

Ref: 3535
5 May 2016

Moran Corporation Pty Ltd
c/- Geoform Design Architects Pty Ltd
Suite 145-H Moore Park Gardens
780 Bourke Street
EAST REDFERN NSW 2016

Attention Mr Rusty Moran

Dear Sir

RE: FLOOD IMPACT ASSESMENT – No 84 KIORA RD, MIRANDA

1. Introduction

At the request of Moran Corporation Pty Ltd, EWFW Pty Ltd has carried out a review of the flooding situation at No 84 Kiora Road Miranda as required by the Director General of the Department of Planning, NSW.

It is understood that the site is being considered for a new multi storey development comprising a number of commercial units, a dental centre on the ground floor and basement carparking. The finished floor level of the proposed basement carpark is to be approximately 5m below the road level in Urunga Lane at the back of the building. Access to the basement carpark will be from Urunga Lane.

The Director General has requested that a flood study be undertaken to determine the impact of any overland flow on the proposed development.

2. Background Information

The site comprising 476 square meters is at the corner of Kiora Road and Urunga Parade and enjoys rear lane access from Urunga Lane. The lane is 6.2m wide with narrow footpaths immediately adjacent to the rear wall of the adjoining buildings. The upstream catchment has an area of approximately 0.22 Ha and extends upstream to the intersection of Urunga Parade and Jackson Avenue. On the north side of Urunga Parade is Westfield's Miranda Fair Shopping Centre.

The catchment is serviced by an underground stormwater pipe system that starts at the corner of Kiora Road and Urunga Parade adjacent to the site. There is also a stormwater pit at the end of Urunga Lane that is piped through to the Railway corridor at Miranda Station.

The catchment is fully paved and extends from property boundary to property boundary on either side of Urunga Parade. The properties on either side of Urunga Parade fall away from the road therefore any stormwater falling within private the properties is generally diverted away from the street catchment. There are a number of downpipes connected to the street kerb and gutter but the flow contribution from these is limited to minor storm events only.

Generally the overland flow affecting the site is generated from rainfall falling on the road and footpath surfaces within Urunga Parade and traveling along the kerb and gutter past the site to the street gully pits. Any flooding affecting the site is a result of the stormwater runoff exceeding the capacity of the kerb and gutter in Urunga Parade and Urunga Lane.

Pipe information was obtained from Sutherland Council's GIS and verified on site by a visual inspection. Detailed survey of the site and Urunga Lane was provided by the client. The extent of the catchment is shown below in Plate 1.

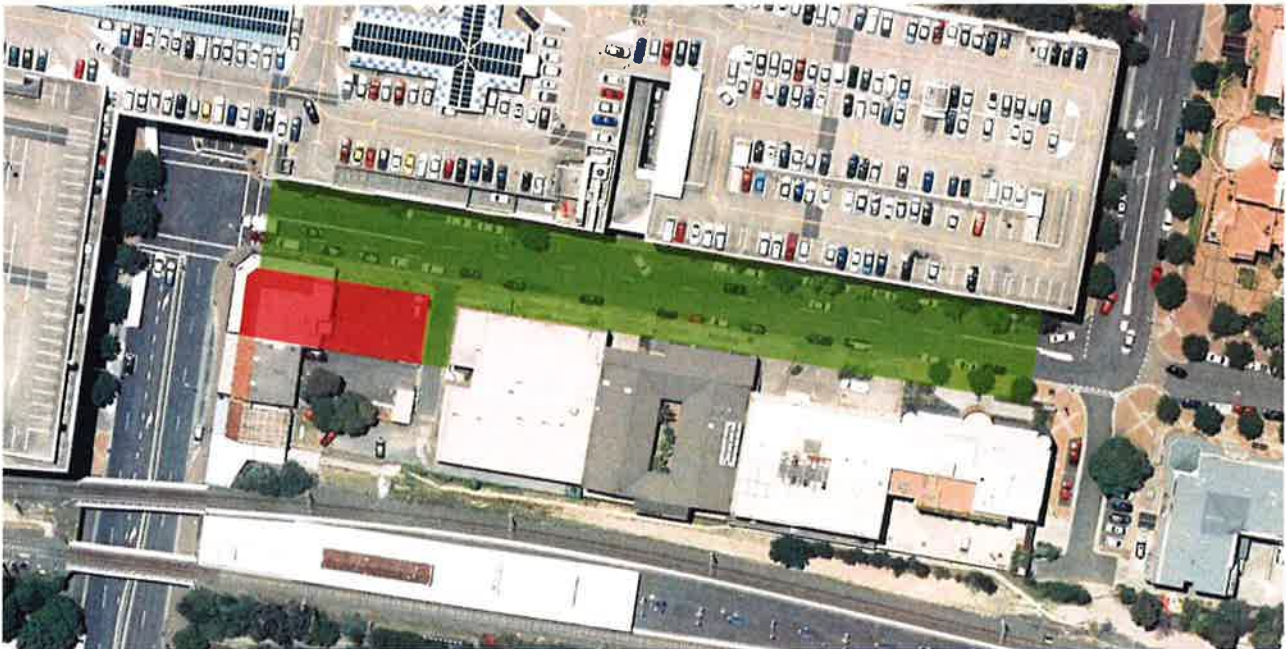


Plate 1 – Aerial Photo showing extent of catchment draining to Urunga Lane in green with the site in red

3. Hydraulic Calculations

Investigation of flood behavior in a catchment requires a hydrological analysis to determine flood discharges and a hydraulic analysis to determine flood profiles (water levels), velocity, extent and depth of flooding. The hydrological analysis for the catchment area was carried out using the DRAINS program.

The DRAINS program was originally developed for urban stormwater drainage analysis. It uses the time-area method to generate flow hydrographs. In this method a rainfall hyetograph is combined with the time-area diagram in a similar manner to unit hydrograph calculations for each sub-catchment. The time base for the time-area diagram is specified by the user and is effectively the same as the time of concentration used in the Rational Method for the sub-catchment area.

Rainfall losses are modeled as initial losses for both impervious and pervious areas while continuing losses are calculated based on the Horton Infiltration Equation for pervious areas only. Losses include rainfall, which does not appear as runoff but is lost by infiltration into the soil and stored in puddles and trapped low spots throughout the catchment and are, therefore, not contributing to the flood waters. The hydrographs which show the quantity of runoff generated at certain time intervals throughout the storm event are then routed through the drainage system with pipe flows and overland flows determined by pit inlet capacities and pipe capacities using hydraulic grade line analysis.

Flood storage includes floodwaters that are temporarily stored during the storm and gradually released as the waters recede. These can be modeled in DRAINS as storage volumes at pits or as detention basins. Information input into the program include details of rainfall, initial and continuing losses and general data for running the program, as well as catchment areas, pits, pipes, channels, storage and overland flow data. The catchment plan for the model and the calculation results are attached in the appendices.

The overland flow along Urunga Parade travels along the kerb and gutter until it splits at the intersection with Urunga Lane where 50% of the flow is diverted down Urunga Lane. We confirm that the design discharge along Urunga Lane for the **100 year ARI** storm is in the order of **0.04 cumecs** for existing site conditions and the design discharge for the **20 year ARI** storm is in the order of **0.03 cumecs**.

Using the detailed survey information we established a **HECRAS** model of Urunga Lane adjacent to the site. We modeled several scenarios using different downstream controls and found that the most appropriate control was normal depth conditions for sub critical flow. The overland flow level along the kerb and gutter in Urunga Lane was found to be **70mm** deep at the kerb and gutter.

4. Conclusion

The depth of overland flow in Urunga Lane is approximately 30mm below the top of kerb level in the laneway. At the proposed driveway to the carpark lift the depth of flow is 300mm below the driveway at the building entry and at the southern boundary of the site the depth of flow is 330mm below the driveway level at the building.

Council normally requires 300mm freeboard above the 100 year ARI flow level which is provided and therefore we recommend that the design levels as proposed be accepted.

We further recommend that a sump pump be incorporated in the basement in the event that water ever does enter the building.

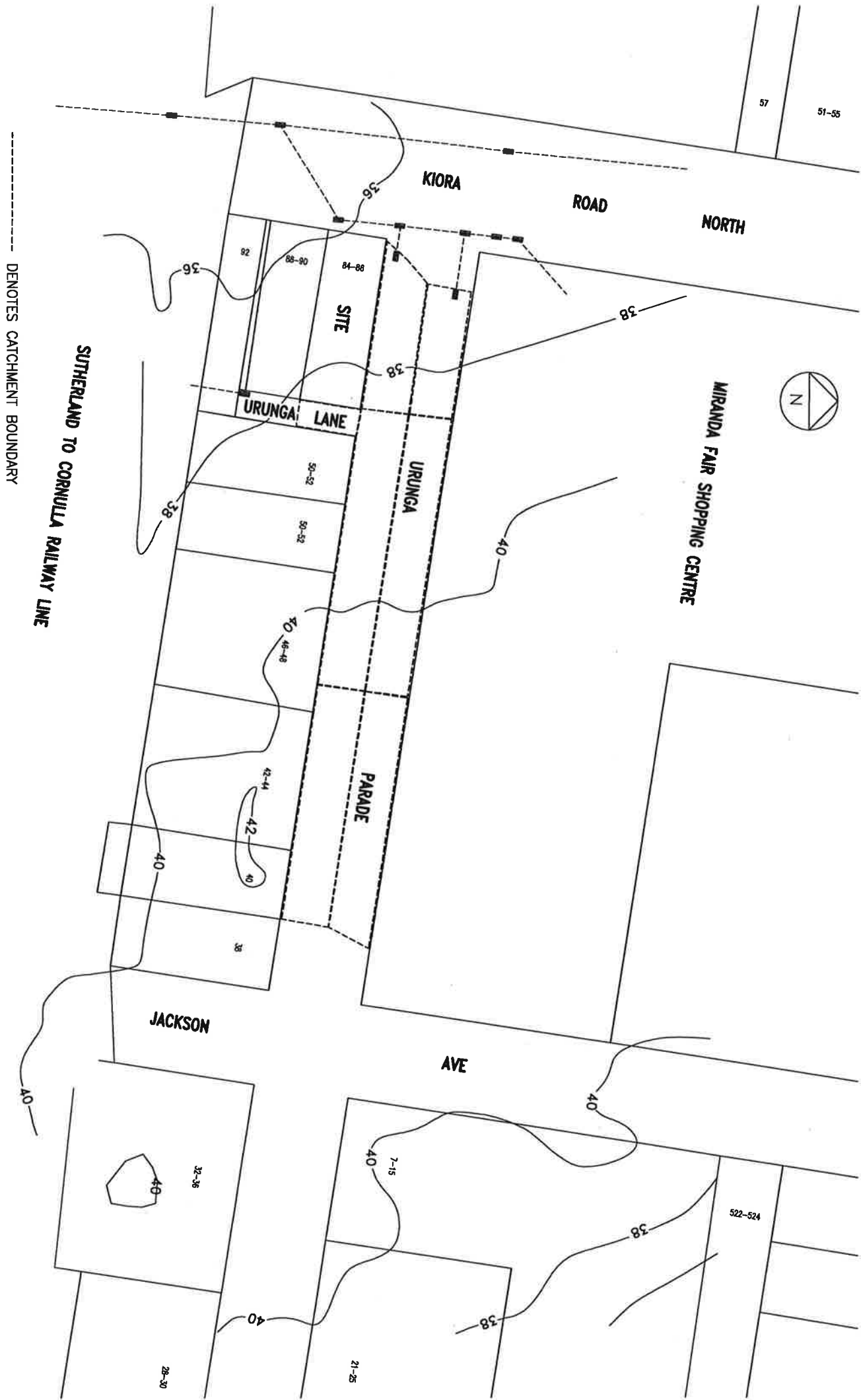
Yours faithfully
EWFw PTY LIMITED



Edward P Lucas MIEAust, CPEng

Enclosures Appendix 1 – DRAINS Catchment Plan (A3)
 Appendix 2 – DRAINS model data and results for 100 year ARI
 Appendix 3 – HECRAS Output Summary and sections
 Appendix 4 – Extent Overland Flow in Urunga Lane Plan (A3)

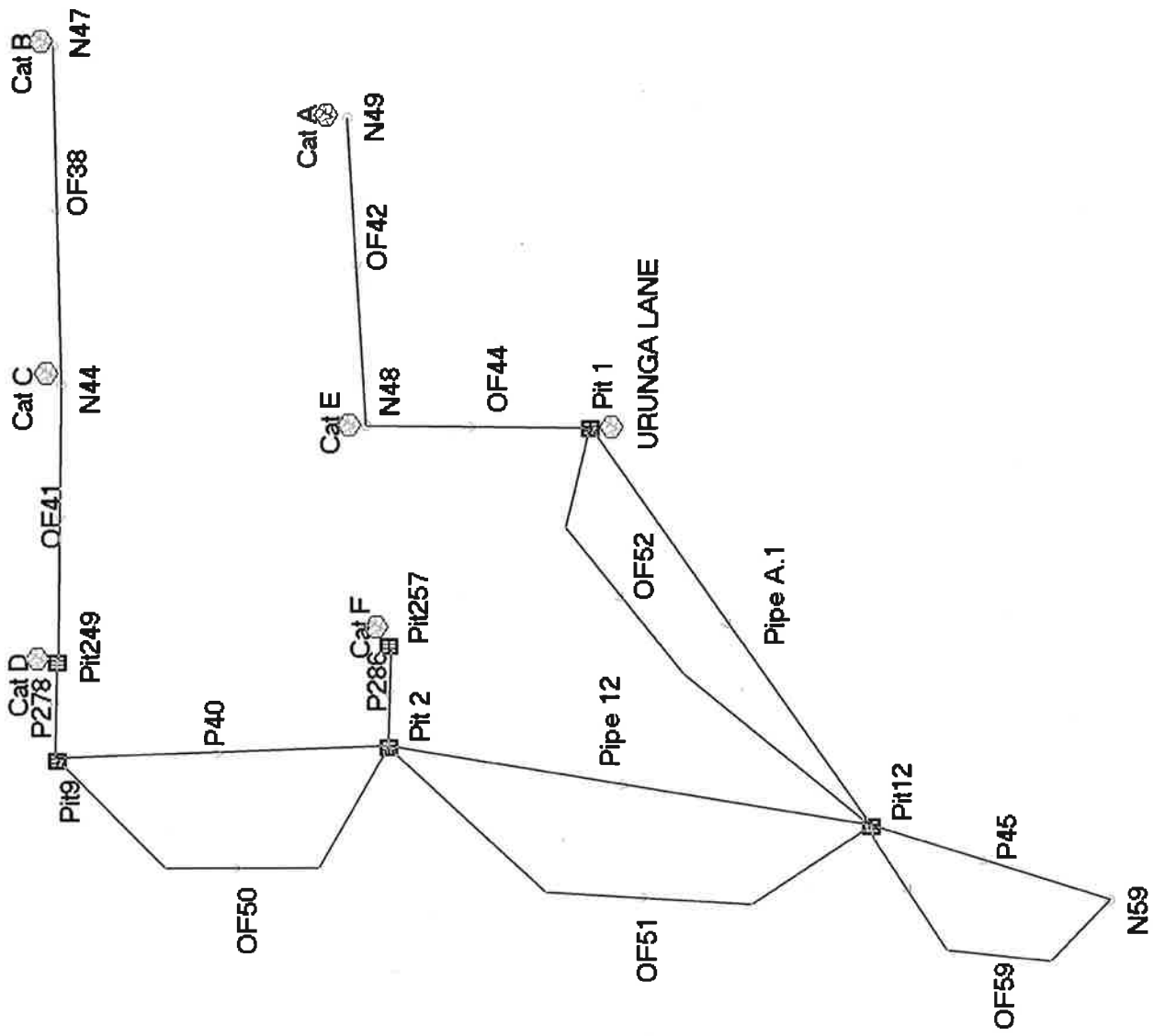
Appendix 1 - DRAINS Catchment Plan (A3)



CATCHMENT PLAN
84 KIORA ROAD, MIRANDA

--- DENOTES CATCHMENT BOUNDARY

Appendix 2 – DRAINS model data and results for 100 year ARI



**FLOOD STUDY
84 KIORA ROAD, MIRANDA
100 YEAR ARI EVENT - DRAINS LAYOUT**

DRAINS results for 100 year ARI Events

PIT / NODE DETAILS		Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
Name								
Pit 1	36.27			0.028	1.73	0.024	Inlet Capacity	
Pit12	35.4			0.003	0.6	0.002	Inlet Capacity	
N59	35.08			0				
Pit249	36.5			0.03	0.7		None	
Pit9	36.42			0	0.68	0	None	
Pit 2	36.35			0	0.65	0	None	
Pit257	36.37			0.008	0.83		None	
B-CATCHMENT DETAILS								
Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)		Due to Storm
URUNGA LANE	0.005	0.005	0	2	6	0		
Cat C	0.035	0.035	0	3	6	0	AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1	
Cat B	0.035	0.035	0	3	6	0	AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1	
Cat E	0.042	0.042	0	3	6	0	AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1	
Cat A	0.035	0.035	0	3	6	0	AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1	
Cat D	0.017	0.017	0	3	6	0	AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1	
Cat F	0.022	0.022	0	3	6	0	AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1	
Outflow Volumes for Total Catchment (0.29 impervious + 0.00 pervious = 0.29 total ha)								
Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)				
	95.81	92.89 (97.0%)	92.89 (97.0%)	0.00 (0.0%)				
	142.98	140.06 (98.0%)	140.06 (98.0%)	0.00 (0.0%)				AR&R 100 year, 10 minutes storm, average 197 mm/h, Zone 1
	176.54	173.62 (98.3%)	173.62 (98.3%)	0.00 (0.0%)				AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1
	248.03	245.11 (98.8%)	245.11 (98.8%)	0.00 (0.0%)				AR&R 100 year, 1 hour storm, average 85 mm/h, Zone 1
	293.26	290.35 (99.0%)	290.35 (99.0%)	0.00 (0.0%)				AR&R 100 year, 1.5 hours storm, average 67 mm/h, Zone 1
	332.65	329.75 (99.1%)	329.75 (99.1%)	0.00 (0.0%)				AR&R 100 year, 2 hours storm, average 57 mm/h, Zone 1
	512.98	510.00 (99.4%)	510.00 (99.4%)	0.00 (0.0%)				AR&R 100 year, 6 hours storm, average 29.3 mm/h, Zone 1
PIPE DETAILS								
Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)				Due to Storm
Pipe A.1	0.053	2.89	36.183	35.397				AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1
P45	0.136	1.7	35.226	35.075				AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1
P278	0.055	1.46	36.439	36.423				AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1

P40	0.055	1.11	36.372	36.352					AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1
Pipe 12	0.071	3.79	36.184	35.397					AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1
P286	0.021	0.51	36.353	36.352					AR&R 100 year, 1.5 hours storm, average 67 mm/h, Zone 1
ERFLOW ROUTE DETAILS									
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max WWidth	Max V		Due to Storm
OF52	0.024	0.024	0	0.01	0	7.4	0.33		AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1
OF59	0.002	0.002	0	0.002	0	7.4	0.09		AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1
OF41	0.067	0.067	0	0.092	0.08	2.17	0.87		AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1
OF38	0.035	0.035	0	0.075	0.06	1.63	0.77		AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1
OF44	0.073	0.073	0	0.094	0.08	2.23	0.9		AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1
OF42	0.035	0.035	0	0.075	0.06	1.63	0.76		AR&R 100 year, 20 minutes storm, average 147 mm/h, Zone 1
OF50	0	0	0	0	0	0	0		
OF51	0	0	0	0	0	0	0		
RR 100 year, 20 minutes storm, average 147 mm/h, Zone									
Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %					
Pit 1	59.9	59.95	0	-0.1					
Pit12	125.41	125.75	0	-0.3					
N59	125.75	125.75	0	0					
N44	51.36	51.36	0	0					
N47	25.92	25.92	0	0					
N48	56.16	56.16	0	0					
N49	25.44	25.44	0	0					
Pit249	63.84	49.63	0	22.3					
Pit9	49.63	49.68	0	-0.1					
Pit 2	65.32	65.46	0	-0.2					
Pit257	16.32	15.65	0	4.1					

DRAINS results for 20 year ARI Events

PIT / NODE DETAILS				Version 8				Constraint	
Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Freeboard (m)	Min	Overflow (cu.m/s)	Constraint	
Pit 1	36.27		0.028		1.73		0.022	Inlet Capacity	
Pit12	35.38		0.003		0.62		0.001	Inlet Capacity	
N59	35.07		0						
Pit249	36.5		0.03		0.7			None	
Pit9	36.42		0		0.68		0	None	
Pit 2	36.35		0		0.65		0	None	
Pit257	36.36		0.008		0.84			None	
SUB-CATCHMENT DETAILS									
Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm		
URUNGA LANE	0.005	0.005	0	2	6	0			
Cat C	0.035	0.035	0	3	6	0	AR&R 100 year, 1.5 hours storm, average 67 mm/h, Zone 1		
Cat B	0.035	0.035	0	3	6	0	AR&R 100 year, 1.5 hours storm, average 67 mm/h, Zone 1		
Cat E	0.042	0.042	0	3	6	0	AR&R 100 year, 1.5 hours storm, average 67 mm/h, Zone 1		
Cat A	0.035	0.035	0	3	6	0	AR&R 100 year, 1.5 hours storm, average 67 mm/h, Zone 1		
Cat D	0.017	0.017	0	3	6	0	AR&R 100 year, 1.5 hours storm, average 67 mm/h, Zone 1		
Cat F	0.022	0.022	0	3	6	0	AR&R 100 year, 1.5 hours storm, average 67 mm/h, Zone 1		
Outflow Volumes for Total Catchment (0.29 impervious + 0.00 pervious = 0.29 total ha)									
Total Rainfall	Total Runoff	Impervious Runoff	Pervious Runoff	Storm					
cu.m	cu.m (Runoff %)	cu.m (Runoff %)	cu.m (Runoff %)						
73.92	71.00 (96.1%)	71.00 (96.1%)	0.00 (0.0%)	AR&R 20 year, 10 minutes storm, average 152 mm/h, Zone 1					
109.91	106.99 (97.3%)	106.99 (97.3%)	0.00 (0.0%)	AR&R 20 year, 20 minutes storm, average 113 mm/h, Zone 1					
135.69	132.77 (97.8%)	132.77 (97.8%)	0.00 (0.0%)	AR&R 20 year, 30 minutes storm, average 93 mm/h, Zone 1					
248.03	245.11 (98.8%)	245.11 (98.8%)	0.00 (0.0%)	AR&R 100 year, 1 hour storm, average 85 mm/h, Zone 1					
293.26	290.35 (99.0%)	290.35 (99.0%)	0.00 (0.0%)	AR&R 100 year, 1.5 hours storm, average 67 mm/h, Zone 1					
332.65	329.75 (99.1%)	329.75 (99.1%)	0.00 (0.0%)	AR&R 100 year, 2 hours storm, average 57 mm/h, Zone 1					
512.98	510.00 (99.4%)	510.00 (99.4%)	0.00 (0.0%)	AR&R 100 year, 6 hours storm, average 29.3 mm/h, Zone 1					
PIPE DETAILS									
Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm				
Pipe A.1	0.052	2.87	36.183	35.38	AR&R 100 year, 2 hours storm, average 57 mm/h, Zone 1				
P45	0.128	1.68	35.218	35.067	AR&R 100 year, 2 hours storm, average 57 mm/h, Zone 1				
P278	0.053	1.48	36.436	36.417	AR&R 100 year, 2 hours storm, average 57 mm/h, Zone 1				

P40	0.053	1.12	36.367	36.345					AR&R 100 year, 2 hours storm, average 57 mm/h, Zone 1
Pipe 12	0.068	3.75	36.183	35.38					AR&R 100 year, 2 hours storm, average 57 mm/h, Zone 1
P286	0.021	0.54	36.345	36.345					AR&R 100 year, 1.5 hours storm, average 67 mm/h, Zone 1
OVERFLOW ROUTE DETAILS									
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V		Due to Storm
OF52	0.022	0.022	0	0.01	0	7.4	0.3		AR&R 100 year, 2 hours storm, average 57 mm/h, Zone 1
OF59	0.001	0.001	0	0.001	0	7.4	0.12		AR&R 100 year, 2 hours storm, average 57 mm/h, Zone 1
OF41	0.065	0.065	0	0.09	0.08	2.13	0.87		AR&R 100 year, 2 hours storm, average 57 mm/h, Zone 1
OF38	0.035	0.035	0	0.075	0.06	1.63	0.77		AR&R 100 year, 1.5 hours storm, average 67 mm/h, Zone 1
OF44	0.071	0.071	0	0.093	0.08	2.21	0.89		AR&R 100 year, 1.5 hours storm, average 67 mm/h, Zone 1
OF42	0.035	0.035	0	0.075	0.06	1.63	0.76		AR&R 100 year, 1.5 hours storm, average 67 mm/h, Zone 1
OF50	0	0	0	0	0	0	0		
OF51	0	0	0	0	0	0	0		
for AR&R 100 year, 1.5 hours storm, average 67 mm/h, Zone 1									
Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %					
Pit 1	124.17	124.2	0	0					
Pit12	271.29	271.44	0	-0.1					
N59	271.45	271.45	0	0					
N44	106.46	106.46	0	0					
N47	53.73	53.73	0	0					
N48	116.42	116.42	0	0					
N49	52.73	52.73	0	0					
Pit249	132.33	113.93	0	13.9					
Pit9	113.93	113.93	0	0					
Pit 2	147.05	147.1	0	0					
Pit257	33.83	33.12	0	2.1					

Appendix 3 – HECRAS Output Summary and sections

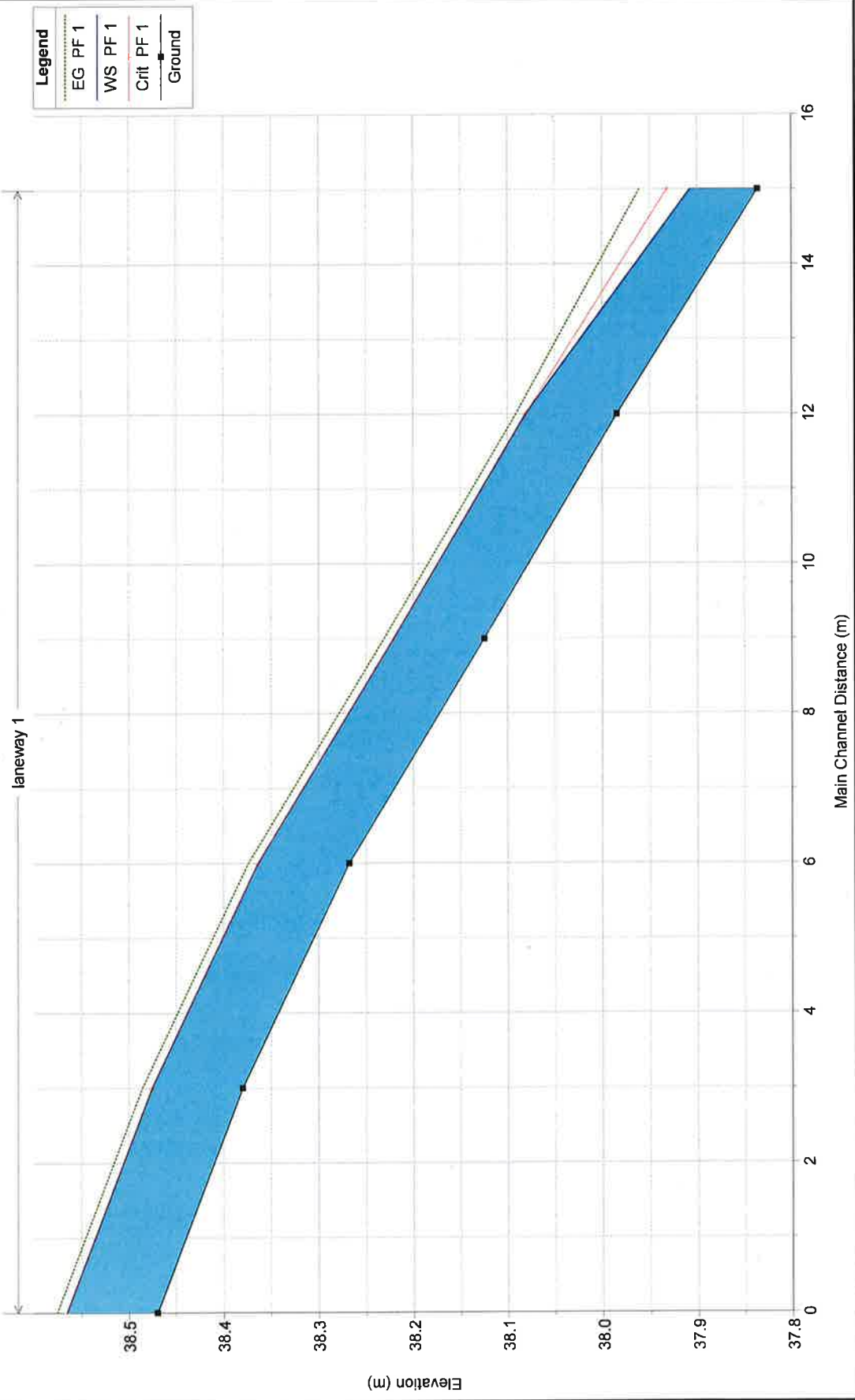
Overland Flow Calculations

Urunga Lane

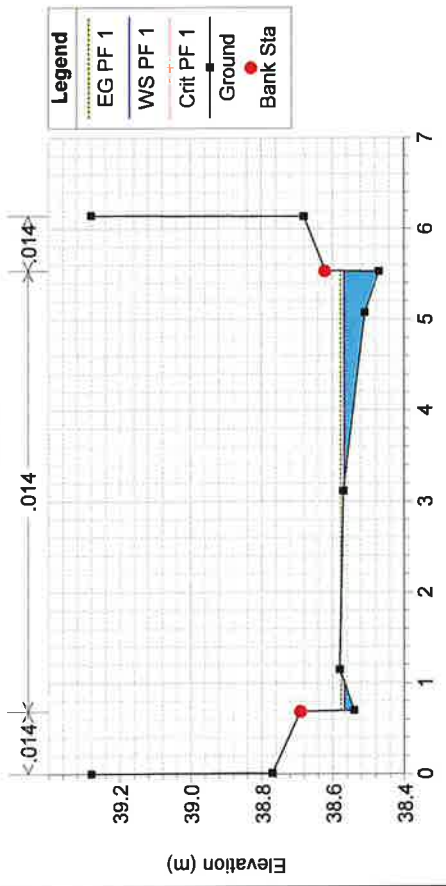
For Proposed Development at 84 Kiora Road, Miranda

Cross Section	Profile	Q Total (m ³ /s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m ²)	Top Width (m)	Froude #	Chl	Depth of Flow (m)
15	PF 1	0.04	37.84	37.91	37.93	37.96	0.028001	1.02	0.04	1.48	2.02		0.07
12	PF 1	0.04	37.99	38.08	38.08	38.09	0.003793	0.45	0.09	2.56	0.78		0.09
9	PF 1	0.04	38.13	38.22	38.22	38.23	0.003791	0.45	0.09	2.56	0.78		0.09
6	PF 1	0.04	38.27	38.36	38.36	38.37	0.003804	0.45	0.09	2.56	0.78		0.09
3	PF 1	0.04	38.38	38.48	38.48	38.49	0.003819	0.45	0.09	2.56	0.78		0.1
0	PF 1	0.04	38.47	38.57	38.57	38.58	0.003809	0.45	0.09	2.56	0.78		0.1

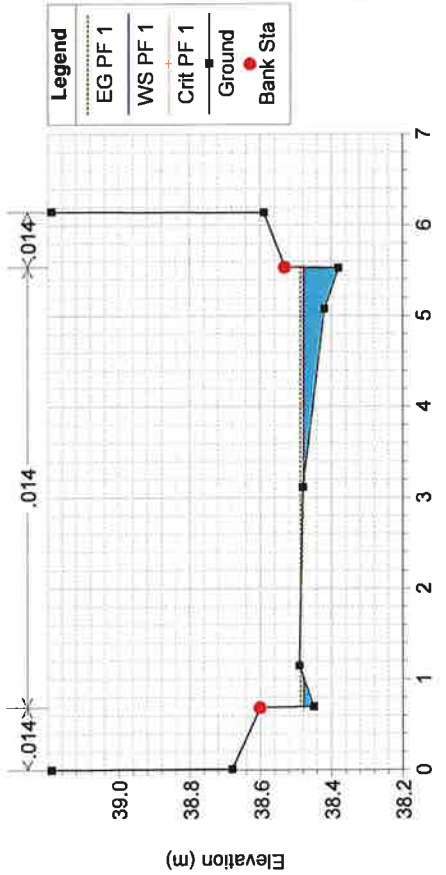
Urunga Lane Plan: Plan 02
Geom: Urunga Lane Flow: 100year flow



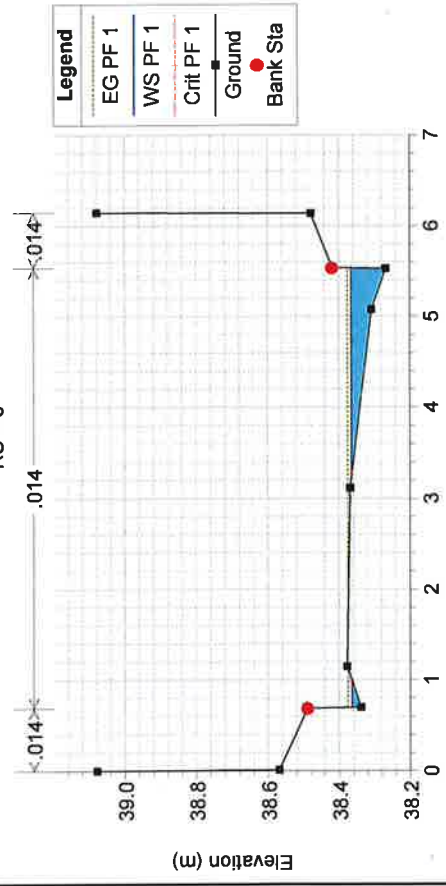
Urunga Lane Plan: Plan 02
 Geom: Urunga Lane Flow: 100year flow
 RS = 0



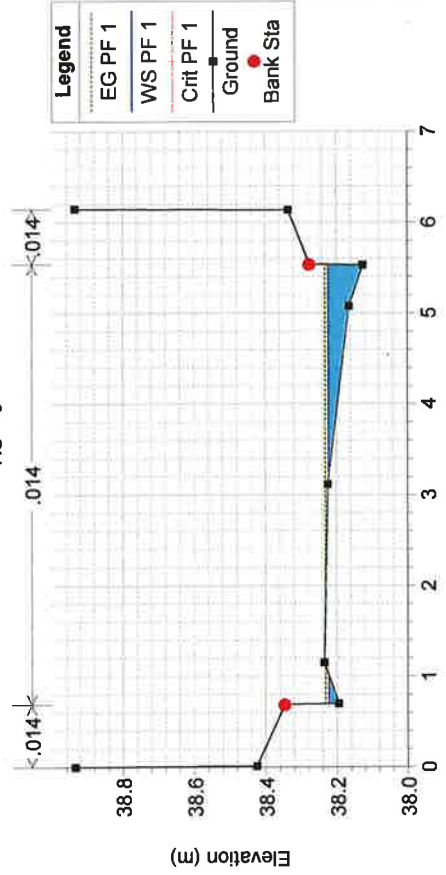
Urunga Lane Plan: Plan 02
 Geom: Urunga Lane Flow: 100year flow
 RS = 3



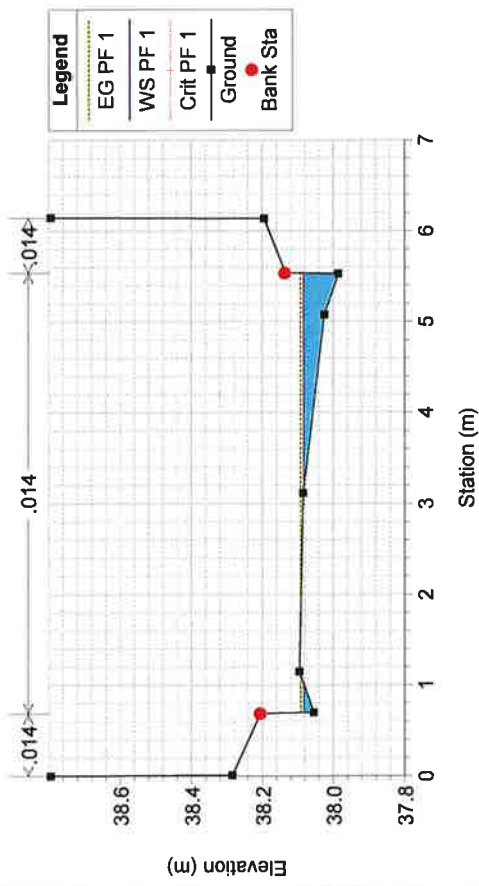
Urunga Lane Plan: Plan 02
 Geom: Urunga Lane Flow: 100year flow
 RS = 6



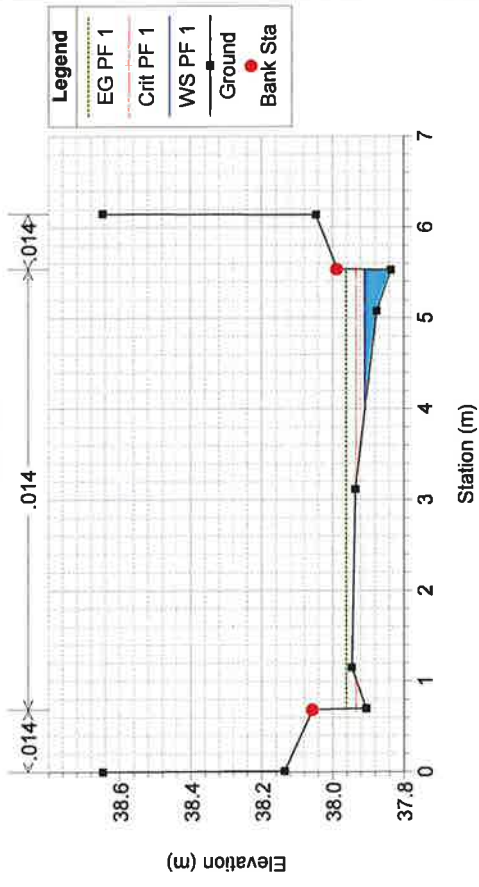
Urunga Lane Plan: Plan 02
 Geom: Urunga Lane Flow: 100year flow
 RS = 9



Urunga Lane Plan: Plan 02
 Geom: Urunga Lane Flow: 100year flow
 RS = 12



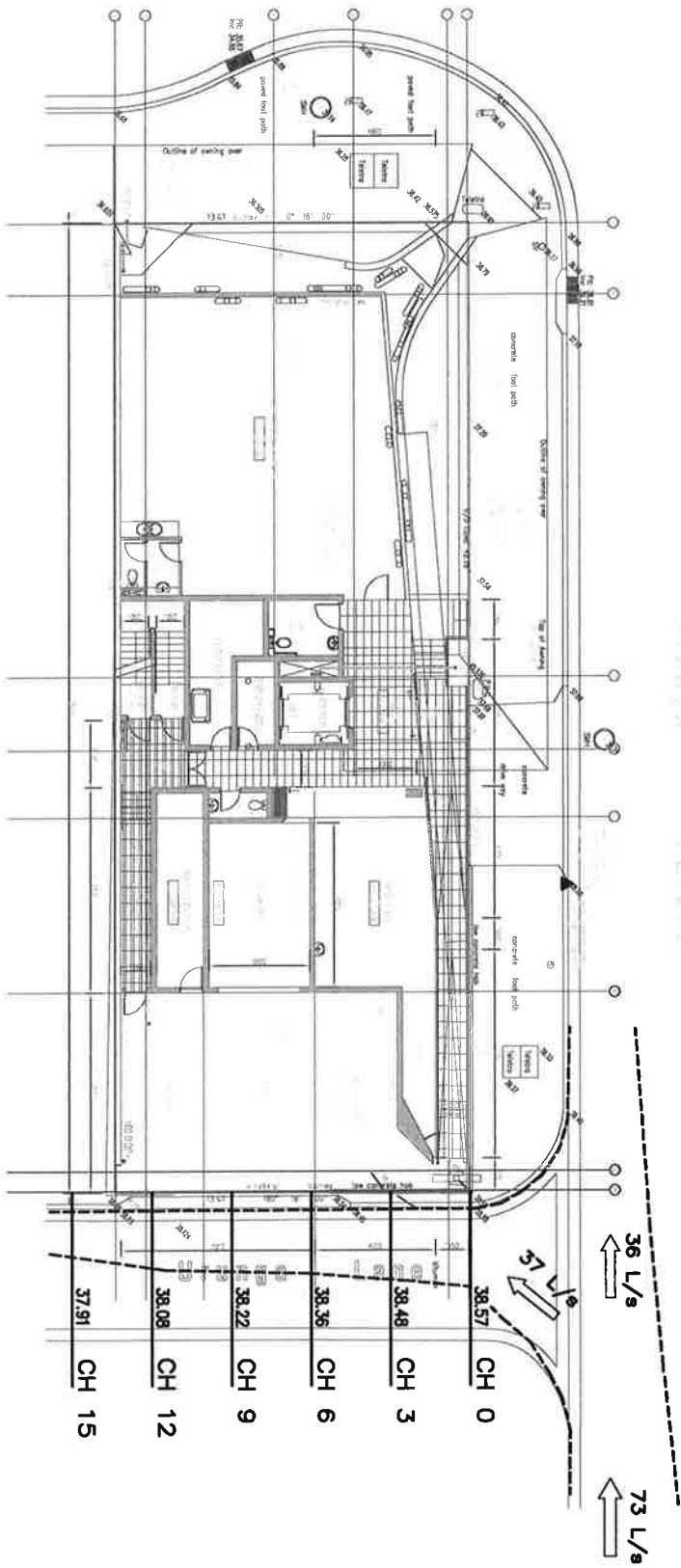
Urunga Lane Plan: Plan 02
 Geom: Urunga Lane Flow: 100year flow
 RS = 15



Appendix 4 – Extent Overland Flow in Norfolk Lane Plan (A3)



Kiora Road



- LEGEND**
- DENOTES HEICRUS CROSS SECTION
 - CH 12 DENOTES CROSS SECTION CHANGGE
 - 38.48 DENOTES 100 YR ARI WATER LEVEL.
 - DENOTES APPROX EXTENT OF OVERLAND FLOW



100 YR OVERLAND FLOW PATH – URUNGA LANE 84 KIORA ROAD, MIRANDA

DATE: 31 MARCH 2011
DRAWING NO: 3535-DA-01