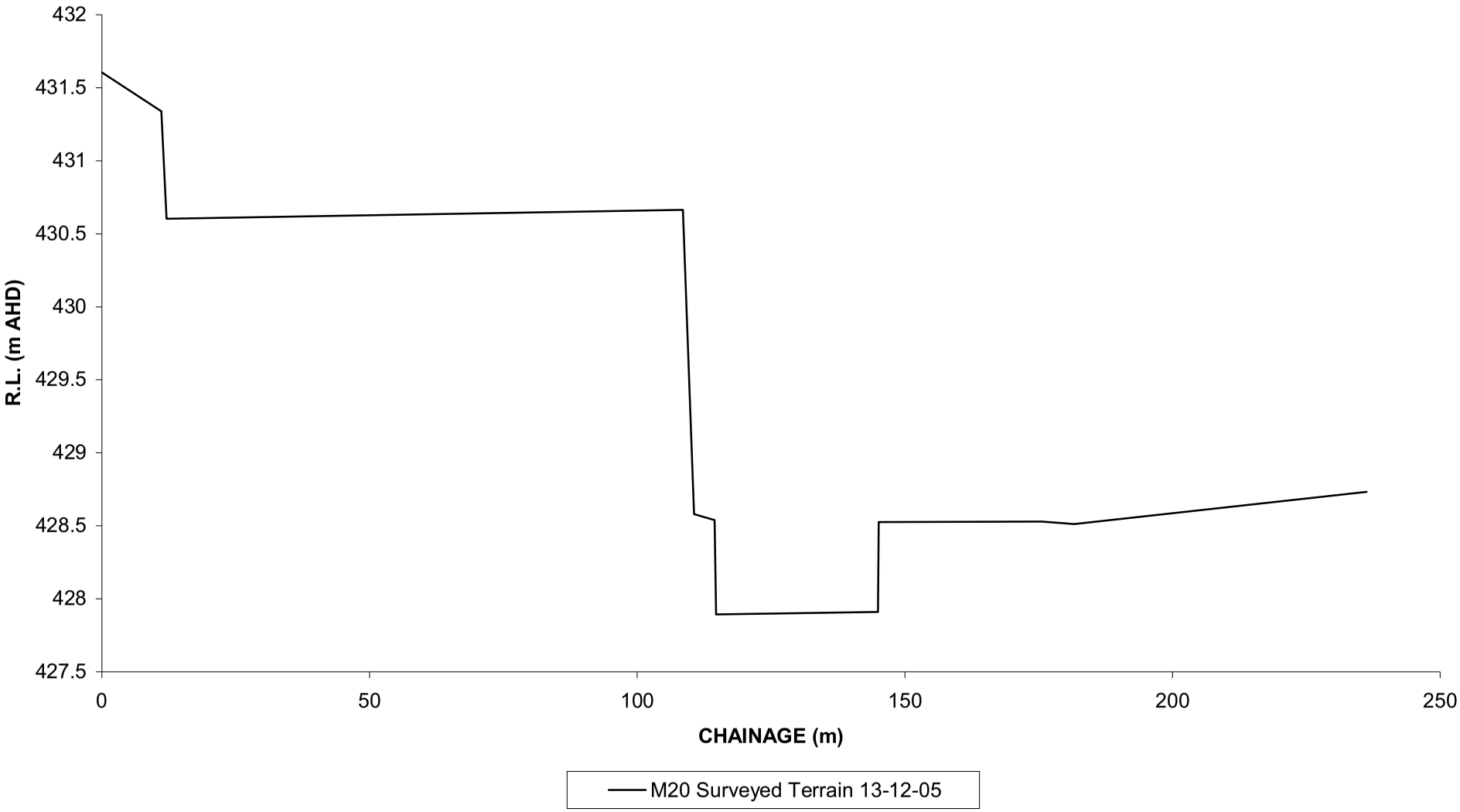
423
422.5
422
421.5
421
420.5
420
419.5
419
418.5
418
R.L. (m AHD)
0
20
40
60
80
100
120
CHAINAGE (m)
M18 Surveyed Terrain 13-12-05

Section M19


434
432
430
428
426
424
422
420
418
R.L. (m AHD)
0
50
100
150
200
250
CHAINAGE (m)
M19 Surveyed Terain 13-12-05

Section M20 (Dam Wall)



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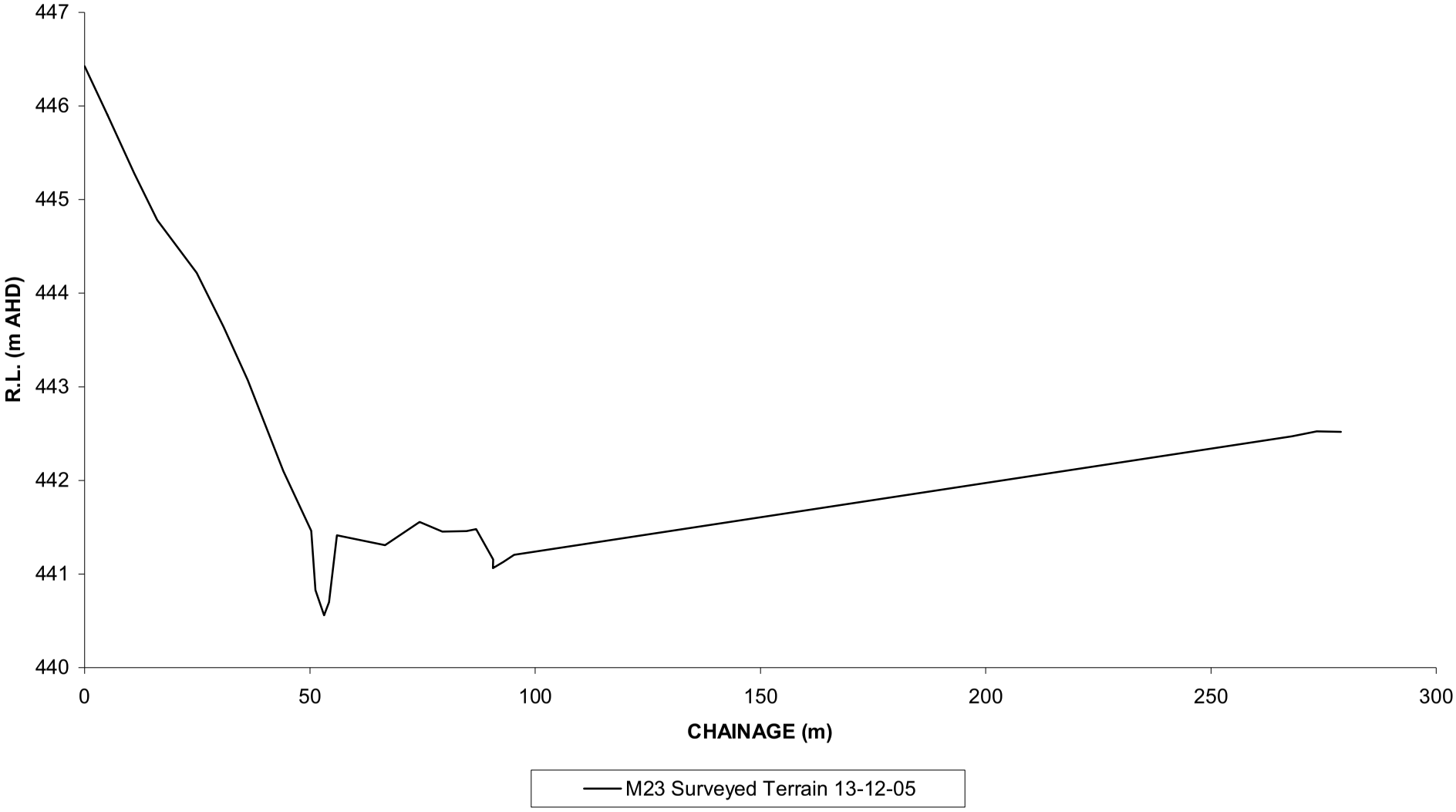
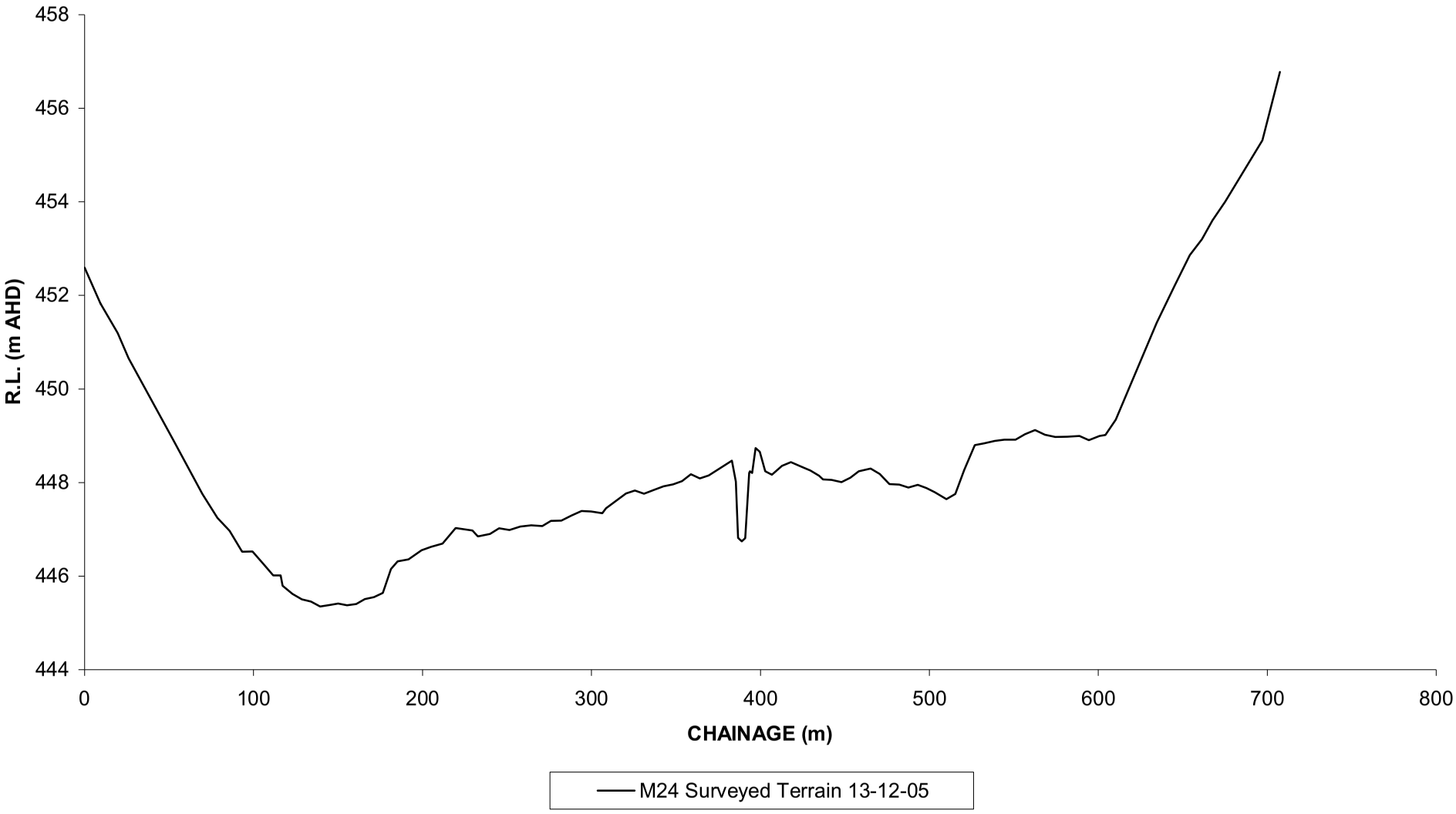
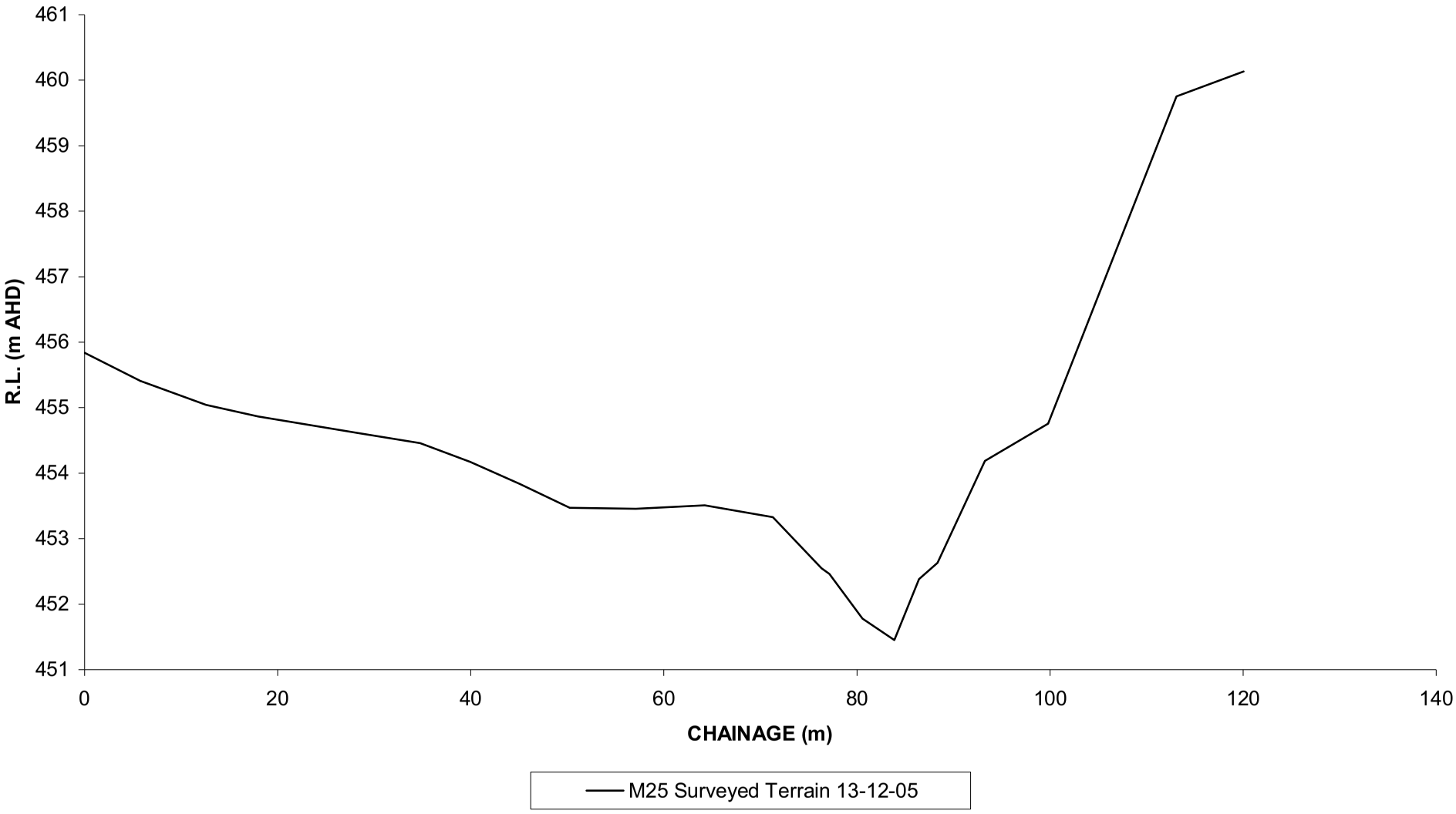

447
446
445
444
443
442
441
440
R.L. (m AHD)
0
50
100
150
200
250
300
CHAINAGE (m)
M23 Surveyed Terrain 13-12-05

Section M24


458
456
454
452
450
448
446
444
R.L. (m AHD)
0
100
200
300
400
500
600
700
800
CHAINAGE (m)
M24 Surveyed Terrain 13-12-05

Section M25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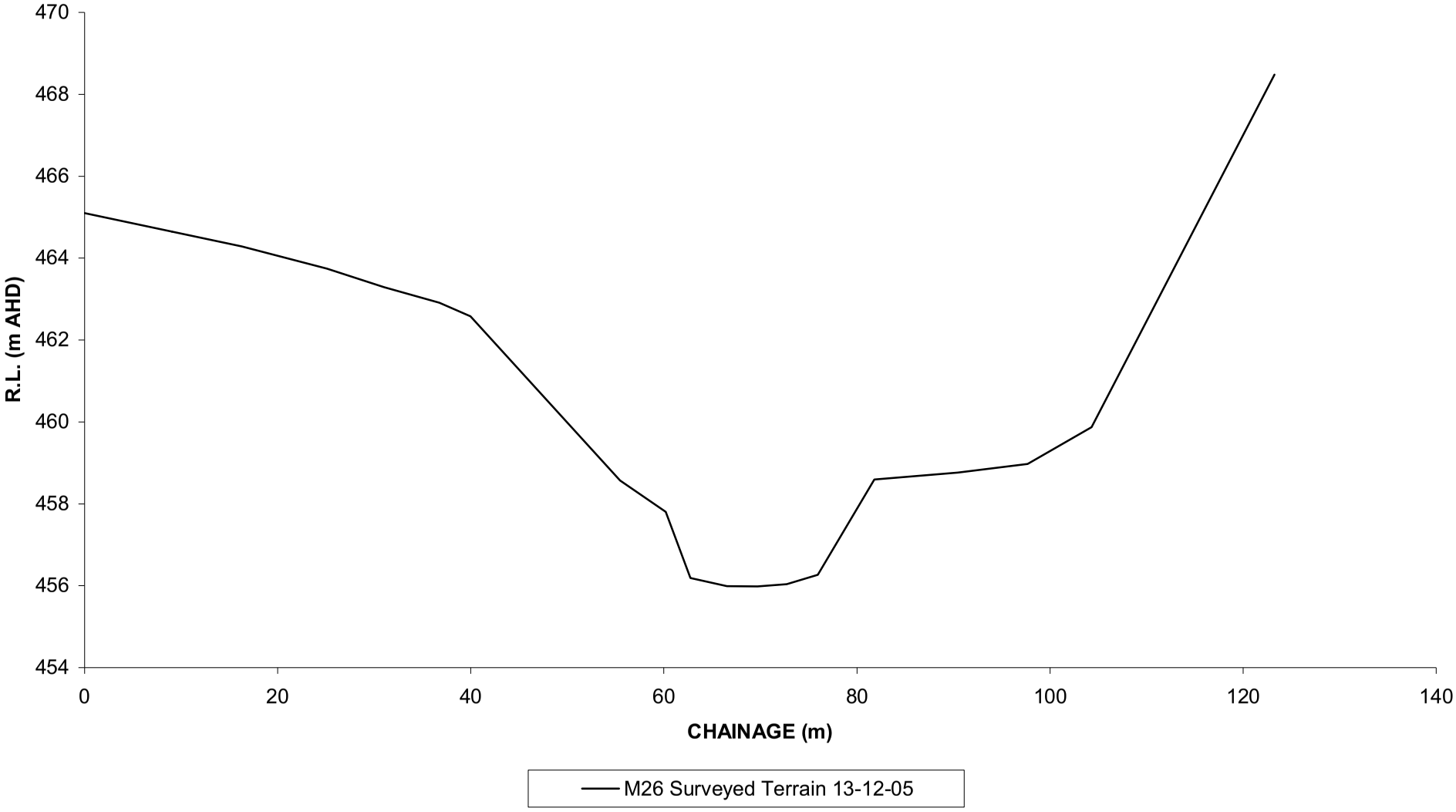
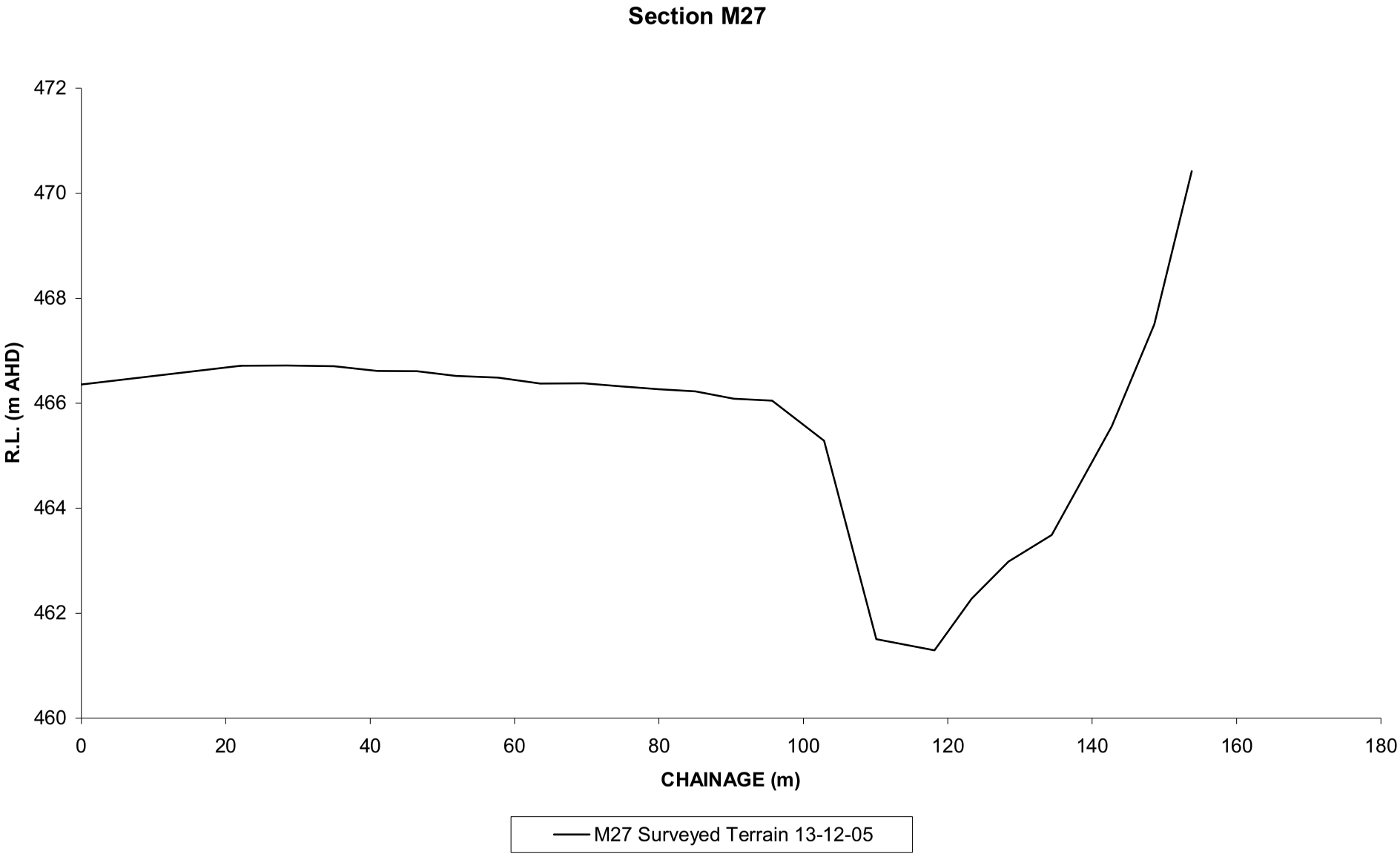
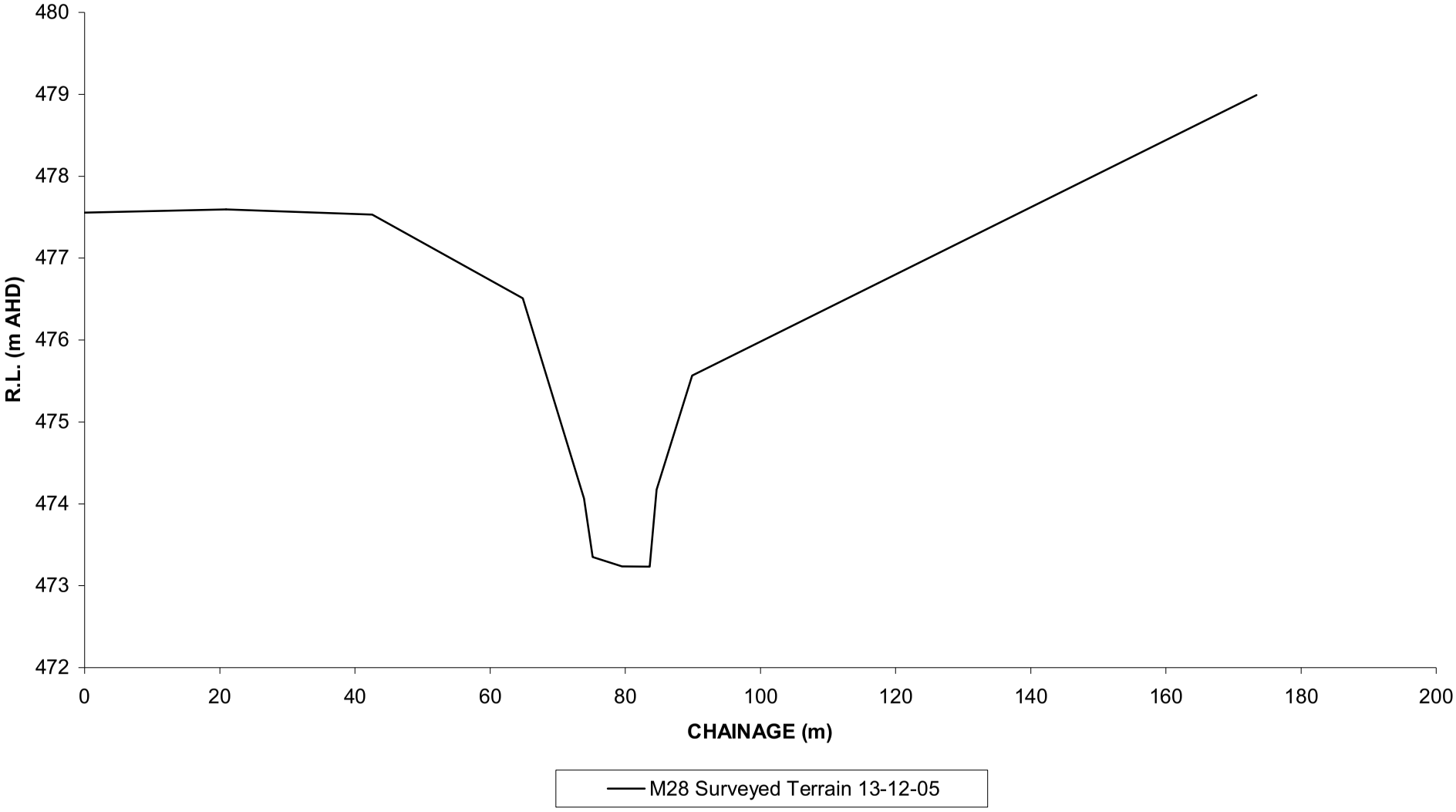
460
459
458
457
456
455
454
453
452
451
R.L. (m AHD)
0
20
40
60
80
100
120
140
CHAINAGE (m)
M25 Surveyed Terrain 13-12-05

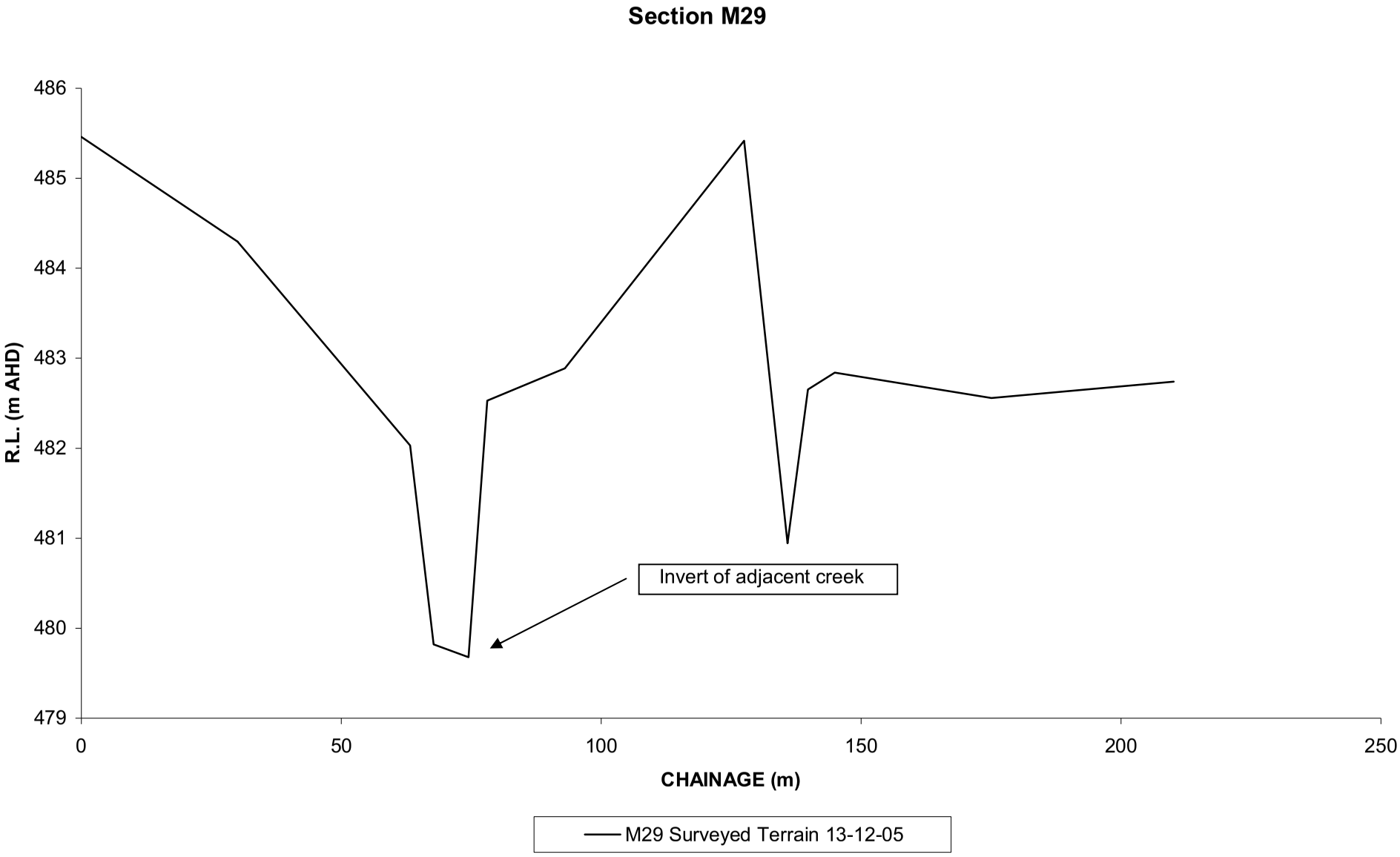
Section M26


470
468
466
464
462
460
458
456
454
R.L. (m AHD)
0
20
40
60
80
100
120
140
CHAINAGE (m)
M26 Surveyed Terrain 13-12-05

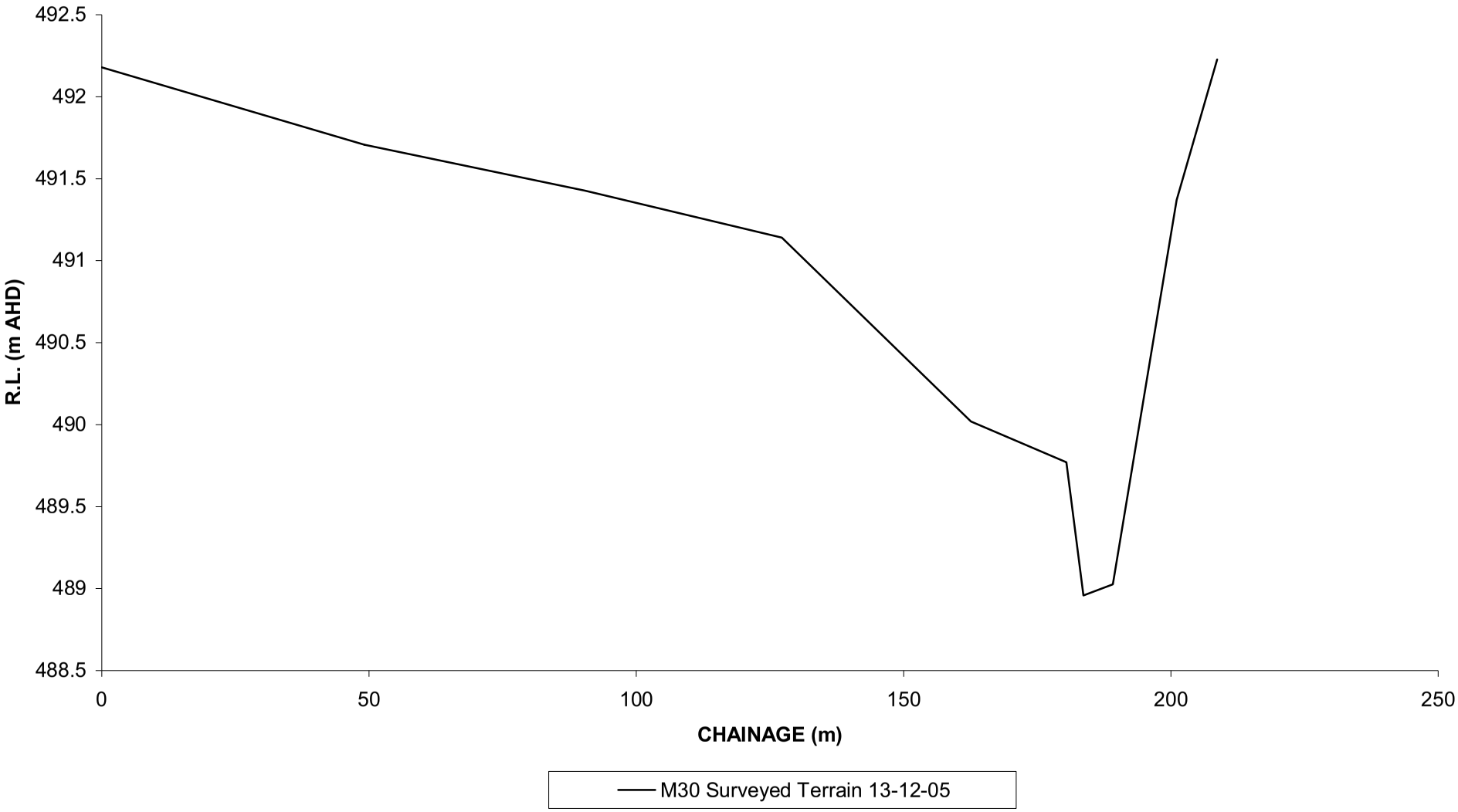

Section M27
472
470
468
466
464
462
460
R.L. (m AHD)
0
20
40
60
80
100
120
140
160
180
CHAINAGE (m)
M27 Surveyed Terrain 13-12-05

Section M28

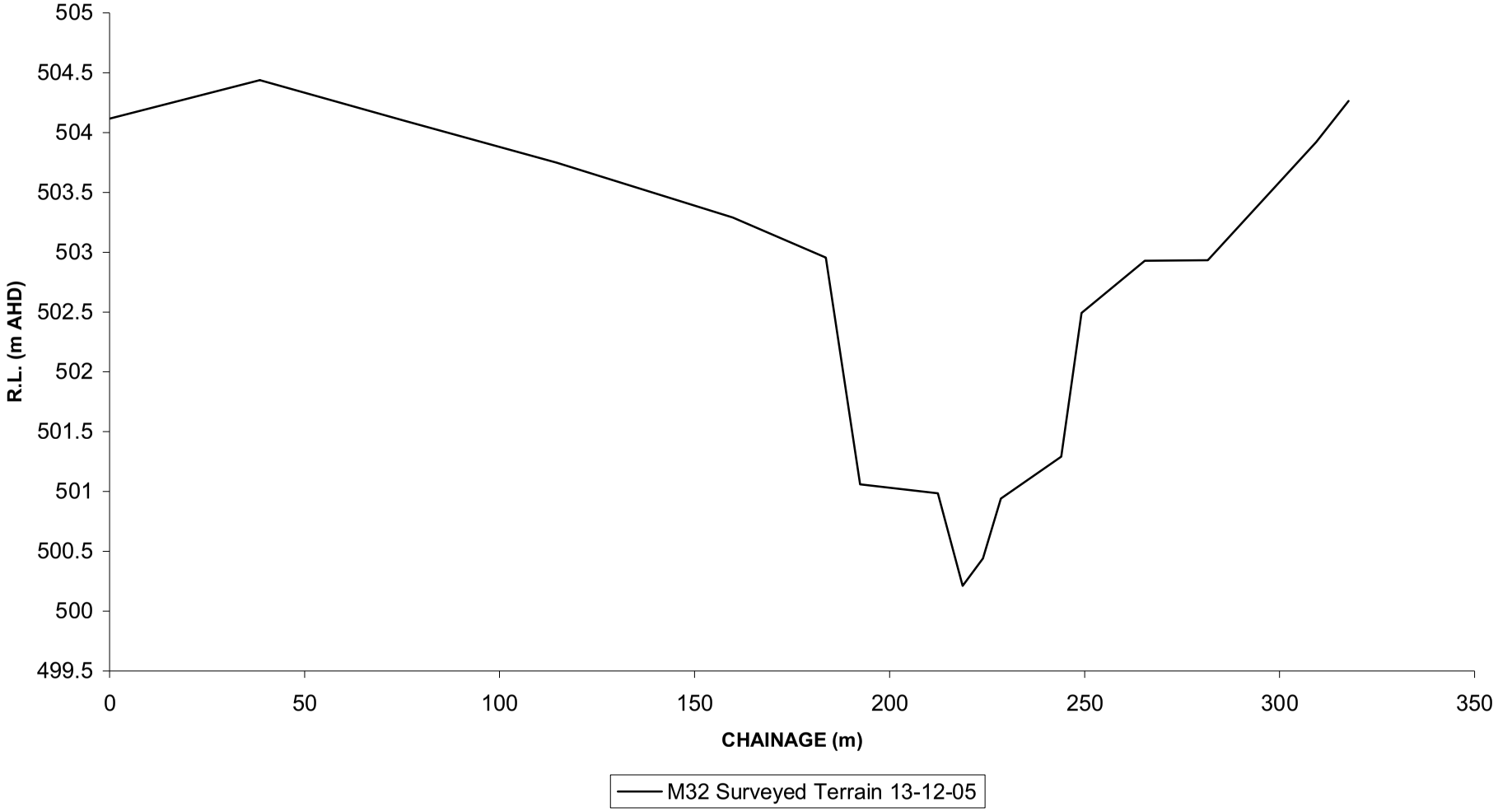

480
479
478
477
476
475
474
473
472
R.L. (m AHD)
0
20
40
60
80
100
120
140
160
180
200
CHAINAGE (m)
M28 Surveyed Terrain 13-12-05

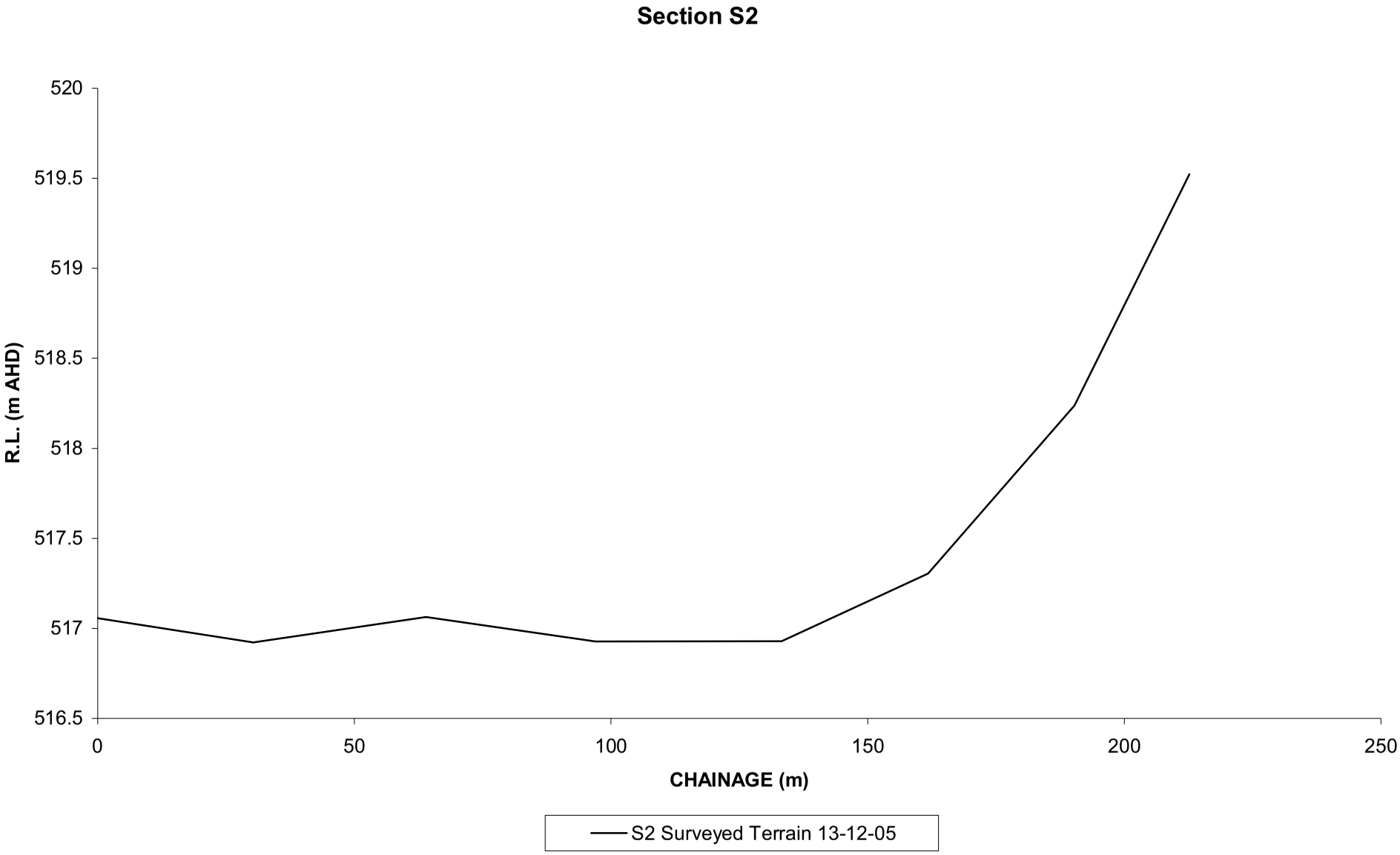

Section M29
R.L. (m AHD)
486
485
484
483
482
481
480
479
0
50
100
150
200
250
CHAINAGE (m)
Invert of adjacent creek
M29 Surveyed Terrain 13-12-05

Section M30


492.5
492
491.5
491
490.5
490
489.5
489
488.5
R.L. (m AHD)
0
50
100
150
200
250
CHAINAGE (m)
M30 Surveyed Terrain 13-12-05

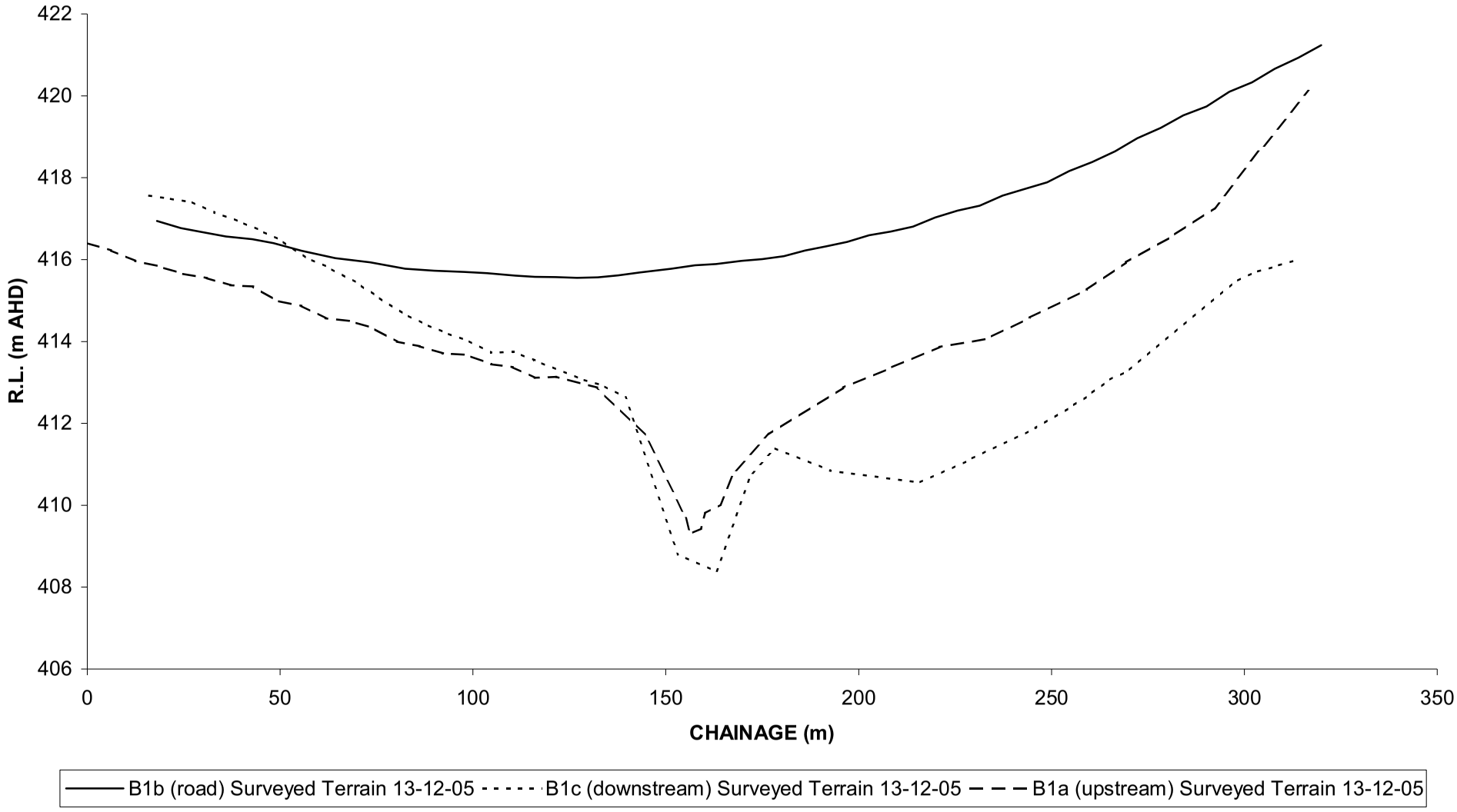
Section M32


505
504.5
504
503.5
503
502.5
502
501.5
501
500.5
500
499.5
R.L. (m AHD)
0
50
100
150
200
250
300
350
CHAINAGE (m)
M32 Surveyed Terrain 13-12-05

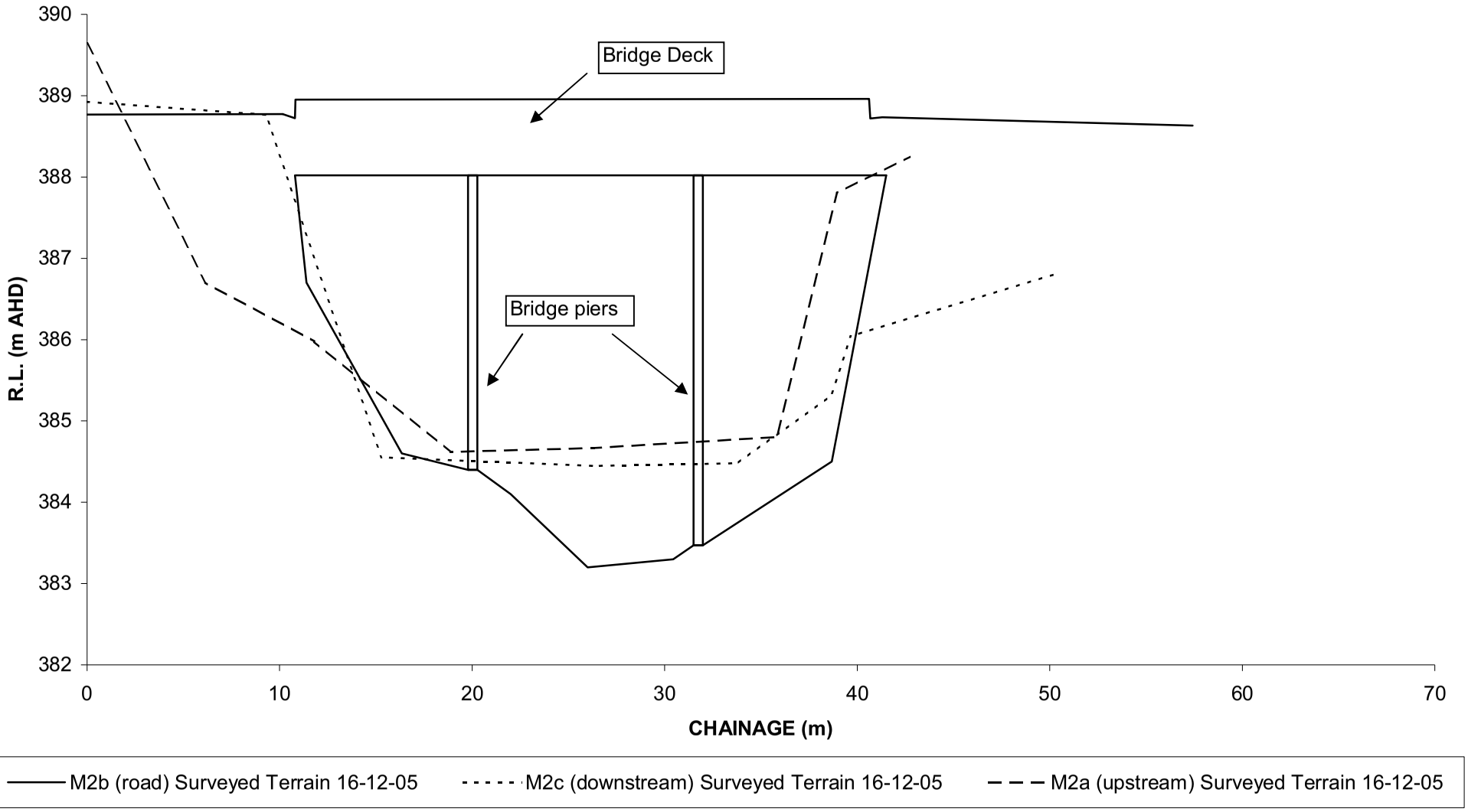

Section S2
520
519.5
519
518.5
518
517.5
517
516.5
R.L. (m AHD)
0
50
100
150
200
250
CHAINAGE (m)
S2 Surveyed Terrain 13-12-05

APPENDIX C
DETAILS OF BRIDGE CROSSINGS OF MOOLARBEN CREEK AND THE GOULBURN RIVER

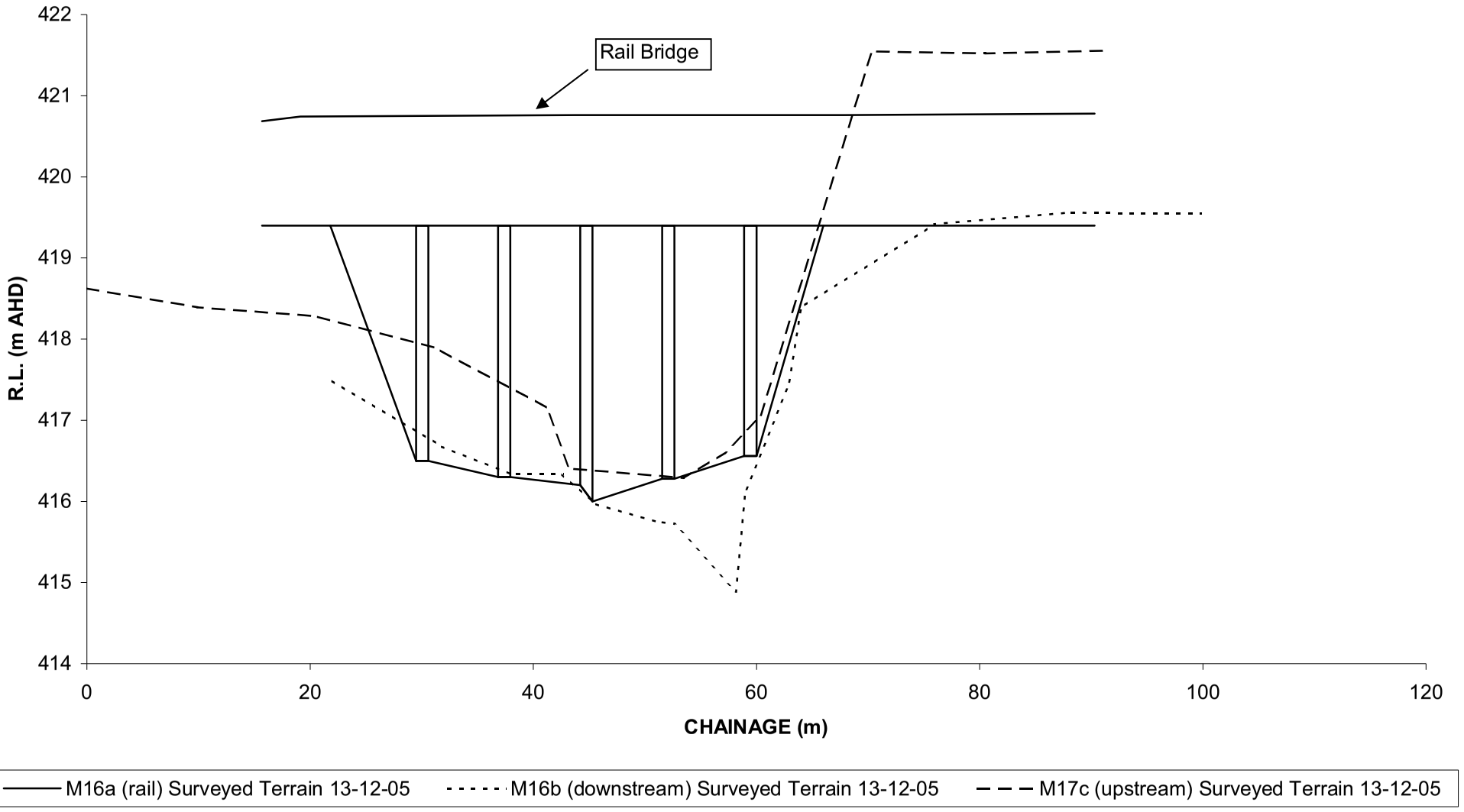
Section B1


422
420
418
416
414
412
410
408
406
R.L. (m AHD)
0
50
100
150
200
250
300
350
CHAINAGE (m)
B1b (road) Surveyed Terrain 13-12-05
B1c (downstream) Surveyed Terrain 13-12-05
B1a (upstream) Surveyed Terrain 13-12-05

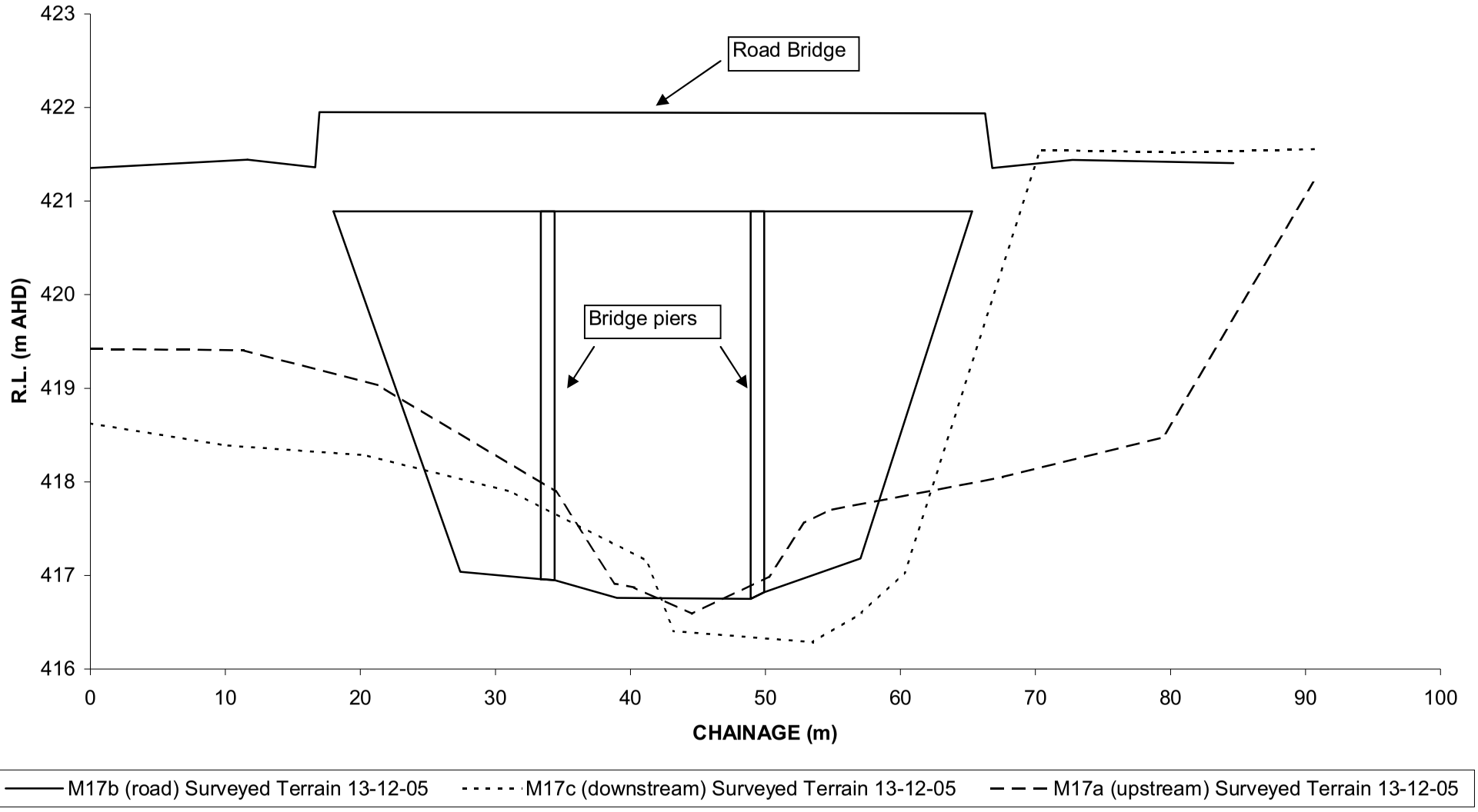
Section M2


Bridge Deck
Bridge piers
R.L. (m AHD)
390
389
388
387
386
385
384
383
382
0
10
20
30
40
50
60
70
CHAINAGE (m)
M2b (road) Surveyed Terrain 16-12-05
M2c (downstream) Surveyed Terrain 16-12-05
M2a (upstream) Surveyed Terrain 16-12-05

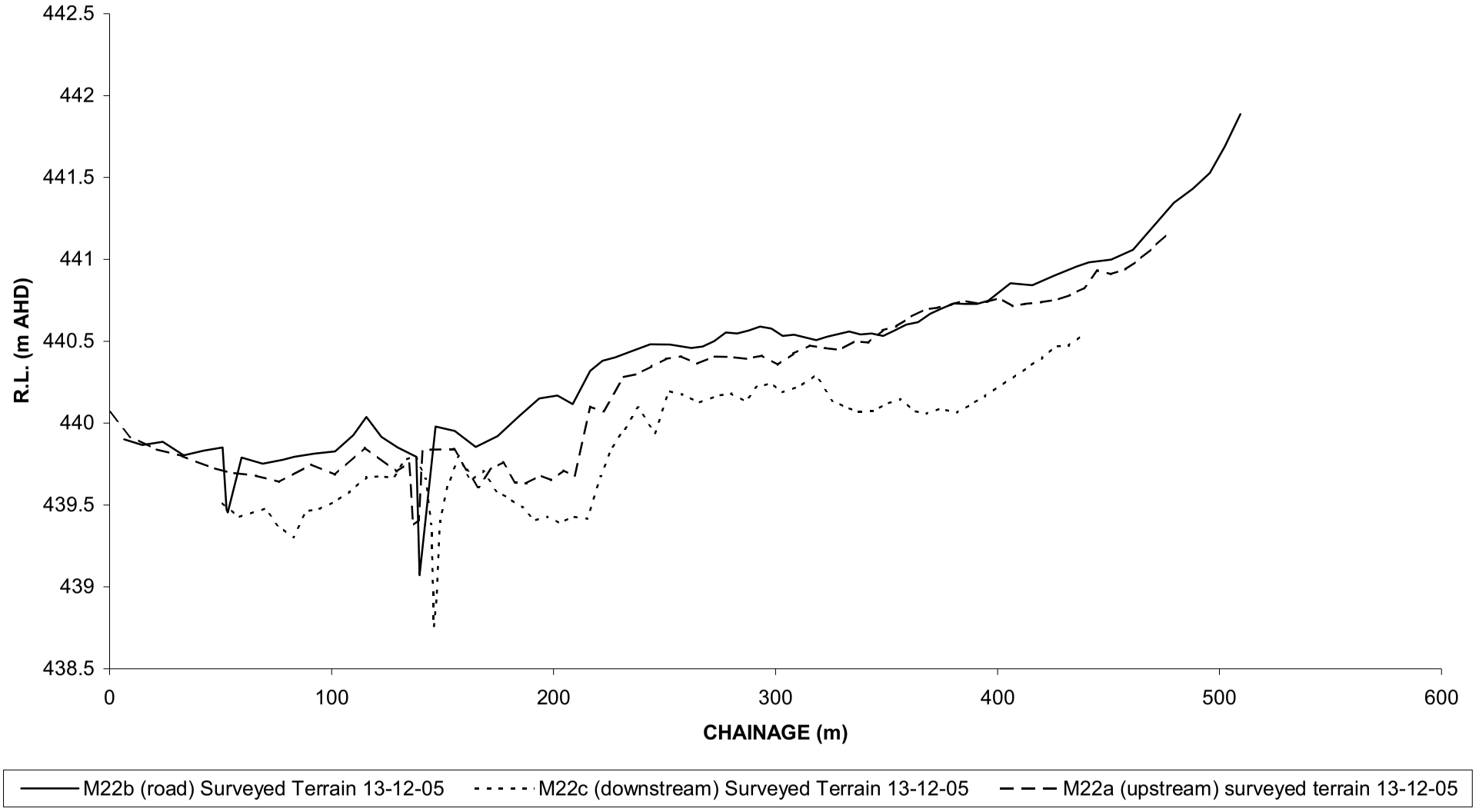
Section 16


Rail Bridge
422
421
420
419
418
417
416
415
414
R.L. (m AHD)
0
20
40
60
80
100
120
CHAINAGE (m)
M16a (rail) Surveyed Terrain 13-12-05
M16b (downstream) Surveyed Terrain 13-12-05
M17c (upstream) Surveyed Terrain 13-12-05

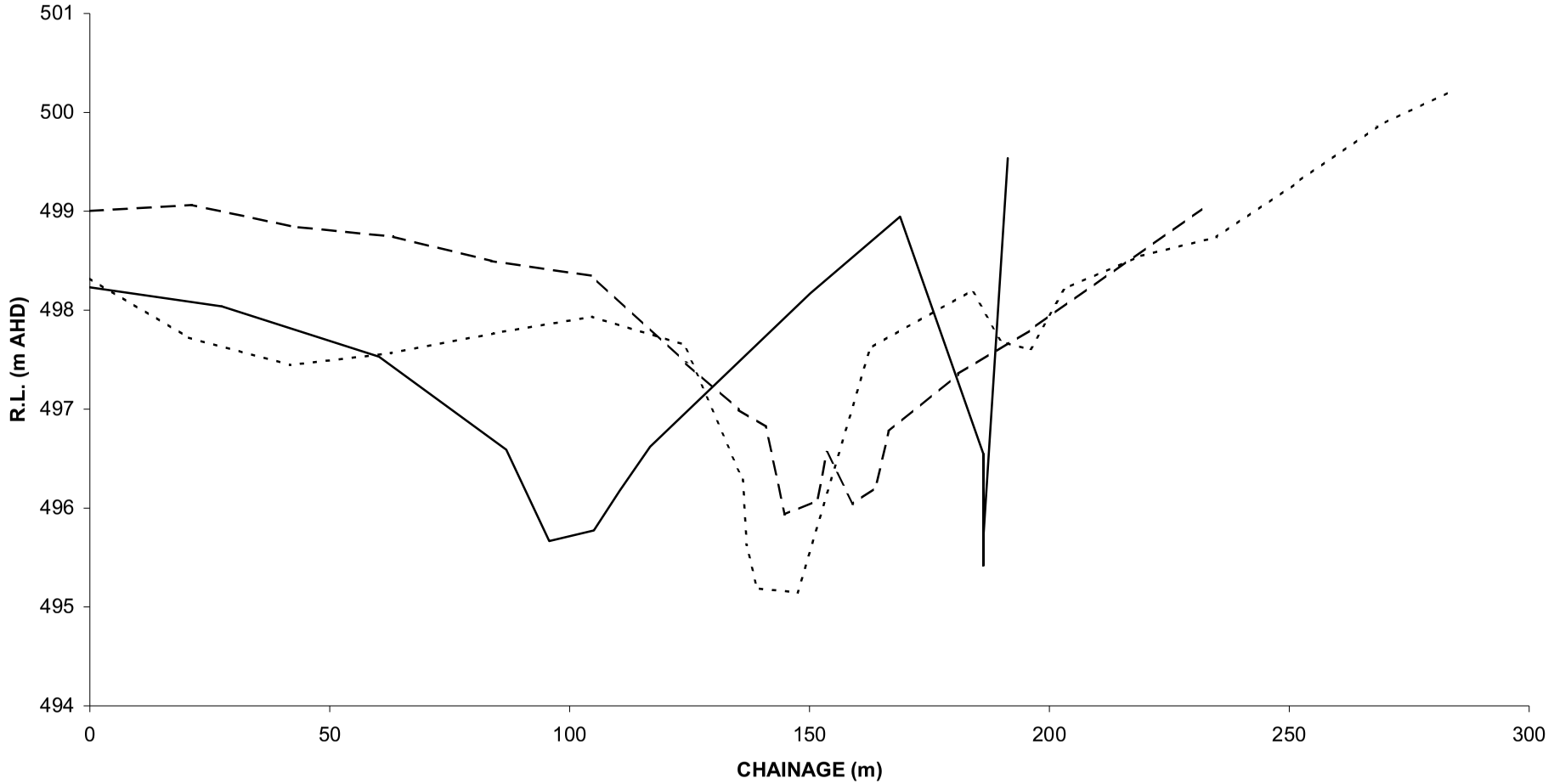
Section M17


Road Bridge
Bridge piers
R.L. (m AHD)
423
422
421
420
419
418
417
416
0
10
20
30
40
50
60
70
80
90
100
CHAINAGE (m)
M17b (road) Surveyed Terrain 13-12-05
M17c (downstream) Surveyed Terrain 13-12-05
M17a (upstream) Surveyed Terrain 13-12-05

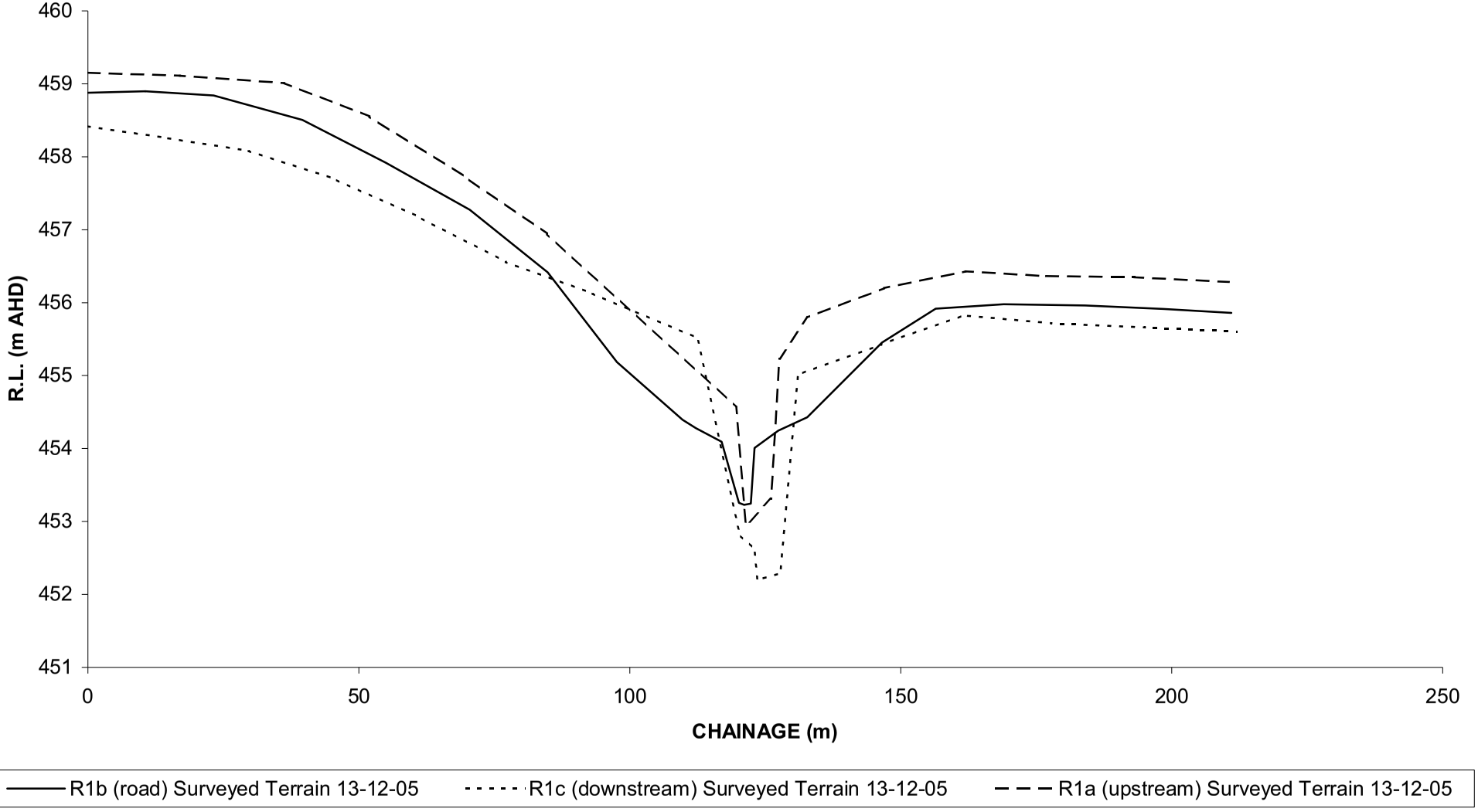
Section M22


442.5
442
441.5
441
440.5
440
439.5
439
438.5
R.L. (m AHD)
0
100
200
300
400
500
600
CHAINAGE (m)
M22b (road) Surveyed Terrain 13-12-05
M22c (downstream) Surveyed Terrain 13-12-05
M22a (upstream) surveyed terrain 13-12-05

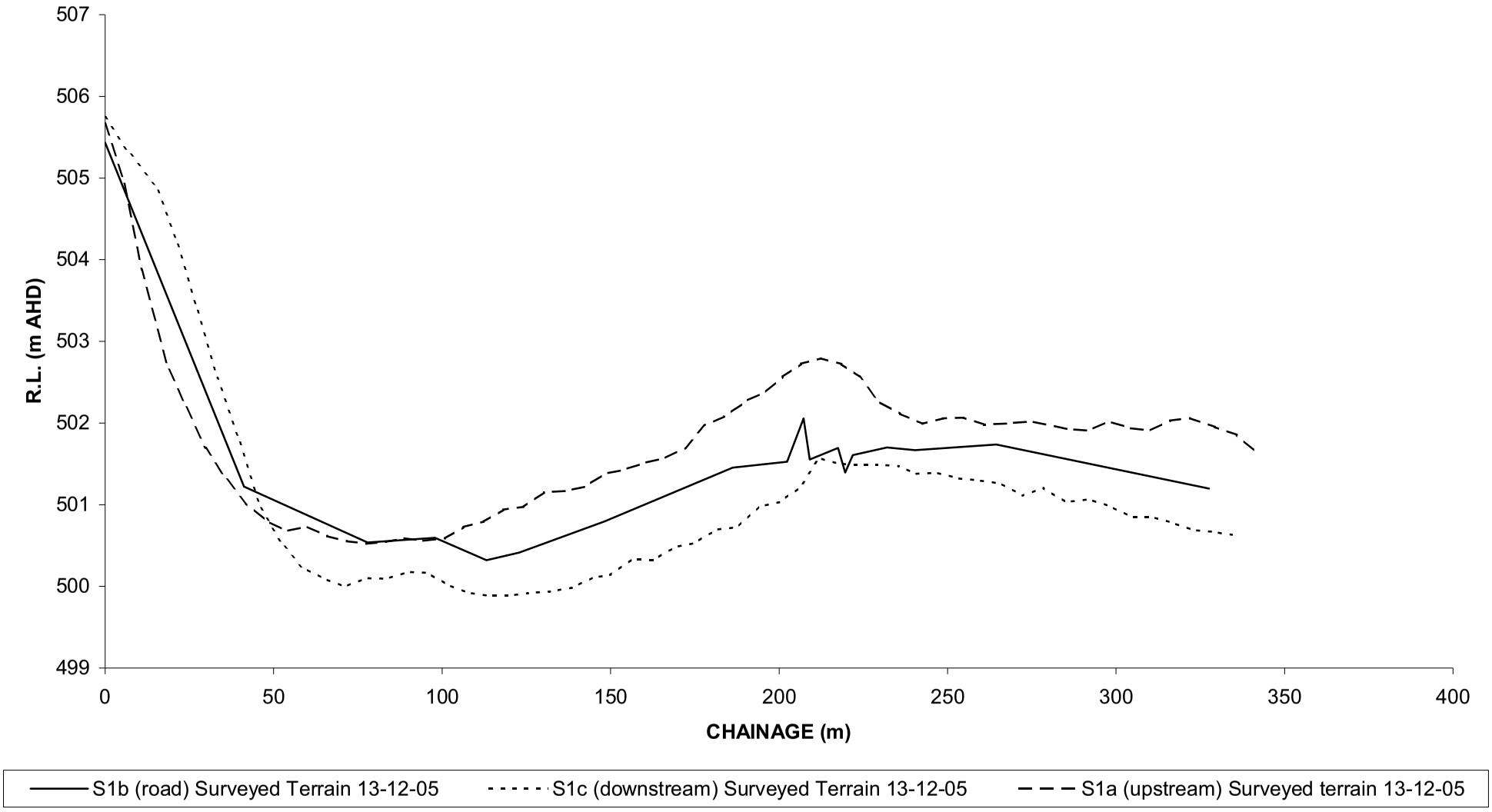
Section M31


501
500
499
498
497
496
495
494
R.L. (m AHD)
0
50
100
150
200
250
300
CHAINAGE (m)
M31b (road) Surveyed Terrain 13-12-05
M31c (downstream) Surveyed Terrain 13-12-05
M31a (upstream) Surveyed Terrain 13-12-05

Section R1


460
459
458
457
456
455
454
453
452
451
R.L. (m AHD)
0
50
100
150
200
250
CHAINAGE (m)
R1b (road) Surveyed Terrain 13-12-05
R1c (downstream) Surveyed Terrain 13-12-05
R1a (upstream) Surveyed Terrain 13-12-05

Section S1


507
506
505
504
503
502
501
500
499
R.L. (m AHD)
0
50
100
150
200
250
300
350
400
CHAINAGE (m)
S1b (road) Surveyed Terrain 13-12-05
S1c (downstream) Surveyed Terrain 13-12-05
S1a (upstream) Surveyed terrain 13-12-05

APPENDIX D
RAFTS MODEL OUTPUT FOR DESIGN FLOOD SIMULATIONS

```
 Run started at: 21st  March  2006  10:57:27


##############################################################################
##########
                          RUNTIME          RESULTS
##############################################################################
##########


Max. no. of links allowed =  2000


Max. no. of routng increments allowed = 25000


Max. no. of rating curve points = 25000


Max. no. of storm temporal points = 25000


Max. no. of channel subreaches =    25


Max link stack level =    25


Input Version number =          650


 LINK BC3               1.000

 ESTIMATED VOLUME (CU METRES*10**3) =           32.10
 ESTIMATED PEAK FLOW         (CUMECS) =      3.00
 ESTIMATED TIME TO PEAK         (MINS) =    340.00

 LINK BC1               2.000

 ESTIMATED VOLUME (CU METRES*10**3) =           42.52
 ESTIMATED PEAK FLOW         (CUMECS) =      4.43
 ESTIMATED TIME TO PEAK         (MINS) =    330.00

 LINK BC2               2.001

 ESTIMATED VOLUME (CU METRES*10**3) =           117.3
 ESTIMATED PEAK FLOW         (CUMECS) =     11.63
 ESTIMATED TIME TO PEAK         (MINS) =    330.00

 LINK BC4               1.001

 ESTIMATED VOLUME (CU METRES*10**3) =           149.4
 ESTIMATED PEAK FLOW         (CUMECS) =     14.60
 ESTIMATED TIME TO PEAK         (MINS) =    330.00

 LINK BC5               3.000

 ESTIMATED VOLUME (CU METRES*10**3) =           98.94
 ESTIMATED PEAK FLOW         (CUMECS) =     10.99
 ESTIMATED TIME TO PEAK         (MINS) =    320.00
```

```
LINK BC6              4.000

ESTIMATED VOLUME (CU METRES*10**3) =          99.64
ESTIMATED PEAK FLOW         (CUMECS) =     10.82
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK BC7              5.000

ESTIMATED VOLUME (CU METRES*10**3) =          145.7
ESTIMATED PEAK FLOW         (CUMECS) =     14.86
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK BC8              1.002

ESTIMATED VOLUME (CU METRES*10**3) =          493.7
ESTIMATED PEAK FLOW         (CUMECS) =     49.21
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK GR3              6.000

ESTIMATED VOLUME (CU METRES*10**3) =          579.2
ESTIMATED PEAK FLOW         (CUMECS) =     45.55
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK MC13             7.000

ESTIMATED VOLUME (CU METRES*10**3) =          70.36
ESTIMATED PEAK FLOW         (CUMECS) =      8.56
ESTIMATED TIME TO PEAK         (MINS) =    310.00

LINK MC14             8.000

ESTIMATED VOLUME (CU METRES*10**3) =          146.3
ESTIMATED PEAK FLOW         (CUMECS) =     13.84
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK MG1              9.000

ESTIMATED VOLUME (CU METRES*10**3) =          502.7
ESTIMATED PEAK FLOW         (CUMECS) =     39.58
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK MC1             10.000

ESTIMATED VOLUME (CU METRES*10**3) =          1034.
ESTIMATED PEAK FLOW         (CUMECS) =     68.21
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK MC2              9.001

ESTIMATED VOLUME (CU METRES*10**3) =          1537.
ESTIMATED PEAK FLOW         (CUMECS) =    107.11
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK SC1             11.000

ESTIMATED VOLUME (CU METRES*10**3) =          384.4
ESTIMATED PEAK FLOW         (CUMECS) =     35.62
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK MC3             12.000
```

```
ESTIMATED VOLUME (CU METRES*10**3) =          335.1
ESTIMATED PEAK FLOW         (CUMECS) =     35.39
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK MC4              9.002

ESTIMATED VOLUME (CU METRES*10**3) =          2255.
ESTIMATED PEAK FLOW         (CUMECS) =    159.54
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK MC5              9.003

ESTIMATED VOLUME (CU METRES*10**3) =          2951.
ESTIMATED PEAK FLOW         (CUMECS) =    184.40
ESTIMATED TIME TO PEAK         (MINS) =    420.00

LINK MC6              9.004

ESTIMATED VOLUME (CU METRES*10**3) =          2951.
ESTIMATED PEAK FLOW         (CUMECS) =    184.40
ESTIMATED TIME TO PEAK         (MINS) =    420.00

LINK MC7             13.000

ESTIMATED VOLUME (CU METRES*10**3) =          109.2
ESTIMATED PEAK FLOW         (CUMECS) =     12.54
ESTIMATED TIME TO PEAK         (MINS) =    320.00

LINK MC8             14.000

ESTIMATED VOLUME (CU METRES*10**3) =          54.95
ESTIMATED PEAK FLOW         (CUMECS) =      6.22
ESTIMATED TIME TO PEAK         (MINS) =    320.00

LINK LC2             15.000

ESTIMATED VOLUME (CU METRES*10**3) =          697.0
ESTIMATED PEAK FLOW         (CUMECS) =     55.26
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK LC1             16.000

ESTIMATED VOLUME (CU METRES*10**3) =          1306.
ESTIMATED PEAK FLOW         (CUMECS) =     90.69
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK LC3             15.001

ESTIMATED VOLUME (CU METRES*10**3) =          2003.
ESTIMATED PEAK FLOW         (CUMECS) =    145.27
ESTIMATED TIME TO PEAK         (MINS) =    350.00

LINK LC4             15.002

ESTIMATED VOLUME (CU METRES*10**3) =          2572.
ESTIMATED PEAK FLOW         (CUMECS) =    179.81
ESTIMATED TIME TO PEAK         (MINS) =    390.00

LINK MC9              9.005

ESTIMATED VOLUME (CU METRES*10**3) =          5683.
ESTIMATED PEAK FLOW         (CUMECS) =    313.51
```

```
ESTIMATED TIME TO PEAK         (MINS) =    460.00

LINK MC10            17.000

ESTIMATED VOLUME (CU METRES*10**3) =          334.2
ESTIMATED PEAK FLOW         (CUMECS) =     33.03
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK MC11            18.000

ESTIMATED VOLUME (CU METRES*10**3) =          153.8
ESTIMATED PEAK FLOW         (CUMECS) =     17.50
ESTIMATED TIME TO PEAK         (MINS) =    320.00

LINK RYC1            19.000

ESTIMATED VOLUME (CU METRES*10**3) =          327.1
ESTIMATED PEAK FLOW         (CUMECS) =     28.40
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK RYC2            19.001

ESTIMATED VOLUME (CU METRES*10**3) =          1077.
ESTIMATED PEAK FLOW         (CUMECS) =     91.18
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK RYC3            19.002

ESTIMATED VOLUME (CU METRES*10**3) =          1233.
ESTIMATED PEAK FLOW         (CUMECS) =    100.99
ESTIMATED TIME TO PEAK         (MINS) =    380.00

LINK RYC4            19.003

ESTIMATED VOLUME (CU METRES*10**3) =          1586.
ESTIMATED PEAK FLOW         (CUMECS) =    120.20
ESTIMATED TIME TO PEAK         (MINS) =    390.00

LINK MC12             9.006

ESTIMATED VOLUME (CU METRES*10**3) =          7753.
ESTIMATED PEAK FLOW         (CUMECS) =    417.53
ESTIMATED TIME TO PEAK         (MINS) =    420.00

LINK MC15             7.001

ESTIMATED VOLUME (CU METRES*10**3) =          7965.
ESTIMATED PEAK FLOW         (CUMECS) =    423.07
ESTIMATED TIME TO PEAK         (MINS) =    450.00

LINK MC16            20.000

ESTIMATED VOLUME (CU METRES*10**3) =          112.1
ESTIMATED PEAK FLOW         (CUMECS) =     12.89
ESTIMATED TIME TO PEAK         (MINS) =    310.00

LINK MC17            21.000

ESTIMATED VOLUME (CU METRES*10**3) =          76.92
ESTIMATED PEAK FLOW         (CUMECS) =      8.62
ESTIMATED TIME TO PEAK         (MINS) =    320.00
```

```
LINK ROC1             22.000

ESTIMATED VOLUME (CU METRES*10**3) =          975.2
ESTIMATED PEAK FLOW         (CUMECS) =     47.95
ESTIMATED TIME TO PEAK         (MINS) =    390.00

LINK ROC2             22.001

ESTIMATED VOLUME (CU METRES*10**3) =          1332.
ESTIMATED PEAK FLOW         (CUMECS) =     72.73
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK SHC1             23.000

ESTIMATED VOLUME (CU METRES*10**3) =          437.9
ESTIMATED PEAK FLOW         (CUMECS) =     30.46
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK SHC2             23.001

ESTIMATED VOLUME (CU METRES*10**3) =          984.6
ESTIMATED PEAK FLOW         (CUMECS) =     69.24
ESTIMATED TIME TO PEAK         (MINS) =    370.00

LINK SHC3             22.002

ESTIMATED VOLUME (CU METRES*10**3) =          2317.
ESTIMATED PEAK FLOW         (CUMECS) =    141.25
ESTIMATED TIME TO PEAK         (MINS) =    370.00

LINK SHC4             22.003

ESTIMATED VOLUME (CU METRES*10**3) =          2903.
ESTIMATED PEAK FLOW         (CUMECS) =    168.73
ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK SHC5             22.004

ESTIMATED VOLUME (CU METRES*10**3) =          3268.
ESTIMATED PEAK FLOW         (CUMECS) =    184.47
ESTIMATED TIME TO PEAK         (MINS) =    430.00

LINK MC18              7.002

ESTIMATED VOLUME (CU METRES*10**3) =         0.1141E+05
ESTIMATED PEAK FLOW         (CUMECS) =    595.45
ESTIMATED TIME TO PEAK         (MINS) =    460.00

LINK GR1              24.000

ESTIMATED VOLUME (CU METRES*10**3) =          409.2
ESTIMATED PEAK FLOW         (CUMECS) =     37.25
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK GR2               7.003

ESTIMATED VOLUME (CU METRES*10**3) =         0.1181E+05
ESTIMATED PEAK FLOW         (CUMECS) =    602.93
ESTIMATED TIME TO PEAK         (MINS) =    500.00

LINK GR4               1.003
```

```
ESTIMATED VOLUME (CU METRES*10**3) =          0.1286E+05
ESTIMATED PEAK FLOW         (CUMECS) =    617.55
ESTIMATED TIME TO PEAK         (MINS) =    530.00

LINK GR5              25.000

ESTIMATED VOLUME (CU METRES*10**3) =           428.1
ESTIMATED PEAK FLOW         (CUMECS) =     39.43
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK GR6              26.000

ESTIMATED VOLUME (CU METRES*10**3) =           375.1
ESTIMATED PEAK FLOW         (CUMECS) =     29.17
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK UC1              27.000

ESTIMATED VOLUME (CU METRES*10**3) =           899.0
ESTIMATED PEAK FLOW         (CUMECS) =     51.16
ESTIMATED TIME TO PEAK         (MINS) =    390.00

LINK UC2              27.001

ESTIMATED VOLUME (CU METRES*10**3) =           2173.
ESTIMATED PEAK FLOW         (CUMECS) =    117.75
ESTIMATED TIME TO PEAK         (MINS) =    410.00

LINK UC3              27.002

ESTIMATED VOLUME (CU METRES*10**3) =           3103.
ESTIMATED PEAK FLOW         (CUMECS) =    159.52
ESTIMATED TIME TO PEAK         (MINS) =    440.00

LINK UC4              27.003

ESTIMATED VOLUME (CU METRES*10**3) =           3262.
ESTIMATED PEAK FLOW         (CUMECS) =    162.44
ESTIMATED TIME TO PEAK         (MINS) =    490.00

LINK GR7               1.004

ESTIMATED VOLUME (CU METRES*10**3) =          0.1690E+05
ESTIMATED PEAK FLOW         (CUMECS) =    753.60
ESTIMATED TIME TO PEAK         (MINS) =    570.00

LINK GR9              28.000

ESTIMATED VOLUME (CU METRES*10**3) =           337.3
ESTIMATED PEAK FLOW         (CUMECS) =     22.91
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK GR8              29.000

ESTIMATED VOLUME (CU METRES*10**3) =           245.8
ESTIMATED PEAK FLOW         (CUMECS) =     22.95
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK GR10              1.005

ESTIMATED VOLUME (CU METRES*10**3) =          0.1742E+05
ESTIMATED PEAK FLOW         (CUMECS) =    757.66
```

ESTIMATED TIME TO PEAK (MINS) = 630.00

##########
Critical Duration

Results for period from 0: 0.0 1/ 1/1990
to 20: 0.0 1/ 1/1990
##########

ROUTING INCREMENT (MINS) = 10.00
STORM DURATION (MINS) = 540.
RETURN PERIOD (YRS) = 100.
BX = 1.0000
TOTAL OF FIRST SUB-AREAS (ha) = 13734.00
TOTAL OF SECOND SUB-AREAS (ha) = 10479.00
TOTAL OF ALL SUB-AREAS (ha) = 24213.00

SUMMARY OF CATCHMENT AND RAINFALL DATA

Link Label	Catch. Area #1 (ha)	Catch. Area #2 (ha)	Slope #1 (%)	Slope #2 (%)	% Impervious #1 (%)	% Impervious #2 (%)	Perm #1	Perm #2	B #1	B #2	Link No.
BC3	44.000	0.000	1.000	0.000	5.000	0.000	.040	0.00	.2094	0.000	1.000
BC1	58.000	0.000	4.000	0.000	10.00	0.000	.080	0.00	.1753	0.000	2.000
BC2	70.000	32.000	4.000	4.000	5.000	10.00	.040	.080	.1335	.1287	2.001
BC4	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	1.001
BC5	77.000	58.000	5.000	5.000	5.000	10.00	.040	.080	.1255	.1569	3.000
BC6	80.000	56.000	4.000	4.000	5.000	10.00	.040	.080	.1431	.1722	4.000
BC7	120.00	79.000	3.000	3.000	5.000	10.00	.040	.080	.2040	.2377	5.000
BC8	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	1.002
GR3	435.00	360.00	2.000	2.000	5.000	10.00	.040	.080	.4878	.6403	6.000
MC13	54.000	42.000	8.000	8.000	5.000	10.00	.040	.080	.0825	.1049	7.000
MC14	150.00	50.000	2.000	2.000	5.000	10.00	.040	.080	.2804	.2294	8.000
MG1	113.00	577.00	3.000	3.000	5.000	10.00	.040	.080	.1977	.6685	9.000
MC1	451.00	976.00	2.000	2.000	5.000	10.00	.040	.080	.4971	1.075	10.00
MC2	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	9.001
SC1	306.00	220.00	3.000	3.000	5.000	10.00	.040	.080	.3319	.4049	11.00
MC3	177.00	281.00	7.000	7.000	5.000	10.00	.040	.080	.1636	.3013	12.00

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MC4       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
9.002
MC5       557.00 400.00  4.000 4.000  5.000 10.00  .040 .080  .3925 .4786
9.003
MC6       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
9.004
MC7       103.00 46.000  6.000 6.000  5.000 10.00  .040 .080  .1333 .1270
13.00
MC8       34.000 41.000  5.000 5.000  5.000 10.00  .040 .080  .0820 .1310
14.00
LC2       794.00 161.00  2.000 2.000  5.000 10.00  .040 .080  .6671 .4214
15.00
LC1       1044.0 753.00  2.000 2.000  5.000 10.00  .040 .080  .7691 .9399
16.00
LC3       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
15.00
LC4       597.00 184.00  4.000 4.000  5.000 10.00  .040 .080  .4070 .3196
15.00
MC9       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
9.005
MC10      306.00 151.00  3.000 5.000  5.000 10.00  .040 .080  .3319 .2580
17.00
MC11      128.00 82.000  7.000 7.000  5.000 10.00  .040 .080  .1382 .1588
18.00
RYC1      423.00 25.000  2.000 2.000  5.000 10.00  .040 .080  .4808 .1600
19.00
RYC2      916.00 110.00  4.000 4.000  10.00 10.00  .040 .080  .4179 .2446
19.00
RYC3      121.00 92.000  3.000 3.000  5.000 10.00  .040 .080  .2048 .2573
19.00
RYC4      199.00 284.00  5.000 5.000  5.000 10.00  .040 .080  .2056 .3583
19.00
MC12      .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
9.006
MC15      .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
7.001
MC16      64.000 89.000  8.000 8.000  5.000 10.00  .040 .080  .0902 .1550
20.00
MC17      98.000  7.000  4.000 4.000  5.000 10.00  .040 .080  .1590 .0584
21.00
ROC1      359.00 1011.0  1.000 1.000  5.000 10.00  .040 .080  .6239 1.548
22.00
ROC2      300.00 191.00  2.000 2.000  10.00 10.00  .040 .080  .3306 .4605
22.00
SHC1      86.000 516.00  2.000 2.000  5.000 10.00  .040 .080  .2100 .7722
23.00
SHC2      356.00 395.00  2.000 2.000  5.000 10.00  .040 .080  .4395 .6720
23.00
SHC3      .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
22.00
SHC4      540.00 269.00  5.000 5.000  5.000 10.00  .040 .080  .3456 .3484
22.00
SHC5      198.00 309.00  2.000 2.000  5.000 10.00  .040 .080  .3240 .5914
22.00
MC18      .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
7.002
GR1       292.00 268.00  3.000 3.000  5.000 10.00  .040 .080  .3239 .4486
24.00
GR2       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
7.003
GR4       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
1.003
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GR5	363.00	223.00	3.000	3.000	5.000	10.00	.040	.080	.3627	.4077
25.00										
GR6	157.00	358.00	2.000	2.000	5.000	10.00	.040	.080	.2872	.6385
26.00										
UC1	642.00	608.00	1.000	1.000	5.000	10.00	.040	.080	.8441	1.188
27.00										
UC2	1776.0	0.000	2.000	0.000	10.00	0.000	.080	0.00	1.468	0.000
27.00										
UC3	384.00	908.00	2.000	2.000	5.000	10.00	.040	.080	.4572	1.035
27.00										
UC4	229.00	.00134	3.000	3.000	5.000	10.00	.040	.080	.2854	.0008
27.00										
GR7	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000
1.004										
GR9	464.00	0.000	2.000	0.000	10.00	0.000	.080	0.00	.7307	0.000
28.00										
GR8	69.000	267.00	4.000	4.000	5.000	10.00	.040	.080	.1325	.3879
29.00										
GR10	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000
1.005										

Link Label	Average Intensity	Init. Loss #1	Init. Loss #2	Cont. Loss #1	Cont. Loss #2	Excess Rain #1	Excess Rain #2	Peak Inflow	Time to Peak	Link Lag
	(mm/h)	(mm)		(mm/h)		(mm)		(m^3/s)		mins
BC3	12.312	20.00	0.000	2.500	0.000	73.308	0.000	3.004	340.0	0.000
BC1	12.312	20.00	0.000	2.500	0.000	73.308	0.000	4.429	330.0	27.00
BC2	12.312	20.00	20.00	2.500	2.500	73.308	73.308	11.631	330.0	0.000
BC4	12.312	20.00	0.000	2.500	0.000	73.308	0.000	14.600	330.0	22.00
BC5	12.312	20.00	20.00	2.500	2.500	73.308	73.308	10.993	320.0	0.000
BC6	12.312	20.00	20.00	2.500	2.500	73.308	73.308	10.822	330.0	0.000
BC7	12.312	20.00	20.00	2.500	2.500	73.308	73.308	14.860	330.0	0.000
BC8	12.312	20.00	0.000	2.500	0.000	73.308	0.000	49.209	330.0	0.000
GR3	12.312	20.00	20.00	2.500	2.500	73.308	73.308	45.549	340.0	0.000
MC13	12.312	20.00	20.00	2.500	2.500	73.308	73.308	8.558	310.0	0.000
MC14	12.312	20.00	20.00	2.500	2.500	73.308	73.308	13.842	340.0	0.000
MG1	12.312	20.00	20.00	2.500	2.500	73.308	73.308	39.583	340.0	0.000
MC1	12.312	20.00	20.00	2.500	2.500	73.308	73.308	68.214	360.0	0.000
MC2	12.312	20.00	0.000	2.500	0.000	73.308	0.000	107.11	340.0	34.00
SC1	12.312	20.00	20.00	2.500	2.500	73.308	73.308	35.619	340.0	0.000
MC3	12.312	20.00	20.00	2.500	2.500	73.308	73.308	35.388	330.0	0.000
MC4	12.312	20.00	0.000	2.500	0.000	73.308	0.000	159.54	360.0	78.00

MC5	12.312	20.00	20.00	2.500	2.500	73.308	73.308	184.40	420.0
0.000									
MC6	12.312	20.00	0.000	2.500	0.000	73.308	0.000	184.40	420.0
50.00									
MC7	12.312	20.00	20.00	2.500	2.500	73.308	73.308	12.543	320.0
0.000									
MC8	12.312	20.00	20.00	2.500	2.500	73.308	73.308	6.218	320.0
0.000									
LC2	12.312	20.00	20.00	2.500	2.500	73.308	73.308	55.259	340.0
0.000									
LC1	12.312	20.00	20.00	2.500	2.500	73.308	73.308	90.687	360.0
0.000									
LC3	12.312	20.00	0.000	2.500	0.000	73.308	0.000	145.27	350.0
50.00									
LC4	12.312	20.00	20.00	2.500	2.500	73.308	73.308	179.81	390.0
0.000									
MC9	12.312	20.00	0.000	2.500	0.000	73.308	0.000	313.51	460.0
39.00									
MC10	12.312	20.00	20.00	2.500	2.500	73.308	73.308	33.031	330.0
0.000									
MC11	12.312	20.00	20.00	2.500	2.500	73.308	73.308	17.502	320.0
0.000									
RYC1	12.312	20.00	20.00	2.500	2.500	73.308	73.308	28.398	340.0
51.00									
RYC2	12.312	20.00	20.00	2.500	2.500	73.308	73.308	91.179	340.0
39.00									
RYC3	12.312	20.00	20.00	2.500	2.500	73.308	73.308	100.99	380.0
22.00									
RYC4	12.312	20.00	20.00	2.500	2.500	73.308	73.308	120.20	390.0
0.000									
MC12	12.312	20.00	0.000	2.500	0.000	73.308	0.000	417.53	420.0
27.00									
MC15	12.312	20.00	0.000	2.500	0.000	73.308	0.000	423.07	450.0
23.00									
MC16	12.312	20.00	20.00	2.500	2.500	73.308	73.308	12.885	310.0
0.000									
MC17	12.312	20.00	20.00	2.500	2.500	73.308	73.308	8.617	320.0
0.000									
ROC1	12.312	20.00	20.00	2.500	2.500	73.308	73.308	47.954	390.0
18.00									
ROC2	12.312	20.00	20.00	2.500	2.500	73.308	73.308	72.728	360.0
0.000									
SHC1	12.312	20.00	20.00	2.500	2.500	73.308	73.308	30.463	340.0
38.00									
SHC2	12.312	20.00	20.00	2.500	2.500	73.308	73.308	69.243	370.0
0.000									
SHC3	12.312	20.00	0.000	2.500	0.000	73.308	0.000	141.25	370.0
51.00									
SHC4	12.312	20.00	20.00	2.500	2.500	73.308	73.308	168.73	400.0
40.00									
SHC5	12.312	20.00	20.00	2.500	2.500	73.308	73.308	184.47	430.0
0.000									
MC18	12.312	20.00	0.000	2.500	0.000	73.308	0.000	595.45	460.0
44.00									
GR1	12.312	20.00	20.00	2.500	2.500	73.308	73.308	37.253	340.0
0.000									
GR2	12.312	20.00	0.000	2.500	0.000	73.308	0.000	602.93	500.0
27.00									
GR4	12.312	20.00	0.000	2.500	0.000	73.308	0.000	617.55	530.0
49.00									
GR5	12.312	20.00	20.00	2.500	2.500	73.308	73.308	39.425	340.0
0.000									

GR6	12.312	20.00	20.00	2.500	2.500	73.308	73.308	29.170	340.0	0.000
UC1	12.312	20.00	20.00	2.500	2.500	73.308	73.308	51.163	390.0	49.00
UC2	12.312	20.00	0.000	2.500	0.000	73.308	0.000	117.75	410.0	51.00
UC3	12.312	20.00	20.00	2.500	2.500	73.308	73.308	159.52	440.0	49.00
UC4	12.312	20.00	20.00	2.500	2.500	73.308	73.308	162.44	490.0	0.000
GR7	12.312	20.00	0.000	2.500	0.000	73.308	0.000	753.60	570.0	56.00
GR9	12.312	20.00	0.000	2.500	0.000	73.308	0.000	22.913	360.0	0.000
GR8	12.312	20.00	20.00	2.500	2.500	73.308	73.308	22.949	330.0	0.000
GR10	12.312	20.00	0.000	2.500	0.000	73.308	0.000	757.66	630.0	0.000

SUMMARY OF BASIN RESULTS

Link Label	Time to Peak	Peak Inflow (m^3/s)	Time to Peak	Peak Outflow (m^3/s)	Total Inflow (m^3)	Basin Vol. Avail	Basin Vol. Used	Basin Stage Used
MC15	450.0	423.1	460.0	420.7	.796E+07	0.0000	184516.	430.04

SUMMARY OF BASIN OUTLET RESULTS

Link Label	No. of	S/D Factor (m)	Dia (m)	Width (m)	Pipe Length (m)	Pipe Slope (%)
MC15	1.0	1.000		0.000	20.000	0.2000

LINK BC3 1.000

ESTIMATED VOLUME (CU METRES*10**3) = 21.02
ESTIMATED PEAK FLOW (CUMECS) = 2.23
ESTIMATED TIME TO PEAK (MINS) = 340.00

LINK BC1 2.000

ESTIMATED VOLUME (CU METRES*10**3) = 27.89
ESTIMATED PEAK FLOW (CUMECS) = 3.32
ESTIMATED TIME TO PEAK (MINS) = 330.00

LINK BC2 2.001

ESTIMATED VOLUME (CU METRES*10**3) = 76.91
ESTIMATED PEAK FLOW (CUMECS) = 8.84
ESTIMATED TIME TO PEAK (MINS) = 330.00

LINK BC4 1.001

ESTIMATED VOLUME (CU METRES*10**3) = 97.92
ESTIMATED PEAK FLOW (CUMECS) = 11.02
ESTIMATED TIME TO PEAK (MINS) = 330.00

LINK BC5 3.000

ESTIMATED VOLUME (CU METRES*10**3) = 64.81

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ESTIMATED PEAK FLOW         (CUMECS) =      8.42
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK BC6              4.000

ESTIMATED VOLUME (CU METRES*10**3) =          65.32
ESTIMATED PEAK FLOW         (CUMECS) =      8.28
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK BC7              5.000

ESTIMATED VOLUME (CU METRES*10**3) =          95.46
ESTIMATED PEAK FLOW         (CUMECS) =     11.07
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK BC8              1.002

ESTIMATED VOLUME (CU METRES*10**3) =          323.5
ESTIMATED PEAK FLOW         (CUMECS) =     36.83
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK GR3              6.000

ESTIMATED VOLUME (CU METRES*10**3) =          378.6
ESTIMATED PEAK FLOW         (CUMECS) =     31.07
ESTIMATED TIME TO PEAK         (MINS) =    350.00

LINK MC13             7.000

ESTIMATED VOLUME (CU METRES*10**3) =          46.08
ESTIMATED PEAK FLOW         (CUMECS) =      6.60
ESTIMATED TIME TO PEAK         (MINS) =    310.00

LINK MC14             8.000

ESTIMATED VOLUME (CU METRES*10**3) =          95.76
ESTIMATED PEAK FLOW         (CUMECS) =     10.29
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK MG1              9.000

ESTIMATED VOLUME (CU METRES*10**3) =          328.6
ESTIMATED PEAK FLOW         (CUMECS) =     27.22
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK MC1             10.000

ESTIMATED VOLUME (CU METRES*10**3) =          674.5
ESTIMATED PEAK FLOW         (CUMECS) =     44.54
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK MC2              9.001

ESTIMATED VOLUME (CU METRES*10**3) =          1003.
ESTIMATED PEAK FLOW         (CUMECS) =     71.00
ESTIMATED TIME TO PEAK         (MINS) =    350.00

LINK SC1             11.000

ESTIMATED VOLUME (CU METRES*10**3) =          251.8
ESTIMATED PEAK FLOW         (CUMECS) =     25.98
ESTIMATED TIME TO PEAK         (MINS) =    340.00
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LINK MC3             12.000

ESTIMATED VOLUME (CU METRES*10**3) =          219.6
ESTIMATED PEAK FLOW         (CUMECS) =     26.84
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK MC4              9.002

ESTIMATED VOLUME (CU METRES*10**3) =          1474.
ESTIMATED PEAK FLOW         (CUMECS) =    110.10
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK MC5              9.003

ESTIMATED VOLUME (CU METRES*10**3) =          1928.
ESTIMATED PEAK FLOW         (CUMECS) =    127.87
ESTIMATED TIME TO PEAK         (MINS) =    440.00

LINK MC6              9.004

ESTIMATED VOLUME (CU METRES*10**3) =          1928.
ESTIMATED PEAK FLOW         (CUMECS) =    127.87
ESTIMATED TIME TO PEAK         (MINS) =    440.00

LINK MC7             13.000

ESTIMATED VOLUME (CU METRES*10**3) =          71.45
ESTIMATED PEAK FLOW         (CUMECS) =      9.64
ESTIMATED TIME TO PEAK         (MINS) =    320.00

LINK MC8             14.000

ESTIMATED VOLUME (CU METRES*10**3) =          36.08
ESTIMATED PEAK FLOW         (CUMECS) =      4.79
ESTIMATED TIME TO PEAK         (MINS) =    320.00

LINK LC2             15.000

ESTIMATED VOLUME (CU METRES*10**3) =          456.1
ESTIMATED PEAK FLOW         (CUMECS) =     37.86
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK LC1             16.000

ESTIMATED VOLUME (CU METRES*10**3) =          852.3
ESTIMATED PEAK FLOW         (CUMECS) =     60.89
ESTIMATED TIME TO PEAK         (MINS) =    370.00

LINK LC3             15.001

ESTIMATED VOLUME (CU METRES*10**3) =          1308.
ESTIMATED PEAK FLOW         (CUMECS) =     98.65
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK LC4             15.002

ESTIMATED VOLUME (CU METRES*10**3) =          1681.
ESTIMATED PEAK FLOW         (CUMECS) =    122.22
ESTIMATED TIME TO PEAK         (MINS) =    390.00

LINK MC9              9.005
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ESTIMATED VOLUME (CU METRES*10**3) =          3713.
ESTIMATED PEAK FLOW         (CUMECS) =    217.33
ESTIMATED TIME TO PEAK         (MINS) =    460.00

LINK MC10            17.000

ESTIMATED VOLUME (CU METRES*10**3) =          218.9
ESTIMATED PEAK FLOW         (CUMECS) =     24.51
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK MC11            18.000

ESTIMATED VOLUME (CU METRES*10**3) =          100.8
ESTIMATED PEAK FLOW         (CUMECS) =     13.50
ESTIMATED TIME TO PEAK         (MINS) =    320.00

LINK RYC1            19.000

ESTIMATED VOLUME (CU METRES*10**3) =          213.9
ESTIMATED PEAK FLOW         (CUMECS) =     20.35
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK RYC2            19.001

ESTIMATED VOLUME (CU METRES*10**3) =          704.7
ESTIMATED PEAK FLOW         (CUMECS) =     65.91
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK RYC3            19.002

ESTIMATED VOLUME (CU METRES*10**3) =          806.7
ESTIMATED PEAK FLOW         (CUMECS) =     73.54
ESTIMATED TIME TO PEAK         (MINS) =    380.00

LINK RYC4            19.003

ESTIMATED VOLUME (CU METRES*10**3) =          1038.
ESTIMATED PEAK FLOW         (CUMECS) =     86.97
ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK MC12             9.006

ESTIMATED VOLUME (CU METRES*10**3) =          5066.
ESTIMATED PEAK FLOW         (CUMECS) =    278.87
ESTIMATED TIME TO PEAK         (MINS) =    430.00

LINK MC15             7.001

ESTIMATED VOLUME (CU METRES*10**3) =          5204.
ESTIMATED PEAK FLOW         (CUMECS) =    282.64
ESTIMATED TIME TO PEAK         (MINS) =    450.00

LINK MC16            20.000

ESTIMATED VOLUME (CU METRES*10**3) =          73.36
ESTIMATED PEAK FLOW         (CUMECS) =      9.84
ESTIMATED TIME TO PEAK         (MINS) =    320.00

LINK MC17            21.000

ESTIMATED VOLUME (CU METRES*10**3) =          50.32
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ESTIMATED PEAK FLOW         (CUMECS) =      6.60
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK ROC1             22.000

ESTIMATED VOLUME (CU METRES*10**3) =          629.4
ESTIMATED PEAK FLOW         (CUMECS) =     30.27
ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK ROC2             22.001

ESTIMATED VOLUME (CU METRES*10**3) =          862.9
ESTIMATED PEAK FLOW         (CUMECS) =     47.64
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK SHC1             23.000

ESTIMATED VOLUME (CU METRES*10**3) =          285.2
ESTIMATED PEAK FLOW         (CUMECS) =     19.88
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK SHC2             23.001

ESTIMATED VOLUME (CU METRES*10**3) =          642.0
ESTIMATED PEAK FLOW         (CUMECS) =     46.78
ESTIMATED TIME TO PEAK         (MINS) =    380.00

LINK SHC3             22.002

ESTIMATED VOLUME (CU METRES*10**3) =          1505.
ESTIMATED PEAK FLOW         (CUMECS) =     94.03
ESTIMATED TIME TO PEAK         (MINS) =    370.00

LINK SHC4             22.003

ESTIMATED VOLUME (CU METRES*10**3) =          1887.
ESTIMATED PEAK FLOW         (CUMECS) =    112.59
ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK SHC5             22.004

ESTIMATED VOLUME (CU METRES*10**3) =          2125.
ESTIMATED PEAK FLOW         (CUMECS) =    124.09
ESTIMATED TIME TO PEAK         (MINS) =    440.00

LINK MC18              7.002

ESTIMATED VOLUME (CU METRES*10**3) =          7445.
ESTIMATED PEAK FLOW         (CUMECS) =    397.82
ESTIMATED TIME TO PEAK         (MINS) =    470.00

LINK GR1              24.000

ESTIMATED VOLUME (CU METRES*10**3) =          267.6
ESTIMATED PEAK FLOW         (CUMECS) =     26.95
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK GR2               7.003

ESTIMATED VOLUME (CU METRES*10**3) =          7699.
ESTIMATED PEAK FLOW         (CUMECS) =    402.52
ESTIMATED TIME TO PEAK         (MINS) =    510.00
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```
LINK GR4              1.003

ESTIMATED VOLUME (CU METRES*10**3) =          8390.
ESTIMATED PEAK FLOW         (CUMECS) =    411.65
ESTIMATED TIME TO PEAK         (MINS) =    540.00

LINK GR5             25.000

ESTIMATED VOLUME (CU METRES*10**3) =          280.6
ESTIMATED PEAK FLOW         (CUMECS) =     28.80
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK GR6             26.000

ESTIMATED VOLUME (CU METRES*10**3) =          245.2
ESTIMATED PEAK FLOW         (CUMECS) =     19.55
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK UC1             27.000

ESTIMATED VOLUME (CU METRES*10**3) =          584.3
ESTIMATED PEAK FLOW         (CUMECS) =     32.76
ESTIMATED TIME TO PEAK         (MINS) =    390.00

LINK UC2             27.001

ESTIMATED VOLUME (CU METRES*10**3) =          1411.
ESTIMATED PEAK FLOW         (CUMECS) =     74.32
ESTIMATED TIME TO PEAK         (MINS) =    430.00

LINK UC3             27.002

ESTIMATED VOLUME (CU METRES*10**3) =          2016.
ESTIMATED PEAK FLOW         (CUMECS) =    101.72
ESTIMATED TIME TO PEAK         (MINS) =    440.00

LINK UC4             27.003

ESTIMATED VOLUME (CU METRES*10**3) =          2118.
ESTIMATED PEAK FLOW         (CUMECS) =    103.53
ESTIMATED TIME TO PEAK         (MINS) =    490.00

LINK GR7              1.004

ESTIMATED VOLUME (CU METRES*10**3) =         0.1101E+05
ESTIMATED PEAK FLOW         (CUMECS) =    499.45
ESTIMATED TIME TO PEAK         (MINS) =    580.00

LINK GR9             28.000

ESTIMATED VOLUME (CU METRES*10**3) =          219.8
ESTIMATED PEAK FLOW         (CUMECS) =     15.07
ESTIMATED TIME TO PEAK         (MINS) =    380.00

LINK GR8             29.000

ESTIMATED VOLUME (CU METRES*10**3) =          160.4
ESTIMATED PEAK FLOW         (CUMECS) =     16.66
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK GR10             1.005
```

```
 ESTIMATED VOLUME (CU METRES*10**3) =          0.1134E+05
 ESTIMATED PEAK FLOW         (CUMECS) =    502.36
 ESTIMATED TIME TO PEAK         (MINS) =    640.00



##############################################################################
##########
Critical Duration

Results for period from  0: 0.0  1/ 1/1990
                     to 20: 0.0  1/ 1/1990
##############################################################################
##########


                                ROUTING INCREMENT (MINS) =      10.00
                                STORM DURATION (MINS)    =       540.
                                RETURN PERIOD (YRS)      =        20.
                                BX                       =     1.0000
                                TOTAL OF FIRST SUB-AREAS  (ha) =   13734.00
                                TOTAL OF SECOND SUB-AREAS (ha) =   10479.00
                                TOTAL OF ALL SUB-AREAS (ha)    =   24213.00


     SUMMARY OF CATCHMENT AND RAINFALL DATA
 Link      Catch. Area      Slope    % Impervious     Pern        B
Link
 Label      #1     #2     #1    #2      #1   #2     #1    #2    #1   #2
No.
           (ha)             (%)           (%)
BC3       44.000  0.000  1.000 0.000  5.000 0.000  .040 0.00  .2094 0.000
1.000
BC1       58.000  0.000  4.000 0.000  10.00 0.000  .080 0.00  .1753 0.000
2.000
BC2       70.000 32.000  4.000 4.000  5.000 10.00  .040 .080  .1335 .1287
2.001
BC4       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
1.001
BC5       77.000 58.000  5.000 5.000  5.000 10.00  .040 .080  .1255 .1569
3.000
BC6       80.000 56.000  4.000 4.000  5.000 10.00  .040 .080  .1431 .1722
4.000
BC7       120.00 79.000  3.000 3.000  5.000 10.00  .040 .080  .2040 .2377
5.000
BC8       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
1.002
GR3       435.00 360.00  2.000 2.000  5.000 10.00  .040 .080  .4878 .6403
6.000
MC13      54.000 42.000  8.000 8.000  5.000 10.00  .040 .080  .0825 .1049
7.000
MC14      150.00 50.000  2.000 2.000  5.000 10.00  .040 .080  .2804 .2294
8.000
MG1       113.00 577.00  3.000 3.000  5.000 10.00  .040 .080  .1977 .6685
9.000
MC1       451.00 976.00  2.000 2.000  5.000 10.00  .040 .080  .4971 1.075
10.00
MC2       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
9.001
SC1       306.00 220.00  3.000 3.000  5.000 10.00  .040 .080  .3319 .4049
```

11.00
MC3 177.00 281.00 7.000 7.000 5.000 10.00 .040 .080 .1636 .3013
12.00
MC4 .00001 0.000 .0010 0.000 0.000 0.000 .025 0.00 .0021 0.000
9.002
MC5 557.00 400.00 4.000 4.000 5.000 10.00 .040 .080 .3925 .4786
9.003
MC6 .00001 0.000 .0010 0.000 0.000 0.000 .025 0.00 .0021 0.000
9.004
MC7 103.00 46.000 6.000 6.000 5.000 10.00 .040 .080 .1333 .1270
13.00
MC8 34.000 41.000 5.000 5.000 5.000 10.00 .040 .080 .0820 .1310
14.00
LC2 794.00 161.00 2.000 2.000 5.000 10.00 .040 .080 .6671 .4214
15.00
LC1 1044.0 753.00 2.000 2.000 5.000 10.00 .040 .080 .7691 .9399
16.00
LC3 .00001 0.000 .0010 0.000 0.000 0.000 .025 0.00 .0021 0.000
15.00
LC4 597.00 184.00 4.000 4.000 5.000 10.00 .040 .080 .4070 .3196
15.00
MC9 .00001 0.000 .0010 0.000 0.000 0.000 .025 0.00 .0021 0.000
9.005
MC10 306.00 151.00 3.000 5.000 5.000 10.00 .040 .080 .3319 .2580
17.00
MC11 128.00 82.000 7.000 7.000 5.000 10.00 .040 .080 .1382 .1588
18.00
RYC1 423.00 25.000 2.000 2.000 5.000 10.00 .040 .080 .4808 .1600
19.00
RYC2 916.00 110.00 4.000 4.000 10.00 10.00 .040 .080 .4179 .2446
19.00
RYC3 121.00 92.000 3.000 3.000 5.000 10.00 .040 .080 .2048 .2573
19.00
RYC4 199.00 284.00 5.000 5.000 5.000 10.00 .040 .080 .2056 .3583
19.00
MC12 .00001 0.000 .0010 0.000 0.000 0.000 .025 0.00 .0021 0.000
9.006
MC15 .00001 0.000 .0010 0.000 0.000 0.000 .025 0.00 .0021 0.000
7.001
MC16 64.000 89.000 8.000 8.000 5.000 10.00 .040 .080 .0902 .1550
20.00
MC17 98.000 7.000 4.000 4.000 5.000 10.00 .040 .080 .1590 .0584
21.00
ROC1 359.00 1011.0 1.000 1.000 5.000 10.00 .040 .080 .6239 1.548
22.00
ROC2 300.00 191.00 2.000 2.000 10.00 10.00 .040 .080 .3306 .4605
22.00
SHC1 86.000 516.00 2.000 2.000 5.000 10.00 .040 .080 .2100 .7722
23.00
SHC2 356.00 395.00 2.000 2.000 5.000 10.00 .040 .080 .4395 .6720
23.00
SHC3 .00001 0.000 .0010 0.000 0.000 0.000 .025 0.00 .0021 0.000
22.00
SHC4 540.00 269.00 5.000 5.000 5.000 10.00 .040 .080 .3456 .3484
22.00
SHC5 198.00 309.00 2.000 2.000 5.000 10.00 .040 .080 .3240 .5914
22.00
MC18 .00001 0.000 .0010 0.000 0.000 0.000 .025 0.00 .0021 0.000
7.002
GR1 292.00 268.00 3.000 3.000 5.000 10.00 .040 .080 .3239 .4486
24.00
GR2 .00001 0.000 .0010 0.000 0.000 0.000 .025 0.00 .0021 0.000

7.003
GR4 .00001 0.000 .0010 0.000 0.000 0.000 .025 0.00 .0021 0.000
1.003
GR5 363.00 223.00 3.000 3.000 5.000 10.00 .040 .080 .3627 .4077
25.00
GR6 157.00 358.00 2.000 2.000 5.000 10.00 .040 .080 .2872 .6385
26.00
UC1 642.00 608.00 1.000 1.000 5.000 10.00 .040 .080 .8441 1.188
27.00
UC2 1776.0 0.000 2.000 0.000 10.00 0.000 .080 0.00 1.468 0.000
27.00
UC3 384.00 908.00 2.000 2.000 5.000 10.00 .040 .080 .4572 1.035
27.00
UC4 229.00 .00134 3.000 3.000 5.000 10.00 .040 .080 .2854 .0008
27.00
GR7 .00001 0.000 .0010 0.000 0.000 0.000 .025 0.00 .0021 0.000
1.004
GR9 464.00 0.000 2.000 0.000 10.00 0.000 .080 0.00 .7307 0.000
28.00
GR8 69.000 267.00 4.000 4.000 5.000 10.00 .040 .080 .1325 .3879
29.00
GR10 .00001 0.000 .0010 0.000 0.000 0.000 .025 0.00 .0021 0.000
1.005

Link Label	Average Intensity (mm/h)	Init. Loss #1 (mm)	Init. Loss #2 (mm)	Cont. Loss #1 (mm/h)	Cont. Loss #2 (mm/h)	Excess Rain #1 (mm)	Excess Rain #2 (mm)	Peak Inflow (m^3/s)	Time to Peak mins	Link Lag
BC3	9.270	20.00	0.000	2.500	0.000	48.097	0.000	2.232	340.0	0.000
BC1	9.270	20.00	0.000	2.500	0.000	48.097	0.000	3.316	330.0	27.00
BC2	9.270	20.00	20.00	2.500	2.500	48.097	48.097	8.843	330.0	0.000
BC4	9.270	20.00	0.000	2.500	0.000	48.097	0.000	11.020	330.0	22.00
BC5	9.270	20.00	20.00	2.500	2.500	48.097	48.097	8.415	330.0	0.000
BC6	9.270	20.00	20.00	2.500	2.500	48.097	48.097	8.278	330.0	0.000
BC7	9.270	20.00	20.00	2.500	2.500	48.097	48.097	11.071	330.0	0.000
BC8	9.270	20.00	0.000	2.500	0.000	48.097	0.000	36.829	330.0	0.000
GR3	9.270	20.00	20.00	2.500	2.500	48.097	48.097	31.069	350.0	0.000
MC13	9.270	20.00	20.00	2.500	2.500	48.097	48.097	6.596	310.0	0.000
MC14	9.270	20.00	20.00	2.500	2.500	48.097	48.097	10.286	340.0	0.000
MG1	9.270	20.00	20.00	2.500	2.500	48.097	48.097	27.221	340.0	0.000
MC1	9.270	20.00	20.00	2.500	2.500	48.097	48.097	44.538	360.0	0.000
MC2	9.270	20.00	0.000	2.500	0.000	48.097	0.000	70.997	350.0	34.00
SC1	9.270	20.00	20.00	2.500	2.500	48.097	48.097	25.979	340.0	0.000
MC3	9.270	20.00	20.00	2.500	2.500	48.097	48.097	26.837	330.0	

0.000
MC4 9.270 20.00 0.000 2.500 0.000 48.097 0.000 110.10 360.0
78.00
MC5 9.270 20.00 20.00 2.500 2.500 48.097 48.097 127.87 440.0
0.000
MC6 9.270 20.00 0.000 2.500 0.000 48.097 0.000 127.87 440.0
50.00
MC7 9.270 20.00 20.00 2.500 2.500 48.097 48.097 9.643 320.0
0.000
MC8 9.270 20.00 20.00 2.500 2.500 48.097 48.097 4.790 320.0
0.000
LC2 9.270 20.00 20.00 2.500 2.500 48.097 48.097 37.862 360.0
0.000
LC1 9.270 20.00 20.00 2.500 2.500 48.097 48.097 60.891 370.0
0.000
LC3 9.270 20.00 0.000 2.500 0.000 48.097 0.000 98.647 360.0
50.00
LC4 9.270 20.00 20.00 2.500 2.500 48.097 48.097 122.22 390.0
0.000
MC9 9.270 20.00 0.000 2.500 0.000 48.097 0.000 217.33 460.0
39.00
MC10 9.270 20.00 20.00 2.500 2.500 48.097 48.097 24.508 340.0
0.000
MC11 9.270 20.00 20.00 2.500 2.500 48.097 48.097 13.498 320.0
0.000
RYC1 9.270 20.00 20.00 2.500 2.500 48.097 48.097 20.351 340.0
51.00
RYC2 9.270 20.00 20.00 2.500 2.500 48.097 48.097 65.910 340.0
39.00
RYC3 9.270 20.00 20.00 2.500 2.500 48.097 48.097 73.535 380.0
22.00
RYC4 9.270 20.00 20.00 2.500 2.500 48.097 48.097 86.966 400.0
0.000
MC12 9.270 20.00 0.000 2.500 0.000 48.097 0.000 278.87 430.0
27.00
MC15 9.270 20.00 0.000 2.500 0.000 48.097 0.000 282.64 450.0
23.00
MC16 9.270 20.00 20.00 2.500 2.500 48.097 48.097 9.839 320.0
0.000
MC17 9.270 20.00 20.00 2.500 2.500 48.097 48.097 6.599 330.0
0.000
ROC1 9.270 20.00 20.00 2.500 2.500 48.097 48.097 30.267 400.0
18.00
ROC2 9.270 20.00 20.00 2.500 2.500 48.097 48.097 47.643 360.0
0.000
SHC1 9.270 20.00 20.00 2.500 2.500 48.097 48.097 19.885 360.0
38.00
SHC2 9.270 20.00 20.00 2.500 2.500 48.097 48.097 46.780 380.0
0.000
SHC3 9.270 20.00 0.000 2.500 0.000 48.097 0.000 94.031 370.0
51.00
SHC4 9.270 20.00 20.00 2.500 2.500 48.097 48.097 112.59 400.0
40.00
SHC5 9.270 20.00 20.00 2.500 2.500 48.097 48.097 124.09 440.0
0.000
MC18 9.270 20.00 0.000 2.500 0.000 48.097 0.000 397.82 470.0
44.00
GR1 9.270 20.00 20.00 2.500 2.500 48.097 48.097 26.945 340.0
0.000
GR2 9.270 20.00 0.000 2.500 0.000 48.097 0.000 402.52 510.0
27.00
GR4 9.270 20.00 0.000 2.500 0.000 48.097 0.000 411.65 540.0

```
49.00
GR5        9.270 20.00 20.00  2.500 2.500  48.097 48.097  28.803  340.0
0.000
GR6        9.270 20.00 20.00  2.500 2.500  48.097 48.097  19.552  340.0
0.000
UC1        9.270 20.00 20.00  2.500 2.500  48.097 48.097  32.760  390.0
49.00
UC2        9.270 20.00 0.000  2.500 0.000  48.097  0.000  74.318  430.0
51.00
UC3        9.270 20.00 20.00  2.500 2.500  48.097 48.097  101.72  440.0
49.00
UC4        9.270 20.00 20.00  2.500 2.500  48.097 48.097  103.53  490.0
0.000
GR7        9.270 20.00 0.000  2.500 0.000  48.097  0.000  499.45  580.0
56.00
GR9        9.270 20.00 0.000  2.500 0.000  48.097  0.000  15.065  380.0
0.000
GR8        9.270 20.00 20.00  2.500 2.500  48.097 48.097  16.662  340.0
0.000
GR10       9.270 20.00 0.000  2.500 0.000  48.097  0.000  502.36  640.0
0.000
```

SUMMARY OF BASIN RESULTS

Link Label	Time to Peak	Peak Inflow (m^3/s)	Time to Peak	Peak Outflow (m^3/s)	Total Inflow (m^3)	Basin Vol. Avail	Basin Vol. Used	Basin Stage Used
MC15	450.0	282.6	460.0	282.0	.520E+07	0.0000	128229.	429.50

SUMMARY OF BASIN OUTLET RESULTS

Link Label	No. of	S/D Factor (m)	Dia (m)	Width (m)	Pipe Length (m)	Pipe Slope (%)
MC15	1.0	1.000		0.000	20.000	0.2000

LINK BC3 1.000

ESTIMATED VOLUME (CU METRES*10**3) = 13.38
ESTIMATED PEAK FLOW (CUMECS) = 1.44
ESTIMATED TIME TO PEAK (MINS) = 340.00

LINK BC1 2.000

ESTIMATED VOLUME (CU METRES*10**3) = 17.67
ESTIMATED PEAK FLOW (CUMECS) = 2.34
ESTIMATED TIME TO PEAK (MINS) = 340.00

LINK BC2 2.001

ESTIMATED VOLUME (CU METRES*10**3) = 48.77
ESTIMATED PEAK FLOW (CUMECS) = 6.24
ESTIMATED TIME TO PEAK (MINS) = 340.00

LINK BC4 1.001

ESTIMATED VOLUME (CU METRES*10**3) = 62.15
ESTIMATED PEAK FLOW (CUMECS) = 7.68
ESTIMATED TIME TO PEAK (MINS) = 340.00

```
LINK BC5              3.000

ESTIMATED VOLUME (CU METRES*10**3) =          41.12
ESTIMATED PEAK FLOW         (CUMECS) =      6.16
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK BC6              4.000

ESTIMATED VOLUME (CU METRES*10**3) =          41.42
ESTIMATED PEAK FLOW         (CUMECS) =      5.97
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK BC7              5.000

ESTIMATED VOLUME (CU METRES*10**3) =          60.55
ESTIMATED PEAK FLOW         (CUMECS) =      7.65
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK BC8              1.002

ESTIMATED VOLUME (CU METRES*10**3) =          205.2
ESTIMATED PEAK FLOW         (CUMECS) =     25.84
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK GR3              6.000

ESTIMATED VOLUME (CU METRES*10**3) =          239.8
ESTIMATED PEAK FLOW         (CUMECS) =     19.38
ESTIMATED TIME TO PEAK         (MINS) =    370.00

LINK MC13             7.000

ESTIMATED VOLUME (CU METRES*10**3) =          29.25
ESTIMATED PEAK FLOW         (CUMECS) =      4.82
ESTIMATED TIME TO PEAK         (MINS) =    310.00

LINK MC14             8.000

ESTIMATED VOLUME (CU METRES*10**3) =          60.82
ESTIMATED PEAK FLOW         (CUMECS) =      6.84
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK MG1              9.000

ESTIMATED VOLUME (CU METRES*10**3) =          208.2
ESTIMATED PEAK FLOW         (CUMECS) =     16.45
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK MC1             10.000

ESTIMATED VOLUME (CU METRES*10**3) =          425.4
ESTIMATED PEAK FLOW         (CUMECS) =     27.03
ESTIMATED TIME TO PEAK         (MINS) =    380.00

LINK MC2              9.001

ESTIMATED VOLUME (CU METRES*10**3) =          633.6
ESTIMATED PEAK FLOW         (CUMECS) =     43.32
ESTIMATED TIME TO PEAK         (MINS) =    370.00

LINK SC1             11.000
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```
ESTIMATED VOLUME (CU METRES*10**3) =          159.6
ESTIMATED PEAK FLOW         (CUMECS) =     16.96
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK MC3             12.000

ESTIMATED VOLUME (CU METRES*10**3) =          139.4
ESTIMATED PEAK FLOW         (CUMECS) =     18.84
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK MC4              9.002

ESTIMATED VOLUME (CU METRES*10**3) =          931.9
ESTIMATED PEAK FLOW         (CUMECS) =     69.25
ESTIMATED TIME TO PEAK         (MINS) =    370.00

LINK MC5              9.003

ESTIMATED VOLUME (CU METRES*10**3) =          1219.
ESTIMATED PEAK FLOW         (CUMECS) =     81.56
ESTIMATED TIME TO PEAK         (MINS) =    440.00

LINK MC6              9.004

ESTIMATED VOLUME (CU METRES*10**3) =          1219.
ESTIMATED PEAK FLOW         (CUMECS) =     81.56
ESTIMATED TIME TO PEAK         (MINS) =    440.00

LINK MC7             13.000

ESTIMATED VOLUME (CU METRES*10**3) =          45.41
ESTIMATED PEAK FLOW         (CUMECS) =      7.03
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK MC8             14.000

ESTIMATED VOLUME (CU METRES*10**3) =          22.85
ESTIMATED PEAK FLOW         (CUMECS) =      3.48
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK LC2             15.000

ESTIMATED VOLUME (CU METRES*10**3) =          288.7
ESTIMATED PEAK FLOW         (CUMECS) =     23.85
ESTIMATED TIME TO PEAK         (MINS) =    370.00

LINK LC1             16.000

ESTIMATED VOLUME (CU METRES*10**3) =          537.7
ESTIMATED PEAK FLOW         (CUMECS) =     37.18
ESTIMATED TIME TO PEAK         (MINS) =    390.00

LINK LC3             15.001

ESTIMATED VOLUME (CU METRES*10**3) =          826.4
ESTIMATED PEAK FLOW         (CUMECS) =     60.52
ESTIMATED TIME TO PEAK         (MINS) =    380.00

LINK LC4             15.002

ESTIMATED VOLUME (CU METRES*10**3) =          1062.
ESTIMATED PEAK FLOW         (CUMECS) =     74.03
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ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK MC9              9.005

ESTIMATED VOLUME (CU METRES*10**3) =          2346.
ESTIMATED PEAK FLOW         (CUMECS) =    141.22
ESTIMATED TIME TO PEAK         (MINS) =    470.00

LINK MC10            17.000

ESTIMATED VOLUME (CU METRES*10**3) =           139.0
ESTIMATED PEAK FLOW         (CUMECS) =     16.79
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK MC11            18.000

ESTIMATED VOLUME (CU METRES*10**3) =           63.99
ESTIMATED PEAK FLOW         (CUMECS) =      9.80
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK RYC1            19.000

ESTIMATED VOLUME (CU METRES*10**3) =           135.7
ESTIMATED PEAK FLOW         (CUMECS) =     12.86
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK RYC2            19.001

ESTIMATED VOLUME (CU METRES*10**3) =           447.0
ESTIMATED PEAK FLOW         (CUMECS) =     43.59
ESTIMATED TIME TO PEAK         (MINS) =    350.00

LINK RYC3            19.002

ESTIMATED VOLUME (CU METRES*10**3) =           511.6
ESTIMATED PEAK FLOW         (CUMECS) =     49.25
ESTIMATED TIME TO PEAK         (MINS) =    380.00

LINK RYC4            19.003

ESTIMATED VOLUME (CU METRES*10**3) =           658.3
ESTIMATED PEAK FLOW         (CUMECS) =     59.36
ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK MC12             9.006

ESTIMATED VOLUME (CU METRES*10**3) =          3203.
ESTIMATED PEAK FLOW         (CUMECS) =    173.19
ESTIMATED TIME TO PEAK         (MINS) =    430.00

LINK MC15             7.001

ESTIMATED VOLUME (CU METRES*10**3) =          3290.
ESTIMATED PEAK FLOW         (CUMECS) =    175.54
ESTIMATED TIME TO PEAK         (MINS) =    460.00

LINK MC16            20.000

ESTIMATED VOLUME (CU METRES*10**3) =           46.59
ESTIMATED PEAK FLOW         (CUMECS) =      7.14
ESTIMATED TIME TO PEAK         (MINS) =    320.00
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LINK MC17             21.000

ESTIMATED VOLUME (CU METRES*10**3) =          31.97
ESTIMATED PEAK FLOW         (CUMECS) =      4.82
ESTIMATED TIME TO PEAK         (MINS) =    330.00

LINK ROC1             22.000

ESTIMATED VOLUME (CU METRES*10**3) =          392.5
ESTIMATED PEAK FLOW         (CUMECS) =     17.48
ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK ROC2             22.001

ESTIMATED VOLUME (CU METRES*10**3) =          540.1
ESTIMATED PEAK FLOW         (CUMECS) =     28.89
ESTIMATED TIME TO PEAK         (MINS) =    370.00

LINK SHC1             23.000

ESTIMATED VOLUME (CU METRES*10**3) =          180.4
ESTIMATED PEAK FLOW         (CUMECS) =     11.97
ESTIMATED TIME TO PEAK         (MINS) =    370.00

LINK SHC2             23.001

ESTIMATED VOLUME (CU METRES*10**3) =          406.2
ESTIMATED PEAK FLOW         (CUMECS) =     29.24
ESTIMATED TIME TO PEAK         (MINS) =    380.00

LINK SHC3             22.002

ESTIMATED VOLUME (CU METRES*10**3) =          946.3
ESTIMATED PEAK FLOW         (CUMECS) =     58.02
ESTIMATED TIME TO PEAK         (MINS) =    380.00

LINK SHC4             22.003

ESTIMATED VOLUME (CU METRES*10**3) =          1188.
ESTIMATED PEAK FLOW         (CUMECS) =     70.60
ESTIMATED TIME TO PEAK         (MINS) =    410.00

LINK SHC5             22.004

ESTIMATED VOLUME (CU METRES*10**3) =          1337.
ESTIMATED PEAK FLOW         (CUMECS) =     78.21
ESTIMATED TIME TO PEAK         (MINS) =    440.00

LINK MC18              7.002

ESTIMATED VOLUME (CU METRES*10**3) =          4698.
ESTIMATED PEAK FLOW         (CUMECS) =    248.30
ESTIMATED TIME TO PEAK         (MINS) =    480.00

LINK GR1              24.000

ESTIMATED VOLUME (CU METRES*10**3) =          169.8
ESTIMATED PEAK FLOW         (CUMECS) =     17.43
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK GR2               7.003
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```
ESTIMATED VOLUME (CU METRES*10**3) =          4856.
ESTIMATED PEAK FLOW         (CUMECS) =    251.36
ESTIMATED TIME TO PEAK         (MINS) =    510.00

LINK GR4              1.003

ESTIMATED VOLUME (CU METRES*10**3) =          5291.
ESTIMATED PEAK FLOW         (CUMECS) =    258.33
ESTIMATED TIME TO PEAK         (MINS) =    540.00

LINK GR5             25.000

ESTIMATED VOLUME (CU METRES*10**3) =           177.8
ESTIMATED PEAK FLOW         (CUMECS) =     18.73
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK GR6             26.000

ESTIMATED VOLUME (CU METRES*10**3) =           155.2
ESTIMATED PEAK FLOW         (CUMECS) =     12.06
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK UC1             27.000

ESTIMATED VOLUME (CU METRES*10**3) =           366.3
ESTIMATED PEAK FLOW         (CUMECS) =     18.86
ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK UC2             27.001

ESTIMATED VOLUME (CU METRES*10**3) =           884.2
ESTIMATED PEAK FLOW         (CUMECS) =     42.47
ESTIMATED TIME TO PEAK         (MINS) =    450.00

LINK UC3             27.002

ESTIMATED VOLUME (CU METRES*10**3) =          1265.
ESTIMATED PEAK FLOW         (CUMECS) =     58.72
ESTIMATED TIME TO PEAK         (MINS) =    450.00

LINK UC4             27.003

ESTIMATED VOLUME (CU METRES*10**3) =          1327.
ESTIMATED PEAK FLOW         (CUMECS) =     59.82
ESTIMATED TIME TO PEAK         (MINS) =    500.00

LINK GR7              1.004

ESTIMATED VOLUME (CU METRES*10**3) =          6930.
ESTIMATED PEAK FLOW         (CUMECS) =    313.84
ESTIMATED TIME TO PEAK         (MINS) =    580.00

LINK GR9             28.000

ESTIMATED VOLUME (CU METRES*10**3) =           138.9
ESTIMATED PEAK FLOW         (CUMECS) =      9.06
ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK GR8             29.000

ESTIMATED VOLUME (CU METRES*10**3) =           101.9
ESTIMATED PEAK FLOW         (CUMECS) =     11.09
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 ESTIMATED TIME TO PEAK          (MINS) =    340.00

 LINK GR10              1.005

 ESTIMATED VOLUME (CU METRES*10**3) =           7126.
 ESTIMATED PEAK FLOW          (CUMECS) =    316.13
 ESTIMATED TIME TO PEAK          (MINS) =    640.00



##########################################################################
##########
Critical Duration

Results for period from  0: 0.0  1/ 1/1990
                    to 20: 0.0  1/ 1/1990
##########################################################################
##########


                                ROUTING INCREMENT (MINS) =      10.00
                                STORM DURATION (MINS)    =       540.
                                RETURN PERIOD (YRS)      =         5.
                                BX                       =     1.0000
                                TOTAL OF FIRST SUB-AREAS  (ha) =   13734.00
                                TOTAL OF SECOND SUB-AREAS (ha) =   10479.00
                                TOTAL OF ALL SUB-AREAS (ha)    =   24213.00


     SUMMARY OF CATCHMENT AND RAINFALL DATA
 Link      Catch. Area      Slope    % Impervious     Pern        B
Link
 Label      #1     #2     #1    #2      #1   #2     #1    #2    #1   #2
No.
           (ha)             (%)           (%)
BC3       44.000  0.000  1.000 0.000  5.000 0.000  .040 0.00  .2094 0.000
1.000
BC1       58.000  0.000  4.000 0.000  10.00 0.000  .080 0.00  .1753 0.000
2.000
BC2       70.000 32.000  4.000 4.000  5.000 10.00  .040 .080  .1335 .1287
2.001
BC4       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
1.001
BC5       77.000 58.000  5.000 5.000  5.000 10.00  .040 .080  .1255 .1569
3.000
BC6       80.000 56.000  4.000 4.000  5.000 10.00  .040 .080  .1431 .1722
4.000
BC7       120.00 79.000  3.000 3.000  5.000 10.00  .040 .080  .2040 .2377
5.000
BC8       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
1.002
GR3       435.00 360.00  2.000 2.000  5.000 10.00  .040 .080  .4878 .6403
6.000
MC13      54.000 42.000  8.000 8.000  5.000 10.00  .040 .080  .0825 .1049
7.000
MC14      150.00 50.000  2.000 2.000  5.000 10.00  .040 .080  .2804 .2294
8.000
MG1       113.00 577.00  3.000 3.000  5.000 10.00  .040 .080  .1977 .6685
9.000
MC1       451.00 976.00  2.000 2.000  5.000 10.00  .040 .080  .4971 1.075
10.00
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MC2       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
9.001
SC1       306.00 220.00  3.000 3.000  5.000 10.00  .040 .080  .3319 .4049
11.00
MC3       177.00 281.00  7.000 7.000  5.000 10.00  .040 .080  .1636 .3013
12.00
MC4       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
9.002
MC5       557.00 400.00  4.000 4.000  5.000 10.00  .040 .080  .3925 .4786
9.003
MC6       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
9.004
MC7       103.00 46.000  6.000 6.000  5.000 10.00  .040 .080  .1333 .1270
13.00
MC8       34.000 41.000  5.000 5.000  5.000 10.00  .040 .080  .0820 .1310
14.00
LC2       794.00 161.00  2.000 2.000  5.000 10.00  .040 .080  .6671 .4214
15.00
LC1       1044.0 753.00  2.000 2.000  5.000 10.00  .040 .080  .7691 .9399
16.00
LC3       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
15.00
LC4       597.00 184.00  4.000 4.000  5.000 10.00  .040 .080  .4070 .3196
15.00
MC9       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
9.005
MC10      306.00 151.00  3.000 5.000  5.000 10.00  .040 .080  .3319 .2580
17.00
MC11      128.00 82.000  7.000 7.000  5.000 10.00  .040 .080  .1382 .1588
18.00
RYC1      423.00 25.000  2.000 2.000  5.000 10.00  .040 .080  .4808 .1600
19.00
RYC2      916.00 110.00  4.000 4.000  10.00 10.00  .040 .080  .4179 .2446
19.00
RYC3      121.00 92.000  3.000 3.000  5.000 10.00  .040 .080  .2048 .2573
19.00
RYC4      199.00 284.00  5.000 5.000  5.000 10.00  .040 .080  .2056 .3583
19.00
MC12      .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
9.006
MC15      .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
7.001
MC16      64.000 89.000  8.000 8.000  5.000 10.00  .040 .080  .0902 .1550
20.00
MC17      98.000  7.000  4.000 4.000  5.000 10.00  .040 .080  .1590 .0584
21.00
ROC1      359.00 1011.0  1.000 1.000  5.000 10.00  .040 .080  .6239 1.548
22.00
ROC2      300.00 191.00  2.000 2.000  10.00 10.00  .040 .080  .3306 .4605
22.00
SHC1      86.000 516.00  2.000 2.000  5.000 10.00  .040 .080  .2100 .7722
23.00
SHC2      356.00 395.00  2.000 2.000  5.000 10.00  .040 .080  .4395 .6720
23.00
SHC3      .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
22.00
SHC4      540.00 269.00  5.000 5.000  5.000 10.00  .040 .080  .3456 .3484
22.00
SHC5      198.00 309.00  2.000 2.000  5.000 10.00  .040 .080  .3240 .5914
22.00
MC18      .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
7.002
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GR1	292.00	268.00	3.000	3.000	5.000	10.00	.040	.080	.3239	.4486
24.00										
GR2	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000
7.003										
GR4	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000
1.003										
GR5	363.00	223.00	3.000	3.000	5.000	10.00	.040	.080	.3627	.4077
25.00										
GR6	157.00	358.00	2.000	2.000	5.000	10.00	.040	.080	.2872	.6385
26.00										
UC1	642.00	608.00	1.000	1.000	5.000	10.00	.040	.080	.8441	1.188
27.00										
UC2	1776.0	0.000	2.000	0.000	10.00	0.000	.080	0.00	1.468	0.000
27.00										
UC3	384.00	908.00	2.000	2.000	5.000	10.00	.040	.080	.4572	1.035
27.00										
UC4	229.00	.00134	3.000	3.000	5.000	10.00	.040	.080	.2854	.0008
27.00										
GR7	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000
1.004										
GR9	464.00	0.000	2.000	0.000	10.00	0.000	.080	0.00	.7307	0.000
28.00										
GR8	69.000	267.00	4.000	4.000	5.000	10.00	.040	.080	.1325	.3879
29.00										
GR10	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000
1.005										

Link Label	Average Intensity	Init. Loss #1	Init. Loss #2	Cont. Loss #1	Cont. Loss #2	Excess Rain #1	Excess Rain #2	Peak Inflow	Time to Peak	Link Lag
	(mm/h)	(mm)		(mm/h)		(mm)		(m^3/s)		mins
BC3	7.168	20.00	0.000	2.500	0.000	30.472	0.000	1.443	340.0	0.000
BC1	7.168	20.00	0.000	2.500	0.000	30.472	0.000	2.342	340.0	27.00
BC2	7.168	20.00	20.00	2.500	2.500	30.472	30.472	6.238	340.0	0.000
BC4	7.168	20.00	0.000	2.500	0.000	30.472	0.000	7.681	340.0	22.00
BC5	7.168	20.00	20.00	2.500	2.500	30.472	30.472	6.160	330.0	0.000
BC6	7.168	20.00	20.00	2.500	2.500	30.472	30.472	5.970	330.0	0.000
BC7	7.168	20.00	20.00	2.500	2.500	30.472	30.472	7.649	340.0	0.000
BC8	7.168	20.00	0.000	2.500	0.000	30.472	0.000	25.842	340.0	0.000
GR3	7.168	20.00	20.00	2.500	2.500	30.472	30.472	19.381	370.0	0.000
MC13	7.168	20.00	20.00	2.500	2.500	30.472	30.472	4.821	310.0	0.000
MC14	7.168	20.00	20.00	2.500	2.500	30.472	30.472	6.835	340.0	0.000
MG1	7.168	20.00	20.00	2.500	2.500	30.472	30.472	16.454	360.0	0.000
MC1	7.168	20.00	20.00	2.500	2.500	30.472	30.472	27.025	380.0	0.000
MC2	7.168	20.00	0.000	2.500	0.000	30.472	0.000	43.316	370.0	34.00

SC1	7.168	20.00	20.00	2.500	2.500	30.472	30.472	16.961	340.0
0.000									
MC3	7.168	20.00	20.00	2.500	2.500	30.472	30.472	18.840	330.0
0.000									
MC4	7.168	20.00	0.000	2.500	0.000	30.472	0.000	69.247	370.0
78.00									
MC5	7.168	20.00	20.00	2.500	2.500	30.472	30.472	81.563	440.0
0.000									
MC6	7.168	20.00	0.000	2.500	0.000	30.472	0.000	81.563	440.0
50.00									
MC7	7.168	20.00	20.00	2.500	2.500	30.472	30.472	7.032	330.0
0.000									
MC8	7.168	20.00	20.00	2.500	2.500	30.472	30.472	3.482	330.0
0.000									
LC2	7.168	20.00	20.00	2.500	2.500	30.472	30.472	23.854	370.0
0.000									
LC1	7.168	20.00	20.00	2.500	2.500	30.472	30.472	37.185	390.0
0.000									
LC3	7.168	20.00	0.000	2.500	0.000	30.472	0.000	60.516	380.0
50.00									
LC4	7.168	20.00	20.00	2.500	2.500	30.472	30.472	74.032	400.0
0.000									
MC9	7.168	20.00	0.000	2.500	0.000	30.472	0.000	141.22	470.0
39.00									
MC10	7.168	20.00	20.00	2.500	2.500	30.472	30.472	16.785	340.0
0.000									
MC11	7.168	20.00	20.00	2.500	2.500	30.472	30.472	9.799	330.0
0.000									
RYC1	7.168	20.00	20.00	2.500	2.500	30.472	30.472	12.856	360.0
51.00									
RYC2	7.168	20.00	20.00	2.500	2.500	30.472	30.472	43.593	350.0
39.00									
RYC3	7.168	20.00	20.00	2.500	2.500	30.472	30.472	49.246	380.0
22.00									
RYC4	7.168	20.00	20.00	2.500	2.500	30.472	30.472	59.364	400.0
0.000									
MC12	7.168	20.00	0.000	2.500	0.000	30.472	0.000	173.19	430.0
27.00									
MC15	7.168	20.00	0.000	2.500	0.000	30.472	0.000	175.54	460.0
23.00									
MC16	7.168	20.00	20.00	2.500	2.500	30.472	30.472	7.140	320.0
0.000									
MC17	7.168	20.00	20.00	2.500	2.500	30.472	30.472	4.825	330.0
0.000									
ROC1	7.168	20.00	20.00	2.500	2.500	30.472	30.472	17.483	400.0
18.00									
ROC2	7.168	20.00	20.00	2.500	2.500	30.472	30.472	28.888	370.0
0.000									
SHC1	7.168	20.00	20.00	2.500	2.500	30.472	30.472	11.966	370.0
38.00									
SHC2	7.168	20.00	20.00	2.500	2.500	30.472	30.472	29.237	380.0
0.000									
SHC3	7.168	20.00	0.000	2.500	0.000	30.472	0.000	58.018	380.0
51.00									
SHC4	7.168	20.00	20.00	2.500	2.500	30.472	30.472	70.601	410.0
40.00									
SHC5	7.168	20.00	20.00	2.500	2.500	30.472	30.472	78.206	440.0
0.000									
MC18	7.168	20.00	0.000	2.500	0.000	30.472	0.000	248.30	480.0
44.00									
GR1	7.168	20.00	20.00	2.500	2.500	30.472	30.472	17.429	340.0
0.000									

GR2	7.168	20.00	0.000	2.500	0.000	30.472	0.000	251.36	510.0
27.00									
GR4	7.168	20.00	0.000	2.500	0.000	30.472	0.000	258.33	540.0
49.00									
GR5	7.168	20.00	20.00	2.500	2.500	30.472	30.472	18.728	340.0
0.000									
GR6	7.168	20.00	20.00	2.500	2.500	30.472	30.472	12.063	360.0
0.000									
UC1	7.168	20.00	20.00	2.500	2.500	30.472	30.472	18.857	400.0
49.00									
UC2	7.168	20.00	0.000	2.500	0.000	30.472	0.000	42.469	450.0
51.00									
UC3	7.168	20.00	20.00	2.500	2.500	30.472	30.472	58.723	450.0
49.00									
UC4	7.168	20.00	20.00	2.500	2.500	30.472	30.472	59.820	500.0
0.000									
GR7	7.168	20.00	0.000	2.500	0.000	30.472	0.000	313.84	580.0
56.00									
GR9	7.168	20.00	0.000	2.500	0.000	30.472	0.000	9.062	400.0
0.000									
GR8	7.168	20.00	20.00	2.500	2.500	30.472	30.472	11.089	340.0
0.000									
GR10	7.168	20.00	0.000	2.500	0.000	30.472	0.000	316.13	640.0
0.000									

SUMMARY OF BASIN RESULTS

Link Label	Time to Peak	Peak Inflow (m^3/s)	Time to Peak	Peak Outflow (m^3/s)	Total Inflow (m^3)	Basin Vol. Avail	Basin Vol. Used	Basin Stage Used
MC15	460.0	175.5	460.0	174.8	.329E+07	0.0000	85878.5	429.09

SUMMARY OF BASIN OUTLET RESULTS

Link Label	No. of	S/D Factor (m)	Dia (m)	Width (m)	Pipe Length (m)	Pipe Slope (%)
MC15	1.0	1.000		0.000	20.000	0.2000

LINK BC3 1.000
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) = 4.690
ESTIMATED PEAK FLOW (CUMECS) = 0.42
ESTIMATED TIME TO PEAK (MINS) = 380.00

LINK BC1 2.000
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) = 6.273
ESTIMATED PEAK FLOW (CUMECS) = 0.76
ESTIMATED TIME TO PEAK (MINS) = 360.00

LINK BC2 2.001
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) = 17.24
ESTIMATED PEAK FLOW (CUMECS) = 2.18
ESTIMATED TIME TO PEAK (MINS) = 360.00

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LINK BC4              1.001
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          21.93
ESTIMATED PEAK FLOW         (CUMECS) =      2.58
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK BC5              3.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          14.49
ESTIMATED PEAK FLOW         (CUMECS) =      2.27
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK BC6              4.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          14.64
ESTIMATED PEAK FLOW         (CUMECS) =      2.07
ESTIMATED TIME TO PEAK         (MINS) =    350.00

LINK BC7              5.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          21.32
ESTIMATED PEAK FLOW         (CUMECS) =      2.42
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK BC8              1.002
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          72.37
ESTIMATED PEAK FLOW         (CUMECS) =      8.86
ESTIMATED TIME TO PEAK         (MINS) =    360.00

LINK GR3              6.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          83.29
ESTIMATED PEAK FLOW         (CUMECS) =      5.49
ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK MC13             7.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          10.28
ESTIMATED PEAK FLOW         (CUMECS) =      2.02
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK MC14             8.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          21.32
ESTIMATED PEAK FLOW         (CUMECS) =      2.05
ESTIMATED TIME TO PEAK         (MINS) =    380.00
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LINK MG1               9.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          72.60
ESTIMATED PEAK FLOW         (CUMECS) =      4.72
ESTIMATED TIME TO PEAK         (MINS) =    390.00

LINK MC1              10.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          146.0
ESTIMATED PEAK FLOW         (CUMECS) =      7.34
ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK MC2               9.001
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          218.6
ESTIMATED PEAK FLOW         (CUMECS) =     11.99
ESTIMATED TIME TO PEAK         (MINS) =    390.00

LINK SC1              11.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          56.05
ESTIMATED PEAK FLOW         (CUMECS) =      5.08
ESTIMATED TIME TO PEAK         (MINS) =    390.00

LINK MC3              12.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          49.11
ESTIMATED PEAK FLOW         (CUMECS) =      6.25
ESTIMATED TIME TO PEAK         (MINS) =    350.00

LINK MC4               9.002
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          323.1
ESTIMATED PEAK FLOW         (CUMECS) =     20.96
ESTIMATED TIME TO PEAK         (MINS) =    390.00

LINK MC5               9.003
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          422.8
ESTIMATED PEAK FLOW         (CUMECS) =     26.46
ESTIMATED TIME TO PEAK         (MINS) =    450.00

LINK MC6               9.004
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          422.8
ESTIMATED PEAK FLOW         (CUMECS) =     26.46
ESTIMATED TIME TO PEAK         (MINS) =    450.00
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LINK MC7              13.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          16.02
ESTIMATED PEAK FLOW         (CUMECS) =      2.77
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK MC8              14.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          8.105
ESTIMATED PEAK FLOW         (CUMECS) =      1.38
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK LC2              15.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          100.3
ESTIMATED PEAK FLOW         (CUMECS) =      6.60
ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK LC1              16.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          185.5
ESTIMATED PEAK FLOW         (CUMECS) =      9.80
ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK LC3              15.001
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          285.8
ESTIMATED PEAK FLOW         (CUMECS) =     16.40
ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK LC4              15.002
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          367.9
ESTIMATED PEAK FLOW         (CUMECS) =     21.48
ESTIMATED TIME TO PEAK         (MINS) =    420.00

LINK MC9               9.005
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          812.8
ESTIMATED PEAK FLOW         (CUMECS) =     44.27
ESTIMATED TIME TO PEAK         (MINS) =    490.00

LINK MC10             17.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          48.82
ESTIMATED PEAK FLOW         (CUMECS) =      5.07
ESTIMATED TIME TO PEAK         (MINS) =    370.00
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LINK MC11             18.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          22.57
ESTIMATED PEAK FLOW         (CUMECS) =      3.81
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK RYC1             19.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          47.61
ESTIMATED PEAK FLOW         (CUMECS) =      3.71
ESTIMATED TIME TO PEAK         (MINS) =    390.00

LINK RYC2             19.001
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          156.9
ESTIMATED PEAK FLOW         (CUMECS) =     14.54
ESTIMATED TIME TO PEAK         (MINS) =    380.00

LINK RYC3             19.002
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          179.5
ESTIMATED PEAK FLOW         (CUMECS) =     16.19
ESTIMATED TIME TO PEAK         (MINS) =    420.00

LINK RYC4             19.003
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          231.0
ESTIMATED PEAK FLOW         (CUMECS) =     19.33
ESTIMATED TIME TO PEAK         (MINS) =    430.00

LINK MC12              9.006
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          1112.
ESTIMATED PEAK FLOW         (CUMECS) =     54.56
ESTIMATED TIME TO PEAK         (MINS) =    510.00

LINK MC15              7.001
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          1141.
ESTIMATED PEAK FLOW         (CUMECS) =     55.57
ESTIMATED TIME TO PEAK         (MINS) =    460.00

LINK MC16             20.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          16.33
ESTIMATED PEAK FLOW         (CUMECS) =      2.84
ESTIMATED TIME TO PEAK         (MINS) =    340.00
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LINK MC17             21.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          11.19
ESTIMATED PEAK FLOW         (CUMECS) =      1.71
ESTIMATED TIME TO PEAK         (MINS) =    340.00

LINK ROC1             22.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          126.1
ESTIMATED PEAK FLOW         (CUMECS) =      4.40
ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK ROC2             22.001
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          177.6
ESTIMATED PEAK FLOW         (CUMECS) =      8.49
ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK SHC1             23.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          61.39
ESTIMATED PEAK FLOW         (CUMECS) =      3.34
ESTIMATED TIME TO PEAK         (MINS) =    390.00

LINK SHC2             23.001
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          139.4
ESTIMATED PEAK FLOW         (CUMECS) =      8.29
ESTIMATED TIME TO PEAK         (MINS) =    410.00

LINK SHC3             22.002
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          316.9
ESTIMATED PEAK FLOW         (CUMECS) =     16.77
ESTIMATED TIME TO PEAK         (MINS) =    400.00

LINK SHC4             22.003
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          400.3
ESTIMATED PEAK FLOW         (CUMECS) =     21.64
ESTIMATED TIME TO PEAK         (MINS) =    430.00

LINK SHC5             22.004
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          450.6
ESTIMATED PEAK FLOW         (CUMECS) =     24.18
ESTIMATED TIME TO PEAK         (MINS) =    470.00
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LINK MC18              7.002
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          1614.
ESTIMATED PEAK FLOW         (CUMECS) =     79.18
ESTIMATED TIME TO PEAK         (MINS) =    480.00

LINK GR1              24.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          59.41
ESTIMATED PEAK FLOW         (CUMECS) =      5.24
ESTIMATED TIME TO PEAK         (MINS) =    380.00

LINK GR2               7.003
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          1665.
ESTIMATED PEAK FLOW         (CUMECS) =     80.82
ESTIMATED TIME TO PEAK         (MINS) =    520.00

LINK GR4               1.003
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          1813.
ESTIMATED PEAK FLOW         (CUMECS) =     84.06
ESTIMATED TIME TO PEAK         (MINS) =    550.00

LINK GR5              25.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          62.47
ESTIMATED PEAK FLOW         (CUMECS) =      5.59
ESTIMATED TIME TO PEAK         (MINS) =    390.00

LINK GR6              26.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          53.68
ESTIMATED PEAK FLOW         (CUMECS) =      3.56
ESTIMATED TIME TO PEAK         (MINS) =    390.00

LINK UC1              27.000
WARNING 8 - LOSSES POSS. EXCEED RAIN
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          121.6
ESTIMATED PEAK FLOW         (CUMECS) =      4.57
ESTIMATED TIME TO PEAK         (MINS) =    420.00

LINK UC2              27.001
WARNING 8 - LOSSES POSS. EXCEED RAIN

ESTIMATED VOLUME (CU METRES*10**3) =          291.9
ESTIMATED PEAK FLOW         (CUMECS) =     10.24
ESTIMATED TIME TO PEAK         (MINS) =    450.00

LINK UC3              27.002
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 WARNING 8 - LOSSES POSS. EXCEED RAIN
 WARNING 8 - LOSSES POSS. EXCEED RAIN

 ESTIMATED VOLUME (CU METRES*10**3) =           420.6
 ESTIMATED PEAK FLOW         (CUMECS) =     15.52
 ESTIMATED TIME TO PEAK         (MINS) =    460.00

 LINK UC4              27.003
 WARNING 8 - LOSSES POSS. EXCEED RAIN
 WARNING 8 - LOSSES POSS. EXCEED RAIN

 ESTIMATED VOLUME (CU METRES*10**3) =           439.9
 ESTIMATED PEAK FLOW         (CUMECS) =     16.06
 ESTIMATED TIME TO PEAK         (MINS) =    500.00

 LINK GR7               1.004
 WARNING 8 - LOSSES POSS. EXCEED RAIN

 ESTIMATED VOLUME (CU METRES*10**3) =           2354.
 ESTIMATED PEAK FLOW         (CUMECS) =    100.36
 ESTIMATED TIME TO PEAK         (MINS) =    600.00

 LINK GR9              28.000
 WARNING 8 - LOSSES POSS. EXCEED RAIN

 ESTIMATED VOLUME (CU METRES*10**3) =           47.25
 ESTIMATED PEAK FLOW         (CUMECS) =      2.29
 ESTIMATED TIME TO PEAK         (MINS) =    400.00

 LINK GR8              29.000
 WARNING 8 - LOSSES POSS. EXCEED RAIN
 WARNING 8 - LOSSES POSS. EXCEED RAIN

 ESTIMATED VOLUME (CU METRES*10**3) =           35.31
 ESTIMATED PEAK FLOW         (CUMECS) =      3.30
 ESTIMATED TIME TO PEAK         (MINS) =    360.00

 LINK GR10              1.005
 WARNING 8 - LOSSES POSS. EXCEED RAIN

 ESTIMATED VOLUME (CU METRES*10**3) =           2406.
 ESTIMATED PEAK FLOW         (CUMECS) =    101.53
 ESTIMATED TIME TO PEAK         (MINS) =    660.00



##########################################################################
##########
Critical Duration

Results for period from  0: 0.0  1/ 1/1990
                    to 20: 0.0  1/ 1/1990
##########################################################################
##########

                              ROUTING INCREMENT (MINS) =      10.00
                              STORM DURATION (MINS)    =       540.
                              RETURN PERIOD (YRS)      =         1.
                              BX                       =    1.0000
                              TOTAL OF FIRST SUB-AREAS  (ha) =   13734.00
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TOTAL OF SECOND SUB-AREAS (ha) = 10479.00
TOTAL OF ALL SUB-AREAS (ha) = 24213.00

SUMMARY OF CATCHMENT AND RAINFALL DATA

Link Label	Catch. Area (ha) #1	Catch. Area (ha) #2	Slope (%) #1	Slope (%) #2	% Impervious #1	% Impervious #2	Pern #1	Pern #2	B #1	B #2	Link No.
BC3	44.000	0.000	1.000	0.000	5.000	0.000	.040	0.00	.2094	0.000	1.000
BC1	58.000	0.000	4.000	0.000	10.00	0.000	.080	0.00	.1753	0.000	2.000
BC2	70.000	32.000	4.000	4.000	5.000	10.00	.040	.080	.1335	.1287	2.001
BC4	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	1.001
BC5	77.000	58.000	5.000	5.000	5.000	10.00	.040	.080	.1255	.1569	3.000
BC6	80.000	56.000	4.000	4.000	5.000	10.00	.040	.080	.1431	.1722	4.000
BC7	120.00	79.000	3.000	3.000	5.000	10.00	.040	.080	.2040	.2377	5.000
BC8	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	1.002
GR3	435.00	360.00	2.000	2.000	5.000	10.00	.040	.080	.4878	.6403	6.000
MC13	54.000	42.000	8.000	8.000	5.000	10.00	.040	.080	.0825	.1049	7.000
MC14	150.00	50.000	2.000	2.000	5.000	10.00	.040	.080	.2804	.2294	8.000
MG1	113.00	577.00	3.000	3.000	5.000	10.00	.040	.080	.1977	.6685	9.000
MC1	451.00	976.00	2.000	2.000	5.000	10.00	.040	.080	.4971	1.075	10.00
MC2	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	9.001
SC1	306.00	220.00	3.000	3.000	5.000	10.00	.040	.080	.3319	.4049	11.00
MC3	177.00	281.00	7.000	7.000	5.000	10.00	.040	.080	.1636	.3013	12.00
MC4	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	9.002
MC5	557.00	400.00	4.000	4.000	5.000	10.00	.040	.080	.3925	.4786	9.003
MC6	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	9.004
MC7	103.00	46.000	6.000	6.000	5.000	10.00	.040	.080	.1333	.1270	13.00
MC8	34.000	41.000	5.000	5.000	5.000	10.00	.040	.080	.0820	.1310	14.00
LC2	794.00	161.00	2.000	2.000	5.000	10.00	.040	.080	.6671	.4214	15.00
LC1	1044.0	753.00	2.000	2.000	5.000	10.00	.040	.080	.7691	.9399	16.00
LC3	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	15.00
LC4	597.00	184.00	4.000	4.000	5.000	10.00	.040	.080	.4070	.3196	15.00
MC9	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	9.005

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MC10      306.00 151.00  3.000 5.000  5.000 10.00  .040 .080  .3319 .2580
17.00
MC11      128.00 82.000  7.000 7.000  5.000 10.00  .040 .080  .1382 .1588
18.00
RYC1      423.00 25.000  2.000 2.000  5.000 10.00  .040 .080  .4808 .1600
19.00
RYC2      916.00 110.00  4.000 4.000  10.00 10.00  .040 .080  .4179 .2446
19.00
RYC3      121.00 92.000  3.000 3.000  5.000 10.00  .040 .080  .2048 .2573
19.00
RYC4      199.00 284.00  5.000 5.000  5.000 10.00  .040 .080  .2056 .3583
19.00
MC12      .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
9.006
MC15      .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
7.001
MC16      64.000 89.000  8.000 8.000  5.000 10.00  .040 .080  .0902 .1550
20.00
MC17      98.000  7.000  4.000 4.000  5.000 10.00  .040 .080  .1590 .0584
21.00
ROC1      359.00 1011.0  1.000 1.000  5.000 10.00  .040 .080  .6239 1.548
22.00
ROC2      300.00 191.00  2.000 2.000  10.00 10.00  .040 .080  .3306 .4605
22.00
SHC1      86.000 516.00  2.000 2.000  5.000 10.00  .040 .080  .2100 .7722
23.00
SHC2      356.00 395.00  2.000 2.000  5.000 10.00  .040 .080  .4395 .6720
23.00
SHC3      .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
22.00
SHC4      540.00 269.00  5.000 5.000  5.000 10.00  .040 .080  .3456 .3484
22.00
SHC5      198.00 309.00  2.000 2.000  5.000 10.00  .040 .080  .3240 .5914
22.00
MC18      .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
7.002
GR1       292.00 268.00  3.000 3.000  5.000 10.00  .040 .080  .3239 .4486
24.00
GR2       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
7.003
GR4       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
1.003
GR5       363.00 223.00  3.000 3.000  5.000 10.00  .040 .080  .3627 .4077
25.00
GR6       157.00 358.00  2.000 2.000  5.000 10.00  .040 .080  .2872 .6385
26.00
UC1       642.00 608.00  1.000 1.000  5.000 10.00  .040 .080  .8441 1.188
27.00
UC2       1776.0  0.000  2.000 0.000  10.00 0.000  .080 0.00  1.468 0.000
27.00
UC3       384.00 908.00  2.000 2.000  5.000 10.00  .040 .080  .4572 1.035
27.00
UC4       229.00 .00134  3.000 3.000  5.000 10.00  .040 .080  .2854 .0008
27.00
GR7       .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
1.004
GR9       464.00  0.000  2.000 0.000  10.00 0.000  .080 0.00  .7307 0.000
28.00
GR8       69.000 267.00  4.000 4.000  5.000 10.00  .040 .080  .1325 .3879
29.00
GR10      .00001  0.000  .0010 0.000  0.000 0.000  .025 0.00  .0021 0.000
1.005
```

Link Label	Average Intensity	Init. Loss #1	Init. Loss #2	Cont. Loss #1	Cont. Loss #2	Excess Rain #1	Excess Rain #2	Peak Inflow	Time to Peak	Link Lag
	(mm/h)	(mm)		(mm/h)		(mm)		(m^3/s)	mins	
BC3	4.419	20.00	0.000	2.500	0.000	10.778	0.000	0.4249	380.0	0.000
BC1	4.419	20.00	0.000	2.500	0.000	10.778	0.000	0.7566	360.0	27.00
BC2	4.419	20.00	20.00	2.500	2.500	10.778	10.778	2.181	360.0	0.000
BC4	4.419	20.00	0.000	2.500	0.000	10.778	0.000	2.580	360.0	22.00
BC5	4.419	20.00	20.00	2.500	2.500	10.778	10.778	2.271	340.0	0.000
BC6	4.419	20.00	20.00	2.500	2.500	10.778	10.778	2.065	350.0	0.000
BC7	4.419	20.00	20.00	2.500	2.500	10.778	10.778	2.424	360.0	0.000
BC8	4.419	20.00	0.000	2.500	0.000	10.778	0.000	8.856	360.0	0.000
GR3	4.419	20.00	20.00	2.500	2.500	10.778	10.778	5.491	400.0	0.000
MC13	4.419	20.00	20.00	2.500	2.500	10.778	10.778	2.022	340.0	0.000
MC14	4.419	20.00	20.00	2.500	2.500	10.778	10.778	2.049	380.0	0.000
MG1	4.419	20.00	20.00	2.500	2.500	10.778	10.778	4.724	390.0	0.000
MC1	4.419	20.00	20.00	2.500	2.500	10.778	10.778	7.342	400.0	0.000
MC2	4.419	20.00	0.000	2.500	0.000	10.778	0.000	11.985	390.0	34.00
SC1	4.419	20.00	20.00	2.500	2.500	10.778	10.778	5.080	390.0	0.000
MC3	4.419	20.00	20.00	2.500	2.500	10.778	10.778	6.248	350.0	0.000
MC4	4.419	20.00	0.000	2.500	0.000	10.778	0.000	20.962	390.0	78.00
MC5	4.419	20.00	20.00	2.500	2.500	10.778	10.778	26.455	450.0	0.000
MC6	4.419	20.00	0.000	2.500	0.000	10.778	0.000	26.455	450.0	50.00
MC7	4.419	20.00	20.00	2.500	2.500	10.778	10.778	2.772	340.0	0.000
MC8	4.419	20.00	20.00	2.500	2.500	10.778	10.778	1.376	340.0	0.000
LC2	4.419	20.00	20.00	2.500	2.500	10.778	10.778	6.600	400.0	0.000
LC1	4.419	20.00	20.00	2.500	2.500	10.778	10.778	9.800	400.0	0.000
LC3	4.419	20.00	0.000	2.500	0.000	10.778	0.000	16.400	400.0	50.00
LC4	4.419	20.00	20.00	2.500	2.500	10.778	10.778	21.476	420.0	0.000
MC9	4.419	20.00	0.000	2.500	0.000	10.778	0.000	44.269	490.0	39.00
MC10	4.419	20.00	20.00	2.500	2.500	10.778	10.778	5.074	370.0	0.000

MC11	4.419	20.00	20.00	2.500	2.500	10.778	10.778	3.814	340.0
0.000									
RYC1	4.419	20.00	20.00	2.500	2.500	10.778	10.778	3.705	390.0
51.00									
RYC2	4.419	20.00	20.00	2.500	2.500	10.778	10.778	14.542	380.0
39.00									
RYC3	4.419	20.00	20.00	2.500	2.500	10.778	10.778	16.190	420.0
22.00									
RYC4	4.419	20.00	20.00	2.500	2.500	10.778	10.778	19.327	430.0
0.000									
MC12	4.419	20.00	0.000	2.500	0.000	10.778	0.000	54.565	510.0
27.00									
MC15	4.419	20.00	0.000	2.500	0.000	10.778	0.000	55.574	460.0
23.00									
MC16	4.419	20.00	20.00	2.500	2.500	10.778	10.778	2.842	340.0
0.000									
MC17	4.419	20.00	20.00	2.500	2.500	10.778	10.778	1.714	340.0
0.000									
ROC1	4.419	20.00	20.00	2.500	2.500	10.778	10.778	4.395	400.0
18.00									
ROC2	4.419	20.00	20.00	2.500	2.500	10.778	10.778	8.489	400.0
0.000									
SHC1	4.419	20.00	20.00	2.500	2.500	10.778	10.778	3.343	390.0
38.00									
SHC2	4.419	20.00	20.00	2.500	2.500	10.778	10.778	8.287	410.0
0.000									
SHC3	4.419	20.00	0.000	2.500	0.000	10.778	0.000	16.766	400.0
51.00									
SHC4	4.419	20.00	20.00	2.500	2.500	10.778	10.778	21.644	430.0
40.00									
SHC5	4.419	20.00	20.00	2.500	2.500	10.778	10.778	24.179	470.0
0.000									
MC18	4.419	20.00	0.000	2.500	0.000	10.778	0.000	79.182	480.0
44.00									
GR1	4.419	20.00	20.00	2.500	2.500	10.778	10.778	5.244	380.0
0.000									
GR2	4.419	20.00	0.000	2.500	0.000	10.778	0.000	80.824	520.0
27.00									
GR4	4.419	20.00	0.000	2.500	0.000	10.778	0.000	84.058	550.0
49.00									
GR5	4.419	20.00	20.00	2.500	2.500	10.778	10.778	5.586	390.0
0.000									
GR6	4.419	20.00	20.00	2.500	2.500	10.778	10.778	3.559	390.0
0.000									
UC1	4.419	20.00	20.00	2.500	2.500	10.778	10.778	4.571	420.0
49.00									
UC2	4.419	20.00	0.000	2.500	0.000	10.778	0.000	10.242	450.0
51.00									
UC3	4.419	20.00	20.00	2.500	2.500	10.778	10.778	15.518	460.0
49.00									
UC4	4.419	20.00	20.00	2.500	2.500	10.778	10.778	16.059	500.0
0.000									
GR7	4.419	20.00	0.000	2.500	0.000	10.778	0.000	100.36	600.0
56.00									
GR9	4.419	20.00	0.000	2.500	0.000	10.778	0.000	2.288	400.0
0.000									
GR8	4.419	20.00	20.00	2.500	2.500	10.778	10.778	3.297	360.0
0.000									
GR10	4.419	20.00	0.000	2.500	0.000	10.778	0.000	101.53	660.0
0.000									

SUMMARY OF BASIN RESULTS

Link Label	Time to Peak	Peak Inflow (m^3/s)	Time to Peak	Peak Outflow (m^3/s)	Total Inflow (m^3)	Basin Vol. Avail	Basin Vol. Used	Basin Stage Used
MC15	460.0	55.57	470.0	55.36	.114E+07	0.0000	50895.9	428.63

SUMMARY OF BASIN OUTLET RESULTS

Link Label	No. of	S/D Factor (m)	Dia (m)	Width (m)	Pipe Length (m)	Pipe Slope (%)
MC15	1.0	1.000		0.000	20.000	0.2000

Run completed at: 21st March 2006 10:57:37

mik open 0

APPENDIX E
HEC-RAS MODEL OUTPUT FOR EXISTING CONDITIONS

HEC-RAS Model Results for Existing Conditions with 0% Culvert/Bridge Blockage

River	Reach	River Sta	Profile	Q Total	Mann Wtd Left	Mann Wtd Chnl	Mann Wtd Rght	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Flow Area	Top Width	Froude # Channel
				(m3/s)				(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m2)	(m)	
Bora_Ck	1	1.1	5_Year_ARI	25.8		0.045		408.38	409.37	409.37	409.7	0.023923		2.55		10.14	15.69	**1.01**
Bora_Ck	1	1.1	20_Year_ARI	36.8		0.045		408.38	409.56	409.56	409.95	0.022529		2.78		13.22	17.07	**1.01**
Bora_Ck	1	1.1	100_Year_ARI	49.2		0.045		408.38	409.74	409.74	410.19	0.021314		2.98		16.51	18.43	**1.01**
Bora_Ck	1	1.1	100_yr_Bora_tc	50.4		0.045		408.38	409.76	409.76	410.22	0.02136		3		16.78	18.54	**1.01**
Bora_Ck	1	1.2		Culvert														
Bora_Ck	1	1.3	5_Year_ARI	25.8	0.04	0.04	0.04	409.30	413.76	410.52	413.76	0.000014	0.05	0.16	0.05	177.62	127.86	**0.03**
Bora_Ck	1	1.3	20_Year_ARI	36.8	0.04	0.04	0.04	409.30	415.69	410.71	415.69	0.000002	0.04	0.09	0.05	540.38	242.37	**0.01**
Bora_Ck	1	1.3	100_Year_ARI	49.2	0.04	0.04	0.04	409.30	415.84	410.9	415.84	0.000003	0.06	0.11	0.06	576.38	249.47	**0.02**
Bora_Ck	1	1.3	100_yr_Bora_tc	50.4	0.04	0.04	0.04	409.30	415.85	410.92	415.86	0.000003	0.06	0.12	0.06	579.92	250.34	**0.02**
Bora_Ck	1	2	5_Year_ARI	7.7		0.1		417.80	418.23	418.23	418.38	0.151188		1.7		4.52	15.56	**1.01**
Bora_Ck	1	2	20_Year_ARI	11		0.1		417.8	418.32	418.32	418.49	0.143684		1.84		5.97	17.53	**1.01**
Bora_Ck	1	2	100_Year_ARI	14.6		0.1		417.8	418.4	418.4	418.6	0.138255		1.96		7.44	19.34	**1.01**
Bora_Ck	1	2	100_yr_Bora_tc	15		0.1		417.8	418.41	418.41	418.61	0.137738		1.97		7.6	19.52	**1.01**
Bora_Ck	1	3	5_Year_ARI	7.7		0.1	0.05	426.85	427.87	427.37	427.88	0.004732		0.45	0.07	17.21	33.76	**0.2**
Bora_Ck	1	3	20_Year_ARI	11	0.05	0.1	0.05	426.85	427.99	427.46	428	0.004784	0.17	0.51	0.24	21.74	41.95	**0.2**
Bora_Ck	1	3	100_Year_ARI	14.6	0.05	0.1	0.05	426.85	428.09	427.53	428.11	0.004811	0.29	0.57	0.34	26.46	49.37	**0.21**
Bora_Ck	1	3	100_yr_Bora_tc	15	0.05	0.1	0.05	426.85	428.1	427.54	428.12	0.004815	0.3	0.57	0.35	26.96	50.11	**0.21**
Bora_Ck	2	3.6	5_Year_ARI	4.7		0.04		435.52	435.77	435.77	435.84	0.03094		1.11		4.22	33.18	**1**
Bora_Ck	2	3.6	20_Year_ARI	6.4		0.04		435.52	435.81	435.81	435.88	0.029656		1.18		5.41	37.63	**0.99**
Bora_Ck	2	3.6	100_Year_ARI	8.3		0.04		435.52	435.84	435.84	435.92	0.028968		1.23		6.72	42.99	**1**
Bora_Ck	2	3.6	100_yr_Bora_tc	12.3		0.04		435.52	435.89	435.89	435.98	0.029282		1.34		9.15	51.87	**1.02**
Bora_Ck	2	5	5_Year_ARI	4.7		0.04		440.59	440.79	440.76	440.83	0.018867		0.96		4.91	33.32	**0.8**
Bora_Ck	2	5	20_Year_ARI	6.4		0.04		440.59	440.82	440.8	440.88	0.019515		1.07		5.98	35.17	**0.83**
Bora_Ck	2	5	100_Year_ARI	8.3		0.04		440.59	440.85	440.83	440.92	0.019924		1.17		7.08	36.99	**0.85**
Bora_Ck	2	5	100_yr_Bora_tc	12.3		0.04		440.59	440.9	440.88	440.99	0.019772		1.34		9.21	39.29	**0.88**
Bora_Ck	2	6	5_Year_ARI	4.7		0.1		451.45	452.69	452.47	452.81	0.052742		1.53		3.06	4.92	**0.62**
Bora_Ck	2	6	20_Year_ARI	6.4		0.1		451.45	452.85	452.61	452.99	0.051274		1.64		3.9	5.56	**0.62**
Bora_Ck	2	6	100_Year_ARI	8.3		0.1		451.45	453	452.73	453.16	0.05084		1.74		4.76	6.13	**0.63**
Bora_Ck	2	6	100_yr_Bora_tc	12.3		0.1		451.45	453.23	452.95	453.43	0.053687		1.96		6.26	7.04	**0.66**
Bora_Ck	2	7	5_Year_ARI	2.3		0.1		464.84	465.43	465.24	465.45	0.020334		0.63		3.67	12.55	**0.37**
Bora_Ck	2	7	20_Year_ARI	3.3		0.1		464.84	465.51	465.3	465.53	0.021254		0.7		4.73	14.25	**0.39**
Bora_Ck	2	7	100_Year_ARI	4.4		0.1		464.84	465.58	465.35	465.61	0.021433		0.75		5.85	15.85	**0.39**
Bora_Ck	2	7	100_yr_Bora_tc	4.8		0.1		464.84	465.65	465.36	465.67	0.016197		0.69		6.94	17.25	**0.35**
Goulburn_River	1	1	5_Year_ARI	316.1	0.1	0.11	0.1	381.93	388.87	385.58	388.98	0.003206	1.03	1.64	0.94	235.41	66.03	**0.21**
Goulburn_River	1	1	20_Year_ARI	502.4	0.1	0.11	0.1	381.93	390.19	386.43	390.33	0.003206	1.26	1.87	1.11	330.63	75.71	**0.22**
Goulburn_River	1	1	100_Year_ARI	757.7	0.1	0.11	0.1	381.93	391.6	387.36	391.77	0.003201	1.54	2.1	1.24	443.33	84.12	**0.23**
Goulburn_River	1	1	100_yr_Bora_tc	757.7	0.1	0.11	0.1	381.93	391.6	387.36	391.77	0.003201	1.54	2.1	1.24	443.33	84.12	**0.23**
Goulburn_River	1	2.1	5_Year_ARI	316.1	0.1	0.11	0.1	384.45	390.05		390.12	0.00282	0.5	1.37	0.83	287.73	124.36	**0.19**
Goulburn_River	1	2.1	20_Year_ARI	502.4	0.1	0.11	0.1	384.45	391.31		391.39	0.002423	0.69	1.47	0.7	506.81	215.53	**0.19**
Goulburn_River	1	2.1	100_Year_ARI	757.7	0.1	0.11	0.1	384.45	392.58		392.63	0.001657	0.63	1.38	0.81	796.72	251.22	**0.16**
Goulburn_River	1	2.1	100_yr_Bora_tc	757.7	0.1	0.11	0.1	384.45	392.58		392.63	0.001657	0.63	1.38	0.81	796.72	251.22	**0.16**
Goulburn_River	1	2.2		Bridge														
Goulburn_River	1	2.3	5_Year_ARI	316.1	0.1	0.11	0.1	384.62	390.71	388.92	390.89	0.008969	0.66	1.95	0.99	185.87	86.2	**0.33**
Goulburn_River	1	2.3	20_Year_ARI	502.4	0.1	0.11	0.1	384.62	391.65	389.76	391.85	0.008258	0.91	2.18	1.04	291.72	136.34	**0.33**
Goulburn_River	*1*	2.3	100_Year_ARI	757.7	0.1	0.11	0.1	384.62	392.75	390.54	392.92	0.006057	1.03	2.16	1.13	473.63	186.94	**0.29**
Goulburn_River	1	2.3	100_yr_Bora_tc	757.7	0.1	0.11	0.1	384.62	392.75	390.54	392.92	0.006057	1.03	2.16	1.13	473.63	186.94	**0.29**
Goulburn_River	1	3	5_Year_ARI	313.8	0.1	0.11		385.82	393.4		393.54	0.0039	0.14	1.66		189.61	31.25	**0.21**
Goulburn_River	1	3	20_Year_ARI	499.4	0.1	0.11	0.1	385.82	394.7		394.93	0.005359	0.54	2.16	0.12	231.97	33.71	**0.26**
Goulburn_River	1	3	100_Year_ARI	753.6	0.1	0.11	0.1	385.82	395.76		396.16	0.007693	0.89	2.84	0.42	268.86	36.2	**0.31**
Goulburn_River	1	3	100_yr_Bora_tc	753.6	0.1	0.11	0.1	385.82	395.76		396.16	0.007693	0.89	2.84	0.42	268.86	36.2	**0.31**
Goulburn_River	1	4	5_Year_ARI	313.8	0.1	0.11	0.1	387.68	394.79		394.85	0.001704	0.78	1.3	0.56	344.97	133.53	**0.16**
Goulburn_River	1	4	20_Year_ARI	499.4	0.1	0.11	0.1	387.68	396.19		396.24	0.001379	0.84	1.32	0.62	576.13	193.09	**0.15**
Goulburn_River	1	4	100_Year_ARI	753.6	0.1	0.11	0.1	387.68	397.47		397.52	0.001212	0.88	1.37	0.7	851.57	236.19	**0.14**
Goulburn_River	1	4	100_yr_Bora_tc	753.6	0.1	0.11	0.1	387.68	397.47		397.52	0.001212	0.88	1.37	0.7	851.57	236.19	**0.14**

River	Reach	River Sta	Profile	Q Total	Mann Wtd Left	Mann Wtd Chnl	Mann Wtd Rght	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Flow Area	Top Width	Froude # Channel
Goulburn_River	1	5	5_Year_ARI	313.8	0.1	0.11		389.64	396.54		396.59	0.001567	0.71	1.1		338.28	94.14	**0.15**
Goulburn_River	1	5	20_Year_ARI	499.4	0.1	0.11	0.1	389.64	397.8		397.87	0.001696	0.84	1.29	0.25	472.7	119.59	**0.16**
Goulburn_River	1	5	100_Year_ARI	753.6	0.1	0.11	0.1	389.64	399.02		399.11	0.001839	0.97	1.5	0.45	632.64	143.98	**0.17**
Goulburn_River	1	5	100_yr_Bora_tc	753.6	0.1	0.11	0.1	389.64	399.02		399.11	0.001839	0.97	1.5	0.45	632.64	143.98	**0.17**
Goulburn_River	1	5.5	5_Year_ARI	258.3	0.1	0.11	0.1	390.94	396.94		396.97	0.000914	0.28	0.79	0.45	416.77	156.92	**0.11**
Goulburn_River	1	5.5	20_Year_ARI	411.7	0.1	0.11	0.1	390.94	398.2		398.22	0.000752	0.33	0.83	0.54	623.42	172.94	**0.1**
Goulburn_River	1	5.5	100_Year_ARI	617.6	0.1	0.11	0.1	390.94	399.44		399.47	0.000706	0.4	0.91	0.64	847.36	189.24	**0.1**
Goulburn_River	1	5.5	100_yr_Bora_tc	617.6	0.1	0.11	0.1	390.94	399.44		399.47	0.000706	0.4	0.91	0.64	847.36	189.24	**0.1**
Goulburn_River	1	5.6	5_Year_ARI	258.3	0.1	0.11	0.1	392	397.18		397.19	0.000531	0.26	0.51	0.35	676.12	353.47	**0.08**
Goulburn_River	1	5.6	20_Year_ARI	411.7	0.1	0.11	0.1	392	398.37		398.37	0.00032	0.29	0.48	0.36	1126.29	405.02	**0.07**
Goulburn_River	1	5.6	100_Year_ARI	617.6	0.1	0.11	0.1	392	399.58		399.59	0.000246	0.31	0.48	0.38	1654.74	466.58	**0.06**
Goulburn_River	1	5.6	100_yr_Bora_tc	617.6	0.1	0.11	0.1	392	399.58		399.59	0.000246	0.31	0.48	0.38	1654.74	466.58	**0.06**
Goulburn_River	1	6	5_Year_ARI	258.3	0.1	0.11		393.89	397.86		397.95	0.006174	0.39	1.42		235.64	268.11	**0.27**
Goulburn_River	1	6	20_Year_ARI	411.7	0.1	0.11		393.89	398.76		398.81	0.002954	0.61	1.14		485.23	285.43	**0.19**
Goulburn_River	1	6	100_Year_ARI	617.6	0.1	0.11		393.89	399.86		399.89	0.001465	0.56	0.93		912.95	415.49	**0.14**
Goulburn_River	1	6	100_yr_Bora_tc	617.6	0.1	0.11		393.89	399.86		399.89	0.001465	0.56	0.93		912.95	415.49	**0.14**
Goulburn_River	1	6.5	5_Year_ARI	258.3	0.1	0.11	0.1	394.87	398.92		398.96	0.002315	0.56	0.95	0.45	359.21	234.54	**0.17**
Goulburn_River	1	6.5	20_Year_ARI	411.7	0.1	0.11	0.1	394.87	399.51		399.55	0.002383	0.69	1.08	0.57	500.14	242.41	**0.18**
Goulburn_River	1	6.5	100_Year_ARI	617.6	0.1	0.11	0.1	394.87	400.32		400.36	0.001936	0.81	1.11	0.59	698.33	251.3	**0.16**
Goulburn_River	1	6.5	100_yr_Bora_tc	617.6	0.1	0.11	0.1	394.87	400.32		400.36	0.001936	0.81	1.11	0.59	698.33	251.3	**0.16**
Goulburn_River	1	7.1	5_Year_ARI	258.3	0.1	0.11	0.1	395.84	399.7		399.73	0.001753	0.12	0.77	0.2	347.27	156.36	**0.14**
Goulburn_River	1	7.1	20_Year_ARI	411.7	0.1	0.11	0.1	395.84	400.36		400.41	0.002105	0.26	0.95	0.43	457.12	170.19	**0.16**
Goulburn_River	1	7.1	100_Year_ARI	617.6	0.1	0.11	0.1	395.84	401.11		401.17	0.002307	0.29	1.13	0.57	601.86	218.78	**0.18**
Goulburn_River	1	7.1	100_yr_Bora_tc	617.6	0.1	0.11	0.1	395.84	401.11		401.17	0.002307	0.29	1.13	0.57	601.86	218.78	**0.18**
Goulburn_River	1	7.2		Bridge														
Goulburn_River	1	7.3	5_Year_ARI	258.3		0.11		395.88	400.54	399.32	400.67	0.009887		1.59		162.45	143.01	**0.33**
Goulburn_River	1	7.3	20_Year_ARI	411.7	0.1	0.11	0.1	395.88	401.17	399.73	401.37	0.011429	0.28	2	0.35	207.02	160.56	**0.37**
Goulburn_River	1	7.3	100_Year_ARI	617.6	0.1	0.11	0.1	395.88	403.23	400.21	403.3	0.00449	0.79	1.28	0.74	523.4	217.12	**0.23**
Goulburn_River	1	7.3	100_yr_Bora_tc	617.6	0.1	0.11	0.1	395.88	403.23	400.21	403.3	0.00449	0.79	1.28	0.74	523.4	217.12	**0.23**
Goulburn_River	1	8	5_Year_ARI	258.3	0.035	0.1	0.035	397.22	402.4		402.44	0.001327	0.39	0.89	0.56	293.5	104.91	**0.14**
Goulburn_River	1	8	20_Year_ARI	411.7	0.035	0.1	0.035	397.22	403.26		403.31	0.001418	1.05	1.05	0.95	395.31	128.93	**0.15**
Goulburn_River	1	8	100_Year_ARI	617.6	0.035	0.1	0.035	397.22	404.44		404.5	0.001071	1.46	1.06	1.15	560.36	155.94	**0.14**
Goulburn_River	1	8	100_yr_Bora_tc	617.6	0.035	0.1	0.035	397.22	404.44		404.5	0.001071	1.46	1.06	1.15	560.36	155.94	**0.14**
Goulburn_River	1	9	5_Year_ARI	258.3		0.035		400.44	404.85		405.32	0.002559		3.05		84.76	23.1	**0.51**
Goulburn_River	1	9	20_Year_ARI	411.7		0.035		400.44	405.89		406.61	0.003106		3.76		109.5	24.48	**0.57**
Goulburn_River	1	9	100_Year_ARI	617.6		0.035		400.44	406.64		407.82	0.004543		4.82		128.22	26.05	**0.69**
Goulburn_River	1	9	100_yr_Bora_tc	617.6		0.035		400.44	406.64		407.82	0.004543		4.82		128.22	26.05	**0.69**
Goulburn_River	2	9.5	5_Year_ARI	251.4		0.035		400.99	405.64		405.91	0.001231		2.29		109.96	27.43	**0.36**
Goulburn_River	2	9.5	20_Year_ARI	402.5		0.035		400.99	406.92		407.3	0.001395		2.75		146.47	29.81	**0.4**
Goulburn_River	2	9.5	100_Year_ARI	602.9		0.035		400.99	408.17		408.72	0.001607		3.26		185.09	31.69	**0.43**
Goulburn_River	2	9.5	100_yr_Bora_tc	602.9		0.035		400.99	408.17		408.72	0.001607		3.26		185.09	31.69	**0.43**
Goulburn_River	2	10	5_Year_ARI	251.4		0.035		402.68	406.18		406.38	0.001359		1.98		126.96	47.82	**0.39**
Goulburn_River	2	10	20_Year_ARI	402.5		0.035		402.68	407.52		407.73	0.000987		2.06		195.41	54.19	**0.35**
Goulburn_River	2	10	100_Year_ARI	602.9		0.035		402.68	408.9		409.15	0.000837		2.19		275.04	61.08	**0.33**
Goulburn_River	2	10	100_yr_Bora_tc	602.9		0.035		402.68	408.9		409.15	0.000837		2.19		275.04	61.08	**0.33**
Goulburn_River	2	10.5	5_Year_ARI	251.4	0.035	0.035	0.035	404.01	406.59		406.79	0.002066	2.1	2.06	1	132.73	91.55	**0.46**
Goulburn_River	2	10.5	20_Year_ARI	402.5	0.035	0.035	0.035	404.01	407.83		407.97	0.000834	1.72	1.8	1.14	256.14	101.64	**0.32**
Goulburn_River	2	10.5	100_Year_ARI	602.9	0.035	0.035	0.035	404.01	409.19		409.31	0.000489	1.58	1.75	1.26	396.98	105.28	**0.26**
Goulburn_River	2	10.5	100_yr_Bora_tc	602.9	0.035	0.035	0.035	404.01	409.19		409.31	0.000489	1.58	1.75	1.26	396.98	105.28	**0.26**
Goulburn_River	2	11	5_Year_ARI	251.4		0.035		405.34	407.93		408.09	0.001401		1.79		140.2	63.7	**0.39**
Goulburn_River	2	11	20_Year_ARI	402.5		0.035		405.34	408.61		408.85	0.001522		2.18		184.31	65.94	**0.42**
Goulburn_River	2	11	100_Year_ARI	602.9		0.035		405.34	409.65		409.94	0.001252		2.37		254.89	69.39	**0.39**
Goulburn_River	2	11	100_yr_Bora_tc	602.9		0.035		405.34	409.65		409.94	0.001252		2.37		254.89	69.39	**0.39**
Goulburn_River	2	11.5	5_Year_ARI	248.3	0.035	0.1		407.83	410.21		410.35	0.012597	1.87	1.64		149.45	103.26	**0.39**
Goulburn_River	2	11.5	20_Year_ARI	397.8	0.035	0.1		407.83	410.87		411.04	0.008847	2.27	1.68		224.33	123.53	**0.35**

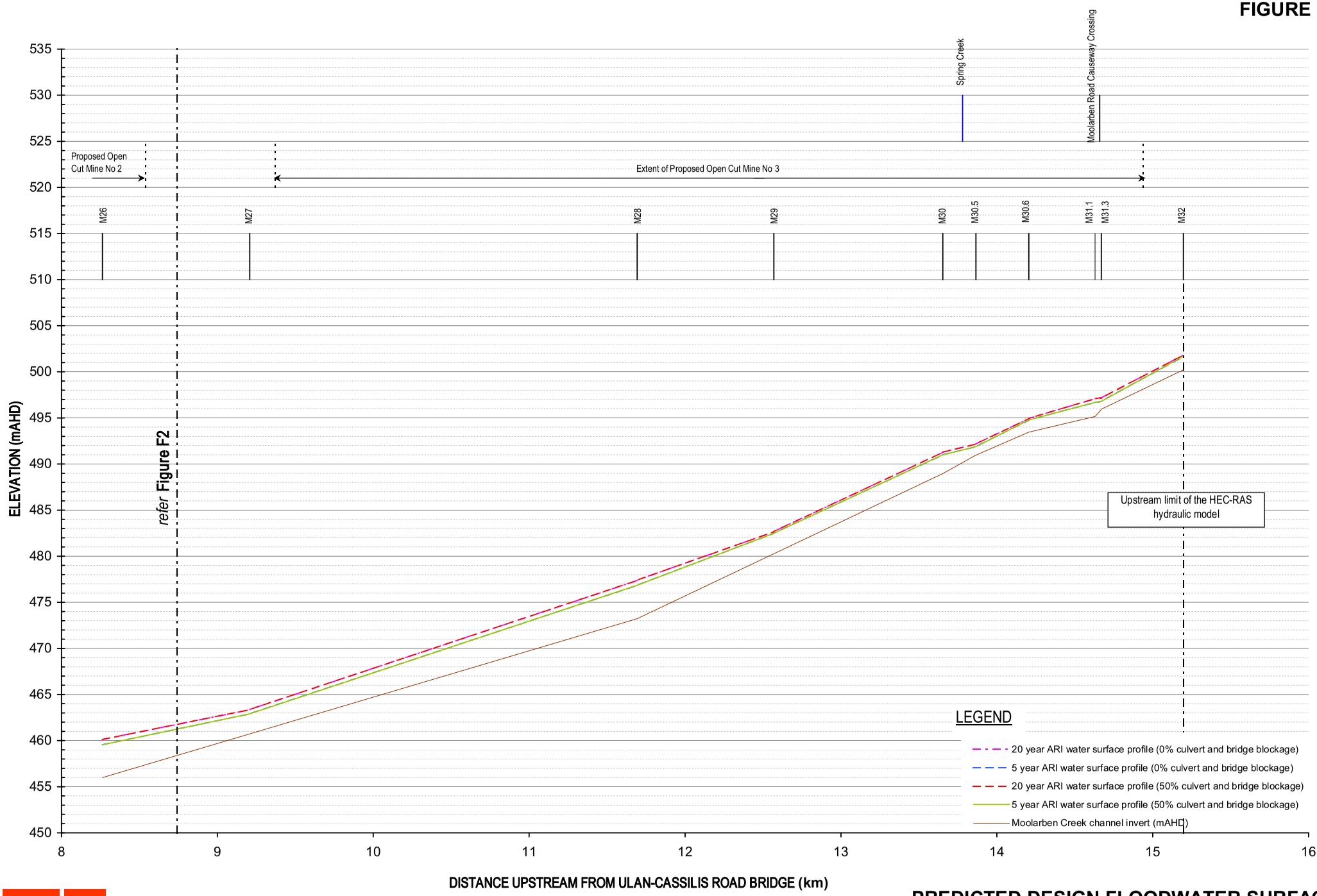
River	Reach	River Sta	Profile	Q Total	Mann Wtd Left	Mann Wtd Chnl	Mann Wtd Rght	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Flow Area	Top Width	Froude # Channel
Goulburn_River	2	11.5	100_Year_ARI	595.5	0.035	0.1		407.83	411.51		411.72	0.007041	2.55	1.74		310.03	143.27	**0.32**
Goulburn_River	2	11.5	100_yr_Bora_tc	595.5	0.035	0.1		407.83	411.51		411.72	0.007041	2.55	1.74		310.03	143.27	**0.32**
Goulburn_River	2	12	5_Year_ARI	248.3	0.035	0.1		408.46	411.02		411.09	0.001385	1.28	0.64		235.57	152.22	**0.13**
Goulburn_River	2	12	20_Year_ARI	397.8	0.035	0.1		408.46	411.59		411.68	0.001303	1.44	0.71		328.82	173.58	**0.13**
Goulburn_River	2	12	100_Year_ARI	595.5	0.035	0.1		408.46	412.19		412.3	0.001236	1.59	0.77		439.93	196.02	**0.13**
Goulburn_River	2	12	100_yr_Bora_tc	595.5	0.035	0.1		408.46	412.19		412.3	0.001236	1.59	0.77		439.93	196.02	**0.13**
Goulburn_River	2	12.5	5_Year_ARI	248.3		0.1		410	411.85		411.93	0.009895		1.23		202.13	147.09	**0.33**
Goulburn_River	2	12.5	20_Year_ARI	397.8		0.1		410	412.37		412.47	0.009305		1.41		281.91	159.04	**0.34**
Goulburn_River	2	12.5	100_Year_ARI	595.5		0.1		410.00	412.93		413.06	0.008966		1.59		374.42	171.65	**0.34**
Goulburn_River	2	12.5	100_yr_Bora_tc	595.5		0.1		410	412.93		413.06	0.008966		1.59		374.42	171.65	**0.34**
Goulburn_River	2	12.6	5_Year_ARI	248.3	0.035	0.1	0.035	410	412.65		412.71	0.001384	1.25	0.69	1.06	247.45	165.46	**0.14**
Goulburn_River	2	12.6	20_Year_ARI	397.8	0.035	0.1	0.035	410.00	413.16		413.25	0.001397	1.48	0.78	1.1	339.85	198.1	**0.14**
Goulburn_River	2	12.6	100_Year_ARI	595.5	0.035	0.1	0.035	410.00	413.71		413.81	0.001363	1.64	0.86	1.14	461.97	248.19	**0.15**
Goulburn_River	2	12.6	100_yr_Bora_tc	595.5	0.035	0.1	0.035	410.00	413.71		413.81	0.001363	1.64	0.86	1.14	461.97	248.19	**0.15**
Goulburn_River	2	13	5_Year_ARI	248.3	0.035	0.1	0.035	410.23	413.02		413.18	0.005073	1.96	1.27	1.85	149.29	133.23	**0.26**
Goulburn_River	2	13	20_Year_ARI	397.8	0.035	0.1	0.035	410.23	413.5		413.69	0.004082	1.79	1.28	2.08	217.93	155.1	**0.24**
Goulburn_River	2	13	100_Year_ARI	595.5	0.035	0.1	0.035	410.23	414.01		414.23	0.003436	1.81	1.31	2.24	302.79	179.53	**0.23**
Goulburn_River	2	13	100_yr_Bora_tc	595.5	0.035	0.1	0.035	410.23	414.01		414.23	0.003436	1.81	1.31	2.24	302.79	179.53	**0.23**
Goulburn_River	2	13.5	5_Year_ARI	248.3	0.035	0.1		411.98	414.94		415.14	0.007516	2.3	1.47		132.85	102.25	**0.31**
Goulburn_River	2	13.5	20_Year_ARI	397.8	0.035	0.1		411.98	415.27		415.6	0.009217	2.91	1.74		168.81	114.15	**0.35**
Goulburn_River	2	13.5	100_Year_ARI	595.5	0.035	0.1		411.98	415.6		416.1	0.010842	3.52	1.99		208.45	125.57	**0.39**
Goulburn_River	2	13.5	100_yr_Bora_tc	595.5	0.035	0.1		411.98	415.6		416.1	0.010842	3.52	1.99		208.45	125.57	**0.39**
Goulburn_River	2	14	5_Year_ARI	248.3	0.035	0.1	0.035	412.15	415.43		415.49	0.001045	1.21	0.65	1.23	235.89	132.13	**0.12**
Goulburn_River	2	14	20_Year_ARI	397.8	0.035	0.1	0.035	412.15	415.92		416.02	0.001211	1.32	0.78	1.54	305.14	144.66	**0.14**
Goulburn_River	2	14	100_Year_ARI	595.5	0.035	0.1	0.035	412.15	416.44		416.58	0.001352	1.48	0.91	1.84	382.68	156.56	**0.15**
Goulburn_River	2	14	100_yr_Bora_tc	595.5	0.035	0.1	0.035	412.15	416.44		416.58	0.001352	1.48	0.91	1.84	382.68	156.56	**0.15**
Goulburn_River	2	14.5	5_Year_ARI	248.3	0.035	0.1	0.035	413.68	416.06		416.21	0.021152	0.61	1.79	1.56	143.29	221.71	**0.49**
Goulburn_River	2	14.5	20_Year_ARI	397.8	0.035	0.1	0.035	413.68	416.54		416.67	0.008486	1.6	1.38	1.97	254.83	245.31	**0.33**
Goulburn_River	2	14.5	100_Year_ARI	595.5	0.035	0.1	0.035	413.68	417.02		417.16	0.004994	1.7	1.24	2.04	381.08	278.31	**0.26**
Goulburn_River	2	14.5	100_yr_Bora_tc	595.5	0.035	0.1	0.035	413.68	417.02		417.16	0.004994	1.7	1.24	2.04	381.08	278.31	**0.26**
Goulburn_River	2	15	5_Year_ARI	248.3	0.035	0.1	0.035	414.96	417.75		417.79	0.002561	1.25	0.85	0.42	266.23	190.03	**0.18**
Goulburn_River	2	15	20_Year_ARI	397.8	0.035	0.1	0.035	414.96	418.04		418.13	0.00349	1.69	1.09	0.67	327.75	232.65	**0.22**
Goulburn_River	2	15	100_Year_ARI	595.5	0.035	0.1	0.035	414.96	418.32		418.46	0.004325	2.18	1.3	1.03	396.42	261.21	**0.25**
Goulburn_River	2	15	100_yr_Bora_tc	595.5	0.035	0.1	0.035	414.96	418.32		418.46	0.004325	2.18	1.3	1.03	396.42	261.21	**0.25**
Goulburn_River	2	15.5	5_Year_ARI	248.3	0.035	0.1	0.035	415.99	418.38		418.54	0.008906	2.04	1.35	0.89	153.56	164.77	**0.33**
Goulburn_River	2	15.5	20_Year_ARI	397.8	0.035	0.1	0.035	415.99	418.75		418.95	0.007167	2.36	1.37	1.08	222.2	228.9	**0.3**
Goulburn_River	2	15.5	100_Year_ARI	595.5	0.035	0.1	0.035	415.99	419.11		419.33	0.006317	2.49	1.43	1.41	315	278.63	**0.29**
Goulburn_River	2	15.5	100_yr_Bora_tc	595.5	0.035	0.1	0.035	415.99	419.11		419.33	0.006317	2.49	1.43	1.41	315	278.63	**0.29**
Goulburn_River	2	16.1	5_Year_ARI	248.3	0.035	0.1	0.035	414.89	419.14		419.24	0.002813	1.48	1.2	1.48	171.9	157.94	**0.2**
Goulburn_River	2	16.1	20_Year_ARI	397.8	0.035	0.1	0.035	414.89	419.5		419.65	0.003074	1.79	1.34	1.37	233.33	185.46	**0.21**
Goulburn_River	2	16.1	100_Year_ARI	595.5	0.035	0.1	0.035	414.89	419.83		420.04	0.003502	2.1	1.5	1.24	305.21	238.49	**0.23**
Goulburn_River	2	16.1	100_yr_Bora_tc	595.5	0.035	0.1	0.035	414.89	419.83		420.04	0.003502	2.1	1.5	1.24	305.21	238.49	**0.23**
Goulburn_River	2	16.2		Bridge														
Goulburn_River	2	17.1	5_Year_ARI	248.3	0.035	0.1	0.035	416.29	421.35	420.18	421.39	0.001442	0.95	0.52	0.41	278.35	336.27	**0.13**
Goulburn_River	2	17.1	20_Year_ARI	397.8	0.035	0.1	0.035	416.29	421.56	421.01	421.63	0.001793	1.22	0.63	0.44	351.02	371.69	**0.15**
Goulburn_River	2	17.1	100_Year_ARI	595.5	0.035	0.1	0.035	416.29	421.79	421.2	421.89	0.002051	1.47	0.73	0.66	437.55	391.39	**0.16**
Goulburn_River	2	17.1	100_yr_Bora_tc	595.5	0.035	0.1	0.035	416.29	421.79	421.2	421.89	0.002051	1.47	0.73	0.66	437.55	391.39	**0.16**
Goulburn_River	2	17.2		Bridge														
Goulburn_River	2	17.3	5_Year_ARI	248.3	0.035	0.1	0.035	416.59	421.82	420.45	421.86	0.001353	0.72	0.76	1.23	304.67	406.01	**0.14**
Goulburn_River	2	17.3	20_Year_ARI	397.8	0.035	0.1	0.035	416.59	422.05	421.49	422.1	0.001584	0.96	0.87	1.24	401.87	432.15	**0.15**
Goulburn_River	2	17.3	100_Year_ARI	595.5	0.035	0.1	0.035	416.59	422.29	421.75	422.36	0.001814	1.22	0.97	1.09	509.25	474.49	**0.17**
Goulburn_River	2	17.3	100_yr_Bora_tc	595.5	0.035	0.1	0.035	416.59	422.29	421.75	422.36	0.001814	1.22	0.97	1.09	509.25	474.49	**0.17**
Goulburn_River	2	17.5	5_Year_ARI	175.5	0.055	0.1	0.055	418	422.18		422.2	0.001269	0.59	0.81	0.39	261.17	234.51	**0.14**
Goulburn_River	2	17.5	20_Year_ARI	282.6	0.055	0.1	0.055	418	422.5		422.54	0.001778	0.72	1.02	0.52	348.79	297.82	**0.17**
Goulburn_River	2	17.5	100_Year_ARI	423.1	0.055	0.1	0.055	418	422.8		422.85	0.002002	0.91	1.14	0.6	442.13	318.13	**0.18**

River	Reach	River Sta	Profile	Q Total	Mann Wtd Left	Mann Wtd Chnl	Mann Wtd Rght	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Flow Area	Top Width	Froude # Channel
Goulburn_River	2	17.5	100_yr_Bora_tc	423.1	0.055	0.1	0.055	418	422.8		422.85	0.002002	0.91	1.14	0.6	442.13	318.13	**0.18**
Goulburn_River	2	18	5_Year_ARI	175.5	0.1	0.1	0.1	418.55	422.71		422.77	0.002865	0.24	1.09	0.42	185.57	108.33	**0.2**
Goulburn_River	2	18	20_Year_ARI	282.6	0.1	0.1	0.1	418.55	423.22		423.31	0.003745	0.36	1.39	0.6	248.27	134.09	**0.24**
Goulburn_River	2	18	100_Year_ARI	423.1	0.1	0.1	0.1	418.55	423.65		423.78	0.004884	0.5	1.71	0.82	309.64	149.98	**0.28**
Goulburn_River	2	18	100_yr_Bora_tc	423.1	0.1	0.1	0.1	418.55	423.65		423.78	0.004884	0.5	1.71	0.82	309.64	149.98	**0.28**
Goulburn_River	2	19	5_Year_ARI	175.5	0.1	0.1		420.46	424.66		424.76	0.006808	0.8	1.45		125.34	58.97	**0.3**
Goulburn_River	2	19	20_Year_ARI	282.6	0.1	0.1	0.1	420.46	425.45		425.59	0.006489	0.98	1.68	0.33	181.99	91.26	**0.31**
Goulburn_River	2	19	100_Year_ARI	423.1	0.1	0.1	0.1	420.46	426.2		426.36	0.006143	1.12	1.89	0.66	259.27	113.75	**0.31**
Goulburn_River	2	19	100_yr_Bora_tc	423.1	0.1	0.1	0.1	420.46	426.2		426.36	0.006143	1.12	1.89	0.66	259.27	113.75	**0.31**
Other_Ck	1	3.5	5_Year_ARI	1.4		0.04		432.44	432.63	432.63	432.67	0.034199		0.95		1.47	15.69	**0.99**
Other_Ck	1	3.5	20_Year_ARI	2.2		0.04		432.44	432.66	432.66	432.72	0.036109		1.09		2.02	18.4	**1.05**
Other_Ck	1	3.5	100_Year_ARI	3		0.04		432.44	432.69	432.69	432.76	0.031642		1.12		2.68	21.19	**1.01**
Other_Ck	1	3.5	100_yr_Bora_tc	2.9		0.04		432.44	432.69	432.69	432.75	0.032335		1.12		2.59	20.84	**1.01**
Other_Ck	1	4	5_Year_ARI	1.4		0.04		436.87	437.05	437	437.06	0.006362		0.43		3.22	31.68	**0.43**
Other_Ck	1	4	20_Year_ARI	2.2		0.04		436.87	437.09	437.02	437.1	0.006205		0.49		4.45	35.34	**0.44**
Other_Ck	1	4	100_Year_ARI	3		0.04		436.87	437.11	437.04	437.13	0.006582		0.55		5.42	37.98	**0.47**
Other_Ck	1	4	100_yr_Bora_tc	2.9		0.04		436.87	437.11	437.04	437.12	0.006523		0.55		5.31	37.69	**0.46**

APPENDIX F

PREDICTED WATER SURFACE PROFILES FOR THE 5 & 20 YEAR RECURRENCE FLOODS FOR EXISTING CONDITIONS

FIGURE F1



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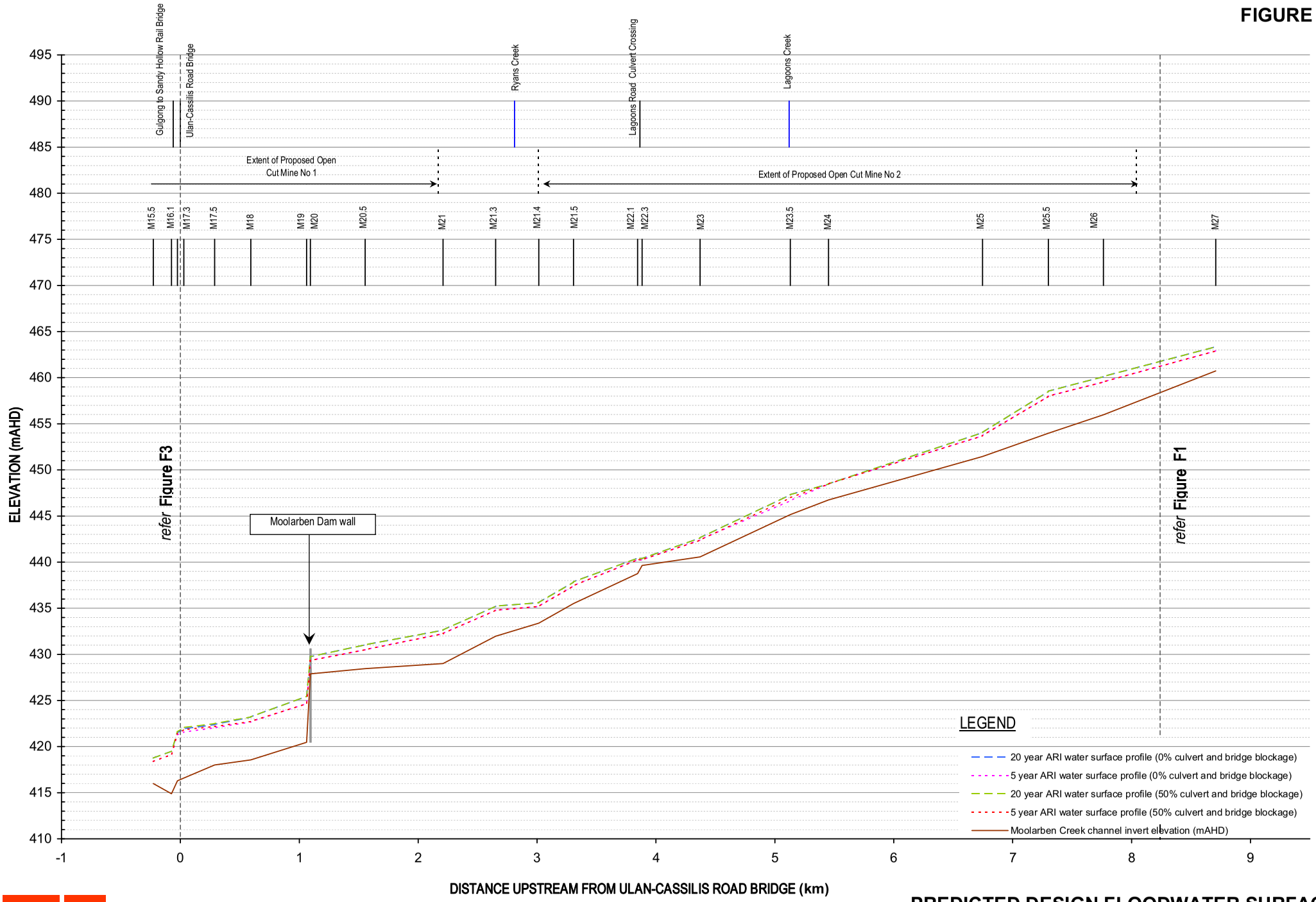
rp6173.00_Moolarben Creek FIA
fg6173_djt060321-WSP.xls
Fig-WSP MC upper 5&20

PREDICTED DESIGN FLOODWATER SURFACE PROFILES FOR THE UPPER REACHES OF MOOLARBEN CREEK

FIGURE F2



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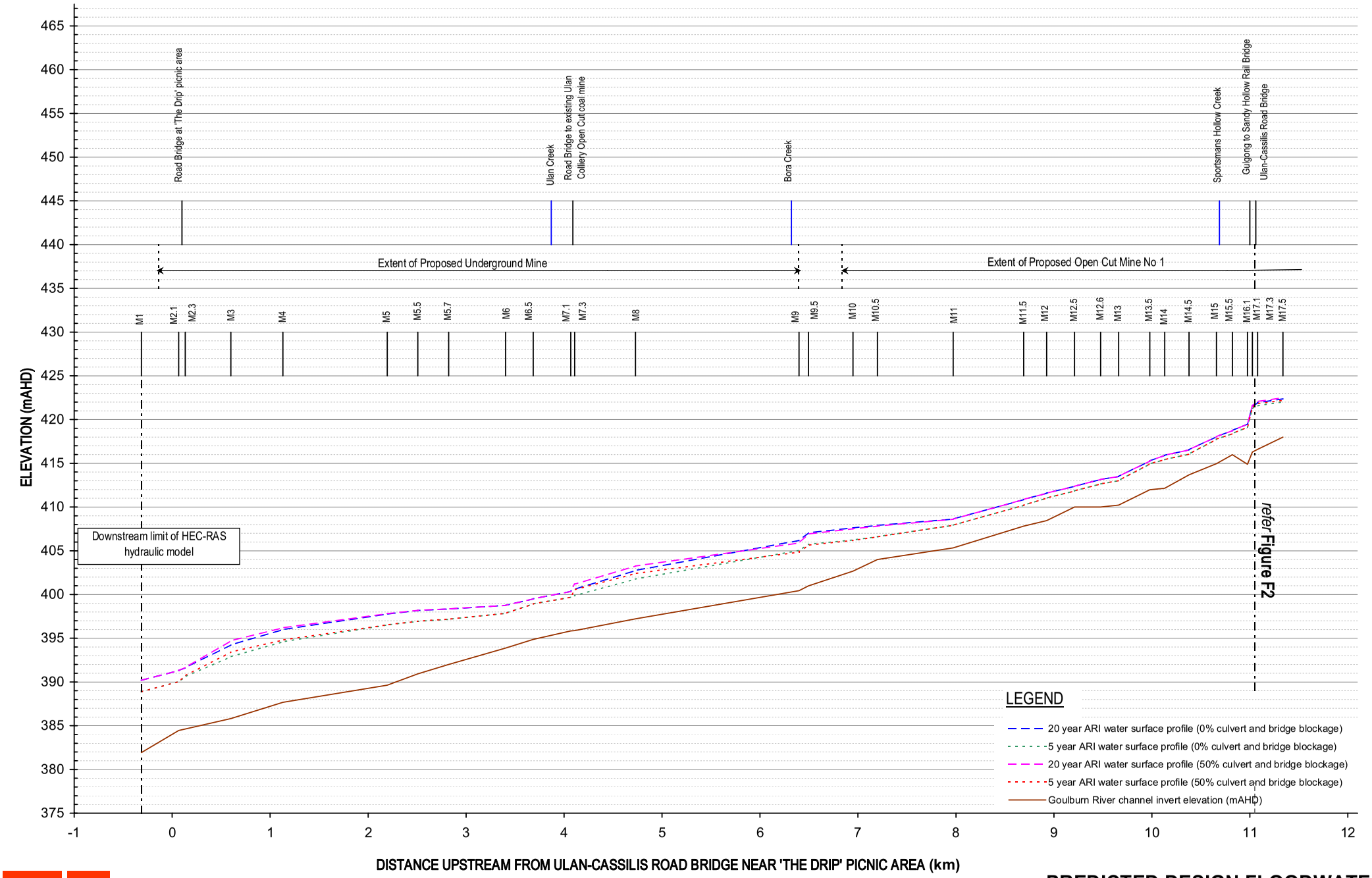
rp6173.00_Moolarben Creek FIA
fg6173_djt060321-WSP.xls
Fig-WSP MC lower 5&20

PREDICTED DESIGN FLOODWATER SURFACE PROFILES FOR THE LOWER REACHES OF MOOLARBEN CREEK

FIGURE F3



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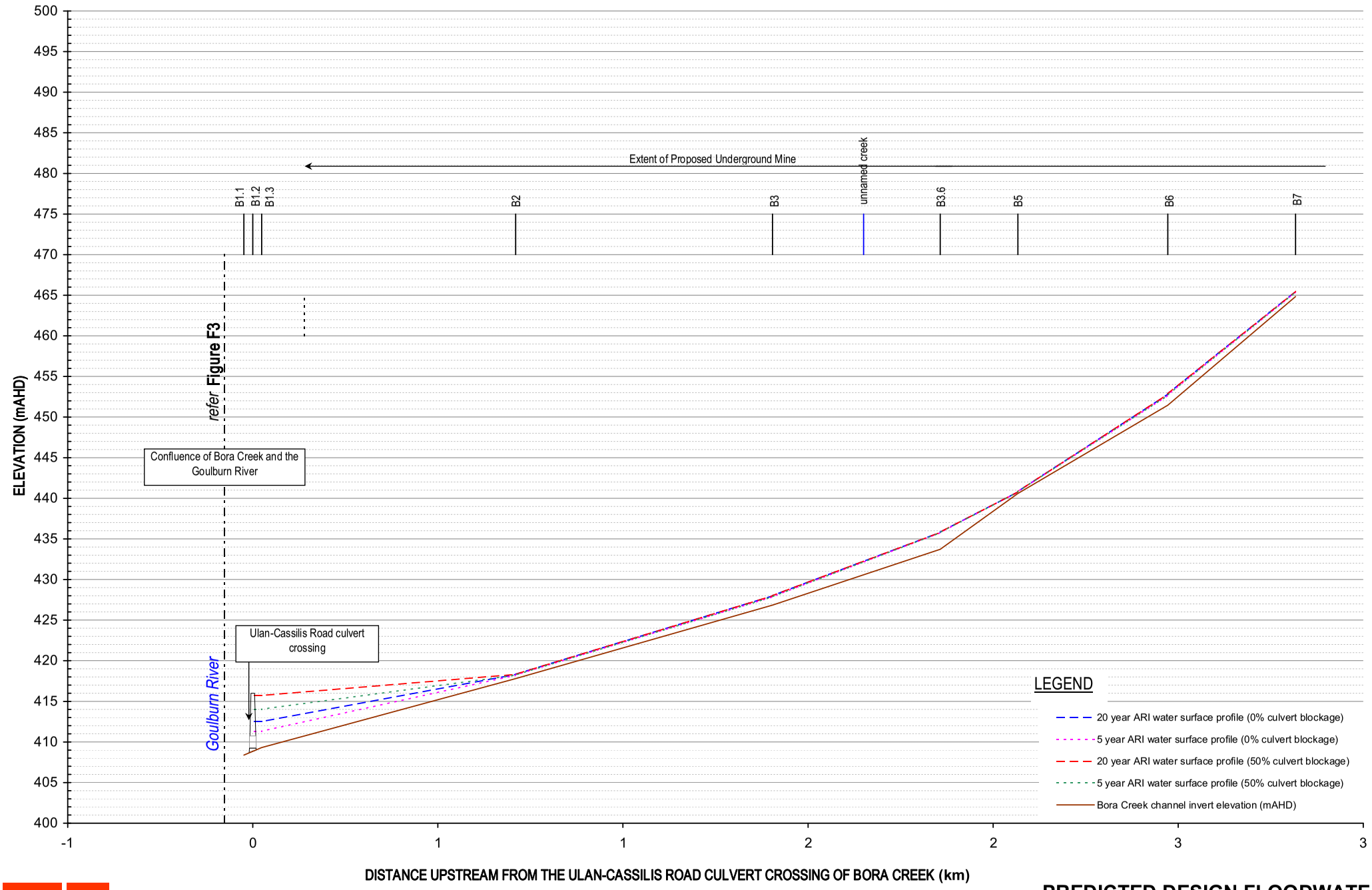
rp6173.00 Moolarben FIA
fg6173_djt060321-WSP.xls
Fig-WSP GR 5&20

PREDICTED DESIGN FLOODWATER SURFACE PROFILES FOR THE GOULBURN RIVER

FIGURE F4



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rp6173.00 Moolarben FIA
fg6173_djt060321-WSP.xls
Fig-WSP BC 5&20

PREDICTED DESIGN FLOODWATER SURFACE PROFILES FOR BORA CREEK