Hutchinson
CONSULTING ENGINEERS

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Our Ref: L20145c

9 April 2018

Dean and Kim Munro
Three Blokes Limited
PO Box 170
Matakana 0948

Dear Dean and Kim,

RE: SITE SPECIFIC HYDRAULIC ANALYSIS AT 362 MATAKANA VALLEY ROAD, MATAKANA (PT ALLOT 51 PSH OF MATAKANA SO 1044) FOR THREE BLOKES LTD

1 INTRODUCTION

This office has been engaged to assess the effects of a stormwater overland flow path passing through the site at the above address and to complete a site specific hydraulic analysis. This report has been prepared to address the S72/73 notice requirement that has been raised during the building consent process for the proposed development.

2 SITE DESCRIPTION

The site is located at No 362 Matakana Valley Road, Matakana. The site is located on the north eastern side of the road and is around 2km from the Matakana Township.

The site has a total land area of around 2.7 Ha and comprises an irregular shaped portion of land. The property encompasses a timber sales yard known as the Matakana Sawmill, comprising timber storage and processing sheds.

The following presents an aerial graphic of the site and the Auckland Council identified overland flow paths. These overland flow paths, and the water depths therein during high intensity rainfall events, are the main focus of this report.

Figure 1 Overland Flow Paths

3 HYDRAULIC ANALYSIS CATCHMENT CHARACTERISTICS

The catchment upstream of the subject site is 6.38km² (638 Ha) and is generally covered in pasture, bush and some impervious areas. The catchment was modelled in the HEC-HMS software package, with four sub-catchments, in accordance with TP-108 – *Guidelines for stormwater runoff modelling in the Auckland Region*.

Three of the sub-catchments combine upstream of the subject site and enter the site along the northern boundary. The remaining sub-catchment enters the subject site from the west. The runoff from all four sub-catchments combines on the subject site and continues due south beyond the site.

The overall catchment was divided into four sub-catchments and the respective characteristics modelled accordingly. A summary of areas used in the model presented in Table 1 below.

Table 1 Catchment Areas

Sub-Catchment No	Gross Area	Bush Area	Grass Area	Impervious Area
Sub catchment 1	0.473km²	0.195km²	0.228km²	0.05km²
Sub catchment 2	0.844km²	0.438km²	0.326km²	0.08km²
Sub catchment 3	3.039km²	2.099km²	0.640km²	0.30km²
Sub catchment 4	2.023km²	1.077km²	0.746km²	0.20km²
Total	6.38 km²			

A catchment plan has been prepared and is enclosed with the appendices of this document.

The land use covering runoff coefficients (SCS numbers) and lag times employed in the analysis are summarised and presented below in Table 2.

Table 2 Run off coefficients & Lag times

Land Use	SCS CN	Lag (min)
Pasture	74	28 - 59 min
Bush	70	29 - 62 min
Impervious gravel	89	23 - 49 min

The precipitation (rain data) was selected from the rainfall graphs presented in TP-108 – *Guidelines for Stormwater Runoff Modelling in the Auckland Region*. The precipitation employed in the catchment analysis is presented in Table 3 below.

Table 3 Rain Data

Rain Data	TP108	Climate Change Adjusted
0.05 AEP (1 n 20yr)	230 mm	230 x 1.151 = 264 mm
0.01 AEP (1 n 100yr)	300 mm	300 x 1.168 = 350 mm

4 HYDRAULIC ANALYSIS CATCHMENT RESULTS

The catchment was modelled in the HEC-HMS software package and was used to determine the peak stormwater runoff at the site. The summary results of the modelling are presented in Table 4 below and a full copy of the engineering calculations supporting this summary are appended to this report.

Table 4 Peak Flow Rates

Event	Sub Catchments	Peak Flow Rate (CC)
0.01 AEP (100yr)	Sub-catchment 1	13.2 m^3/s
0.01 AEP (100yr)	Sub-catchment 2 - 4	112.2 m^3/s
0.01 AEP (100yr)	All**	120.6 m^3/s
0.05 AEP (20yr)	All	85.7 m^3/s

**Note; the total peak flow rate for all four sub-catchments is less than the sum of Sub-catchment 1 and Sub-catchment 2 – 4 as the time of concentration varies, this means that the time of the peak run-off doesn't occur at the same time. This is an expected outcome and is appropriate.

The peak flow rate runoff results were used to determine the flood water depth in the respective channels. The 1 in 20 year event runoff flow rate is used further on to for the design of a wastewater dispersal field.

5 CHANNEL MODELLING - MAIN CHANNEL (SUB-CATCHMENTS 1-4)

The main channel flowing though the site flows in a north-to-south manner and continues to flow south for around 2.2km before forming an upper tributary of the Matakana River.

The point of interest where the channel modelling was carried out is shown below.

Figure 2 Point of interest to main channel (red section marker)

The water depth in the main channel was determined using Manning's open-channel calculations. The model parameters and results are presented in Table 5 below.

Table 5 Main Channel – Parameters & Results

Variable	Property / Result
Slope	1.0%
Manning's co-efficient	0.085
Peak Flow Rate 0.01AEP	120.6 m^3/sec
Stream Invert Level (Buckton's Survey)	RL 17.5
Water Depth	RL 23.5m (6.0m water depth)

The water depth in the main channel during the theoretical 0.01 AEP event is RL 23.5m.

6 CHANNEL MODELLING - MINOR CHANNEL (SUB-CATCHMENT 1)

A minor channel enters the site from the west and conveys runoff west-to-east. The runoff from this channel flows through an extending culvert conduit before reaching the main channel. This culvert was modelled using the HY-8 Culvert Hydraulic Analysis Program (developed by the US Federal Highway Administration (FHWA)).

The following modelling input parameters have been applied. The model parameters and results are presented in Table 6 below.

Table 6 Existing Minor Channel – Primary Flow path

Variable	Property / Result
Average Slope	1%
Culvert n=0.024 (mitred inlet)	1.6m Ø
Peak Flow Rate 0.01AEP	13.2 m^3/s
Flood Level 0.01AEP	RL 23.58 m
Track Level	RL 23.20 m

The analysis identifies that the water will over top the track passing over the culvert during the theoretical 0.01 AEP event, the water level is is RL 23.58m.

The Auckland Council Code of Practice requires that secondary flow path to be provided just in case the main path is blocked –i.e. the culvert becomes blocked, and to check the effects/water depths of same. Further analysis of the minor channel, assuming the culvert becomes blocked, was also completed using the HY-8 programme. The results are presented below.

Table 7 Existing Minor Channel – Secondary Flow Path

Variable	Property / Result
Average Slope	1%
Culvert n=0.024 (mitred inlet)	blocked
Peak Flow Rate 0.01AEP	13.2 m^3/s
Flood Level 0.01AEP (Secondary Path)	RL 23.83 m

The depth of water flowing over the existing track, when the main culvert becomes blocked is RL 23.83m. This level is the critical level and should be adopted to set floor levels for the proposed development.

Notwithstanding this, the proposal is to construct new buildings on the subject site, as shown in Figure 2 above, with a finished floor level of RL 24.0m. Understanding the results of the secondary flow path in the table above, further analysis was required to check how the track can be altered to provide the necessary freeboard. To do this a *back analysis* was carried out.

The back analysis results identified that lowering the track as shown in the centre and tapering to suit existing ground levels as depicted in Figure 3, would be sufficient to provide 0.3m free board for development at RL 24.0m. The results are presented in Table 8 below.

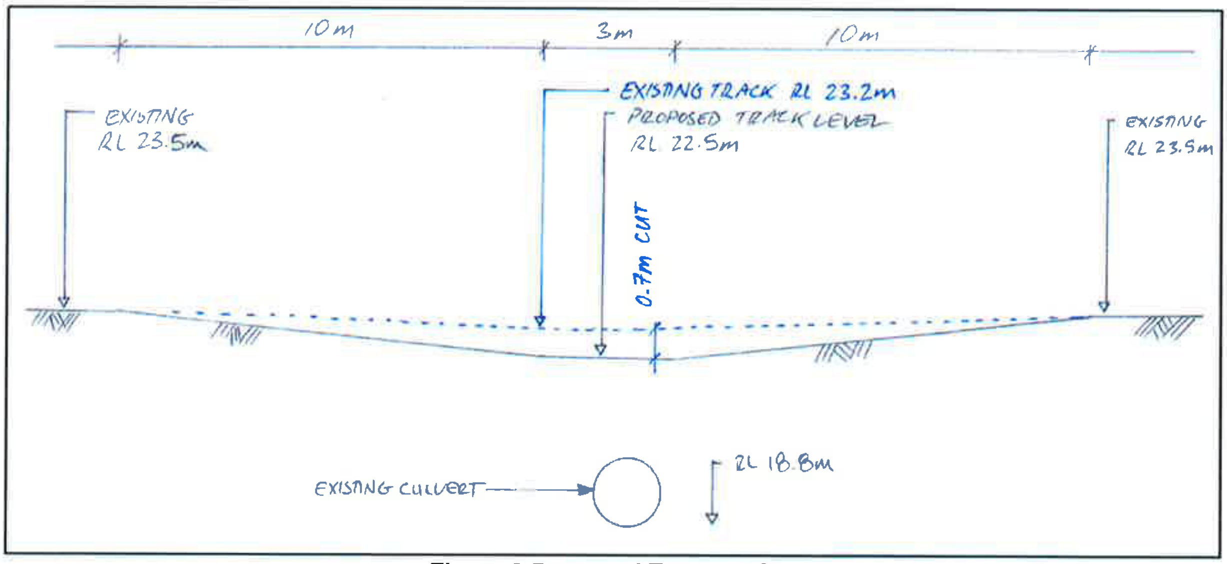


Figure 3 Proposed Track profile

Table 8 Modified Minor Channel – Secondary Flow Path

Variable	Property / Result
Average Slope	1%
Culvert n=0.024 (mitred inlet)	blocked
Peak Flow Rate 0.01AEP	13.2 m³/s
Flood Level 0.01AEP (Secondary Path)	RL 23.41 m
Floor Level Habitable (+0.5m)	RL 23.91 m***
Floor Level Non-Habitable (+0.3m)	RL 23.71 m***

*** levels only apply if track is modified.

Following the minor modification of the track passing over the culvert, the 0.01AEP water depth would rise to RL 23.41 m during the theoretical 0.01AEP event.

It is recommended a minimum habitable floor level of RL 23.9 be adopted for future development in the vicinity of the 'Planing Shed' <u>once the track</u> has been modified.

The proposed Planing Shed complies with the required non-habitable minimum floor requirement of RL 23.7m (proposed shed at RL 24.0m).

Note, this analysis only considers the hydraulic capacity of the secondary flow path only, other considerations i.e. geotechnical, planning and otherwise may need to be addressed.

7 CALIBRATION

In the context of this site, and the recorded Auckland Council Geomaps mapping tool data, the calculated flood level in the main channel corresponds with the geo mapping tool information. The flood level water is expected to be well contained within the geo maps contour for RL 24m as highlighted (cyan line) in Figure 4 below.

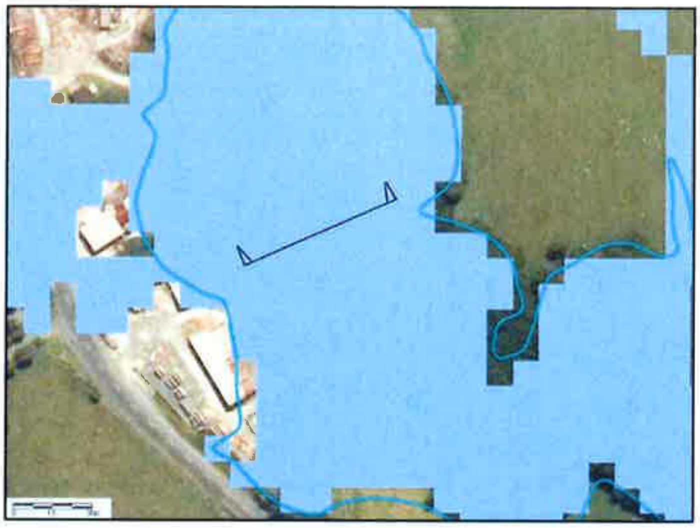


Figure 4 Auckland Council GeoMaps – Contour RL 24.0m

8 WASTEWATER

The flood depth of the channel was also determined for the 0.05AEP (1 in 20 year) event adjacent the proposed *Market Building*. The purpose of this was to confirm the height of the proposed wastewater dispersal field is above the 1 in 20 year flood level.

The wastewater dispersal field is detailed in the report prepared by this office, reference 20145b dated 3 November 2018.

Table 9 Channel Depths for 1 in 20 year event

Variable	Property / Result
Flood Level 0.05AEP (main channel)	RL 22.06 m
Proposed wastewater field	RL 22.15 m

The above table identifies that the proposed wastewater field is above the 0.05AEP water depth demonstrating compliance with the provisions of TP58 and confirming the location of the wastewater dispersal field as depicted in the aforementioned report.

A full copy of the engineering calculations supporting this summary is appended to this document.

9 LIMITATION

This report has been prepared solely for the benefit of Three Blokes Limited as our client with respect to the brief for their proposal on the subject site. The reliance by other parties on the information or opinions contained in the report shall, without prior review and agreement in writing be at such parties sole risk.

10 SUMMARY

It is understood that during the processing of the resource consent application to develop the site, Auckland Council Development Engineers have requested further information regarding overland flow.

The catchment and hydraulic analysis carried out as part of this project identifies that the water level in the main channel, flowing along the eastern boundary, is expected to rise to around RL 23.5m during the theoretical 0.01AEP event.

The analysis also identified that the existing culvert located within the subject site conveying runoff, that enters the site from the west, is inadequately sized to accommodate the 0.01AEP flows at the site. Furthermore, the Auckland Council Code of Practice requires a secondary flow path to be provided should the primary path become blocked. A back analysis was carried out and determined that the secondary path could pass over the culvert embankment if the embankment level is lowered.

It is recommended a minimum habitable floor level of RL 23.9 be adopted for future development in the vicinity of the 'Planing Shed' once the track has been modified. The proposed Planing Shed complies with the required non-habitable minimum floor requirement of RL 23.7m (proposed shed at RL 24.0m).

This office recommends that the S72/73 notice requirement that has been raised during the building consent process for the proposed development be removed.

Should you wish to discuss any aspects of the above information, please contact this office.

We trust this meets with your approval.

Yours faithfully,
IAN HUTCHINSON CONSULTANTS LTD

Prepared by N. Broad
ENGINEER

Reviewed by P. Farley
CIVIL MANAGER

Approved by I. Hutchinson
MANAGING DIRECTOR

HYDRAULIC CATCHMENT ANALYSIS

TP108 using HEC-HMS

AT

362 MATAKANA VALLEY ROAD, MATAKANA

CLIENT: THREE BLOKES LTD

DATE MAR 2018

Ref :20145

HYDRAULIC CATCHMENT ANALYSIS
TP108 using HEC-HMS

Introduction:

The TP-108 guidelines present a recommended method for the application of the U.S. Soil Conservation Service rainfall-runoff model to catchments in the Auckland Region. They are based largely on Technical Release No. 55 (TR55) prepared by the U.S. Soil Conservation Service (SCS, 1986). The Soil Conservation Service (SCS) model has been selected for stormwater management design in the Auckland Region on the basis of an evaluation against gauged catchments (BCHF, 1999a, 1999b, 1999c). Those reports provide the background to the selection, calibration and validation of the method. Streamflow data from the gauged catchments have been used to select input parameters for the model (soil classifications, times of concentration, etc) and to validate the model.

The model can be applied using a number of available software packages to predict runoff volumes, flow rates and the timing of peak flows.

Contents:

Introduction

Assumptions/Calculations

HEC HMS Output/Results

1 Catchment Plan
2 Runoff Curve Numbers (CN)
3 Daily Rainfall Depths
4 HEC HMS RESULTS

TP108 Stormwater Runoff Modelling

SITE INFORMATION

Map Reference:

Site Address : 362 Matakana Valley Road
Easting (NZTM) : 1752760.12,
Northing (NZTM) : 5977271.65

Catchment Area (A): (refer appendix 1)

A = 6379000 m^2
= 637.9 Hectares
= 6.379 km^2

Rainfall Depth at Site Location:

Refer Appendix 3 (Daily Rainfall Depth Charts)

Rain fall Depth	Climate Change	Rain for HEC
100-year ARI = 300 mm (Figure A6)	116.8%	350.4 mm

EXISTING

Runoff curve Numbers:

Sub Catchment 1

Soil Name and Classification	Cover Description: (cover type, treatment and hydrologic condition)	Curve Number	Area (KM^2)	t_c (hr)	t_p (Lag, mins)
Waitemata Clay Class C	*Impervious - Gravel*	89	0.050	0.58	23
Waitemata Clay Class C	*Bush*	70	0.195	0.73	29
Waitemata Clay Class C	*Pasture*	74	0.228	0.69	28
			0.473		

Note: minimum lag time of 6.67mins

Elevation (m)	h (m)	x (m)	Δ x (m/m)	$\underline{h}$ (m)	Δ x . $\underline{h}$ (m^2)
25.0	0	-	-	-	-
50.0	25.0	821	821	12.5	10263
75.0	50.0	1037	216	37.5	8100
100.0	75.0	1285	248	62.5	15500
125.0	100.0	1600	315	87.5	27563
150.0	125.0	1645	45	112.5	5063
175.0	150.0	1840	195	137.5	26813
200.0	175.0	1980	140	162.5	22750
					0
		1980.00			116050.00

Slope (Sc) = 0.06 = 5.920 %

Time of Concentration (t_c):

$t_c = 0.14 \times C \times L^{0.66} \times R^{-0.55} \times S_c^{-0.30}$

t_c =	time of concentration (hours)		
C =	channelisation factor refer to TP108 table 4.2	1.0	
L =	catchment length along drainage path (km)	1.98	km
R =	runoff factor $R = \frac{CN}{200-CN}$		

t_p = time to peak (hours) lag time for HEC-HMS $t_p = ⅔\, t_c$

Sub Catchment 2

Soil Name and Classification	Cover Description: (cover type, treatment and hydrologic condition)	Curve Number	Area (KM^2)	t_c (hr)	t_p (Lag, mins)
Waitemata Clay Class C	*Impervious - Gravel*	89	0.080	0.78	31
Waitemata Clay Class C	*Bush*	70	0.438	0.97	39
Waitemata Clay Class C	*Pasture*	74	0.326	0.93	37
			0.844		

Note: minimum lag time of 6.67mins

Sub- catchment 2

Elevation (m)	h (m)	x (m)	Δ x (m/m)	h (m)	Δ x . h (m^2)
25.0	0	-	-	-	-
50.0	25.0	2185	2185	12.5	27313
75.0	50.0	2400	215	37.5	8063
100.0	75.0	2475	75	62.5	4688
125.0	100.0	2505	30	87.5	2625
150.0	125.0	2555	50	112.5	5625
175.0	150.0	2640	85	137.5	11688
200.0	175.0	3020	380	162.5	61750
225.0	200.0	3090	70	187.5	13125
		3090			134875

Slope (Sc) = 0 = 2.825 %

Time of Concentration (t_c):

$t_c = 0.14 \times C \times L^{0.66} \times R^{-0.55} \times S_c^{-0.30}$

t_c =	time of concentration (hours)		
C =	channelisation factor refer to TP108 table 4.2	1.0	
L =	catchment length along drainage path (km)	3.09	km

R = runoff factor $R = \frac{CN}{200-CN}$

t_p = time to peak (hours) lag time for HEC-HMS $t_p = \frac{2}{3} t_c$

Sub Catchment 3

Soil Name and Classification	Cover Description: (cover type, treatment and hydrologic condition)	Curve Number	Area (KM^2)	t_c (hr)	t_p (Lag, mins)
Waitemata Clay Class C	*Impervious - Gravel*	89	0.050	1.24	49
Waitemata Clay Class C	*Bush*	70	2.099	1.54	62
Waitemata Clay Class C	*Pasture*	74	0.890	1.47	59
			3.039		

Note: minimum lag time of 6.67mins

Elevation (m)	h (m)	x (m)	Δ x (m/m)	h (m)	Δ x . h (m^2)
25.0	0	-	-	-	-
50.0	25.0	3750	3750	12.5	46875
75.0	50.0	4065	315	37.5	11813
100.0	75.0	4250	185	62.5	11563
125.0	100.0	4610	360	87.5	31500
150.0	125.0	4660	50	112.5	5625
175.0	150.0	5540	880	137.5	121000
200.0	175.0	5645	105	162.5	17063
225.0	200.0	5715	70	187.5	13125
250.0	225.0	5995	280	212.5	59500
275.0	250.0	6145	150	237.5	35625
300.0	275.0	6220	75	262.5	19688
		5995			373375

Slope (Sc) = 0 = 2.078 %

Time of Concentration (t_c):

$t_c = 0.14 \times C \times L^{0.66} \times R^{-0.55} \times S_c^{-0.30}$

t_c = time of concentration (hours)
C = channelisation factor refer to TP108 table 4.2 — 1.0
L = catchment length along drainage path (km) — 6.22 km
R = runoff factor $R = \frac{CN}{200-CN}$

t_p = time to peak (hours) lag time for HEC-HMS $t_p = \frac{2}{3} t_c$

Sub Catchment 4

Soil Name and Classification	Cover Description: (cover type, treatment and hydrologic condition)	Curve Number	Area (KM^2)	t_c (hr)	t_p (Lag, mins)
Waitemata Clay Class C	*Impervious - Gravel*	89	0.050	1.00	40
Waitemata Clay Class C	*Bush*	70	1.077	1.26	50
Waitemata Clay Class C	*Pasture*	74	0.896	1.20	48
			2.023		

Note: minimum lag time of 6.67mins

Elevation (m)	h (m)	x (m)	Δ x (m/m)	h (m)	Δ x . h (m^2)
25.0	-	-	-	-	-
50.0	25	2950	2950	25.0	73750
75.0	25	3025	75	25.0	1875
100.0	25	3240	215	25.0	5375
125.0	25	3750	510	25.0	12750
150.0	25	4005	255	25.0	6375
175.0	25	4150	145	25.0	3625
200.0	25	4275	125	25.0	3125
225.0	25	4360	85	25.0	2125
250.0	25	4430	70	25.0	1750
275.0	25	4478	48	25.0	1200
300.0	25	4545	67	25.0	1675
					0
		4430			113625

Slope (Sc) = 0 = 1.158 %

Time of Concentration (t_c):

$t_c = 0.14 \times C \times L^{0.66} \times R^{-0.55} \times S_c^{-0.30}$

t_c = time of concentration (hours)

C = channelisation factor refer to TP108 table 4.2 — 1.0

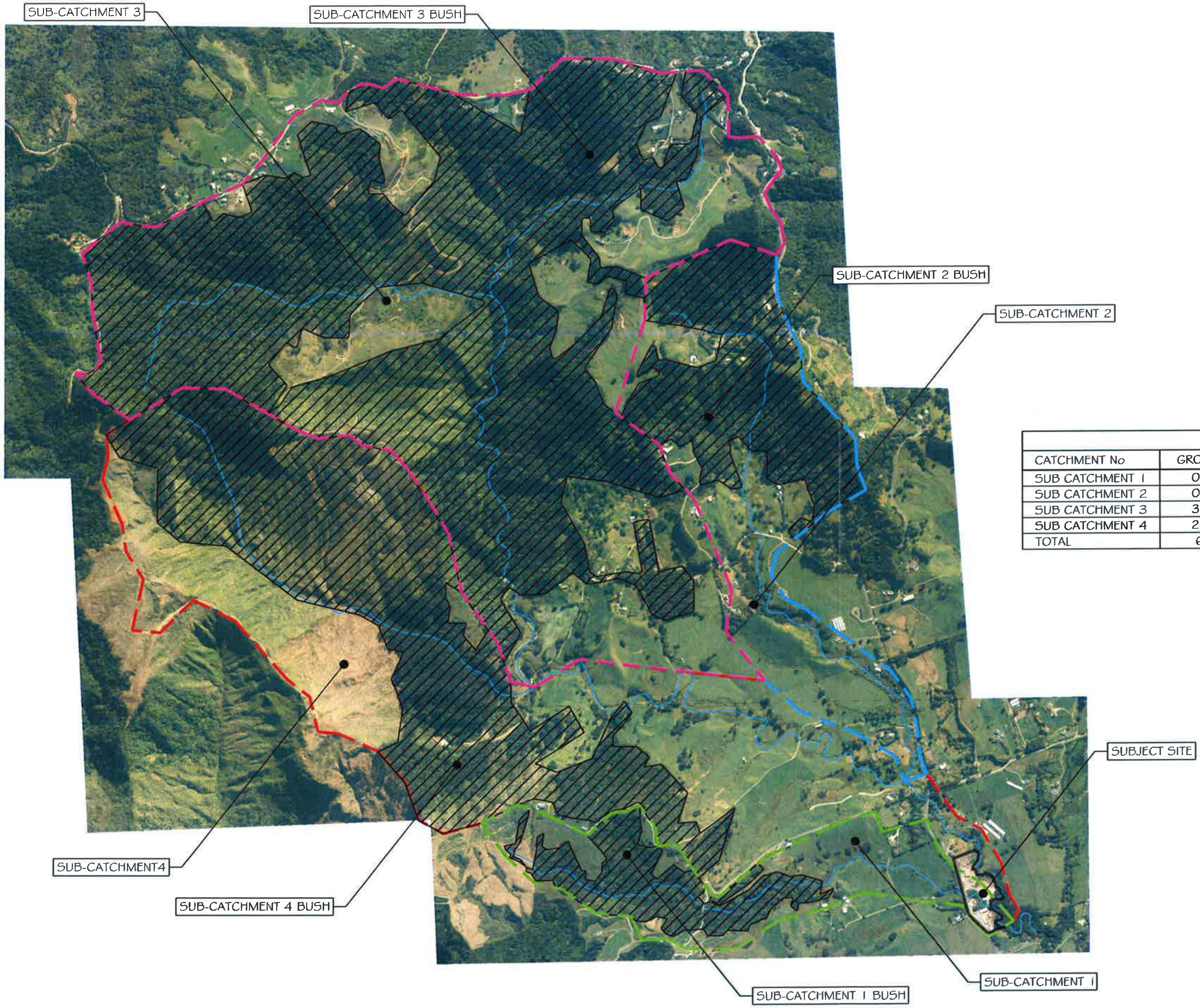
L = catchment length along drainage path (km) — 4.55 km

R = runoff factor $R = \frac{CN}{200-CN}$

t_p = time to peak (hours) lag time for HEC-HMS $t_p = \frac{2}{3} t_c$

1

Catchment Plan



CATCHMENT CHARACTERISTICS				
CATCHMENT No	GROSS AREA	BUSH AREA	GRASS AREA	IMPERVIOUS AREA
SUB CATCHMENT 1	0.473KM²	0.195KM²	0.228KM²	0.05KM²
SUB CATCHMENT 2	0.844kM²	0.438KM²	0.326KM²	0.08KM²
SUB CATCHMENT 3	3.147KM²	2.159KM²	0.890KM²	0.05KM²
SUB CATCHMENT 4	2.072KM²	1.077KM²	0.896KM²	0.05KM²
TOTAL	6.379KM²			

No.	Revision	Drawn	Chk.	Appd.	Date
-	FOR BUILDING CONSENT	B.N	P.J	I.H	JAN 2018

Hutchinson
CONSULTING ENGINEERS

PO Box 150, Orewa 0946
154 Centreway Road, Orewa 0931
Ph: 09 426 5702 www.hc.co.nz

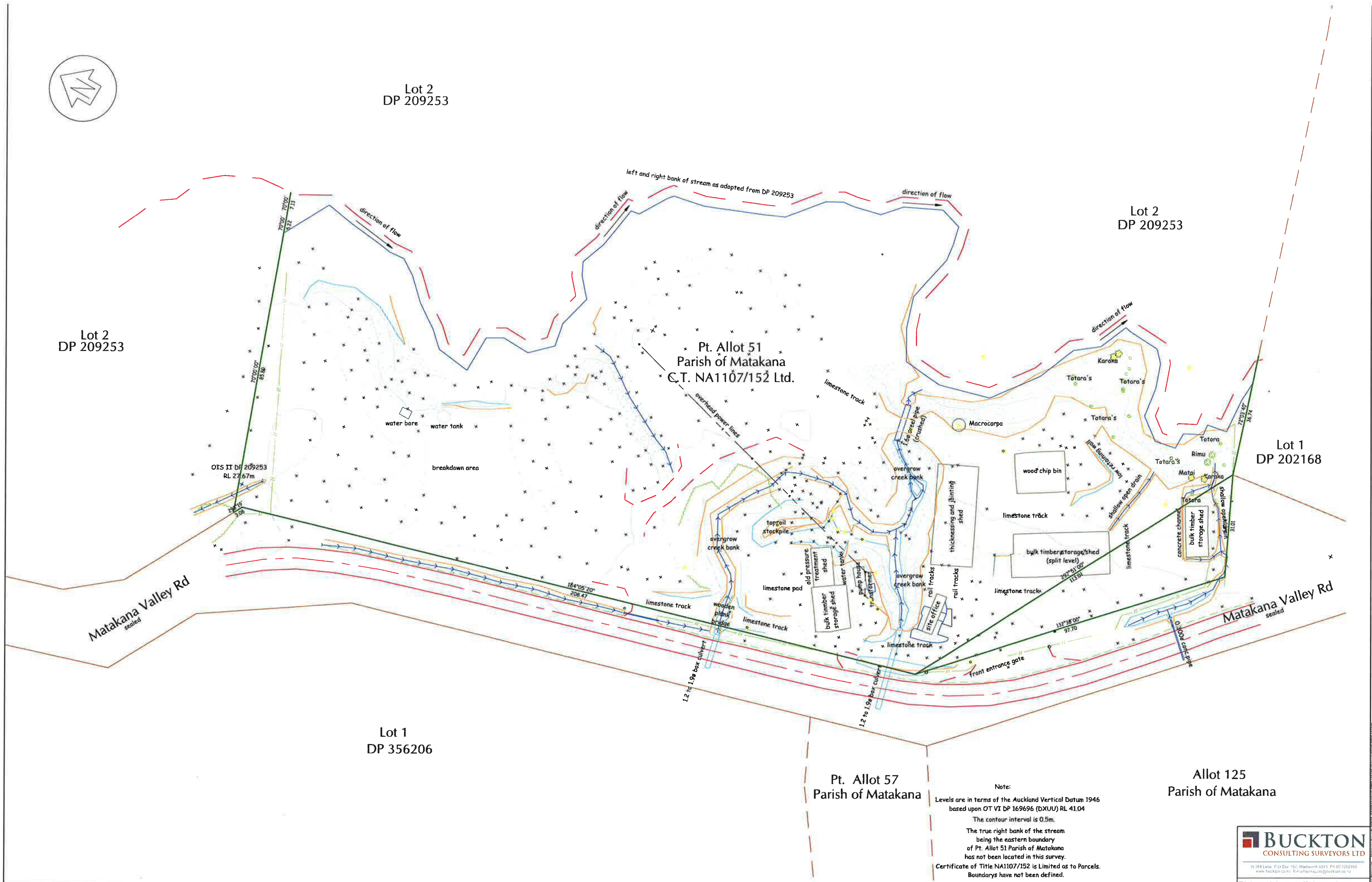
Design	P. WILSON	JAN 2018
Drawn	R. MIRDAD	JAN 2018
Checked	P. FARMER	JAN 2018
Approved	I. HUTCHINSON	JAN 2018
Scale	1:1500 @ A3	
Scale vert. exag.		

Project
THREE BLOKES LTD
362 MATAKANA VALLEY ROAD,
MATAKANA, AUCKLAND
Sec 1 SO 400726, Pt Allot 51 Psh of
MATAKANA SO 1044

Title
CATCHMENT

Job No.
20145

Sheet No.
CA01



Note:
Levels are in terms of the Auckland Vertical Datum 1946
based upon OT VI DP 169696 (DXUU) RL 41.04
The contour interval is 0.5m.
The true right bank of the stream
being the eastern boundary
of Pt. Allot 51 Parish of Matakana
has not been located in this survey.
Certificate of Title NA1107/152 is Limited as to Parcels.
Boundarys have not been defined.

Prepared for:

Three Blokes Limited
c/o Dean & Kim Munro

Topographical Survey of Matakana Sawmill
Located at Pt.Allot 51, Parish of Matakana, Matakana Valley Rd

BUCKTON
CONSULTING SURVEYORS LTD
16 Mill Lane P O Box 107, Warkworth 0941 Ph 09 4258350
www.buckton.co.nz E-mail surveyors@buckton.co.nz

Scale	1:500 (A1)		
Date Drawn 17/7/06	Drawn by SMC	Chckd by	Ref No. 8113
Revision Details:- 29/11/17 - Levels and Contours on original topo from June 2006 updated to AVD46			
Dwg No. TP01	Rev No. A	Sheet No. 1 of 1	

2

Runoff Curve Numbers (CN)

Table 2-2a.-Runoff curve numbers for urban areas[1] (SCS, 1986)

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3] :					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)[5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

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[1] Average runoff condition, and Ia = 0.2S.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 24, based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b.-Runoff curve numbers for cultivated agricultural lands[1] (SCS, 1986)

Cover description			Curve numbers for hydrologic soil group-			
Cover type	Treatment[2]	Hydrologic condition[3]	A	B	C	D
Fallow	Bare soil		77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T + CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T + CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

---

[1] Average runoff condition, and Ia = 0.2S.

[2] *Crop residue cover* applies only if residue is on at least 5% of the surface throughout the year.

[3] Hydrologic condition is based on combination of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes in rotations, (d) percent of residue cover on the land surface (good >_ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c.-Runoff curve numbers for other agricultural lands[1] (SCS, 1986)

Cover description		Curve numbers for hydrologic soil group-			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range-continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow-continuous grass, protected from grazing and generally mowed for hay.		30	58	71	78
Brush-brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods-grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads-buildings, lanes, driveways, and surrounding lots.		59	74	82	86

[1] Average runoff condition, and Ia = 0.2S.

[2] *Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

[3] *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: > 75% ground cover.

[4] Actual curve number is less than 30; use CN = 30 for runoff computations.

[5] CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6] *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair:. Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Table 2-2d.-Runoff curve numbers for arid and semi-arid rangelands[1] (SCS, 1986)

Cover description		Curve numbers for hydrologic soil group-			
Cover type	Hydrologic condition[2]	A[3]	B	C	D
Herbaceous-mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen-mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper-pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub-major plants include saltbush, greasewood, creosote bush, black brush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

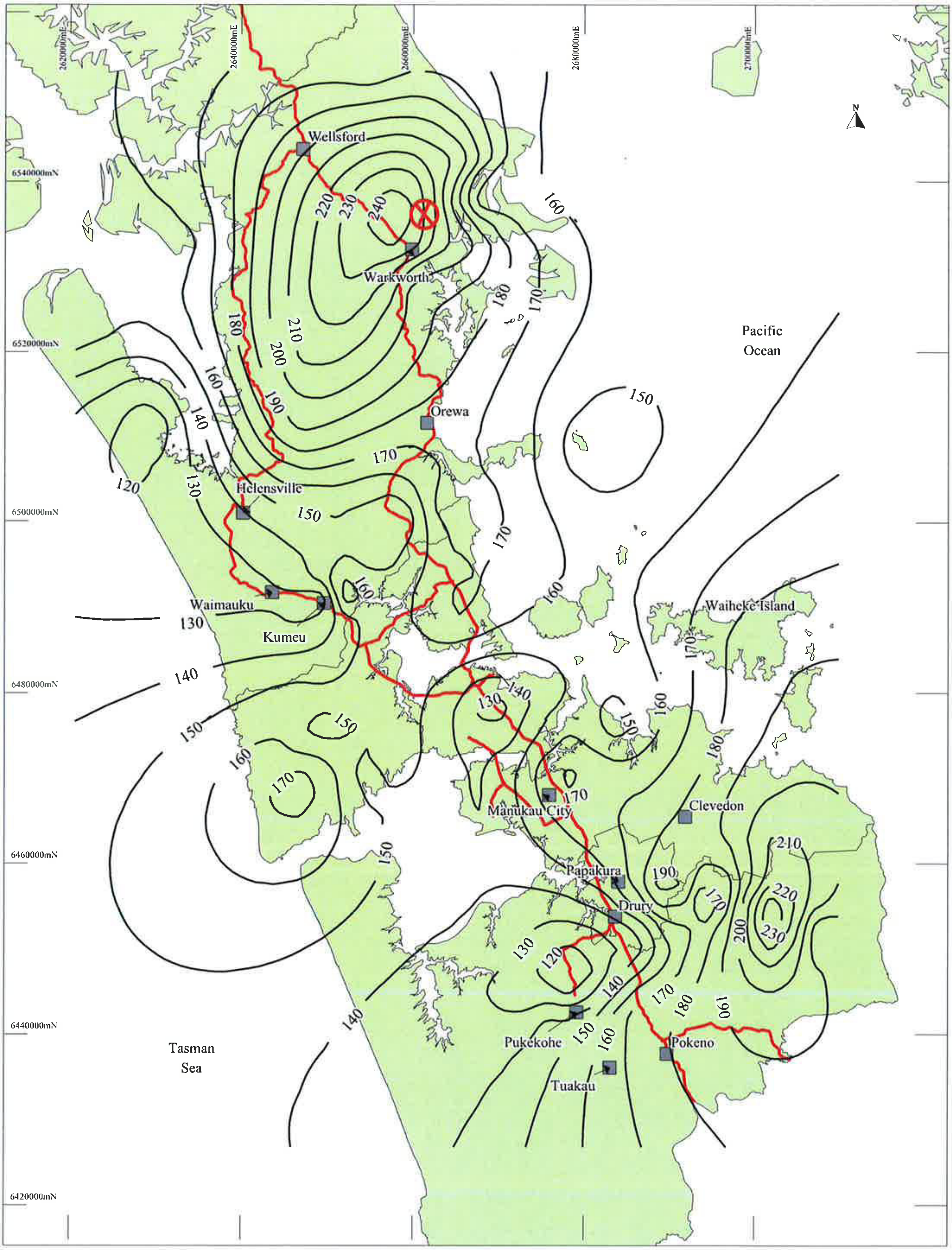
[1] Average runoff condition, and $I_a = 0.2S$. For range in humid regions, use table 2-2c.

[2] Poor: < 30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: >70% ground cover.

[3] Curve numbers for group A have been developed only for desert shrub.

3

Daily Rainfall Depths



Auckland Regional Council

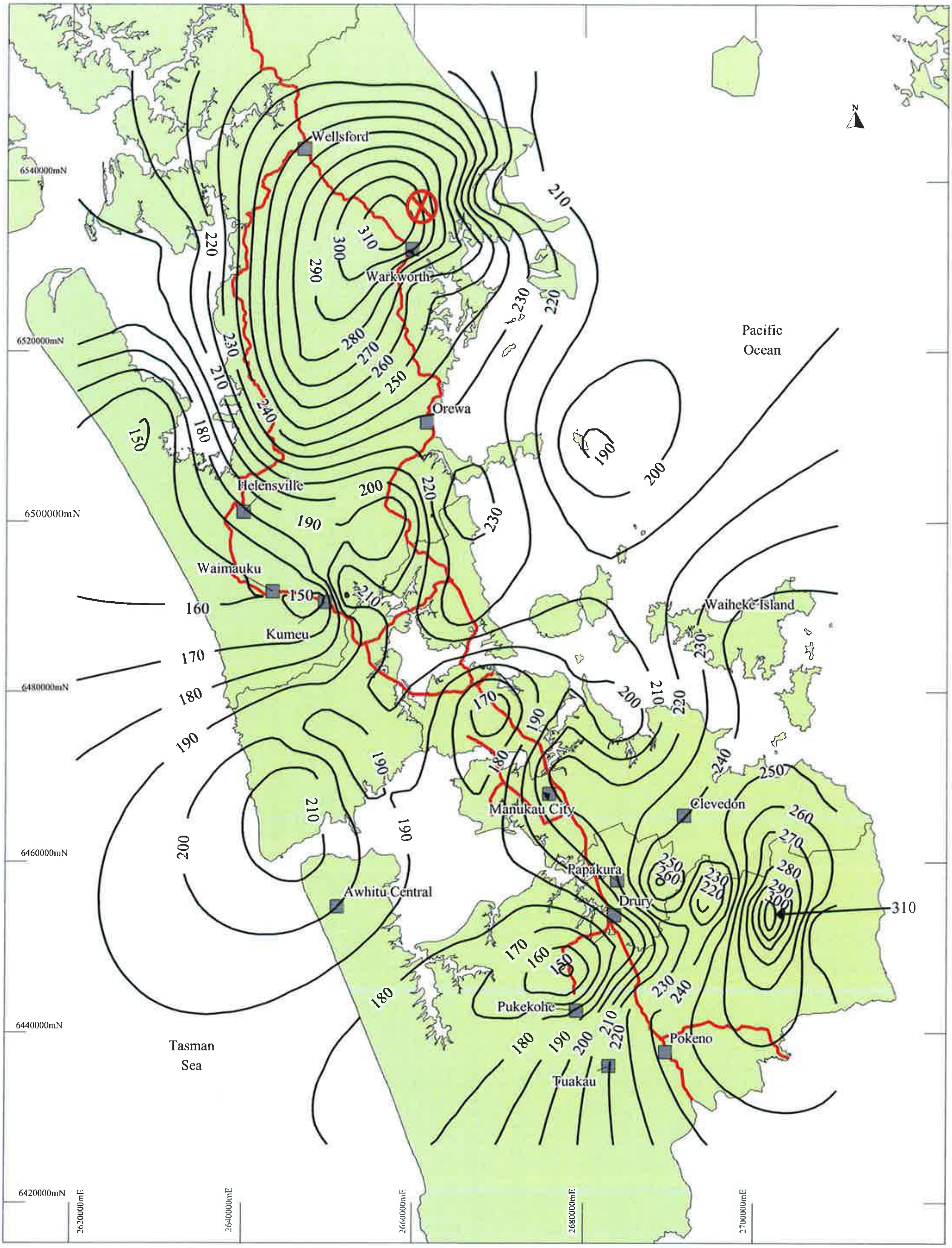
Legend: — 90 — Rainfall Contour (mm)

State Highways

Figure A.4
20 Year ARI
Daily Rainfall Depth

Scale: 1:600,000 (at A4)

(Revised 25/08/1999)



Legend: — 90 — Rainfall Contour (mm)

State Highways

Auckland Regional Council

Figure A.6
100 Year ARI
Daily Rainfall Depth

Scale: 1:600,000 (at A4)

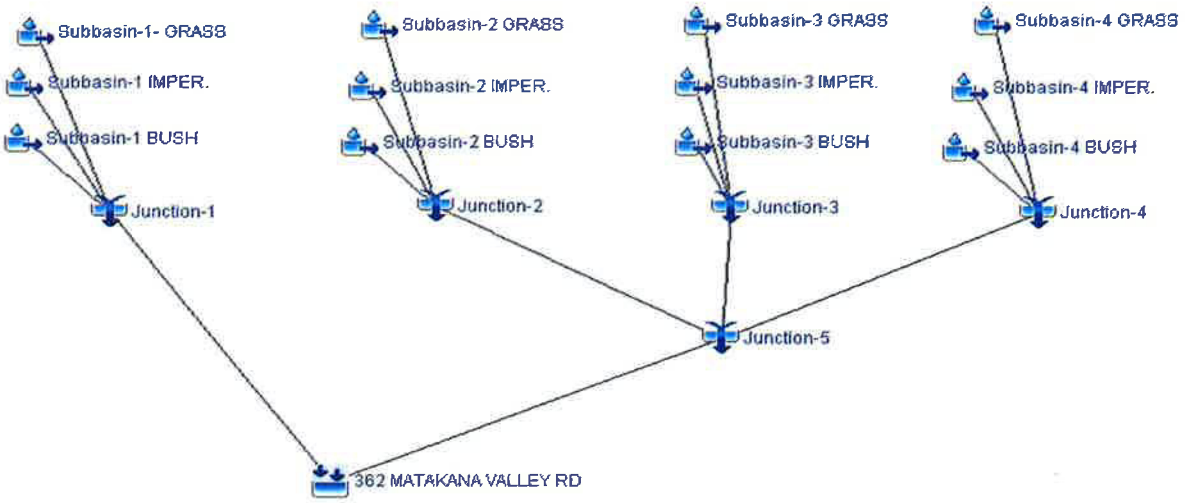
(Revised 25/08/1999)

Workspace: N:(civil)\25\2507757\gis\mapinfo\wor\100yrari.wor Date: 25/08/1999

4

HEC HMS & HEC RAS RESULTS

HEC HMS OUTPUTS

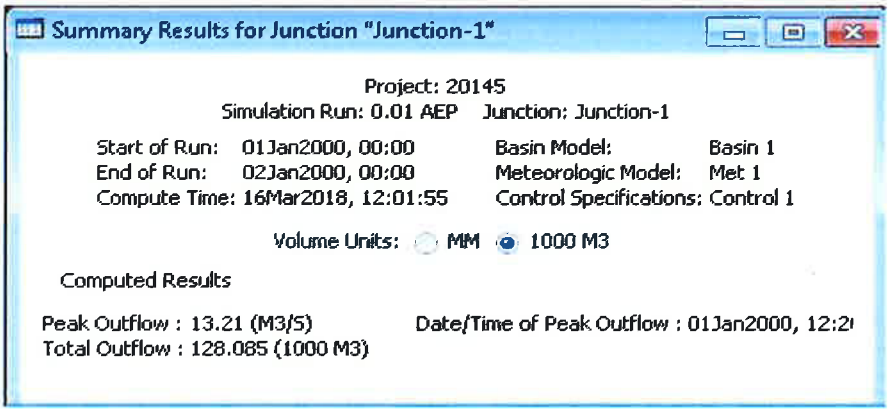


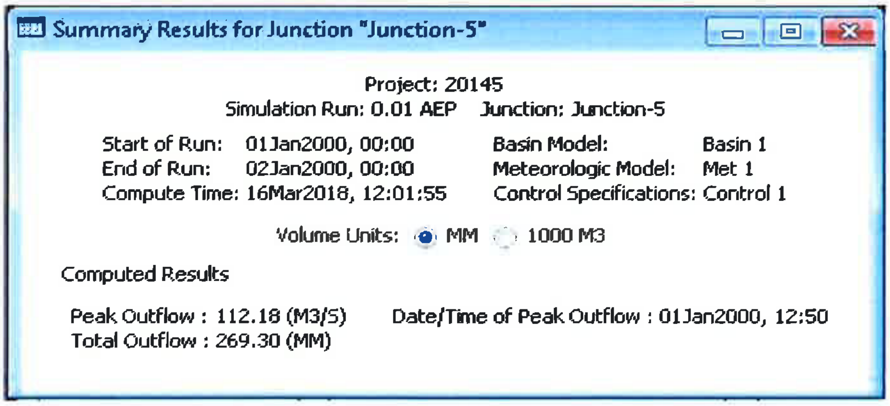
Basin model from HEC HMS

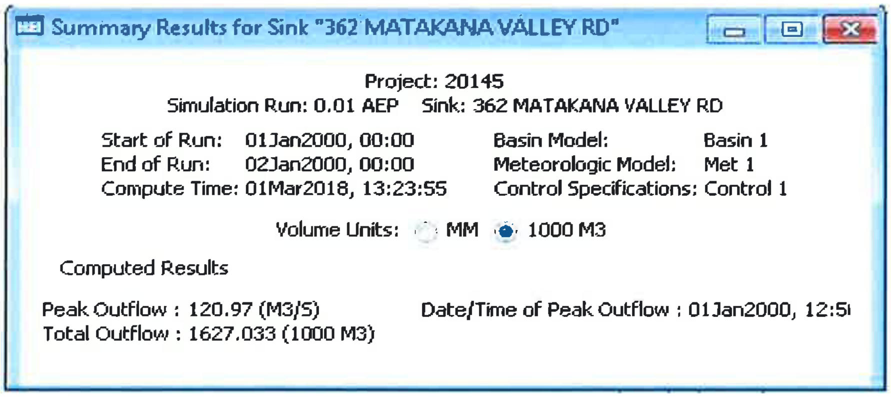
HEC-HMS RESULTS

SUMMARY OF RESULTS (from HEC-HMS Output)

Storm Event	Sub catchment No	Peak Discharge (m³/s)
100 yr	Sub catchment 1	13.21
100 yr	Sub catchment 2-4	112.2
Total		125.41

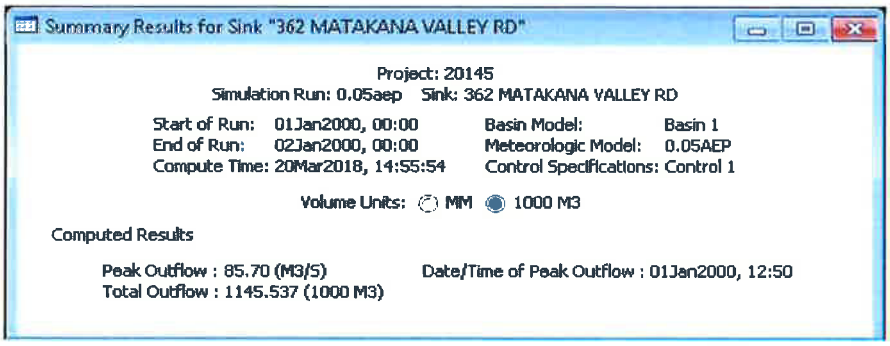






SUMMARY OF RESULTS (from HEC-HMS Output)

Storm Event	Sub catchment No	Peak Discharge (m^3/s)
20 yr	all	85.7
Total		85.7



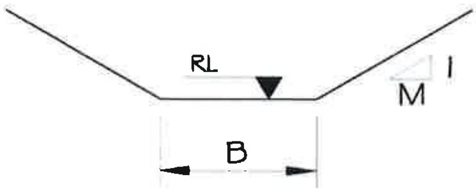
5

OPEN CHANNEL FLOW CALCS

SUBCATCHMENT ALL
MAIN CHANNEL
0.05 AEP
"MARKET BUILDING"

Mannings Open Channel Flow Calculations
(Uneven Channel Sides)

Project Name:	Three Blokes Ltd
Job Number:	20145
Date:	Mar-18
Location of Section:	Adjacent market building - 20yr [wastewater]



TYPICAL CHANNEL CROSS SECTION

Input Variables:

M =	2.40	m
B =	0.20	m
Y =	4.32	m (water depth)
S =	1.0%	Slope
n =	0.085	mannings
RL =	17.74	m

Area:

Area = $BY + MY^2$ m^2

Area = 45.67 m^2

Wetted Perimeter:

Wetted perimeter = $B + 2Y\ SQRT[(1+M^2)]$

Wetted perimeter = 22.67 m

R = A/P m
R = 2.01 m

Q = AR^(2/3) Sqrt(S)

$Q_{channel}$ = 85.70 m^3 / sec

Q_{demand} = 85.70 m^3 / sec

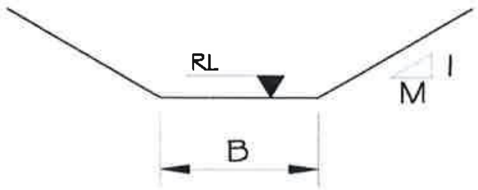
Water depth RL

RL = 22.06 m

SUBCATCHMENT ALL
(MAIN CHANNEL)
(0.01 AEP)

Mannings Open Channel Flow Calculations
(Uneven Channel Sides)

Project Name: Three Blokes Ltd
Job Number: 20145
Date: Mar-18
Location of Section: Downstream of existing 1.6m dia culvert



TYPICAL CHANNEL CROSS SECTION

Input Variables:

M =	1.50	m
B =	0.20	m
Y =	6.00	m (water depth)
S =	1.0%	Slope
n =	0.085	mannings
RL =	17.5	m

Area:

Area =	$BY + MY^2$	m^2
Area =	55.23	m^2

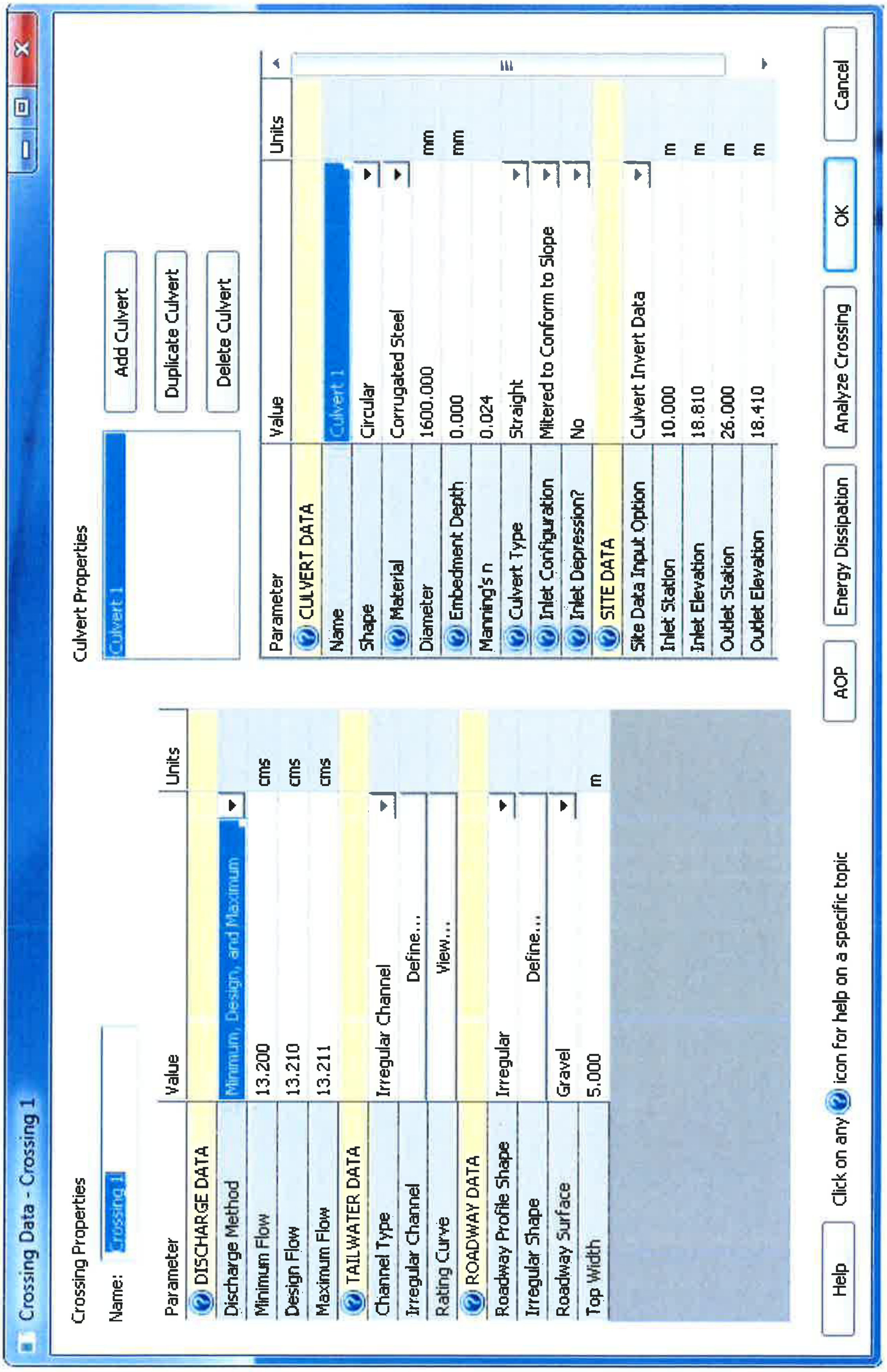
Wetted Perimeter:

Wetted perimeter =	B + 2Y SQRT[(1+M²)]	
Wetted perimeter =	21.84	m
R =	A/P	m
R =	2.53	m
Q =	AR^(2/3) Sqrt(S)	
$Q_{channel}$ =	120.60	m^3 / sec
Q_{demand} =	120.60	m^3 / sec

Water depth RL

RL = 23.5 m

MINOR CHANNEL
EXISTING CULVERT



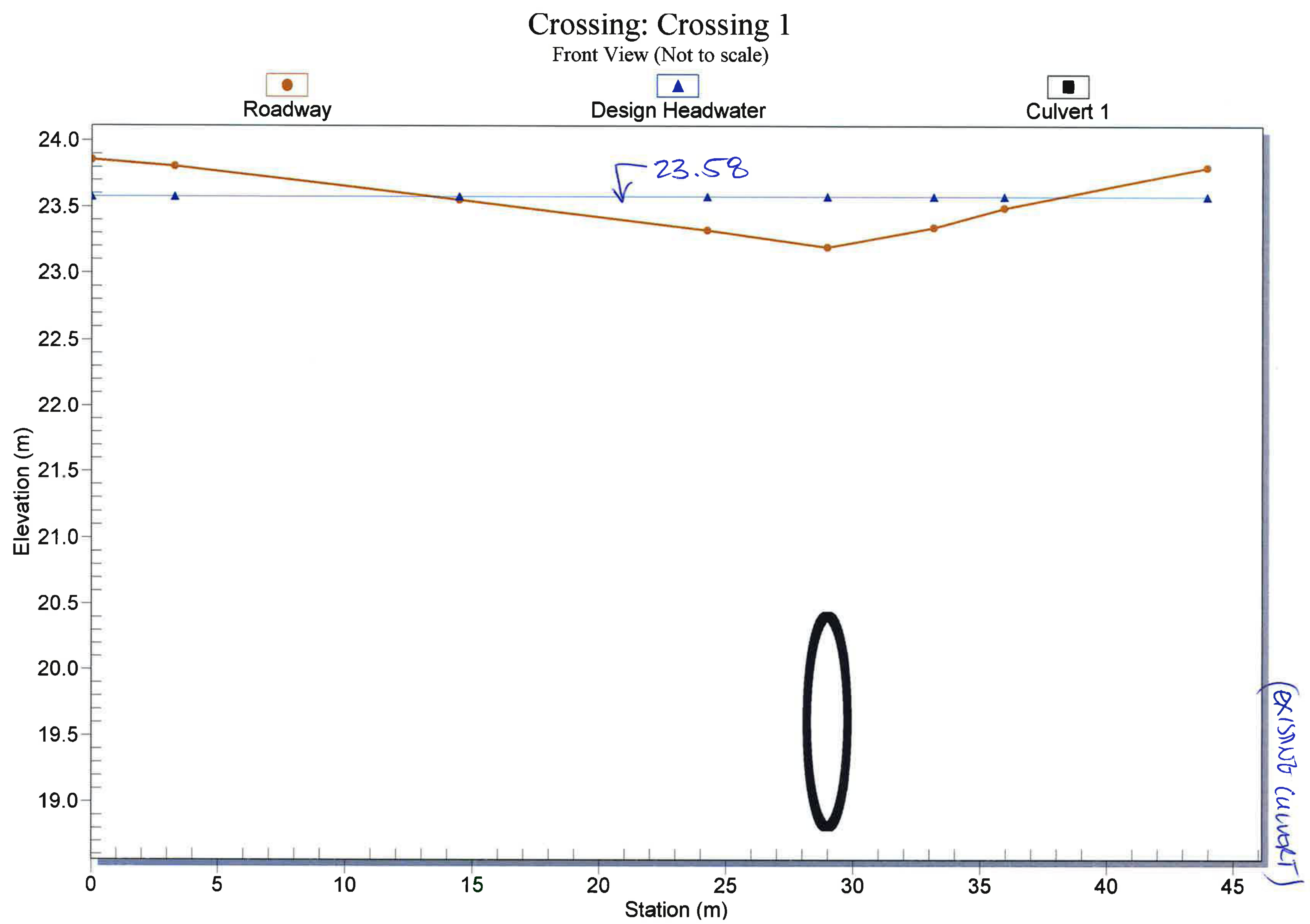
EXISTING CULVERT

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: Crossing 1

Headwater Elevation (m)	Total Discharge (cms)	Culvert 1 Discharge (cms)	Roadway Discharge (cms)	Iterations
23.58	13.20	9.67	3.53	18
23.58	13.20	9.67	3.53	2
23.58	13.20	9.67	3.53	2
23.58	13.20	9.67	3.53	2
23.58	13.20	9.67	3.53	2
23.58	13.21	9.67	3.53	2
23.58	13.21	9.67	3.53	2
23.58	13.21	9.67	3.53	2
23.58	13.21	9.67	3.53	2
23.58	13.21	9.67	3.53	2
23.58	13.21	9.67	3.53	2
23.19	9.12	9.12	0.00	Overtopping


Crossing: Crossing 1
Front View (Not to scale)
Roadway
Design Headwater
Culvert 1
23.58
Elevation (m)
24.0
23.5
23.0
22.5
22.0
21.5
21.0
20.5
20.0
19.5
19.0
Station (m)
0
5
10
15
20
25
30
35
40
45
(EXISTING CULVERT)

minor channel
Blocked - existing

Crossing Data - Crossing 1

Crossing Properties

Name: Crossing 1

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	Minimum, Design, and Maximum	
Minimum Flow	13.200	cms
Design Flow	13.210	cms
Maximum Flow	13.211	cms
TAILWATER DATA		
Channel Type	Irregular Channel	
Irregular Channel	Define...	
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Irregular	
Irregular Shape	Define...	
Roadway Surface	Gravel	
Top Width	5.000	m

Culvert Properties

Culvert 1

Add Culvert

Duplicate Culvert

Delete Culvert

Parameter	Value	Units
CULVERT DATA		
Name	Culvert 1	
Shape	Circular	
Material	Corrugated Steel	
Diameter	1.000	mm
Embedment Depth	0.000	mm
Manning's n	0.024	
Culvert Type	Straight	
Inlet Configuration	Mitered to Conform to Slope	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	10.000	m
Inlet Elevation	18.810	m
Outlet Station	26.000	m
Outlet Elevation	18.410	m

Help | Click on any icon for help on a specific topic | AOP | Energy Dissipation | Analyze Crossing | OK | Cancel

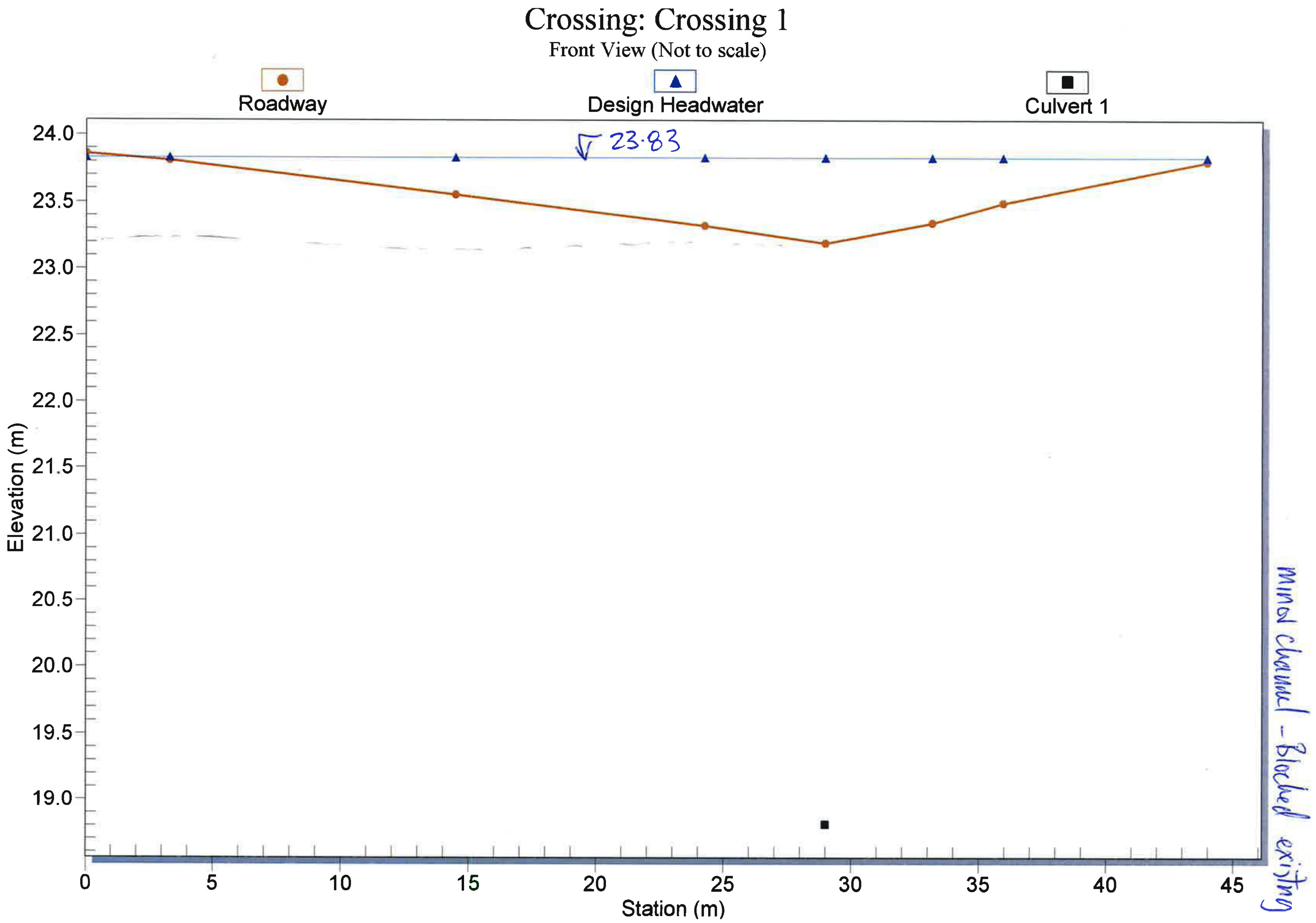
MINOR CHANNEL
BLOCKED - EXISTING

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: Crossing 1

Headwater Elevation (m)	Total Discharge (cms)	Culvert 1 Discharge (cms)	Roadway Discharge (cms)	Iterations
23.83	13.20	0.00	13.20	15
23.83	13.20	0.00	13.20	1
23.83	13.20	0.00	13.20	1
23.83	13.20	0.00	13.20	1
23.83	13.20	0.00	13.20	1
23.83	13.21	0.00	13.20	1
23.83	13.21	0.00	13.20	1
23.83	13.21	0.00	13.20	1
23.83	13.21	0.00	13.20	1
23.83	13.21	0.00	13.20	1
23.83	13.21	0.00	13.20	1
23.19	0.00	0.00	0.00	Overtopping



Crossing: Crossing 1
Front View (Not to scale)
Roadway
Design Headwater
Culvert 1
23·83
24.0
23.5
23.0
22.5
22.0
21.5
21.0
20.5
20.0
19.5
19.0
Elevation (m)
0
5
10
15
20
25
30
35
40
45
Station (m)
minor channel - Blocked existing

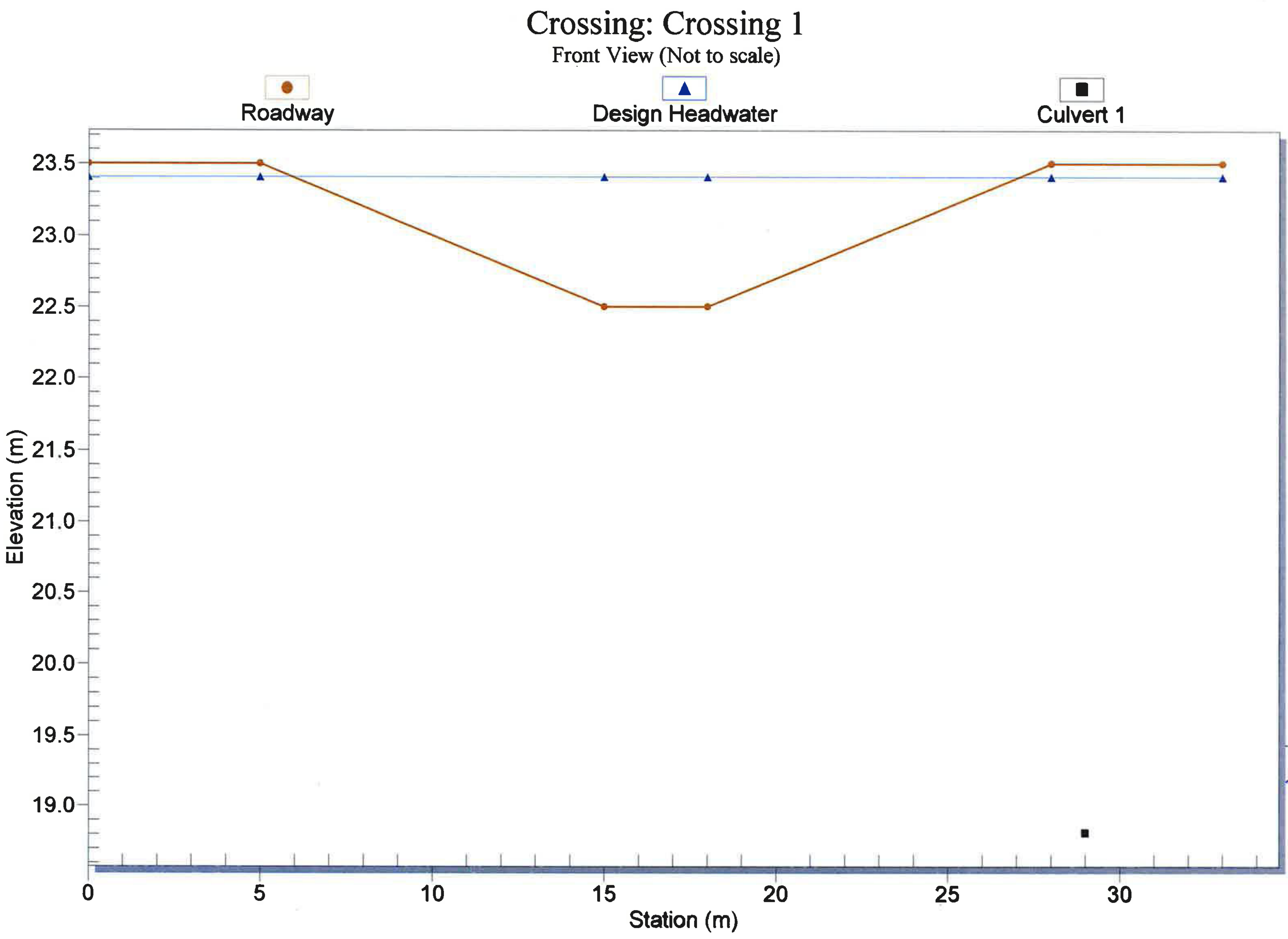
minor channel
'Proposed modification'

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: Crossing 1

Headwater Elevation (m)	Total Discharge (cms)	Culvert 1 Discharge (cms)	Roadway Discharge (cms)	Iterations
23.41	13.20	0.00	13.20	13
23.41	13.20	0.00	13.20	2
23.41	13.20	0.00	13.20	2
23.41	13.20	0.00	13.21	1
23.41	13.20	0.00	13.21	1
23.41	13.21	0.00	13.21	1
23.41	13.21	0.00	13.21	1
23.41	13.21	0.00	13.21	1
23.41	13.21	0.00	13.21	1
23.41	13.21	0.00	13.21	1
23.41	13.21	0.00	13.21	1
22.50	0.00	0.00	0.00	Overtopping



Minor channel
"proposed modificatio

Hutchinson
CONSULTING ENGINEERS

JOB: 3 BROKES LTD			
SUBJECT: 362 MATAKANA RD "Proposed mods"			
BY: NB	PAGE: 1	DATE: APRIL 18	JOB NO: 20145