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FLOOD STUDY FOR PROPOSED HIGHWAY SERVICE CENTRE DEVELOPMENT AT LOT 1, 27782 HUME HIGHWAY, BOWNING, NSW 2582

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1.0 INTRODUCTION

Richmond and Ross Pty Ltd, Consulting Engineers, have been engaged to carry out a flood study for the proposed highway service centre (HSC) on Lot 1, 27782 Hume Highway, Bowning, NSW, 2582. No responsibility to third parties under the law of contract, tort or otherwise for any loss or damage is accepted.

The purpose of this assessment is to provide advice with respect to flooding for the proposed HSC and the downstream farm dams. The results of this study are limited to this scope.

This assessment has been prepared by reviewing published topographic maps, physical land survey, hydraulic and hydrological calculations and available Ariel photography of the site.

This report is to be read in conjunction with Architectural and Stormwater concept plans: A100, A101, C100 and C101 as attached in the Appendix.

2.0 SITE LOCATION AND DESCRIPTION

The subject site is located at proposed Lot 1, 27782 Hume Highway, Bowning, NSW, 2582. The total area of the Lot is 19.63 Hectares (Ha) and is currently vacant and undeveloped. The lot generally slopes from the West to the East and is bounded by the Hume Highway to the South. Out of the 19.63Ha, approximately 5.2 Ha will be developed into the HSC. The existing site does not contain any impermeable areas.



Figure 1 Proposed Development Location

3.0 STUDY DATA

The following data has been processed in a Geographic Information System (GIS) software package and used in developing hydrologic and hydraulic models for this study:

- Architectural plans
- Existing ground survey (Ariel LiDAR survey of whole catchment and peg-out survey within property boundary)
- Civil drawings for proposed ground levels
- Ariel imagery

4.0 DEVELOPMENT PROPOSAL

It is proposed to construct a new highway service centre on part of Lot 1, 27782 Hume Highway. The development proposes two fuel canopies with a combined area of approximately 1530m² and a building with a floor area of approximately 2100m². The building will include a retail area, dining area, a playground and an amenities area for the drivers.

5.0 HYDRAULIC MODELLING

A hydraulic model of the catchment was created in DRAINS (Stormwater drainage system design and analysis program) to assess the impact of the development on the peak discharge at the downstream farm dam. As a result, discharge rates from the whole catchment pre and post development have been established.

5.1 Model Detail and Extent

The catchment was subdivided into sub catchments as shown in Fig 2. A number of assumptions were made when creating the DRAINS model. These are:

- Three major farm dams within the catchment were modelled. The remaining smaller farm dams are assumed to have a negligible impact on the discharge volume from the catchment and therefore not modelled. The areas and elevations of the three major farm dams are estimated from Ariel and Topographic imagery.
- The outlet farm dam is assumed to have a 5m long outlet overflow weir and the other two farm dams (Those in sub-catchments A2 and D3) are assumed to have a 2.5m overflow weir.

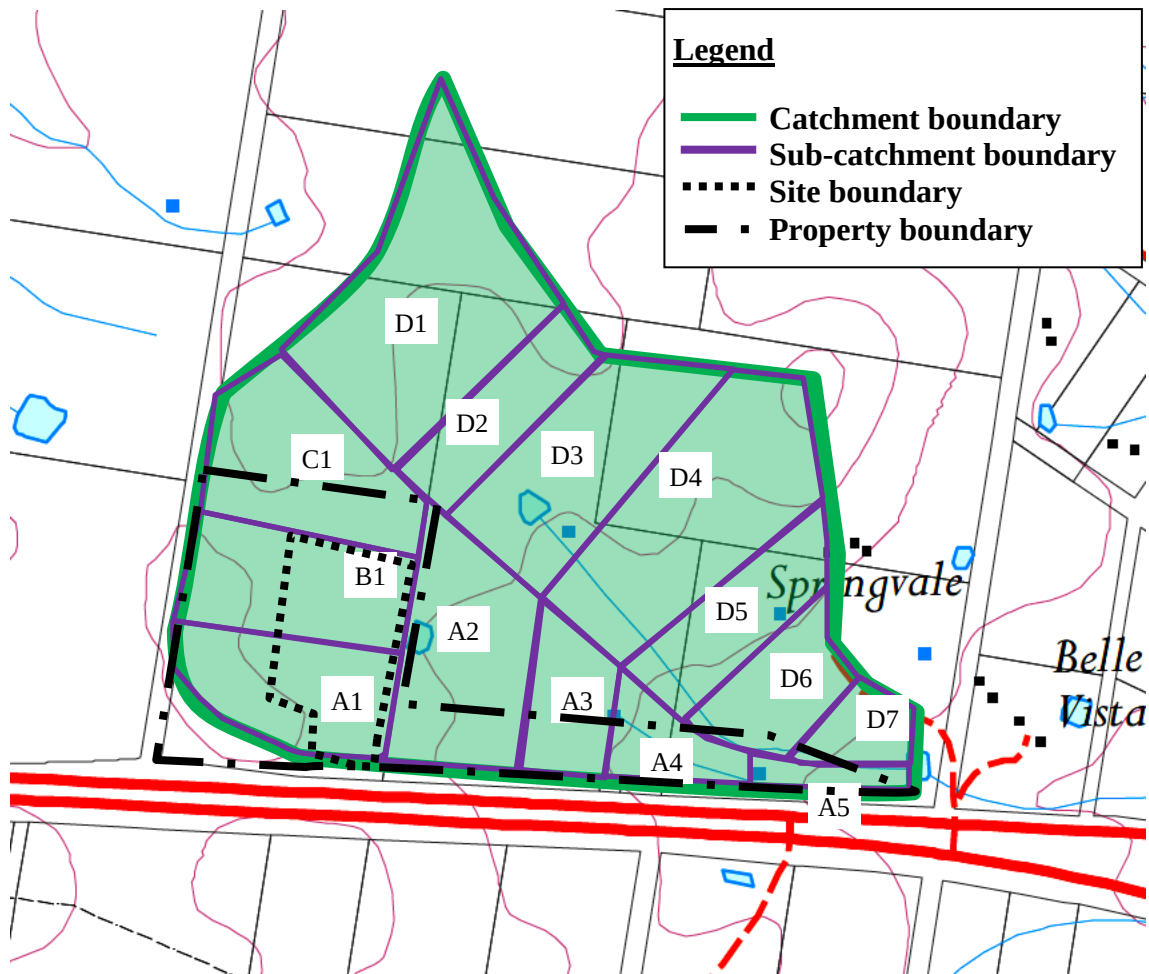


Figure 2 Sub-Catchment Identification

5.2 Pre-Development Conditions Modelling

A hydraulic model was prepared in DRAINS for the pre-development conditions as shown in Figure 4 which also includes the resulting peak flows.

The results of the model show a peak flow of approximately $3.62\text{m}^3/\text{s}$ at the outlet farm dam.

5.3 Post Development Conditions Modelling

A hydraulic model was prepared in DRAINS for the post development conditions as shown in Figure 5 which also includes the resulting peak flows. The results of the model show a peak flow of approximately $3.78\text{m}^3/\text{s}$ at the outlet farm dam.

5.4 Impact of the Development

The results of the model were assessed and the size of the proposed detention basin adjusted accordingly in order to minimize the increase in peak flows while keeping the detention basin at a reasonable size. The results show a negligible increase in post development peak flows of $0.16\text{m}^3/\text{s}$ (4.42%).

6.0 HYDROLOGIC MODELLING

A hydrologic model of the development was prepared and analyzed in TUFLOW to determine the flood affectation within the catchment of which the site is a part. The catchment was assessed for a 100 year Average Recurrence Interval (ARI) storm event.

6.1 Model Detail and Extent

The model is based on a 2m x 2m grid to ensure sufficient detail in the model while maintaining reasonable model runtimes. TUFLOW build 2017-09-AC-iDP-w64 was used in this flood study. The extent of the TUFLOW model is the catchment of the downstream farm dam as shown in Appendix C.

6.2 Pre-Development Conditions Modelling

The model was run for the 100 year ARI 90 min storm, which is considered to be the critical storm event for the catchment. The pre-development model results are presented in Appendix C:

The max pre-development flow depth in the whole catchment is roughly 0.5m (ignoring the depths within the farm dams) whereas the max depth within the site boundary pre-development is 0.1m.

The max pre-development flow velocity in the whole catchment is between 1.3 and 1.5m/s whereas the max velocity within the site boundary pre-development is between 0.7 and 0.9m/s.

According to Australian Rainfall and Runoff Book 9, Chapter 5, Section 5.6.2, “The product of depth and velocity ($dg.V$), with V being the average velocity and dg the depth, should not exceed $0.4 \text{ m}^2/\text{s}$ for safety of pedestrians, 0.6 to $0.7 \text{ m}^2/\text{s}$ for stability of parked vehicles (depending on size), or as directed by the consent authority.” Therefore, TUFLOW was used to directly output the depth/velocity product for the catchment pre development. Refer to Appendix C.

The NSW Floodplain Development Manual (NSW FDM 2005) assess flood hazard as a combination of the flow velocity and depth.

NSW FDM describes the hazard categories as follows:

- High Hazard – Possible danger to personnel safety; evacuation by trucks difficult; able-bodied adults would have difficulty in wading to safety; potential for significant structural damage.
- Low Hazard – Should it be necessary, truck could evacuate people and their possession; able-bodied adults would have little difficulty in wading to safety.

TUFLOW was used to directly output the provisional hazard for the catchment pre development. Refer to Appendix C.

6.3 Post-Development Conditions Modelling

The proposed ground level of the proposed development was added into the model. The main building within the site was represented in the model by raising the elevation of that part of land by approximately 5m above ground level.

Based on the pre-development modelling conditions, the post-development model was also run for a 100 year ARI 90 minute storm. The post development model results are presented in Appendix C.

The max post-development flow depth in the whole catchment is roughly 0.5m (ignoring the depths within the farm dams) whereas the max depth within the site boundary post-development is 0.1m.

The max post-development flow velocity in the whole catchment is between 1.3 and 1.5m/s whereas the max velocity within the site boundary pre-development is between 0.7 and 0.9m/s.

Similar to pre development conditions modelling, the depth.velocity product and provisional hazard for post development conditions were also output directly from TUFLOW.

6.4 Impact of the Development

The impact of the development is determined by finding the difference in the results layers obtained from TUFLOW for the pre and post development conditions. Refer to Appendix C for these layers.

The change in floodwater depths is shown In Figure C10. The proposed HSC development results in a maximum increase in floodwater depths downstream of approximately 0.025m. Figure C10 shows higher depths around the site boundary however this is due to the presence of stormwater cutoff/diversion swales and this is as expected.

The change in the depth.velocity product is shown in Figure C12. The proposed HSC development results in a maximum increase in the depth.velocity product of 0.1m²/s.

The change in floodwater velocities is shown in Figure C11. The proposed HSC development results in a maximum increase in floodwater velocities of 0.3m/s (25%) above the existing velocity of 1.2m/s. (ignoring the higher velocity increase within the cutoff/diversion swales). As shown in Figure 3 below, silt has an approximate erosion velocity of 30-80cm/s (0.3-0.8m/s). We therefore propose lining the farm dam embankments with a geo fabric for scour protection so as to reduce the impact of the proposed HSC.

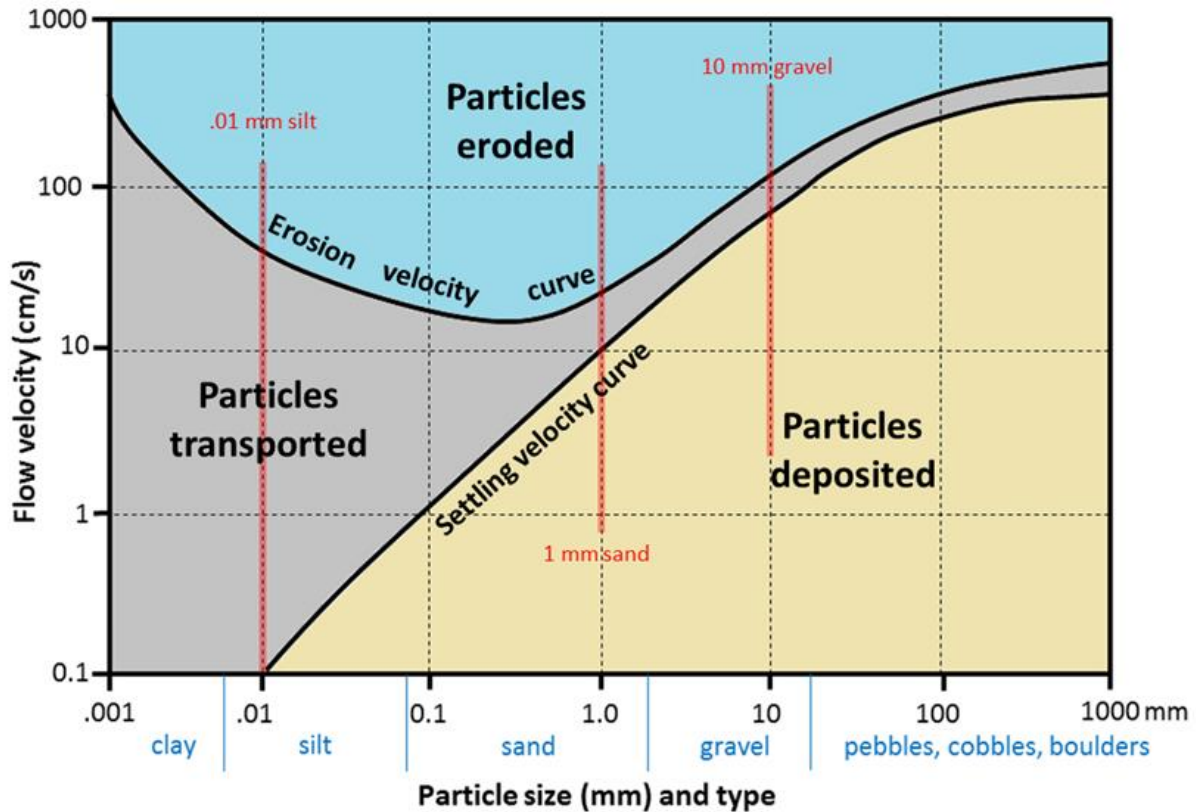


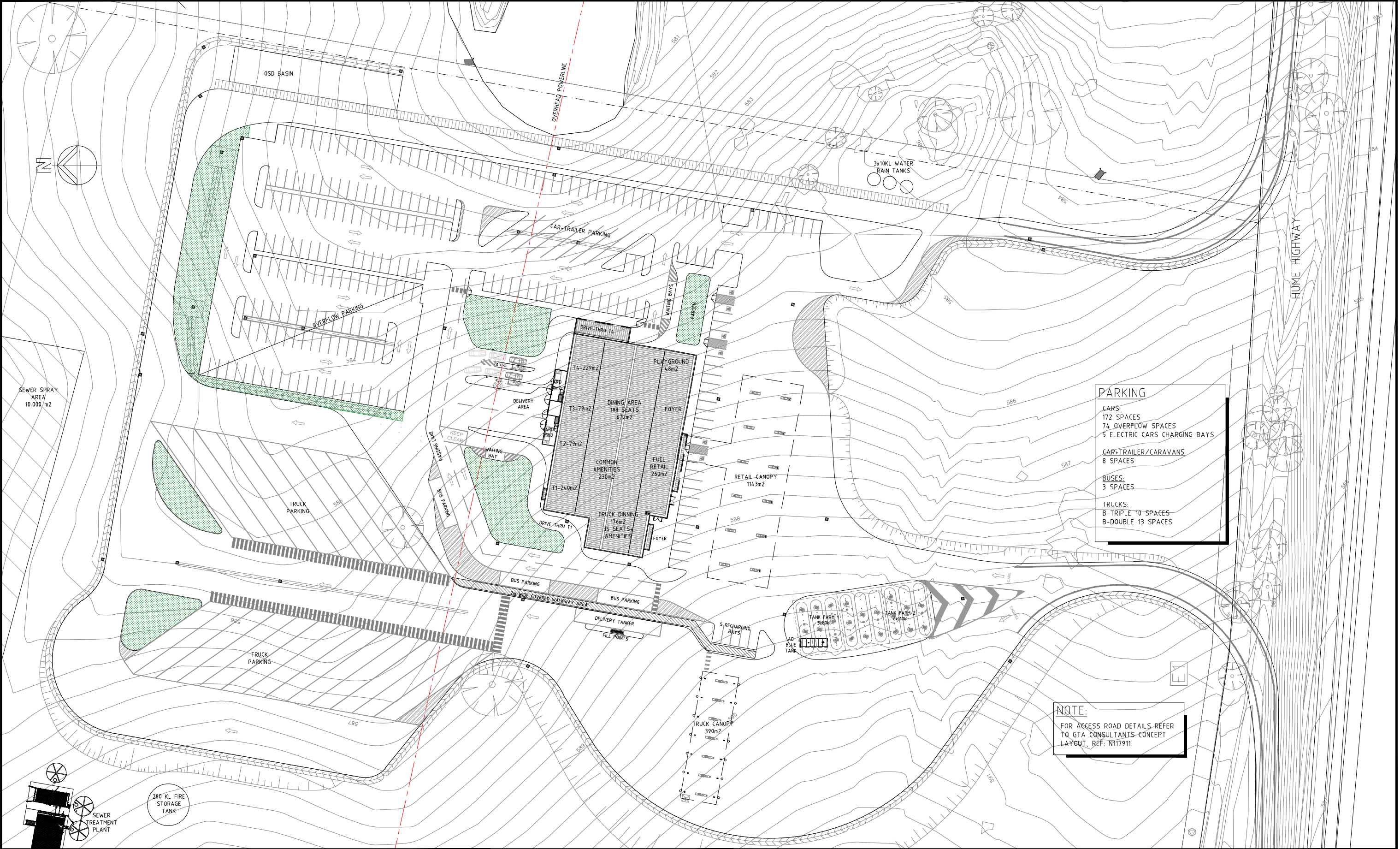
Figure 3 Hjulström curve

7.0 CONCLUSION

The proposed highway service centre at Lot 1, 27782 Hume Highway, Bowning was assessed for flood impact on surrounding areas by preparing hydraulic and hydrologic models. Both hydraulic and hydrologic modelling has confirmed that the proposed HSC development will have a negligible effect on the existing conditions. We propose a geofabric lining for the farm dam embankments so as to improve on the scour protection from the existing conditions.

In conclusion, we have assessed that the HSC as proposed will not alter the flood levels on adjoining allotments and will provide the required level of flood safety for the development.

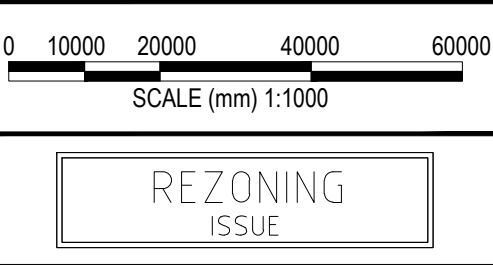
APPENDIX A – Site Plan



PARKING	
CARS:	
172 SPACES	
74 OVERFLOW SPACES	
5 ELECTRIC CARS CHARGING BAYS	
CAR-TRAILER/CARAVANS	
8 SPACES	
BUSES:	
3 SPACES	
TRUCKS:	
B-TRIPLE 10 SPACES	
B-DOUBLE 13 SPACES	

NOTE:
FOR ACCESS ROAD DETAILS REFER
TO GTA CONSULTANTS CONCEPT
LAYOUT, REF: N117911

REV No.	COMMENTS	DATE	INIT.
F	SURVEY ADDED, BUILDING RELOCATED CLEAR FROM POWER LINES	16.09.16	DM
G	ENTRY LAYOUT REVISED	17.11.16	SK
H	REVISED SITE PLAN - UPDATED SLIP LANE	23.01.17	DM
I	REZONING ISSUE	14.02.17	DM
J	REVISED REZONING ISSUE	27.03.18	DM
K	REVISED REZONING ISSUE	25.05.18	DM
L	REVISED REZONING ISSUE	04.06.18	DM
M	ISSUE FOR REZONING APPROVAL	10.07.18	DM



PROJECT:
HIGHWAY SERVICE CENTRE
BOWNING, NSW

CLIENT:

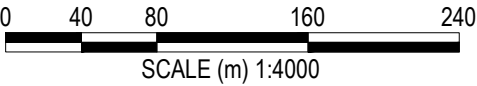
Richmond+Ross PTY LIMITED
ABN 34 001 485 436

CONSULTING ENGINEERS
38 WILLOUGHBY ROAD,
CROWS NEST, NSW 2065
TEL : (02) 9490 9600
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PROPOSED SITE PLAN		
DATE:	MAY 2016	DRG.No.
SCALE:	1:1000 @ A3	A100
JOB No.	160173	REV M



REV No.	COMMENTS	DATE	INIT.
A	CIRCULATION ISSUE	16.09.16	DM
B	CIRCULATION ISSUE	17.11.16	SK
C	REVISED CIRCULATION ISSUE - SLIP LANE REVISED	23.01.17	DM
D	REZONING ISSUE	14.02.17	DM
E	REVISED REZONING ISSUE	27.03.18	DM
F	REVISED REZONING ISSUE	25.05.18	DM
G	ISSUE FOR REZONING APPROVAL	10.07.18	DM



REZONING
ISSUE

PROJECT:
HIGHWAY SERVICE CENTRE
BOWNING, NSW

CLIENT:

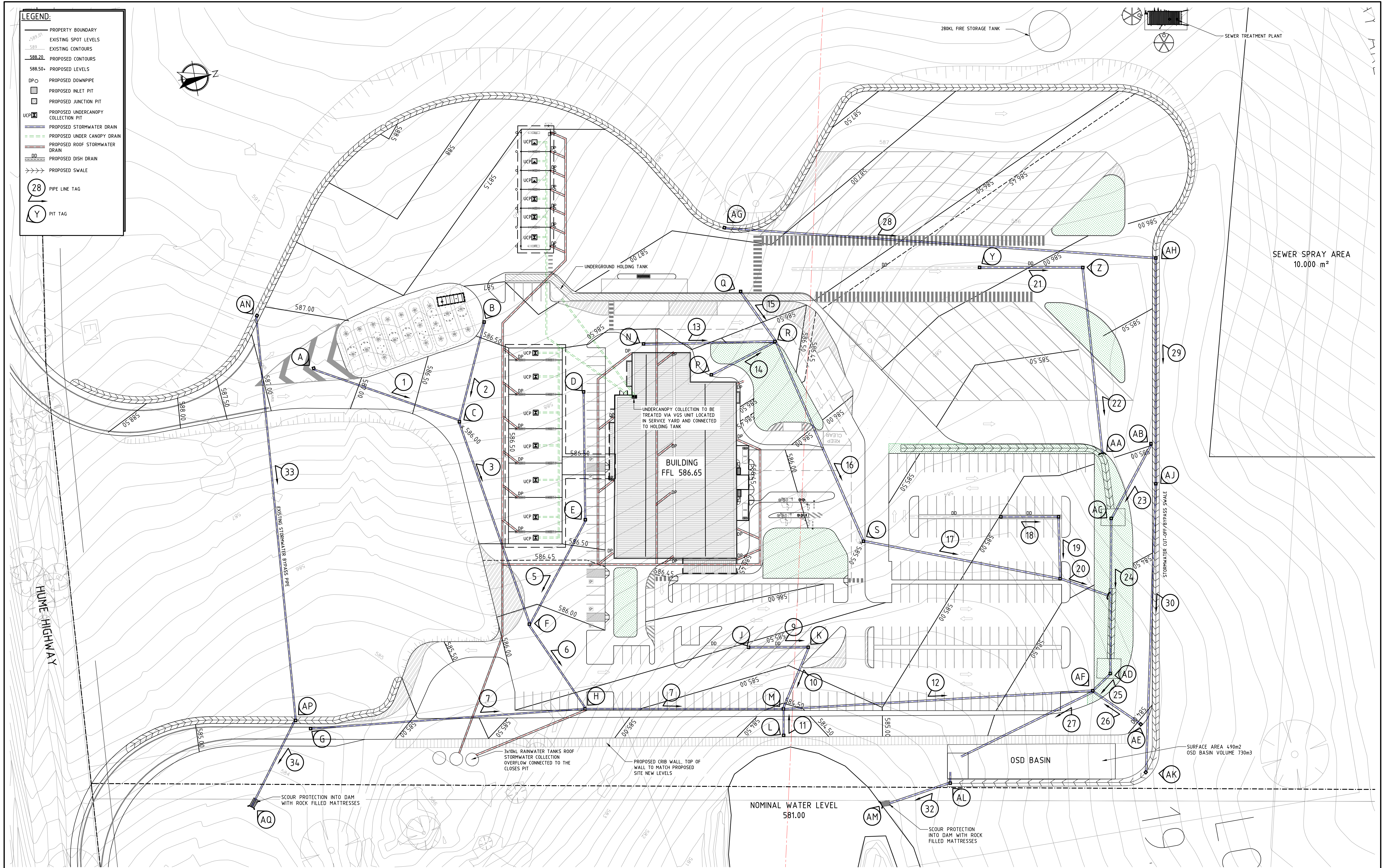
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CONSULTING ENGINEERS
38 WILLOUGHBY ROAD,
CROWS NEST, NSW 2065
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OVERALL SITE PLAN		
DATE:	SEPT 2016	DRG.No.
SCALE:	1:4000 @ A3	A101
JOB No.	160173	REV. G

LEGEND:

- PROPERTY BOUNDARY
- EXISTING SPOT LEVELS
- EXISTING CONTOURS
- 588.20 PROPOSED CONTOURS
- 588.50+ PROPOSED LEVELS
- DP O PROPOSED DOWNPIPE
- PROPOSED INLET PIT
- PROPOSED JUNCTION PIT
- UCP X PROPOSED UNDERCANOPY COLLECTION PIT
- PROPOSED STORMWATER DRAIN
- PROPOSED UNDER CANOPY DRAIN
- PROPOSED ROOF STORMWATER DRAIN
- PROPOSED DISH DRAIN
- PROPOSED SWALE
- 28 PIPE LINE TAG
- Y PIT TAG



REV No.	COMMENTS	DATE	INIT.
A	ISSUE FOR REZONING APPROVAL	10.07.18	DM

PROJECT:
HIGHWAY SERVICE CENTRE
BOWNING, NSW

CLIENT:
-

Richmond+Ross PTY LIMITED
CONSULTING ENGINEERS
ABN 34 001 485 438

38 WILLOUGHBY ROAD,
CROWS NEST, NSW 2065
TEL : (02) 9490 9600
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**PROPOSED STORMWATER
CONCEPT PLAN**

DATE:	JULY 2018	DRG.No.
SCALE:	1:500 @ A1	C100
JOB No.	160173	REV A

**REZONING
ISSUE**

STORMWATER NOTES

1. THIS IS A STORMWATER DRAINAGE PLAN ONLY. REFER TO ARCHITECTURAL DRAWINGS FOR ALL SETOUT INFORMATION.
2. ALL DRAINAGE LAYOUTS, LEVELS & DETAILS ARE DIAGRAMMATIC AND INDICATIVE ONLY. NOTE ONLY MAJOR LINES ARE SHOWN.
3. ALL PIPES TO BE 150 DIA UPVC LAID AT 1.0% MIN GRADE. UPVC PIPES TO BE SOLVENT WELDED JOINTS U.N.O.
4. ALL PITS AND COVERS TO PROPRIETARY PRECAST ITEMS, COVER LEVELS TO MATCH SURFACE U.N.O.
5. ALL GRATED DRAINS TO HAVE BASE GRADED 1.0% MIN WITH HEAVY DUTY GRATES.
6. IT IS THE BUILDERS RESPONSIBILITY TO LAY ALL PIPES IN ACCORDANCE WITH ALL RELEVANT AUTHORITY REQUIREMENTS (EG. COUNCIL, EPA, SYDNEY WATER).
7. CONTRACTOR SHALL LOCATE EXISTING SERVICES ON SITE PRIOR TO CONSTRUCTION AND SHALL TAKE EXTREME CAUTION DURING CONSTRUCTION.

STORMWATER DISPOSAL PHILOSOPHY

1. COLLECT ALL SITE RUNOFF FROM SURFACE GRADES, SUMPS AND UNDERGROUND DRAINS AND DISCHARGE TO EXISTING STORMWATER SYSTEM.

FLOW CALCULATIONS

USING FORMULA $Q = 0.00028 CAI$

WHERE Q = DISCHARGE IN LITRES PER SECOND
 C = A RUNOFF COEFFICIENT (SEE TABLE)
 A = CATCHMENT AREA IN SQ.M.
 I = RAINFALL INTENSITY IN MILLIMETRES PER HOUR
 $100 I$ = 196mm/HR FOR 100 YEAR RETURN PERIOD 5 MINUTE DURATION STORM

FLOW CALCULATION SCHEDULE

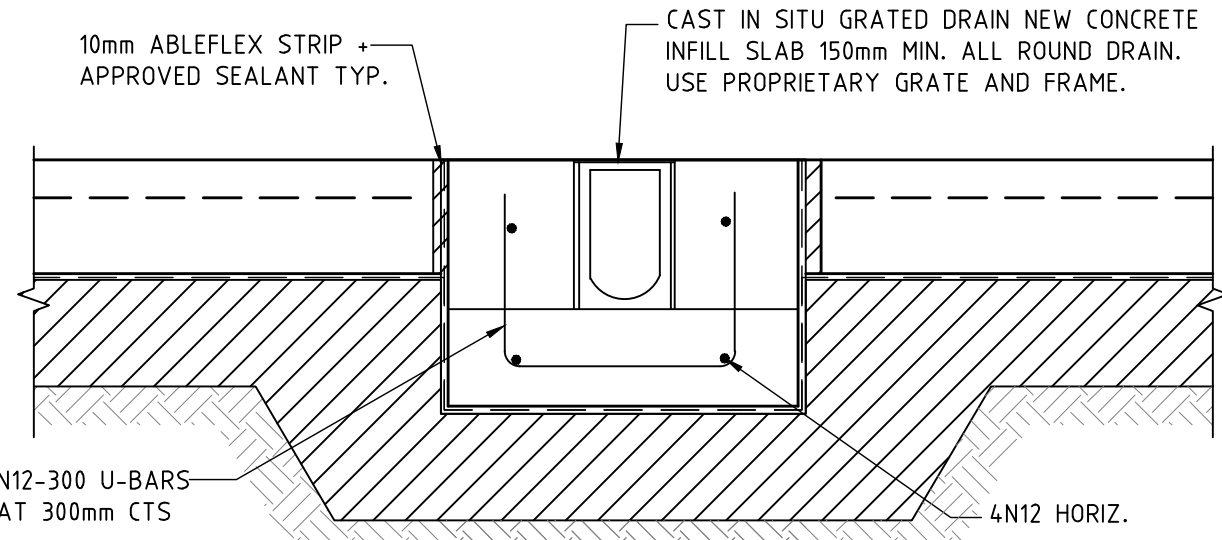
LINE	CATCHMENT AREA (SQM) (OVERLAND FLOWS)			FLOW INTO LINE FROM CATCHMENT (L/S)			TOTAL FLOW (L/S)	MINIMUM PIPE REQUIREMENT			
	ROOF	PAVE'T	L'SCAPE	ROOF C=1.00	PAVEMENT C=0.95	LANDSCAPE C=0.65		SIZE (mm)	GRADE (MIN)	CAPACITY (L/S)	
1		3000			155.29		155.29	375	1.93	207.54	
2		1935			100.16		100.16	300	1.98	112.22	
3		2341			121.18		121.18	525	1.86	523.27	
4		852			44.10		44.10	225	1.79	58.51	
5		353			18.27		62.38	300	1.86	119.87	
6							439.01	525	1.66	597.83	
7		1090			56.42		56.42	300	1.178	82.97	
8	3180	14.86		173.27	76.92		76.92	675	1.148	770.26	
9		528			27.33		27.33	225	1.77	59.27	
10		381			19.72		47.05	225	1.51	72.98	
11		920			47.62		47.62	225	1.70	62.20	
12		2130	14.0		110.26	4.96	955.51	750	1.103	1218.80	
13		501			25.93		25.93	225	1.114	48.60	
14		260			13.46		13.46	150	1.100	17.73	
15		2288			118.44		118.44	450	1.66	398.64	
16		435	150		22.52	5.31	185.66	450	1.66	398.64	
17		1615	570		83.60	20.19	289.44	525	1.81	539.29	
18		452			23.40		23.40	150	1.52	24.69	
19		515			26.66		50.06	225	1.95	53.30	
20		1124			58.18		397.68	600	1.136	589.97	
21		1765			91.36		91.36	300	1.88	118.49	
22		2265			117.24		208.61	375	1.61	256.69	
23		1731	44.0		89.60	15.58	105.19	300	1.54	151.58	
24		4105	200		212.49	7.08	533.37	600	1.70	824.20	
25			650			23.02	954.07	750	1.102	1224.79	
26		1215			62.89		62.89	225	1.61	66.68	
27		2785			144.16		2116.64	1200	1.240	2727.11	
28							139.00	375	1.87	214.64	
29							298.00	450	1.61	414.76	
30							497.00	525	1.82	535.97	
31							696.00	600	1.72	812.60	
32							2812.64	900	1.56	2669.30	
33							123.00	375	1.103	197.12	
34							253.00	525	1.175	365.75	

LINE SCHEDULE

TAG	UPSTREAM INVERT	SIZE Ø (mm)	MATERIAL	LENGTH (m)	GRADE (ACTUAL)	DOWN-STREAM INVERT
1	585.66	375	CONCRETE	45.60	1.93	585.17
2	585.47	300	UPVC	29.40	1.98	585.17
3	585.02	525	CONCRETE	62.00	1.86	584.30
4	585.37	225	UPVC	37.20	1.79	584.90
5	584.70	300	CONCRETE	34.40	1.86	584.30
6	584.05	525	CONCRETE	29.50	1.66	583.60
7	583.75	300	CONCRETE	80.00	1.178	583.30
8	583.30	675	CONCRETE	57.70	1.148	582.91
9	584.20	225	UPVC	14.70	1.77	584.01
10	583.71	225	UPVC	20.80	1.51	583.30
11	583.20	225	UPVC	7.70	1.70	583.09
12	582.91	750	CONCRETE	83.50	1.103	582.10
13	585.72	225	UPVC	38.60	1.114	585.38
14	585.59	150	UPVC	20.90	1.100	585.38
15	585.75	450	CONCRETE	24.40	1.66	585.38
16	585.38	450	CONCRETE	63.20	1.66	584.42
17	584.42	525	CONCRETE	58.80	1.81	583.69
18	584.20	150	UPVC	16.70	1.52	583.88
19	583.88	225	UPVC	18.00	1.95	583.69
20	583.69	600	CONCRETE	15.00	1.136	583.58
21	585.38	300	UPVC	30.00	1.88	585.04
22	585.04	375	CONCRETE	57.00	1.61	584.10
23	583.80	300	UPVC	24.20	1.54	583.35
24	583.20	600	CONCRETE	45.80	1.70	582.55
25	582.47	750	CONCRETE	12.30	1.102	582.35
26	582.62	225	UPVC	16.50	1.61	582.35
27	582.10	1200	CONCRETE	24.00	1.240	582.00
28	586.16	375	CONCRETE	125.80	1.87	584.72
29	584.72	450	CONCRETE	65.70	1.61	583.65
30	583.65	600	CONCRETE	78.20	1.82	582.70
31	582.40	525	CONCRETE	35.80	1.72	581.90
32	581.90	900	CONCRETE	50.00	1.56	581.00
33	585.10	375	CONCRETE	118.30	1.103	583.95
34	583.95	525	CONCRETE	35.00	1.175	583.75

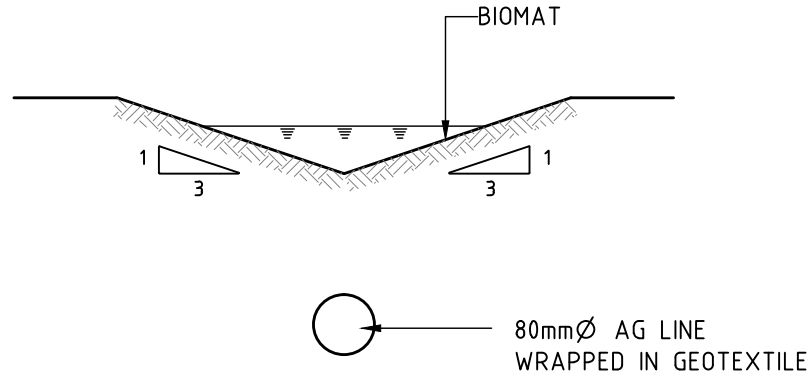
PIT SCHEDULE

TAG	TYPE	SIZE	RL TOP	IL	COVER	NOTES
A	INLET	900x900	584.50	585.66	CLASS D GRATE	
B	INLET	600x900	584.66	585.47	CLASS D GRATE	
C	INLET	600x900	584.00	585.02	CLASS D GRATE	BACKDROP PIT
D	INLET	600x600	584.25	585.37	CLASS D GRATE	
E	INLET	900x900	584.25	584.70	CLASS D GRATE	BACKDROP PIT
F	JUNCTION PIT	900x900	585.93	584.05	CLASS D SEALED LID	BACKDROP PIT
G	INLET	600x600	584.50	583.75	CLASS D GRATE	
H	INLET	900x900	585.30	583.30	CLASS D GRATE	BACKDROP PIT
J	INLET	900x900	585.42	584.20	CLASS D GRATE	
K	INLET	900x900	585.25	583.71	CLASS D GRATE	BACKDROP PIT
L	INLET	600x900	584.25	583.20	CLASS D GRATE	
M	INLET	900x900	584.42	582.91	CLASS D GRATE	BACKDROP PIT
N	INLET	600x600	586.40	585.72	CLASS D GRATE	
P	INLET	600x600	586.40	585.59	CLASS D GRATE	
Q	INLET	600x600	586.65	585.75	CLASS D GRATE	
R	INLET	600x900	586.35	585.38	CLASS D GRATE	
S	INLET	600x900	585.50	584.42	CLASS D GRATE	
T	INLET	600x600	585.00	584.20	CLASS D GRATE	
U	INLET	600x900	584.84	583.88	CLASS D GRATE	
V	INLET	600x600	584.59	583.69	CLASS D GRATE	BACKDROP PIT
W	HEADWALL	Enter RL		583.58		
Y	INLET	600x600	586.13	585.38	CLASS D GRATE	
Z	INLET	600x600	585.87	585.04	CLASS D GRATE	
AA	HEADWALL	Enter RL		584.10		
AB	INLET	900x900	585.00	583.80	CLASS D GRATE	
AC	INLET	600x600	584.10	583.20	CLASS D GRATE	BACKDROP PIT
AD	INLET	600x900	583.62	582.47	CLASS D GRATE	BACKDROP PIT
AE	INLET	900x900	583.99	582.62	CLASS D GRATE	
AF	INLET	900x900	584.19	582.00	CLASS D GRATE	
AG	INLET	600x600	587.00	586.16	CLASS D GRATE	
AH	INLET	600x600	585.55	584.72	CLASS D GRATE	
AJ	INLET	600x600	584.55	583.65	CLASS D GRATE	
AK	INLET	900x900	583.70	582.40	CLASS D GRATE	BACKDROP PIT
AL	INLET	600x900	583.00	581.90	CLASS D GRATE	
AM	HEADWALL	Enter RL		581.00		
AN	INLET	900x900	586.60	585.10	CLASS D GRATE	
AP	INLET	450x450	584.30	583.95	CLASS D GRATE	
AQ	HEADWALL	Enter RL		583.75		



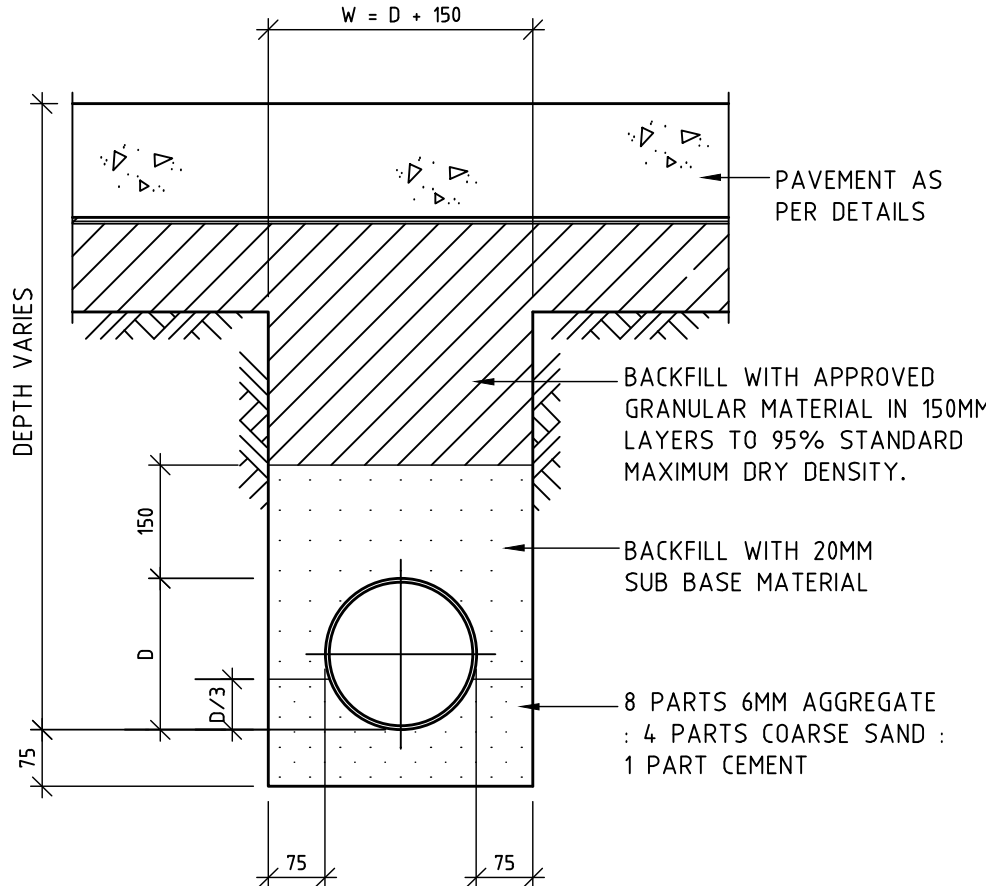
TYPICAL GRATED DRAIN DETAIL

GRATINGS TO BE HEELGUARD D.I. ADJACENT TO CANOPIES AND WALKWAYS & EXTRA HEAVY DUTY SLOTTED D.I. TO ROAD RESERVE CROSSOVER. PROVIDE LOCK DOWNS AS SPECIFIED BY MANUFACTURER. ALONG WITH RUBBER GASKETS TO GRATINGS.



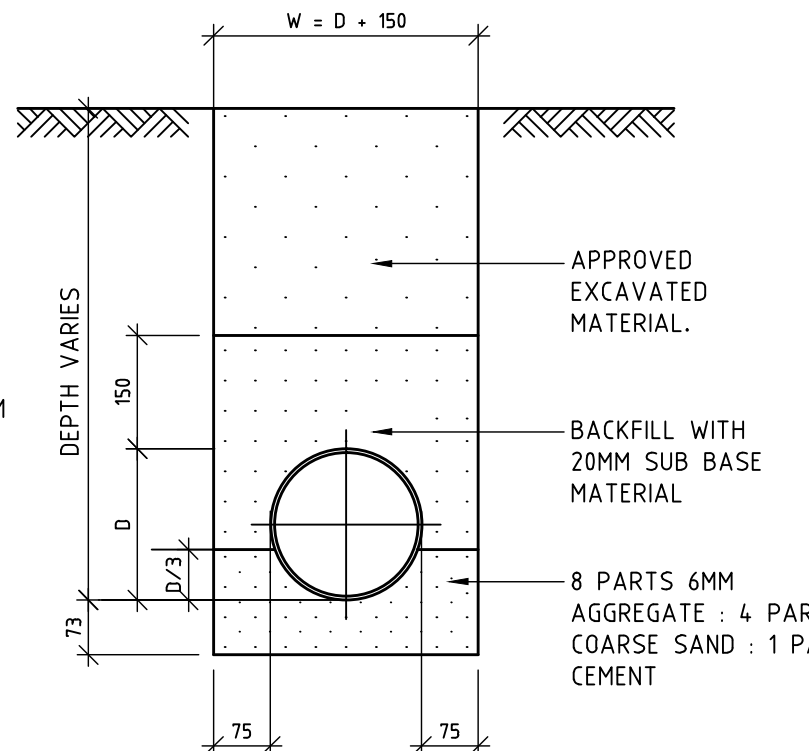
SWALE/AG DRAIN

MIN GRADE 1%
SCALE 1:10



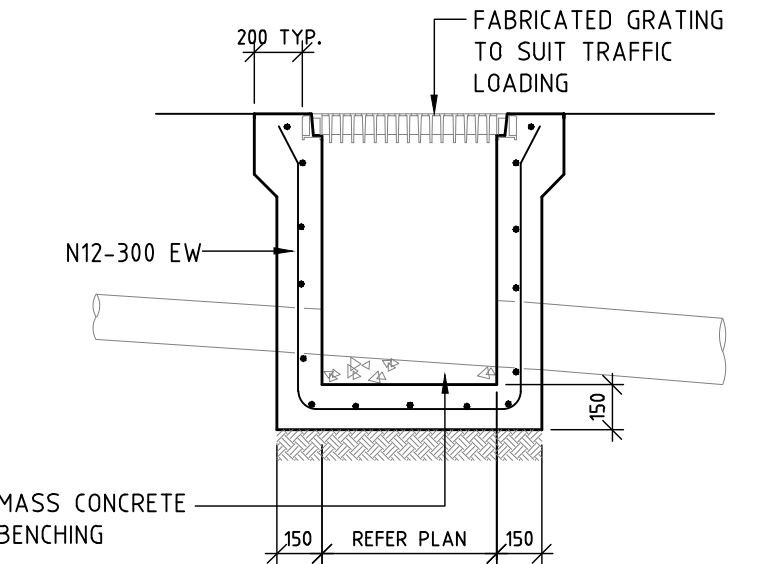
STORMWATER PIPE BEDDING DETAIL

SCALE 1:10



STORMWATER PIPE BEDDING DETAIL UNDER GROUND

SCALE 1:10



TYPICAL CONCRETE STORMWATER DRAINAGE PIT

SCALE 1:25

REV No.	COMMENTS	DATE	INIT.
A	ISSUE FOR REZONING APPROVAL	10.07.18	DM

PROJECT:
HIGHWAY SERVICE CENTRE
BOWNING, NSW

CLIENT:
-

Richmond+Ross PTY LIMITED
CONSULTING ENGINEERS
ABN 34 001 485 436

38 WILLOUGHBY ROAD,
CROWS NEST, NSW 2065
TEL : (02) 9490 9600
FAX : (02) 9438 1224

PROPOSED STORMWATER
DETAILS AND SCHEDULES

DATE: JULY 2018
SCALE: AS SHOWN @ A1
JOB No. 160173
DRG.No. C101
REV A

REZONING
ISSUE

APPENDIX B – DRAINS Model Results

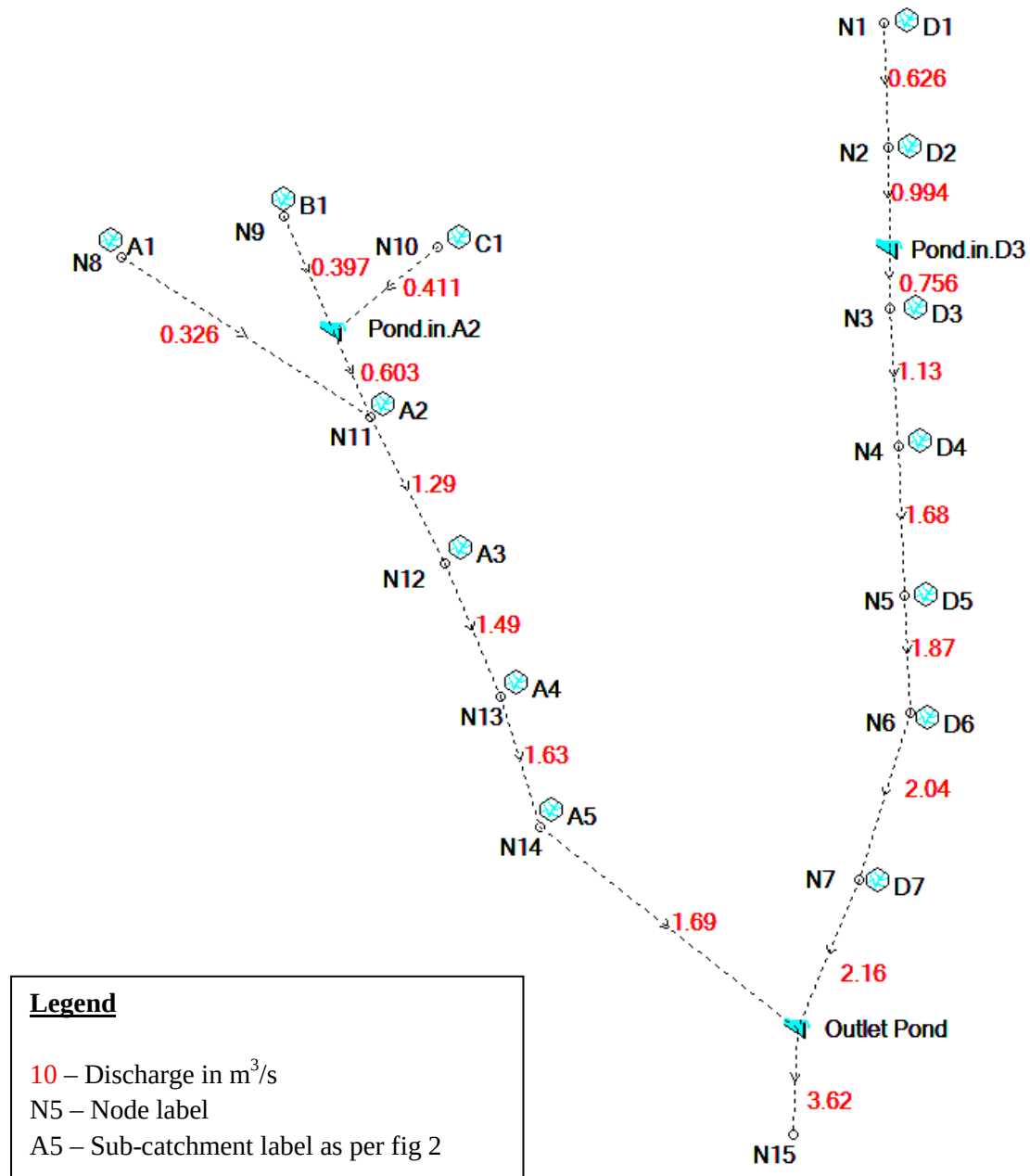


Figure 4 Pre-Development DRAINS Model and Output

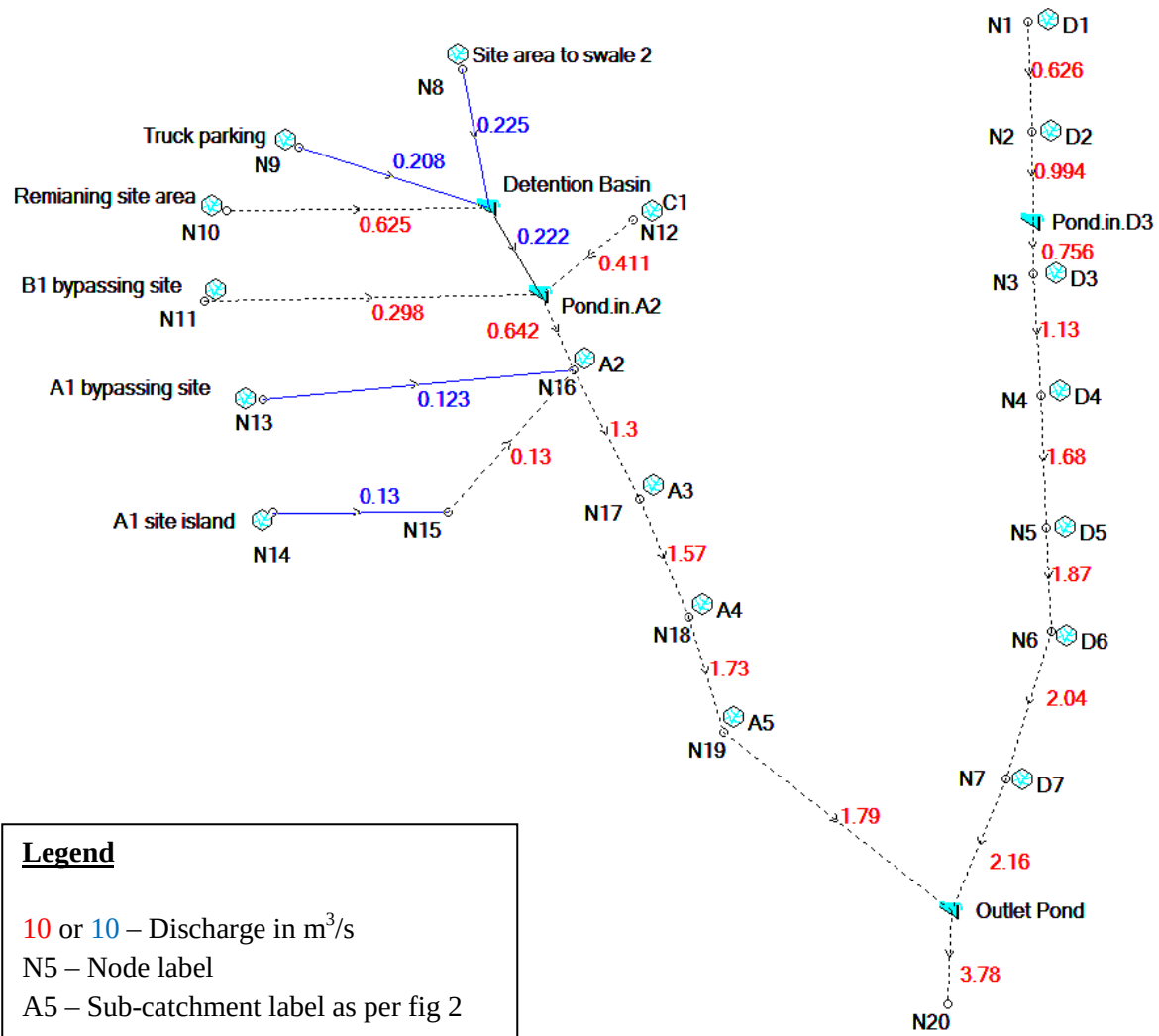


Figure 5 Post-Development DRAINS Model and Output

APPENDIX C – TUFLOW Model Results

Figure C1 – Extent of TUFLOW Model

Figure C2 – Pre development flow depths for 1 in 100 Yr ARI storm event

Figure C3 – Pre development flow velocities for 1 in 100 Yr ARI storm event

Figure C4 – Pre development depth.velocity product for 1 in 100 Yr ARI storm event

Figure C5 – Pre development provisional flood hazard for 1 in 100 Yr ARI storm event

Figure C6 – Post development flow depths for 1 in 100 Yr ARI storm event

Figure C7 – Post development flow velocities for 1 in 100 Yr ARI storm event

Figure C8 – Post development depth.velocity product for 1 in 100 Yr ARI storm event

Figure C9 – Post development provisional flood hazard for 1 in 100 Yr ARI storm event

Figure C10 – Change in floodwater depths post development for 1 in 100 Yr ARI storm event

Figure C11 – Change in floodwater velocities post development for 1 in 100 Yr ARI storm event

Figure C12 – Change in depth.velocity product post development for 1 in 100 Yr ARI storm event

Legend

 TUFLOW Model Extent
 Site Boundary



**Figure C1:
TUFLOW Model Extent**



Scale 1:5000 @ A3



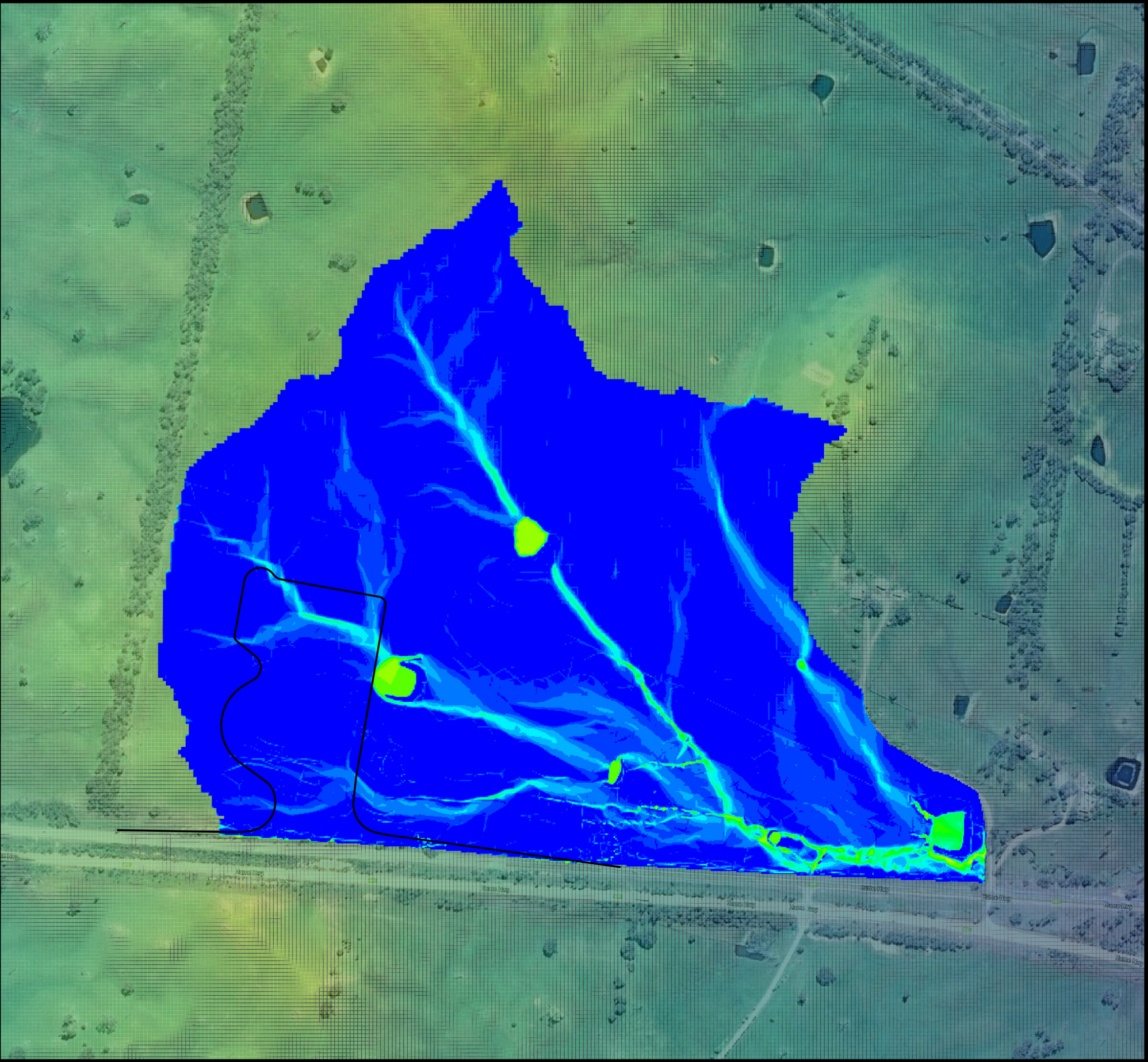
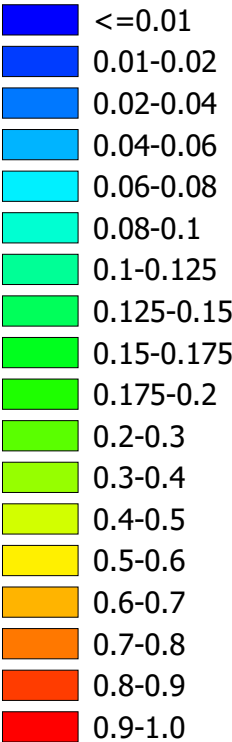
Prepared By:

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Legend

— Site Boundary

Pre Dev 1% AEP Floodwater Depths



**Figure C2:
Pre Dev
1% AEP Floodwater Depths**



Scale 1:5000 @ A3

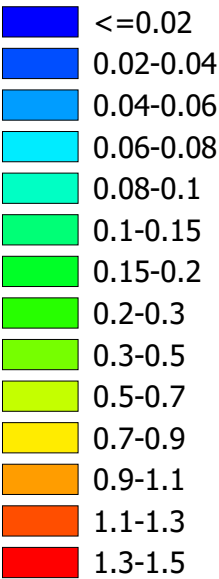


Prepared By:

Legend

— Site Boundary

Pre Dev 1% AEP Floodwater Velocities



**Figure C3:
Pre Dev
1% AEP Floodwater Velocities**



Scale 1:5000 @ A3



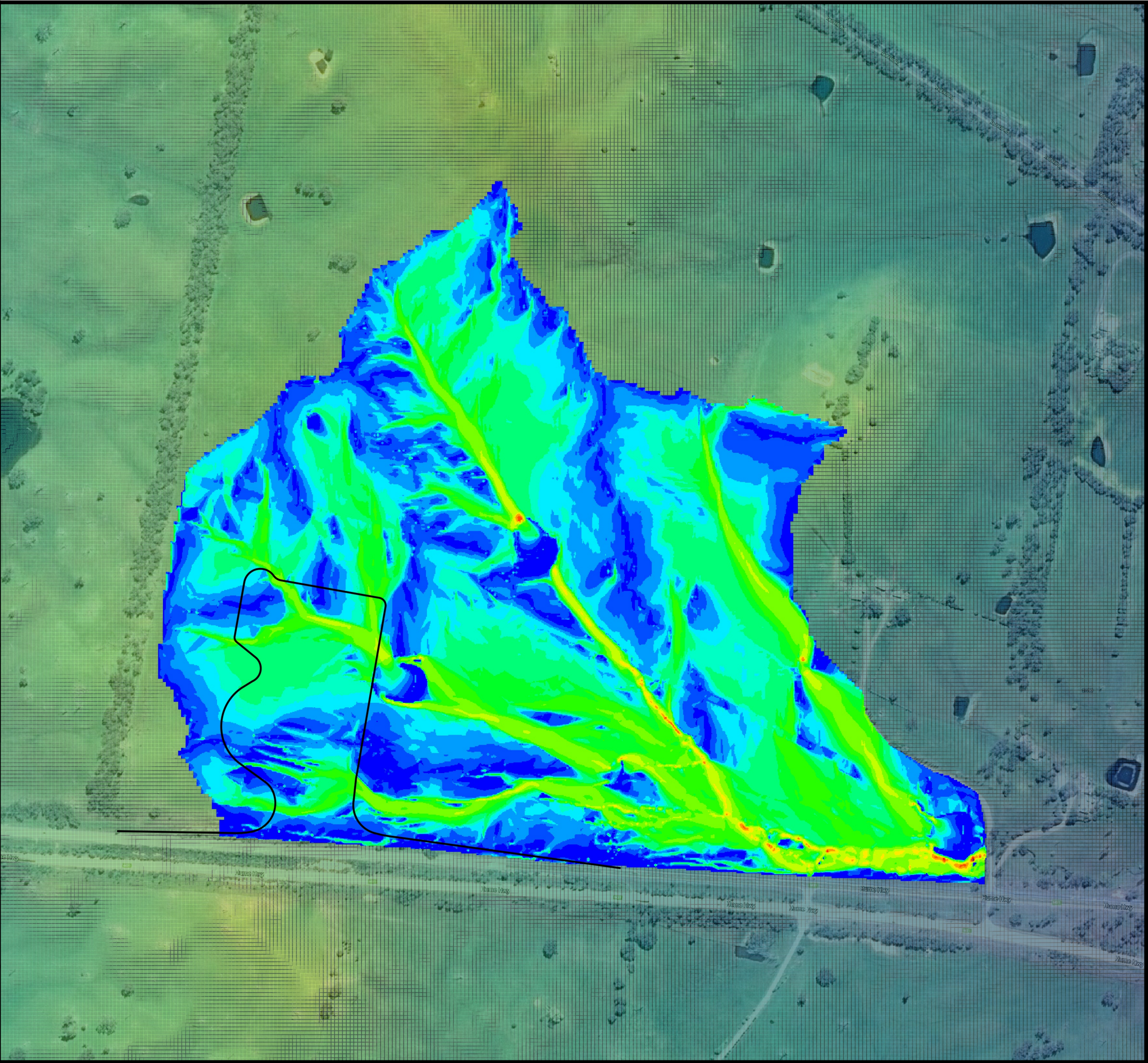
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Legend

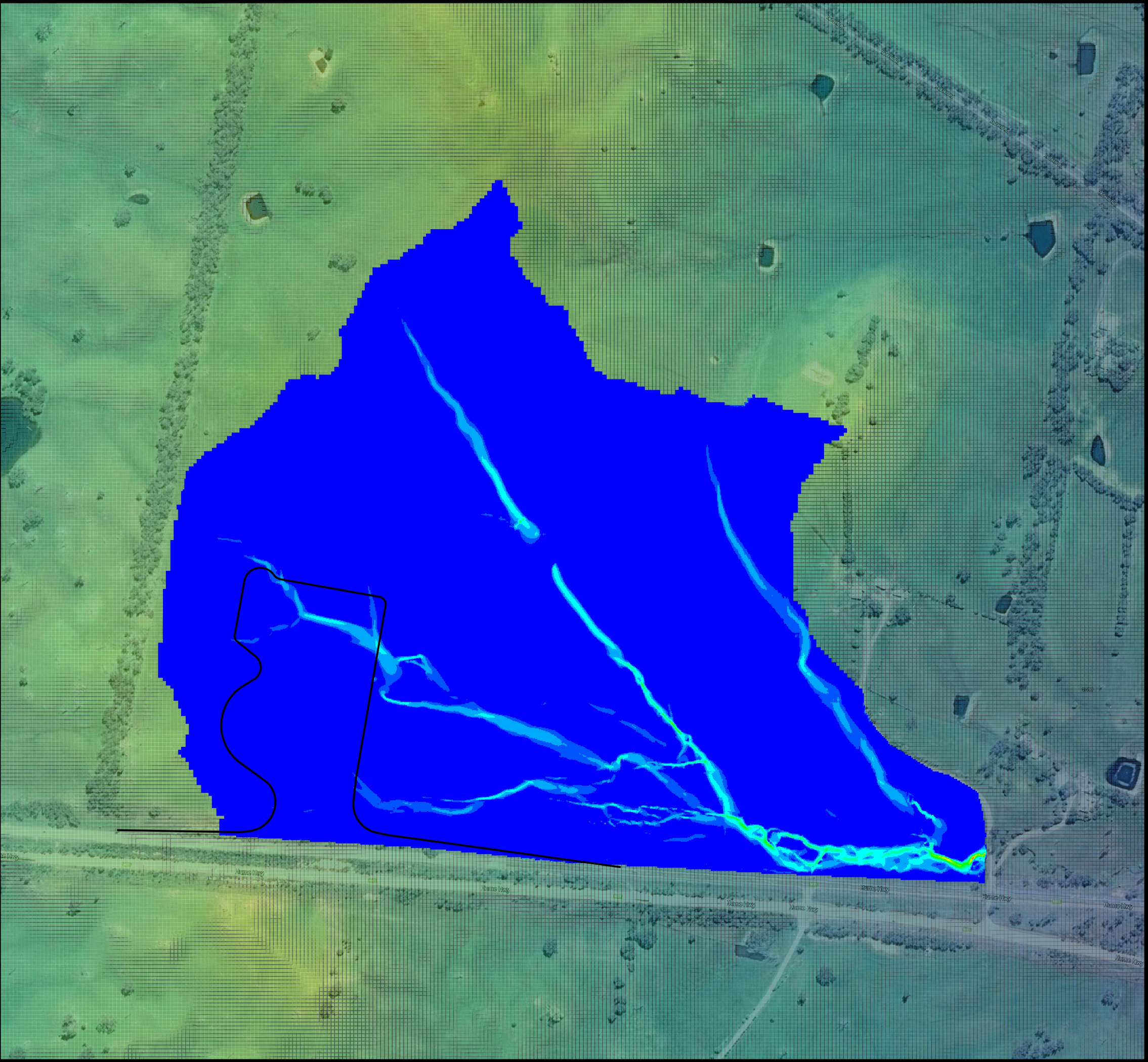
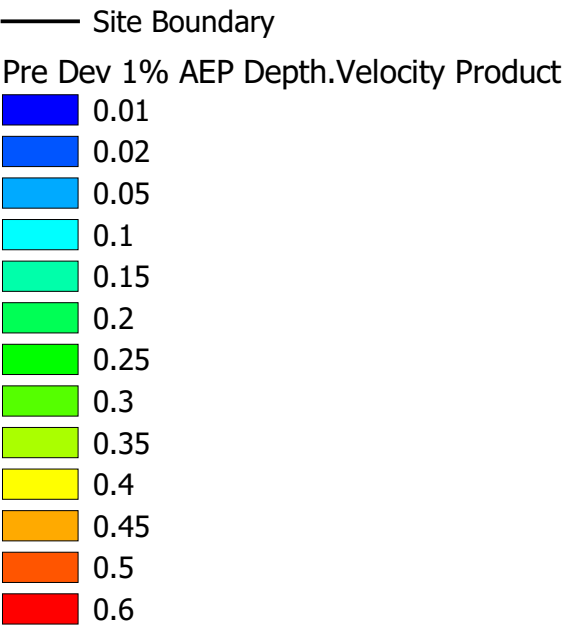
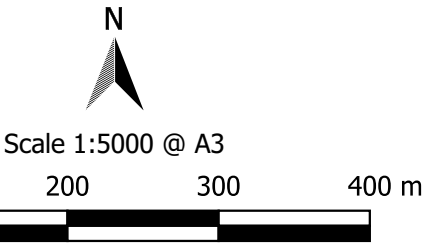


Figure C4:
Pre Dev
1% AEP Depth.Velocity Product

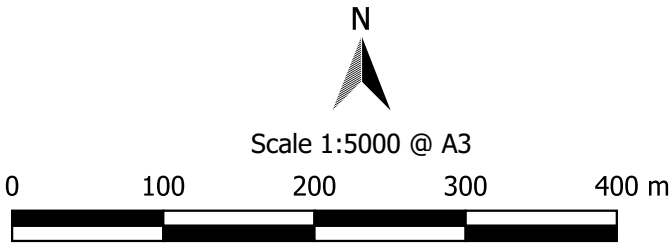


Legend

- Site Boundary
- Pre Dev 1% AEP Provisional Flood Hazard
 - Low
 - Medium
 - High



**Figure C5:
Pre Dev
1% AEP Provisional Hazard**



Notes:
Provisional flood hazard categories based on the
Australian NSW Floodplain Development Manual
(NSWG, 2005).

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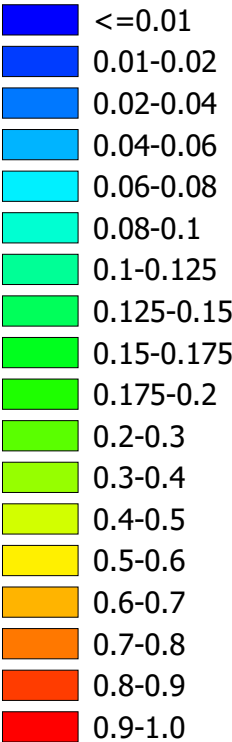
ABN 34 001 485 436

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Legend

— Site Boundary

Post Dev 1% AEP Floodwater Depths



**Figure C6:
Post Dev
1% AEP Floodwater Depths**



Scale 1:5000 @ A3



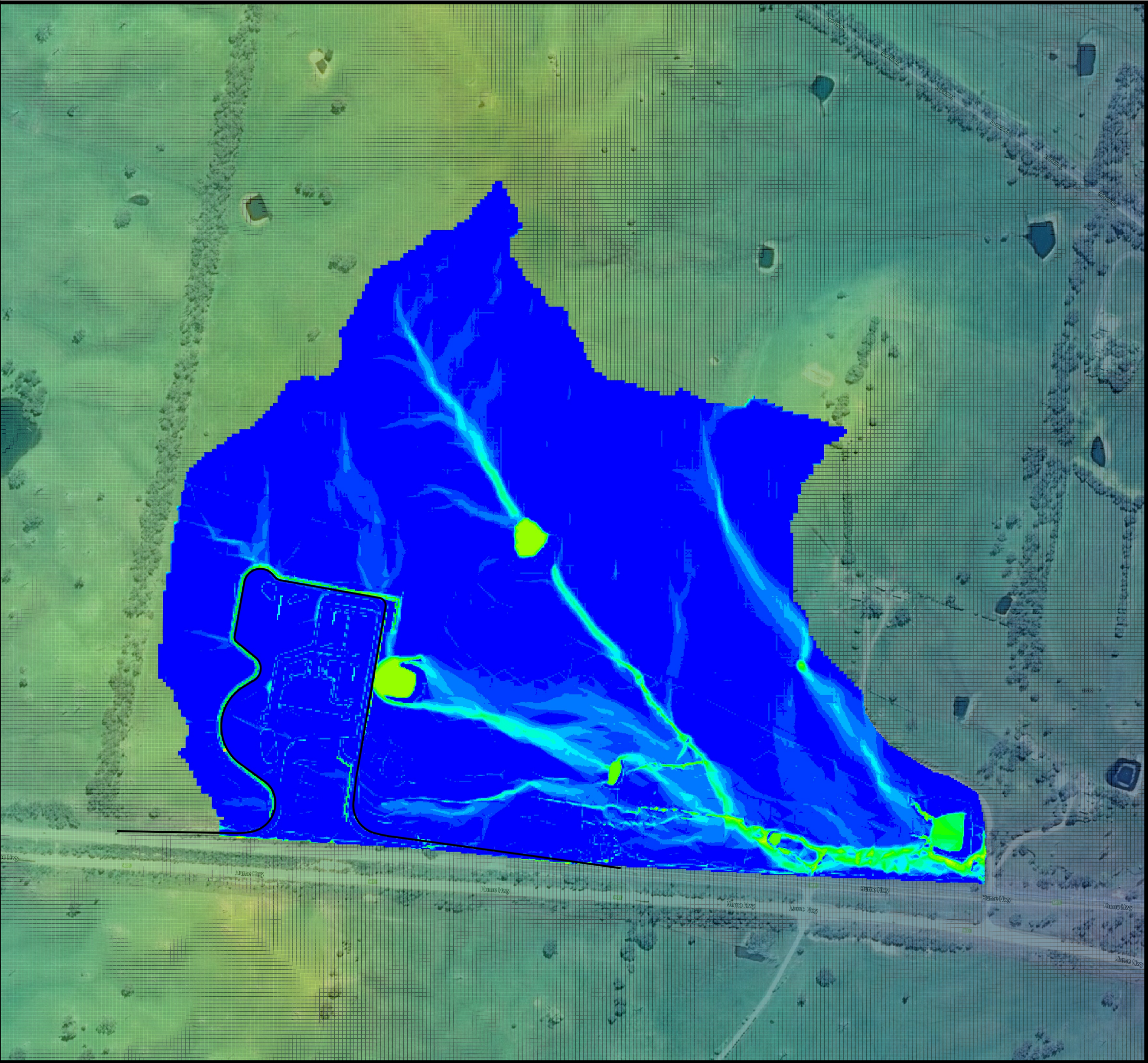
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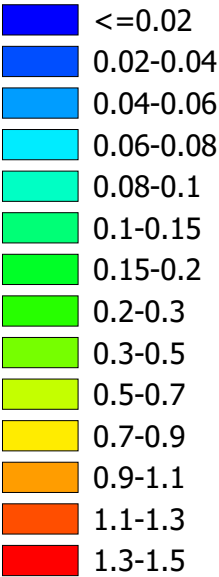
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Legend

— Site Boundary

Post Dev 1% AEP Floodwater Velocities



**Figure C7:
Post Dev
1% AEP Floodwater Velocities**



Scale 1:5000 @ A3

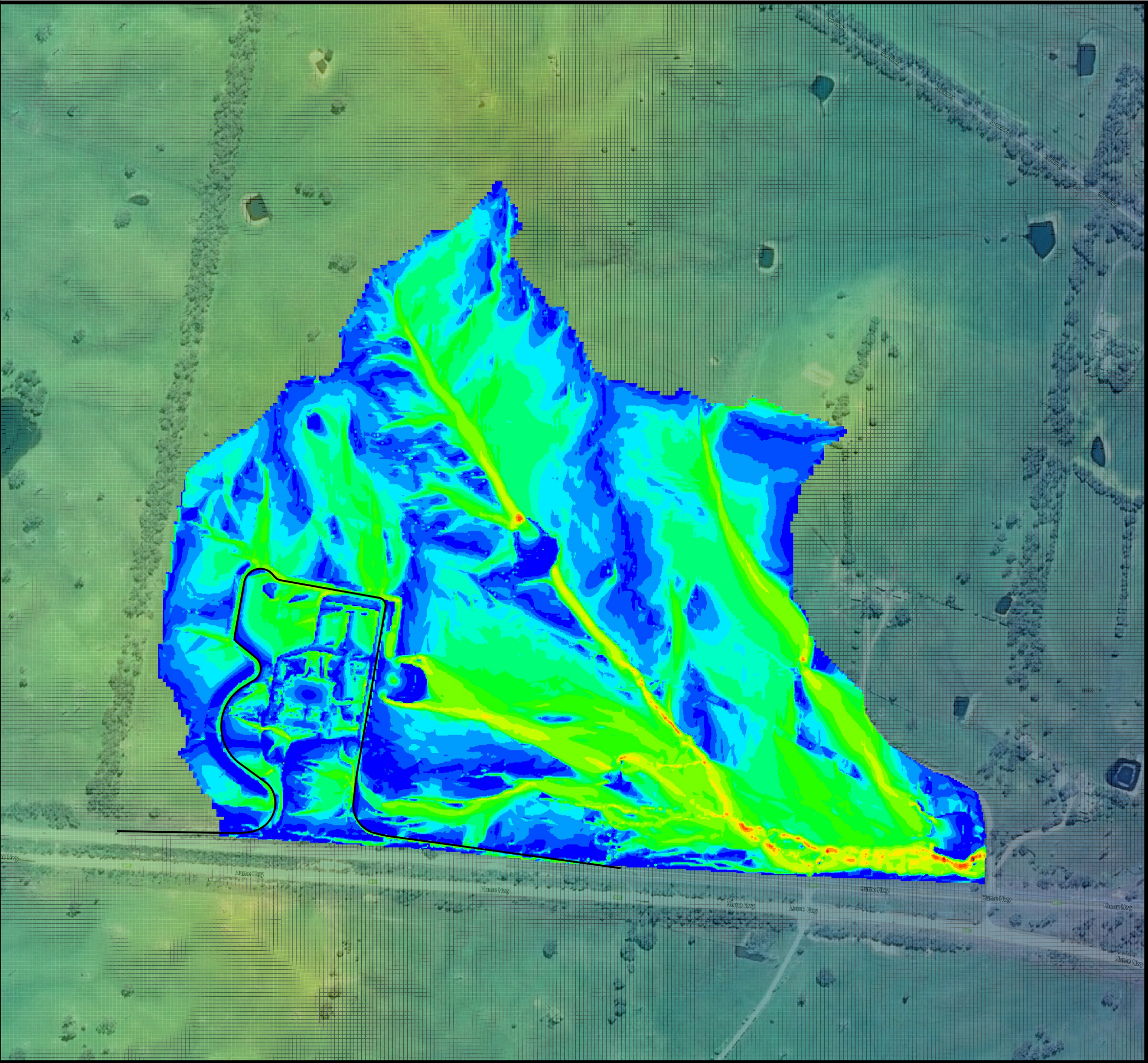


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Legend

— Site Boundary

Post Dev 1% AEP Depth.Velocity Product

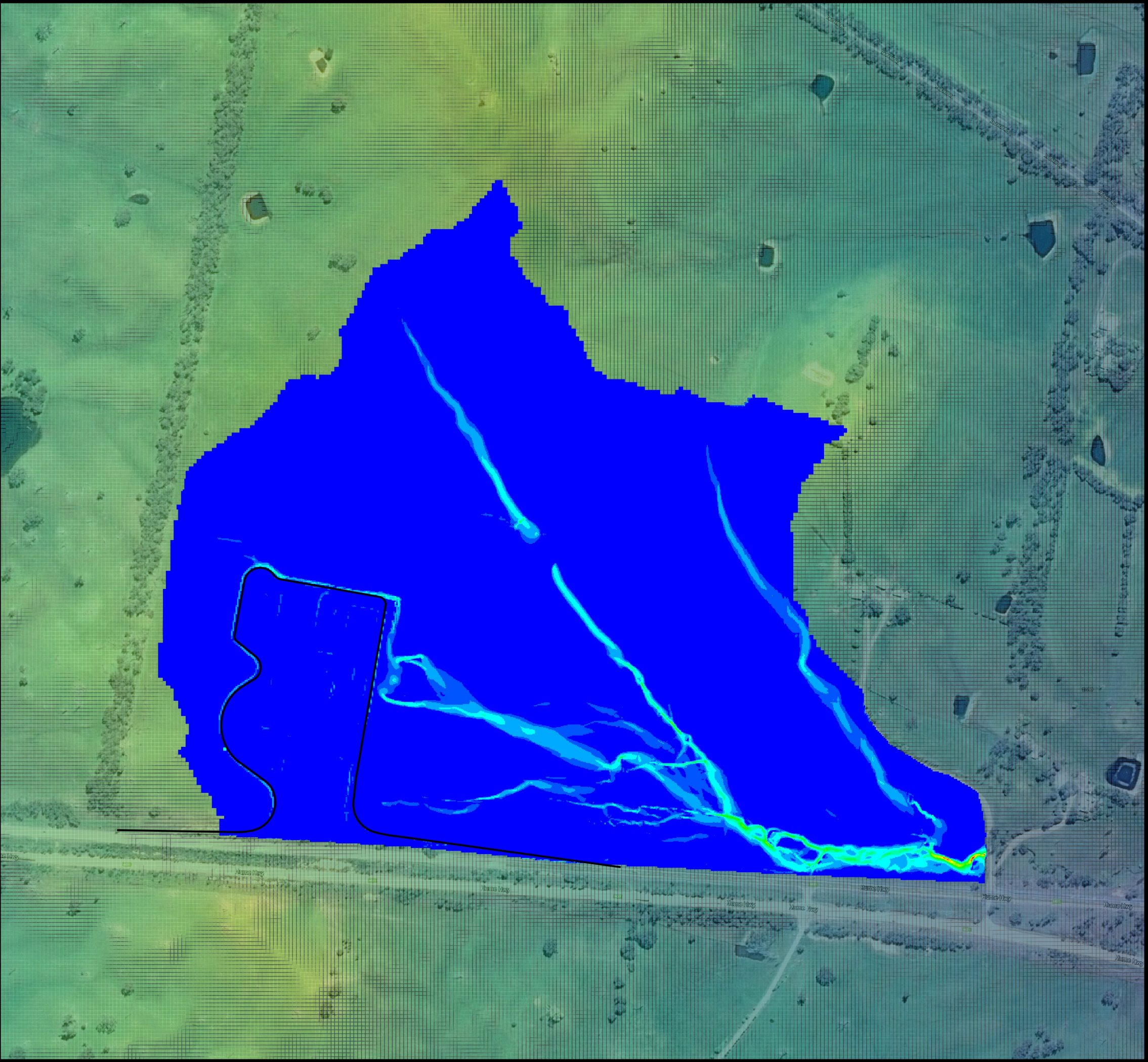
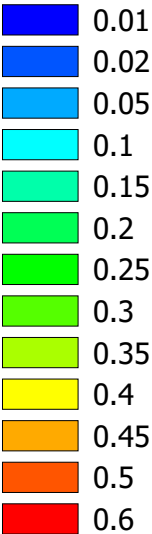


Figure C8:

Post Dev

1% AEP Depth.Velocity Product



Scale 1:5000 @ A3



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Legend

— Site Boundary

Post Dev 1% AEP Provisional Hazard

Low

Medium

High



**Figure C9:
Post Dev
1% AEP Provisional Hazard**



Scale 1:5000 @ A3



Notes:
Provisional flood hazard categories based on the
Australian NSW Floodplain Development Manual
(NSWG, 2005).

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Legend

— Site Boundary

Change in Floodwater Depths Post Development (m)

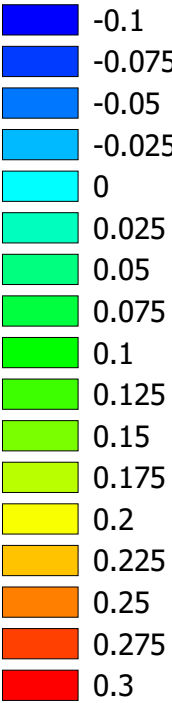
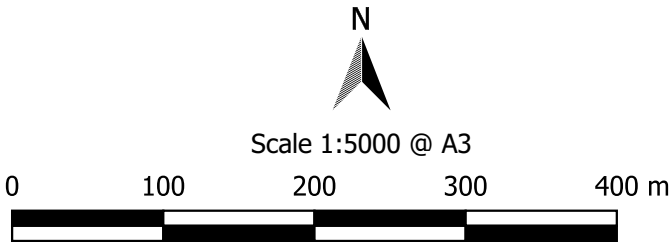


Figure C10:
Change in 1% AEP Floodwater Depths
Post Dev



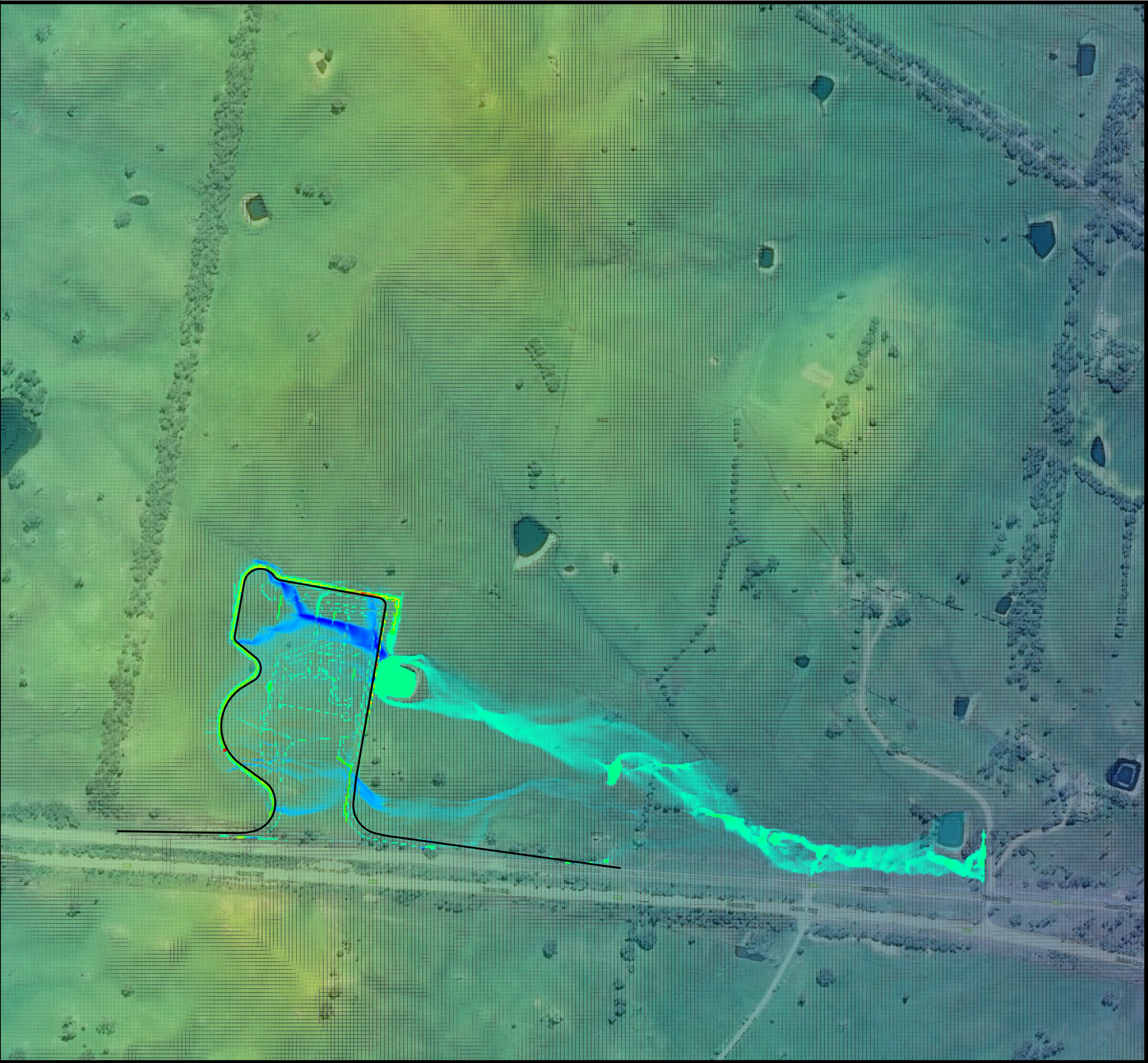
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Legend

— Site Boundary

Change in Floodwater Velocities Post Development

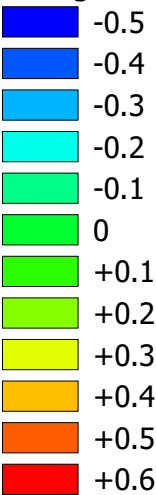


Figure C11:
Change in 1% AEP Floodwater
Velocities
Post Dev



Scale 1:5000 @ A3

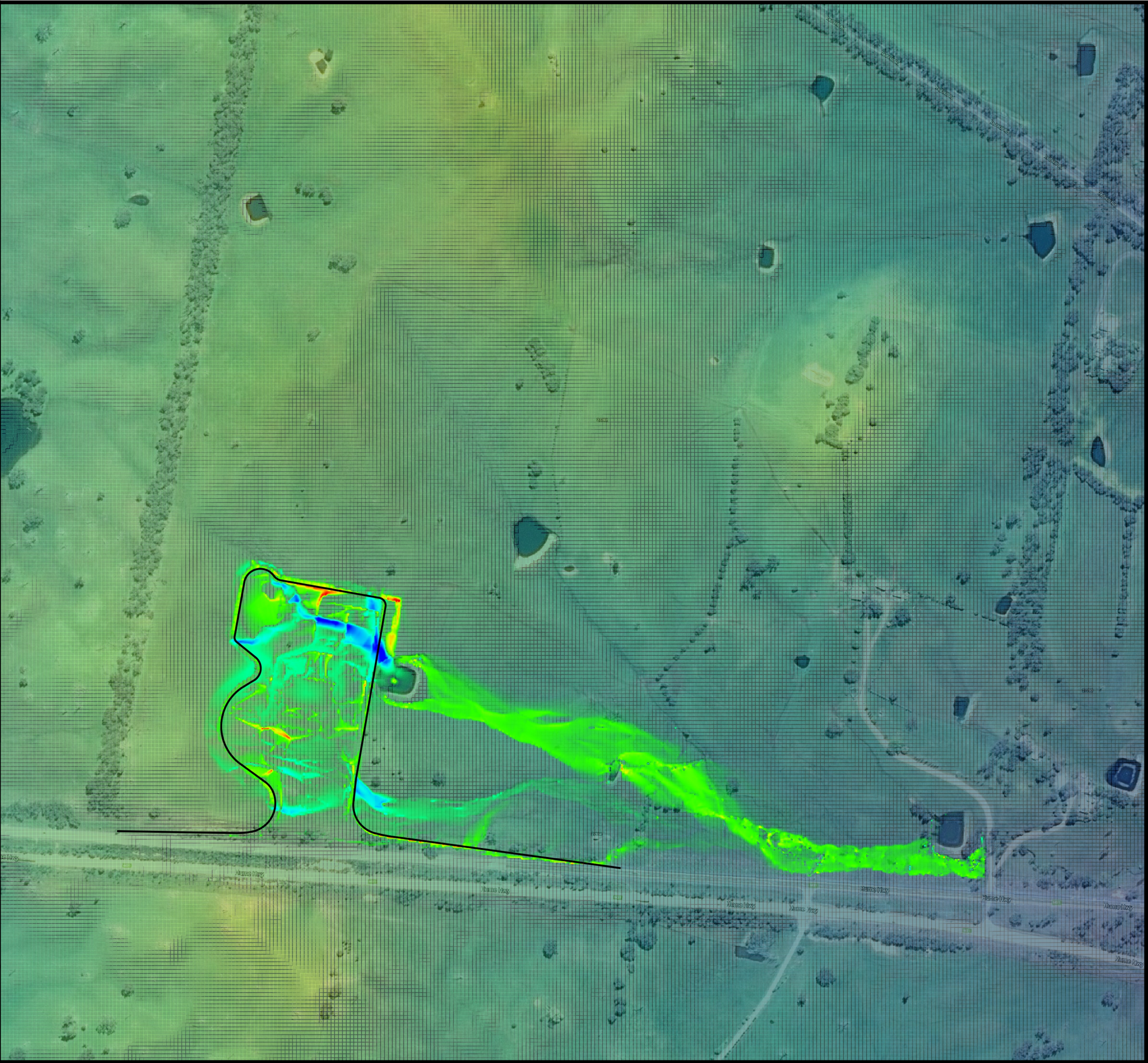


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Legend

— Site Boundary

Change in Depth.Velocity Product Post Development

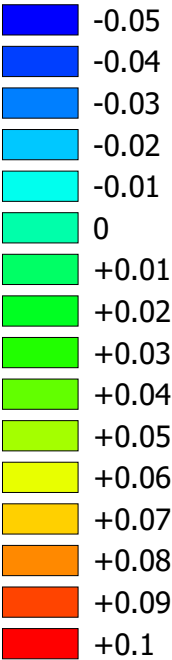
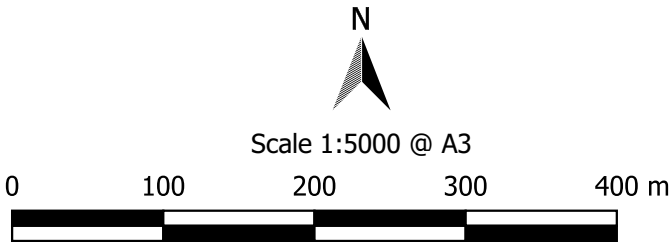


Figure C12:
Change in 1% AEP Depth.Velocity
Product
Post Dev



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