APPENDIX 7
Flooding and Overland Flow Report

51 Henry Street, Penrith
Report on diversion of stormwater pipe and overland flow

9 May 2017 | 16-233

Contents

Document control

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1	9.5.2017	Approved Issue	CMW	JG	CMW

1. Introduction

Redevelopment is proposed at 51 Henry Street, Penrith. Refer to Figure 1 for the location of the site. The site currently has a 1.5m wide by 1.2m high stormwater culvert running east-west across the site. The site is also affected by overland flow, resulting from flows in excess of the capacity of the existing pipe system.

This report has been prepared to detail the measures required to divert the pipe and allow development of the site, as well as to address flood related issues.. During development of the concept, Woolacotts met with Steve Masters from Penrith Council on site to discuss possible options for the diversion of the culvert.

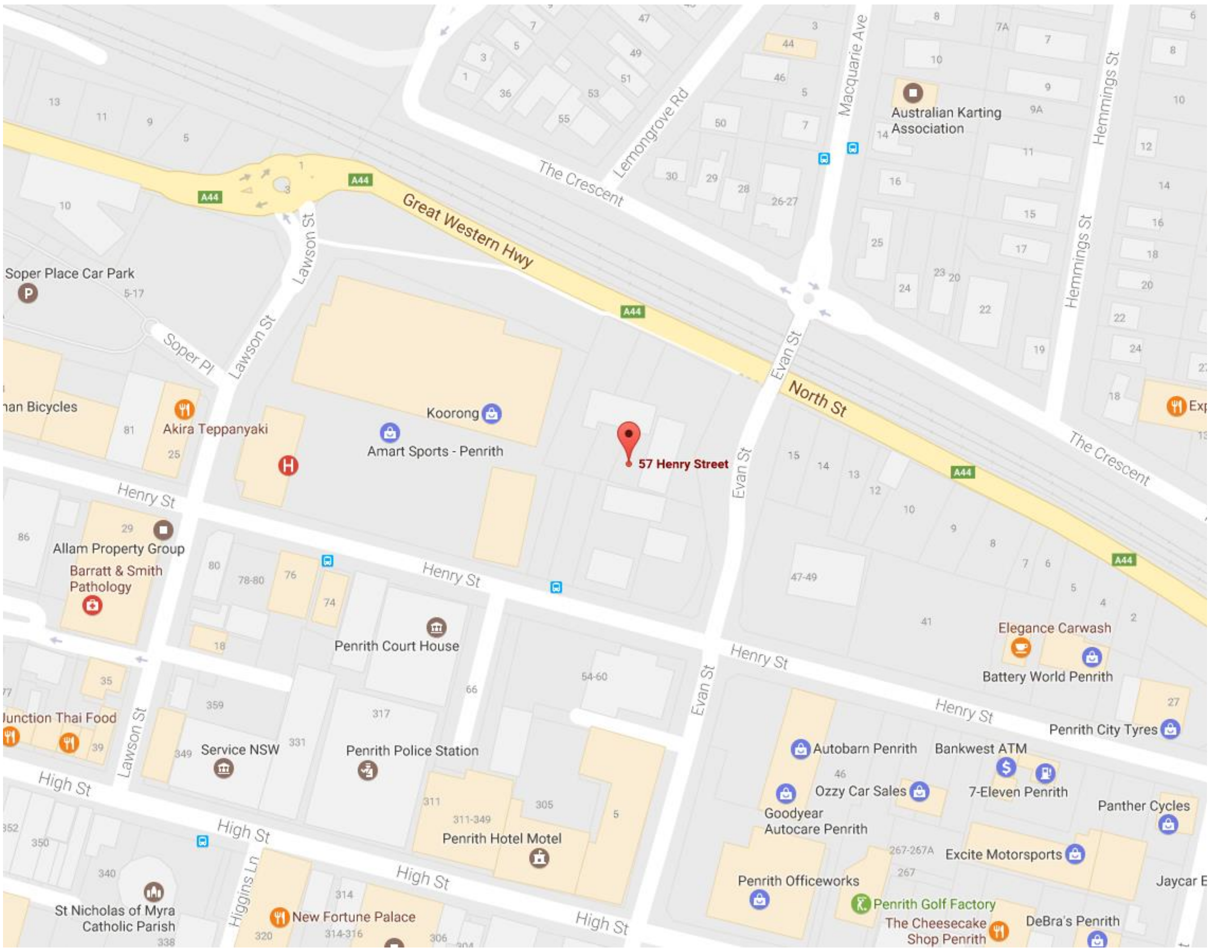


Figure 1 – Site Location

2. Existing situation

The site has a 1.5m wide by 1.2m high culvert running east-west across the middle of the site. It connects an existing pit at the base of the Evan Street bank to the culvert through the site to the west. Refer to Figure 2 for location.

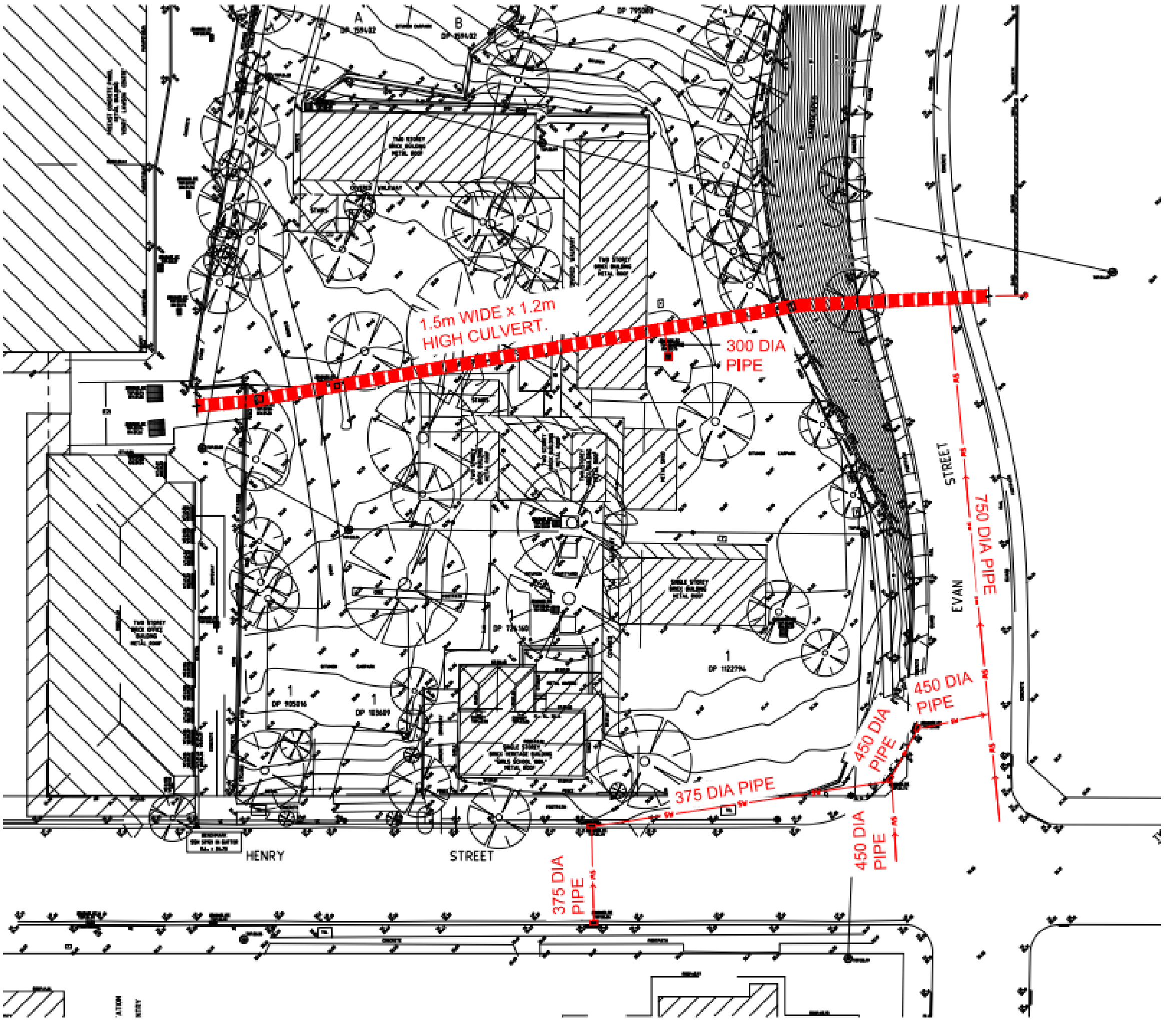


Figure 2 – Location of existing pipes

From Council's Tuflow model and flood plans, the site is currently subject to flooding due to overland flow in excess of the capacity of the pipe network. From the detailed survey of the site, the current depth of water is due to an existing low point within the site.

Council's Tuflow model provided details of peak stormwater flows at the site. From the model, the peak 100year ARI flows are:

- Flow in existing culvert = 6.25m^3/s
- Overland flow from sag / low point in Henry Street = 4.00m^3/s

The Tuflow model and Council's flood mapping detailed that the site is affected by flooding, due to flows in excess of the capacity of the pipe system.   From Tuflow, the existing flood levels at the site are:

- 35.28m AHD at the south-east corner (intersection of Henry and Evan Streets)
- 33.44m AHD at the western boundary, where the culvert crosses to the downstream property.

3. Proposed diversion

To allow development of the site, including a basement parking area, the existing culvert needs to be diverted around the edge of the site. Two locations for this diversion were considered – one around the southern side, adjacent to Henry Street and one around the northern side. Following conversations with Council and analysis of the overland flow path, the northern route was adopted.

The stormwater drainage works proposed for the site consist of:

- A new 2100 wide by 1500 high culvert around the north side of the site. This culvert will start at the existing pit at the base of the Evan Street embankment and will connect back to the existing system at the western property boundary.
- New double kerb inlet pits and pipe connections at the corner of Henry and Evan Streets to the pit at the base of the embankment.
- New pits along the system, to allow access for cleaning and to take additional overland flow

Refer to Drawing SW1 in Appendix A for details of the proposed pipe location.

4. Flows and overland flow paths

Penrith City Council provided a copy of their Tuflow model for the catchment. As detailed above, the flows detailed in the model for the 100 year ARI storm are:

- Flow in existing culvert = 6.25m^3/s
- Overland flow from sag / low point in Henry Street = 4.00m^3/s

As there is a low point at the existing site, the new culvert around the proposed site will be sized to carry a flow of 10.25m^3/s – that is, the current flow in the culvert plus the existing overland flow for the 100 year ARI event. Additional double kerb inlet pits will also be provided at the upstream end, in Henry St, to capture 3.8m^3/s of overland flow currently occurring at the low point. The inlet capacity of the pits were based on a 30% blockage factor. Refer Appendix B – Calculations for additional details.

While the culvert system will be sized to carry the 100year ARI flow, an overland flow path will be provided along the pipe system, in the event of blockages. This will require the existing Council footpath to be raised, to remove the low point. A 300mm high wall is also proposed along the eastern end of the site to contain overland flow resulting from pit blockages within council's footpath.

With the pits at the intersection of Henry Street and Evan Street capturing the majority of the existing overland flow from the upstream catchment, the overflow path is required to carry a minimum flow of $0.2m^3/s$. The proposed overland flow path is capable of carrying a flow of $1.02m^3/s$.

Refer to Drawing SW1 in Appendix A for details of the flow path.

5. Flood and recommended floor levels

Penrith Council's DCP requires floor levels for residential and commercial developments to be at a level of the 100year ARI flood level plus 500mm.

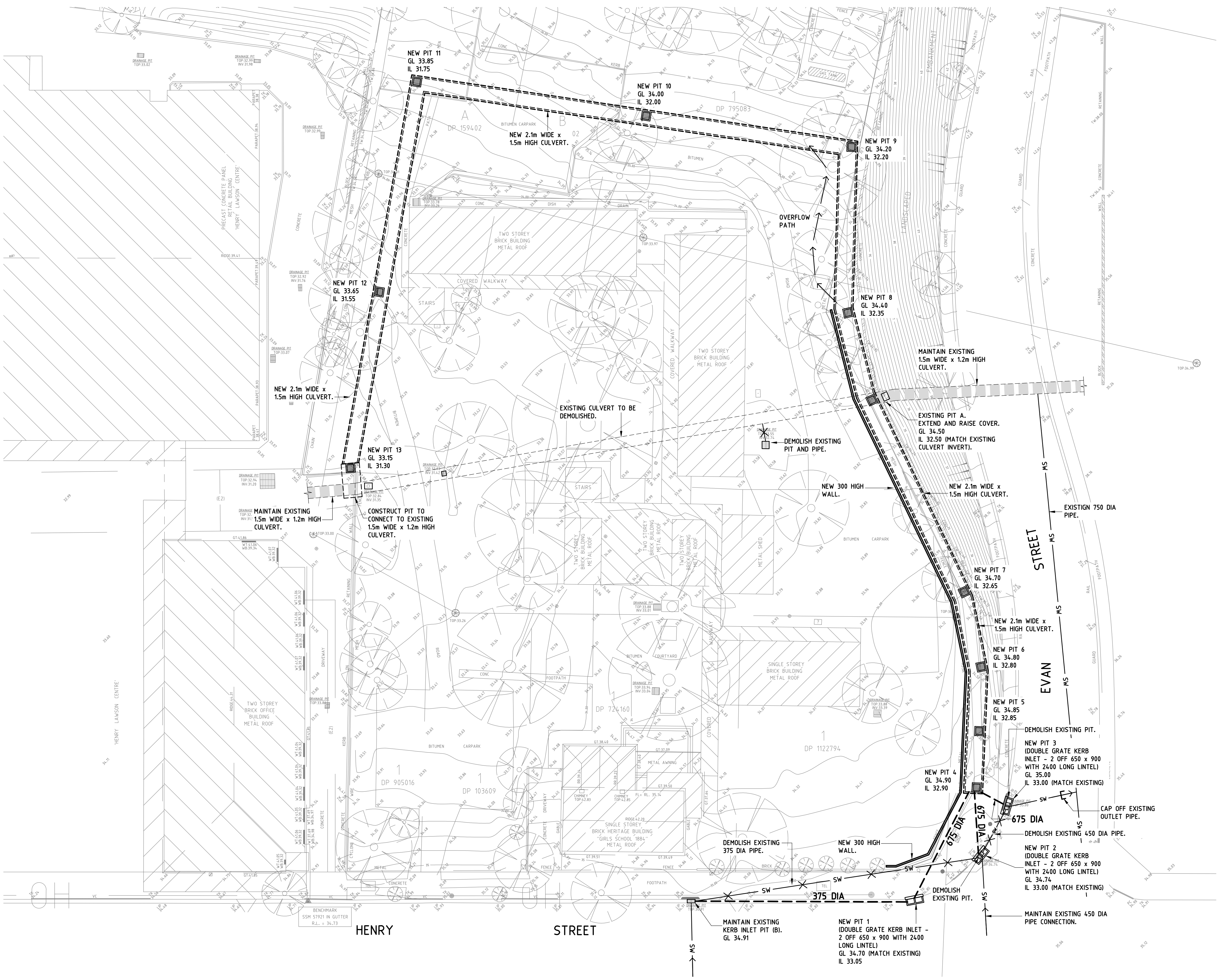
For the existing upstream end of the site, the 100year ARI flood level is RL 35.28, which would require a minimum floor level of RL 35.78.

With the proposed diversion of the culvert, the new culvert has been sized to take the 100year ARI flow with an overland flow of approximately 200L/s. As such, through the majority of the site, the depth of overland flow is typically 70-100mm. Consequently, the water level varies from 33.30m AHD at the western boundary to 34.95m at the south-east corner of the site.

At the intersection of Henry Street and Evan Street, arriving overland flow ponds to a depth of 150mm as it is captured by the grated inlet pits. As a result, the water level developed varies from 34.95 – 35.05m AHD.

Due to water ponding at the intersection of Henry Street and Evan Street, all buildings fronting Henry Street require a minimum flood level of 35.55m (35.05 + 0.5m).

Appendix A
Drawings



LEGEND

— — — —	NEW STORMWATER PIPE
—— SW ——	EXISTING STORMWATER PIPE TO BE MAINTAINED
—×— SW —×—	EXISTING STORMWATER PIPE TO BE DEMOLISHED
========	NEW CULVERT
▒▒▒▒	EXISTING CULVERT TO BE MAINTAINED
- - - -	EXISTING CULVERT TO BE DEMOLISHED
▣ ▭	NEW STORMWATER PIT
← ←	OVERFLOW PATH
▬▬	EXTENT OF 300 HIGH WALL FOR OVERLAND FLOW

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51 HENRY STREET
PENRITH

STORMWATER DIVERSION PLAN

Date	Approved	Verified	Prepared
MAY 2017	CMW 09.05.17	JG 09.05.17	JC 09.05.17

Scale @ A1: 1:250
Job number: 16-233
Drawing number: SW1
Amendment:

Appendix B
Calculations

Job HENRY ST Date 31/3/17

DESIGN INFORMATION SUMMARY

STORMWATER MANAGEMENT DESIGN

PROJECT = 57 Henry St, Penrith.

REFERENCES = - AS2500.3 (2015)

- Australian Rainfall + Runoff.
- Penrith DCP 2014.

DESIGN = - Extraction of flooding results from TUFLOW model.

REF: Penrith CBD Detailed overland flow flood study (7 July 2015)

supplied by Council.

- Sizing of culvert to accomodate 100yr ARI flow through site (upstream pipe network + site overland flow).
- Nominate overland flow path around site.
- Relocation of existing culvert around northern perimeter of site.

Job HENRY ST　　Date 31/3/17

* TUFLOW RESULTS SUMMARY (EXISTING).

MAX flow in 1.5 x 1.2m culvert = 6.25 m³/s
(100yr ARI)

Critical overland flow within Henry St = 4 m³/s

Job HENRY Date 31/3/17

* PROPOSED CULVERT

NOTE: size to suit existing pipe flow ($6.25\ m^3/s$ max) + overland flow ($4\ m^3/s$)

$\therefore$ $Q_{100} = 10.25\ m^3/s$ = total flow through site.

TRIAL 1: 1.8 x 1.2m @ 0.6%

$A = 2.16\ m^2$

$R = \frac{2.16}{6} = 0.36m$

$S = 0.006$

$n = 0.012$

$$Q = \frac{2.16 \times 0.36^{\frac{2}{3}} \times 0.006^{\frac{1}{2}}}{0.012} = 7.1\ m^3/s$$

TRIAL 2: 1.8 x 1.5m @ 0.6%

$A = 2.7m^2$

$R = 0.41$

$S = 0.006$

$n = 0.012$

$$Q = \frac{2.7 \times 0.41^{\frac{2}{3}} \times 0.006^{\frac{1}{2}}}{0.012} = 9.62\ m^3/s$$

TRIAL 3: 2.1 x 1.5m @ 0.6%

$A = 3.15m^2$

$R = \frac{3.15}{7.2} = 0.44$

$S = 0.006$

$n = 0.012$

$$Q = \frac{3.15 \times 0.44^{\frac{2}{3}} \times 0.006^{\frac{1}{2}}}{0.012} = 11.76\ m^3/s > 10.25\ m^3/s$$

(REQUIRED)

$\therefore$ PREFERRED SIZE = 2.1 x 1.5m culvert.
to accomodate total site flow 100yr ARI.

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Job HENRY ST   Date 2/5/17

→ INVESTIGATE UPGRADE TO EXISTING KERB INLET PIT:

INLET CAPACITY CALC

(a) Double grate pit: + (b) 2.4 Lintel (150 h)

[650 × 900] × 2

(a) $F_1 = 0.6 \times A \times (2gh_1)^{0.5} \times C$

$A = (0.65 \times 0.9 \times 2) \times (0.6)$ ← 60% open area assumed

$= 0.702\ m^2$

$h_1 = 0.3m$

$C = 30\%$ clogging $= 0.7$

$F_1 = 0.6 \times 0.702 \times (2 \times 9.81 \times 0.3)^{0.5} \times 0.7$

$= 0.72\ m^3/s$

(b) $F = 1.66 \times L \times h^{1.5} \times C$

$= 1.66 \times 2.4 \times 0.15^{1.5} \times 0.9$ ← 10% clogging factor

$= 0.21\ m^3/s$

∴ CAPACITY OF Double 650×900 + 2.4m Li = $0.93\ m^3/s$

Designed SG   Job no. 16-233   Sheet no.

Job HENRY ST Date 2/5/17

* INLET CAPACITY 900 x 900 grated pit.

$F_1 = 0.6 \cdot A \cdot (2gh_1)^{0.5} \cdot C$

$A = 0.9 \times 0.9 \times (0.6)_{opening}$
$= 0.49 m^2$

$h_1 = 0.3m$

$C = 0.7$ (30% clogging factor).

$\therefore F_1 = 0.6 \times 0.49 \times (2 \times 9.81 \times 0.3)^{0.5} \times 0.7$
$= 0.50 \ m^3/s$

* CRITICAL O/F = $4 m^3/s$; INLET SUM = $(0.93 \times 3) + (0.5 \times 2) = 3.8 m^3/s \approx 4 m^3/s$.

* SIZING OF SW PIPES TO PITS WITHIN HENRY/EUAN ST.

NOTE: SIZE for $\approx 0.9 \ m^3/s$

TRIAL 1 : 600Ø

$Q = \frac{A \cdot R^{\frac{2}{3}}}{n} S^{\frac{1}{2}}$

$A = \frac{\pi \cdot D^2}{4} = \frac{\pi \times 0.6^2}{4} = 0.28$ 0.35

$W_p = \pi \times D = \pi \times 0.6$
$= 1.9 m$ 2.12

$R = \frac{0.28}{1.9} = 0.15$ 0.17

$S = 0.01$

$n = 0.012$

$Q = \frac{0.28 \times 0.15^{\frac{2}{3}} \times 0.01^{\frac{1}{2}}}{0.012} = 0.66 m^3/s$

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Job HENRY ST Date 2/5/17

TRIAL 2 : 675 ø

$A = \frac{\pi \times 0.675^2}{4} = 0.36\ m^2$

$W_p = \pi \times 0.675 = 2.12\ m$

$R = \frac{0.36}{2.12} = 0.17$

$S = 0.01$

$n = 0.012$

$Q = \frac{0.36 \times 0.17^{\frac{2}{3}} \times 0.01^{\frac{1}{2}}}{0.012} = 0.92\ m^3/s$ ∴ OK.

* OVERLAND FLOW CAPACITY CHECK.

Critical overland flow within Henry St = $4 m^3/s - 3.8 m^3/s$ (Inlet pits at Henry St & Evan St intersection)

∴ TARGET = $0.2 m^3/s$

SOLVE FOR OVERFLOW CHANNEL CAPACITY

width = 1.4m

depth = allow 0.3m

$$Q = \frac{A \cdot R^{\frac{2}{3}} \cdot S^{\frac{1}{2}}}{n}$$

$A = 1.4 \times 0.3 = 0.42 m^2$

$Wp = 0.3 + 1.4 + 0.3$

$= 2m$

$R = \frac{0.42}{2} = 0.21$

$S = 0.8\% = 0.008$

$n = 0.013$

$$Q = \frac{0.42 \times 0.21^{\frac{2}{3}} \times 0.008^{\frac{1}{2}}}{0.013} = 1.02 m^3/s.$$

> 0.2 ∴ ok.

∴ 0.3m high wall required around eastern perimeter

→ SUMMARY: O/F will be collected by NEW PITS 1-5

Job HENRY ST Date 5/5/17

* CALCULATING PROPOSED FLOOD LEVELS AT THE SITE.

* PROPOSED SITE FLOWRATE

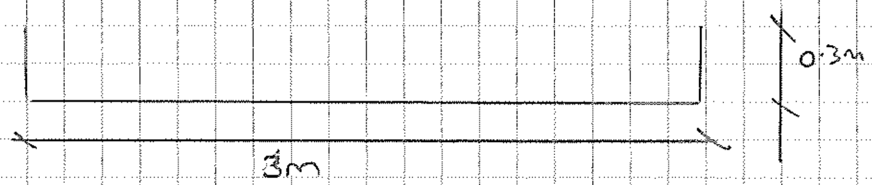
∴ INLET CAPACITY OF PITS = 3.8 m³/s
(with 20% blockage)

Overflow = 0.2 m³/s

∴ Channel to allow for 0.2 m³/s → say 0.5 m³/s

* PROPOSED SECTION 1-1

Slope = 0.80%



$$Q = \frac{A \cdot R^{\frac{2}{3}} \cdot S^{\frac{1}{2}}}{n}$$

$$\therefore Q = \frac{0.9 \times 0.25^{\frac{2}{3}} \times 0.008^{\frac{1}{2}}}{0.013} = 2.46 \text{ m}^3/\text{s}$$

A = (3 × 0.3)
= 0.9 m² 0.3

WP = 0.3 + 3 + 0.3
= 3.6 3.2

$R = \frac{0.9}{3.6}$ = 0.25 0.094

S = 0.008

n = 0.013

Job HENRY ST Date 5/5/17

→ Determine @ what TWL a flow of $0.5 m^3/s$ will reach @ section 1-1

Let d = 110mm

$A = 3 \times 0.11$
$= 0.33 m^2$

$Q = \dfrac{0.33 \times 0.102^{\frac{2}{3}} \times 0.008^{\frac{1}{2}}}{0.013} = 0.5 m^3/s$

$wp = 0.11 + 3 + 0.11$
$= 3.22 m$

$R = \dfrac{0.33}{3.22} = 0.102$

$S = 0.008$

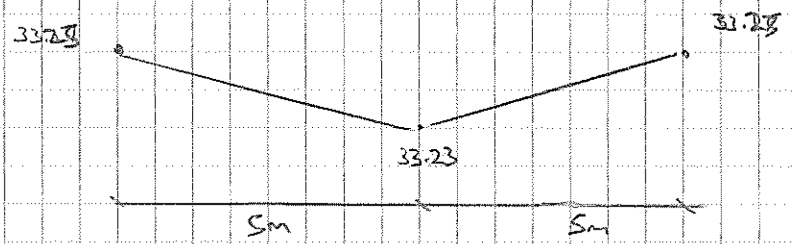
∴ Section 1-1 proposed = +100mm

∴ FLOOD LEVEL U/S = 34.85 + 100
= 34.95 RL

Job: HENRY ST Date: 5/5/17

* PROPOSED SECTION 2-2

Slope ≈ 2%



$$Q = \frac{A \cdot R^{2/3} \cdot S^{1/2}}{n}$$

$A = \frac{1}{2} \times 10 \times 0.02$

$= 0.1\ m^2$

$WP \approx 10$

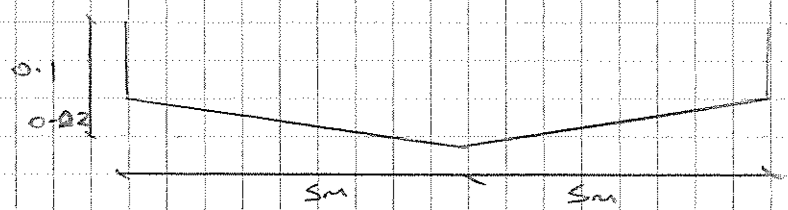
$R = \frac{0.1}{10} = 0.01$

$S = 0.02$

$n = 0.025$

$$\therefore Q = \frac{0.1 \times 0.01^{2/3} \times 0.02^{1/2}}{0.025} = 0.03\ m^3/s$$

TRIAL 2:



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$A = (0.1 \times 10) + 0.1$

$= 1.1$

$wp = 10.2$

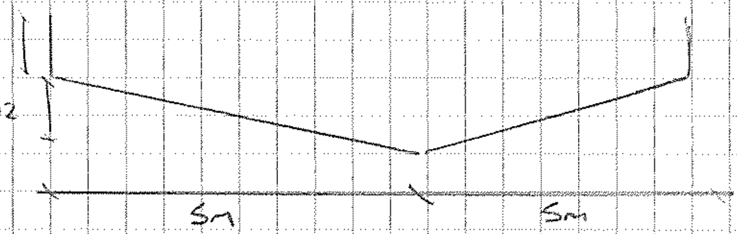
$R = \frac{1.1}{10.2} = 0.11$

$S = 0.02$

$n = 0.025$

$Q = \frac{1.1 \times 0.11^{\frac{2}{3}} \times 0.02^{\frac{1}{2}}}{0.025} = 1.43\ m^3/s$

TRIAL 3:



$A = (0.03 \times 10) + 0.1$

$= 0.4\ m^2$

$wp = 10.03$

$R = \frac{0.4}{10.03} = 0.04$

$S = 0.02$

$n = 0.025$

$Q = \frac{0.4 \times 0.04^{\frac{2}{3}} \times 0.02^{\frac{1}{2}}}{0.025} = 0.3\ m^3/s$

TRIAL 4 $] = 0.05$

$A = (0.05 \times 10) + 0.1 = 0.6 m^2$

$wp = 10 + 0.05 + 0.05$

$R = \frac{0.6}{10.1} = 0.06$

$S = 0.02$

$n = 0.025$

$Q = \frac{0.6 \times 0.06^{\frac{2}{3}} \times 0.02^{\frac{1}{2}}}{0.025} = 0.52\ m^3/s$

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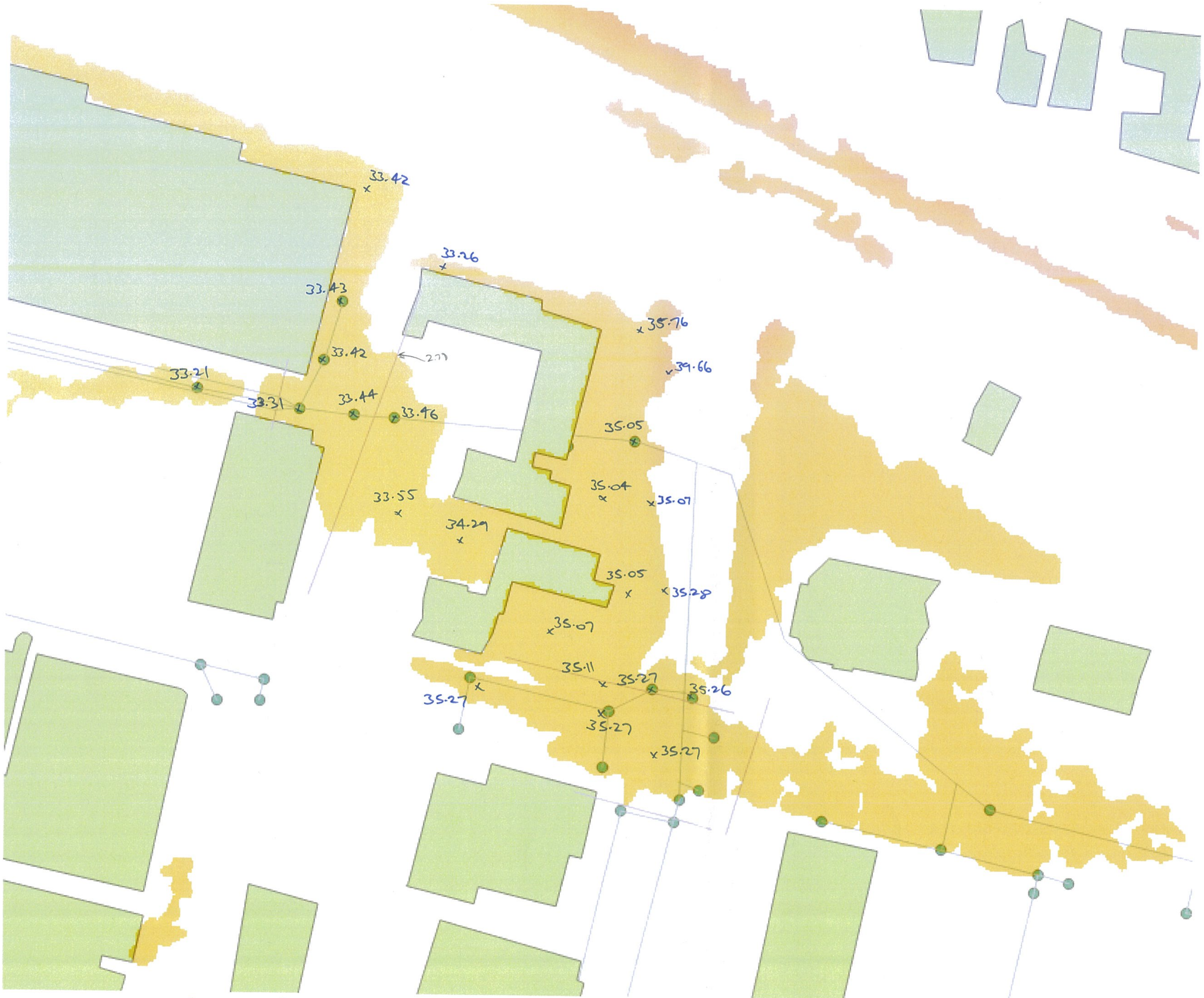
SECTION 2-2 PROPOSED : + 0.07m = 70mm

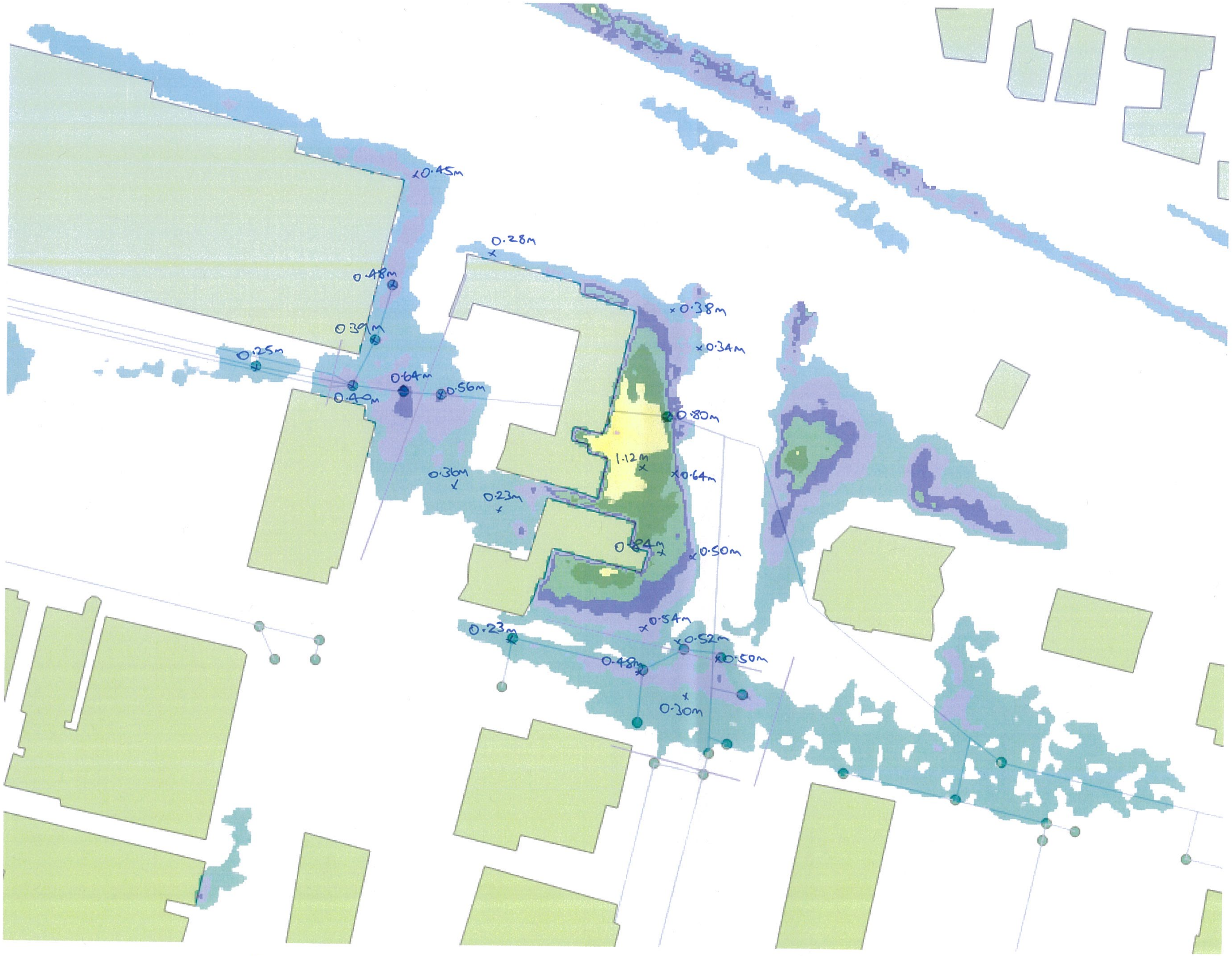
∴ FLOOD LVLS D/S = 33.23 + 0.07

= 33.30 RL

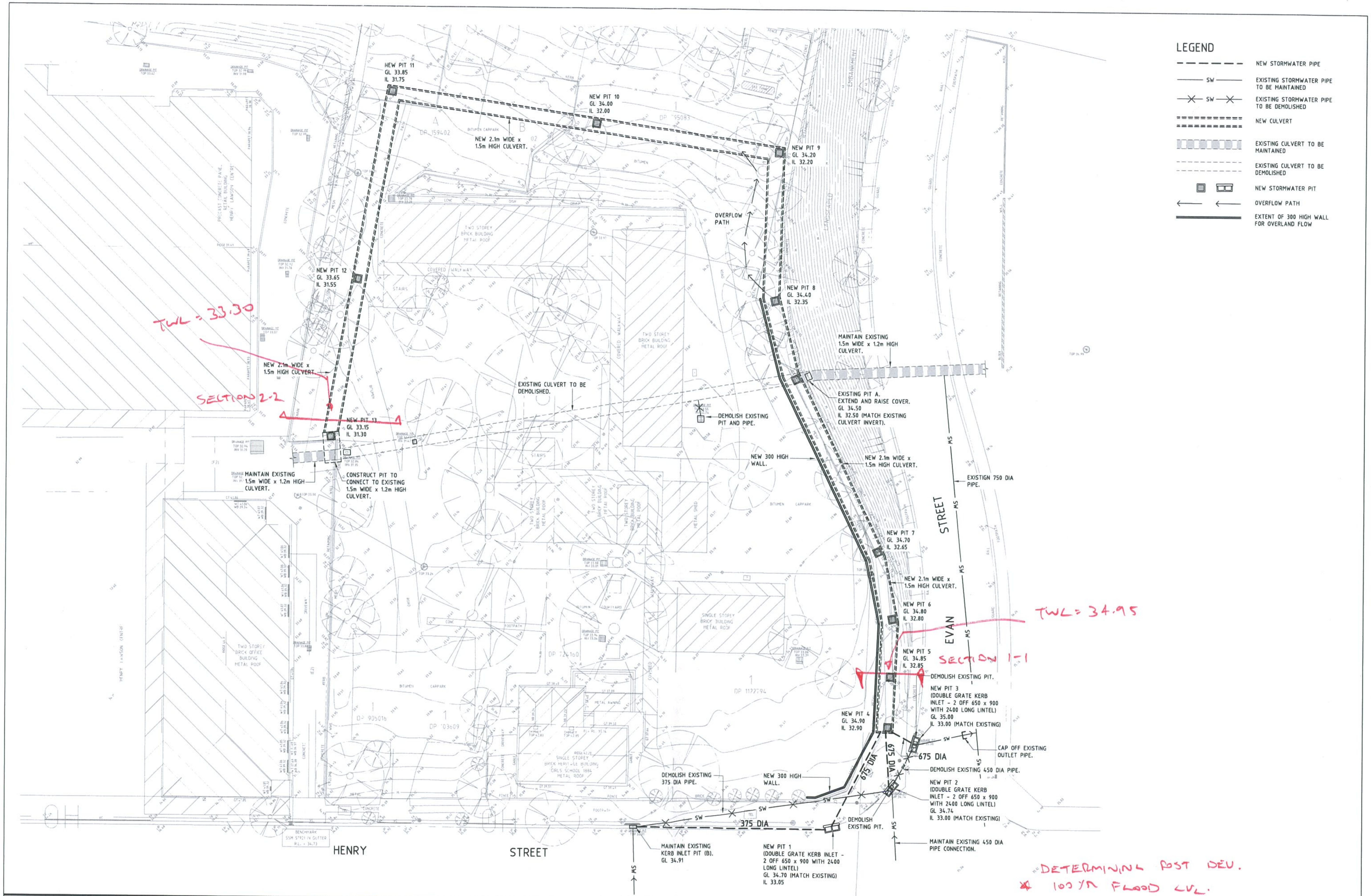


100yr ARI - Peak WL (RL)

HENRY ST - PENRITH.



100yr ARI - peak depth (m)



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