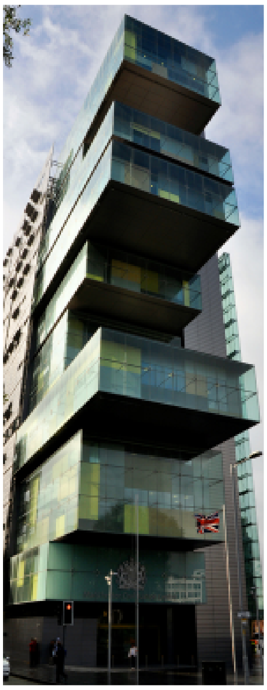
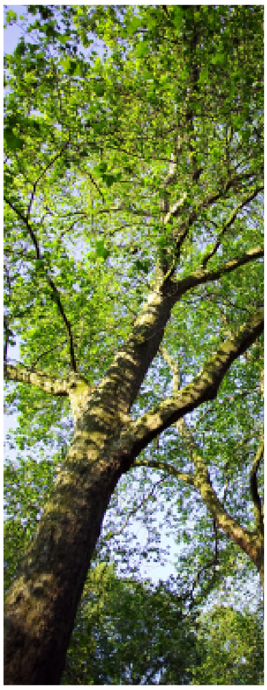


238 - 240 Mona Vale Road

Flood Assessment Report

July 2014

Bupa Care Services

Mott MacDonald

238 - 240 Mona Vale Road

Flood Assessment Report

July 2014

Bupa Care Services

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Issue and revision record

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C	20.03.2013	AH	CA	CA	For DA Submission
D	21.03.2014	SR	CA	CA	For DA Submission
E	22.07.2014	SR	JT	JT	For DA Submission

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Mott MacDonald

Content

1. Introduction

1.1 Purpose

Bupa Care Services propose to develop the existing Camellia Grove nursery at 238-240 Mona Vale Road, St Ives into a new 98 bed Residential Aged Care Facility (RACF).

A preliminary investigation has discovered two drainage easements located over the existing drainage infrastructure present within the subject site. One is in favour of the Roads and Maritime Service (RMS) and the other is in favour of Ku-ring-gai Council. The existing easements converge towards the centre of the existing site.

It is proposed that an alternative drainage system be established in order to maximise the development potential of the subject site. In order to determine the infrastructure required to convey the existing flows, a flood assessment has been undertaken to understand the nature of flooding and flows that traverse the site.

This report will outline the extent of flooding during large storm events, and propose an alternative drainage arrangement which considers suitable freeboard to the habitable floor levels of the proposed aged care facility.

The objectives of this study are to address the following principles;

- Estimate the 100 year Average Recurrence Interval (ARI) flood levels within the subject site;
- Align and size an alternative drainage (piped) system for the site;
- Recommend floor levels for the proposed development by considering suitable freeboard above estimated 100 year ARI flood levels; and
- Assess the impacts on overland flow and provide a suitable flowpath for the safe passage of flows through the site.

1.2 Methods Adopted

A hydraulic model using DRAINS software was used to model the flows entering the site and conveyed through the proposed drainage infrastructure. The flow rates for both the piped infrastructure and overland flows were provided by Council from their existing model of the local catchment.

A one-dimensional steady state flow hydraulic model (HEC-RAS) was then created to represent the major overland flowpath within the subject site. This model was used to determine the 100 year ARI flood levels and velocities.

2. Site Description and Data

2.1 Physical Setting

The subject site is located in St Ives and is bound by Killeaton Street to the North, Mona Vale Road to the South East and Link Road to the South West. Figure 2.1 shows the subject site location.

Figure 2.1: Subject Site

Source: www.nearmap.com

2.2 Topography

The site slopes towards the north from the intersection of Mona Vale Road and Link Road (approximate RL152.25m AHD) towards the Killeaton Street frontage (RL150.05m AHD). The Mona Vale Road frontage falls at a gradual grade down from the Killeaton Street intersection towards Link Road. Link Road is quite flat along the site frontage with an approximate RL152.15m AHD along the street kerb.

The Killeaton Street frontage falls to a sag point at the centre of the street from both Mona Vale Road and Link Road. The existing drainage infrastructure located at this sag discharges to an existing creek to the north that runs between the existing residential dwellings.

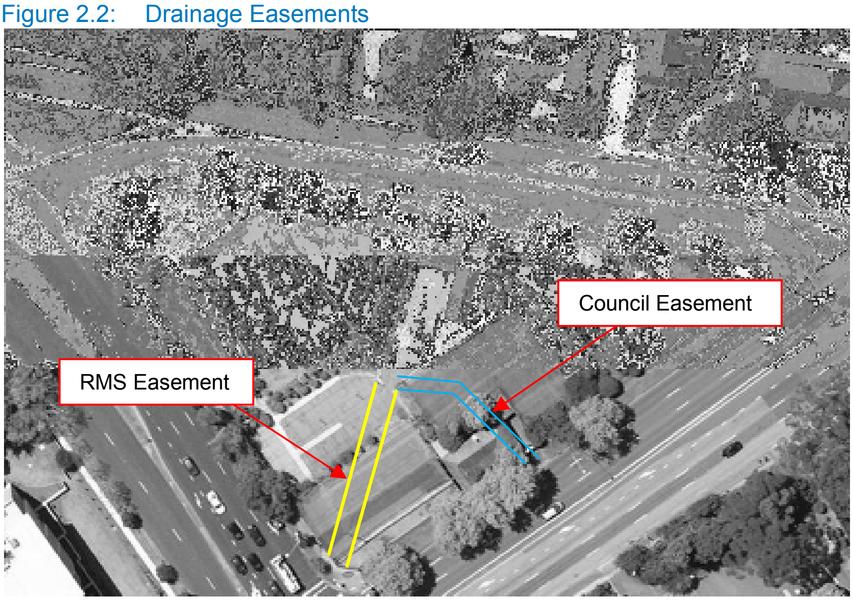
2.3 Drainage Easements

The existing RMS easement projects to the north through the centre of the subject site from the intersection of Mona Vale Road and Link Road. The easement is 2.44m wide and is approximately 35 metres in length. The Ku-Ring-Gai Council easement enters the site from the Mona Vale Road frontage at mid block. The easement is 1.83m wide and bends towards the RMS easement. Figure 2.2 shows the location of the drainage easements contained within the site.

It should be noted that the connection from these existing pipes and easements to the Council system in Killeaton Street are not currently covered by an easement (northern section of the site).

It is proposed that these existing easements be extinguished and the drainage line relocated to provide a more favourable configuration for the proposed development. An analysis of the flood characteristics of the site and recommendation for the proposed drainage infrastructure relocation is addressed in this report.

Figure 2.2: Drainage Easements



Source: www.nearmap.com

2.4 Data Collection

2.4.1 Survey

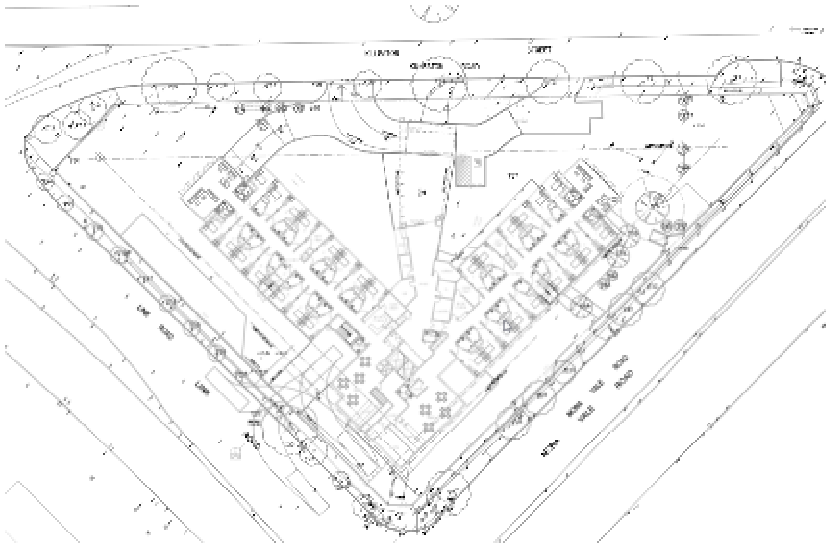
A preliminary ground survey of the site has been undertaken by Usher & Company Surveying and Land Development Consultants Pty Ltd. The survey datum is referenced to Australian Height Datum (AHD).

2.5 Proposed Works

The proposed development consists of a new aged care facility including;

- Entry from & exit to Killeaton St, connected to basement level car parking;
- Service vehicle loading area from Link Road;
- Three storey building (Ground Floor, Level 1 and Level 2);
- Access pathways, courtyards and landscaping around the building.

Figure 2.3: Architectural Layout



Source: DWP Suters Architects

Refer to the proposed Civil engineering plans attached in Appendix A, and Architectural documentation by DWP Suters Architects.

2.5.1 Proposed Scenario

As part of the development submission, it is proposed that the converging piped trunk drainage systems that currently traverse the site be consolidated and directed around the development site A proposed overland flow/culvert structure is to be utilised for emergency overland flows when the trunk pipe system capacity is exceeded (greater then 20 year ARI storm event).

The underground piped system will convey flows from the existing street drainage located in Mona Vale Road, through a new pipe system located within the verge along Link Road. The pipe will then turn at the corner of Killeaton Street before connecting back into the existing drainage system at the discharge point located sag in Killeaton Street.

The emergency overland flow culvert structure is proposed to convey flows that exceed the piped system under the raised building podium. In an effort to maintain existing conditions both upstream and downstream of the development site, the proposed structure follows a similar path to the existing natural flowpath through the site.

It should be noted that the proposed piped system through the site caters for the 20 year ARI storm event (as required by *Chapter 9 – Road and Trunk Drainage Design in Councils Water Management DCP47*), and that only in storm events of a greater magnitude (i.e. 50, 100 year ARI, etc.) will flows exceed the piped network and flow within the emergency overland flowpath system.

The flows from the piped network and the overland flowpath will meet at the low point at the northern boundary adjacent to the sag in Killeaton Street. The piped system will connect at this point into Council's existing drainage infrastructure in Killeaton Street (existing 900mm diameter pipe). In extreme storm events, flows from the piped network will surcharge and flow across the verge into the local drainage system, therefore maintaining exiting flow conditions during extreme flooding events. By maintaining flow conditions at both the upstream and downstream points of discharge, the proposed development will have minimal impact on the existing flood conditions of the surrounding road networks and properties.

2.5.2 Easement/Flowpath Options Explored

A number of options were explored to determining the best possible outcome for the drainage easement and emergency flowpath through the site. It should be appreciated that a number of design aspects contribute to the planning stages of the development and each were considered in the design of the above mentioned easement/flowpath configuration.

A number of constraints and conflicting compliance issues restricted the options available for the easement and flowpath reconfiguration through the development site. They include the following;

- Landscaping requirements; - Providing useable landscaping area was a priority for the development and a requirement under a number of planning conditions (both SEPP Controls and Council policies). Council also require adequate deep soil planting in landscaped areas, particularly at the rear of the development.

Adequate planting is also required for screening purposes along these eastern and western rear boundaries. Due to the irregular layout/nature of the site area, providing suitable emergency overland flowpaths through these landscaped areas proved a difficult task without detracting from the landscape character of the surrounding upper north shore local area.

- Setbacks/Site Configuration; - Based on the site's irregular shape and layout, it is important to maximise the high quality, useable areas for the residents of this proposed development.
- Basement Access – It is recommended that major flowpaths be located away from basement carpark entrances to avoid the possibility of flows entering the lower levels during an extreme flood event.

The following options were explored to provide a suitable piped trunk drainage system and emergency flowpath through the development site.

Option 1 – *Provide piped system and overland flowpath/channel around western boundary (Link Road and then east along Killeaton Street);*

- Advantages:
  - Route avoids historic Magnolia tree and planting at north eastern corner of the site.
- Disadvantages:
  - Relatively large and deep excavation required for overland flowpath channel to achieve suitable freeboard requirements to Finished Floor Level (with Building height restrictions).
  - Prismatic shape of open channel does not lend itself to adequate landscaping requirements (deep soil planting) for development along the long Link Road boundary.
  - Potential for flood waters from overland flow to flood basement based on close proximity of flowpath to basement entrance. Relocation of basement entry would be required (presents access issues).

Option 2 – *Provide piped system and overland flowpath channel around eastern boundary (Mona Vale Road and then west along Killeaton Street);*

- Advantages:
  - Overland flows do not need to pass by the basement entrance.
- Disadvantages:
  - Unable to run pipe and overland flows around this boundary without disturbing historic Magnolia tree and existing Camellias. Other large trees to be relocated.

  - Prismatic shape of open channel does not lend itself to adequate landscaping requirements (deep soil planting) for development along the long Mona Vale Road boundary.
  - Makes quality useable garden areas in eastern corner redundant

Option 3 – Provide piped system and emergency flow culvert under building;

- Advantages:
  - Significantly reduces excavation on site as the culvert follows the natural flowpath on site (least change to existing conditions).
  - Setbacks on Link Road and Mona Vale Road able to be landscaped in a more natural form.
  - Historical Magnolia tree and other trees (existing Camellias) to be retained are avoided.
  - Proposed floor levels can be maintained with adequate freeboard requirements satisfied.
- Disadvantages:
  - Access will need to be provided to overland flow culvert for maintenance.

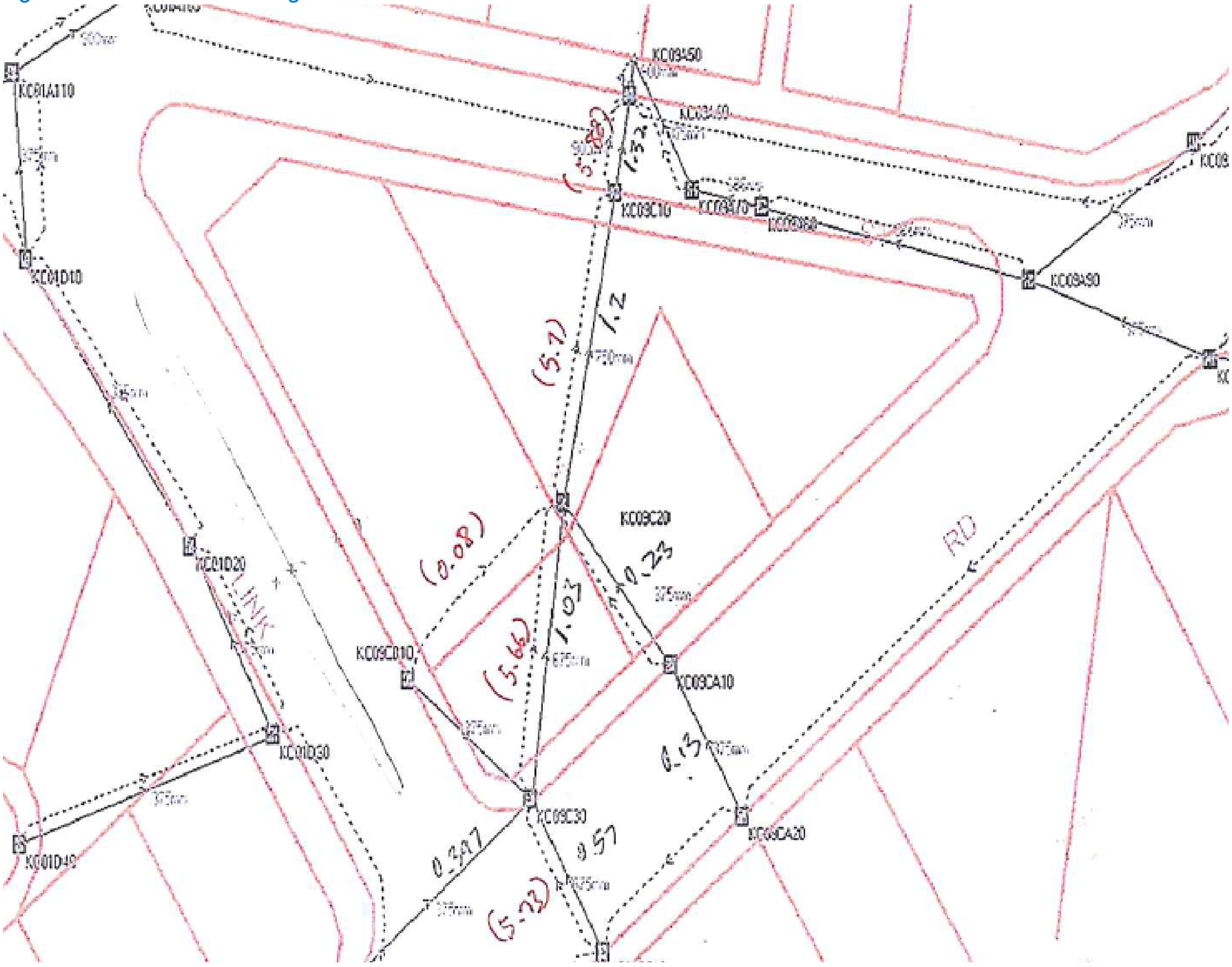
It was determined through lengthy consultation with the project team that Option 3 was the most suitable option, and met with the least conflicting compliance issues for the development. This option had the least impact on a range of design considerations including landscaping, site layout, etc., and was able to provide the development with a design that was in keeping with relevant authority requirements.

3. Hydraulics and Hydrology

3.1 Council Flow Data (DRAINS Model)

Ku-ring-gai Council have provided a mark-up of their existing drainage network (Council DRAINS model as shown in Figure 3.1) complete with overland flow and piped flow rates for the 100 year ARI flood event contributing to the subject site.

Figure 3.1: Council's Existing DRAINS Model



Source: Ku-ring-gai Council

The intent of this study is to demonstrate that flow conditions will not be adversely affected by the proposed development. The flow rates provided by Council will be adopted in the following flood assessment to determine the suitable design of the proposed trunk drainage system.

These flow rates will also provide a reference for maintaining the hydraulic function of the existing flow regimes (of both the piped and overland systems) entering and exiting the subject site.

A copy of the information provided by Council can be found in Appendix B.

3.2 DRAINS Model

A DRAINS model was set up to model the flows approaching the site in both the piped and overland systems to assess the performance of the proposed trunk stormwater system around the site. The DRAINS program typically performs design and analysis calculations for urban stormwater systems based on the development of a network of pipes, pits and nodes.

3.2.1 Model Parameters

In order to assess the performance of the proposed system, a DRAINS base model was established with the following input parameters as described below.

Hydrological Model

- Paved (impervious) area depression storage = 1 mm
- Supplementary area depression storage = 0 mm
- Grassed (pervious) area depression storage = 5 mm
- Soil type = 3

DRAINS user guide describes soil type 3 as follows:

Type 3 (or C) slow infiltration rates (may have layers that impede downward movement of water).

Rainfall Data

- Antecedent Moisture Condition = 3

Table 3.1 – DRAINS AMC Numbers

AMC Number	Description	Total Rainfall in 5 days preceding the storm (mm)
1	Completely Dry	0
2	Rather Dry	0 to 12.5
3	Rather Wet	12.5 to 25
4	Saturated	Over 25

AMC = 3 will generate higher runoff rates due to lower infiltration to soil compared to lower AMC numbers, therefore aiding in a conservative approach to inlet structure, pipe and stormwater detention design.

Inflow Hydrographs

- Based on the flow data received from Ku-ring-gai Council, the Rational Unit Hydrograph approach was adopted to construct basic inflow hydrographs for the model. This approach has a time to peak equal to the time of concentration. Both the rising and receding limbs of the hydrograph have a duration equal to the time of concentration. This approach was adopted in the absence of more detailed flow data (hydrographs), which were not supplied by Council.
- These hydrographs were applied to various nodes, pits and pipes to replicate the existing flow conditions entering the site. The locations of these inflows are shown on the DRAINS network shown in Figure 3.2.

3.2.2 Existing Regime

The exiting flow regime, illustrated in Council's DRAINS model (Appendix B), shows piped flows entering the site at two locations along Mona Vale Road. These existing pipes, shown as an existing 675mm across Mona Vale Road with a flow of 0.57 m^3/s, a 375mm diameter pipe across Link Road with a flow of 0.397m^3/s joining with the 675mm diameter pipe and a 375mm diameter pipe across Mona Vale Road with a flow of 0.23m^3/s.

In addition to the piped flows, a substantial amount of overland flow enters the site at the intersection of Mona Vale Road and Link Road (5.66m^3/s) by overtopping the kerb and crossing the verge towards the subject site. A smaller quantity of overland flow is shown to enter the site further to the north along Link Road (0.08m^3/s) in a similar manner (5.74m^3/s total).

3.2.3 Proposed Scenario

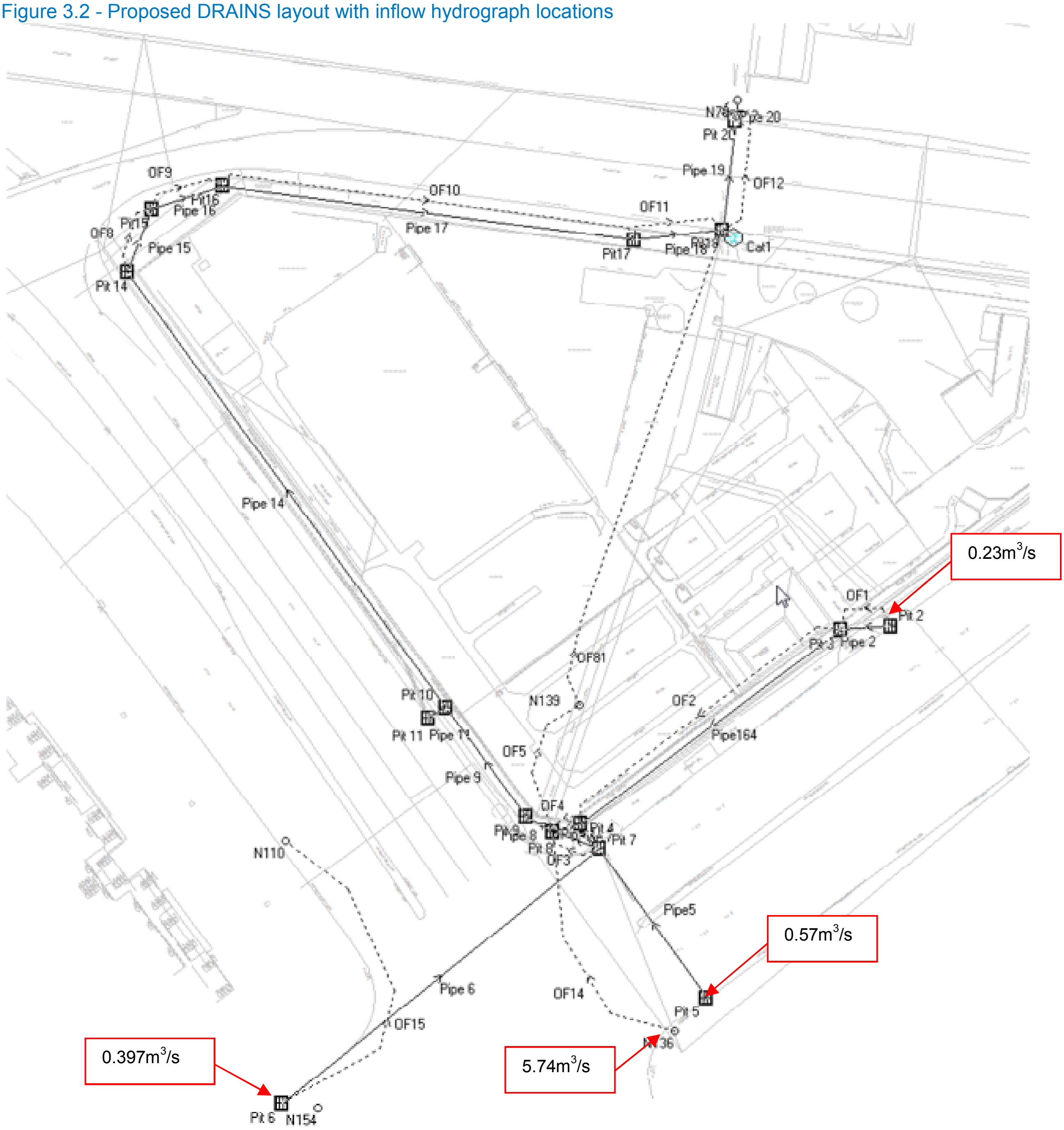
As part of the development submission, it is proposed that the existing piped network currently traversing the site be consolidated and directed around the development site. A proposed overland flow/culvert structure will also be constructed beneath the raised building podium to cater for emergency overland flows that exceed the piped network.

The underground piped system will convey flows from the existing street drainage located in Mona Vale Road, through a new pipe system located within the verge along Link Road. The pipe will then turn at the corner of Killeaton Street before connecting back into the existing drainage system at the discharge point located sag in Killeaton Street.

The emergency overland flow culvert structure is proposed to convey flows that exceed the piped system under the raised building podium. In an effort to maintain existing conditions both upstream and downstream of the development site, the proposed structure follows a similar path to the existing natural flowpath through the site.

The flows from the piped network and the overland flowpath will meet at the low point at the northern boundary adjacent to the sag in Killeaton Street. The piped system will connect at this point into Council's existing drainage infrastructure in Killeaton Street (existing 900mm diameter pipe). In large storm events, flows from the piped network will surcharge and flow across the verge into the local drainage system, therefore maintaining existing flow conditions. By maintaining flow conditions at both the upstream and downstream points of discharge, the proposed development will have minimal impact on the existing flood conditions of the surrounding road networks and properties.

Figure 3.2 - Proposed DRAINS layout with inflow hydrograph locations



To achieve this, it is proposed to construct a new 525mm diameter stormwater line (Pipe 2 and Pipe 164 shown in Figure 3.2 above) from the existing 375mm diameter stormwater line on Mona Vale Road (Pit 2) and connect this to a junction pit (Pit 8). From Pit 8 a 900mm diameter pipe is proposed to be drained around the site through a series of pits and pipes connecting to Council's existing infrastructure in Killeaton Street (Pit 18).

The pits that run around the corner of Link Road and Killeaton Street are proposed to have benching within the pits to allow smoother transition of flow around the bend.

3.2.4 Proposed System

The DRAINS model for the proposed site was developed based upon the following methodology;

- The site's proposed pipe network discharges to the existing stormwater pit located at the sag in Killeaton Street.
- The model discharges freely to the existing creek on the northern side of Killeaton St.
- The surcharge pit at the discharge point within the site is modelled as a sag pit within the landscaped area at the driveway entrance. Water can pond to a depth of 0.3m in this landscaped area before discharging over the verge as overland flow.
- A blockage factor of 50% was applied to all pipes within the model to determine the 100 year ARI surcharge flows for the emergency overland flow culvert (shown as OF Flowpath in Figure 3.2). This flowpath will be modelled using HEC-RAS and will be discussed in more detail in Section 3.3.

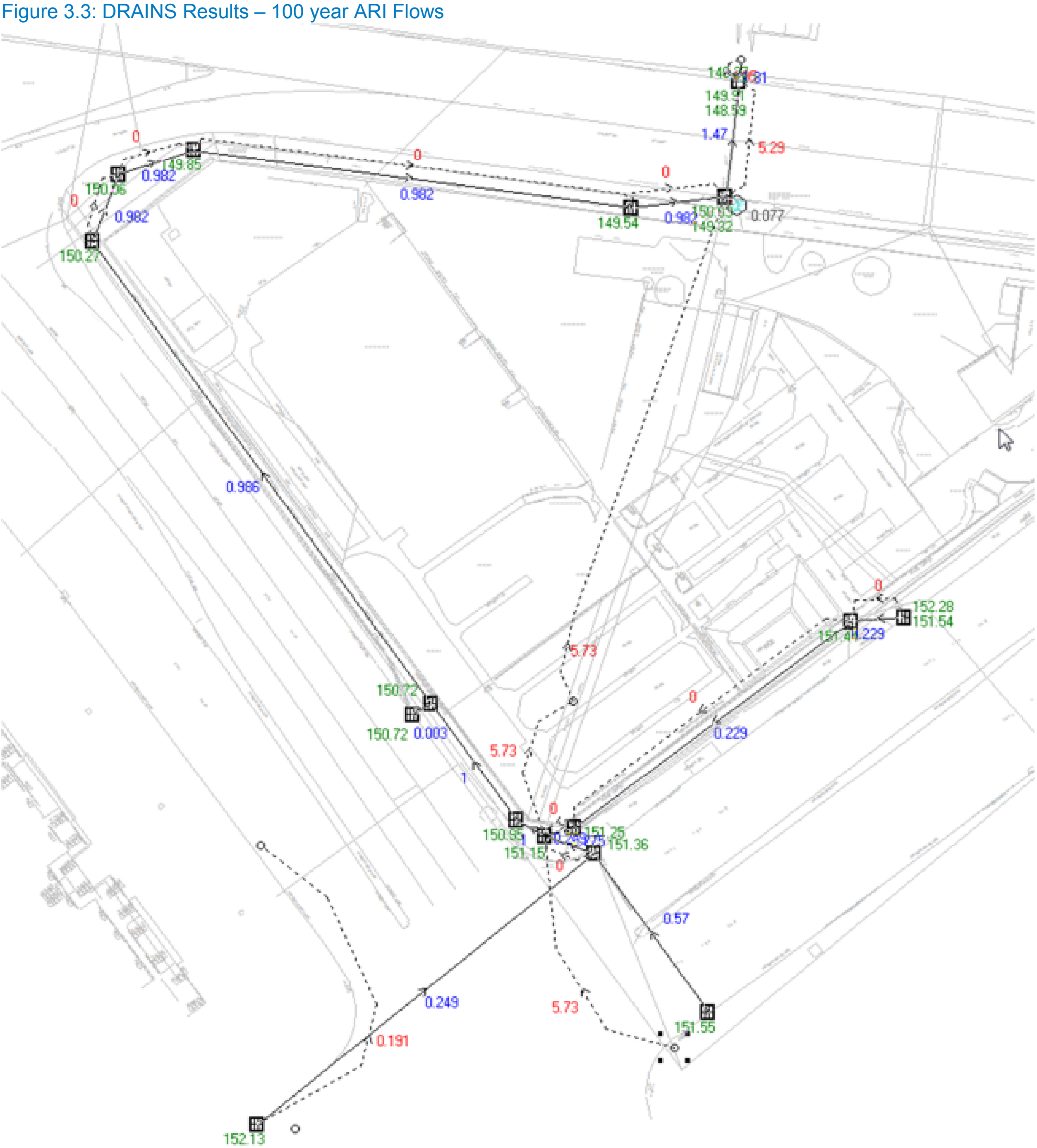
3.2.5 Results

3.2.5.1 Stormwater Pipe Drainage System

Iterations were performed in the DRAINS model to determine the size of the proposed piped network for the site to satisfy requirements in accordance with Ku-ring-gai Council standards and to maintain the existing flow regime.

Results of the assessment indicate that there is generally no adverse effect of realigning the stormwater pipe within the site as indicated in Figure 3.3 below.

Figure 3.3: DRAINS Results – 100 year ARI Flows



3.3 HEC-RAS Model

The HEC-RAS hydraulic analysis program was used to analyse the effect of the overland flows on the subject site. The HEC-RAS Version 4.1.0 (Jan 2010) hydraulic model, developed by the US Army Corps of Engineers, Hydrologic Engineering Centre, is widely used for analysis of hydraulic conditions where floodplain storage effects are small.

HEC-RAS is an integrated package of hydraulic analysis programs capable of performing one-dimensional, steady or unsteady flow, water surface profile calculations. The model can handle a full network of channels, a branching system or a single river reach. It is capable of modelling subcritical, supercritical and mixed flow water surface profiles.

The basic computational procedure is based on the solution of the one-dimensional energy equation. Energy losses are evaluated by friction (Manning's Equation). The effects of various obstructions such as bridges, culverts, weirs and obstructions in the floodplain are also considered in the computations.

3.4 Model Formulation

Formulating a HEC-RAS model involves defining cross sectional geometry and boundary conditions.

3.4.1 Geometry

The cross-sections used in the HEC-RAS model were generated from the detailed survey received from Usher & Company Surveyors Pty Ltd. Locations were selected based upon the topography of the site, location of existing structures and geometry of the proposed flow path culvert through the site. Appendix C shows the locations of the cross-sections used in the HEC-RAS model.

The spacing of the major cross-sections along the proposed flowpath culvert were set based on points of interest such as retaining walls and the existing building footprint and ranged between 8-25 metres.

Resistance to flow is a function of the surface roughness. Roughness was represented by Manning's 'n' values. The HEC-RAS Hydraulic Reference Manual (2003) was used as a guide for selecting Manning's 'n' values. The adopted values are tabulated in Table 3.2.

Table 3.2: Adopted Manning's 'n' Values

Description	Manning's 'n'
Landscaped Areas - Grassed, Planting, etc.	0.035
Hard Surfaces – Concrete, etc.	0.013

3.4.2 Boundary Conditions

Normal depth was used as the upstream and downstream boundary conditions within the HEC-RAS model.

The normal depth was calculated as the average slope of the terrain determined from the survey. Boundary condition slopes of 1.0% were set as the normal depth for the upstream and downstream boundary conditions respectively.

3.4.3 Peak Flows

The peak flow rate applied to the HEC-RAS model was determined by the DRAINS model for the emergency overland flowpath incorporating 50% operational pipelines in a 100 year ARI event (in accordance with *Chapter 9 – Road and Trunk Drainage Design – DCP47*). The peak flow to be applied was based on the surcharge generated when all pipelines were running at 50% capacity. The flowpath is to be designed to accommodate the increase in flow rate contributing to flows under the building as shown below in Table 3.3.

Table 3.3: Comparison of Flow Rates for Overland Flowpath

Flow from DRAINS at OF Flowpath	Flow Rate (m^3/s)
100 year ARI Flow Rate	5.74
100 year ARI Flow Rate (Pipes @ 50% Capacity)	6.04

This flow was applied to the HEC-RAS model to produce design flood levels and velocities. The model was run in steady-state mode as there was considered to be negligible flood storage to warrant an unsteady flow analysis.

3.5 Results - Design Flood Levels and Velocities

The estimated flood levels for the 100 year ARI design storms are tabulated in Appendix C and shown below in Table 3.4. The corresponding depths and velocities are also shown. Levels and velocities are quoted to the nearest 0.01m and m/s respectively. This is the industry accepted order of accuracy of hydraulic models.

Table 3.4: Design Flood Levels (100 Year ARI)

Location	Water Surface Level (m AHD)	Depth (m)	Velocity (m/s)
CH 79	151.19	0.48	1.56
CH 73.5	151.15	0.48	1.56
CH 57.4	151.01	0.47	1.6
CH 51	150.96	0.47	1.61
CH 40.5	150.86	0.46	1.64
CH 34	150.74	0.39	1.95
CH 22	150.58	0.33	1.65
CH 16	150.51	0.3	1.55
CH 8	150.5	0.36	1.1
CH 0.1	150.38	0.37	0.97
CH 00	150.38	0.37	0.98
CH -4	150.33	0.33	1.1

4. Risk Management

4.1 Flood Level Risk Factors

Freeboard is the difference between the finished floor level and the design flood level. It is a safety factor that is applied to account for uncertainty in the flood level estimation and provide a factor of safety.

A minimum height clearance specified above the 100 year ARI storm event will minimise the possibility of localised floodwater entering the ground floor additions.

Protection against the 100 year flood can be achieved by raising the proposed floor levels to a suitable height above the design flood level.

Ku-ring-gai Council's Water Management Development Control Plan – DCP 47 Chapter 7has been used as the design guideline for flood management for this site.

This document provides recommendations that a freeboard of 0.3m should be achieved above the design flood standard which is calculated based on the overland flow associated with the 100 year ARI storm event with any underground pipes operating at a maximum of 50% capacity.

4.2 Recommended Flood Planning Levels

4.2.1 Floor Levels

After assessing the risk factors associated with the site and Council's flood policy, the resulting flood planning levels are listed in Table 4.1. The resulting levels are listed in Australian Height Datum (AHD) in Table 4.1. These results have been recommended as minimum flood planning levels. The calculated minimum floor level comprises of;

- 100 year flood level (m AHD), plus;
- 300mm freeboard, plus;
- 200mm for structure and services.

The above allowances should provide adequate freeboard to the underside of any proposed services under the slab. This is to account for any floating debris that may damage proposed services or block flows from travelling unimpeded under the proposed slab.

Table 4.1: Minimum Flood Planning Levels

Location	Flood Planning Level (m AHD)
CH 79	RL 151.69
CH 73.5	RL 151.65
CH 57.4	RL 151.51
CH 51	RL 151.46
CH 40.5	RL 151.36
CH 34	RL 151.24
CH 28	RL 151.08
CH 16	RL 151.01
CH 8	RL 151.00
CH 0.1	RL 150.88
CH 00	RL 150.88
CH -4	RL 150.83

5. Conclusion

Mott MacDonald has undertaken the above flooding assessment of the proposed development for 238 -240 Mona Vale Road.

Flow rates for both the piped infrastructure and overland flows were provided by Council from their existing model of the local catchment. A DRAINS model was set up to model the flows entering and exiting the vicinity of the site in both the piped and overland systems to assess the performance of the proposed site stormwater system.

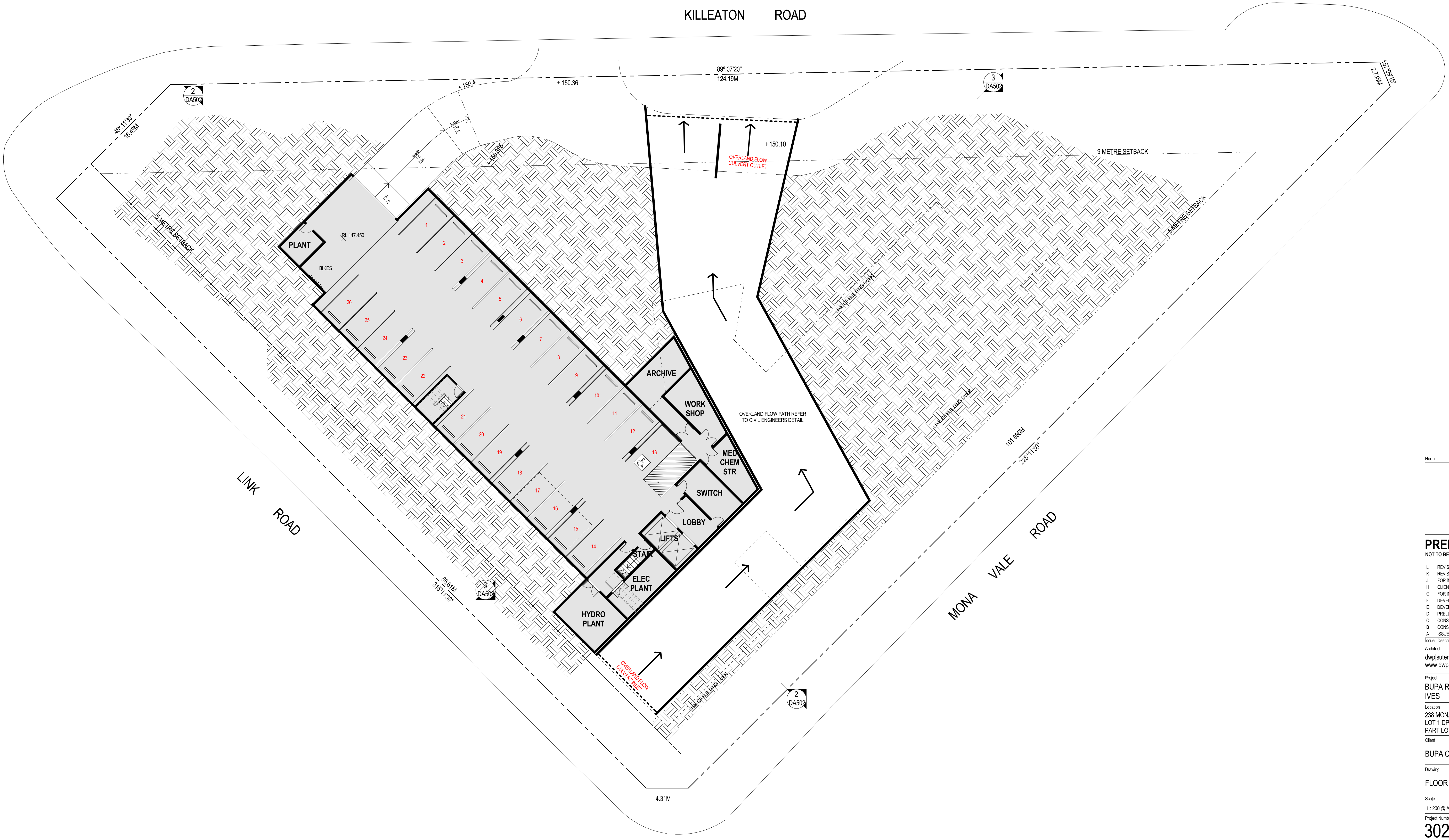
A one-dimensional steady state flow hydraulic model (HEC-RAS) was then created to represent the major overland flowpath within the subject site. This model was used to determine the 100 year ARI flood levels and velocities.

The following key results and recommendations were determined for the site based on the post-development flood levels.

- Mott MacDonald modelling results indicate that under the proposed scenario, no adverse impacts to upstream or downstream properties/flow regimes were observed due to the proposed development.
- The existing drainage infrastructure on site can be consolidated and diverted around the site to allow for the exisinguishment of existing easements.
- A culvert like structure is to be constructed with the building over (elevated podium) to allow for emergency overland flows in extreme storm events to pass under the development unimpeded along the sites natural flowpath.
- Minimum flood planning levels have been recommended.

Appendices

Appendix A. Proposed Architectural Layout



1 200_GENERAL ARRANGEMENT_BASEMENT
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PRELIMINARY
NOT TO BE USED DURING CONSTRUCTION

Issue	Description	Date	Chk	Auth
L	REVISED DA ISSUE	210714	MC	MC
K	REVISED DA ISSUE	140313	MC	MC
J	FOR INFORMATION	140310	MC	MC
H	CLIENT REVIEW	140217	MC	MC
G	FOR INFORMATION	140117	MC	MC
F	DEVELOPMENT APPLICATION	130325	RM	DC
E	DEVELOPMENT APPLICATION	130321	RM	DC
D	PRELIMINARY DA ISSUE	130312	RM	DC
C	CONSULTANTS ISSUE	130228	RM	DC
B	CONSULTANTS ISSUE	130225	RM	DC
A	ISSUE FOR INFORMATION	130221	RM	DC

Architect
dwp|suters
www.dwpsuters.com

Project
BUPA RESIDENTIAL AGED CARE FACILITY ST IVES

Location
238 MONA VALE ROAD, ST IVES NSW 2075
LOT 1 DP 238521, PART LOT A DP 336620,
PART LOT A+B DP 341616

Client
BUPA CARE SERVICES

Drawing
FLOOR PLAN - LOWER GROUND

Scale: 1 : 200 @ A1
Date Printed: 21/07/2014 2:17:07 PM

Project Number: 302668
Drawing Number: DA161
Issue: L

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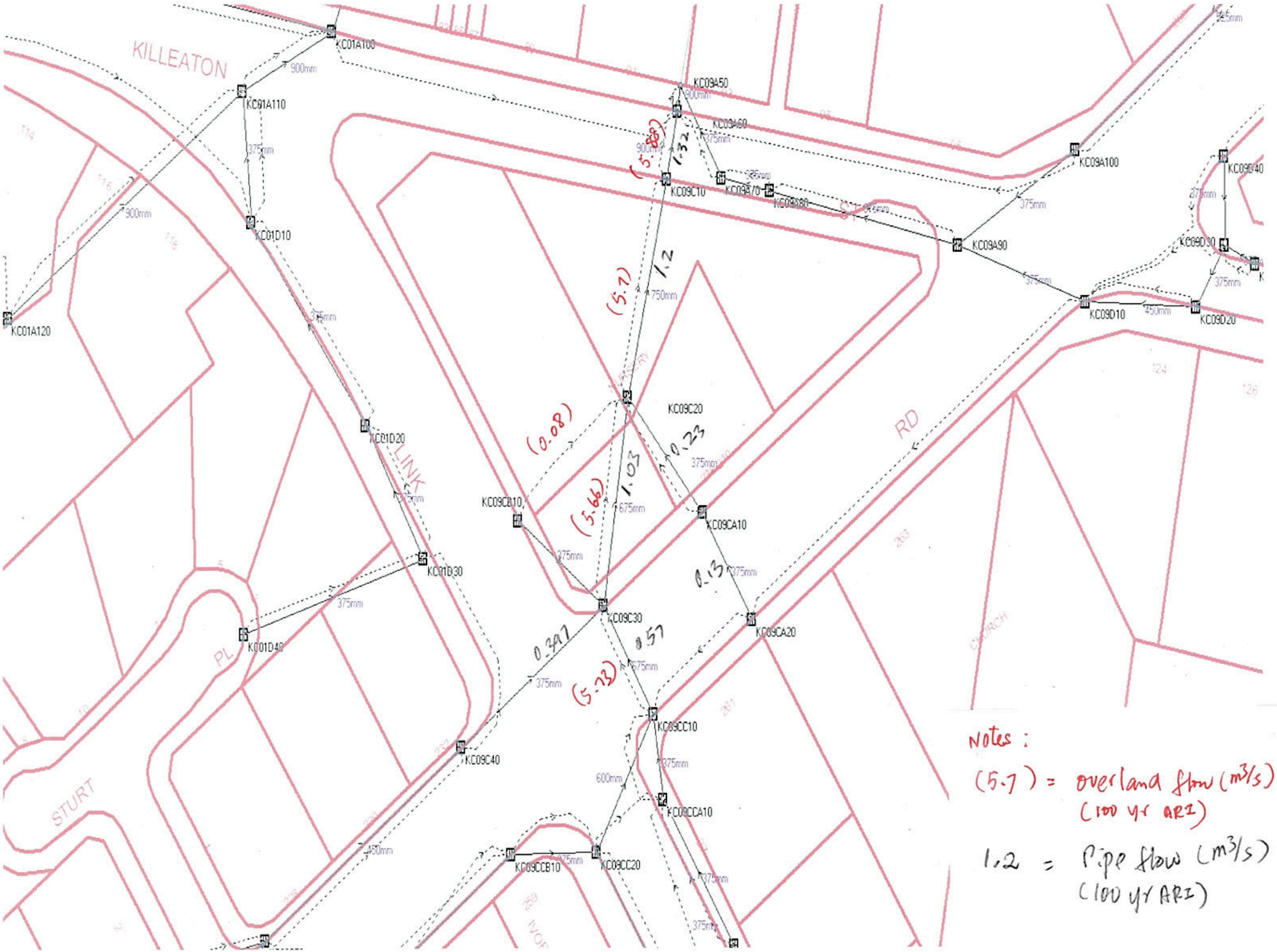
Appendix B. Council Flow Data


KILLEATON
LINK
PL
STURT
RD
CHURCH
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KC09A100
KC09C10
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KC09CB10
KC09CC10
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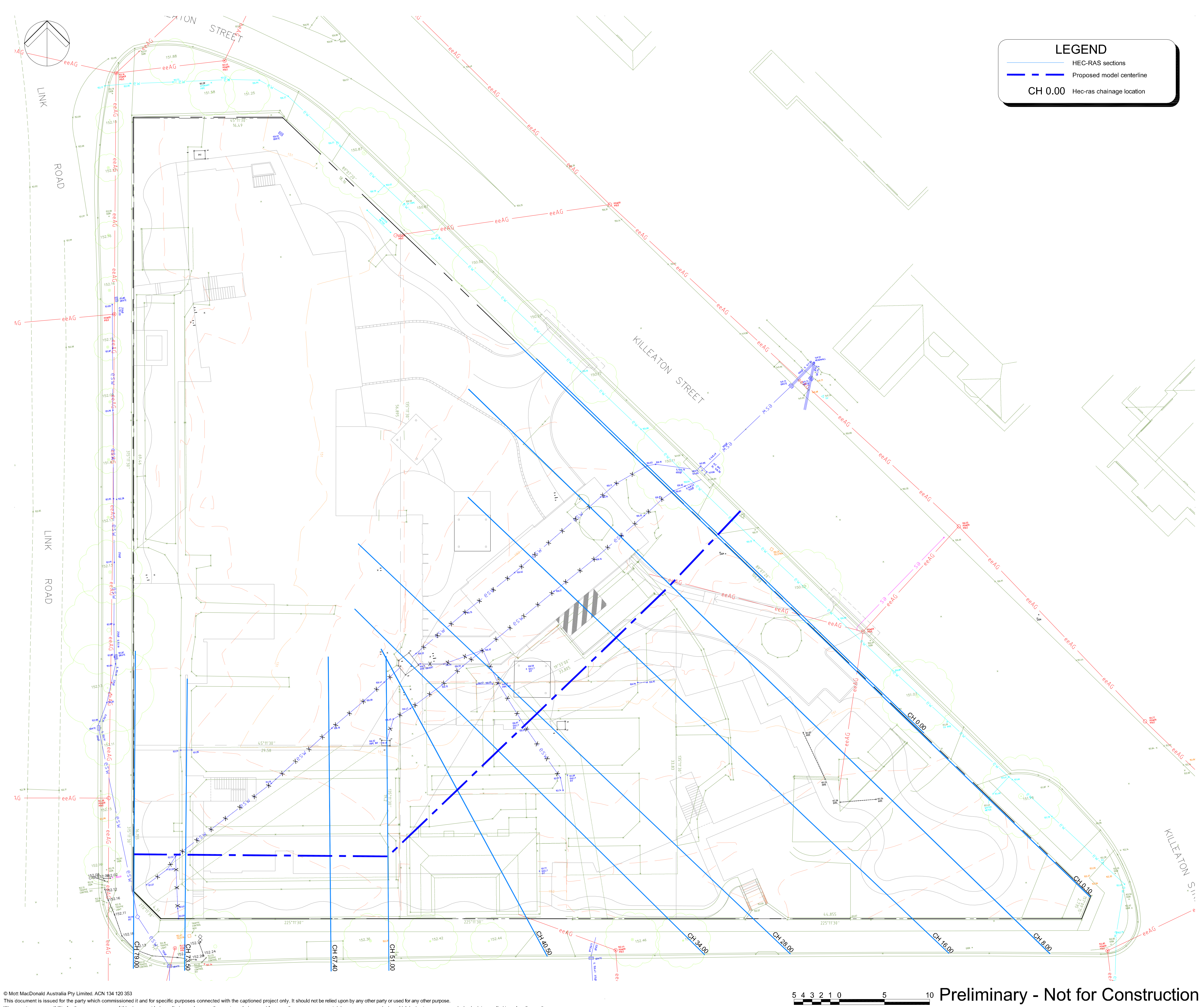
KC09CCA10
KC09CCB10
KC09D10
KC09D20
KC09D30
KC09D40
900mm
750mm
675mm
600mm
450mm
375mm
(5.88)
1.32
(5.7)
1.2
(0.08)
0.23
(5.66)
1.03
0.13
0.347
0.57
(5.23)
Notes :
(5.7) = overland flow (m3/s)
(100 yr ARI)
1.2 = Pipe flow (m3/s)
(100 yr ARI)

Appendix C. HEC-RAS Results



Preliminary - Not for Construction

Notes

Key to symbols

Reference drawings

Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	20.03.13	AMP	Issued for Information	AH	

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Client
BUPA Care Facilities

Title
BUPA St Ives
HEC-RAS Section Locations

Designed	AH	.	Eng check		.
Drawn	AH	.	Coordination	AH	.
Dwg check	AH	.	Approved		.

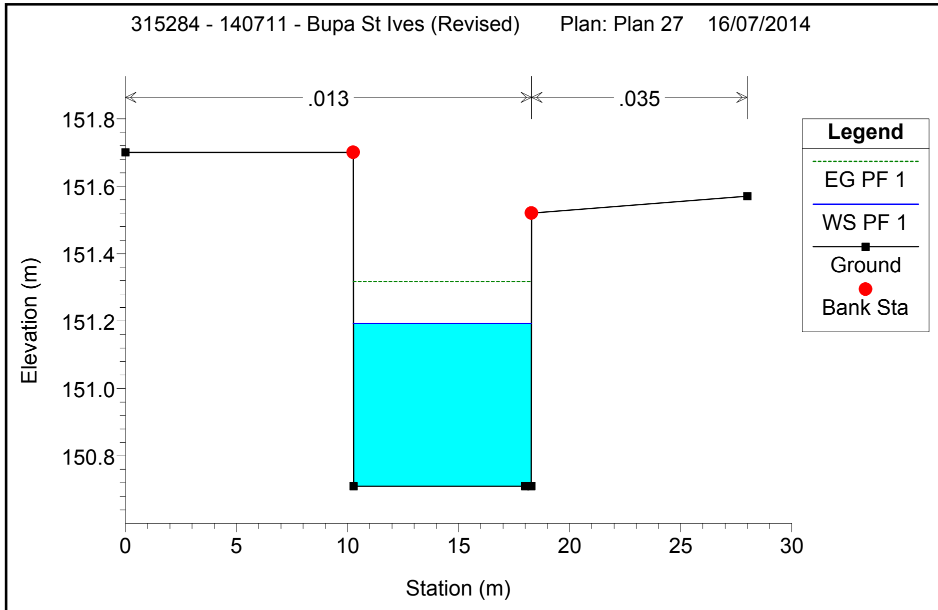
Scale at A1	Status	Rev
1:200	PRE	P1

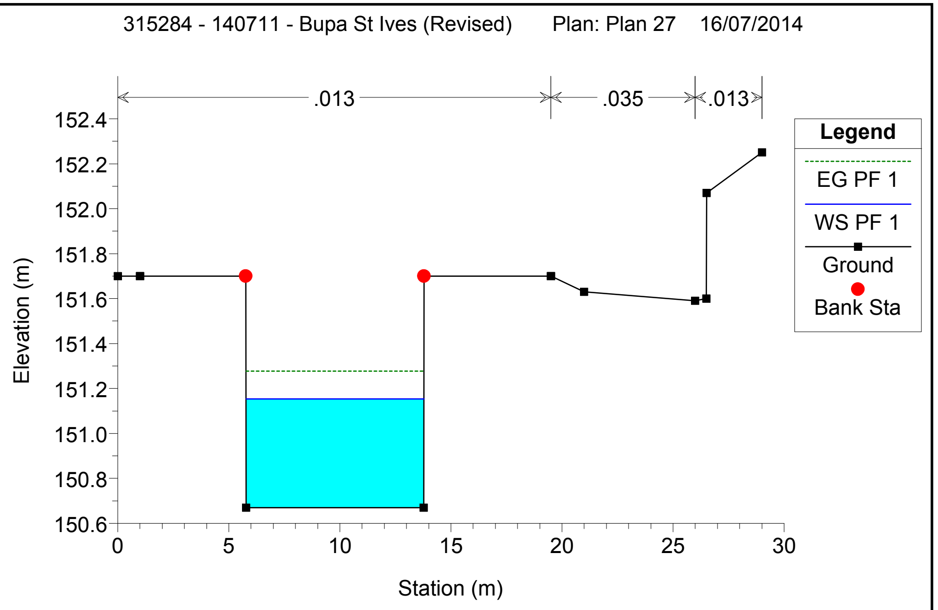
Drawing Number
MMD-315284-C-SK-00-XX-FIG03

P:\Parramatta\Projects\31xxxx\315284\06 CAD\6_4 Working drawings\Civil\Autocad\Sketches\MMD-315284-C-SK-00-XX-FIG03.dwg Mar 20, 2013 - 2:31PM hil55900

HEC-RAS Plan: Plan 27 River: Flowpath Reach: 1 Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	79	PF 1	6.04	150.71	151.19		151.32	0.001265	1.56	3.87	8.01	0.72
1	78.0833*	PF 1	6.04	150.70	151.19		151.31	0.008802	1.54	3.92	8.01	0.70
1	77.1666*	PF 1	6.04	150.70	151.18		151.31	0.009027	1.55	3.89	8.01	0.71
1	76.25*	PF 1	6.04	150.69	151.17		151.30	0.009159	1.56	3.87	8.01	0.72
1	75.3333*	PF 1	6.04	150.68	151.16		151.29	0.009306	1.57	3.85	8.01	0.72
1	74.4166*	PF 1	6.04	150.68	151.16		151.28	0.009467	1.58	3.83	8.01	0.73
1	73.5	PF 1	6.04	150.67	151.15		151.28	0.001258	1.56	3.87	8.01	0.72
1	72.5529*	PF 1	6.04	150.66	151.15		151.27	0.008682	1.54	3.93	8.01	0.70
1	71.6058*	PF 1	6.04	150.66	151.14		151.27	0.008797	1.54	3.92	8.01	0.70
1	70.6588*	PF 1	6.04	150.65	151.14		151.26	0.008834	1.54	3.91	8.01	0.71
1	69.7117*	PF 1	6.04	150.64	151.13		151.25	0.008850	1.54	3.91	8.01	0.71
1	68.7647*	PF 1	6.04	150.63	151.12		151.24	0.008986	1.55	3.89	8.01	0.71
1	67.8176*	PF 1	6.04	150.62	151.11		151.23	0.009046	1.56	3.88	8.01	0.71
1	66.8705*	PF 1	6.04	150.62	151.10		151.22	0.009112	1.56	3.87	8.01	0.72
1	65.9235*	PF 1	6.04	150.61	151.09		151.22	0.009280	1.57	3.85	8.01	0.72
1	64.9764*	PF 1	6.04	150.60	151.08		151.21	0.009371	1.57	3.84	8.01	0.72
1	64.0294*	PF 1	6.04	150.59	151.07		151.20	0.009496	1.58	3.82	8.01	0.73
1	63.0823*	PF 1	6.04	150.59	151.06		151.19	0.009522	1.59	3.80	8.01	0.74
1	62.1353*	PF 1	6.04	150.58	151.05		151.18	0.009523	1.59	3.79	8.01	0.74
1	61.1882*	PF 1	6.04	150.57	151.04		151.17	0.009666	1.61	3.76	8.01	0.75
1	60.2411*	PF 1	6.04	150.56	151.03		151.16	0.009722	1.61	3.75	8.01	0.75
1	59.2941*	PF 1	6.04	150.56	151.02		151.15	0.009780	1.62	3.73	8.01	0.76
1	58.3470*	PF 1	6.04	150.55	151.01		151.15	0.009857	1.63	3.71	8.01	0.76
1	57.4	PF 1	6.04	150.54	151.01		151.14	0.001277	1.60	3.77	8.01	0.75
1	56.4857*	PF 1	6.04	150.53	151.01		151.14	0.009104	1.58	3.82	8.01	0.73
1	55.5714*	PF 1	6.04	150.53	151.00		151.13	0.009509	1.59	3.80	8.01	0.74
1	54.6571*	PF 1	6.04	150.52	150.99		151.12	0.009905	1.60	3.77	8.01	0.74
1	53.7428*	PF 1	6.04	150.51	150.98		151.11	0.010007	1.61	3.76	8.01	0.75
1	52.8285*	PF 1	6.04	150.50	150.97		151.10	0.010314	1.62	3.73	8.01	0.76
1	51.9142*	PF 1	6.04	150.50	150.96		151.10	0.010497	1.63	3.71	8.01	0.76
1	51	PF 1	6.04	150.49	150.96		151.09	0.001395	1.61	3.75	8.01	0.75
1	50.0454*	PF 1	6.04	150.48	150.96		151.09	0.009603	1.58	3.81	8.01	0.73
1	49.0909*	PF 1	6.04	150.47	150.95		151.08	0.009744	1.59	3.79	8.01	0.74
1	48.1363*	PF 1	6.04	150.47	150.94		151.07	0.009801	1.59	3.79	8.01	0.74
1	47.1818*	PF 1	6.04	150.46	150.93		151.06	0.009938	1.60	3.77	8.01	0.75
1	46.2272*	PF 1	6.04	150.45	150.92		151.05	0.010130	1.61	3.75	8.01	0.75
1	45.2727*	PF 1	6.04	150.44	150.91		151.04	0.010355	1.62	3.72	8.01	0.76
1	44.3181*	PF 1	6.04	150.43	150.89		151.03	0.010619	1.64	3.69	8.01	0.77
1	43.3636*	PF 1	6.04	150.42	150.88		151.02	0.010888	1.65	3.66	8.01	0.78
1	42.4090*	PF 1	6.04	150.42	150.87		151.01	0.011117	1.66	3.64	8.01	0.79
1	41.4545*	PF 1	6.04	150.41	150.86		151.00	0.011350	1.67	3.62	8.01	0.79
1	40.5	PF 1	6.04	150.40	150.86		151.00	0.001484	1.64	3.68	8.01	0.77
1	39.5714*	PF 1	6.04	150.39	150.86		150.99	0.010350	1.62	3.72	8.01	0.76
1	38.6428*	PF 1	6.04	150.39	150.85		150.98	0.010704	1.64	3.68	8.01	0.77
1	37.7142*	PF 1	6.04	150.38	150.83		150.97	0.011127	1.66	3.64	8.01	0.79
1	36.7857*	PF 1	6.04	150.37	150.82		150.96	0.011513	1.68	3.60	8.01	0.80
1	35.8571*	PF 1	6.04	150.36	150.80	150.75	150.95	0.012294	1.71	3.53	8.01	0.82
1	34.9285*	PF 1	6.04	150.36	150.75	150.74	150.94	0.018471	1.94	3.11	8.01	1.00
1	34	PF 1	6.04	150.35	150.74	150.74	150.93	0.002578	1.95	3.10	8.01	1.00
1	33.*	PF 1	6.04	150.34	150.73	150.72	150.91	0.017247	1.88	3.21	8.28	0.96
1	32.*	PF 1	6.04	150.33	150.72	150.70	150.89	0.016752	1.84	3.28	8.54	0.95
1	31.*	PF 1	6.04	150.32	150.70	150.69	150.87	0.016593	1.82	3.32	8.81	0.95
1	30.*	PF 1	6.04	150.32	150.69	150.67	150.85	0.016515	1.80	3.36	9.08	0.94
1	29.*	PF 1	6.04	150.31	150.67	150.66	150.83	0.016207	1.77	3.42	9.35	0.93
1	28.*	PF 1	6.04	150.30	150.66	150.64	150.81	0.016274	1.75	3.45	9.62	0.93
1	27.*	PF 1	6.04	150.29	150.64	150.63	150.80	0.016479	1.74	3.47	9.89	0.94
1	26.*	PF 1	6.04	150.28	150.63	150.61	150.78	0.016519	1.73	3.50	10.16	0.94
1	25.*	PF 1	6.04	150.27	150.61	150.60	150.76	0.017217	1.73	3.49	10.43	0.96
1	24.*	PF 1	6.04	150.27	150.59	150.59	150.75	0.018534	1.76	3.44	10.70	0.99
1	23.*	PF 1	6.04	150.26	150.57	150.57	150.73	0.019132	1.76	3.44	10.96	1.00
1	22	PF 1	6.04	150.25	150.58	150.56	150.71	0.002194	1.65	3.67	11.23	0.92
1	21.*	PF 1	6.04	150.24	150.58		150.70	0.013162	1.54	3.92	11.50	0.84
1	20.*	PF 1	6.04	150.24	150.57		150.69	0.013486	1.54	3.93	11.77	0.85
1	19.*	PF 1	6.04	150.23	150.56	150.52	150.68	0.013686	1.53	3.94	12.04	0.86
1	18.*	PF 1	6.04	150.22	150.54	150.51	150.66	0.014250	1.54	3.92	12.31	0.87
1	17.*	PF 1	6.04	150.22	150.51	150.50	150.65	0.018444	1.65	3.66	12.58	0.98
1	16	PF 1	6.04	150.21	150.51	150.49	150.64	0.002133	1.55	3.89	12.85	0.90
1	12		Bridge									
1	8	PF 1	6.04	150.14	150.50		150.57	0.006102	1.10	5.47	15.01	0.58
1	7.0125*	PF 1	6.04	150.12	150.49		150.56	0.001544	1.21	5.01	14.33	0.65
1	6.025*	PF 1	6.04	150.11	150.47		150.56	0.002759	1.31	4.60	13.95	0.73
1	5.0375*	PF 1	6.04	150.09	150.45		150.56	0.004515	1.44	4.21	13.93	0.83
1	4.05*	PF 1	6.04	150.08	150.42	150.42	150.55	0.008167	1.57	3.85	14.30	0.96
1	3.0625*	PF 1	6.04	150.06	150.41	150.41	150.54	0.011625	1.57	3.85	15.56	1.01
1	2.075*	PF 1	6.04	150.04	150.39	150.39	150.51	0.014797	1.50	4.01	17.74	1.01
1	1.08749*	PF 1	6.04	150.03	150.36	150.36	150.47	0.017208	1.42	4.25	20.83	1.00
1	0.1	PF 1	6.04	150.01	150.38	150.32	150.43	0.008976	0.97	6.20	28.73	0.67
1	00	PF 1	6.04	150.01	150.38		150.43	0.007004	0.98	6.17	28.80	0.67
1	-1.*	PF 1	6.04	150.01	150.37		150.42	0.007418	1.00	6.05	28.52	0.68
1	-2.*	PF 1	6.04	150.00	150.36		150.41	0.007985	1.02	5.91	28.16	0.71
1	-3.*	PF 1	6.04	150.00	150.35		150.40	0.008818	1.06	5.72	27.68	0.74
1	-4	PF 1	6.04	150.00	150.33	150.29	150.39	0.010007	1.10	5.49	27.06	0.78


315284 - 140711 - Bupa St Ives (Revised) Plan: Plan 27 16/07/2014
.013
.035
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
151.8
151.6
151.4
151.2
151.0
150.8
0
5
10
15
20
25
30
Station (m)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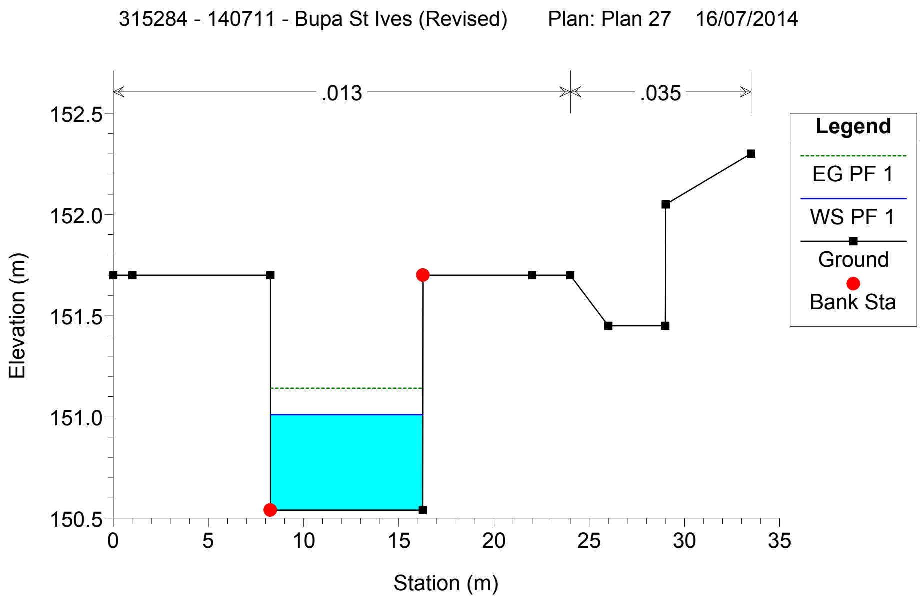
.013
.035
.013
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
152.4
152.2
152.0
151.8
151.6
151.4
151.2
151.0
150.8
150.6
0
5
10
15
20
25
30
Station (m)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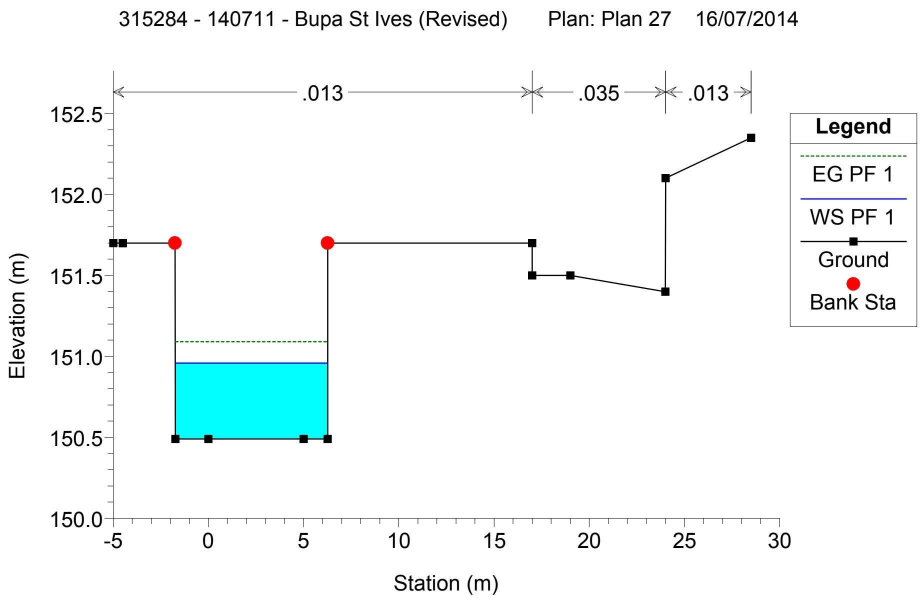
.035
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
152.5
152.0
151.5
151.0
150.5
0
5
10
15
20
25
30
35
Station (m)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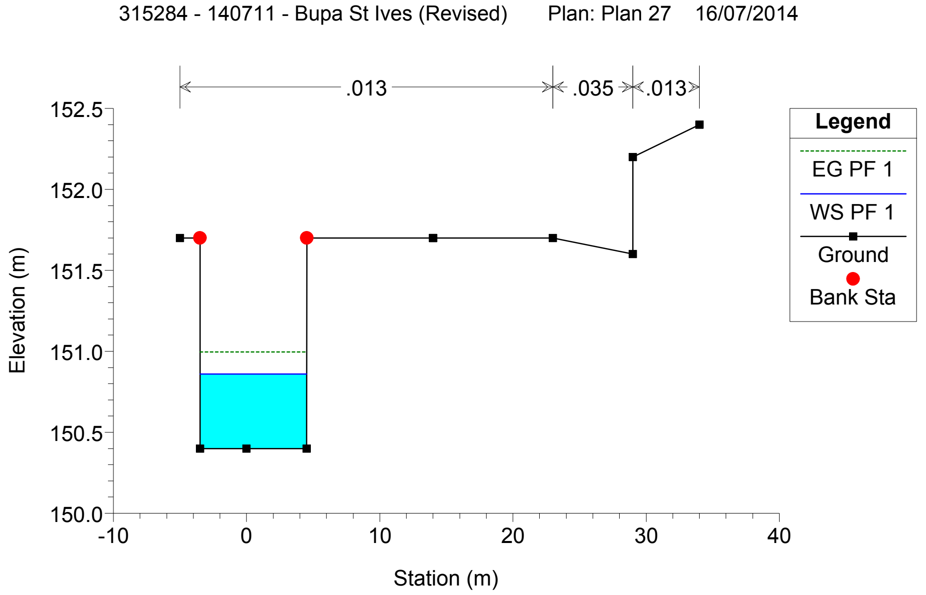
.013
.035
.013
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
152.5
152.0
151.5
151.0
150.5
150.0
-5
0
5
10
15
20
25
30
Station (m)



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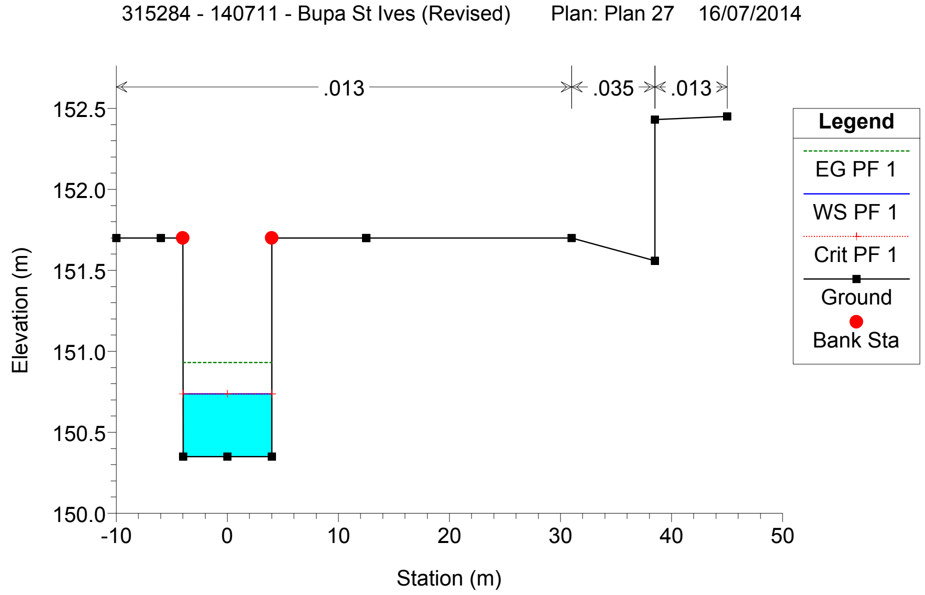
.035
.013
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)



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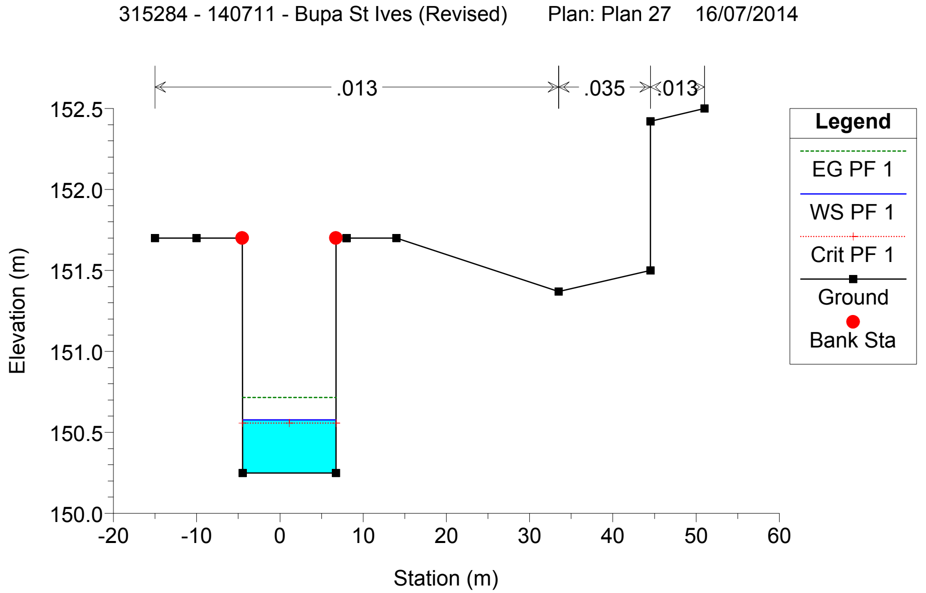
.035
.013
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (m)
Station (m)



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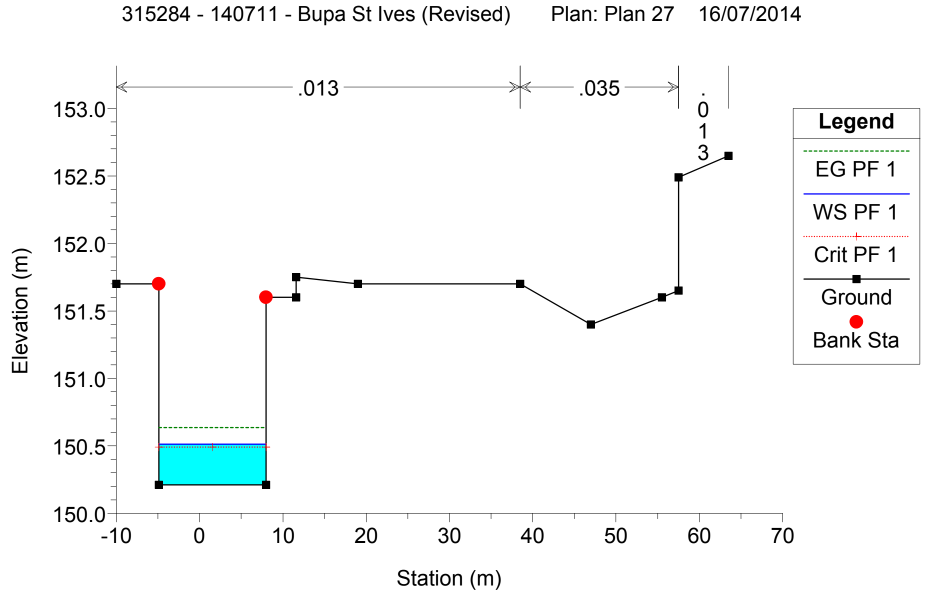
.035
.013
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (m)
Station (m)



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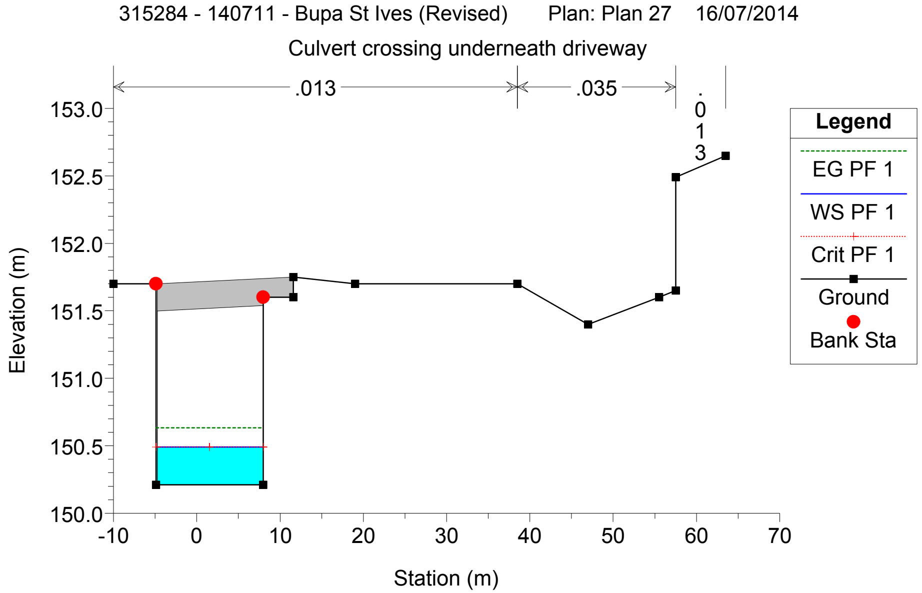
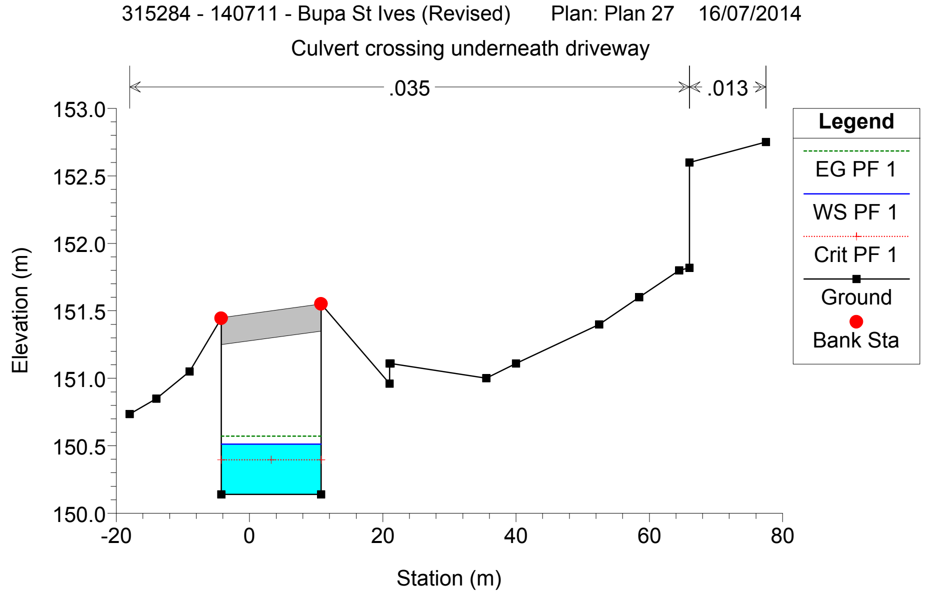
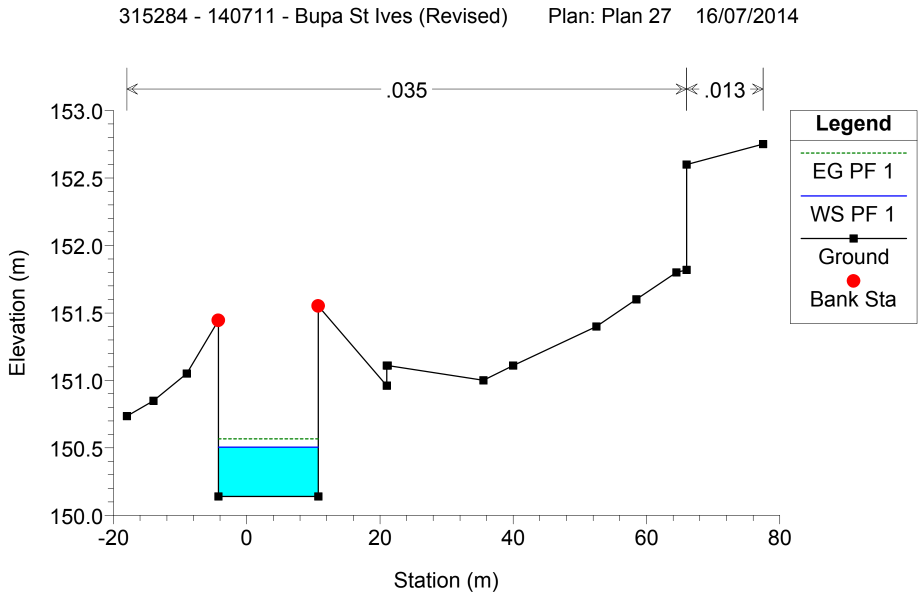
.035
.013
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (m)
Station (m)


315284 - 140711 - Bupa St Ives (Revised) Plan: Plan 27 16/07/2014
Culvert crossing underneath driveway
.013
.035
.013
Elevation (m)
Station (m)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta


315284 - 140711 - Bupa St Ives (Revised) Plan: Plan 27 16/07/2014
Culvert crossing underneath driveway
.035
.013
Elevation (m)
Station (m)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta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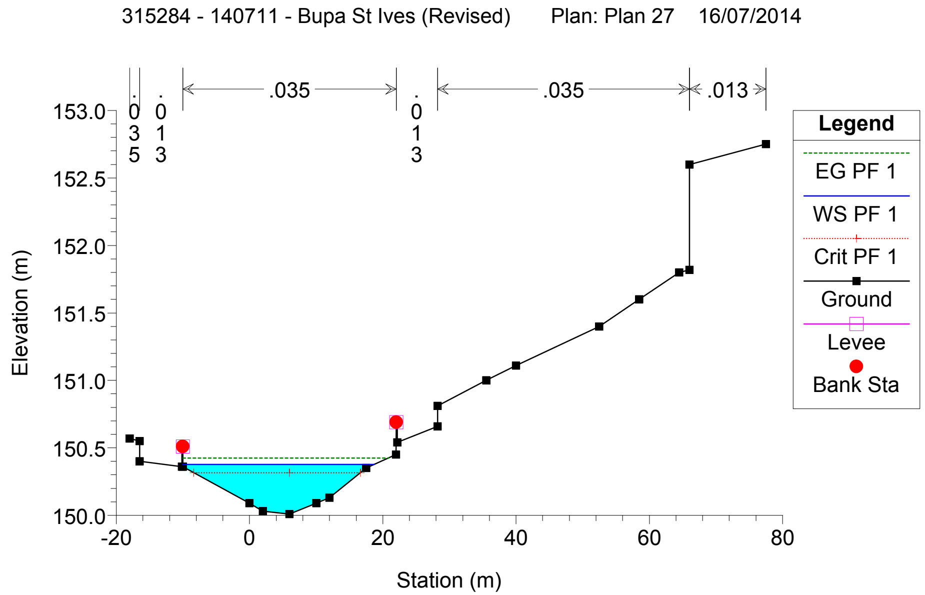
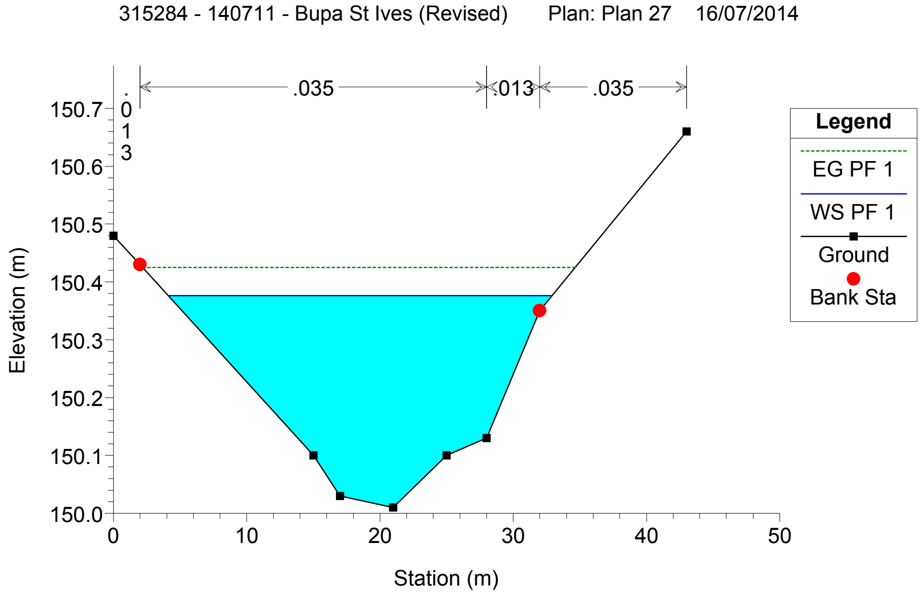
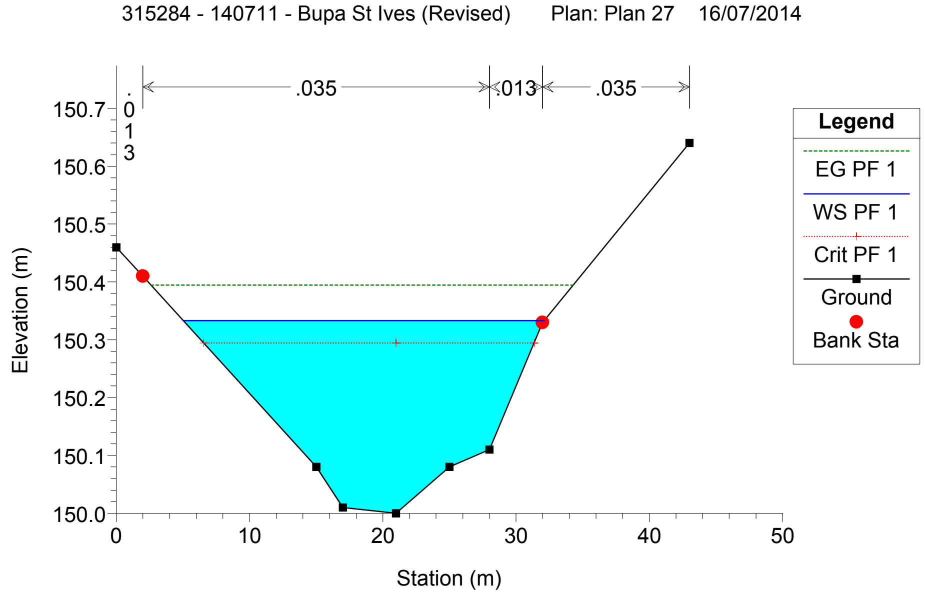
.035
.013
Elevation (m)
Station (m)
Legend
EG PF 1
WS PF 1
Ground
Bank Sta

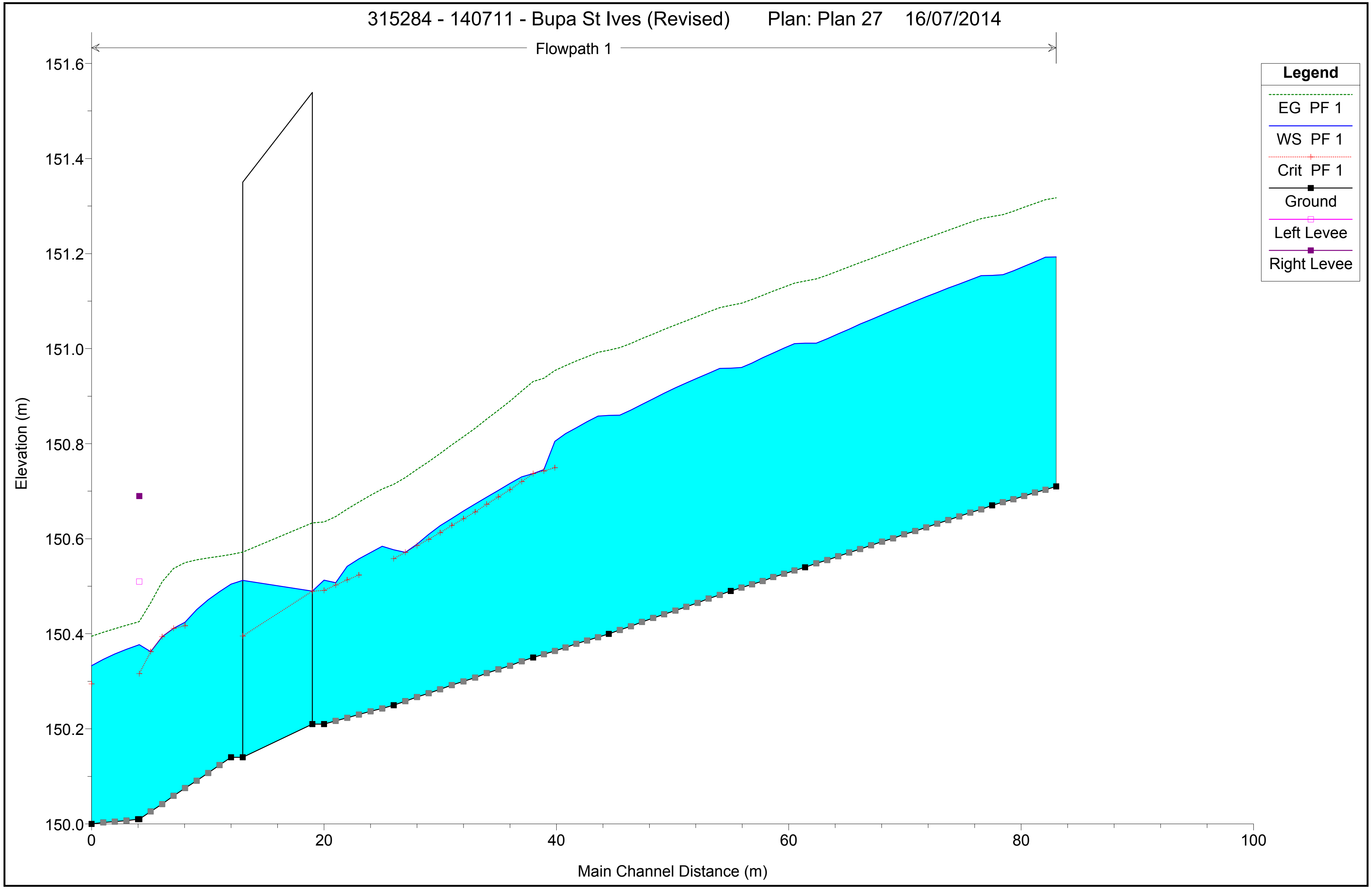

315284 - 140711 - Bupa St Ives (Revised) Plan: Plan 27 16/07/2014
.035
.013
.035
.013
.035
.013
Elevation (m)
Station (m)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta

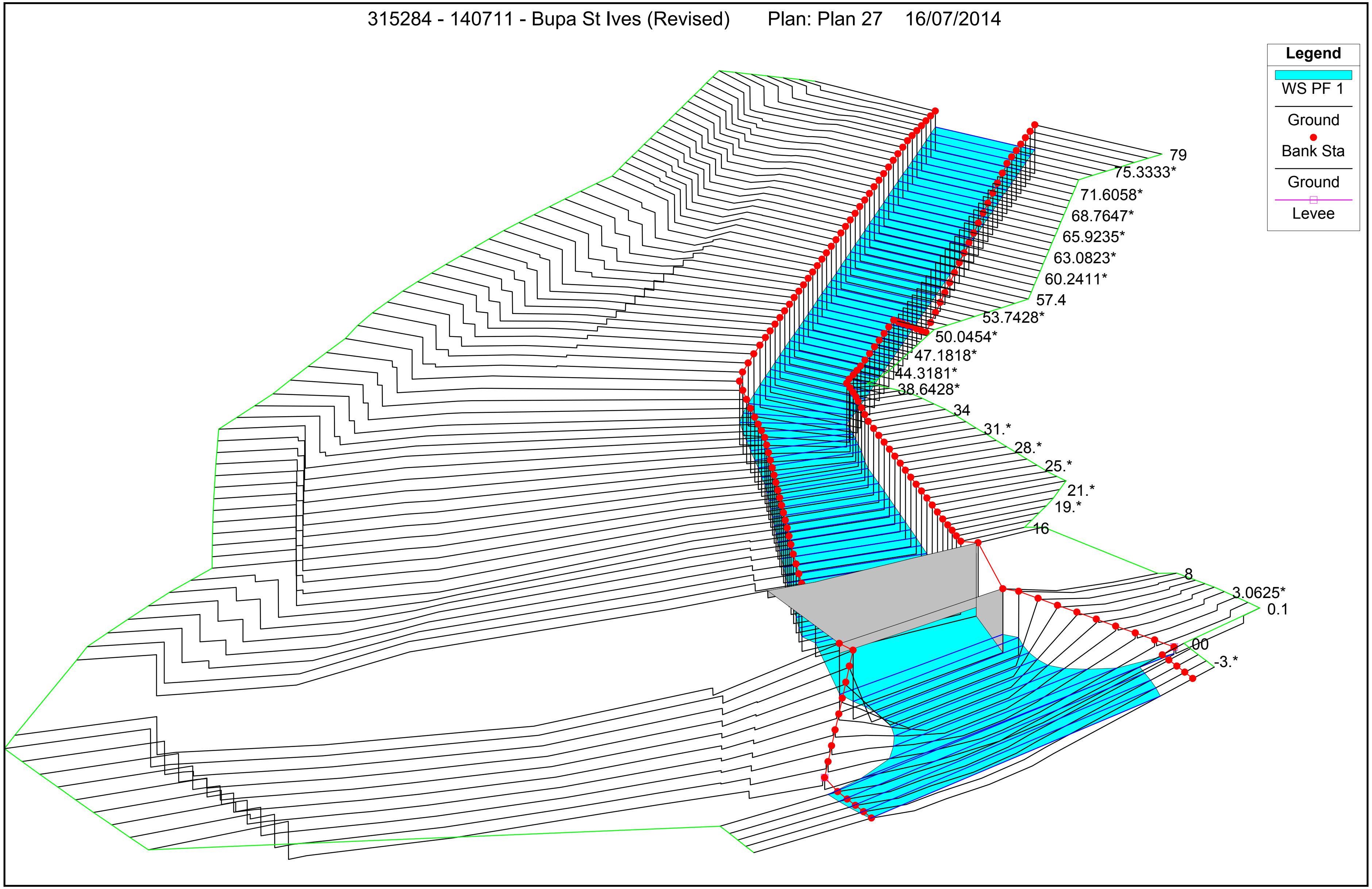


315284 - 140711 - Bupa St Ives (Revised)
Plan: Plan 27
16/07/2014
.035
.013
.035
.013
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
150.0
150.1
150.2
150.3
150.4
150.5
150.6
150.7
0
10
20
30
40
50



315284 - 140711 - Bupa St Ives (Revised)
Plan: Plan 27
16/07/2014
.035
.013
.035
.013
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
150.0
150.1
150.2
150.3
150.4
150.5
150.6
150.7
0
10
20
30
40
50


315284 - 140711 - Bupa St Ives (Revised)   Plan: Plan 27   16/07/2014
Flowpath 1
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Left Levee
Right Levee
Elevation (m)
151.6
151.4
151.2
151.0
150.8
150.6
150.4
150.2
150.0
0
20
40
60
80
100
Main Channel Distance (m)



315284 - 140711 - Bupa St Ives (Revised)   Plan: Plan 27   16/07/2014
Legend
WS PF 1
Ground
Bank Sta
Ground
Levee
79
75.3333*
71.6058*
68.7647*
65.9235*
63.0823*
60.2411*
57.4
53.7428*
50.0454*
47.1818*
44.3181*
38.6428*
34
31.*
28.*
25.*
21.*
19.*
16
8
3.0625*
0.1
00
-3.*