

Our ref: 12609144

16 September 2024

Matt Johnson  
Habitat Planning  
409 Kiewa Street  
Albury, NSW, 2640

### **Additional Flood Modelling for 197 Urana Street, Jindera**

Dear Matt,

Thank you for the opportunity to undertake additional flood modelling associated with the drainage reserve adjacent to the southern boundary of 197 Urana Street, Jindera. This letter outlines the methodology used, and the findings of the additional works, being a variation to the Flood Impact Assessment prepared by GHD in September 2023. Flood maps associated with the works have been attached to this letter.

## **1. Scope and limitations**

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The opinions, conclusions and any recommendations in this letter are based on assumptions made by GHD described below. GHD disclaims liability arising from any of the assumptions being incorrect. The following are key assumptions, based on which, this letter has been prepared:

- The hydrology from the Jindera Floodplain Risk Management Study and Plan (GHD, 2017) was adopted without amendments, as per the scope of our engagement. However, we note that the hydrology at the time of the 2017 study was undertaken under Australian Rainfall and Runoff 1987 methodologies. Australian Rainfall and Runoff guidelines, and associated design rainfall data have since been updated in 2016 and 2019.
- The Bureau of Meteorology (BOM) 1987 rainfall data has not been corrected for global temperature increases to current day (2024). The BOM rainfall data for this assessment has been applied without any climate change adjustment, in accordance with the scope of our engagement.
- We have not allowed for updates to the existing TUFLOW hydraulic model in the floodplain beyond the immediate vicinity of the subject site (Lot 2 DP 801591) and the drainage reserve near its southern boundary.

- It was assumed that the 1%, 5% and 20% Annual Exceedance Probability (AEP) flood events would be sufficient to determine the flood impacts.
- It was previously noted for the 5% AEP event, that available hydrology was limited to the 2- and 3-hour duration storms. For the current study, a greater number of storms could be extracted from the original RAFTS hydrological model and incorporated into the additional flood modelling to provide better confidence with respect to this flood event. This is outlined in Section 3.1.
- Details of the existing Council drainage channel would be provided to GHD by Habitat Planning.
- No additional survey would be required.

## 2. References

The following documents were referred to in the preparation of this letter:

- Greater Hume Local Environment Plan (LEP), 2012.
- Greater Hume Development Control Plan (DCP), 2013.
- Flood Risk Management Manual (NSW Department of Planning and Environment, 2023).
- Australian Rainfall and Runoff: A Guide to Flood Estimation (Geoscience Australia, 2019).
- Jindera Floodplain Risk Management Study and Plan (GHD, 2017)
- 197 Urana Street, Jindera – Flood Impact Assessment (GHD, 2023).

## 3. Methodology

### 3.1 Hydrology Update

Additional storm durations were extracted from the RAFTS hydrological model from GHD's 2017 study, for the 5% AEP flood event in order to provide better confidence with respect to this event. These durations were incorporated into the TUFLOW flood model for all subsequent simulations. The below scenarios were simulated for the 1%, 5% and 20% AEP events.

### 3.2 Existing Conditions

The configuration of the TUFLOW model for existing conditions at 197 Urana Street remained mostly as described in Section 2.1 of the Flood Impact Assessment (GHD, 2023). The following are the changes to the existing case TUFLOW model implemented for the current study:

- The existing Council drain at the southern boundary of the site was modelled as a one-dimensional (1D) channel embedded into the two-dimensional (2D) model grid. This was done under the assumption that a 1D channel would better simulate the conveyance in the context of the 2D model grid size. The drain was given a Mannings n roughness of 0.04 based on its natural and lightly grassed construction. Cross-sections for the drain were configured based on 2020 LiDAR topographical data as there were no other sources of cross-sectional data available.
- Box culverts (blue arrows in Figure 1) were included in the model with dimensions 1800 W x 525 H (as per Council drawing) and Mannings n roughness of 0.013. The invert levels and lengths for the culverts were estimated based on the LiDAR data and aerial imagery.
- Source-area inflows were distributed evenly across catchment areas.



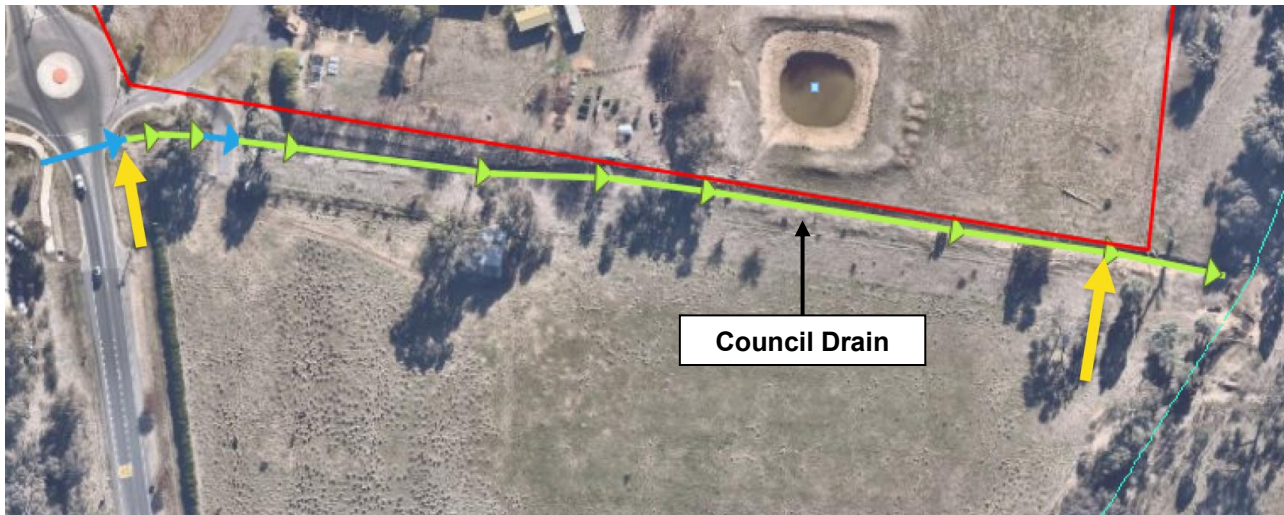


Figure 1 Schematic of drainage channel (blue – culverts, green – drain, yellow – location markers)

### 3.3 Design Case

The aforementioned model changes were retained for the design case. The proposed development (new school buildings, design pad for retirement village and driveway) was represented in the model as described in Section 2.2 of the Flood Impact Assessment (GHD, 2023).

### 3.4 Design Case with Drain Upgrade

The upgrade of the existing Council swale drain was explored through four drain upgrade options below:

- Option 1 – 2m base, 3V:10H side slopes, graded down at approximately 0.3% longitudinal slope.
- Option 2 – 1m base, 3V:10H side slopes, graded down at approximately 0.3% longitudinal slope.
- Option 3 – 0.5m base, 3V:10H side slopes, graded down at approximately 0.3% longitudinal slope.
- Option 4 – 0.5m base, 3V:10H side slopes, graded down at approximately 0.2% longitudinal slope.

The drain upgrade options were evaluated on their efficacy in reducing the flood impacts previously noted (GHD, 2023) on the 44 Molkentin Road property, as a result of the proposed development in the 1% AEP event. A reduction of the flood impact on the property to 10 mm or less was considered acceptable. Another objective was to minimise the downstream impact as a result of the flow diverted by the drainage channel, such that properties would not be affected by impacts greater than 10 mm.

Option 4 provided the best outcome in terms of minimising impacts with respect to the development, as well as ensuring minimal impact downstream of the channel. The longitudinal data in Figure 2 shows the Option 4 upgraded drain featuring a steeper grade of 0.2% between the points indicated by the yellow arrows, as compared to the flatter existing drain. The invert level of the upgraded drain at the first yellow marker on Figure 2 (chainage 21.3 m) was set at 234.28 mAHD, and 233.75 mAHD at the second yellow marker (chainage 281.5 m).

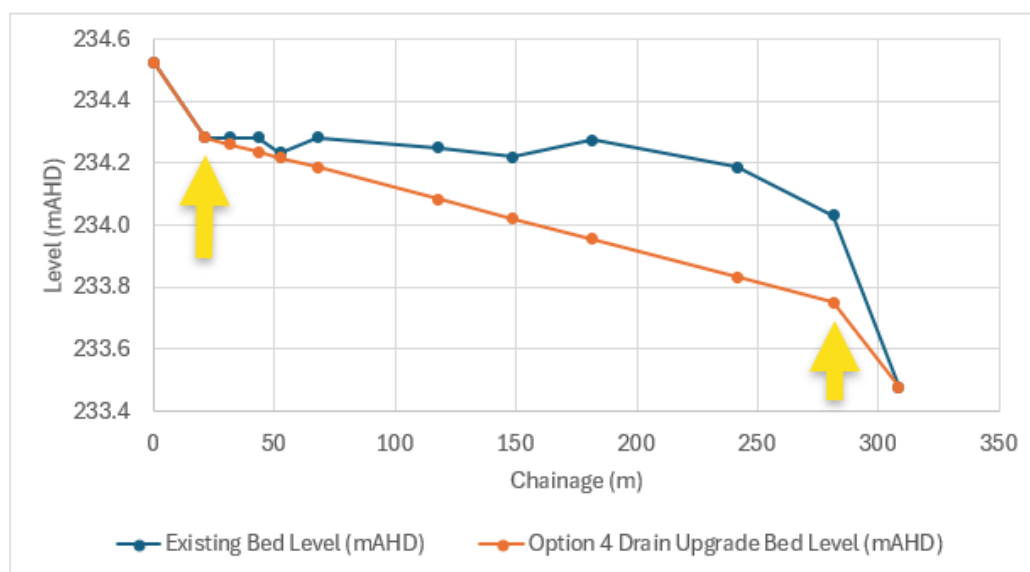


Figure 2 Drainage channel invert levels

## 4. Key Findings and Recommendations

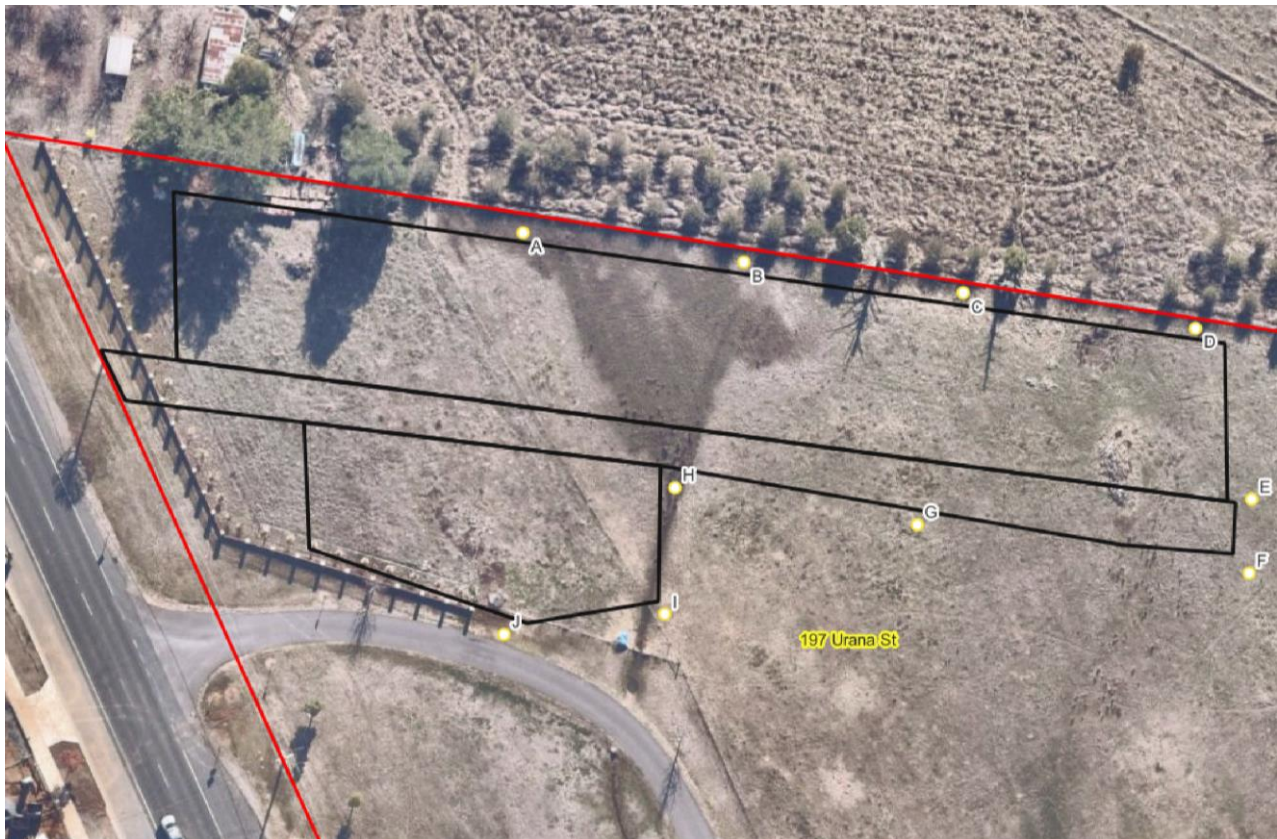
Below are the key findings of the additional modelling undertaken, however, this discussion of results is not exhaustive. Please refer to the flood maps attached to this letter for the full set of results with respect to each event modelled (flood extent, depth, level, velocity, hazard).

The configuration of the existing Council drain in the TUFLOW model as a 1D channel as described in Section 3.2 led to a reduction of the impact on 44 Molkentin Ave (from previously approx. 35 mm to approx. 10 mm in the 1% AEP event) in the design case, without any upgrade of the drainage channel. An upgrade of the channel (Option 4) was simulated to provide some benefit, reducing the impact on the property to approximately 6 mm.

Figure 3 and Table 1 show the 1% AEP flood levels and depths modelled at key locations around the pad for the proposed retirement homes. The highest flood level in Table 1 is 233.93 mAHD at location J. Around the eastern side of the pad, the presence of water (shown on the maps) is likely due to runoff from the design pad, rather than due to main stream flooding.

Section 2.4 in the Greater Hume DCP (2013) states that 'Council may require the floor level of a dwelling to be constructed at a minimum level of 600mm above natural ground level in areas considered to be subject to the passage and/or storage of stormwater during and/or following major rainfall events'. As there is no further guidance in the DCP regarding the flood planning level (FPL), it was confirmed with Greater Hume Council during preparation of the Flood Impact Assessment (GHD, 2023), that the FPL for the development would be the 1% AEP flood level plus 500 mm freeboard. As this FPL would generally exceed the 600 mm above natural ground level required by Council, the finished floor level (FFL) recommended for the retirement homes in the Design Case would be the flood level at location J (233.93 mAHD) plus 500 mm,

i.e., 234.43 mAHD. The minimum FFL at 234.43 mAHD is also recommended if undertaking construction of the Drain Upgrade (Option 4).



**Figure 3** Key locations around retirement homes

**Table 1** 1% AEP flood levels and depths at key locations

Location ID	Drain Upgrade Flood Level (mAHD)	Design Flood Level (mAHD)	Existing Flood Level (mAHD)	Dry Ground Level (mAHD)	Drain Upgrade Flood Depth (m)	Design Flood Depth (m)	Existing Flood Depth (m)
A	233.60	233.60	232.95	232.86	0.74	0.74	0.09
B	233.62	233.63	233.00	232.90	0.73	0.73	0.11
C	233.65	233.65	233.03	232.86	0.79	0.79	0.17
D	233.68	233.69	233.07	232.91	0.77	0.77	0.15
E	233.30	233.31	233.17	233.02	0.28	0.29	0.15
F	233.37	233.39	233.22	233.09	0.28	0.29	0.13
G	233.70	233.71	233.22	233.10	0.60	0.60	0.11
H	233.85	233.86	233.16	233.08	0.77	0.78	0.08
I	233.68	233.69	233.34	233.33	0.35	0.36	0.00
J	233.93	233.93	233.68	233.60	0.34	0.34	0.09

Existing Flood Level – the flood level modelled as a result of existing conditions (without new school buildings or aged care facility)

Design Flood Level – the flood level modelled with the proposed new school buildings and aged care facility

Drain Upgrade Flood Level – the flood level modelled with the proposed new school buildings, aged care facility, and Council Drain Upgrade

Dry Ground Level – the level of the topography in the model without flooding

Existing/Design/Drain Upgrade Flood Depth – the flood level minus the dry ground level

Kind Regards,

**Michelle Zhang**  
Engineer – Water Resources  
+61 2 92397738  
Michelle.Zhang@ghd.com

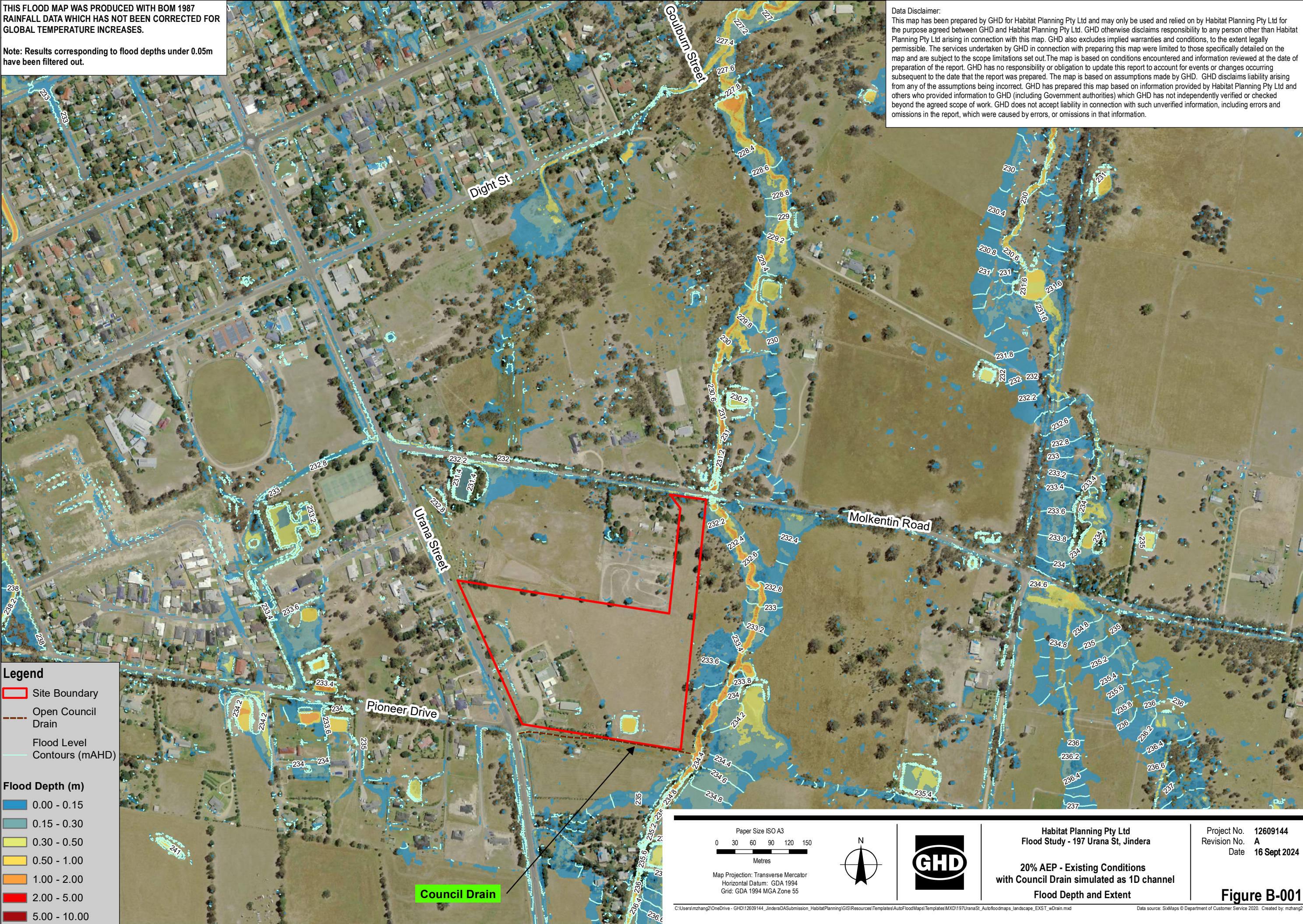
Copy to: [Rainer.berg@ghd.com](mailto:Rainer.berg@ghd.com), [Leona.Zha@ghd.com](mailto:Leona.Zha@ghd.com)



THIS FLOOD MAP WAS PRODUCED WITH BOM 1987 RAINFALL DATA WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES.

Note: Results corresponding to flood depths under 0.05m have been filtered out.

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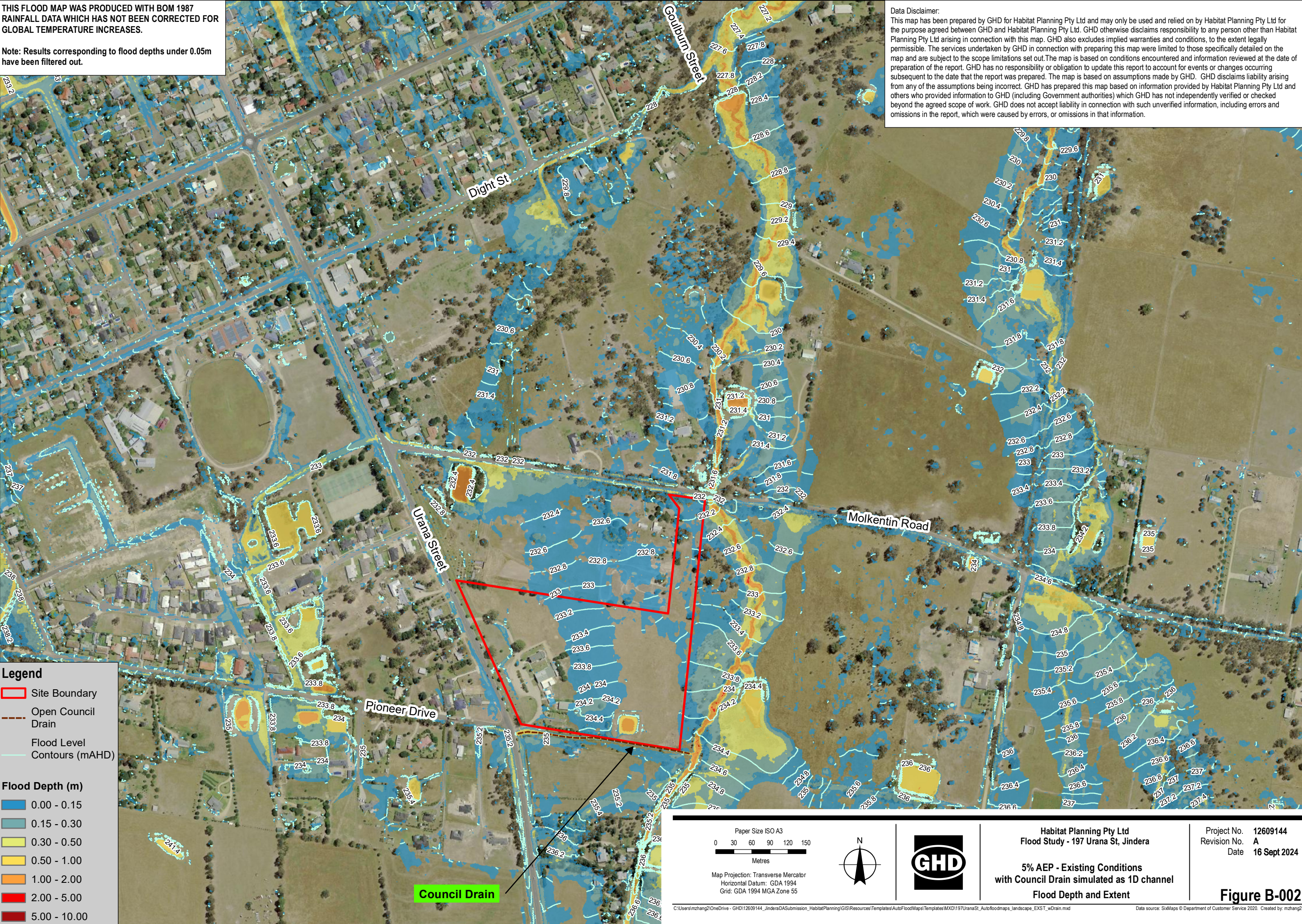




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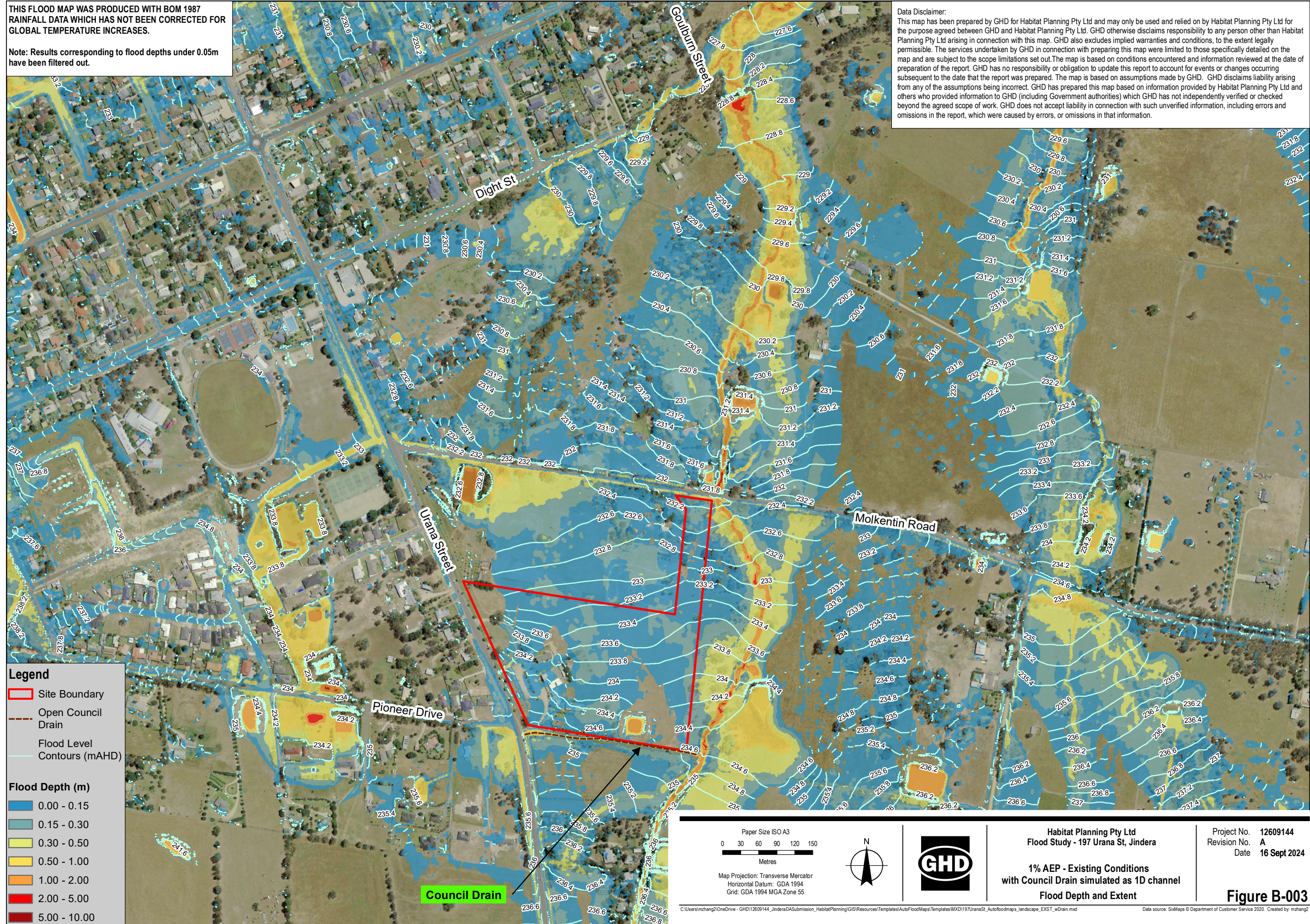
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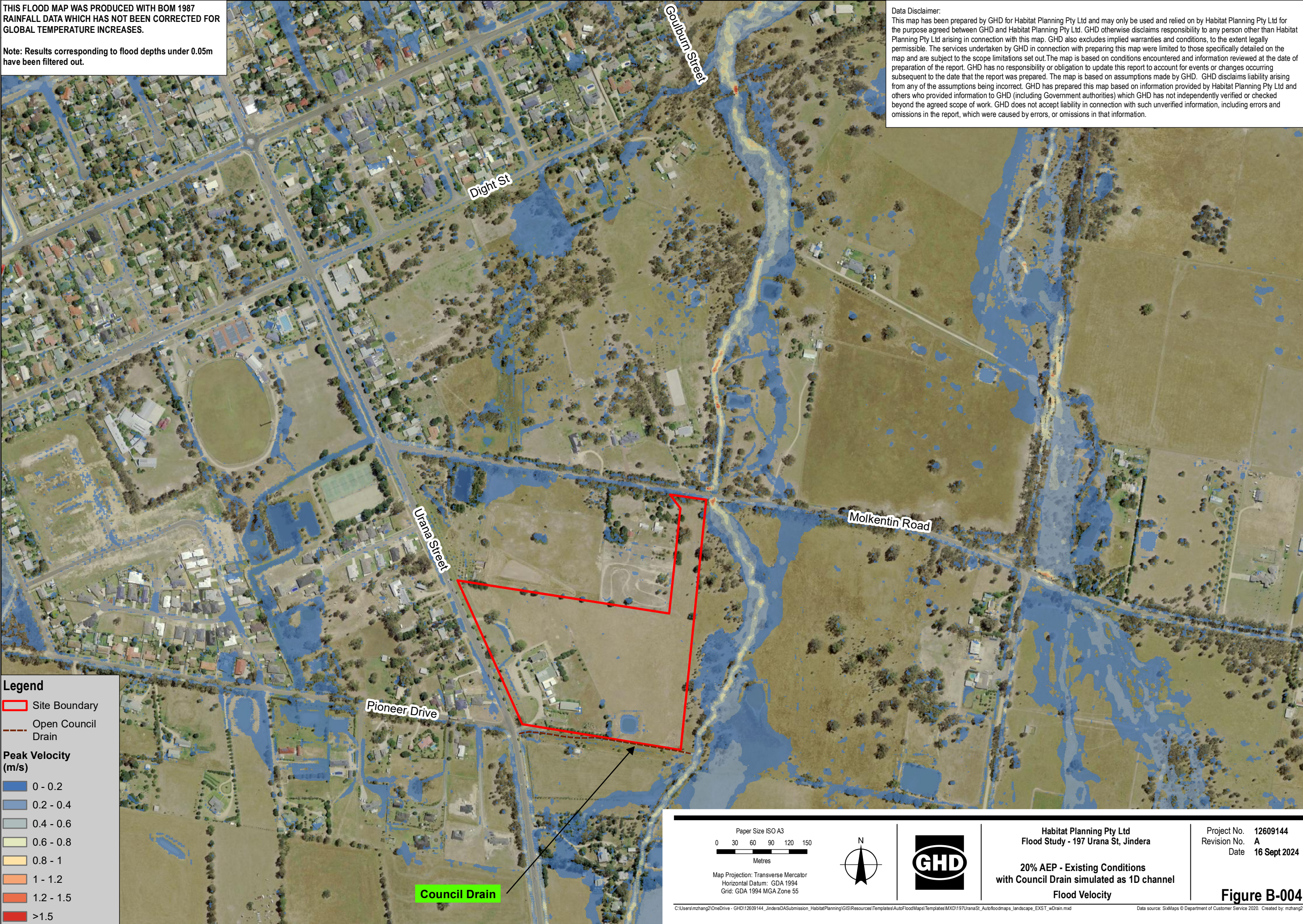


Figure B-004

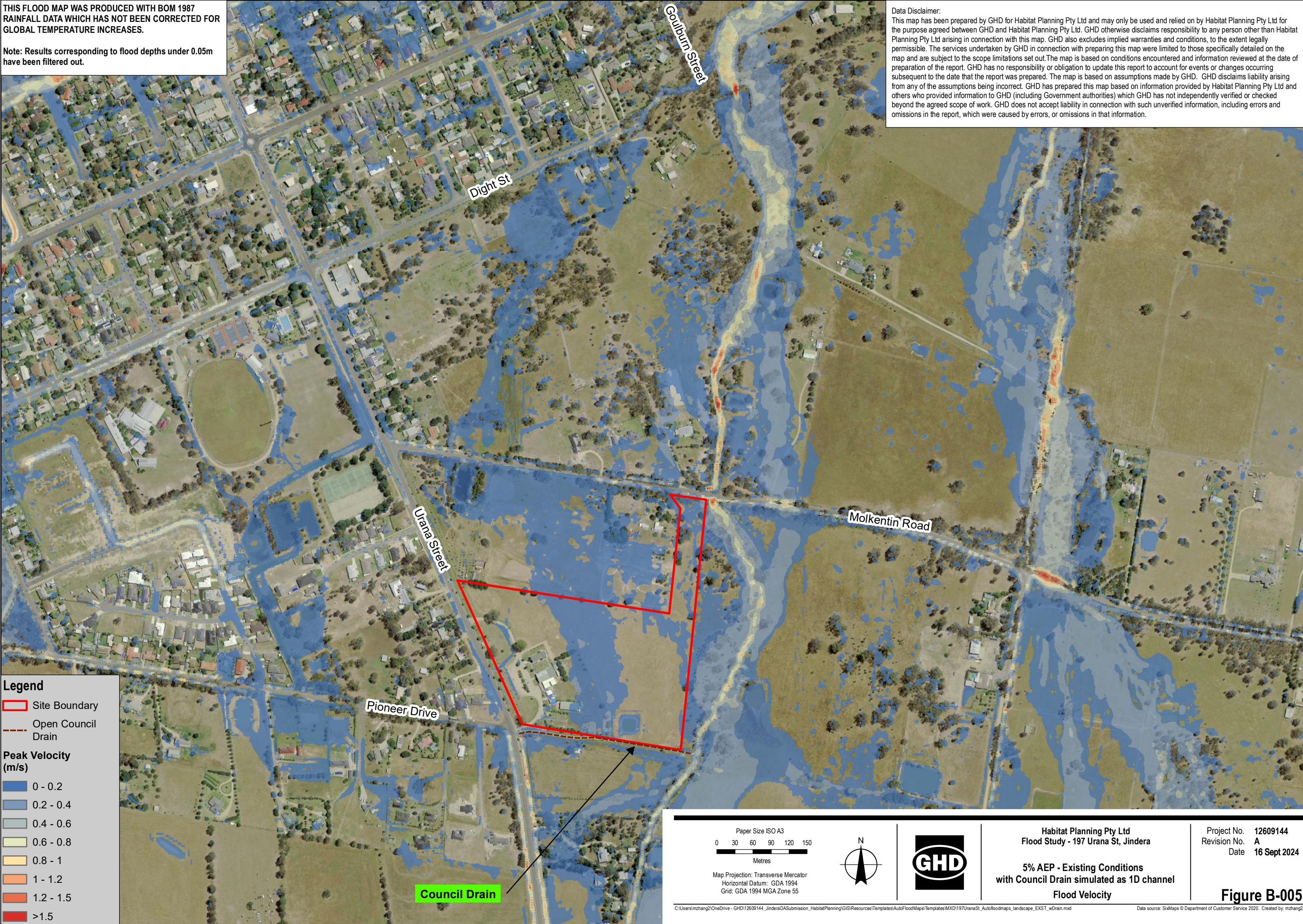


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**Legend**

Site Boundary

Open Council Drain

**Peak Velocity (m/s)**

- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- 1 - 1.2
- 1.2 - 1.5
- >1.5

Paper Size ISO A3

0 30 60 90 120 150

Metres

Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55

N

Habitat Planning Pty Ltd  
Flood Study - 197 Urana St, Jindera

5% AEP - Existing Conditions  
with Council Drain simulated as 1D channel

Flood Velocity

Project No. 12609144  
Revision No. A  
Date 16 Sept 2024

**Figure B-005**

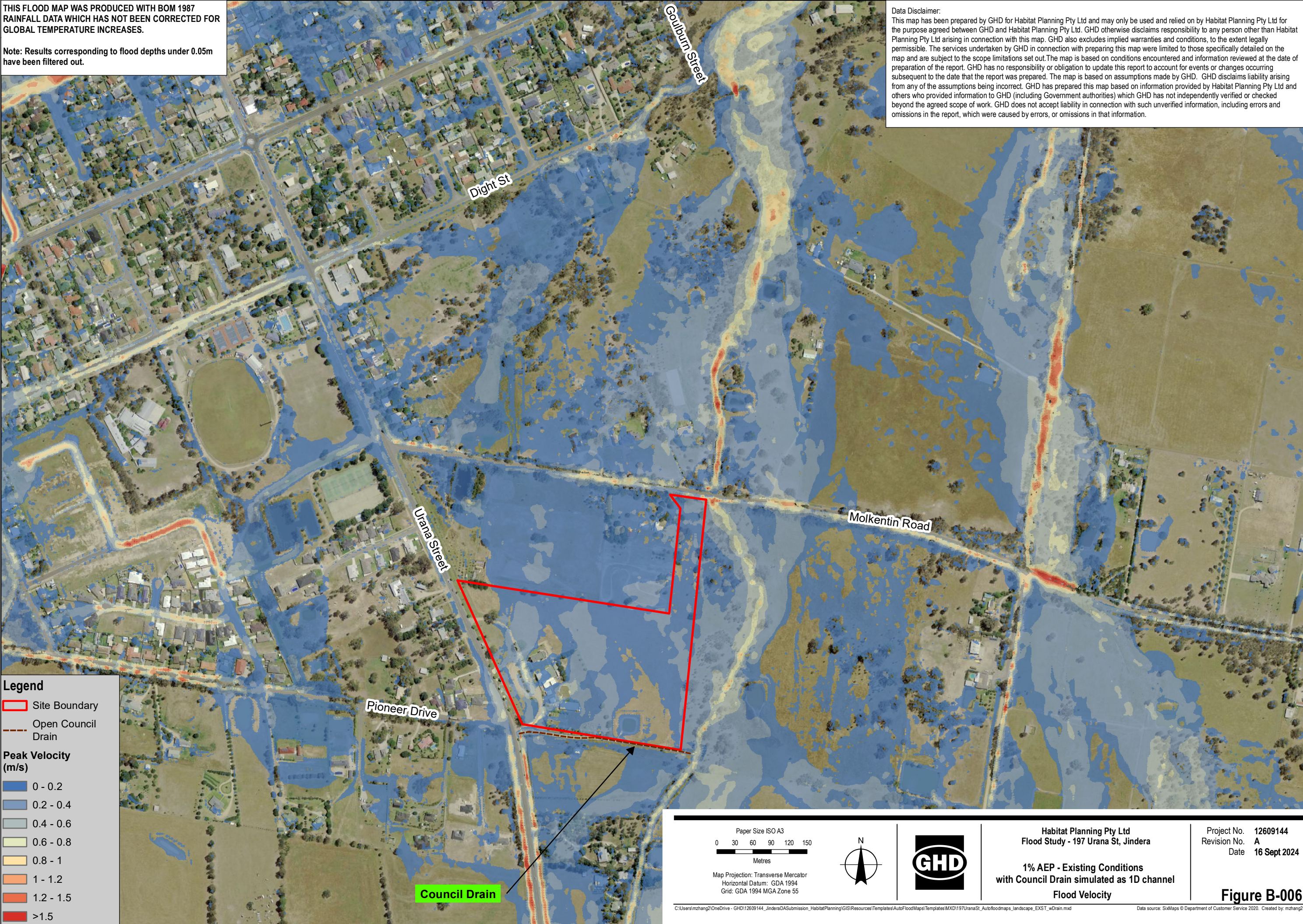


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**Legend**

Site Boundary

Open Council Drain

**Flood Hazard**

H1 - generally safe for people, vehicles and buildings

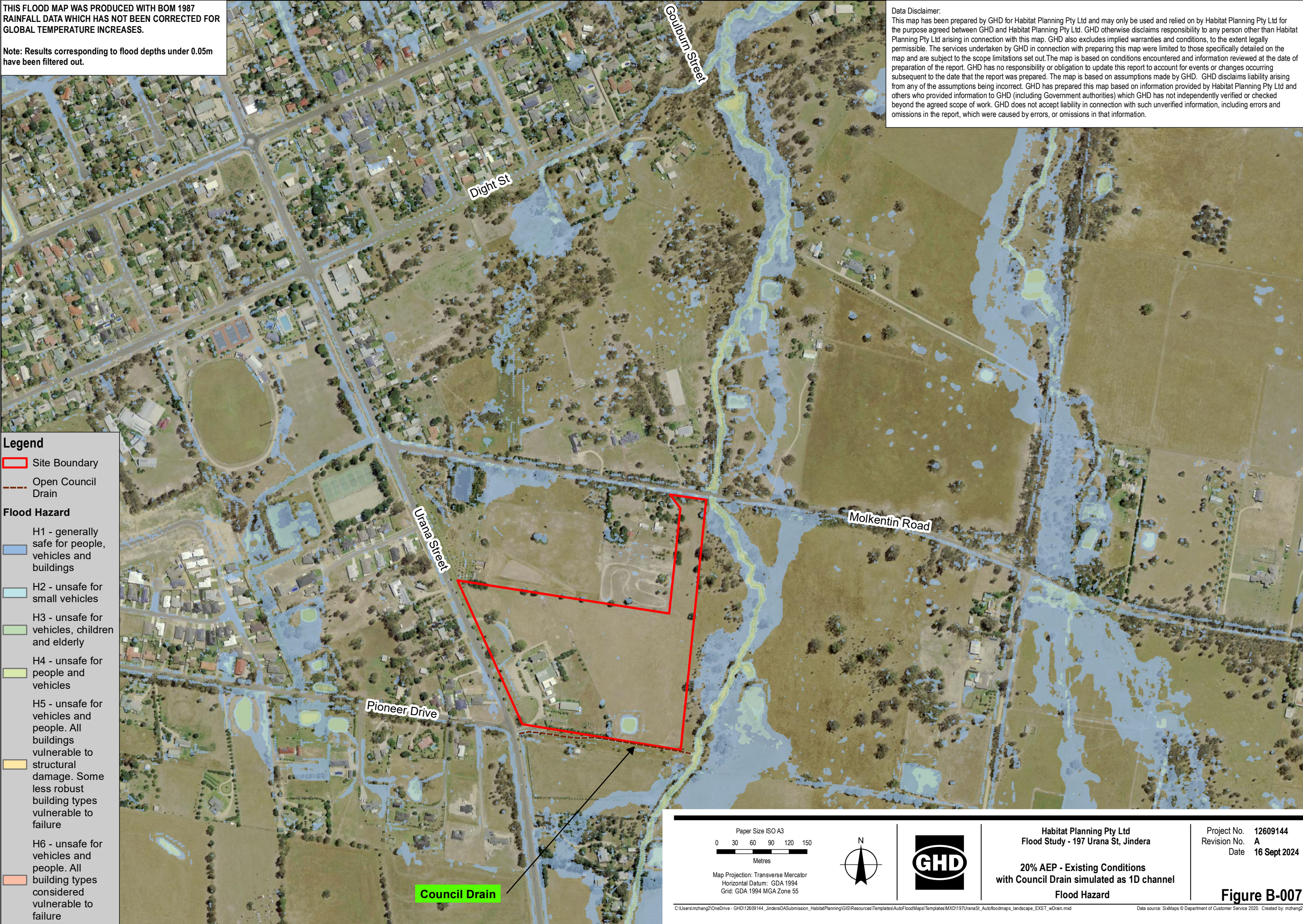
H2 - unsafe for small vehicles

H3 - unsafe for vehicles, children and elderly

H4 - unsafe for people and vehicles

H5 - unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust building types vulnerable to failure

H6 - unsafe for vehicles and people. All building types considered vulnerable to failure



Paper Size ISO A3

0306090120150

Metres

Map Projection: Transverse Mercator

Horizontal Datum: GDA 1994

Grid: GDA 1994 MGA Zone 55

N

GHD

Habitat Planning Pty Ltd

Flood Study - 197 Urana St, Jindera

20% AEP - Existing Conditions

with Council Drain simulated as 1D channel

Flood Hazard

Project No. 12609144

Revision No. A

Date 16 Sept 2024

Figure B-007



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Legend

Site Boundary

Open Council Drain

Flood Hazard

H1 - generally safe for people, vehicles and buildings

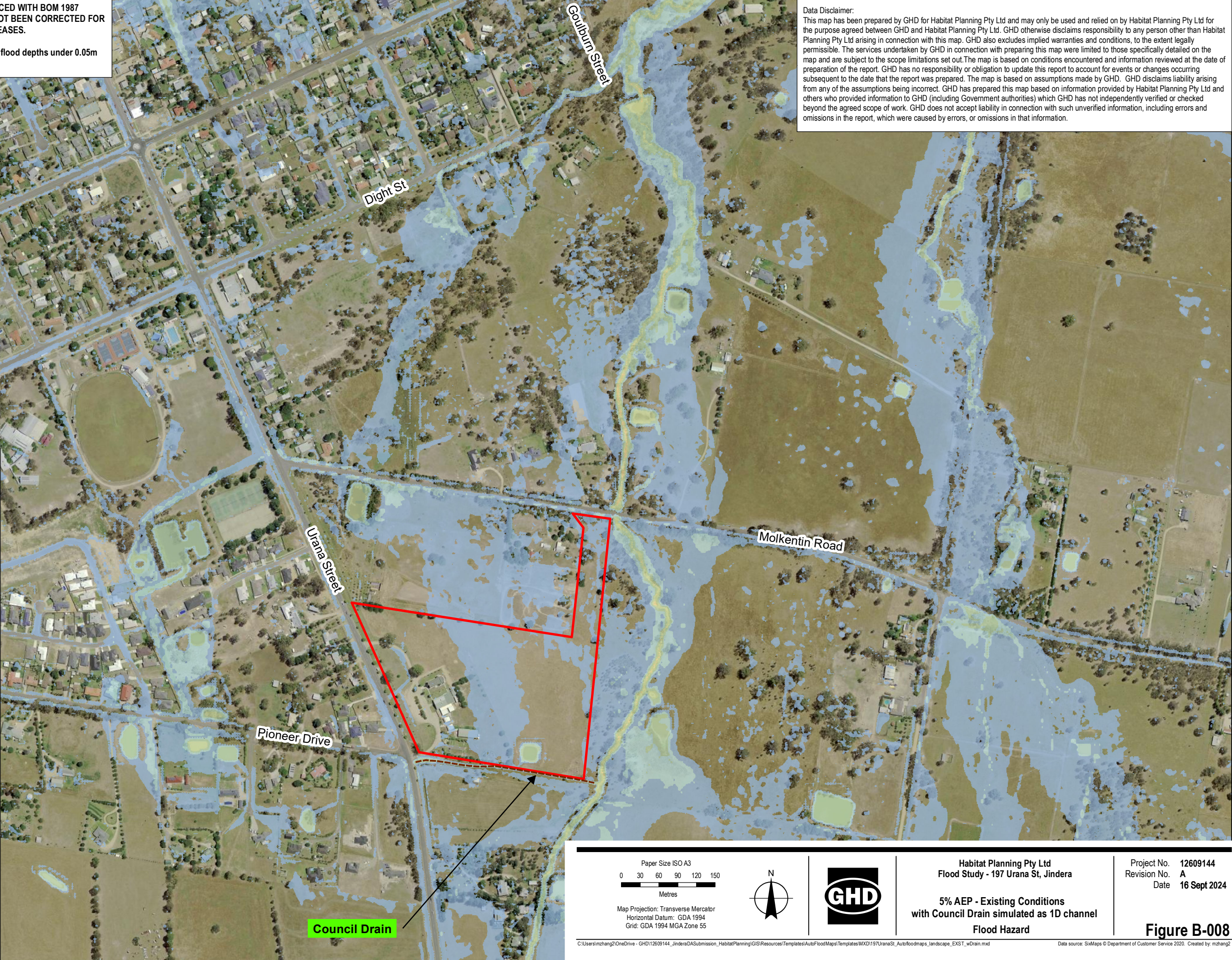
H2 - unsafe for small vehicles

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Paper Size ISO A3

0 30 60 90 120 150

Metres

Map Projection: Transverse Mercator

Horizontal Datum: GDA 1994

Grid: GDA 1994 MGA Zone 55

N

GHD

Habitat Planning Pty Ltd

Flood Study - 197 Urana St, Jindera

5% AEP - Existing Conditions

with Council Drain simulated as 1D channel

Flood Hazard

Project No. 12609144

Revision No. A

Date 16 Sept 2024

Figure B-008



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**Legend**

Site Boundary

Open Council Drain

**Flood Hazard**

H1 - generally safe for people, vehicles and buildings

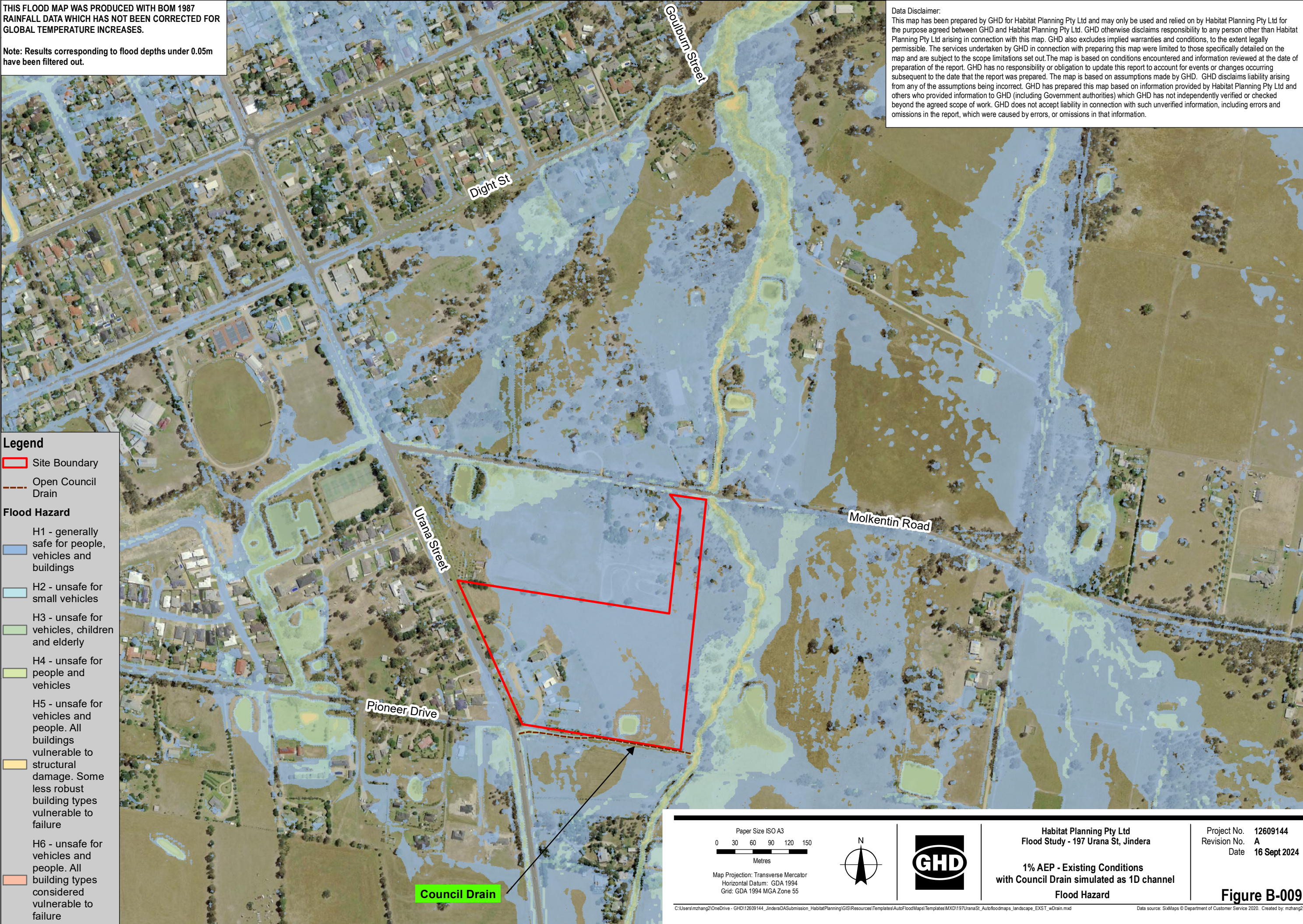
H2 - unsafe for small vehicles

H3 - unsafe for vehicles, children and elderly

H4 - unsafe for people and vehicles

H5 - unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust building types vulnerable to failure

H6 - unsafe for vehicles and people. All building types considered vulnerable to failure



Paper Size ISO A3

0306090120150

Metres

Map Projection: Transverse Mercator

Horizontal Datum: GDA 1994

Grid: GDA 1994 MGA Zone 55

N

GHD

Habitat Planning Pty Ltd

Flood Study - 197 Urana St, Jindera

1% AEP - Existing Conditions

with Council Drain simulated as 1D channel

Flood Hazard

Project No. 12609144

Revision No. A

Date 16 Sept 2024

Figure B-009

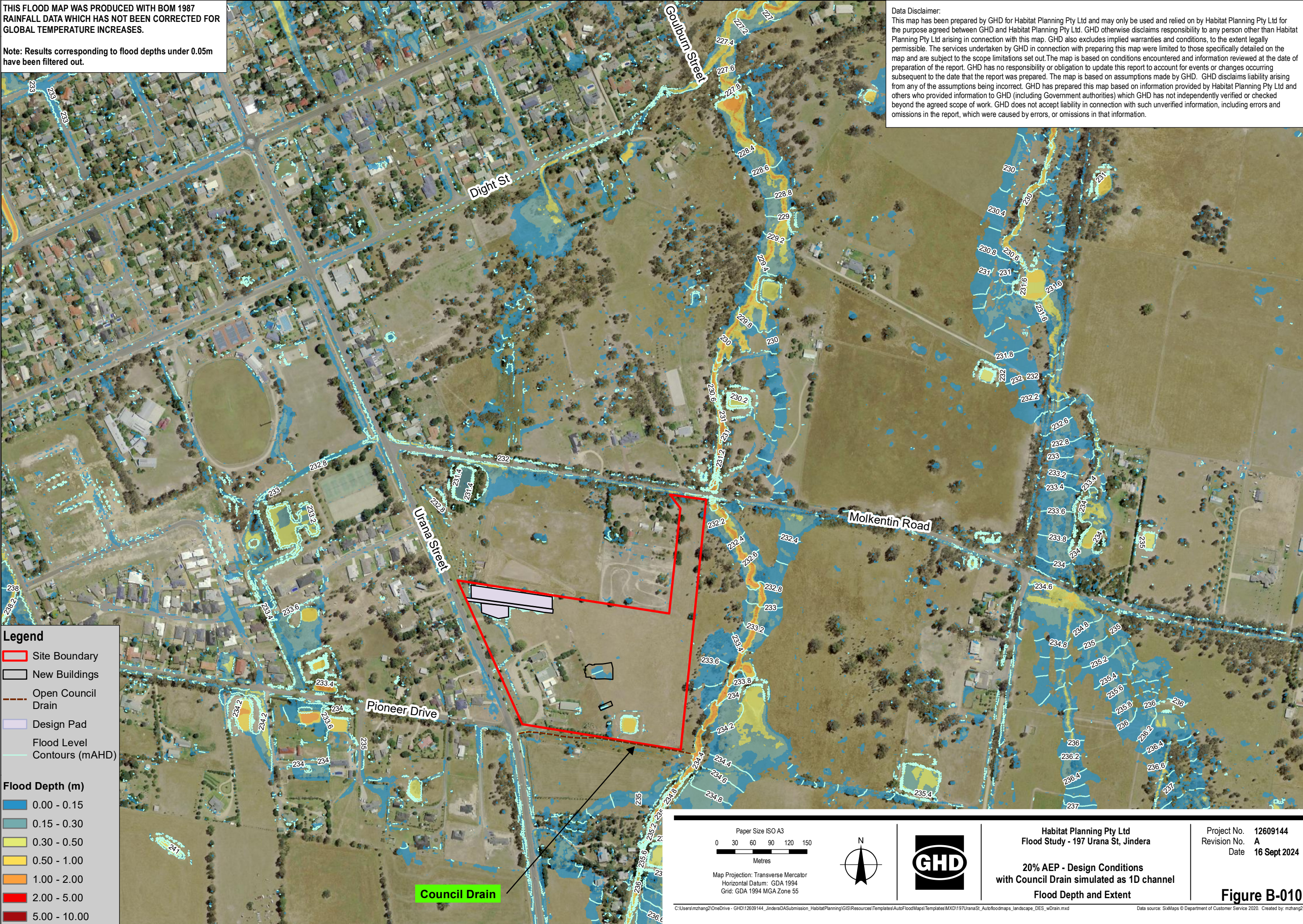


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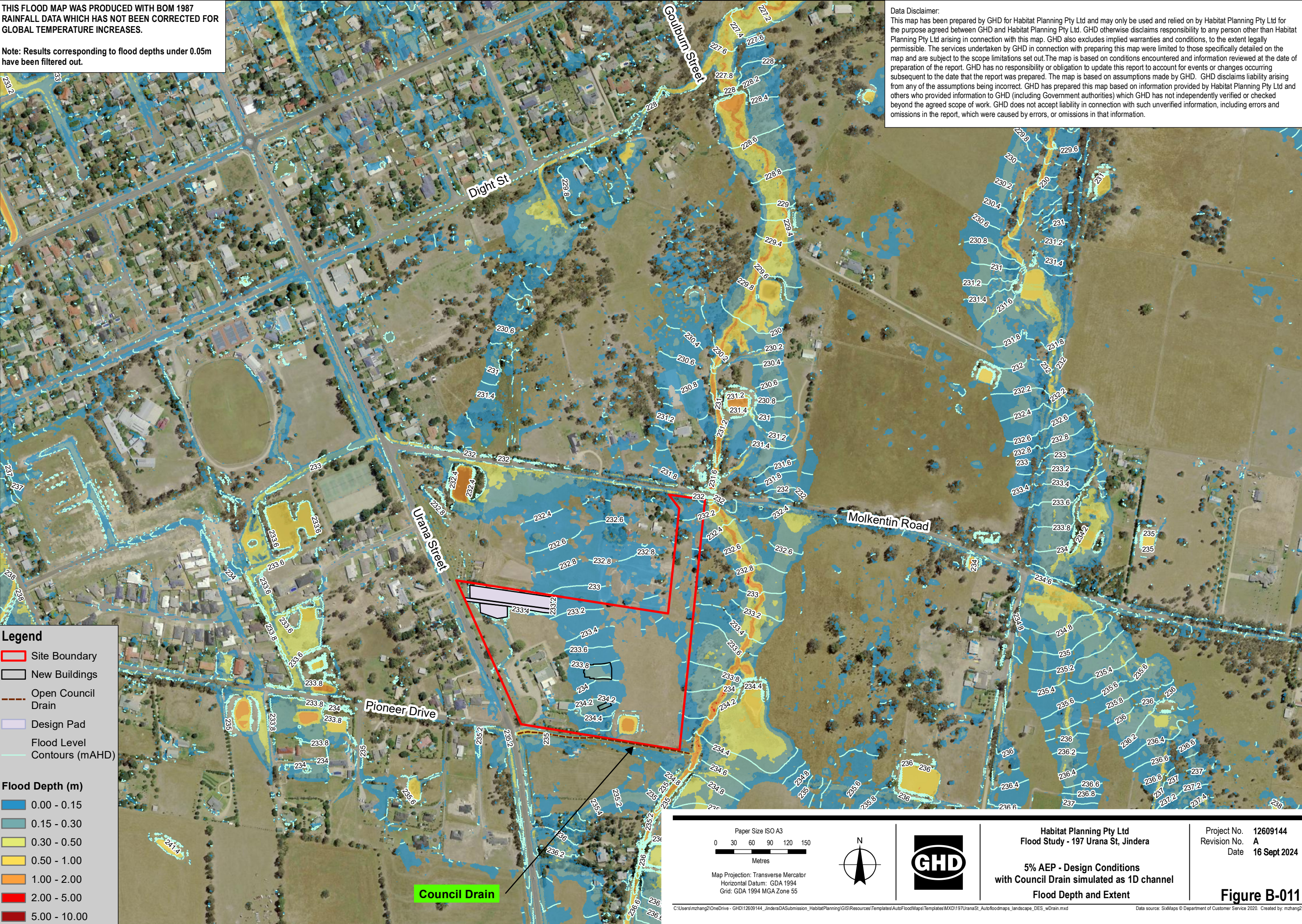




THIS FLOOD MAP WAS PRODUCED WITH BOM 1987 RAINFALL DATA WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES.

Note: Results corresponding to flood depths under 0.05m have been filtered out.

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**Legend**

Site Boundary

New Buildings

Open Council Drain

Design Pad

Flood Level Contours (mAHD)

**Flood Depth (m)**

0.00 - 0.15

0.15 - 0.30

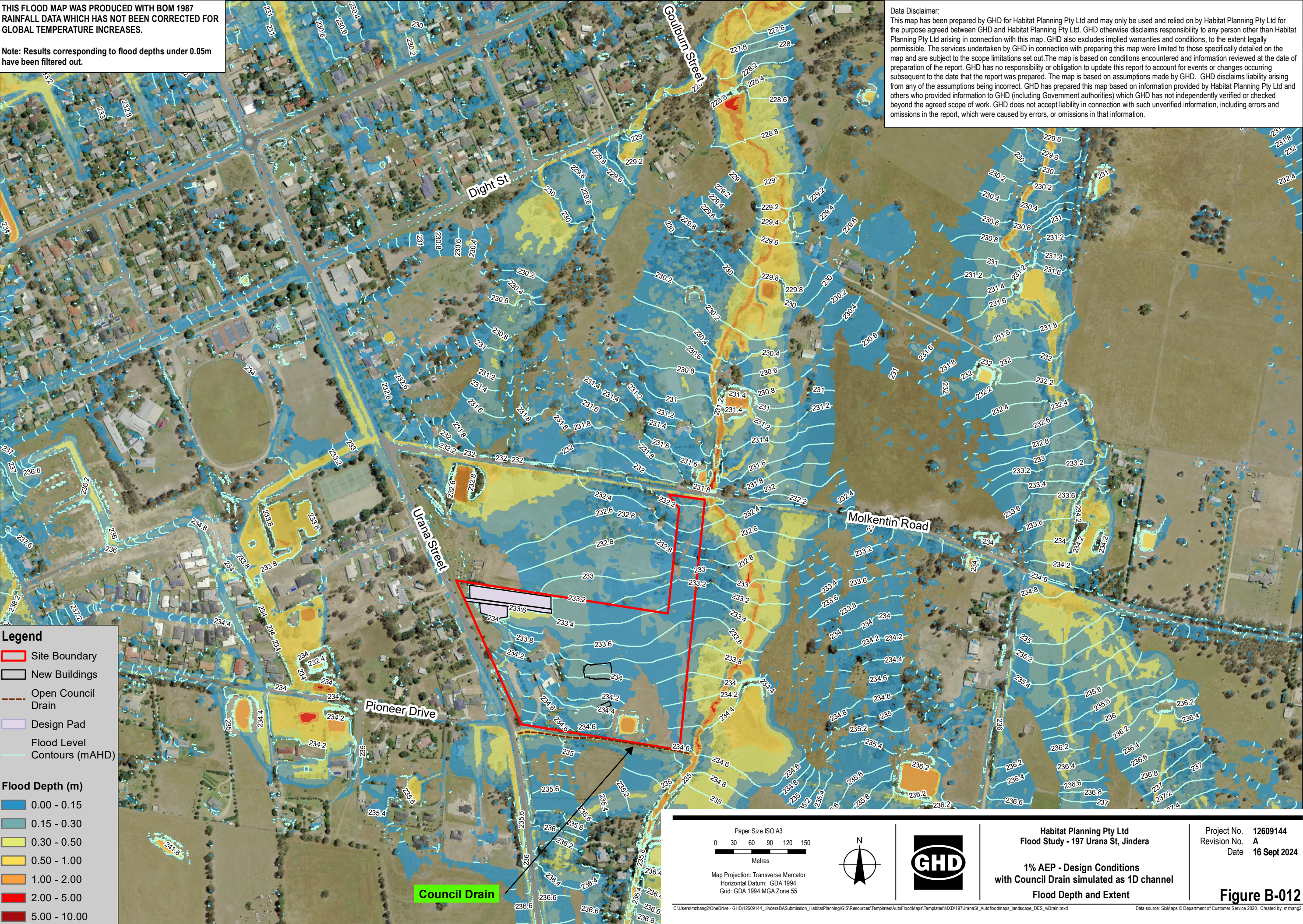
0.30 - 0.50

0.50 - 1.00

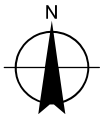
1.00 - 2.00

2.00 - 5.00

5.00 - 10.00



Paper Size ISO A3  
0 30 60 90 120 150  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



Habitat Planning Pty Ltd  
Flood Study - 197 Urana St, Jindera  
  
1% AEP - Design Conditions  
with Council Drain simulated as 1D channel  
Flood Depth and Extent

Project No. 12609144  
Revision No. A  
Date 16 Sept 2024

Figure B-012

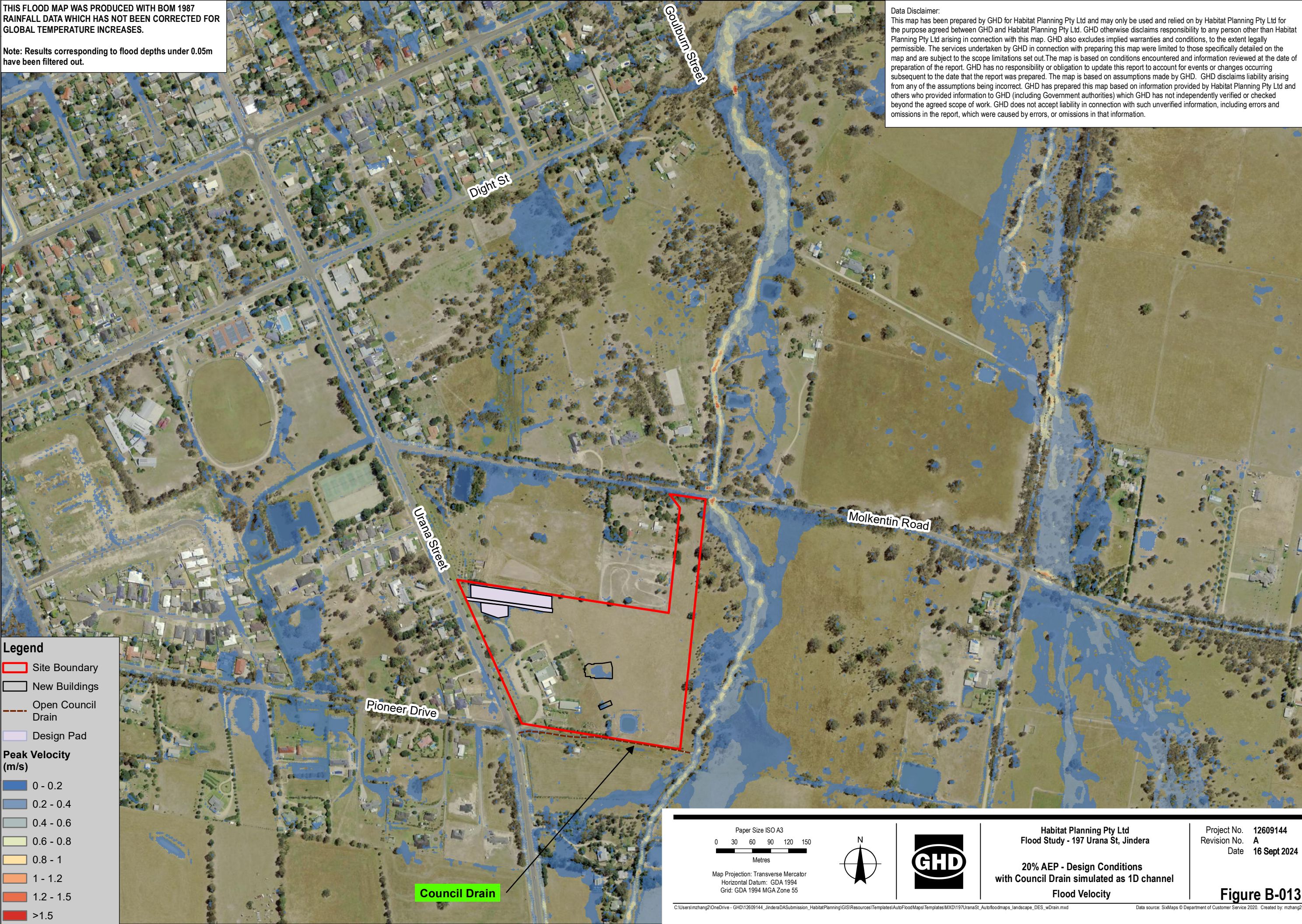


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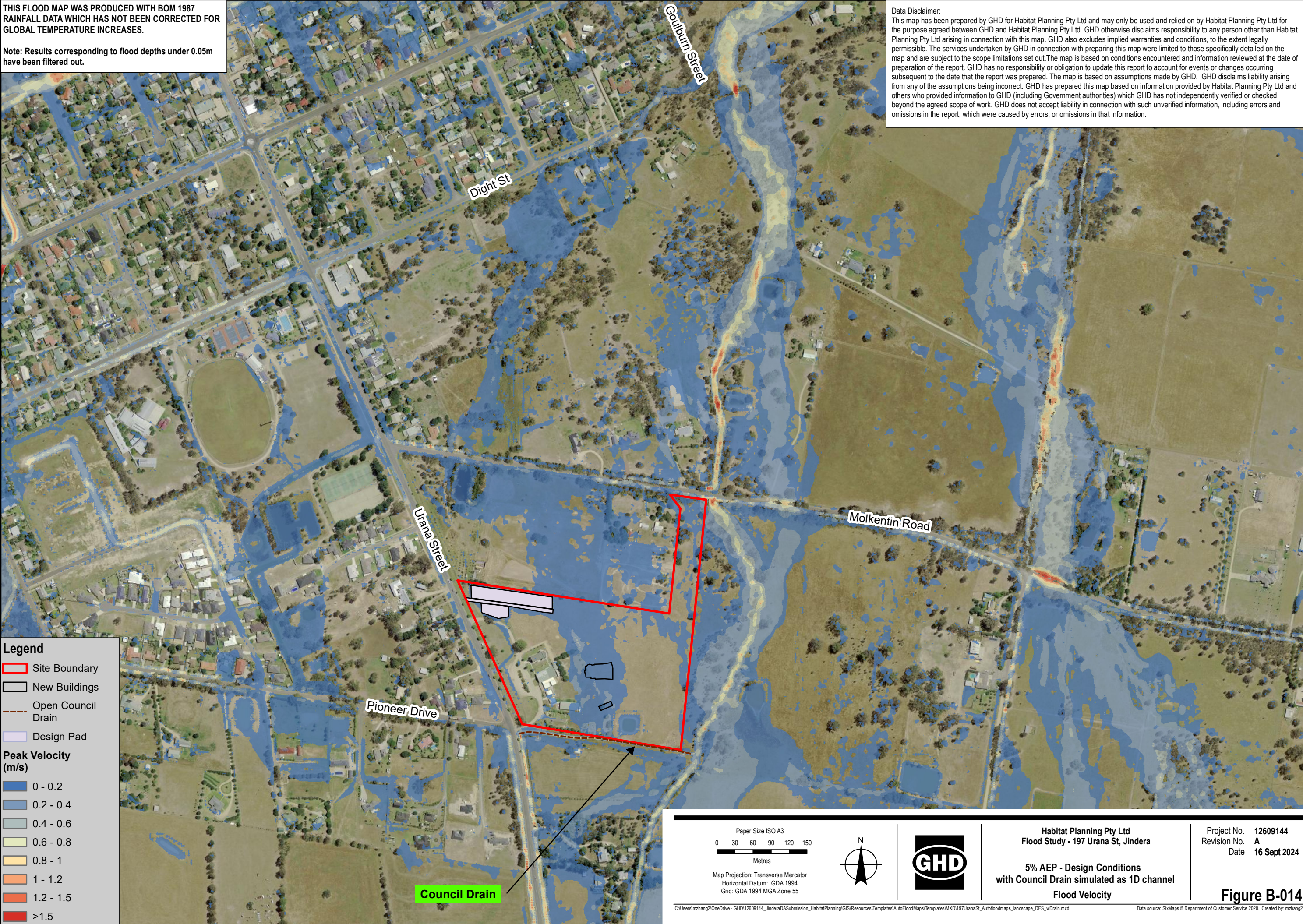


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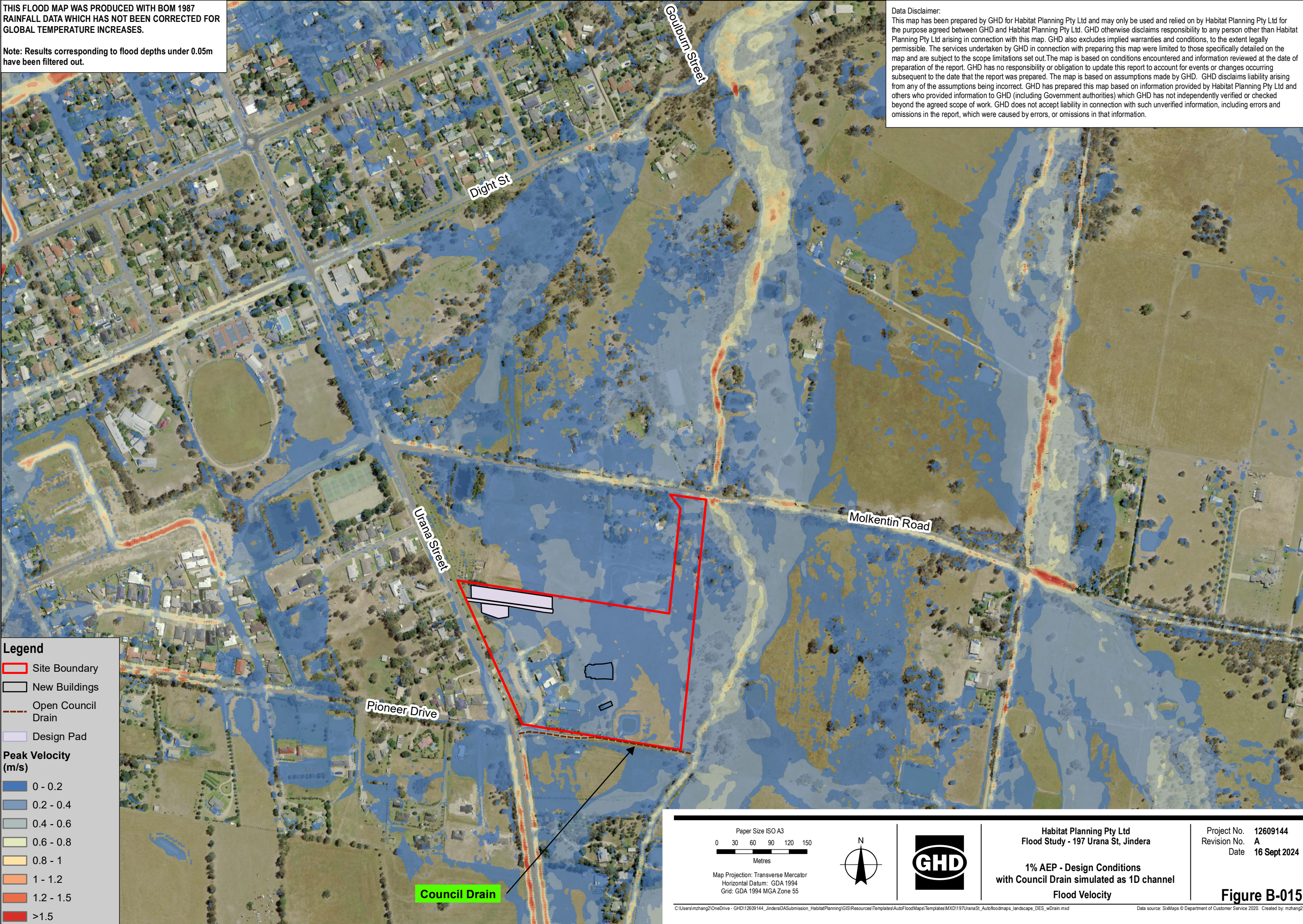


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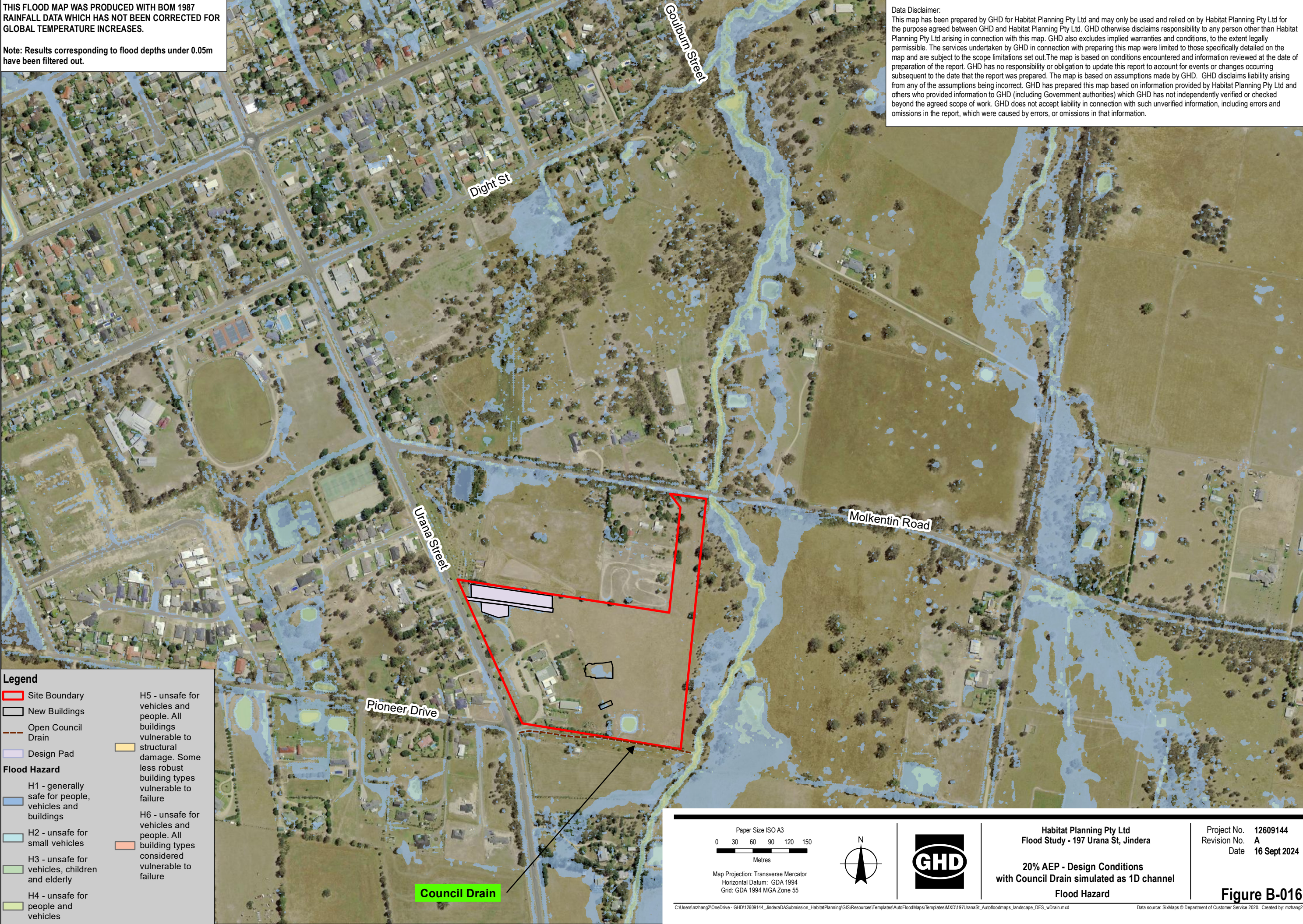


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Paper Size ISO A3

0 30 60 90 120 150

Metres

Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55

Habitat Planning Pty Ltd  
Flood Study - 197 Urana St, Jindera

20% AEP - Design Conditions  
with Council Drain simulated as 1D channel  
Flood Hazard

Project No. 12609144  
Revision No. A  
Date 16 Sept 2024

Figure B-016

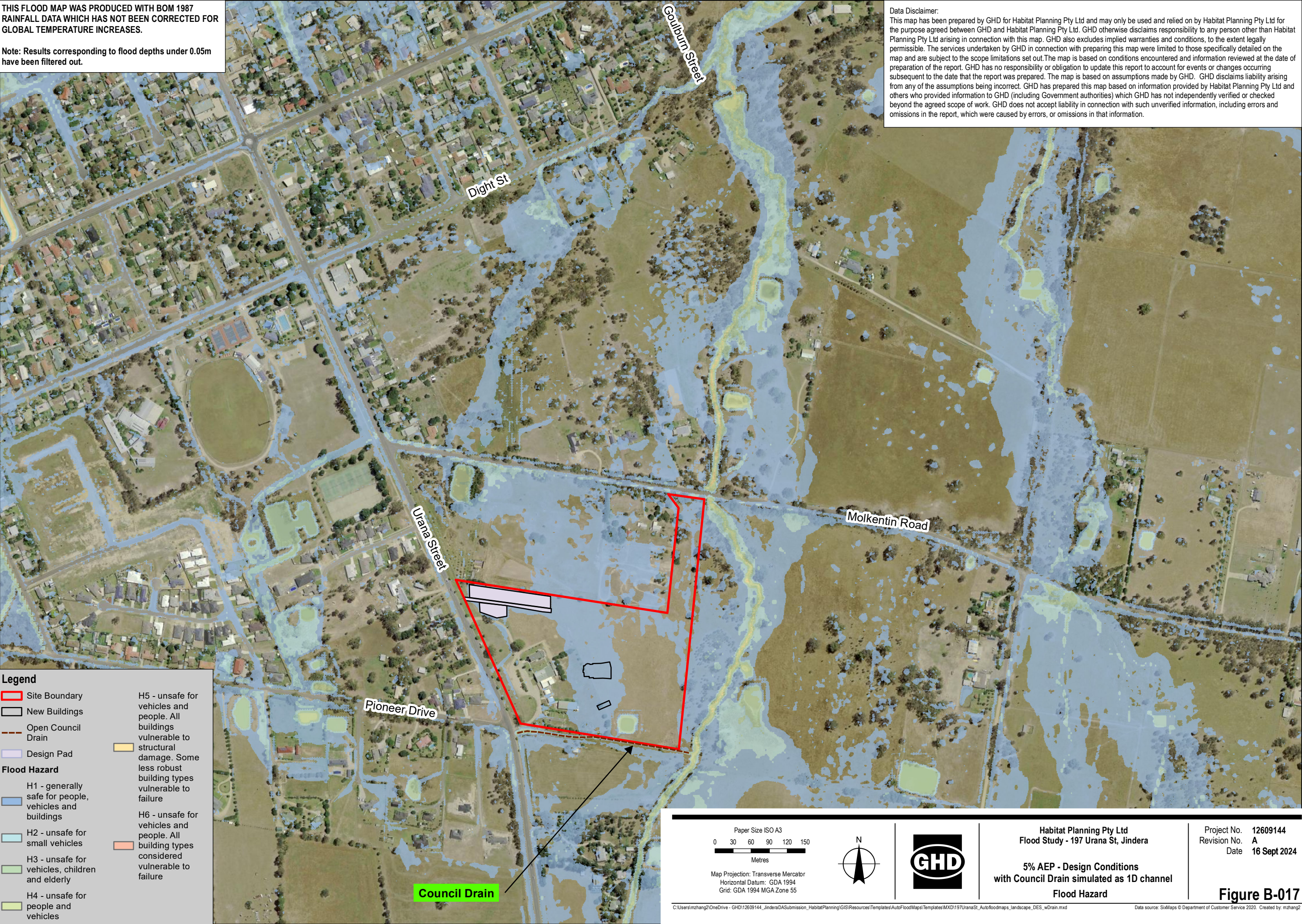


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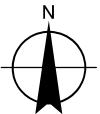
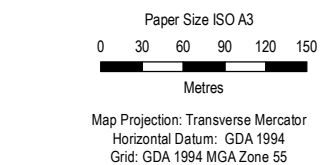
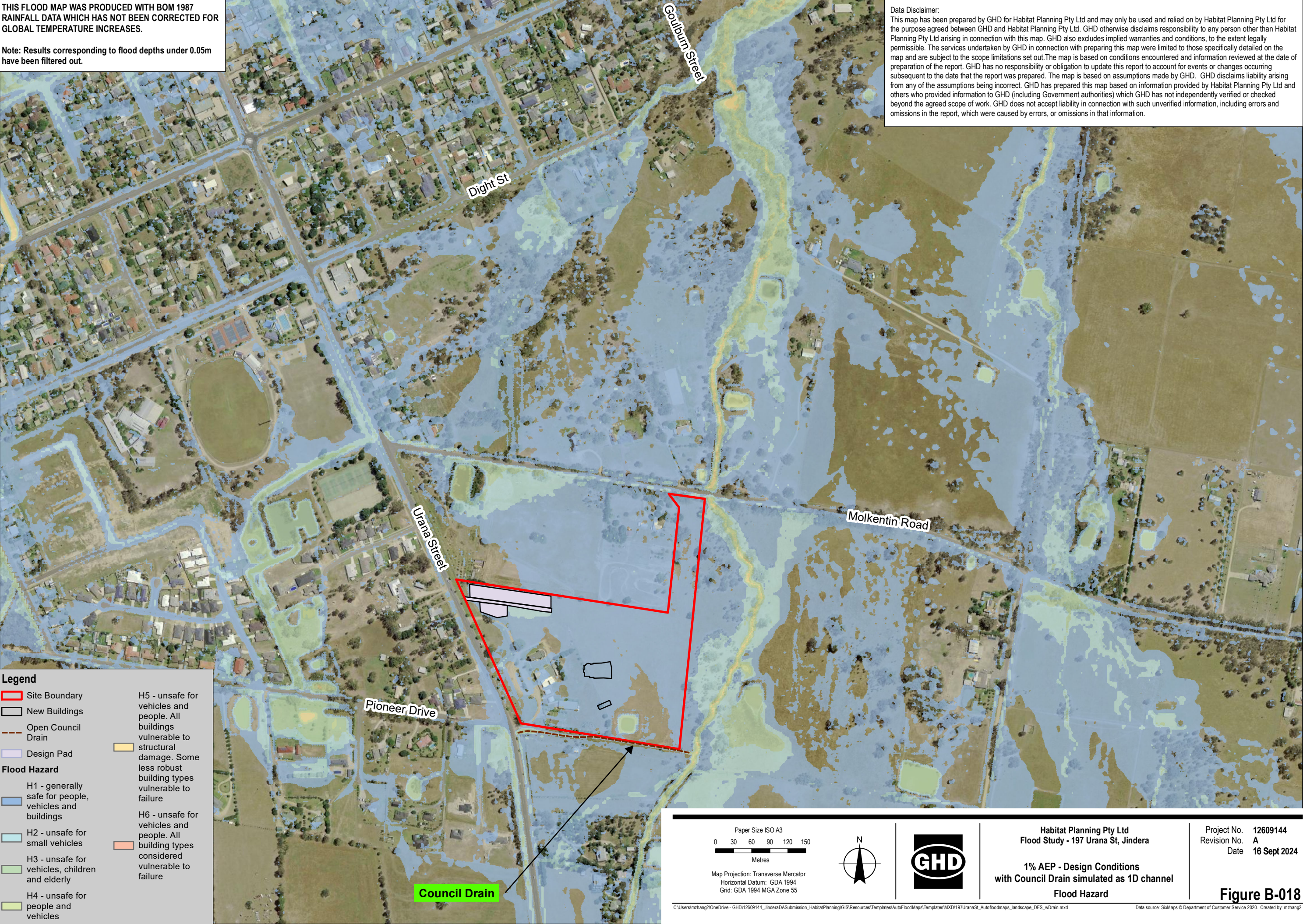


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Habitat Planning Pty Ltd Flood Study - 197 Urana St, Jindera	Project No. 12609144 Revision No. A Date 16 Sept 2024
1% AEP - Design Conditions with Council Drain simulated as 1D channel Flood Hazard	<b>Figure B-018</b>



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**Legend**

Site Boundary

New Buildings

Open Council Drain

Design Pad

**Flood Afflux (mm)**

> -500mm

-500 - -400

-400 - -300

-300 - -200

-200 - -100

-100 - -50

-50 - -25

-25 - -10

-10 - +10

+10 - +25

+25 - +50

+50 - +100

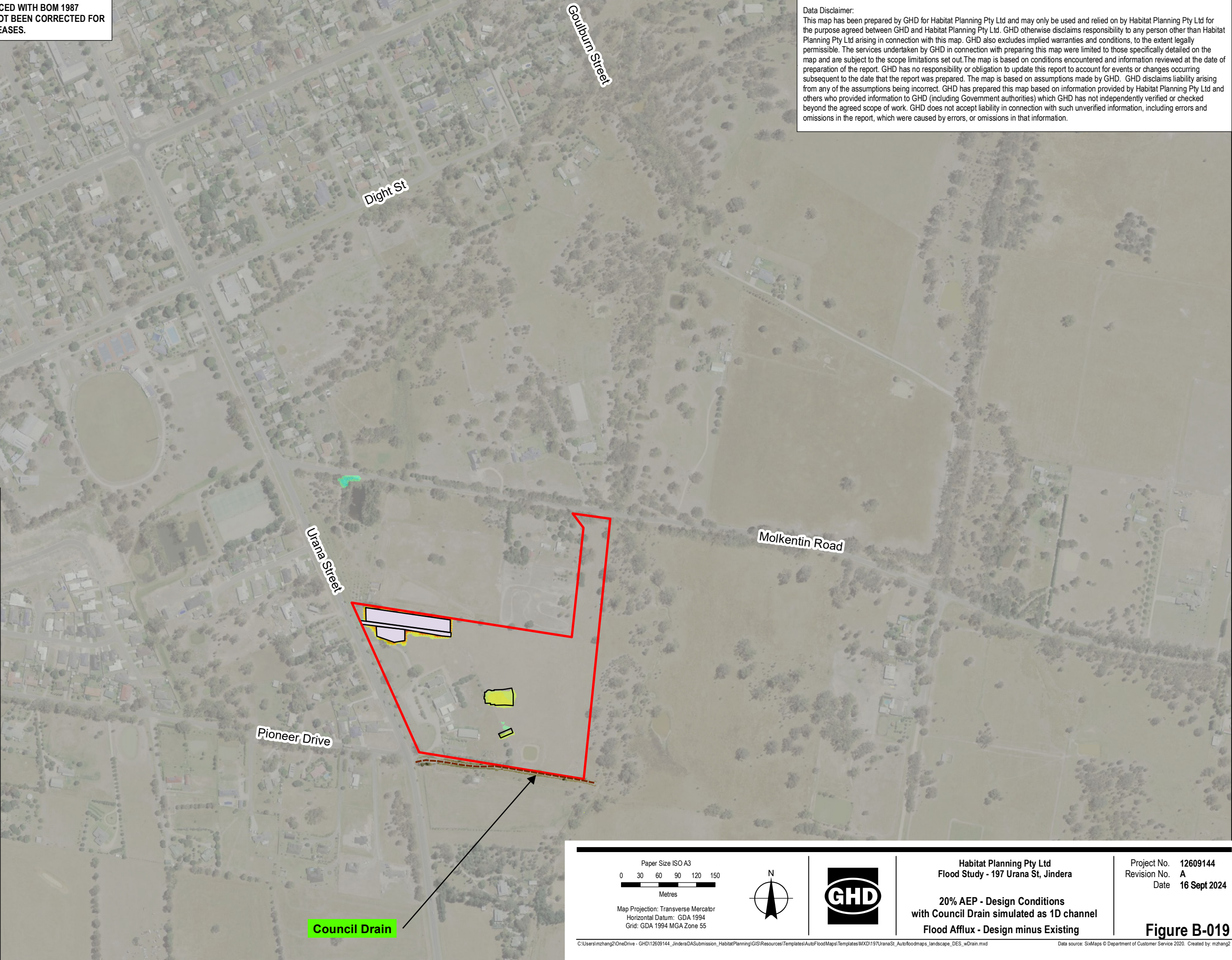
+100 - +200

+200 - +300

+300 - +400

+400 - +500

> +500



Paper Size ISO A3

0 30 60 90 120 150

Metres

Map Projection: Transverse Mercator

Horizontal Datum: GDA 1994

Grid: GDA 1994 MGA Zone 55

N

Habitat Planning Pty Ltd

Flood Study - 197 Urana St, Jindera

20% AEP - Design Conditions

with Council Drain simulated as 1D channel

Flood Afflux - Design minus Existing

Project No. 12609144

Revision No. A

Date 16 Sept 2024

Figure B-019



THIS FLOOD MAP WAS PRODUCED WITH BOM 1987 RAINFALL DATA WHICH HAS NOT BEEN CORRECTED FOR GLOBAL TEMPERATURE INCREASES.

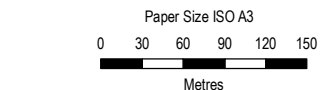
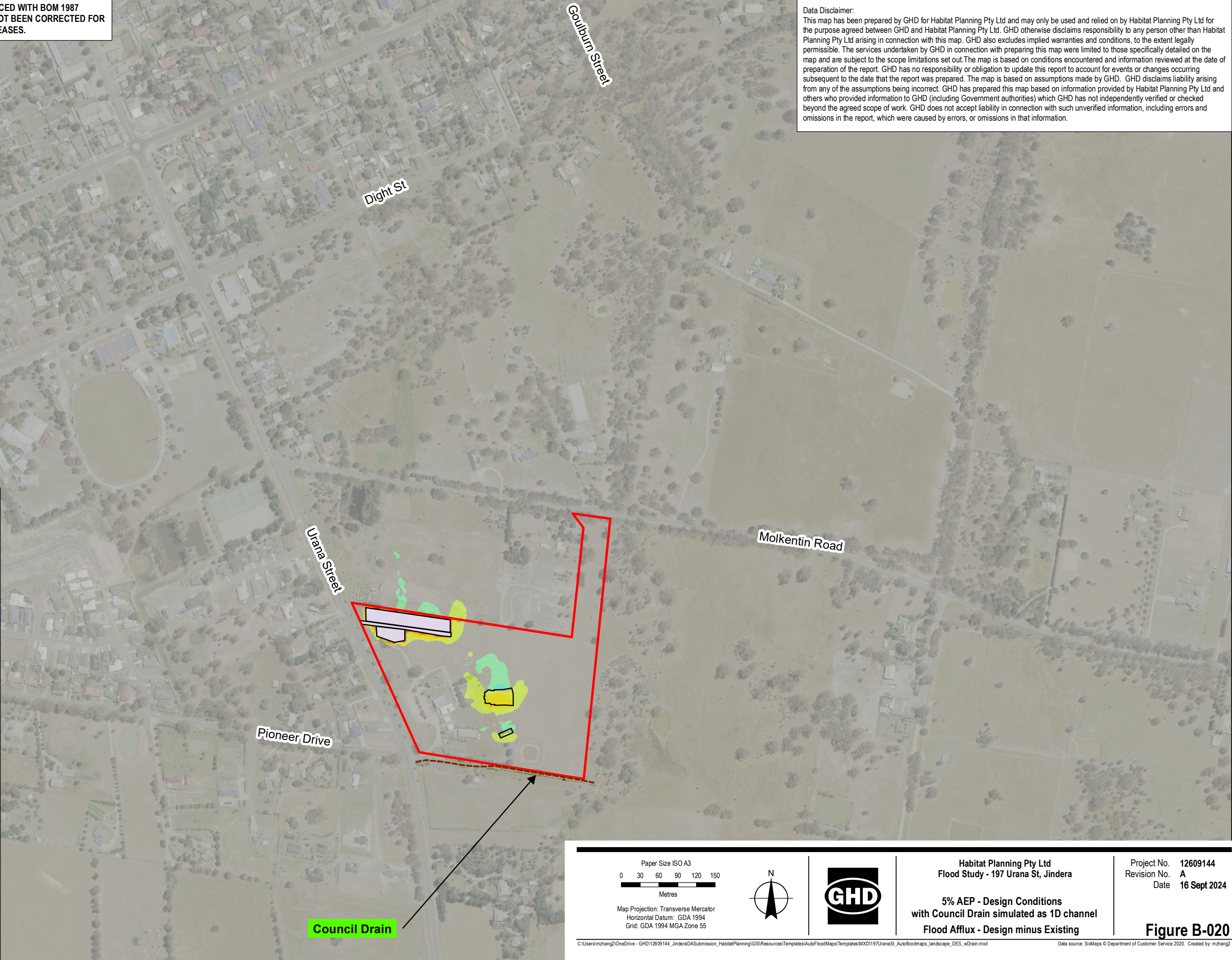
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Legend

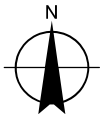
- Site Boundary
- New Buildings
- Open Council Drain
- Design Pad

Flood Afflux (mm)

- > -500mm
- 500 - -400
- 400 - -300
- 300 - -200
- 200 - -100
- 100 - -50
- 50 - -25
- 25 - -10
- 10 - +10
- +10 - +25
- +25 - +50
- +50 - +100
- +100 - +200
- +200 - +300
- +300 - +400
- +400 - +500
- > +500



Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



Habitat Planning Pty Ltd  
Flood Study - 197 Urana St, Jindera  
  
5% AEP - Design Conditions  
with Council Drain simulated as 1D channel  
Flood Afflux - Design minus Existing

Project No. 12609144  
Revision No. A  
Date 16 Sept 2024

Figure B-020



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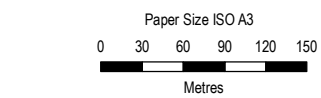
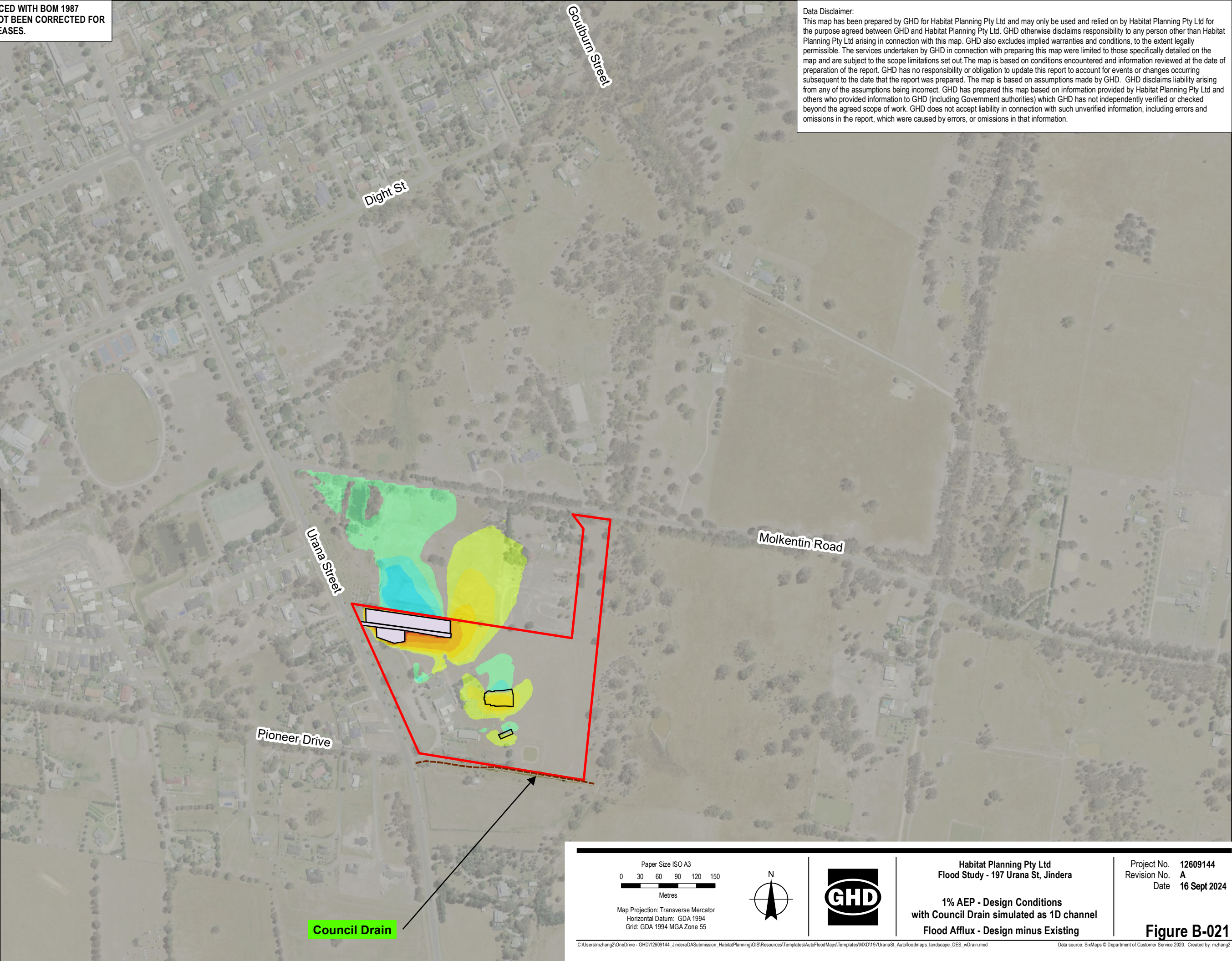
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Legend

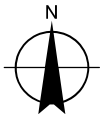
- Site Boundary
- New Buildings
- Open Council Drain
- Design Pad

Flood Afflux (mm)

- > -500mm
- 500 - -400
- 400 - -300
- 300 - -200
- 200 - -100
- 100 - -50
- 50 - -25
- 25 - -10
- 10 - +10
- +10 - +25
- +25 - +50
- +50 - +100
- +100 - +200
- +200 - +300
- +300 - +400
- +400 - +500
- > +500



Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



Habitat Planning Pty Ltd  
Flood Study - 197 Urana St, Jindera  
  
1% AEP - Design Conditions  
with Council Drain simulated as 1D channel  
Flood Afflux - Design minus Existing

Project No. 12609144  
Revision No. A  
Date 16 Sept 2024

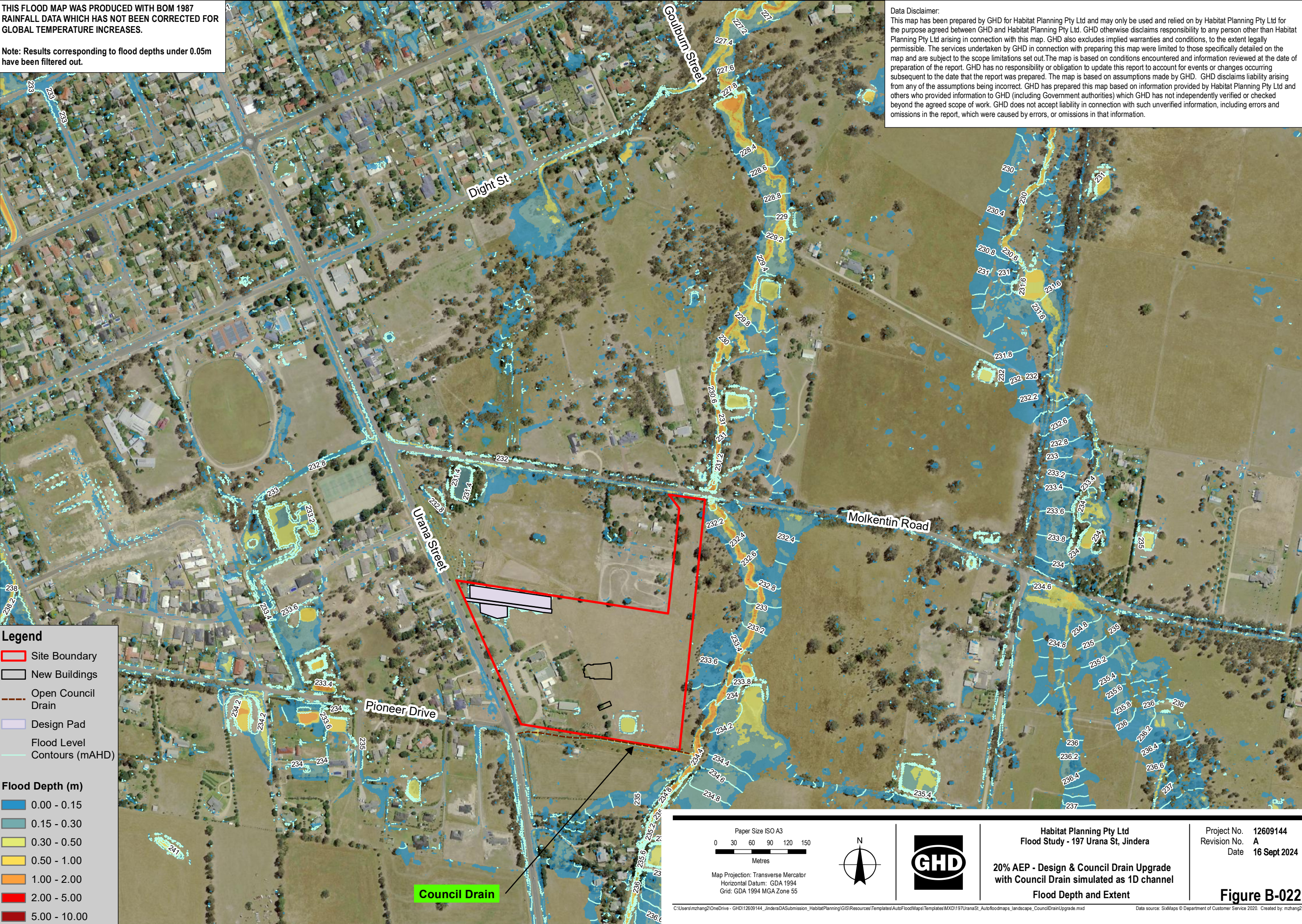
Figure B-021



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**Legend**

- Site Boundary
- New Buildings
- Open Council Drain
- Design Pad
- Flood Level Contours (mAHD)

**Flood Depth (m)**

- 0.00 - 0.15
- 0.15 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- 2.00 - 5.00
- 5.00 - 10.00

Paper Size ISO A3

0 30 60 90 120 150

Metres

Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55

N

Habitat Planning Pty Ltd  
Flood Study - 197 Urana St, Jindera

**20% AEP - Design & Council Drain Upgrade  
with Council Drain simulated as 1D channel**

**Flood Depth and Extent**

Project No. 12609144  
Revision No. A  
Date 16 Sept 2024

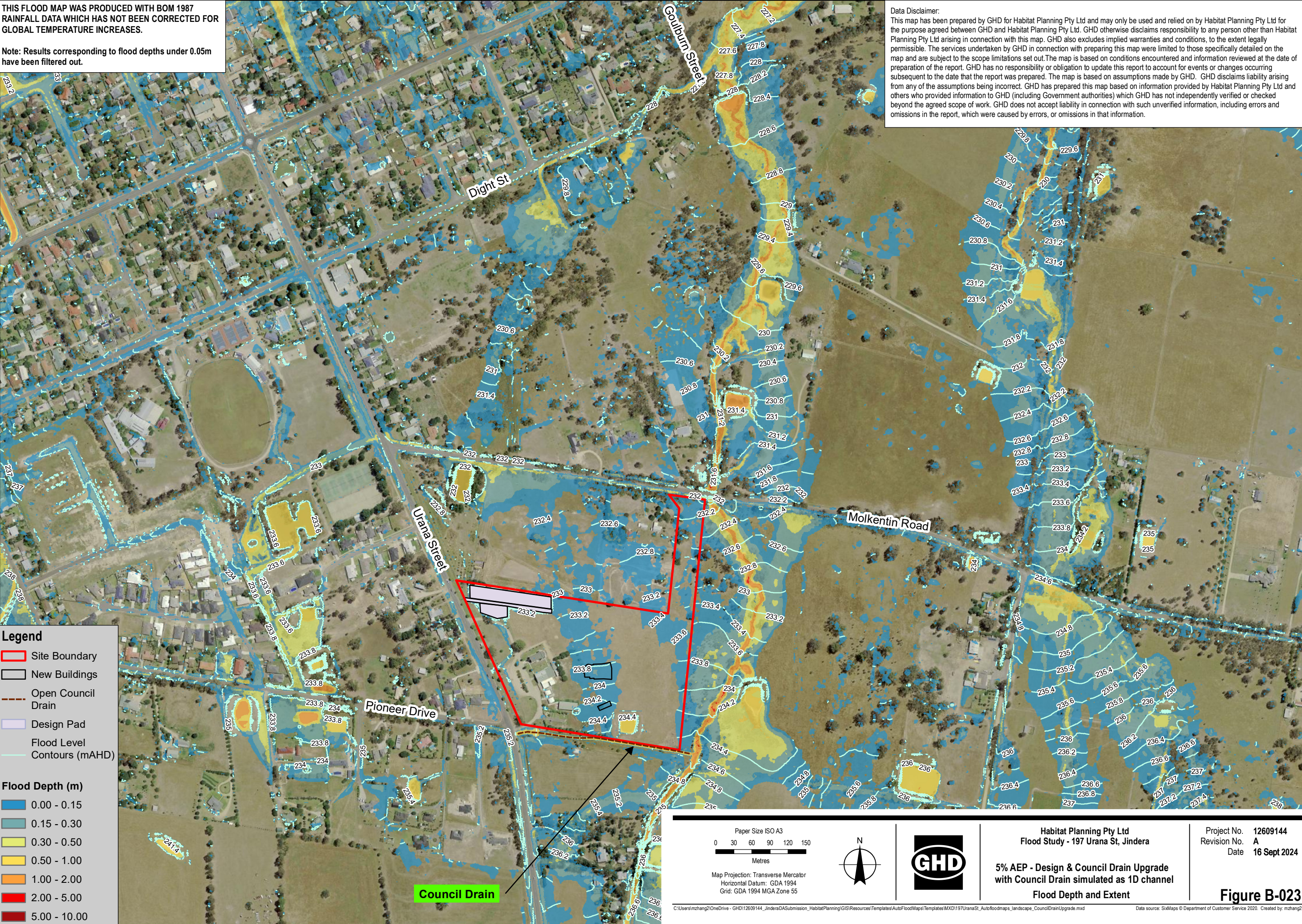
**Figure B-022**



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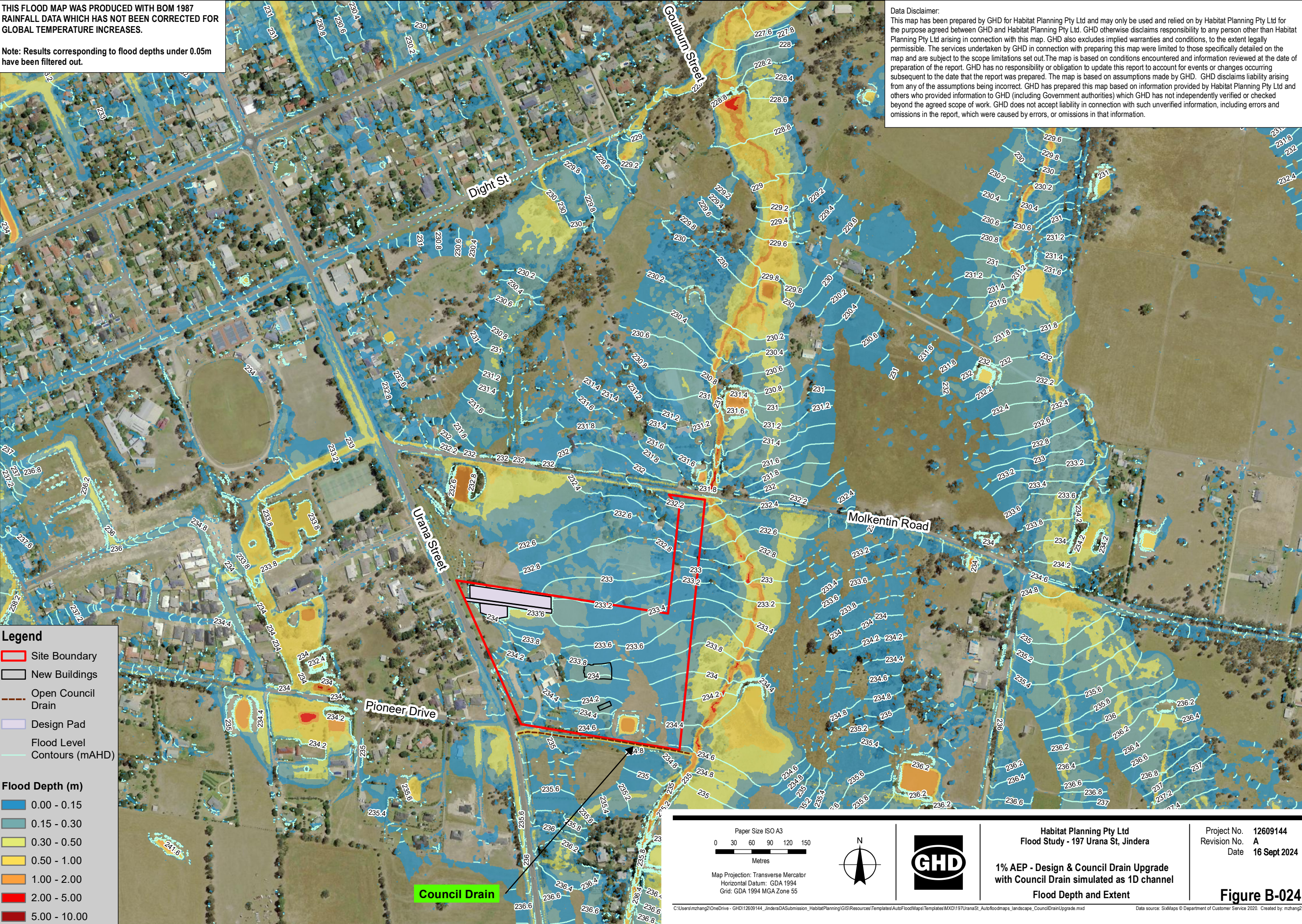




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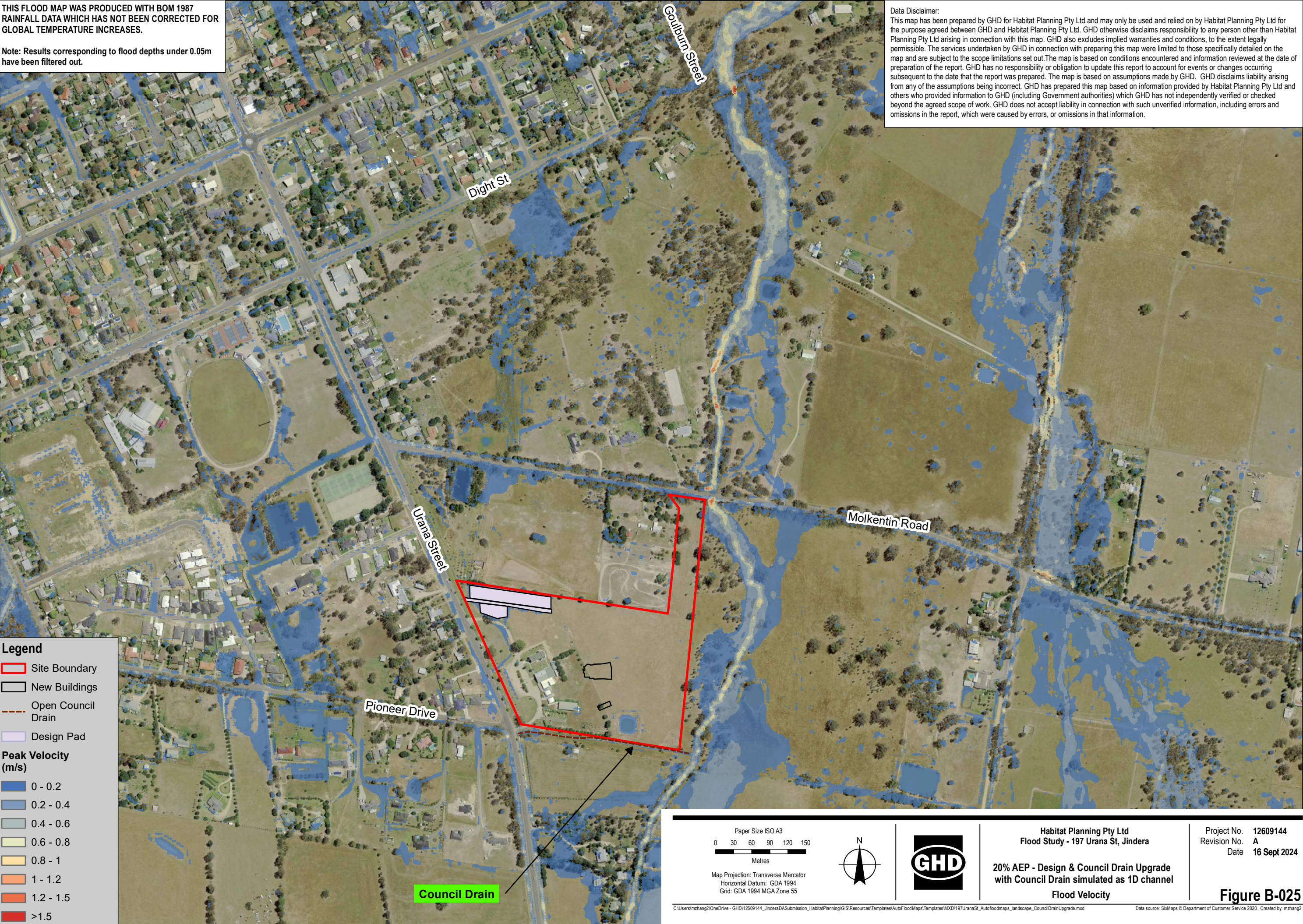




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<p>Paper Size ISO A3</p> <p>0 30 60 90 120 150</p> <p>Metres</p> <p>Map Projection: Transverse Mercator Horizontal Datum: GDA 1994 Grid: GDA 1994 MGA Zone 55</p>			<p>Habitat Planning Pty Ltd Flood Study - 197 Urana St, Jindera</p> <p><b>20% AEP - Design &amp; Council Drain Upgrade with Council Drain simulated as 1D channel</b></p> <p>Flood Velocity</p>	<p>Project No. 12609144 Revision No. A Date 16 Sept 2024</p>
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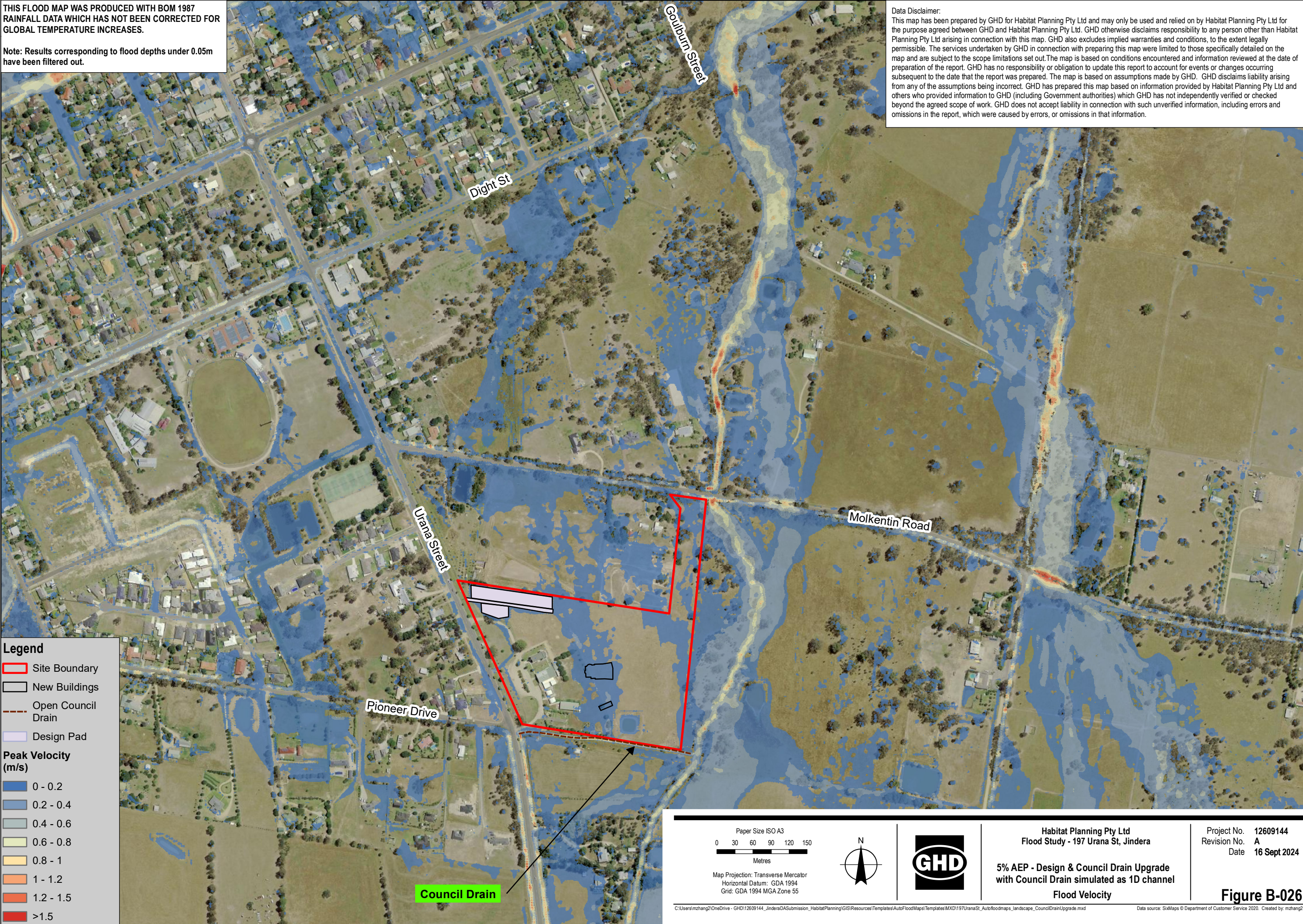


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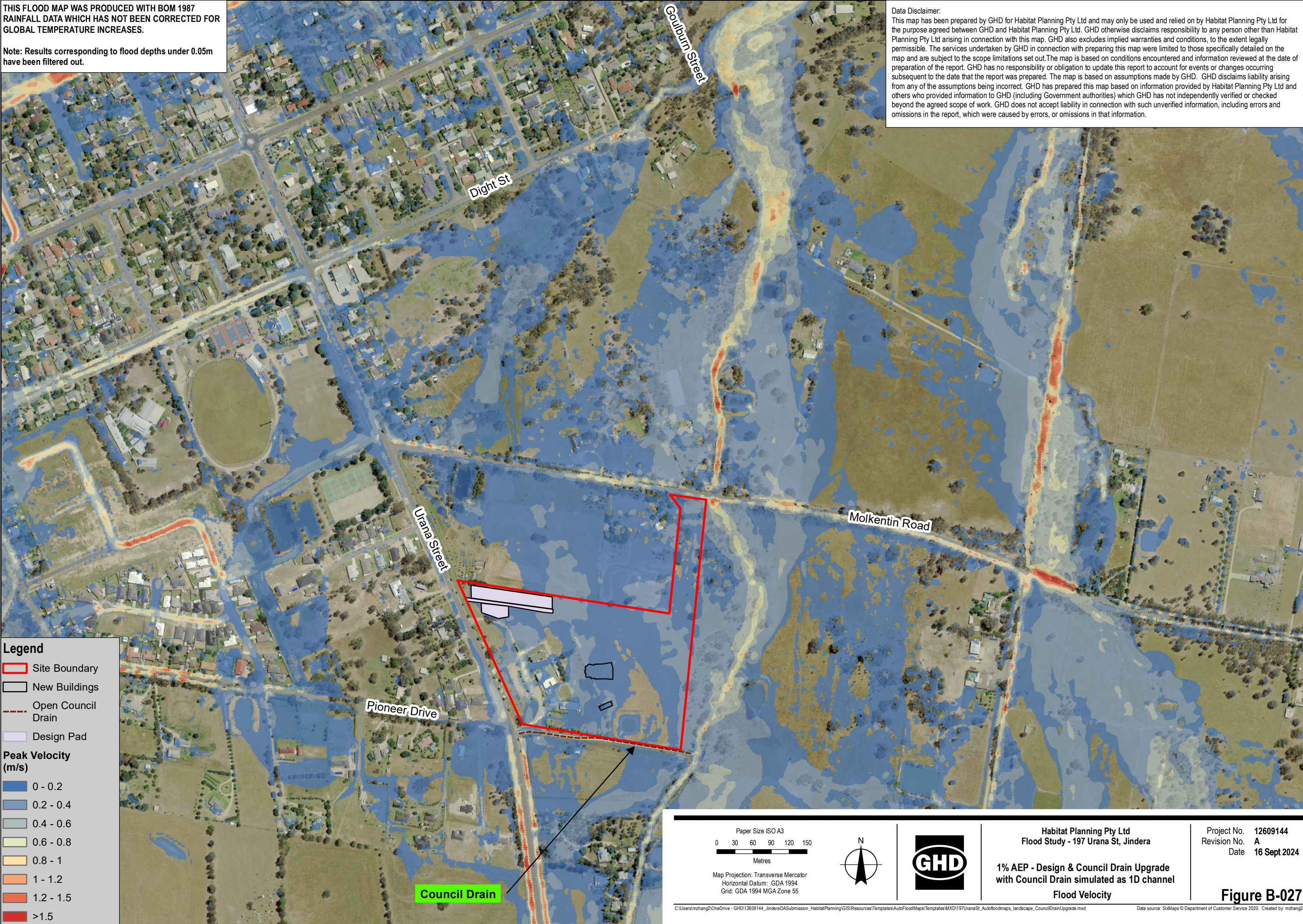


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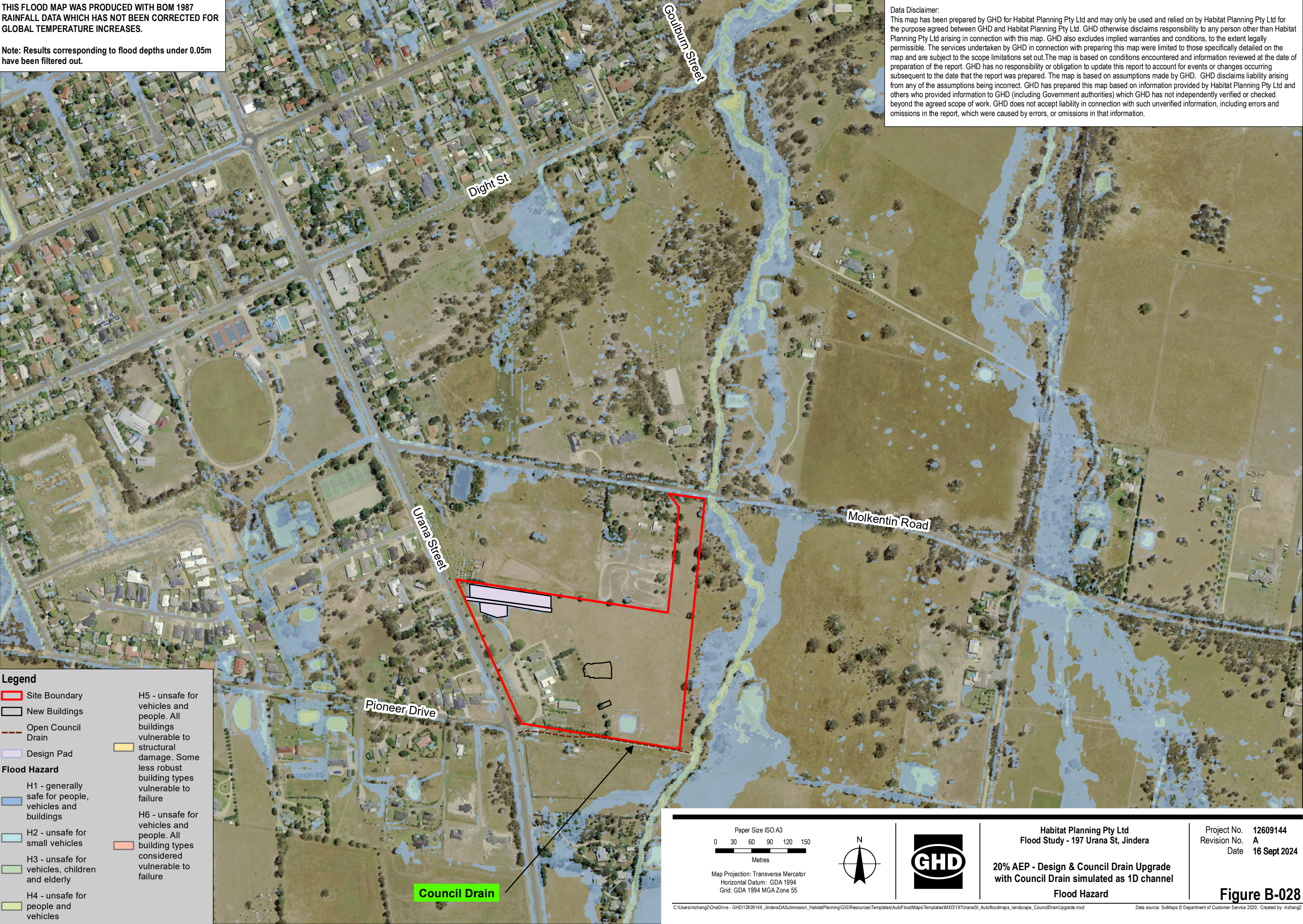


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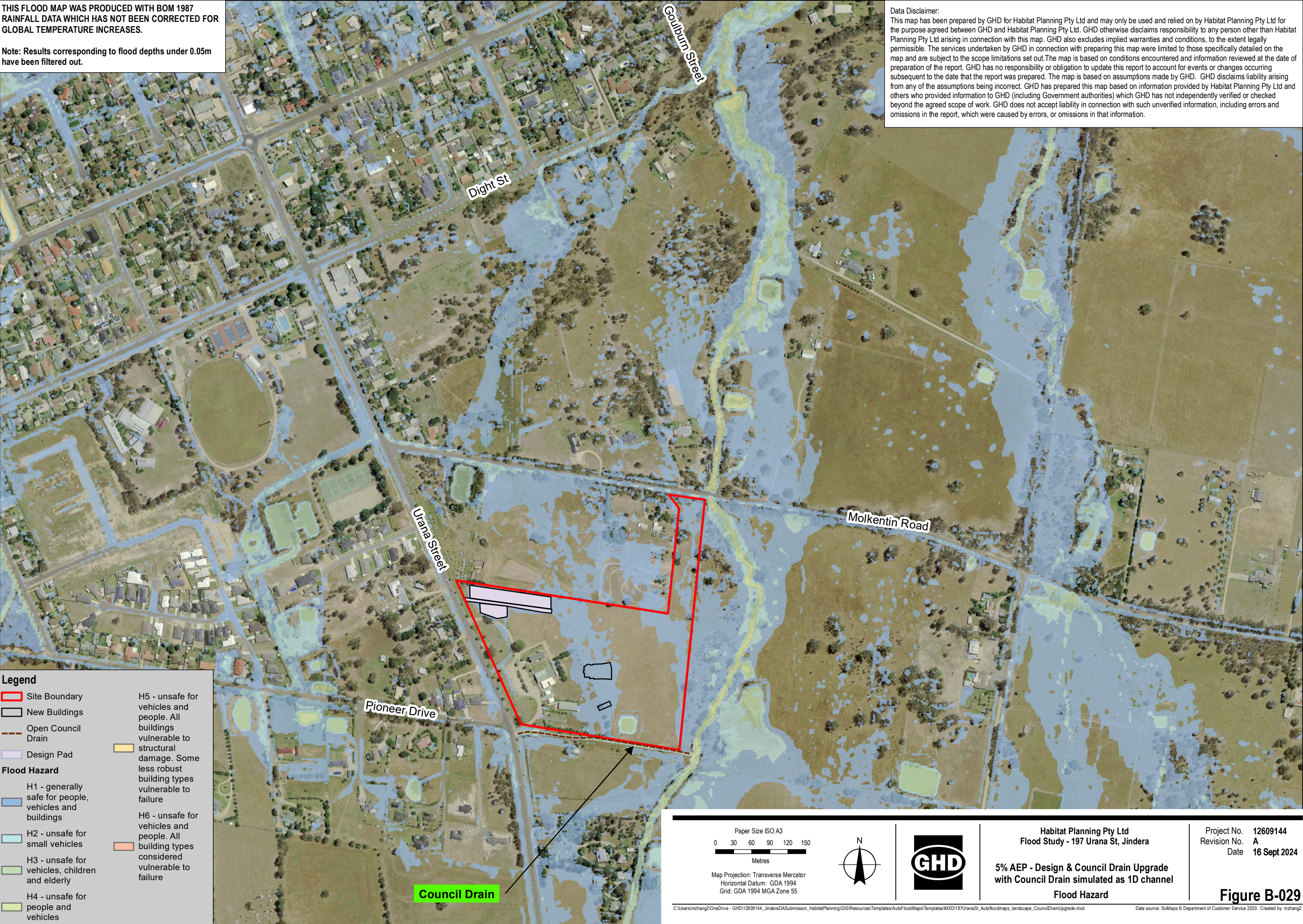


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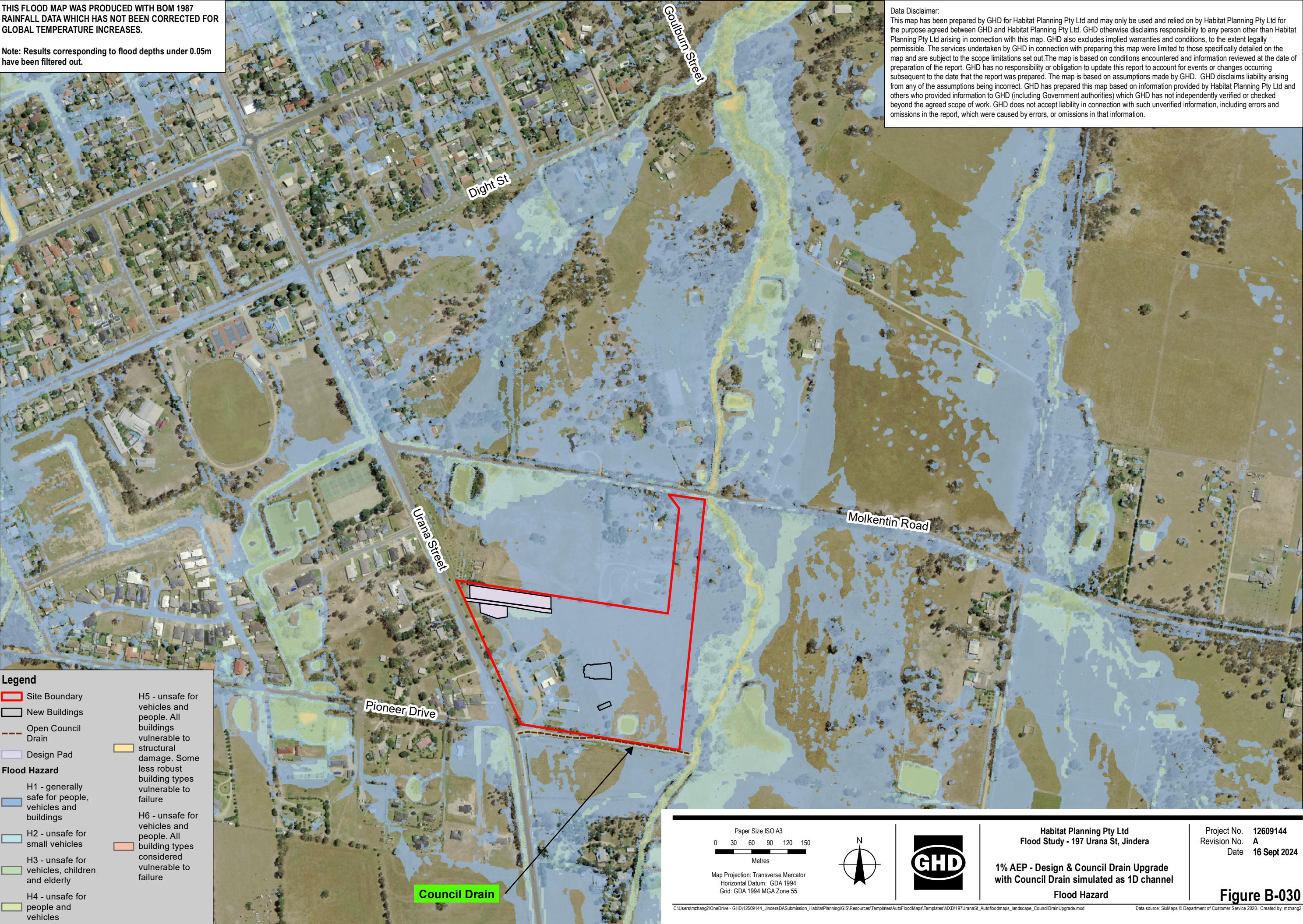


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Paper Size ISO A3

0 30 60 90 120 150

Metres

Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55

Habitat Planning Pty Ltd  
Flood Study - 197 Urana St, Jindera

1% AEP - Design & Council Drain Upgrade  
with Council Drain simulated as 1D channel

Flood Hazard

Project No. 12609144  
Revision No. A  
Date 16 Sept 2024



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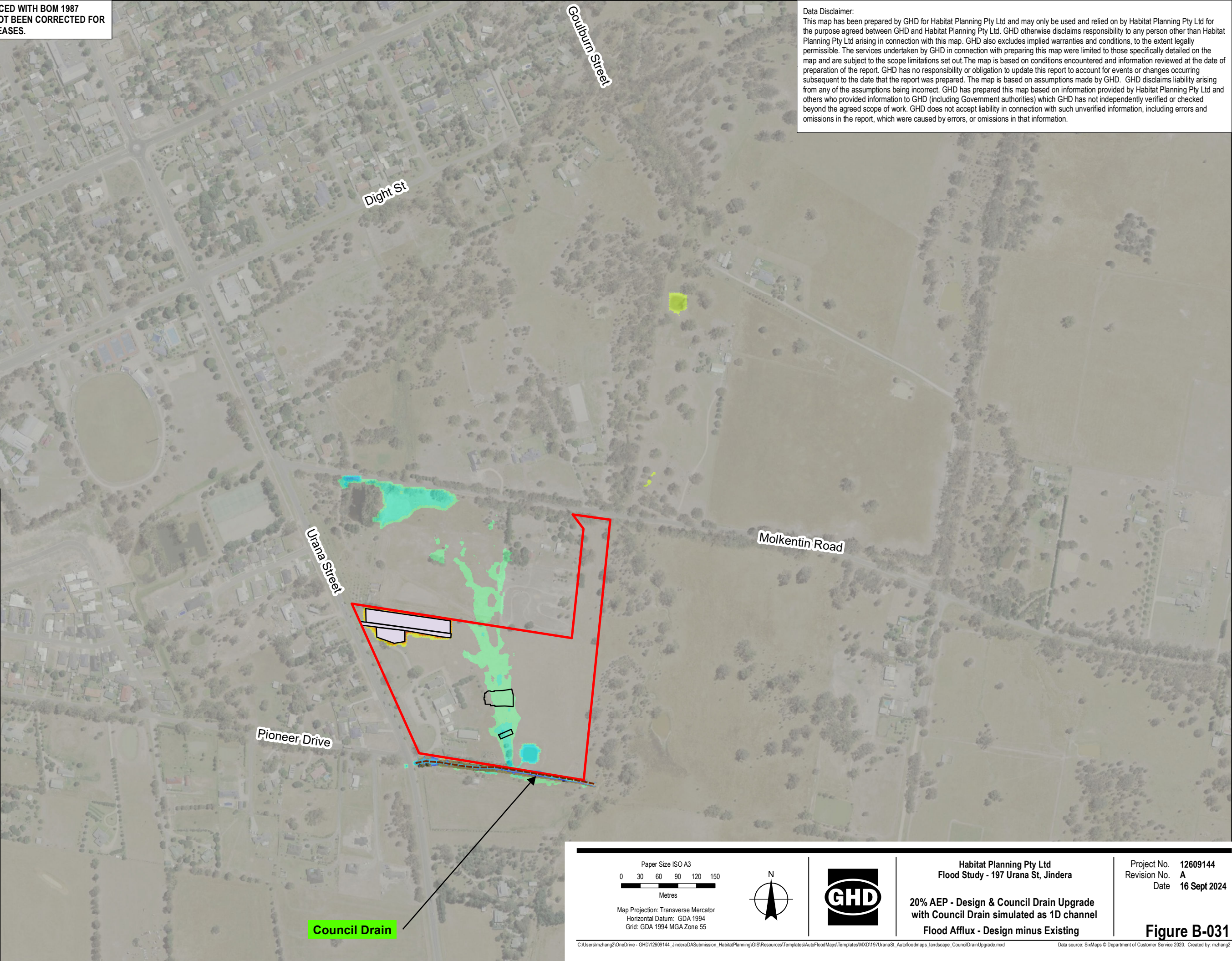
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Legend

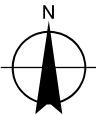
- Site Boundary
- New Buildings
- Open Council Drain
- Design Pad

Flood Afflux (mm)

- > -500mm
- 500 - -400
- 400 - -300
- 300 - -200
- 200 - -100
- 100 - -50
- 50 - -25
- 25 - -10
- 10 - +10
- +10 - +25
- +25 - +50
- +50 - +100
- +100 - +200
- +200 - +300
- +300 - +400
- +400 - +500
- > +500



Paper Size ISO A3  
0 30 60 90 120 150  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



Habitat Planning Pty Ltd  
Flood Study - 197 Urana St, Jindera  
20% AEP - Design & Council Drain Upgrade  
with Council Drain simulated as 1D channel  
Flood Afflux - Design minus Existing

Project No. 12609144  
Revision No. A  
Date 16 Sept 2024

Figure B-031



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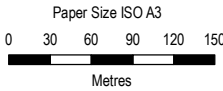
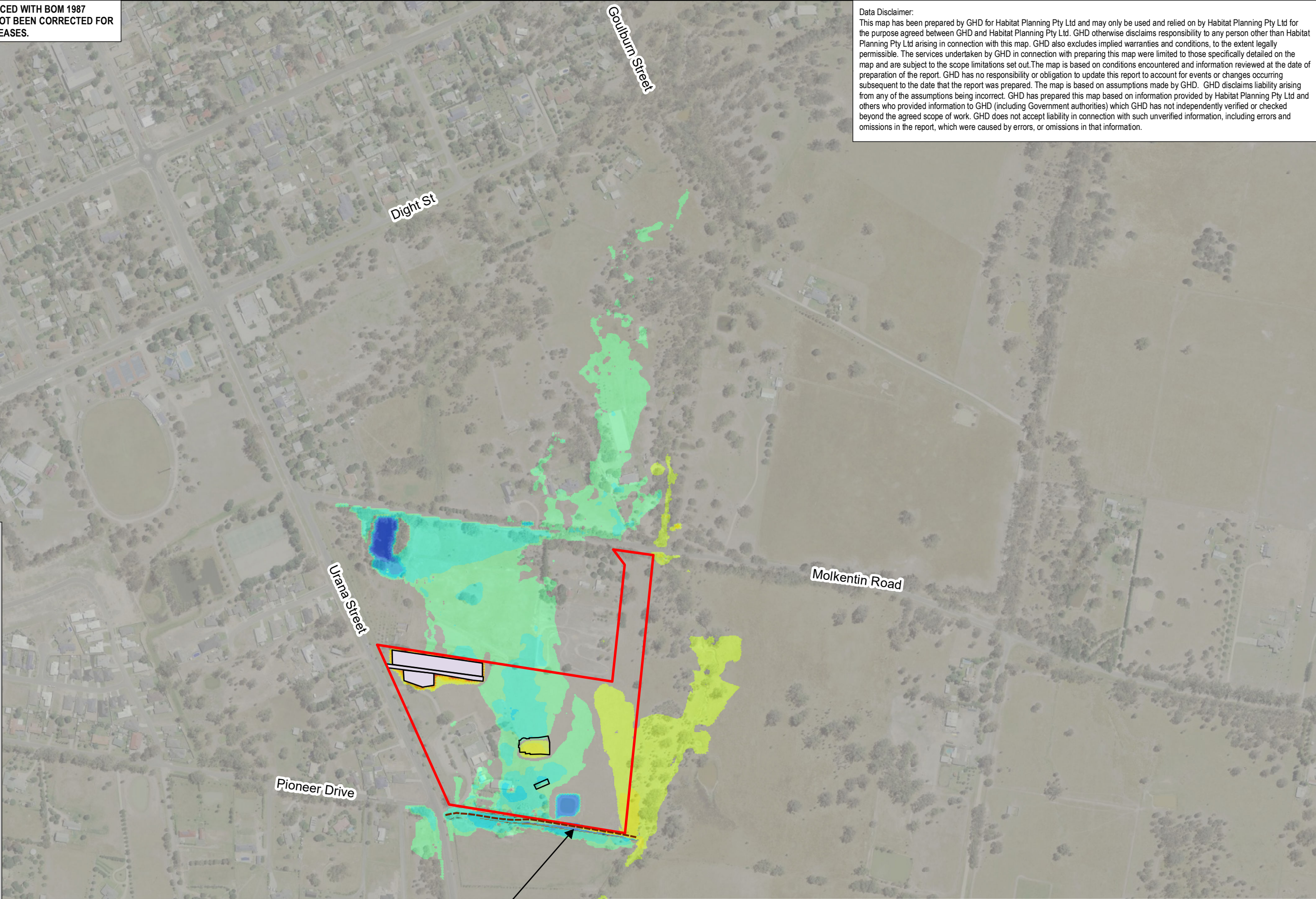
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Legend

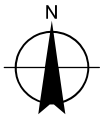
- Site Boundary
- New Buildings
- Open Council Drain
- Design Pad

Flood Afflux (mm)

- > -500mm
- 500 - -400
- 400 - -300
- 300 - -200
- 200 - -100
- 100 - -50
- 50 - -25
- 25 - -10
- 10 - +10
- +10 - +25
- +25 - +50
- +50 - +100
- +100 - +200
- +200 - +300
- +300 - +400
- +400 - +500
- > +500



Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



Habitat Planning Pty Ltd  
Flood Study - 197 Urana St, Jindera

5% AEP - Design & Council Drain Upgrade  
with Council Drain simulated as 1D channel  
Flood Afflux - Design minus Existing

Project No. 12609144  
Revision No. A  
Date 16 Sept 2024

Figure B-032



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**Legend**

Site Boundary

New Buildings

Open Council Drain

Design Pad

**Flood Afflux (mm)**

> -500mm

-500 - -400

-400 - -300

-300 - -200

-200 - -100

-100 - -50

-50 - -25

-25 - -10

-10 - +10

+10 - +25

+25 - +50

+50 - +100

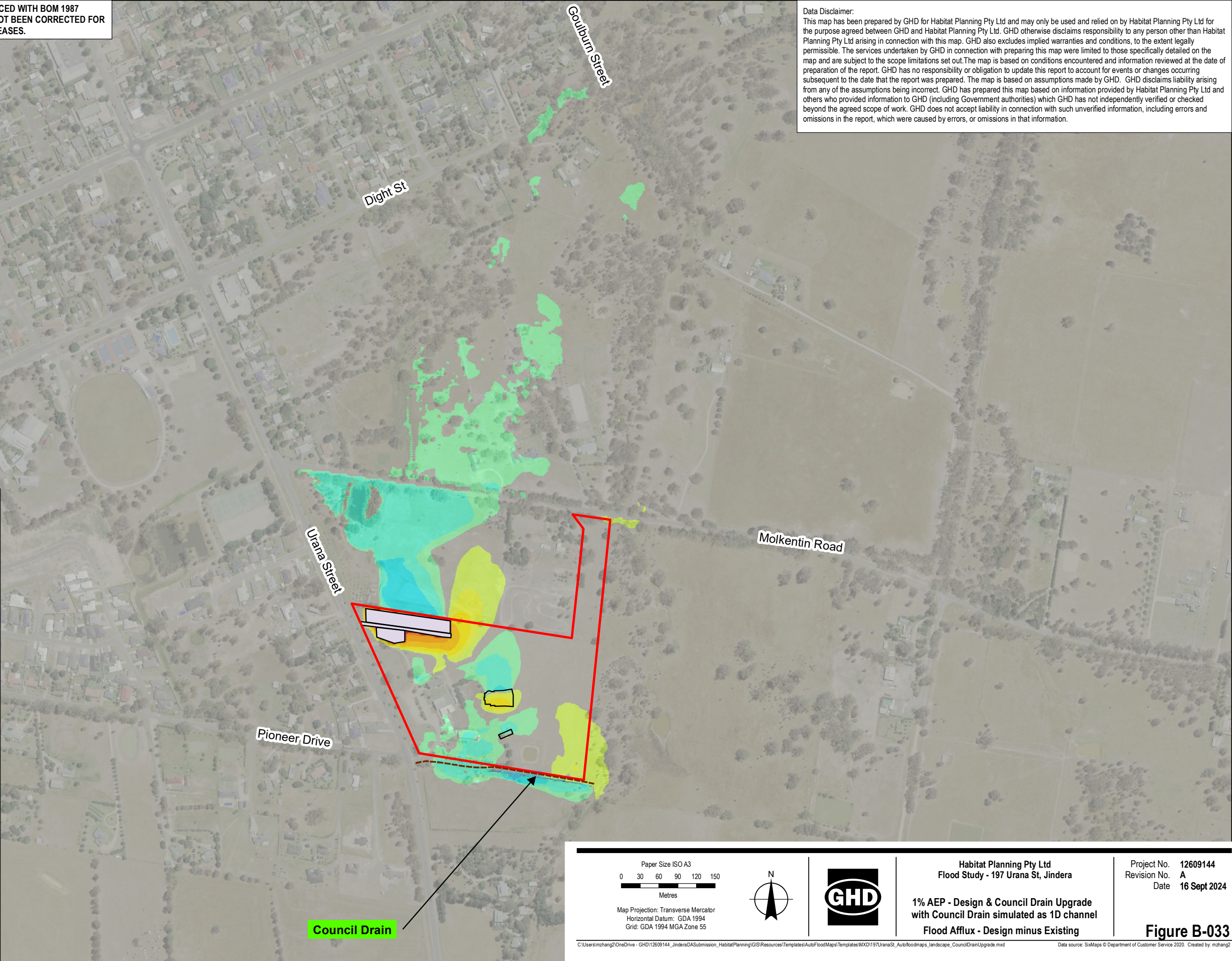
+100 - +200

+200 - +300

+300 - +400

+400 - +500

> +500



Paper Size ISO A3

0306090120150

Metres

Map Projection: Transverse Mercator

Horizontal Datum: GDA 1994

Grid: GDA 1994 MGA Zone 55

N

GHD

Habitat Planning Pty Ltd

Flood Study - 197 Urana St, Jindera

1% AEP - Design & Council Drain Upgrade

with Council Drain simulated as 1D channel

Flood Afflux - Design minus Existing

Project No. 12609144

Revision No. A

Date 16 Sept 2024

Figure B-033

C:\Users\mzhang2\OneDrive - GHD\12609144\_Jindera\DASubmission\_HabitatPlanning\GIS\Resources\Templates\AutoFloodMaps\Templates\MXD\197UranaSt\_AutoFloodmaps\_Landscape\_CouncilDrainUpgrade.mxd

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