Flood Risk Assessment

for State Significant Development Application

Prepared for: Loftex Chatswood Pty Ltd

Attn: Ryan Lidgard

Date: 7 May 2025

Prepared by: Stantec Australia

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Stantec

Revision

Site Address:	3-5 Help Street, Chatswood
Real Property Description:	Lot 05 SP52320 Lot 03 SP134
Proposed Development:	Commercial and Residential Mixed Use Tower
Client:	Loftex Chatswood Pty Ltd
Authority Reference #:	N/A
Stantec Reference:	301351072-CV-RP-002

Frank Guo

Senior Water Engineer

Stantec Australia Pty Ltd

Revision	Date	Comment	Prepared By	Approved By
01	31.03.2023	Draft Issue for Review	LKS	JMB
02	06.04.2023	Draft Issue for Review	LKS	JMB
03	09.06.2023	Issue for Information	LKS	JMB
04	20.12.2024	for SSDA client review	FG	JMB
05	04.03.2025	for SSDA submission	FG	JMB
06	07.05.2025	for SSDA submission	FG	AT

1. Introduction

Stantec have been engaged by Loftex to provide engineering consulting services for the proposed development at 3-5 Help Street, Chatswood, as part of a State Significant Development Application (SSDA). The development comprises the construction of a commercial and residential mixed use tower, with a single basement access from Help St.

The site is located within the Willoughby City Council Local Government Area (LGA). The site is bound by McIntosh Street to the north, commercial properties to the east, Help Street to the south and Cambridge Lane to the west. Refer to Figure 1 for an aerial view of the site.

Figure 1: Site Aerial (Source: NearMap 2023)

1.1 Update to original assessment

The original design, which has received DA approval (DA-2023/160) with conditions (refer Section 1.2), will undergo updates as part of a SSDA lodgement. These updates primarily impact the upper levels of the design, while the ground levels, which are subject to overland flow, will remain unchanged. This report has been updated to address the conditions of the DA and the additional flood-related requirements(refer Section 1.2) outlined in issue 15 Flood risk of the Planning Secretary’s Environmental Assessment Requirements (SEARs).

1.2 DA conditions and SEARs requirements

DA Conditions(DA-2023/160):

19. Overland Flow/Flood Level Certification

A suitably qualified and experienced civil engineer must certify that: (a) The finished floor levels of the development comply with the requirements of Technical Standard 2. (b) All access points to the basement are at or above the 1%AEP water level + 500mm of the PMF, whichever is higher. (c) The proposed works comply with the requirements of Technical Standard 2 Floodplain Management. (d) That the proposed works comply with the Stantec's report "Detailed Catchment Analysis – Review of Pre-Development & Post-Development Flood Levels" dated 9 June 2023.

The engineer must undertake an assessment of the critical flows as determined necessary to satisfy this condition. Where floor levels need to be raised or other flood protection measures are deemed necessary, details must be submitted and approved by the Certifying Authority prior to the issue of the Construction Certificate. (Reason: Prevent property damage)

SEARs requirements:

15. Flood Risk

- *Identify the flood planning level as set out in the relevant council LEP or SEPP and identify any:*
- *flood risks on site having regard to adopted flood studies*
  - *the potential effects of climate change, and*
  - *any relevant provisions of the NSW Flood Risk Management Manual.*
- *Where the development is occurring on flood prone land a flood impact and risk assessment (FIRA) must be prepared having regard to the Flood Impact and Risk Assessment Guideline - LU01 (FIRA guide). When determining the scope and category of the FIRA the requirements outlined in the FIRA guide must be considered.*
- *Detail any flood risk management measures that are to be incorporated as part of the development having regard to relevant guidelines (including any design solutions, flood modification measures, property modification measures, operational procedures or Flood Emergency Response Plan).Detail any flood risk management measures that are to be incorporated as part of the development having regard to relevant guidelines (including any design solutions, flood modification measures, property modification measures, operational procedures or Flood Emergency Response Plan).*

1.3 Update of the scope

Although the site is subject to overland flow, it is located outside of flood-prone land, and a full-scale Flood Impact and Risk Assessment is not deemed necessary. Additional stormwater modelling has been conducted to meet the DA conditions and SEARs, specifically for the 1% AEP with climate change and PMF storms. The climate change assessment was carried out in accordance with the latest ARR guidelines (dated 27/08/24), which account for an 86% increase in rainfall. The PMF was assessed using the GSDM methodology to verify the required basement entry level as specified by the DCP.

2. The Existing Catchment

2.1.1 Existing Flooding

The proposed development site is located within the upstream reaches of the Scotts Creek catchment. A flood study was commissioned by Willoughby City Council and the Department of Environment and Climate Change, and undertaken by Lyall and Associates, for the Scotts Creek catchment in 2008. This flood study defined indicative flooding extents for flood events ranging from the 20% AEP to the PMF flood event. Flood hazard and hydraulic categorisation were defined for the 5% and 1% AEP flood events.

Flood behaviour was defined using a hydrological DRAINS rainfall-runoff routing model, to determine flood flows in the catchment, and a hydraulic model of overland flow path based on a HEC-RAS 1D model, to model flood levels in Scotts Creek. The flood mapping for this project extends from Chatswood Chase near Havilah Street to the east to discharge to Castle Cove near Eastern Valley Way. The proposed development site and its surrounds are therefore not included in the mainstream floodplain of Scotts Creek.

2.1.2 Upstream Catchment

GIS topography was retrieved from the NSW free source website ELVIS and converted into contours at 1.0m intervals to determine the extent of the upstream catchment reticulating towards the site. The LiDAR data is based on the 2020 data obtained by the NSW government. The topography of the site and extent of the upstream catchment is shown in Figure 2.

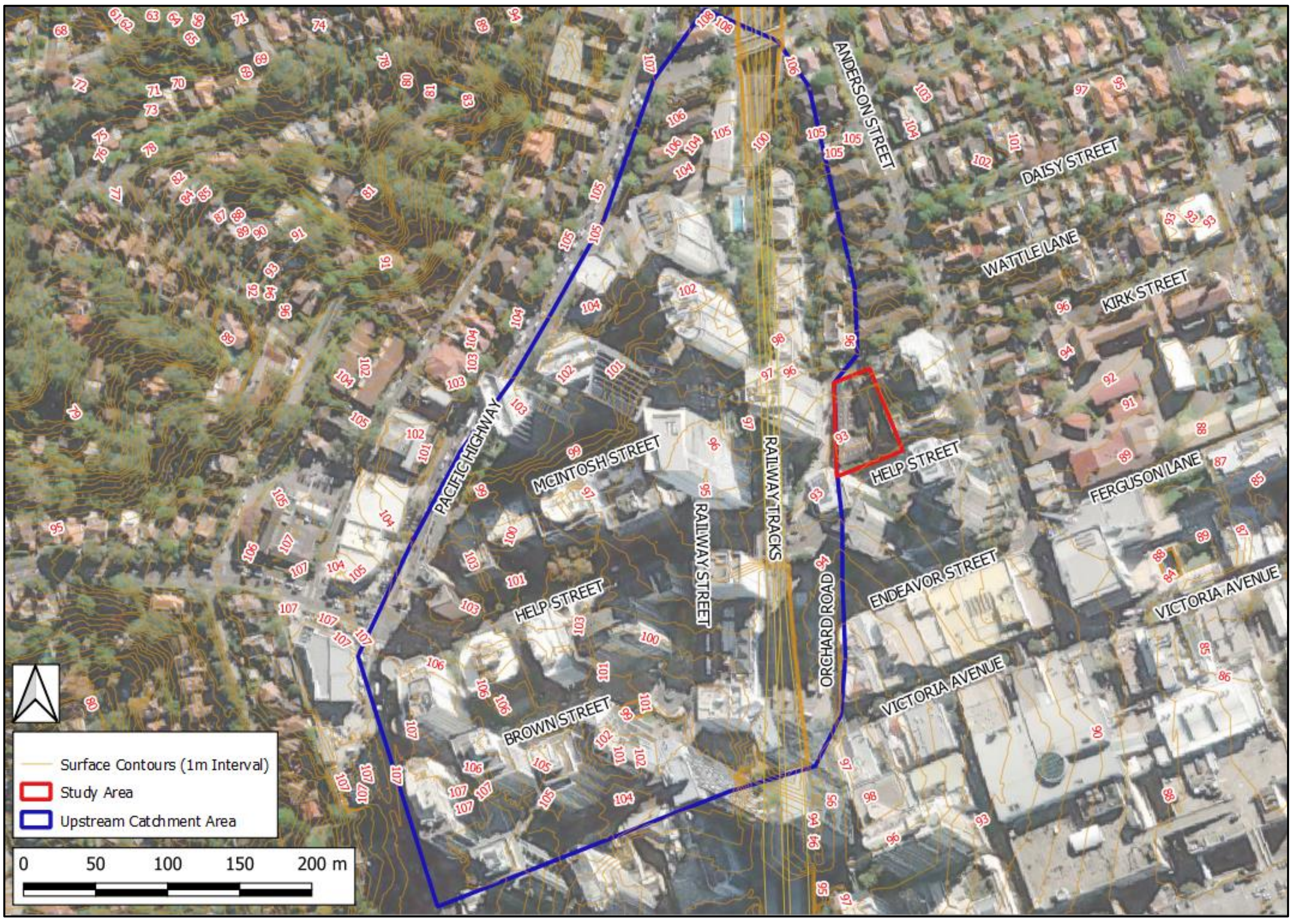

Figure 2: Existing Site Topography and Upstream Catchment

As can be seen in Figure 2, the existing ground grades in an easterly direction. The upstream catchment covers an area of approximately 12.92Ha. Existing Council stormwater infrastructure information, obtained from Dial Before You Dig (DBYD), indicates that the large majority of the upstream flows are picked up by an extensive stormwater pit and pipe network and ultimately conveyed via the trunk drainage system via Help St and Victoria Avenue to Chatswood Chase. Refer to Figure 3 for an illustration of the extent of the existing stormwater drainage conveying upstream flows via the piped network that has been modelled as part of the upstream catchment analysis.

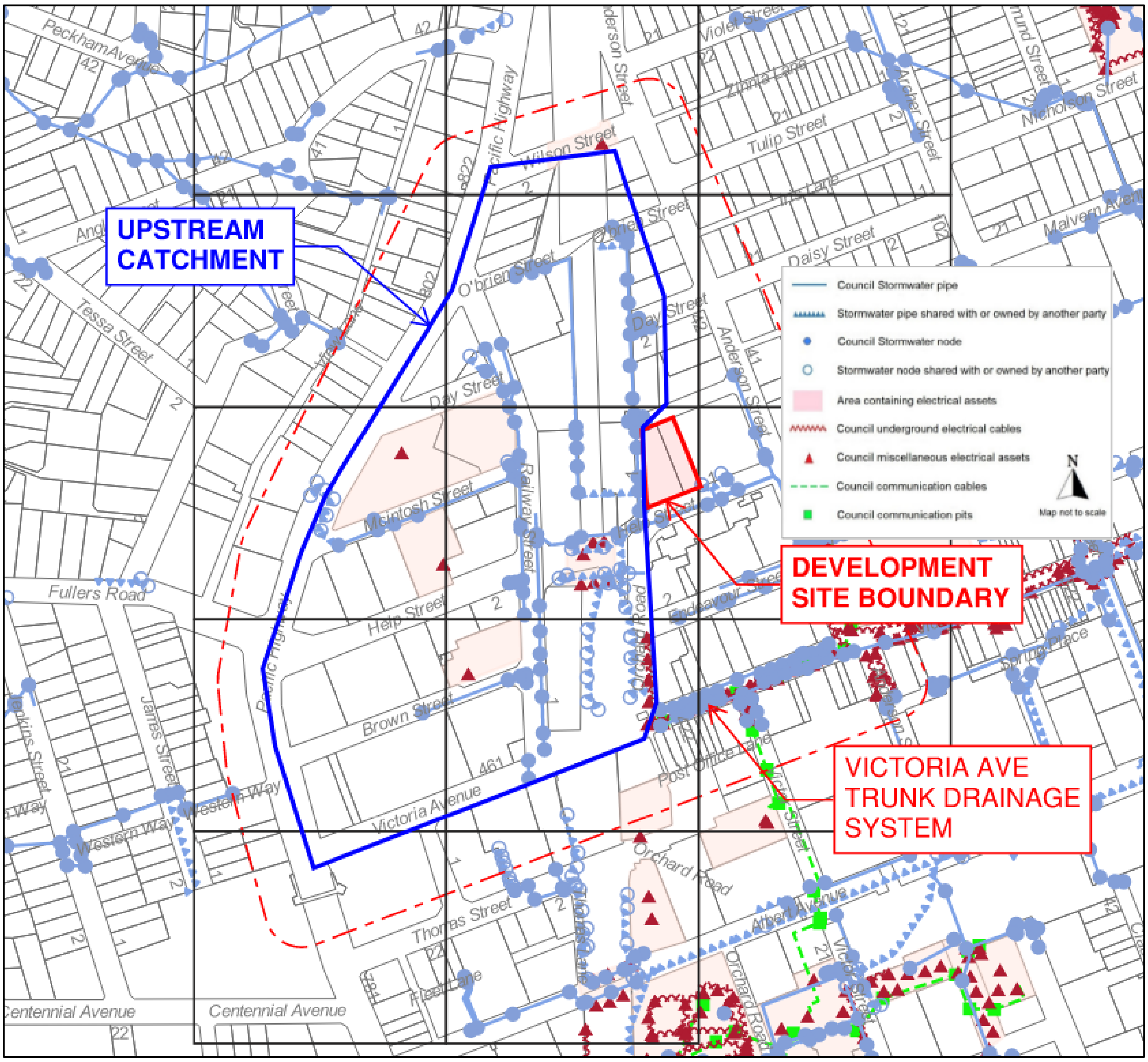

Figure 3: Existing Site Topography and Upstream Catchment (Source: DBYD 2023)

3. Proposed Development

The proposed development shall consist of the demolition of the existing multi-storey buildings, site clearing and construction of a 34 storey high-rise residential and commercial tower inclusive of 5 basement levels. The lower ground floor shall consist of retail and commercial space, and the upper ground and mezzanine levels shall consist of commercial space. All levels above the mezzanine shall consist of residential living space.

Primary vehicular access into the site shall be provided via Help St at lower ground floor level into the basement which shall consist of car and bike parking spaces, the rainwater tank and grease arrestor. Refer to Appendix A for the proposed development lower and upper ground floor plans.

4. Abbreviations Definitions

AEP	Annual Exceedance Probability
AHD	Australian Height Datum
AIDR	Australian Institute for Disaster Resilience
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
BoM	Bureau of Meteorology
DCP	Development Control Plan
DN	Diameter Nominal (mm)
EY	Exceedances per Year
FFL	Finished Floor Level
FPL	Flood Planning Level
HGL	Hydraulic Grade Line
IFD	Intensity-Frequency-Duration
IL	Invert Level
L/s	Litres per second
m/s	Metres per second
OSD	On-Site Stormwater Detention
PSD	Permissible Site Discharge
RCP	Reinforced Concrete Pipe
RL	Relative Level
SSR	Site Storage Requirement
WCC	Willoughby City Council

5. Basis of Design

5.1 Purpose of this Document

The purpose of this document is to describe the civil, flooding and stormwater services in relation to the proposed mixed use development at 3-5 Help Street, Chatswood.

5.2 Reference Documents

This report is based on the following reference documents:-

- Survey Plan by SDG, dated 24/04/2023 (Plan Ref: 8917, Revision A);
- Architectural Plans by EMBECE Architects, issued on 12.02.2025
- NSW LiDAR Data, available on the NSW free source website ELVIS
- Cadastral information, available on the NSW free source website SIXMAPS
- Google Maps
- Willoughby City Council Dial Before You Dig Data
- Stormwater Pipe Network Details, issued by WCC on 09/03/23.

5.3 Methodology

Table 1 outlines the methodology that was applied for the analysis of the stormwater system to inform the design.

Table 1: Existing Stormwater Drainage System Analysis Methodology

Step	Description
Step 1 – Desktop Review	• Review of existing available topography • Review of Council information relating to the upstream catchment
Step 2 – Data Collection	• Review and collation of all topographical data for the upstream catchment area • Review and collation of all existing stormwater models and details within the upstream catchment and immediately downstream of the development site • Review of Council existing stormwater pipe data
Step 3 – Approach to Modelling	• Preparation of DRAINS model to undertake catchment analysis in accordance with Council's requirements
Step 4 – Setting Model Parameters	• Determination of hydrologic and hydraulic parameters, including model extent, GIS data, pit and pipe network, boundary conditions and time of concentration
Step 5 – Design Event Modelling	• Modelling of the pre-development and post development scenarios to determine impacts of the proposed development on the existing stormwater network and flood levels

5.4 Limitations

This report is based primarily on the information provided by Council, visual observations made through Google Maps, information made available through free source websites ELVIS and SIXMAPS, and the stormwater design submitted as part of the SSDA for the proposed development at 3-5 Help St. Any assumptions made in the modelling of the existing stormwater system have been communicated in this report.

6. Catchment Characteristics and Modelling

A catchment plan was prepared to determine the extent of the catchment reticulating via the existing stormwater drainage system to the trunk drainage in Help St. In preparation of this catchment plan, existing survey contours were utilised to determine the fall and topography of the ground. A walk-through of the streets was also conducted to determine the discharge method and direction of the properties. It was found that the majority of properties, consisting of commercial developments, discharged directly to existing stormwater pits. No kerb and gutter outlets were observed. In preparing the catchment plan, it was assumed that the lots would discharge to the nearest stormwater pit in the public domain. No potential on-site detention (OSD) installed as part of the commercial properties have been considered in the modelling to reflect a worst-case scenario.

The Scotts Creek catchment DRAINS model, prepared as part of the Scotts Creek Catchment Flood Study, was obtained from Willoughby City Council. The DRAINS model was prepared using pre-ARR 2019 data and did not include any data upstream of the railway tracks at the Help St and Railway St intersection. This model has not been used in the preparation of the current modelling undertaken for the upstream catchment analysis.

6.1 Survey Data

A detailed survey was only made available for the development site (3-5 Help St) and the surrounding Cambridge Lane and Help St. In order to model the entirety of the upstream stormwater network, LiDAR data was retrieved from the NSW ELVIS website and converted into contours at 1.0m intervals. The LiDAR data is based on the 2020 data obtained by the NSW government.

Pit cover and grate levels have been estimated based on the contours produced from the LiDAR data as this information was not provided within the Council existing stormwater plan, issued for information.

6.2 Catchment Modelling

Cadastral data made available on SIXMAPS has been utilised to determine the extent of lots and separate these to the public domain roadways and footpaths. To assign catchments with a pervious/impervious fraction, the following assumptions were made during the design and modelling of the existing stormwater system:-

- The pervious/impervious percentage has been conservatively assumed based on observations made from Google Maps for each lot, ranging between 50% and 100% imperviousness for the lots, and;
- Roadways and footpaths were observed to be largely 100% impervious. No landscaped buffer has been provided in the large majority of the upstream catchment. As such, the public domain has been conservatively assigned an impervious fraction of 100% for modelling purposes.

6.3 Time of Concentration

The time of concentration for a catchment measures the maximum time taken for the surface runoff to reach a stormwater pit. The time of concentration for the catchments have been calculated using two (2) different methods.

For all existing lot catchments discharging directly to a stormwater pit, the time of concentration has been calculated based on the Pilgrim McDermott method and converted into minutes for the purposes of modelling due to their size and variety of surfaces and drainage systems. Refer to the equation below for the Pilgrim McDermott time of concentration formula.

$$ToC = 0.76A^{0.38}$$

In the equation above, ToC is the time of concentration measured in hours and A is the catchment area measured in km^2.

For catchments with public domain catchment only; i.e. roadways and footpaths, a more detailed method of calculating time of concentration has been adopted using the steady state kinematic wave equation. Refer to the equation below for the kinematic wave equation for calculating time of concentration.

$$t_{overland} = 6.94\ x\ \frac{(L.n^{*})^{0.6}}{I^{0.4}.S^{0.3}}$$

In the equation above, $t_{overland}$ is the time of concentration measured in minutes, L is the overland flow path length measured in metres, n^{*} is the retardance coefficient, I is the rainfall intensity in mm/he and S is the ground slope.

The kinematic wave equation differs to the Pilgrim McDermott formula for calculating time of concentration in that the rainfall intensity is a dependent variable in the calculation. As such, with every storm event, the time of concentration changes to reflect the varying intensities of the storm and speed at which surface runoff shall travel to the receiving pit. With the Pilgrim McDermott formula, the time of concentration remains the same for all storm events as it is based simply on the area of the catchment that shall reticulate towards the outlet of that catchment.

6.4 Retardance Coefficient

A retardance coefficient was assigned for catchments using the kinematic wave equation to calculate the time of concentration. For impervious areas, including roadways footpaths and driveways, a retardance coefficient value of 0.012 was assigned. For vegetated areas, a retardance coefficient value of 0.17 was adopted to reflect the relatively small and thin characteristics of the vegetated areas, and therefore, the little friction that would be experienced by surface runoff.

6.5 Overland flow Modelling

To address SEARS flood requirements that a catchment analysis be undertaken to ensure the proposed development will have no impact on existing flood levels and velocities, the pre-development and post development scenario have been modelled to determine the existing capacity of the existing stormwater network and its ability to convey the flows generated from the new development.

6.6 Modelling Software

A DRAINS model has been prepared to establish the pre-development post development conditions with regards to the existing stormwater drainage system and flood levels. DRAINS is a runoff routing software program which assesses stormwater drainage hydraulics based on catchment hydrology input from various sources including the Bureau of Meteorology (BoM) and the Australian Rainfall and Runoff (ARR) Datahub. The ARR2019 method of rainfall analysis has been adopted for modelling purposes.

6.6.1 DRAINS Input Parameters

The parameters used in the DRAINS model are as follows:-

- Soil Type – Normal 3.0
- Paved (Impervious) Area Depression Storage 1mm
- Supplementary Area Depression Storage 1mm
- Grassed (Pervious) Area Depression Storage 5mm
- Antecedent Moisture Condition 3.0
- Minimum Pit Blockage (Sag Pits) 0.5
- Minimum Pit Blockage (On-Grade Pits) 0.2
- Minimum Pit Freeboard 150mm
- Minimum Fall Across Pits 30mm

6.6.2 Hydrology

Rainfall intensities and temporal patterns have been obtained from the Bureau of Meteorology (BoM) and ARR Datahub website for the catchment to allow for the development of the DRAINS model. Temporal patterns for EC South, representing rainfall patterns in five (5) minute increments across the south-east coast of Australia, have been applied in the DRAINS model to reflect the region in which the development is situated.

Figure 4 presents the rainfall intensities (mm/hr) for all storm events up to, and including, the 1% Annual Exceedance Probability (AEP) which have been input into the DRAINS model.

	Annual Exceedance Probability (AEP)						
Duration	**63.2%**	**50%#**	**20%***	**10%**	**5%**	**2%**	**1%**
1 min	145	163	219	259	299	353	396
2 min	120	134	176	207	237	282	318
3 min	111	124	164	193	222	263	297
4 min	105	117	156	183	211	250	281
5 min	99.1	111	148	175	201	239	268
10 min	78.4	87.9	119	140	162	192	215
15 min	65.3	73.2	99.0	117	135	160	179
20 min	56.2	63.1	85.2	101	116	137	154
25 min	49.6	55.6	75.0	88.6	102	121	136
30 min	44.6	50.0	67.2	79.4	91.6	108	121
45 min	34.7	38.8	52.0	61.3	70.7	83.7	94.0
1 hour	28.9	32.2	43.0	50.7	58.5	69.3	77.9
1.5 hour	22.2	24.7	32.9	38.8	44.7	53.1	59.9
2 hour	18.5	20.5	27.3	32.1	37.1	44.1	49.8
3 hour	14.3	15.9	21.1	24.9	28.9	34.4	38.9
4.5 hour	11.2	12.4	16.6	19.6	22.8	27.2	30.8
6 hour	9.43	10.5	14.1	16.7	19.4	23.3	26.4
9 hour	7.49	8.36	11.3	13.5	15.7	18.9	21.4
12 hour	6.38	7.14	9.71	11.6	13.6	16.3	18.5
18 hour	5.09	5.73	7.87	9.44	11.1	13.3	15.1
24 hour	4.33	4.89	6.76	8.13	9.55	11.5	13.0
30 hour	3.80	4.31	5.98	7.20	8.46	10.2	11.5
36 hour	3.41	3.87	5.39	6.49	7.63	9.17	10.4
48 hour	2.85	3.24	4.53	5.46	6.41	7.69	8.69
72 hour	2.17	2.47	3.46	4.16	4.86	5.82	6.55
96 hour	1.75	2.00	2.80	3.35	3.91	4.65	5.22
120 hour	1.47	1.68	2.34	2.80	3.25	3.85	4.31
144 hour	1.26	1.44	2.00	2.39	2.77	3.27	3.65
168 hour	1.11	1.26	1.75	2.08	2.41	2.83	3.15

Figure 4: Rainfall Intensities (Source: BoM)

The 1% AEP storm event was assessed to determine the critical storm duration for the catchment immediately downstream of the development at the intersection of Help St and Anderson St. A tailwater level has been assumed for the 1% AEP event at the point of termination of the DRAINS modelling at the pipe obvert level.

6.7 Hydraulics

The pipe sizes for the stormwater drainage network upstream of the Help St trunk drainage system were provided by Council to allow for the catchment analysis to be undertaken. Pipe sizes and pit locations nominated in the stormwater plan received from Council have been incorporated into the DRAINS model.

Where this information was not provided, all assumptions made have been listed below to allow the model to be generated:-

- Pit sizes (on-grade, sag, lintel and grate dimensions) were assumed based on a visual observation made through Google Maps and contours generated from the LiDAR data;
- Where pipe diameters were not provided, the pipe diameter has been assumed based on the downstream pipe diameter;
- Invert levels were assumed based on upstream and/or downstream pipe invert levels, where known. Alternatively, a minimum cover of 600mm was applied in roadways and 450mm in landscaped areas and a minimum grade of 1% has been applied to all pipes;
- No on-site detention (OSD) that may be catering for the existing properties has been accounted for in the modelling, with the modelled condition considered the worst case scenario, and;
- A fall of 30mm has been provided from obvert to obvert for incoming and outgoing pipes.

6.8 Stormwater Infrastructure

The existing stormwater network consists of a number of pits and pipes which connect into a main drainage trunk link which reticulates east via Help St to Victoria Ave and ultimately discharges to Scotts Creek. A couple of detention basins are located downstream of Victoria Avenue and upstream of Scotts Creek. Detailed information regarding the pit types; i.e. on grade, sag, lintel and grate dimensions, where not available and assumptions have been made based on visual observations made through Google Maps and the contours created from LiDAR data. A blockage factor of 20% was assigned for on-grade pits and 50% for sag pits, unless visual observations of existing pit blockages warranted a higher blockage factor be applied to the individual pit. Where additional pits have been observed and were not picked up on the stormwater plan provided by Council, these have been included in the DRAINS model to accurately reflect catchment conditions.

6.9 Climate Change Assessment

The climate change assessment was conducted in accordance with the latest ARR guidelines (dated 27/08/24). The worst-case scenario, SSP5-RCP8.5 projection for 2100, was assumed, accounting for an 86% increase in rainfall (refer to Figure 7). The increased IFDs were applied to critical storm events (less than 1-hour duration) to calculate the elevated 1% AEP flood level around the proposed building as part of a sensitivity check.

SSP5-8.5

Year	<1 hour	1.5 Hours	2 Hours	3 Hours	4.5 Hours	6 Hours	9 Hours	12 Hours	18 Hours	>24 Hours
2030	**1.2**	**1.18**	**1.17**	**1.16**	**1.14**	**1.13**	**1.13**	**1.12**	**1.11**	**1.11**
2040	1.26	1.24	1.22	1.2	1.18	1.17	1.16	1.15	1.14	1.14
2050	**1.34**	**1.31**	**1.29**	**1.26**	**1.24**	**1.23**	**1.21**	**1.2**	**1.18**	**1.18**
2060	1.42	1.38	1.35	1.32	1.29	1.28	1.26	1.24	1.22	1.21
2070	1.52	1.47	1.43	1.4	1.36	1.34	1.31	1.29	1.27	1.26
2080	1.63	1.57	1.52	1.48	1.43	1.4	1.37	1.35	1.33	1.31
2090	**1.77**	**1.69**	**1.64**	**1.58**	**1.52**	**1.49**	**1.45**	**1.42**	**1.39**	**1.37**
2100	1.86	1.77	1.71	1.64	1.58	1.54	1.5	1.47	1.43	1.41

Figure 5: Climate Change factor (Source: ARR Datahub)

6.10 PMF Assessment

The PMF was assessed using the GSDM methodology to verify the required basement entry level as specified by the DCP. The PMP rainfall was calculated and manually input into the drainage system (refer to Figure 8). The critical duration for the PMF is 15 minutes.

If area < 1 km²,

Catchment Area (km²)	1	
Percent Rough (%)	0	Section 4.2
Elevation of Catchment (m)	100	Section 4.3
Moisture Adjustment Factor (%)	70	Figure 3

for the particular catchment area.

Duration (h)	Smooth Depth (mm)	Rough Depth (mm)	Averaged Depth (mm)	Adjusted Depth (mm)	Rounded Depth (mm)	Check - Depths taken from Figure 4: Point Value (Smooth) (mm)	1 km² Value	Point Value (Rough) (mm)	1 km² Value (Rough) (mm)
0.25	245	245	245	172	170	250	245	250	245
0.5	350	350	350	245	250	360	350	360	350
0.75	440	440	440	308	310	460	440	460	440
1	510	510	510	357	360	570	510	570	510
1.5	580	655	580	406	410	640	580	740	655
2	647	770	647	453	450	710	647	880	770
2.5	690	852	690	483	480	760	690	990	852
3	722	938	722	505	510	810	722	1090	938
4	793	1065	793	555	560	900	793	1250	1065
5	856	1176	856	599	600	960	856	1360	1176
6	900	1242	900	630	630	1000	900	1450	1242

2. Transfer the results from either of the above procedures to the coloured columns below.

Note: Depths are calculated from those in Bulletin 53 corresponding to zero area and to 1 km².

3. The intensities in the coloured columns given below can be transferred directly to the rainfall data base in *DRAINS*.
Using your mouse, select the numbers in the pairs of columns required and choose Copy from the View menu.
Go to the *DRAINS* rainfall data base using the **Project -> Rainfall Data...** option in *DRAINS*. Click the **Add a New Storm** button.
When the new window appears, click the **Paste** button. The numbers and accompanying graph will appear. Enter a suitable title.
Repeat the process as required.

Adjusted Depth (mm)
250
360
460
570
740
880
990
1090
1250
1360
1450

15 Minute Pattern

Time (minutes)	ntensitie (mm/h)	ercentages (%)
0	1320	44
5	1140	38
10	540	18
15		

30 Minute Pattern

Time (minutes)	Intensities (mm/h)	'ercentages (%)
0	864	20
5	1037	24
10	864	20
15	778	18
20	518	12
25	259	6
30		

45 Minute Pattern

Time (minutes)	ntensitie (mm/h)	ercentages (%)
0	662	12
5	938	17
10	828	15
15	773	14
20	718	13
25	607	11
30	497	9
35	331	6
40	166	3
45		

60 Minute Pattern

Time (minutes)	ntensitie (mm/h)	ercentages (%)
0	547	8
5	821	12
10	821	12
15	821	12
20	752	11
25	684	10
30	616	9
35	547	8
40	479	7
45	342	5
50	274	4
55	137	2
60		

Figure 6: PMP calculation

7. Results

7.1 Pre-Development Results

The pre-development hydraulic model has been established as described in the previous sections, with the following results immediately downstream of 3-5 Help St at the intersection of Cambridge Lane and Help Street (section of pipe from Pit 70 to Pit 68) and the main trunk drainage line in Help St at the Help St and Anderson St intersection (after Junction 144). Refer to Figure 7 for the locations at which flows have been measured.

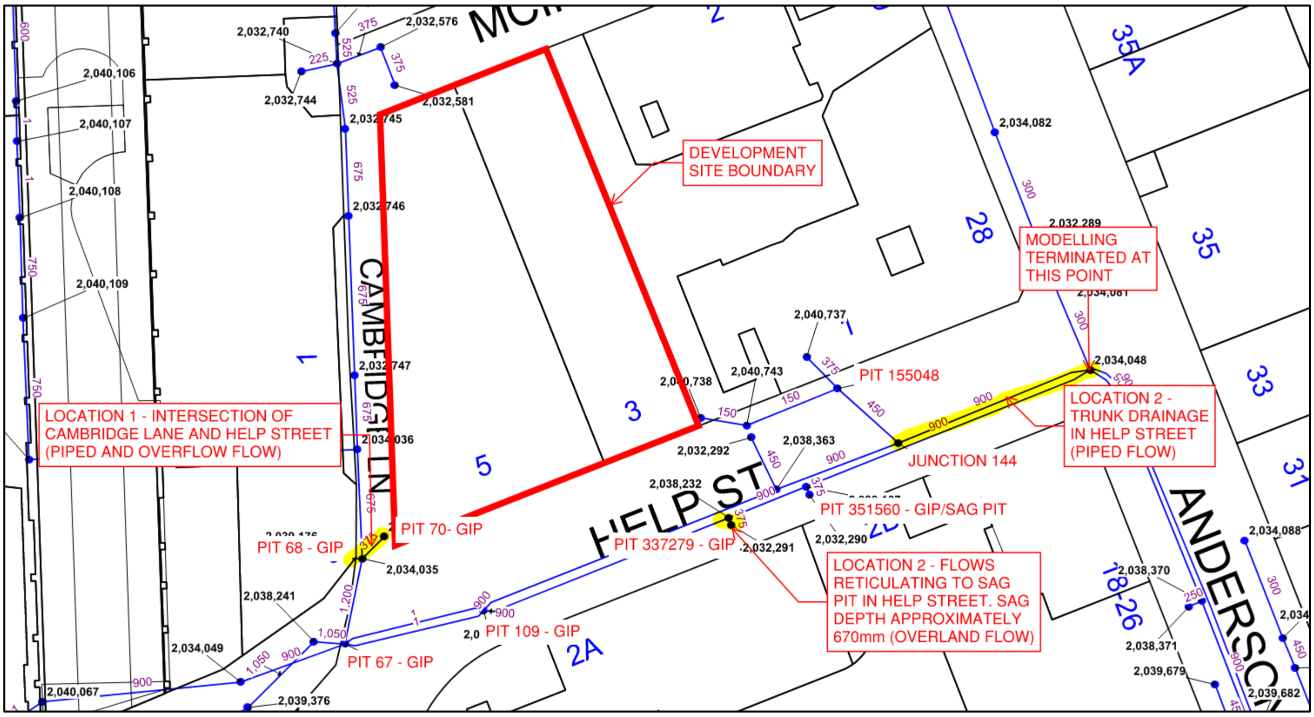

Figure 7: Flow Measurement Locations

In the pre-development scenario, the western portion of 5 Help St is assumed to discharge directly to Pit 70 as no kerb outlets were observed. The remaining eastern portion of 5 Help St and 3 Help St were assumed to discharge to kerb and gutter in Help St as kerb outlets were observed adjacent to the site. It is assumed the catchment flows overland to Pit 155048 before discharging to the trunk drainage in Help St. A sag is located at Pit 351560, with a sag depth of approximately 670mm before flows can discharge via Anderson St. Overland flows for Location 2 are provided at Pit 337279 to the sag pit. Refer to Figure 8 for an illustration of the portion of the development site assumed to discharge to Pit 70 and the portion discharging to kerb and gutter in Help St in the existing scenario.

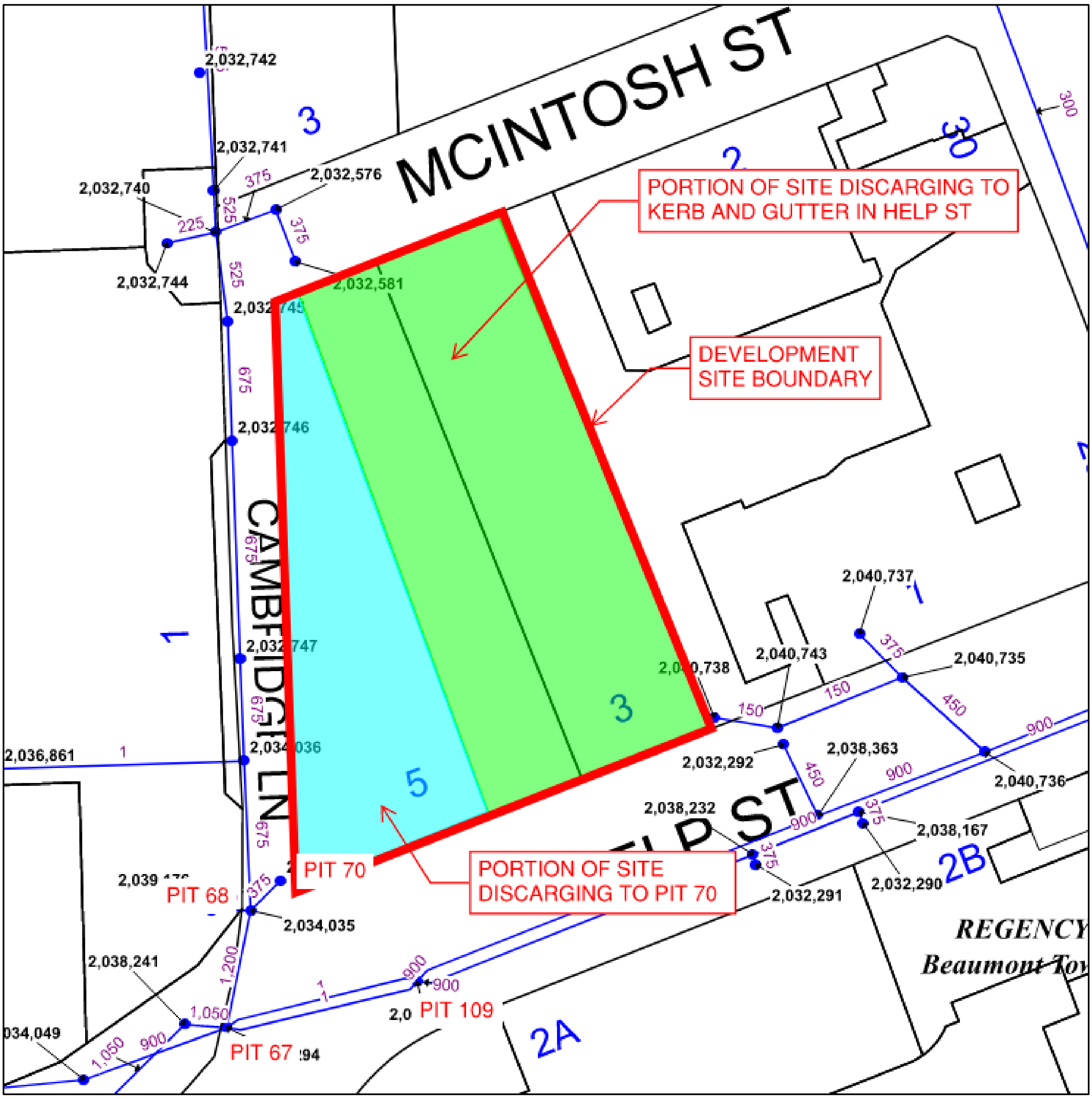

Figure 8: Pre-Development Catchment Breakdown for 3-5 Help St

In the pre-development scenario, the critical storm duration for the 1% AEP storm event is 10 minutes for the peak piped flow of 5.19m^3/s downstream of Junction 144 and overland flow of 1.04m^3/s downstream of Pit 337279. In the post development scenario, the critical storm duration for the 1% AEP storm event is 10 minutes for the peak piped flow of 5.11m^3/s downstream of Junction 144 and overland flow of 0.989m^3/s downstream of Pit 337279.

7.1.1 Location 1 – Intersection of Cambridge Lane & Help Street

The pre-development flows at the intersection of Cambridge Lane and Help Street are as follows in the 1% AEP storm event:-

- 1% AEP Piped Flow:- 129L/s
- 1% AEP Overland Flow:- 21L/s

Refer to Figure 9 and Figure 10 for the hydraulic grade line (HGL) within the piped section of the stormwater network at the intersection of Cambridge Lane and Help Street and overland flow section from Pit 70 in the 1% AEP storm event, respectively.

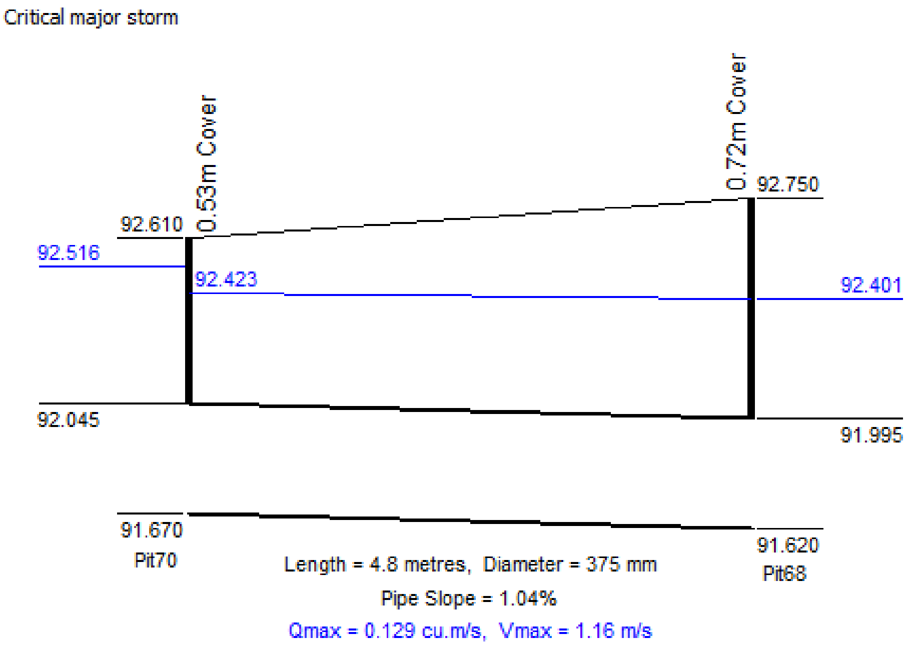

Figure 9: 1% AEP Storm Event Pre-Development HGL within Piped System between Pit 70 and Pit 68

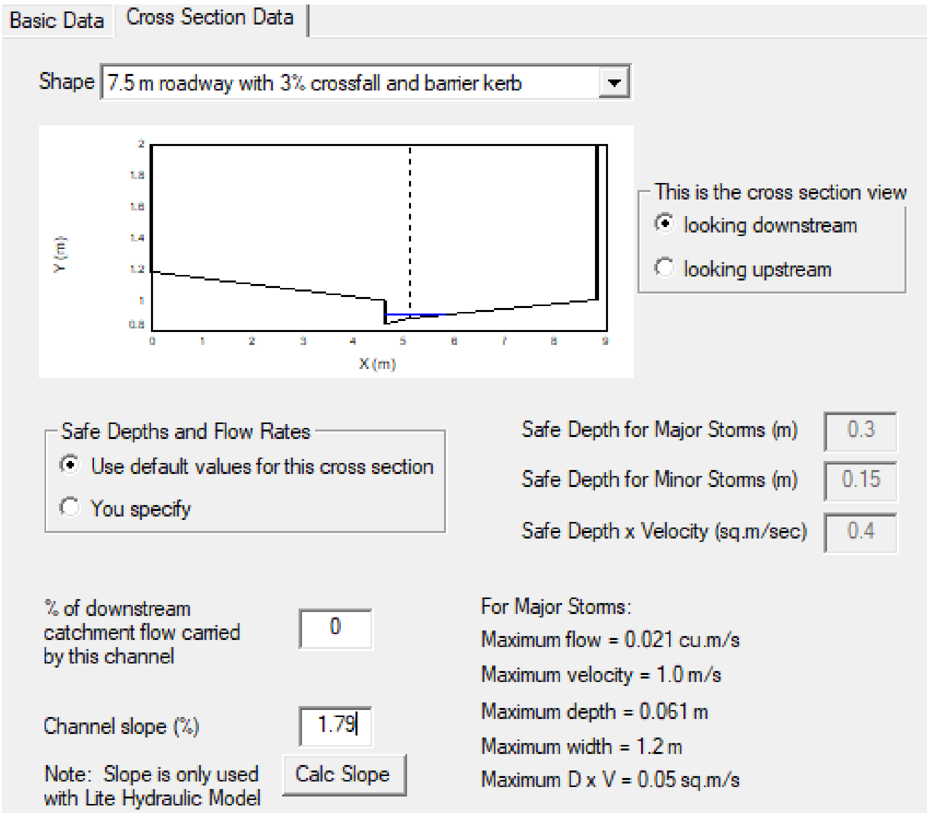

Figure 10: 1% AEP Storm Event Pre-Development Overland Flow Section from Pit 70

A peak velocity of 1.0m/s is observed adjacent to the site in Help Street. Overland flows generated in the model can be attributed to the slope of the catchment, existing pit locations and their inlet capacities to receive the surface flows. The flows attributed to Pit 70 are contained within the piped network.

7.1.2 Location 2 – Help Street Trunk Drainage

The pre-development flows downstream of Junction 144 in Help Street are as follows in the 1% AEP storm event:-

- 1% AEP Piped Flow:- 5190L/s
- 1% AEP Overland Flow:- 1040L/s

Refer to Figure 11 and Figure 12 for the hydraulic grade line (HGL) within the piped section of the stormwater network at the intersection of Help St and Anderson St and overland flow section from Pit 337279 in the 1% AEP storm event, respectively.

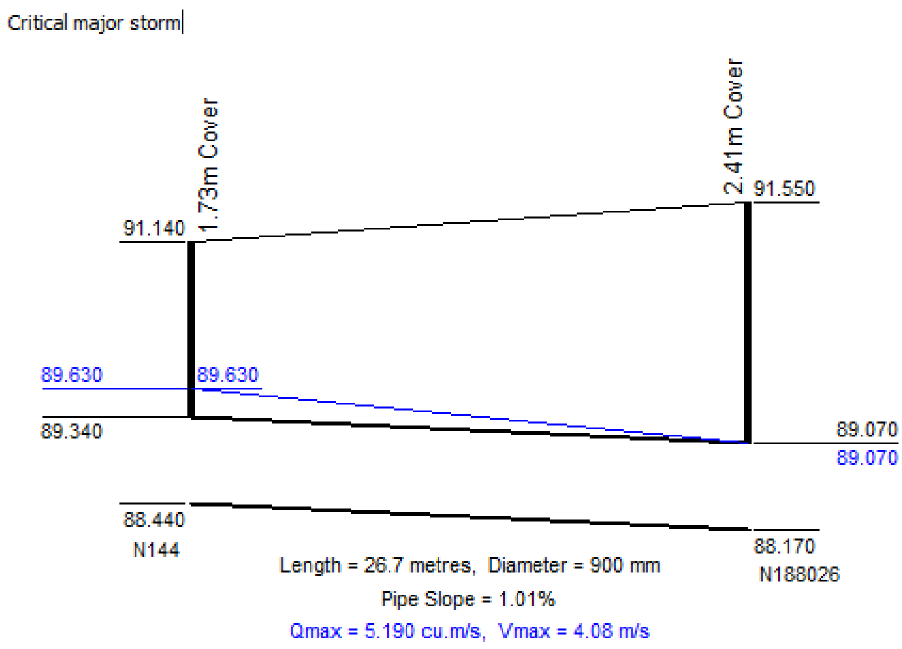

Figure 11: 1% AEP Storm Event Pre-Development HGL within Piped System downstream of Junction 144

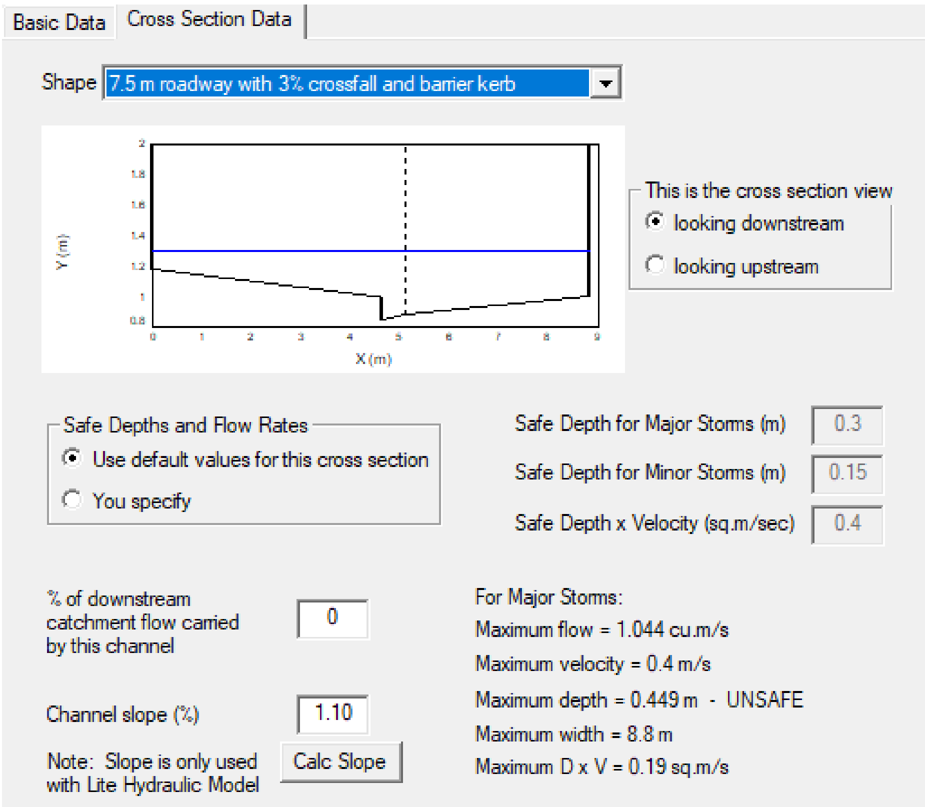

Figure 12: 1% AEP Storm Event Pre-Development Overland Flow Section from Pit 337279

Figure 12 demonstrates that the overland flow path from Pit 337279 in Help Street is unsafe in the 1% AEP storm event, with flow depths amounting to 449mm and a velocity of 0.4m/s. In accordance with the Australian Institute of Disaster Resilience (AIDR), a velocity of 1.0m/s and flow depth of 61mm at Location 1 and 0.4m/s and flow depth of 449mm at Location 2 equates to a flood hazard of H1 and H2, respectively. A flood hazard of H1 is generally safe for people, vehicles and buildings while a flood hazard of H2 is unsafe for small vehicles.

Flows are contained within the sag point of Help Street and eventually discharge via the piped network.

Refer to Figure 13 for the flood hazard framework which has been applied to the modelling presented in this report, and the corresponding flood hazard classification for the existing scenario.

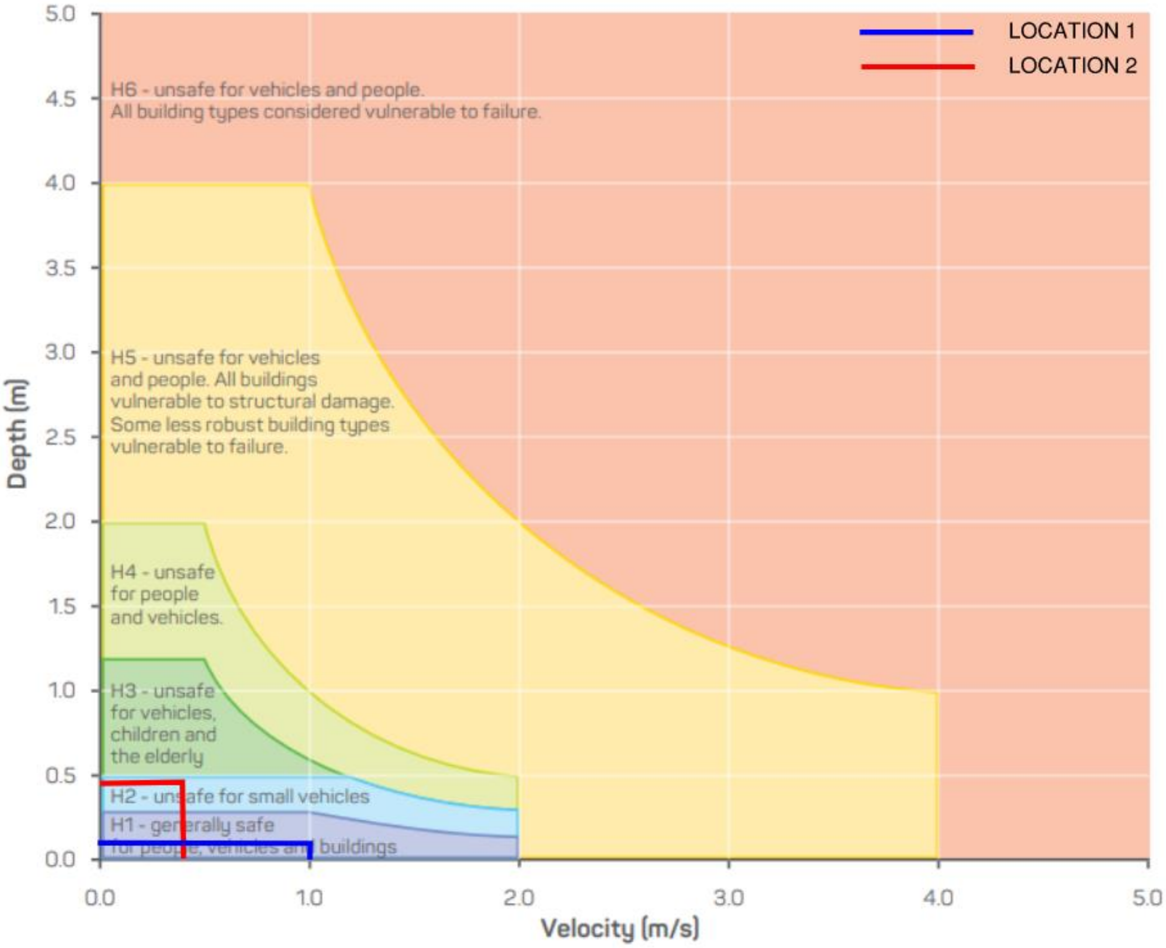

Figure 13: 1% AEP Storm Event Pre-Development Flood Hazard Category (AIDR)

7.2 Post Development Results

The post-development hydraulic model is based on the pre-development DRAINS model, incorporating the proposed stormwater strategy for 3-5 Help Street. The existing site is approximately 90% impervious and is assumed to lack OSD for the development.

As part of the 3-5 Help Street project, an OSD system—designed per WCC's Stormwater Management Policy and Technical Standard No. 1—will capture runoff from the entire site and discharge into the existing sag pit (refer to 01/04 in drains model) near the southeastern corner of Help Street. The OSD will provide a storage volume of approximately 82m³, accounting for backflow effects within the stormwater network to achieve the prescribed permissible site discharge (PSD) of 39 L/s.

Refer to the Civil documentation for SSR and PSD calculations. OSD tank flows have been incorporated into the model as piped flow. The post-development site will be approximately 91% impervious.

The flood impacts have been assessed on the existing drainage line at the Cambridge Lane and Help Street intersection, as well as the main trunk drainage line at the Help Street and Anderson Street intersection, aligning with pre-development flow locations. The assessment confirms that the post-development site discharge does not cause additional water backing up from the trunk drainage system.

7.2.1 Location 1 – Intersection of Cambridge Lane & Help Street

The post development flows at the intersection of Cambridge Lane and Help Street are as follows in the 1% AEP storm event:-

- 1% AEP Piped Flow:- 78L/s
- 1% AEP Overland Flow:- 22L/s

Refer to Figure 14 and Figure 15 for the hydraulic grade line (HGL) within the piped section of the stormwater network at the intersection of Cambridge Lane and Help Street and overland flow section from Pit 70 in the 1% AEP storm event, respectively.

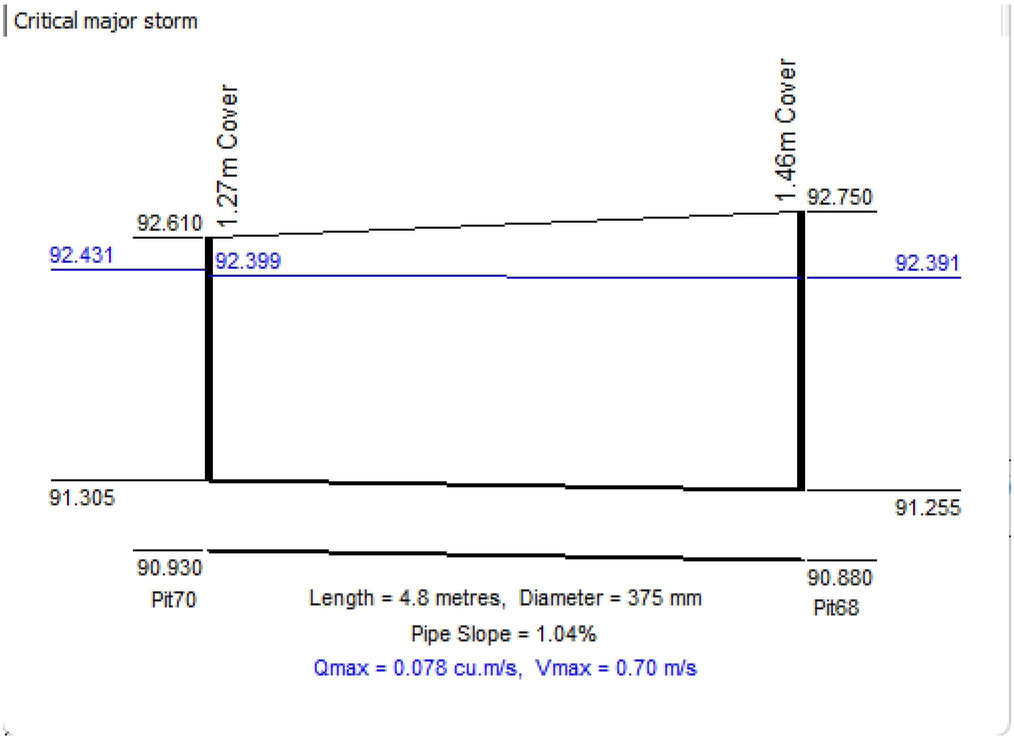

Figure 14: 1% AEP Storm Event Post Development HGL within Piped System between Pit 70 and Pit 68

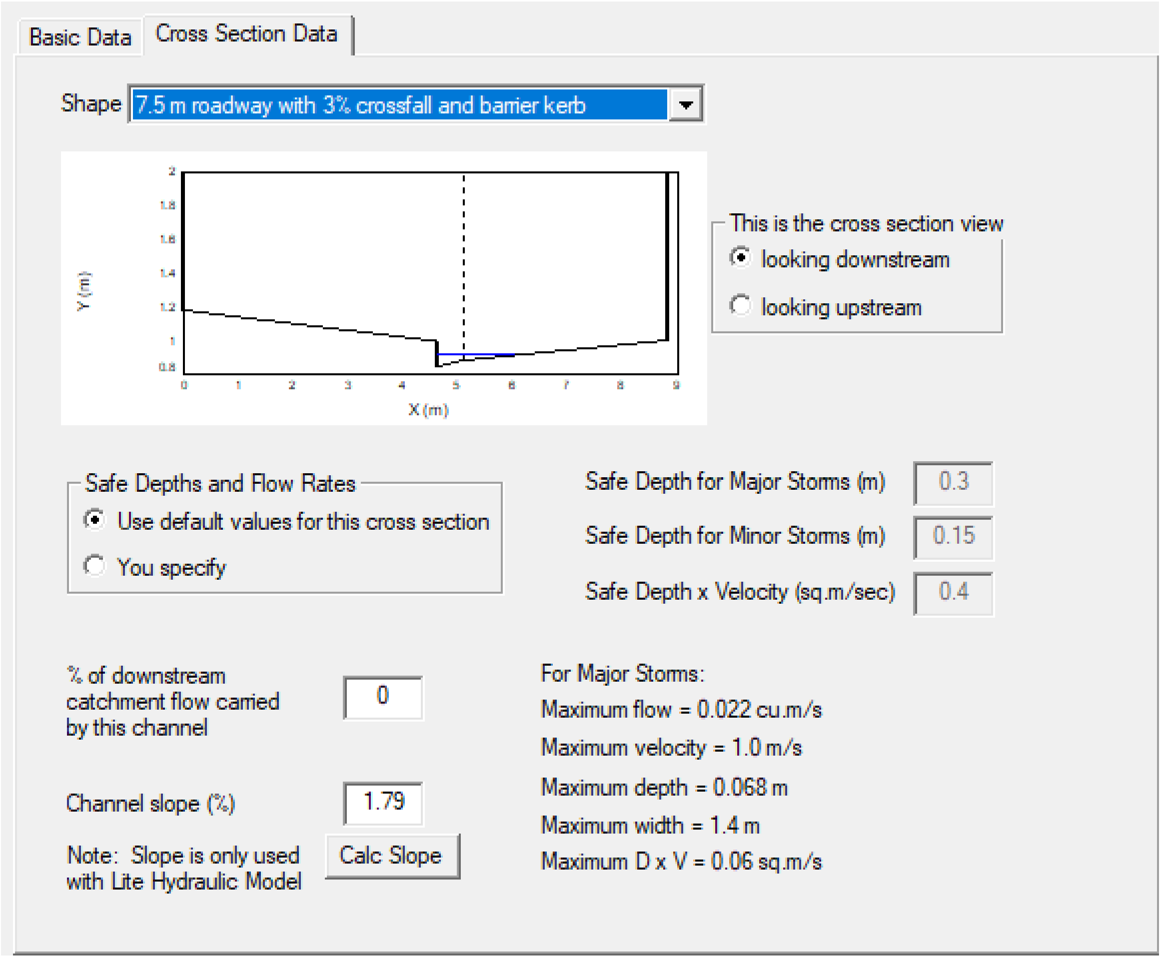

Figure 15: 1% AEP Storm Event Post Development Overland Flow Section from Pit 70

The post-development flows are still contained within the piped network, with the minor overflow attributed to inlet capacities of the existing stormwater network.

7.2.2 Location 2 – Help Street Trunk Drainage

The post development flows downstream of Junction 144 in Help Street are as follows in the 1% AEP storm event:-

- 1% AEP Piped Flow:- 5152L/s
- 1% AEP Overland Flow:- 988L/s

Refer to Figure 16 and Figure 17 for the hydraulic grade line (HGL) within the piped section of the stormwater network at the intersection of Help St and Anderson St and overland flow section from Pit 337279 in the 1% AEP storm event, respectively.

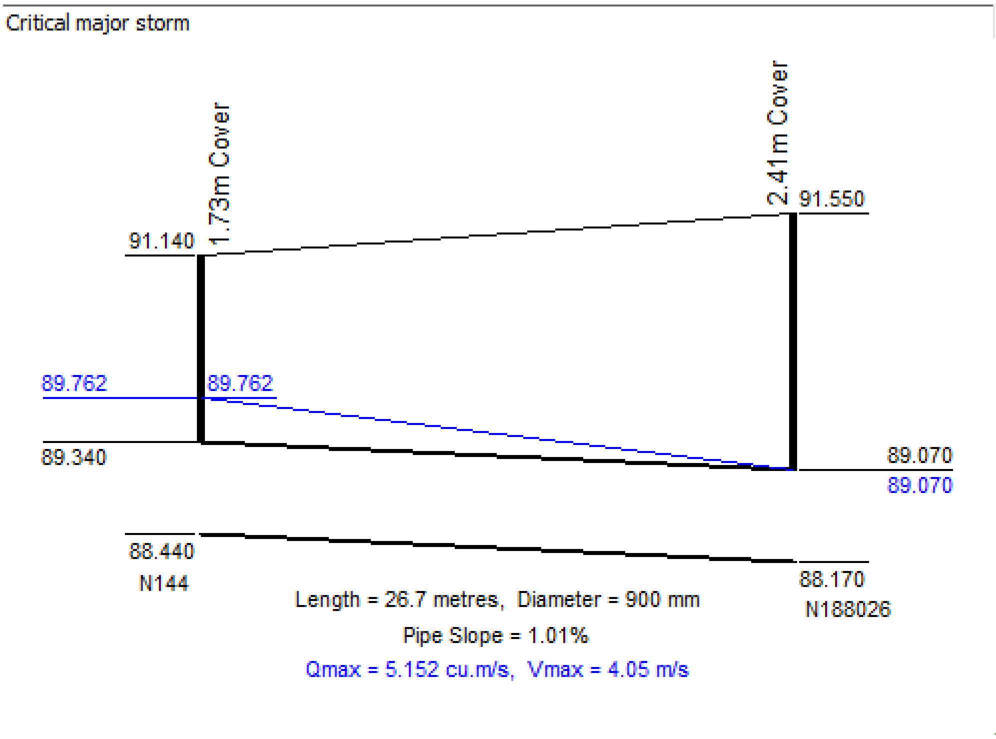

Figure 16: 1% AEP Storm Event Post Development HGL within Piped System downstream of Junction 144

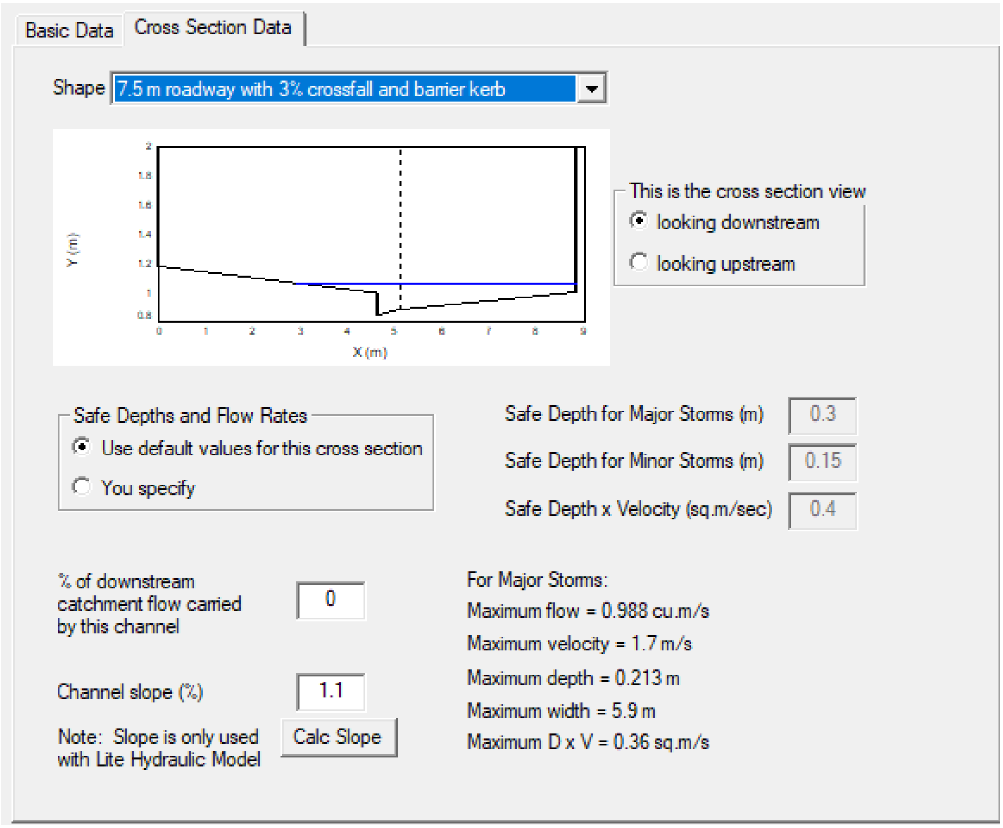

Figure 17: 1% AEP Storm Event Post Development Overland Flow Section from Pit 337279

Refer to Figure 18 for the post development flood hazard categories, demonstrating there is no change in flood hazard between pre-development and post development conditions.

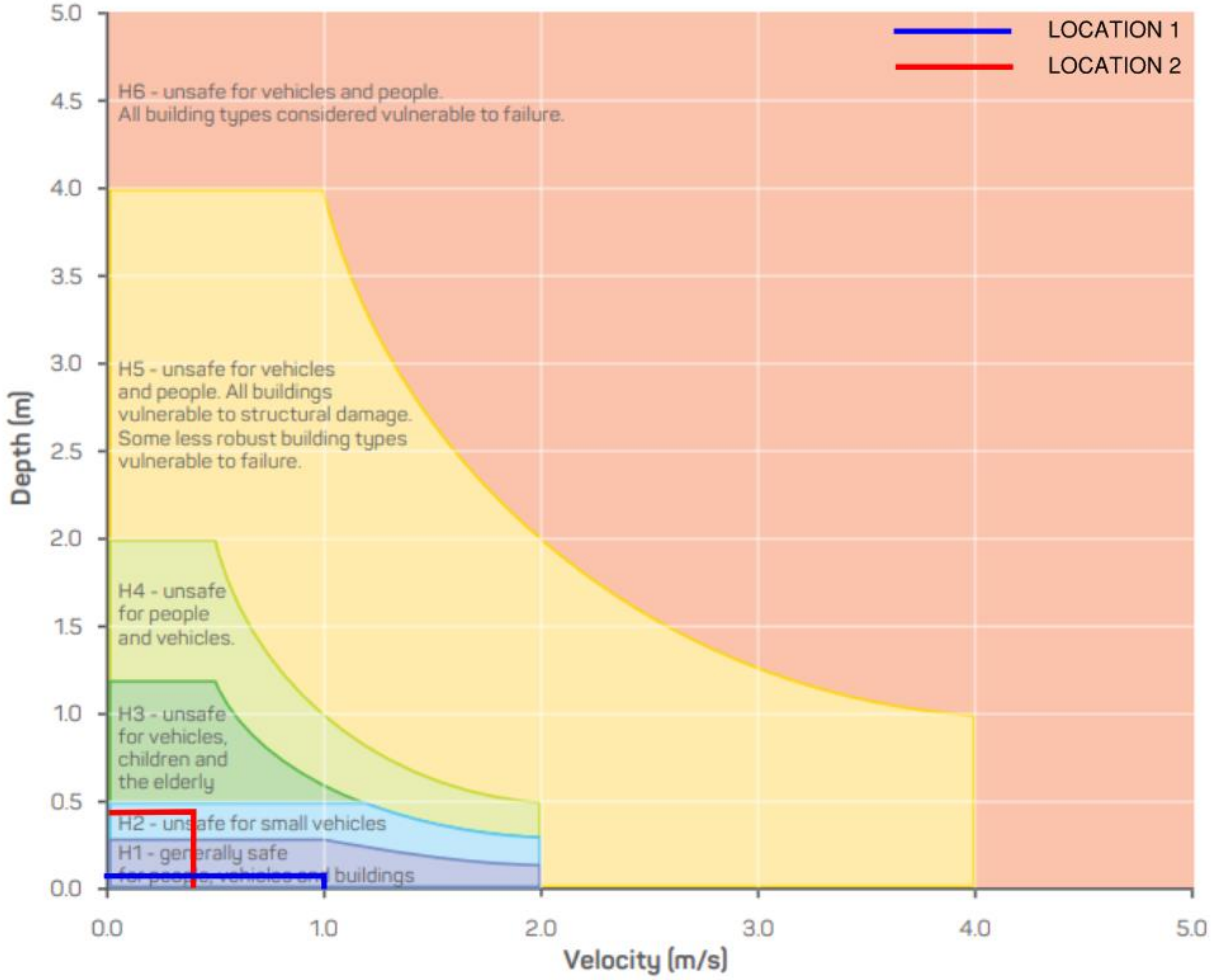

Figure 18: 1% AEP Storm Event Post Development Flood Hazard Category (AIDR)

8. Flood-Related Development Controls and SEARS Requirements

8.1 Climate Change Results

It is assessed that the modelled rainfall increase of 86% under the worst-case climate change scenario results in a flood level increase ranging from 300mm to 490mm around the proposed building(refer Table 2). Therefore, a 500mm freeboard is considered adequate to account for the extreme case within the building's service life.

8.2 Flood Planning Levels

Willoughby City Council have specified the design flood planning levels required in the DCP and are noted below:-

- **Habitable Floor Levels** to be set at a minimum of the **1% AEP flood level + 500mm freeboard**, and;
- **All access points to the basement** are at or above the 1%AEP water level + 500mm of the PMF, whichever is higher
- **Non-Habitable Floor Levels** to be set at a minimum of the **1% AEP flood level**, and;
- **Critical Infrastructure** to be set at a minimum of the **1% AEP flood level + 500mm freeboard**.

It is noted that Location N has basement access, and the proposed floor level for these locations is above the FPL (1% AEP + 500mm). However, to achieve PMF immunity, the access ramp would need to be raised by an additional 1.6m, which would result in poor urban design for daily use. The site is not located in flood-prone land and is only subject to overland flow, meaning the risk of structural damage or harm to occupants is very low. The floor levels have been set at the highest practical level of flood protection, considering both current conditions and future climate change, while maintaining an appropriate balance between flood immunity and accessibility.

The applicable flood planning levels across the development are tabulated below. Refer to Figure 19 and Appendix A for the location plan corresponding with the location ID's in Table 2.

By adopting these flood planning levels, the risk of flood impact on the development will be reduced to a level sufficient to meet the requirements set by Willoughby City Council. It is noted that the original SSDA design Levels were exactly the same levels that were approved by Council for the development application. Locations D, G, & I have been raised to address the DPHI comments however we still believe that the levels adopted for location N are appropriate.

Table 2: FPL Compliance

Location	Use	Flood Planning Requirement	1% AEP Flood Level	1% AEP + Climate Change Flood Level	PMF Flood Level	Applicable Flood Planning Level	Proposed Floor Level	Comments
A	Fire Stair with Basement Access	Greater Level of 1% AEP flood level + 0.5m freeboard and PMF	95.218	95.268	95.306	95.718	95.85	Floor level is compliant
B	Commercial Tenancy –	1% AEP flood level	94.634	94.684	94.722	94.634	95	Floor level is compliant

	No Basement Access							
C	Fire Stair with no Basement Access	1% AEP flood level	93.765	93.815	93.853	93.765	94	Floor level is compliant
D	Commercial Lobby with Basement Access	Greater Level of 1% AEP flood level + 0.5m freeboard and PMF	93.467	93.517	93.555	93.967	93.97	Floor level is compliant
E	Commercial Lobby with no Basement Access	1% AEP flood level	93.467	93.517	93.555	93.467	93.93	Floor level is compliant
F	Fire Stair with no Basement Access	1% AEP flood level	93.219	93.269	93.307	93.219	93.35	Floor level is compliant
G	Fire Stair with Basement Access	Greater Level of 1% AEP flood level + 0.5m freeboard and PMF	93.285	93.320	93.364	93.785	93.79	Floor level is compliant
H	Residential Lobby with Basement Access	Greater Level of 1% AEP flood level + 0.5m freeboard and PMF	93.136	93.171	93.215	93.636	93.77	Floor level is compliant
I	Fire Control Room	Greater Level of 1% AEP flood level + 0.5m freeboard and PMF	93.136	93.171	93.215	93.636	93.64	Floor level is compliant
J	Commercial Tenancy with no Basement Access	1% AEP flood level	93.044	93.079	93.123	93.044	93.25	Floor level is compliant
K	Gas Meter Room	1% AEP flood level + 0.5m freeboard	91.410	91.710	N/A	91.910	92.6	Floor level is compliant
L	Access way to Switch Room	1% AEP flood level + 0.5m freeboard	91.410	91.710	N/A	91.910	92.45	Floor level is compliant
M	Substation	1% AEP flood level + 0.5m freeboard	91.410	91.710	N/A	91.910	92.09	Floor level is compliant

N	Ramp to Basement Parking	Greater Level of 1% AEP flood level + 0.5m freeboard and PMF	91.400	91.570	93.540	91.900	91.91	PMF level is impractical, a dispensation for lower floor level is required for the basement access.

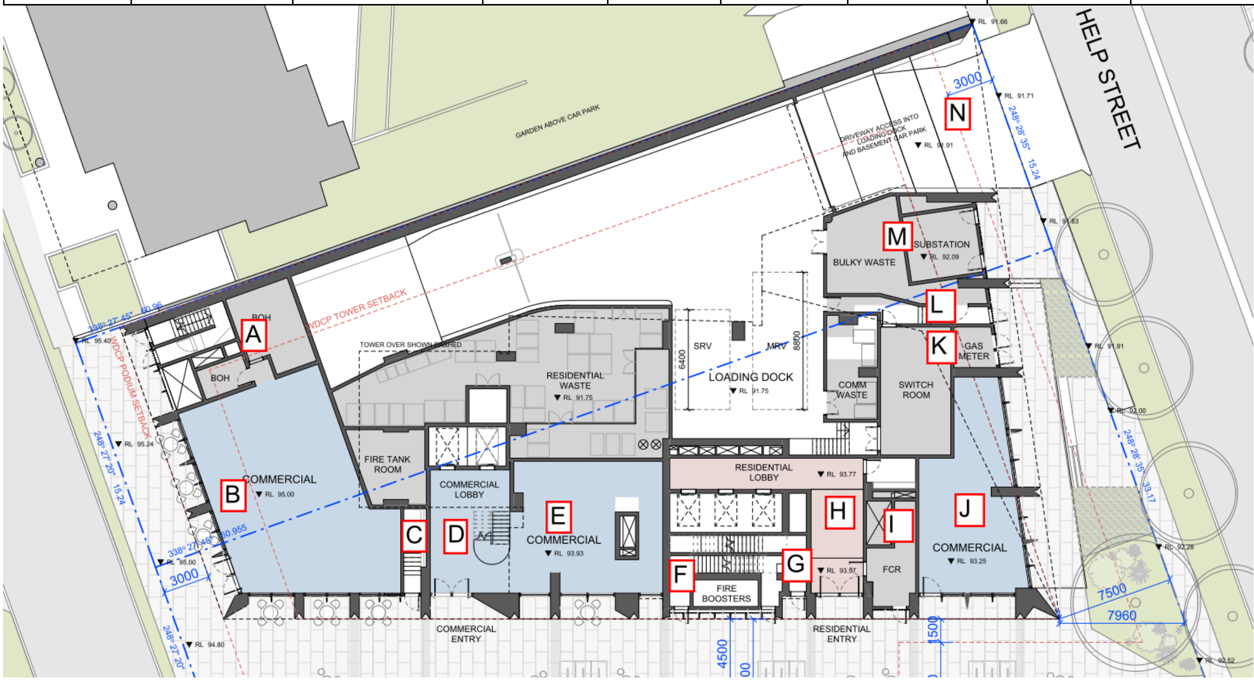

Figure 19: FPL Location Plan

8.3 Flood Impacts Assessment

The site is not classified as flood-prone land; however, due to its proximity to the trunk drainage line, an overland flow impact assessment was conducted using the DRAINS model. The assessment, including pipe and overflow sections, confirms that the existing drainage system and overflow path are not adversely affected by post-development flows or OSD attenuation. As a result, the development does not pose an increased risk to human life or damage to surrounding properties.

8.4 Flood Risk Management Measures and Flood Evacuation

The following measures have been implemented to minimize flood risk:

- An OSD tank is proposed to mitigate peak discharge, thereby reducing off-site impacts.
- Practical Flood Planning Levels (FPLs) have been incorporated into the design.
- Additional flood control measures, including appropriate building materials and structural integrity considerations, will be implemented to minimize risk in the event of a flood.

Due to the short flood duration and the upper level of the building being above the PMF level, a shelter-in-place strategy is recommended for the proposed building during a flood event.

9. Conclusion

The modelling undertaken for the pre-development and post development conditions demonstrate that there will be no negative impact on existing flooding levels, overland flow velocities and flood hazard as a result of the proposed development. All flows from the development are adequately conveyed through the existing stormwater drainage network, with the OSD tank improving downstream conditions.

The flood risk assessment required by SEARs has been completed, confirming that all SEARs flood requirements have been met.

Appendix A –Architectural Plan

Design with
community in mind

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For more information, please visit
www.stantec.com

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