GENERAL NOTES:
Use figured dimensions in preference to scaled. Confirm the scale of hardcopy drawings by using the attached scale bar. Check all dimensions on site before fabriction or before setout.

KEY PLAN

1 LOTS AREA
1 : 500

Site Lot Areas	
Name	Area
LOT 1	211.58 m²
LOT 2	211.60 m²
LOT 3	211.57 m²
LOT 4	211.62 m²
LOT 5	177.53 m²
LOT 6	177.52 m²
LOT 7	177.53 m²
LOT 8	177.52 m²
LOT 9	177.53 m²
LOT 10	177.53 m²
LOT 11	177.53 m²
LOT 12	177.53 m²
LOT 13	177.52 m²
LOT 14	177.53 m²
LOT 15	177.52 m²
LOT 16	177.53 m²
LOT 17	177.53 m²
LOT 18	177.53 m²
LOT 19	192.93 m²
LOT 20	192.93 m²
LOT 21	192.93 m²
LOT 22	192.93 m²
LOT 23	177.53 m²
LOT 24	177.53 m²

Site Lot Areas	
Name	Area
LOT 25	177.53 m²
LOT 26	177.53 m²
LOT 27	177.53 m²
LOT 28	177.53 m²
LOT 29	177.53 m²
LOT 30	177.53 m²
LOT 31	177.53 m²
LOT 32	177.53 m²
LOT 33	177.53 m²
LOT 34	177.53 m²
LOT 35	177.53 m²
LOT 36	177.53 m²
LOT 37	177.53 m²
LOT 38	177.53 m²
LOT 39	177.53 m²
LOT 40	177.53 m²
LOT 41	177.53 m²
LOT 42	177.53 m²
LOT 43	177.53 m²
LOT 44	177.53 m²
LOT 45	219.43 m²
LOT 46	221.43 m²
LOT 47	221.43 m²
LOT 48	227.16 m²

REVISION	AMENDMENT	DATE
1	PRELIMINARY SITE COMPOSITION	27.05.2025
2	INTERSECTION DETAIL	12.06.2025
3	SECOND PASS OVERALL CONCEPTS	11.08.2025
4	SECOND PASS B	15.08.2025
5	OPTION C	26.09.2025
6	OPTION D	29.10.2025
7	TEST ADJOINING SITE 908/B	03.11.2025
8	LOT 45-48	20.11.2025
9	DA-1	26.11.2025
10	DA-1_BINS ENCLOSURE UPDATE	01.12.2025

PRELIMINARY ISSUE
NOT FOR CONSTRUCTION

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SCALE:
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1 : 500 @ A1

DRAWN: Author
APPROVED: MICHAEL JULLYAN
NORTH:

CLIENT:
BMD

PROJECT:
LOT 907 TOWNSVILLE
PINNACLE DRIVE

TITLE:
LOTS AREAS

PROJECT NUMBER: 27-25
SHEET NUMBER: SD603
REV: 10

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200mm
100
50
10mm
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GENERAL NOTES:
Use figured dimensions in preference to scaled. Confirm the scale of hardcopy drawings by using the attached scale bar. Check all dimensions on site before fabriction or before setout.

KEY PLAN

8 OVERALL - VIEW A

1 OVERALL - VIEW B

2 OVERALL - VIEW C

3 OVERALL - VIEW D

REVISION	AMENDMENT	DATE
1	PRELIMINARY SITE COMPOSITION	27.05.2025
2	INTERSECTION DETAIL	12.06.2025
3	SECOND PASS OVERALL CONCEPTS	11.08.2025
4	SECOND PASS B	15.08.2025
5	OPTION C	26.09.2025
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7	TEST ADJOINING SITE 908/B	03.11.2025
8	LOT 45-48	20.11.2025
9	DA-1	26.11.2025
10	DA-1_BINS ENCLOSURE UPDATE	01.12.2025

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SCALE:
10 0 10 20 30 40 50 60 70 mm
@ A1

DRAWN:	APPROVED:	NORTH:
MP	MICHAEL JULLYAN	

CLIENT:
BMD

PROJECT:
LOT 907 TOWNSVILLE
PINNACLE DRIVE

TITLE:
PERSPECTIVES

PROJECT NUMBER:	SHEET NUMBER:	REV:
27-25	SD900	10

PRELIMINARY ISSUE
NOT FOR CONSTRUCTION

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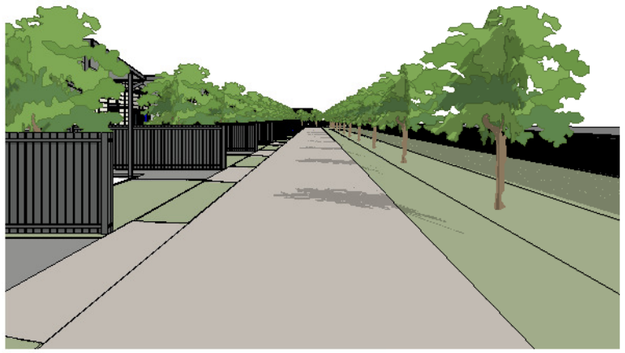
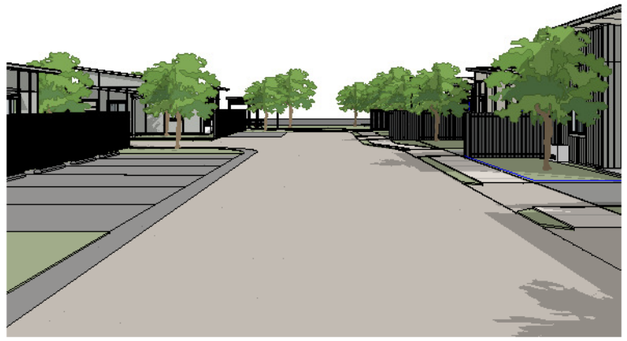
GENERAL NOTES:
Use figured dimensions in preference to scaled. Confirm the scale of hardcopy drawings by using the attached scale bar. Check all dimensions on site before fabriction or before setout.

KEY PLAN

3 OVERALL - VIEW E



1 OVERALL - VIEW F



2 OVERALL - VIEW G

4 OVERALL - VIEW H

REVISION	AMENDMENT	DATE
1	PRELIMINARY SITE COMPOSITION	27.05.2025
2	INTERSECTION DETAIL	12.06.2025
3	SECOND PASS OVERALL CONCEPTS	11.08.2025
4	SECOND PASS B	15.08.2025
5	OPTION C	26.09.2025
6	OPTION D	29.10.2025
7	TEST ADJOINING SITE 908/B	03.11.2025
8	LOT 45-48	20.11.2025
9	DA-1	26.11.2025
10	DA-1_BINS ENCLOSURE UPDATE	01.12.2025

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SCALE:
10 0 10 20 30 40 50 60 70 mm
@ A1

DRAWN: MP
APPROVED: MICHAEL JULLYAN
NORTH:

CLIENT:
BMD

PROJECT:
LOT 907 TOWNSVILLE
PINNACLE DRIVE

TITLE:
PERSPECTIVES

PROJECT NUMBER: 27-25
SHEET NUMBER: SD901
REV: 10

PRELIMINARY ISSUE
NOT FOR CONSTRUCTION

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Appendix B Swept Path Assessments

Stage 12A Multiple Dwellings Development, Somers & Hervey Residential Estate, Rasmussen, Townsville

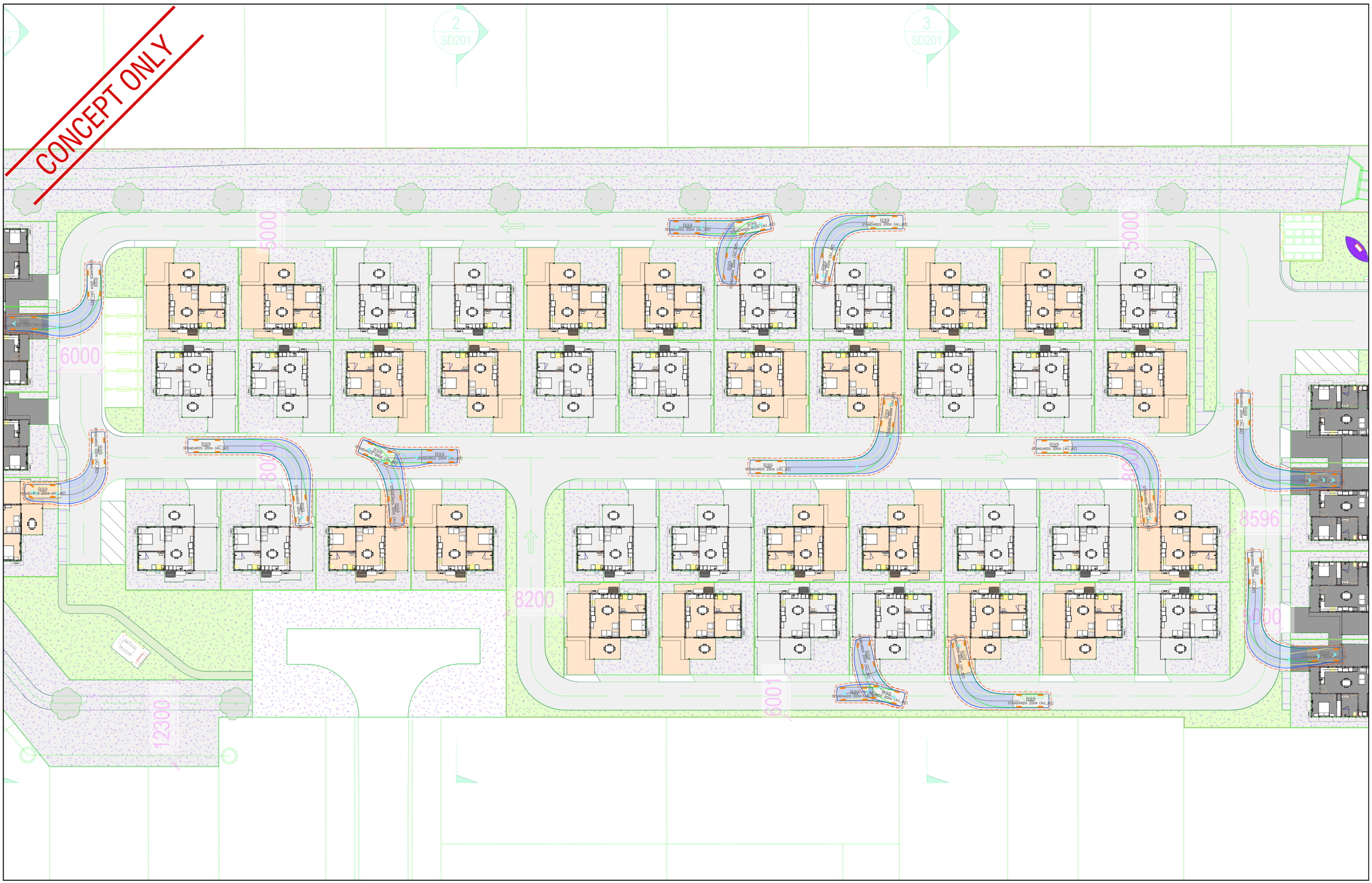
Traffic Impact Assessment

Urbex Pty Ltd

SLR Project No.: 620.30870.00107

18 December 2025

CONCEPT ONLY



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AUSTRALIA
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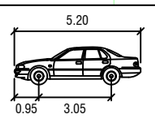
www.slrconsulting.com

Project No:	620.30870
Date:	10/12/25
Drawn by:	ME
Certified by:	-
Sheet Size:	A3
Projection:	-

SWEPT PATH LEGEND

- Vehicle Path
- Vehicle Body
- Body Clearance
- Front Wheels



B99

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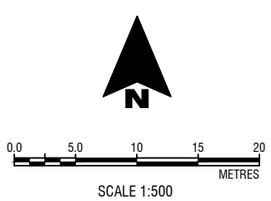
Track	: 1.84
Lock to Lock Time	: 6.0
Steering Angle	: 33.9



SCALE 1:500

Urbex 118

Somers & Hervey Stage 12

Swept Path Assessment - B99
Sheet 1 of 4

FIGURE SK01

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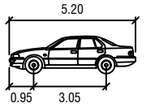
SWEPT PATH LEGEND

- Vehicle Path
- Vehicle Body
- Body Clearance
- Front Wheels



B99

	meters
Width	: 1.94
Track	: 1.84
Lock to Lock Time	: 6.0
Steering Angle	: 33.9

N

0.0 5.0 10 15 20
METRES

SCALE 1:500

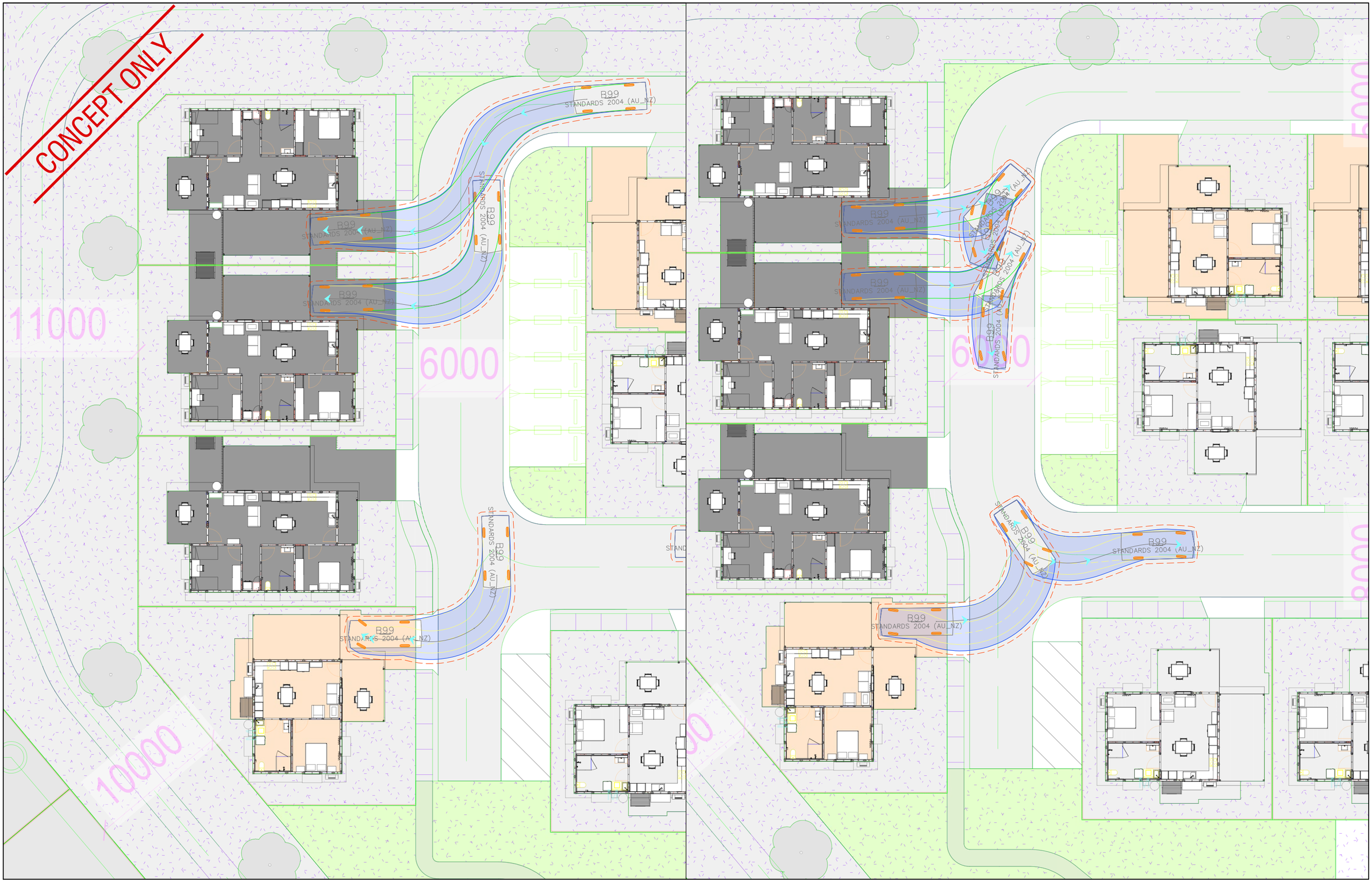
Urbex 118

Somers & Hervey Stage 12

Swept Path Assessment - B99
Sheet 2 of 4

FIGURE SK02

CONCEPT ONLY



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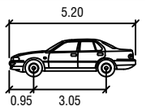
Projection:	-

SWEPT PATH LEGEND

- Vehicle Path
- Vehicle Body
- Body Clearance
- Front Wheels



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Track	: 1.84
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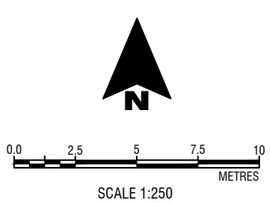
Steering Angle	: 33.9



SCALE 1:250

Urbex 118

Somers & Hervey Stage 12

Swept Path Assessment - B99
Sheet 3 of 4

FIGURE SK03

CONCEPT ONLY

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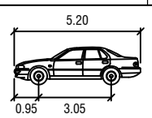
Certified by:	-
Sheet Size:	A3
Projection:	-

SWEPT PATH LEGEND
- Vehicle Path
- Vehicle Body
- Body Clearance
- Front Wheels



B99

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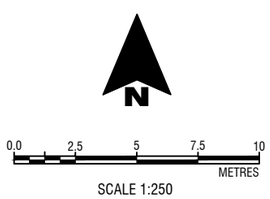

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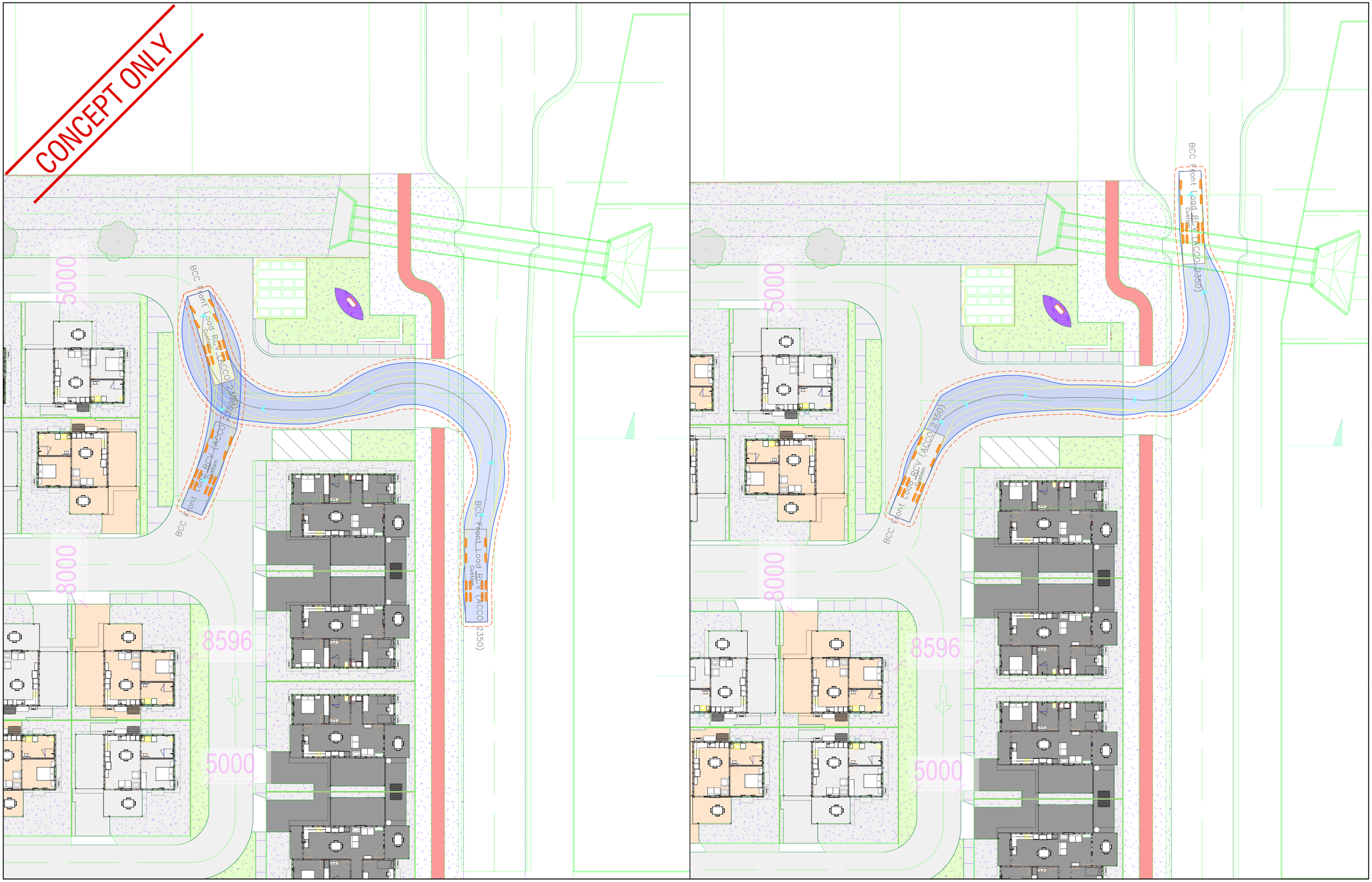
Urbex 118

Somers & Hervey Stage 12

Swept Path Assessment - B99
Sheet 4 of 4

FIGURE SK04

CONCEPT ONLY



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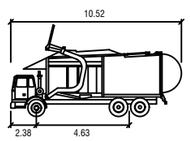
Project No:	620.30870
Date:	10/12/25
Drawn by:	ME
Certified by:	-
Sheet Size:	A3
Projection:	-

SWEPT PATH LEGEND

- Vehicle Path
- Vehicle Body
- Body Clearance
- Front Wheels



BCC Front Load RCV (ACCO 2350)

meters

Width	: 2.50
Track	: 2.50
Lock to Lock Time	: 6.0
Steering Angle	: 28.0

N

0.0 4 8 12 16
METERS

SCALE 1:400

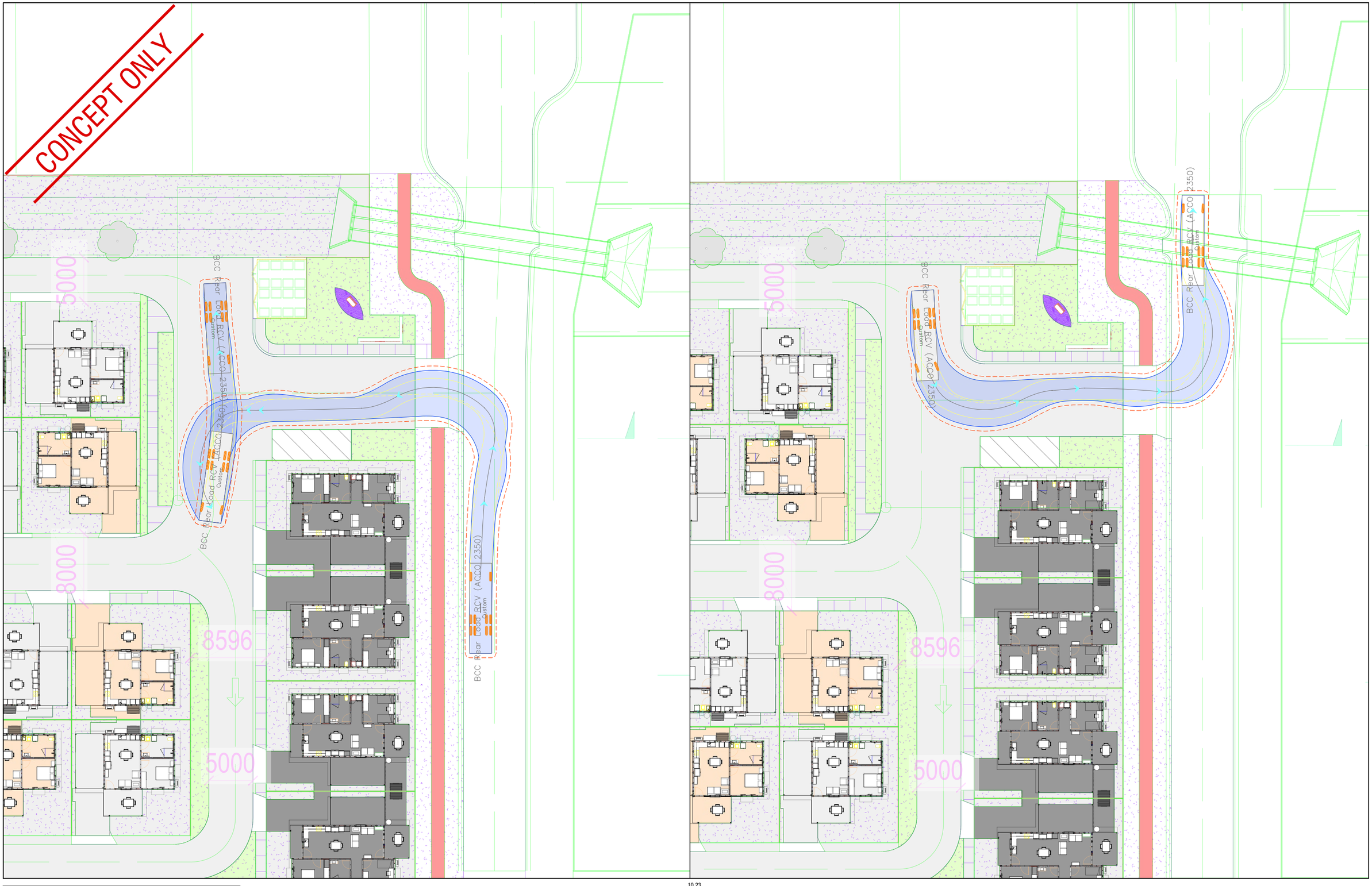
Urbex 118

Somers & Hervey Stage 12

Swept Path Assessment
Front Lift RCV

FIGURE SK05

CONCEPT ONLY



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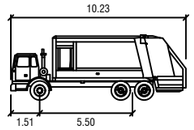
Project No:	620.30870
Date:	10/12/25
Drawn by:	ME
Certified by:	-
Sheet Size:	A3
Projection:	-

SWEPT PATH LEGEND

- Vehicle Path
- Vehicle Body
- Body Clearance
- Front Wheels



BCC Rear Load RCV (ACCO 2350)

meters

Width	:	2.50
Track	:	2.50
Lock to Lock Time	:	6.0
Steering Angle	:	40.3

N

0.0 4 8 12 16
METERS

SCALE 1:400

Urbex 118

Somers & Hervey Stage 12

Swept Path Assessment Rear Lift RCV

FIGURE SK06

Appendix C Code Responses

Stage 12A Multiple Dwellings Development, Somers & Hervey Residential Estate, Rasmussen, Townsville

Traffic Impact Assessment

Urbex Pty Ltd

SLR Project No.: 620.30870.00107

18 December 2025

The subject development has been assessed against the requirements of the Townsville City Plan *Transport Impact, Access and Parking* (TIAP) Code in Table 1 below.

Table 1 TIAP Code Compliance Review

Performance Outcomes	Acceptable Outcomes	Response
Transport impact		
PO1 The development is located on roads that are appropriate for the nature of traffic generated, having regard to the safety and efficiency of the transport network, and the functions and characteristics identified of the road hierarchy. The road hierarchy is shown on figure 9.5 – Road hierarchy existing and Figure 9.6 Road Hierarchy Future.	No acceptable outcome is nominated.	**Complies with PO1** The development will be accessed via the link between Sorghum Street and Pinnacle Drive, which is an appropriate access road.
PO2 Development does not compromise the orderly provision or upgrading of the transport network.	No acceptable outcome is nominated.	**Complies with PO2** The development does not compromise the orderly provision or upgrading of the transport network
PO3 On-site transport network infrastructure (including roads, parking, access and public transport, pedestrian and cyclist facilities) appropriately integrates and connects with surrounding networks.	No acceptable outcome is nominated.	**Complies with PO3** The development provides appropriate connection to the fronting road (link between Sorghum Street and Pinnacle Drive).
PO4 As far as practicable, development is designed to encourage travel by public transport, walking and cycling.	No acceptable outcome is nominated.	**Complies with PO4** The development includes internal footpaths that run east-west, providing connection from dwellings to the site frontage, mailboxes and bin enclosure. Footpaths are provided as appropriate on frontage works.
Site access		
PO5 Access arrangements are appropriate for: (a) the capacity of the parking area; (b) the volume, frequency and type of vehicle usage; (c) the function and characteristics of the access road and adjoining road network; and (d) the safety and efficiency of the road network.	**AO5** Access is provided in accordance with the standards identified in the Development manual planning scheme policy SC6.4 — SC6.4.5.5 Driveways, SC6.4.5.3 Public Transport Facilities and SC6.4.5.4 Car Parking..	**Complies with PO5** Driveway access to be provided in accordance with Council standards.

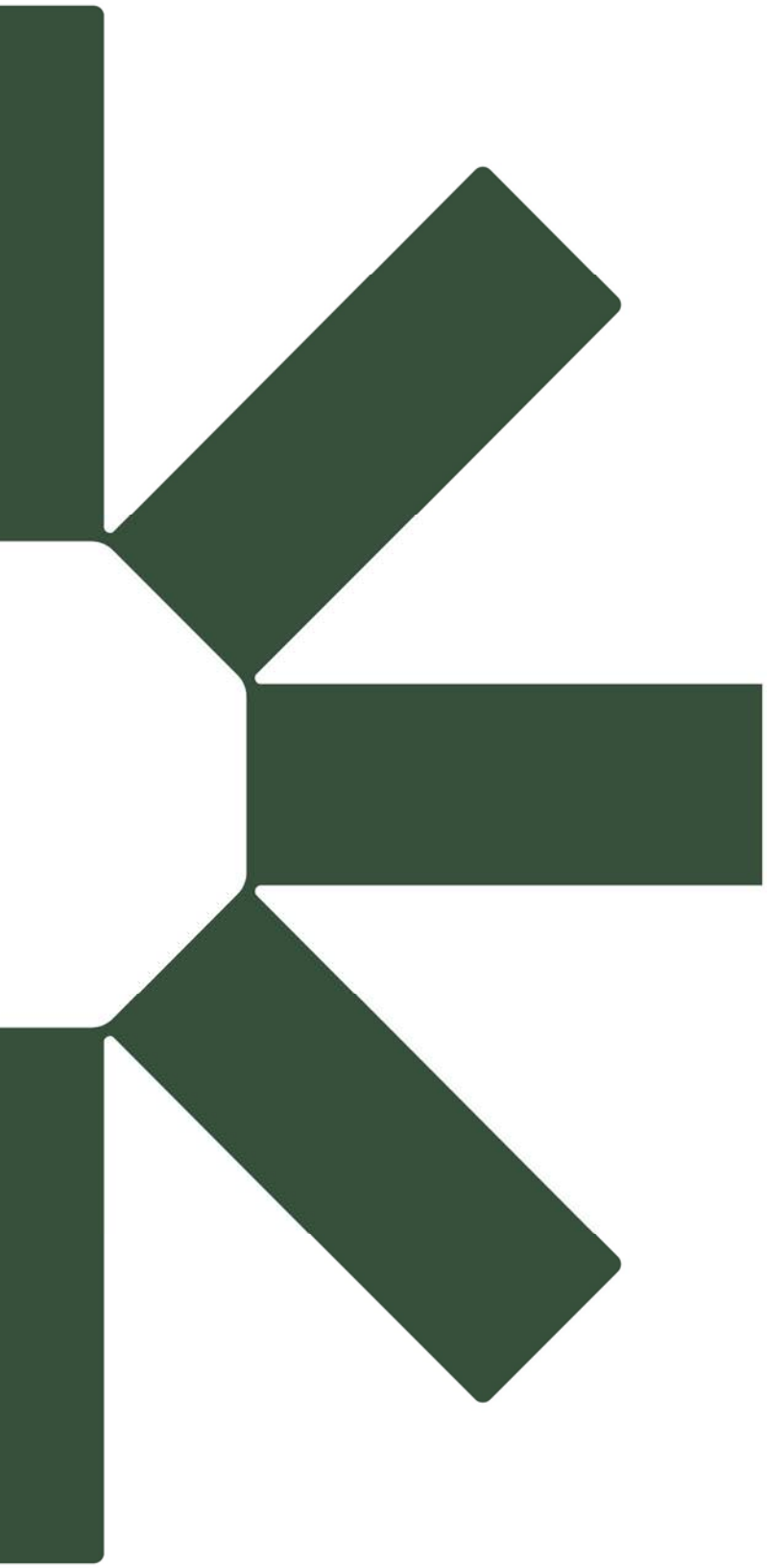
Performance Outcomes	Acceptable Outcomes	Response
PO6 Where practical, access for cyclists and pedestrians is clearly distinguished from vehicle access.	No acceptable outcome is nominated.	**Not applicable** The development includes internal footpaths that run east-west, providing connection from dwellings to the site frontage, mailboxes and bin enclosure.
PO7 Access is located and designed to provide safe and easy access to the site, having regard to its position, width and gradient.	**AO7** Access is provided in accordance with the standards identified in the Development manual planning scheme policy no. SC6.4 — SC6.4.5.5 Driveways and SC6.4.3 Standard Drawings.	**Satisfies AO7** The driveway access is appropriately located and has an access width in excess of the minimum width for Multiple Dwellings
PO8 All vehicles reasonably expected to use the site are able to travel the length of the driveway or driveway access without damage to vehicle or the driveway surface.	**AO8** Access is provided in accordance with the standards identified in the Development manual planning scheme policy no. SC6.4 — SC6.4.5.5 Driveways, SC6.4.5.3 Public Transport Facilities and SC6.4.5.4 Car Parking.	**Complies with PO8** All vehicles reasonably expected to use the site are able to travel the length of the driveway or driveway access without damage to vehicle or the driveway surface.
PO9 A driveway does not cause change in the level of a footpath that is unsafe or inaccessible for people with mobility difficulties.	**AO9** Access is provided in accordance with the standards identified in the Development manual planning scheme policy no. SC6.4 — SC6.4.5.5 Driveways and SC6.4.3 Standard Drawings.	**Not applicable** To be addressed in further design stages
PO10 Driveways are designed to withstand loadings from all vehicles reasonably expected to use the site.	**AO10** Access is provided in accordance with the standards identified in the Development manual planning scheme policy no. SC6.4 — SC6.4.5.5 Driveways	**Not applicable** To be addressed in further design stages
PO11 A driveway does not allow water to pond on adjacent properties or adjacent buildings and does not allow water to enter a building or property	**AO11** Access is provided in accordance with the standards identified in the Development manual planning scheme policy no. SC6.4 — SC6.4.5.5 Driveways	**Not applicable** To be addressed in further design stages
PO12 Construction of a driveway does not damage or interfere with the location, function of or access to any services and infrastructure.	**AO12** Access is provided in accordance with the standards identified in the Development manual planning scheme policy no. SC6.4 — SC6.4.5.5 Driveways, SC6.4.5.3 Public Transport Facilities, SC6.4.5.4 Car Parking and SC6.4.3 Standard Drawings.	**Not applicable** To be addressed in further design stages

Performance Outcomes	Acceptable Outcomes	Response
PO13 All vehicles reasonably expected to access the site can safely manoeuvre to allow vehicles to exit and enter in a forward motion.	**AO13** Access is provided in accordance with the standards identified in Development manual planning scheme policy no. SC6.4 - SC6.4.5.5 Driveways, SC6.4.5.3 Public Transport Facilities, SC6.4.5.4 Car Parking and SC6.4.3 Standard Drawings such that all vehicles reasonably expected to access the site, can exit and enter in a forward motion with no more than a three-point turn.	**Complies with PO13** Refuse vehicles are able to enter and exit the site in forward gear.
Pedestrian and cyclist facilities		
PO14 Provision is made for the safe and convenient movement of pedestrians on-site and connecting to the external network, having regard to desire lines, legibility, safety, topographical constraints, shading and other weather protection and equitable access arrangements.	No acceptable outcome is nominated.	**Complies with PO14** The development includes internal footpaths that run east-west, providing connection from dwellings to the site frontage, mailboxes and bin enclosure.
PO15 Provision is made for safe and convenient cycle movement to the site and within the site and connecting to the external network having regard to desire lines, users' needs, safety, topographical constraints and legibility.	No acceptable outcome is nominated.	**Complies with PO15** The development includes internal footpaths that run east-west, providing connection from dwellings to the site frontage, mailboxes and bin enclosure.
PO16 Car parking areas, pathways and other elements of transport network infrastructure are designed to enhance public safety by discouraging crime and antisocial behaviour, having regard to: (a) provision of opportunities for casual surveillance; (b) provision of lighting; (c) the use of fencing to define public and private spaces, whilst allowing for appropriate sight lines; (d) minimising potential concealment points and assault locations; (e) minimising opportunities for graffiti and other vandalism; and (f) restricting unlawful access to buildings and between buildings.	No acceptable outcome is nominated.	**Not addressed** Not addressed in this report.
Parking		

Performance Outcomes	Acceptable Outcomes	Response
PO17 Provision is made for on-site vehicle parking to: (a) meet the demand likely to be generated by the development; and (b) avoid on street parking that would adversely impact on the safety or capacity of the road network or unduly impact on local amenity.	**AO17** Car parking is provided in accordance with the standards identified in Parking rates planning scheme policy no. SC6.10.	**Satisfies AO17** See section 5.4 of this TIA.
PO18 Parking ensures access is provided for people with disabilities.	**AO18** Car parking areas are designed in accordance with the standards identified in the Development manual planning scheme policy no. SC6.4 — SC6.4.5.4 Car Parking.	**Not addressed** The design of parking at each lot is not addressed in this report
PO19 Where the nature of the proposed development creates a demand, provision is made for set-down and pick-up facilities by bus, taxis or private vehicle, which: (a) are safe for pedestrians and vehicles; (b) are conveniently connected to the (c) main component of the development by pedestrian pathway; and (d) provide for pedestrian priority and clear sight lines.	No acceptable outcome is nominated.	**Not applicable**
PO20 Car parking and servicing areas are designed to: (a) be clearly defined, marked and signed; (b) be convenient and accessible; (c) minimise large unbroken areas of hardstand to the extent practicable; (d) be safe for vehicles, pedestrians and cyclists; (e) provide shading; (f) be located to encourage multi-purpose trip ends and minimise vehicle movements within the site; and (g) minimise any adverse impacts on the amenity of surrounding land.	No acceptable outcome is nominated.	**Complies with PO20** Bin store is adjacent to the site entrance with sufficient space for waste recovery vehicles to manoeuvre. Visitor parking provision is provided in accordance with AS2890.1.

Performance Outcomes	Acceptable Outcomes	Response
PO21 Vehicle spaces have adequate dimensions to meet user requirements.	**AO21** Car parking areas are designed in accordance with the standards identified in the Development manual planning scheme policy no. SC6.4 — SC6.4.5.3 Public Transport Facilities and SC6.4.5.4 Car Parking.	**Complies with PO21** Parking spaces have adequate dimensions to meet user requirements.
PO22 Pavement is constructed to an appropriate standard.	No acceptable outcome is nominated.	**Not applicable** This detail beyond the scope of the masterplan TIA, but pavement will be designed by suitably qualified engineers and constructed to an appropriate standard.
PO23 Parking and servicing areas are kept accessible and available for use as a car park at all times during the normal business hours of the activity.	No acceptable outcome is nominated.	**Not applicable**
PO24 Visitor parking for accommodation activities remains accessible and useable to visitors at all times.	No acceptable outcome is nominated.	**Complies with PO24** Visitor parking will remain accessible and useable to visitors at all times
PO25 Multi-level car parking areas are designed, articulated and finished to make a positive contribution to the local external streetscape character, as well as the internal user experience of the facility ensuring way finding technologies and aesthetic treatments are provided.	No acceptable outcome is nominated.	**Not applicable**
Servicing		
PO26 Provision is made for the on-site loading, unloading, manoeuvring and access by service vehicles that: (a) are adequate to meet the demands generated by the development; (b) are able to accommodate the design service vehicle requirements; and (c) does not unduly impede vehicular, cyclist and pedestrian safety and convenience both within the site and external to the site.	**AO26** Servicing areas are provided and designed in accordance with the standards identified in the Development manual planning scheme policy no. SC6.4 – SC6.4.3.5 Car parking and public transport facilities guidelines.	**Complies with PO26** Refuse vehicles are able to enter and exit the site in forward gear.
PO27 Refuse collection vehicles are able to safely access on- site refuse collection facilities.	**AO27** Refuse collection areas are provided and designed in accordance with the standards identified in the Development manual planning scheme policy no. SC6.4 – SC6.4.3.22 Waste management guidelines and SC6.4.5.3 Public Transport Facilities and SC6.4.5.4 Car Parking.	**Complies with PO27** Refuse vehicles are able to enter and exit the site in forward gear and access the bin store, which is located adjacent to the site entrance.

Performance Outcomes	Acceptable Outcomes	Response
PO28 Servicing arrangements minimise any adverse impact on the amenity of premises in the vicinity, having regard to operating hours, noise generation, proximity to sensitive uses, odour generation and dust.	No acceptable outcome is nominated.	**Not addressed** Waste removal arrangements are yet to be confirmed. However the bin store is located adjacent to the site entrance to minimise impact on residents.



Making Sustainability Happen

Appendix E

Northern Consulting Engineers Pty Ltd Flood Impact Assessment - Precinct 4 - Stage 12A Somers & Hervey, Rasmussen Residential Development

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NORTHERN CONSULTING engineers

CIVIL & STRUCTURAL ENGINEERS

FLOOD IMPACT ASSESSMENT

PRECINCT 4 – STAGE 12A
SOMERS & HERVEY ESTATE, RASMUSSEN
RESIDENTIAL DEVELOPMENT

FOR
URBEX PTY LTD

JOB No: URB0001-P4

Doc Ref: URB0001-P4-Stage12A-FIA

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DOCUMENT CONTROL

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A	Brendan Blair	Andrew Wallace	Andrew Wallace (RPEQ 6743)		19/12/2025	Urbex	To support DA application

EXECUTIVE SUMMARY

Northern Consulting Engineers (NCE) has been commissioned by Urbex Pty Ltd, to undertake a flood impact assessment (FIA) for the proposed Somers & Hervey Estate, Rassmussen, Precinct 4, Stage 12A. The proponent is seeking to subdivide the land into residential lots. The objective of this assessment is to assess the impacts associated with the proposed development in a manner that demonstrates compliance with the Townsville City Council Planning Scheme.

The assessment was completed with the development of a fine scale 2D hydraulic model using TUFLOW software, utilising the sub grid sampling (SGS) feature, to generate high resolution results.

The results of the assessment have demonstrated that the development can be carried out in accordance with Townsville City Council's planning scheme including PO6 and PO7 of the flood hazard overlay code. There are highly isolated areas showing minor, non-actionable afflux which are considered inconsequential and not considered further. Any generated afflux is generally contained within roadways or drainage infrastructure and do not alter the flood hazard classification. NCE note that any impacts will likely be resolved by future development stages as future development will redirect flows to the north.

Peak 100-year ARI flood levels have been identified at all locations throughout the model. All allotments were demonstrated to be immune in the 100-year ARI flood event. Where ponding reaches the edge of a proposed lot, any habitable FFL will be set a minimum of 300mm above the 1% AEP WSL in both the adjacent major drains and the local runoff within the internal roads.

A sensitivity assessment was undertaken to investigate the potential impacts on the local development site associated with the potential for culverts being 100% blocked. The findings of this assessment that the worst-case blockage resulted in minimal impact to the flooding outcomes and minimal impact on controlling flood levels within the development site.

This report demonstrates that the proposed development can comply with the Townsville City Council's flood hazard overlay and flood hazard planning scheme policy. The development is not expected to increase the risk to life, property, community, economic activity or increase the potential for flood damage on-site or to adjacent and downstream properties. Furthermore, the development is not anticipated to be significantly impacted or significantly impact adjacent properties by future climate change.

GLOSSARY

AEP	Annual Exceedance Probability - the probability of an event being equalled or exceeded within a year.
Afflux	Defined as the relative change in a flooding characteristic (eg. WSL , Velocity)
AHD	Australian Height Datum
AIDR	Australian Institute for Disaster Resilience
ARI	Average Recurrence Interval
ARR 2019	Australian Rainfall and Runoff (2019)
BoM	Bureau of Meteorology
CC	Climate Change
DEM	Digital Elevation Model
DFE	Defined Flood Event
EY	Average number of Exceedances per Year - 1EY is exceeded on average once per year
FFL	Finished Floor Level
FIA	Flood Impact Assessment
HAT	Highest Astronomical Tide – The highest level of water that can be predicted to occur under average meteorological conditions and any combination of astronomical condition
IFD	Intensity-Frequency-Duration
LiDAR	Light Detection and Ranging (Aerial Laser Survey)
Mannings n	Measure of resistance to flow in a channel influenced by the physical roughness of the surface
MHWS	Mean High Water Springs
NCE	Northern Consulting Engineers
PMF	Probable Maximum Flood
PO	Performance Outcome
QSpatial	Queensland Spatial Catalogue - Queensland Government geospatial data and information
QUDM	Queensland Urban Drainage Manual
RAFTS / XP-RAFTS	An urban and rural runoff-routing hydrologic model
RD	Renewable Diesel
ROG	Rain on Grid – Applies rainfall directly to the model domain
SGS	Sub-grid Sampling
TCC	Townsville City Council
TUFLOW	Two-dimensional Unsteady Flow – Flood hydraulic modelling software
WSE	Water Surface Elevation
WSL	Water Surface Level (interchangeable with WSE)

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APPENDICES

1.0 INTRODUCTION

1.1 Background

Northern Consulting Engineers (NCE) has been commissioned by Urbex Pty Ltd to undertake a flood impact assessment (FIA) for the proposed Somers & Hervey Estate, Rasmussen, Precinct 4, Stage 12A.

This report is prepared in support of the proposed development application (DA) associated with subdividing the land into residential lots. The objective of this assessment is to update the baseline of model developed as part of Precinct 1 of the development (URB0001-FIA) and assess the impacts associated with the proposed development in a manner that demonstrates compliance with the Townsville City Council (TCC) Planning Scheme.

In reference to the Flood Hazard Overlay Map OM-6.1 of the Townsville City Council (TCC) Planning Scheme, it has been identified that the proposed development site is generally overlaid by the low and medium hazard mapping. Refer to Figure 1-3. Therefore, as per the Flood Hazard Overlay Code 8.2.6, the development must not generate off-site impacts and in particular Performance Outcomes (PO) PO2 and PO3.

To undertake this study, NCE have updated the TUFLOW model previously developed as part of Precinct 2 to assess the potential impacts associated with the proposed development as discussed in Section 2.0.

As this model has been developed utilising inflows from the historical Upper-Middle Bohle Flood Study (2014) for consistency, the new model also adopts the ARR 87 ARI (average concurrence interval) as the rainfall event frequency and naming convention.

NCE note that the baseline model has been updated to align with the most up-to-date version of TUFLOW and the associated best-practice procedures. Further updates have been applied to the baseline model where detailed on-site assessments of local catchments have been conducted and approved developments have been completed. Updates to the baseline model are outlined in Section 3.2.

1.2 Proposed Development

It is proposed that the site will be further subdivided into 1 englobo housing development and 5 freehold lots. The development is separated into Stage 1 which contains the englobo housing lots and Stage 2 which contains the freehold land parcels. The proposed development will include the following:

- Stage 1 / Lot 907:
  - 1 Lot at approximately 1.714 hectares.
  - To be developed further as an englobo parcel with 44 dwellings.
  - Inclusive of private internal roadways to connect dwellings to Pinnacle Drive to the east.
  - Tee head turn about connection to Resolution Street to provide turn about for emergency and larger vehicles.
  - Internal drains along the northern boundary to connect drainage from Pinnacle Drive and upstream catchments from the east to the downstream existing drainage to the west that eventually outlets at the Beck Drive culverts contained in Precinct 1 of the Somers and Hervey Estate.
  - 10m wide drain with 3.6m base width generally.
  - Internal drain along the south-western boundary to drain from internal roads and Resolution Street to the downstream existing drainage to the west as outlined above.
  - 5m wide drain with 2m base width generally.

- Pinnacle Drive Connection to Sorghum Street:
  - Connection of Pinnacle Drive to the north to Sorghum Steet to the south.
  - Narrowing of roadway profile to align with the width of Sorghum Street.
  - Culverts under road extension to provide outlet to upstream catchments.
  - Sag point to grade runoff from the road into the adjacent drains as part of Stage 1 and 2 and remove the need for kerb inlets.
  - If Stage 2 lots are to be constructed separately, table drains along the eastern side of the Pinnacle Drive extension will be required to ensure no ponding against the roadway and free draining of upstream catchments.

- Stage 2:
  - 5 lots at approximately 5,510m^2 in total.
  - Drainage easements along the back of the lots (east) and through the middle to connect upstream catchments to the culvert under Pinnacle Drive and into the Stage 1 drains.
  - 15m wide drains with 5m base width generally.

The precincts are based on the expected progression of the estate aligning with the construction intent of the proponent. The development plan for Stage 12A of Precinct 4 forming the basis of this FIA is shown in Figure 1-1 but included in full in Appendix I for reference.

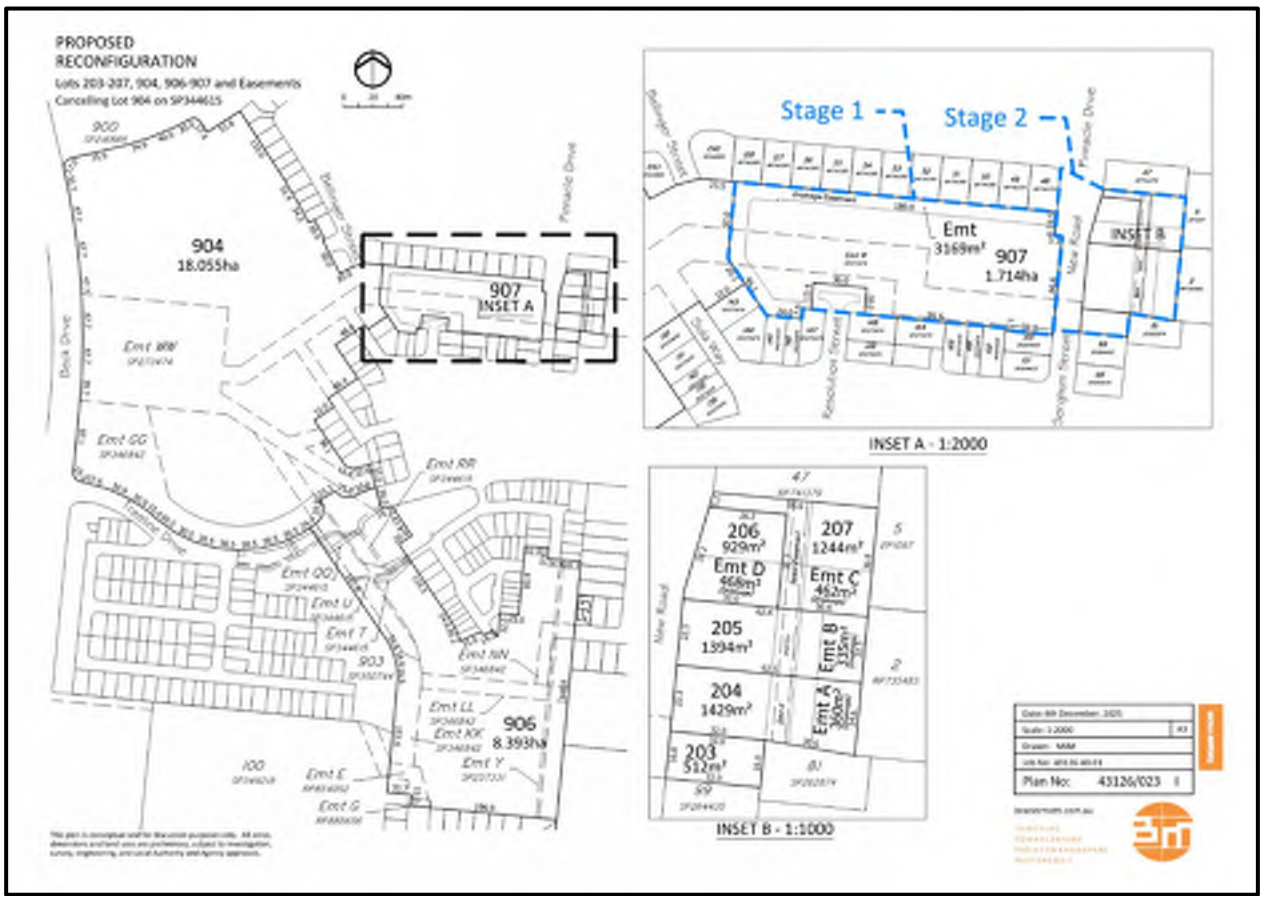

Figure 1-1 Development layout

1.3 Study Area

The study area is located approximately 15km south-west of Townsville's CBD, at Beck Drive, Rasmussen. Proposed Precinct 2 of Bluewattle Estate is located on land described as Lot 904 on SP344615, hereinafter referred to as the site. The site for Precinct 4 is located to the east of the balance lot between the existing development to the north, east and south. In particular Stage 12A encompasses the area to the east of

Bellinger Street and Sida Way, south of Stephanie Street and north of Resolution and Accord Street. Stage 12A covers an area of approximately 2.56ha, which is to be reconfigured to generally residential allotments including the lot 907 englobo parcel. The site and development extent are depicted in Map A01 and Figure 1-2. The site is located approximately 1km east of the Bohle River, however it is expected that flows from the Bohle River will not result in significant impacts on the development but may control tailwater conditions for drains proposed as part of the development. This is discussed and addressed further in Section 1.5.

1.4 Purpose of Report and Scope of Works

The flood model development and assessment has been undertaken in consideration of the proposed development application for the expected residential subdivision.

The assessment has been carried out in accordance with the current Council standards and is based on lots, outside of the drainage easements, being fully immune in the 100-year ARI event which is Councils current definition of the Defined Flood Event (DFE).

The report and modelling has been completed with respect to the currently approved development Precincts 1 & 2 and other construction works in place including but not limited to, Precinct 3 preliminary earthworks and soil erosion and sediment control measures. Previously approved stages have not been modelled as part of the baseline scenario to ensure any cumulative flood impacts from the whole development are accounted for. NCE have not conducted further assessment of the previously accepted baseline model and has adopted it as fit for use for the purpose of modelling Stage 12A.

Based on advice from TCC Planning and Development, the baseline and developed models have been assessed for all events from the major (100-year ARI) to the minor (2-year ARI). Sensitivity and climate assessments have been undertaken for the major flood event only.

Figure 1-2 Study area locality

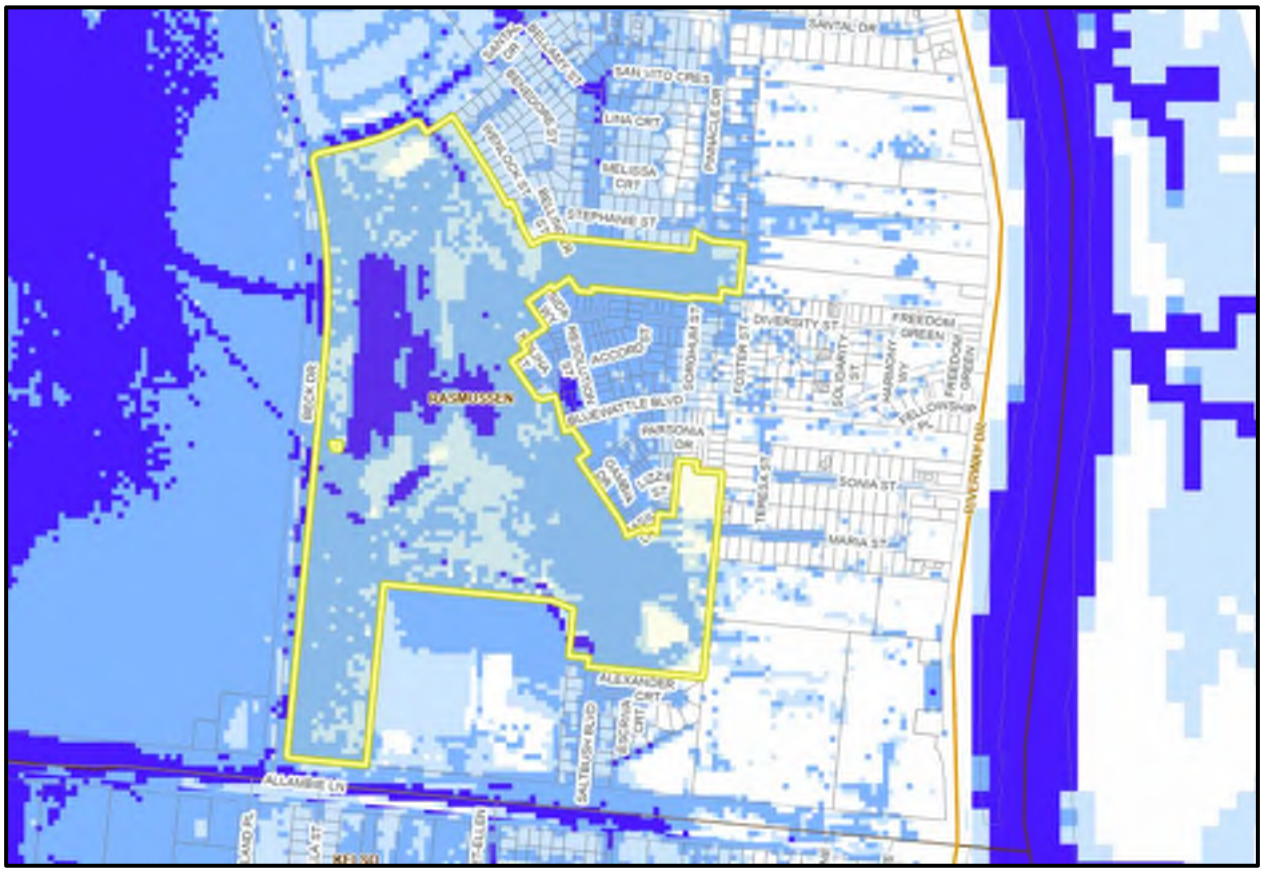

Figure 1-3 Existing flood hazard extents within the proposed development area

1.5 Existing Site Drainage

The Somers and Hervey residential subdivision development site is located in the upper eastern reaches of the streams and drains of the Middle Bohle River flood study. The split between the Middle and Upper Bohle River flood studies occurs roughly 600 metres to the south of the development site. The Stage 12A development area generally falls from east to west towards Beck Drive via sheet flow or overland drains and into the culvert north of the constructed Precinct 1 of the development. The culvert drains into the upper ends of a tributary of the Bohle River this outlet tributary has a stream order of 1. The existing drainage for the Stage 12A development inclusive of the approved Precinct 1 and 2 is shown in Figure 1-4. In the current and proposed scenarios all runoff will be directed to the existing sediment basin upstream of the Beck Drive culvert. NCE note that as part of the master planned development, flows from Precinct 4 will be directed to the north via a major drain in the future Precinct 3. Any future redirection of flows will be designed to ensure no impacts to both upstream and downstream areas.

The Stage 12A development area has multiple upstream catchments that flow through the site as outlined below:

- The adjacent Riverway Drive lots to the east drain generally from east to west towards the Stage 12A development. Flows are generally overland sheet flows into the Stage 12A area and continues to overland flow until it concentrates into the existing drain adjacent to Sida Way.

- The southern most section of Pinnacle Drive in particular the eastern kerb grades southward into Stage 12A which then sheet flows overland to the west into the existing drain adjacent to Sida Way.

- The northern most section of Resolution Street grades to the north into Stage 12A which then sheet flows overland to the west into the existing drain adjacent to Sida Way.

The general grade of the existing Stage 12A land is 0.15% on average from east to west with uneven ground recorded in the survey resulting in ponding across some areas. The baseline DEM is shown in Map A05 and in the Figure 1-4 below.

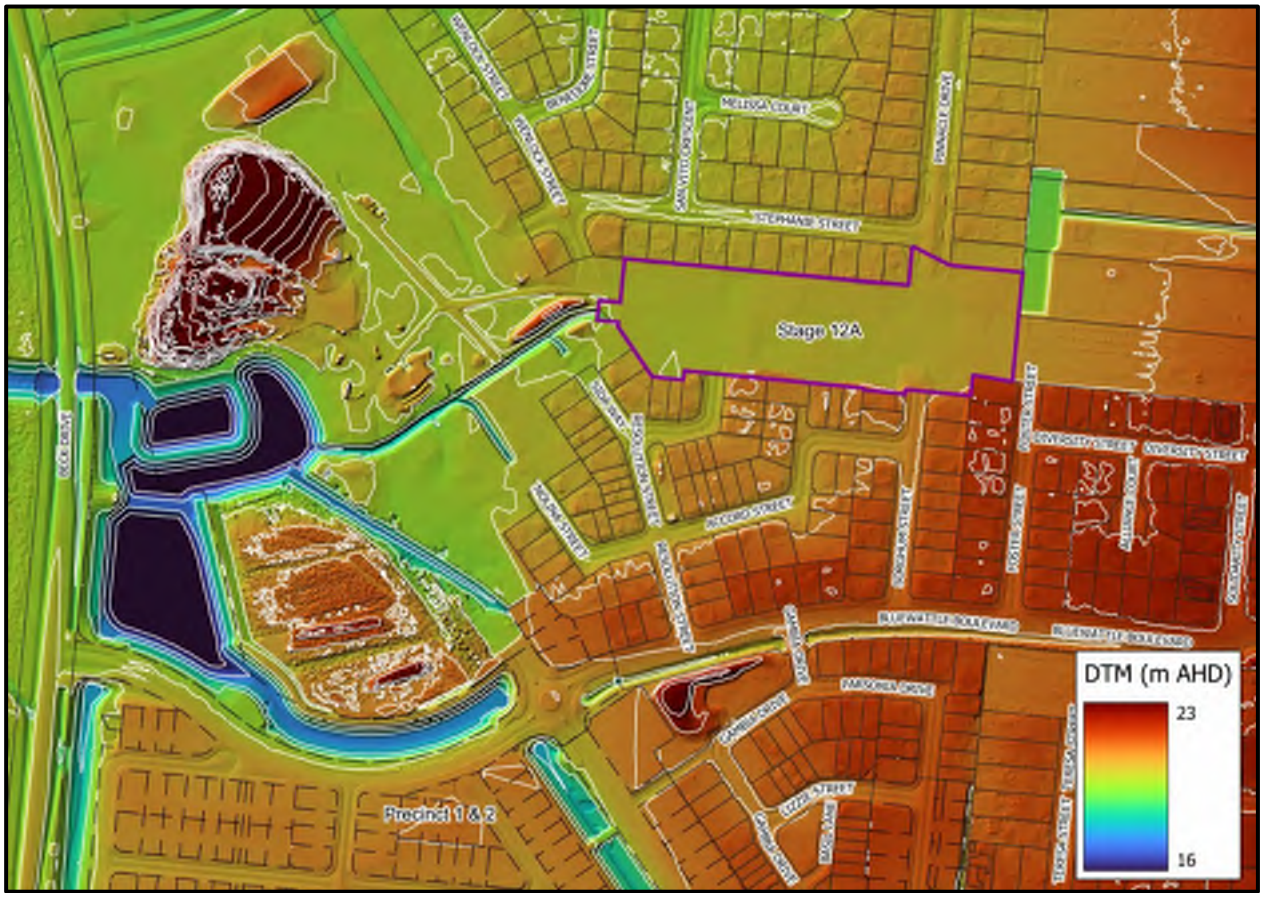

Figure 1-4 Base-line DEM inclusive of approved Precinct 1 and 2 developments (1m contours)

1.6 Limitations

Preparation of the models necessary to undertake this assessment have been conducted in accordance with good engineering practices however, is bound by the practical limitations of the accuracy of information and data used for the modelling, and the software. The information produced in this report is accurate at the time of issue and is based on the information available at the time of the analysis. It is also noted that this report does not identify any funding sources or mechanisms associated with any of the works identified.

NCE otherwise disclaims responsibility to any person other than Urbex arising in connection with this report. NCE also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by NCE in connection with preparing this report were limited to those specifically detailed in the scope and limitations of the report.

The opinions, conclusions and any recommendations in this report are based on assumptions made by NCE described in this report. NCE disclaims liability arising from any of the assumptions being incorrect.

NCE has prepared this assessment on the basis of information provided by 3rd parties, which NCE has not independently verified or checked beyond the agreed scope of work. NCE does not accept liability in connection with such unverified information, including errors and omissions in the supplied.

2.0 AVAILABLE DATA

2.1 Topographic Information

A Digital Elevation Model (DEM) based on LiDAR survey data over the entire model extent was captured as part of the Townsville City Council 2019 LiDAR project and source from the Open Data portal. The sourced data has a 1m grid resolution that was read into TUFLOW. As some potential issues were noted with the 2019 LiDAR data, a comparison was carried out between the 2012 and 2019 LiDAR datasets and survey data. The comparison with 2012 data was completed to help compare to the current flood study in the surrounding area (Upper-Middle Bohle Flood Study 2014). This review found that where the survey overlapped the LiDAR, the survey was generally lower except through drains. This is not unexpected as the LiDAR can often pick up on higher points in areas that are densely vegetated.

A comparison between the 2019 and 2012 LiDAR indicates that the 2019 LiDAR is generally higher in developed areas and through the development site and lower through the undeveloped open areas. The 2019 LiDAR seemingly has better definition through the Bohle River channel and picks up on recently developed areas and changes to the surface over time.

Whilst the survey is not as fine scale and does not pick up on some narrower existing channels through the developed area, the more accurate definition and better tie in to the development surface models is the reason it has been adopted through the development area. The 2019 LiDAR was found to have good correlation and was adopted as the basis for the digital elevation model (DEM) outside of the surveyed development area.

Some areas within or adjacent to Stage 12A were noted as potentially incorrect where survey levels indicated existing lot levels were significantly lower than the LiDAR data. These survey DEM was excluded from these areas to ensure that flood results did not misrepresent the actual topography of the area.

Additionally, adjacent developments to the north-east of Stage 12A were found to be resulting in changes to the baseline flood conditions that were not represented in the modelling. Approved design plans were sourced from the online TCC planning portal and were utilised to represent the works completed on adjacent lots.

2.2 Spatial Data

The following data was acquired to undertake this assessment:

- TCC supplied 2012 and 2019 LiDAR.
- Cadastral data and other various data sources (i.e. watercourses, property extents, roads, stormwater infrastructure, etc) of the site and surrounding area, sourced from the TCC Open Data portal and Queensland Government's QSpatial catalogue.
- Survey of existing lot and partial survey of adjacent lots and roads.
- Final design terrain for precincts 1 & 2 provided by Empower Engineers.
- LiDAR drone survey for Stage 6 earthworks provided by Empower Engineers.

- Preliminary design surface for Stage 12A provided by Empower Engineers.
- Additional culvert survey under Beck Drive and Allambie Lane.
- Site visit to determine local catchment hydraulic control measures including culverts not included in survey or TCC data, high points or impervious fences that directly impact on the local catchment flows.

2.3 Aerial Imagery

The following sources of aerial imagery have been utilised in this assessment:

- TCC's 2019 aerial photography, sourced from the TCC Open Data portal.
- Google satellite imagery, sourced from the Quick Map Services Plugin in QGIS.
- Queensland Globe online mapping service satellite imagery.

The above imagery has been utilised for roughness / land use mapping and flood results mapping. The site was also attended on the 21st of March 2024 to confirm roughness / land use as well as the above important hydraulic controls / features.

3.0 MODELLING METHODOLOGY

In reference to the previous FIA (URB0001-P2_FIA) NCE have maintained the pre-existing hydraulic model developed for the purpose of addressing the Flood Hazard Overlay code for the development of Precinct 1 & 2.

In reference to the Flood Hazard Overlay Map discussed in Section 1.1 and lack of detailed flood information, to address the hydrological processes and stormwater drainage components of the Healthy Water Code 9.3.2, a 2D hydraulic model has been developed.

The modelling approach utilised for this study included the development of a detailed fine scale 2D rain-on-grid (ROG) hydraulic model, for the purpose of defining and understanding the flooding characteristics of the site and whether the proposed development has any impacts on surrounding properties. The ROG method was adopted in conjunction with hydrograph inflows due to the upstream flows from the Bohle River and Spring Creek contributing to the flooding over the modelled catchment. The ROG approach has been used extensively for flooding assessment and is a standard industry and local government authority (LGA) approach.

The modelling methodology as outlined in the Precinct 2 flood impact assessments (URB0001-P2-FIA) has been adopted for the continuation of the estate. The specific modelling features utilised for Precinct 2 have not been altered for the modelling of Precinct 4 Stage 12A. The assessment of TUFLOW modelling capabilities and the cell-size convergence testing is contained within the original FIA and the outcomes remain unchanged for the Precinct 4 modelling. ARR87 hydrologic methodology has been adopted as NCE have continued to use the model as accepted for the Precinct 1 RAL.

3.1 TUFLOW

The TUFLOW (Two-dimensional Unsteady FLOW) modelling software was utilised to undertake the hydraulic modelling required for this flood level assessment. TUFLOW is a powerful computational engine that allows the ROG method to be applied directly to the 2D hydraulic model which provides 1D and 2D solutions of the

free-surface flow equations to simulate flood and tidal wave propagation. TUFLOW is specifically oriented towards establishing flow and inundation patterns in floodplains, coastal waters, estuaries, rivers and urban areas where the flow behaviour is essentially 2D in nature and cannot or would be onerous to represent using a 1D model. Subsequently, TUFLOW is ideally suited for this assessment.

TUFLOW currently incorporates two (2) grid-based solvers:

- TUFLOW Classic: A second order semi-implicit solution available for computations using CPU hardware on a single core; and
- TUFLOW HPC (Heavily Parallelised Compute): A second order explicit solver. TUFLOW HPC can run a simulation using multiple CPU cores, or alternately GPU hardware for high-speed execution without sacrificing model accuracy.

Outputs from TUFLOW include GIS compatible maps of flood depths, water surface levels (WSL), velocities and inundation extents.

For this assessment, a site specific 2D TUFLOW model has been developed which has adopted the HPC solver. Where applicable, 1D elements have been incorporated in the model.

3.2 Baseline Model

NCE have generally utilised the approved baseline model as developed as part of the Precinct 2 FIA (URB0001-P2-FIA). An approved development to the north-east of the Stage 12A development has been incorporated into the baseline modelling to ensure the impacts on the flow regime are mirrored within the 2d modelling. The approved development is the initial stages of the Yumba Meta which are depicted below in Figure 3-1. The full set of approved design plans are provided in Appendix J which have been extracted from the TCC Planning online portal.

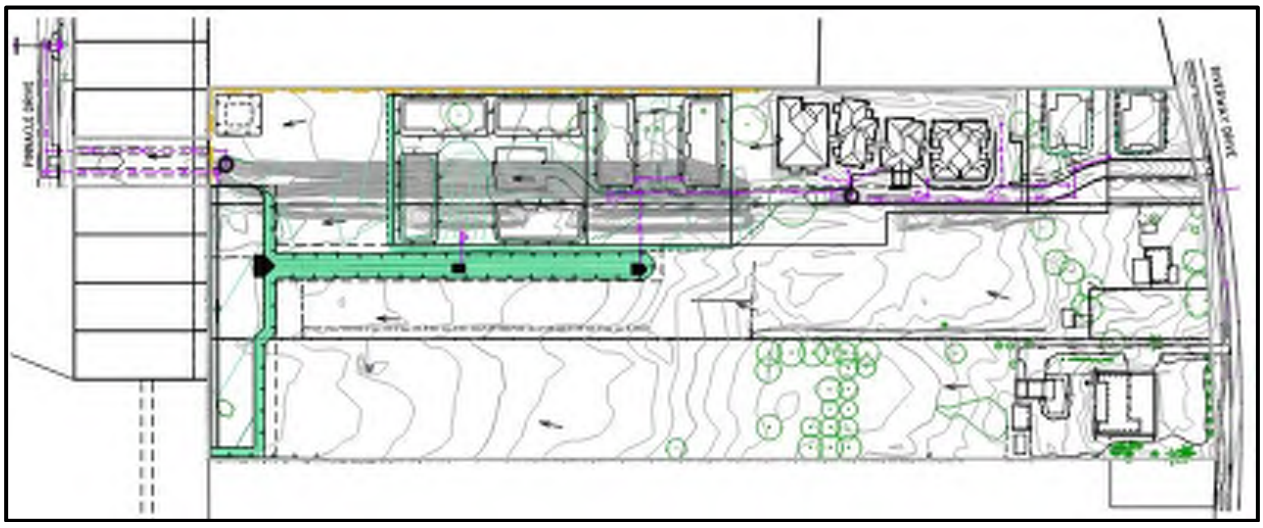

Figure 3-1 Yumba Meta stage 1 development

The location of the Yumba Meta development in comparison to the different stages and precincts is shown in Figure 3-2 below for reference.

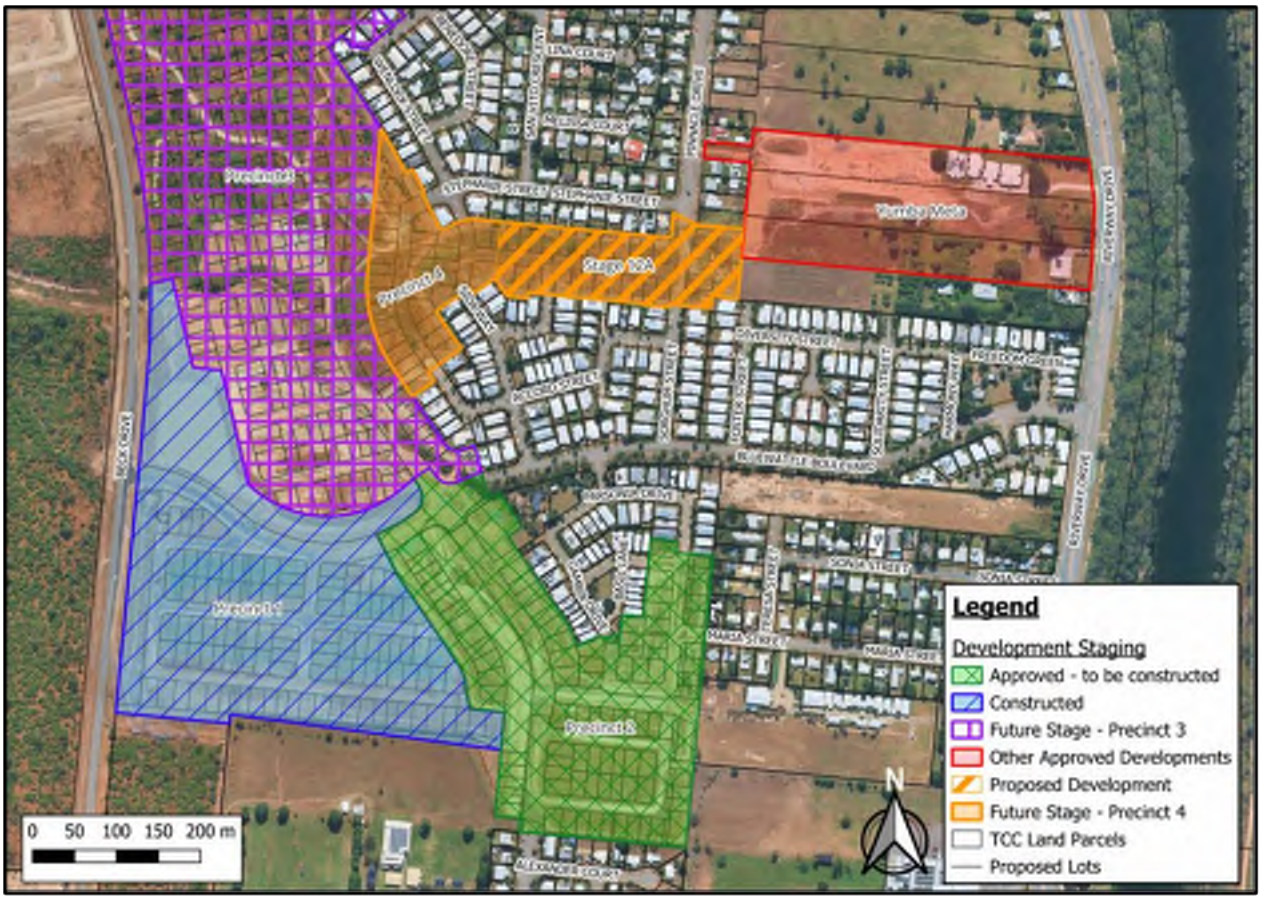

Figure 3-2 Development locations comparisons

The Yumba Meta development captures all runoff to the west within the drain and detention basin and then provides an underground pit and pipe connection into Pinnacle Drive to create a legal point of discharge. The drain and basin topography updates can be seen in Figure 1-4. The shapefiles and culverts specific to the Yumba Meta development can be seen in Figure 3-3.

Additional edits to the baseline surface have been utilised to revert select areas of surveyed levels back to 2019 LiDAR levels as they extended into existing residential areas and inaccurately depicted lot levels. These areas have only been specifically updated surrounding the Stage 12A development to ensure results mapping does not inaccurately depict flood conditions on adjacent lots. The areas where the site survey has been excluded can be seen in in Figure 3-3 as well.

Figure 3-3 Yumba Meta development shapefiles

3.3 Developed Model

Given the nature of the assessment, the modelling to identify the development layout was an iterative process, where one set of results was used to inform or refine the subsequent simulation. This iterative process also extended to the identification of mitigation measures. With this in mind, the following approach was used:

- Assess the design Digital Terrain Model (DTM) provided by Empower Engineers.
- Modify the DTM to better fit/tie into the base-line model to account for proposed drainage, roads, earthworks and culverts.
- Identify and assess the development impacts through an iterative process of various flood mitigation measures to ensure non-worsening conditions beyond the extent of the proposed development.
- Stage 12A of development was refined to ensure a suitable outcome which aligned with the ultimate outcomes.
- Modelling of interim staging which mirrors the expected construction programming. This includes the modelling of temporary drainage measures and other requirements during the construction. Given this staging is temporary NCE have mainly focused on the resolution of the major (1% AEP) and minor (0.5EY) events.
- Climate change scenario and complete blockage scenario to assess the robustness of the development and the worst-case development impacts.

In addition to demonstrating compliance with the objectives of Section 1.4, the modelling works are anticipated to provide confirmation of the expected flood levels within the development. NCE note that the future removal of the HESB will occur and new drainage paths will be required to be cut to ensure drainage to the Beck Drive culvert. Additionally, the future master planned estate will capture flows from Stage 12A and divert them to the north via a diversion drain as part of Precinct 3 any impacts generated by diverting the flows to the north must be addressed as part of future modelling as part of the Precinct 3 FIA.

3.4 Proposed Development Site Drainage

The proposed development site drainage is represented in Figure 3-4 and generally consists of the following components:

- The fully completed development of Precinct 1 as approved as part of the original FIA (URB0001-FIA).
- The fully completed development of Precinct 2 as approved as part of the Precinct 2 FIA (URB0001-P2-FIA).
- Stage 6 earthworks as approved by the Precinct 1 FIA addendum (220914-URB0001-03-Addendum_01).
- Filling for proposed allotments to align with adjacent developments, provide appropriate grade and bring development above 1% AEP.
- Trapezoidal open channels to provide drainage to development runoff and upstream catchments and mitigate flood impacts.
- Extension of Pinnacle Drive and Sorghum Street to connect through. Raised sealed urban roads acting as embankments.
- Culvert under road extension to connect open channels.
- Low-flow weirs with culverts through the downstream existing stormwater drain connecting to the sediment basin to detain flows in the minor events within the existing drainage infrastructure.
- Significant earthworks are proposed to natural land fall for the developed allotments to maintain immunity in the DFE.
- The outlet discharge locations from the site are consistent with the existing flows with the runoff conveyed and mitigated via channels, flow diversions and flow restrictions. The primary flow discharge locations at the western boundary are based on the existing drainage channel in place on the balance lot which directs flows to the sediment basin and Beck Drive culvert.
- The intent is for flows to be sufficiently mitigated before reaching the sedimentation basin to ensure no additional impacts downstream. Therefore, all mitigation measures are contained within the Stage 12A development extent or within the existing drainage channel connecting Stage 12A to the sediment basin.

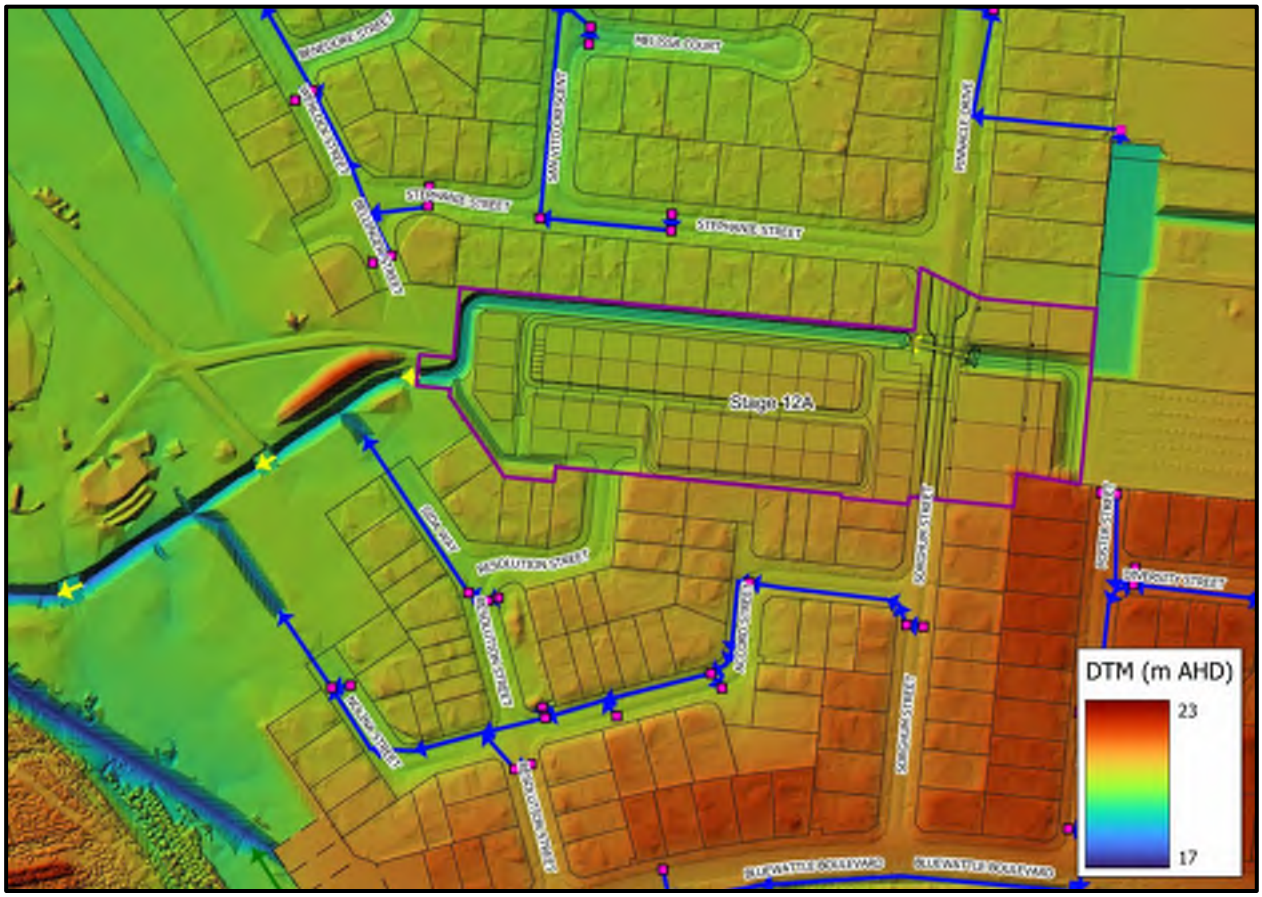

Figure 3-4 Proposed development site drainage

3.5 Development Staging

The development is intended to be split between two stages as depicted in Figure 1-1. The stages are as outlined in Section 1.2. For the construction Stage 1 the new road connecting Pinnacle Drive and Sorghum Street will be required for access to the development. To ensure that flows upstream of the road extension are adequately captured a v-cut table drain is to be installed along the eastern batter of the road to direct flows into the culvert under the road extension and into the drainage paths through Stage 1. Downstream low flow weirs must also be installed as part of Stage 1 of the development.

4.0 HYDROLOGIC ASSESSMENT

As discussed in the preceding sections, the hydrology has been primarily based on the rain-on-grid (ROG) method and upstream inflows with input parameters based on the ARR1987 temporal pattern ensembles for each event and duration. No alterations have been made to the hydrologic methodology adopted as part of the original FIA.

4.1 Rain-on-grid (ROG)

The same rain-on-grid and materials/land-use approach has been adopted as per the previous FIA (URB0001-P2-FIA).

Land use / imperviousness maps (Map A03 and Map A04) have been developed for each scenario (base-line and developed respectively) corresponding with the relevant imperviousness and roughness which has been categorised as per Table 4-1. Depth varying Mannings values have been adopted for some land uses as it generates runoff that is more accurate to real life conditions. Depth varying values are listed in the order

y1, n1, y2 and n2. Y1 is the depth below which n1 is applied. Whereas y2 is the depth above which n2 is applied. Values in between these depths are linearly interpolated.

Table 4-1 Land use summary

Land use type	Mannings n	Fraction Impervious	Description
1	0.03	0	Bohle River bed upstream
2	0.04	0	Bohle River bed downstream
3	0.02,0.1,0.1,0.04	0	Parkland
4	0.03,0.1,0.1,0.06	0	Vegetation (light) / Open Space / Vegetated Channel
5	0.05,0.12,0.1,0.08	0	Vegetation (medium)
6	0.1	0	Vegetation (dense)
7	0.05	0.1	Rural
8	0.04	0.2	Rural Roads
9	0.04	0.2	Sports & Recreation
10	0.03	0.5	Urban Roads
11	0.06	0.65	Low Density Residential
12	0.06	0.7	Residential
13	0.03,0.02,0.1,0.05	0.9	Commercial/Industrial
14	0.018	1	Concrete Channels / Impervious
15	0.025	1	Water
16	0.15	0	Downstream portion of Bohle River
17	0.12	0	Downstream portion of Bohle River
18	0.1	0	Wetland
19	0.08	0	Linear Wetland
20	0.03	0	Developed – cleared areas

The Mannings values provided above have been adopted from one of the following three technical guidelines/documents, in the following order of precedence; TCC City Plan SC6.7.4, Australian Rainfall and Runoff (ARR2019), Queensland Urban Drainage Manual (QUDM).

The existing residential allotments were assessed from aerial imagery to determine a rough percent imperviousness. This resulted in the newer development areas adopting a fraction impervious of 0.7 whilst older low density residential zoned areas have adopted a value of 0.65 as is outlined in the TCC City Plan.

5.0 HYDRAULIC ANALYSIS

The hydraulic analysis has been carried out using a fine scale 2D model identifying the flooding depths, velocities and inundation extent of the base-line and developed case models as well as assessing and mitigating the impacts associated with the proposed development. NCE have generally utilised the existing model developed as part of the Precinct 2 assessment (URB0001-P2-FIA), any updates to this model are outlined in the following sections.

5.1 Model Setup and Boundary Conditions

There are no changes to the model extents or adopted boundary conditions.

5.2 Topography

NCE have utilised the previously conducted survey in conjunction with the 2019 LiDAR data for the unchanged baseline topography. Minor updates are noted in Section 3.2.

For the developed scenario, the baseline topography was modified to include the filling for the proposed lots, the construction of open channels, extension of existing roads and flow mitigation measures such as low flow weirs. The development topography is depicted in Figure 3-4. The proposed development site drainage is outlined in Section 3.4. NCE note that additional stockpile material is also represented by the model directly to the north of the previous stockpile location.

5.3 1D Stormwater Drainage Structures

In TUFLOW pipes and culverts are modelled as 1D structures. The existing infrastructure as recorded in TCC's online infrastructure mapping has already been included in the previous hydraulic model. Minor changes to the existing network are due to the inclusion of the Yumba Meta development. Culverts have been modelled as per the long sections and information provided in the design plans contained in Appendix J.

Further, major culverts included as part of the proposed development scenario (additional to those utilised in URB0001-FIA-P2 for Precinct 1 & 2) are outlined in Table 5-1.

The spatial representation of each pit, pipe and culvert not included in TCC's online infrastructure mapping is shown in the attached maps.

Table 5-1 Developed culvert structures

Culvert ID	Type	Size
Stage_12A_P01	RCBC	3/1200x300
STAGE_12A_LOW_FLOW_1	RCP	Ø375
STAGE_12A_LOW_FLOW_2	RCP	Ø375
STAGE_12A_LOW_FLOW_3	RCP	Ø375

It should be noted that there is no internal drainage for Stage 12A with the intent that all runoff will be discharged through overland drainage paths.

5.4 Hydraulic Roughness

The hydraulic roughness is a measure of the resistance to flow and is typically defined as the Manning's n value. Map A03 and Map A04 depict the Manning's n values and land use applied to the various surface types for the base-line and developed cases respectively. These roughness values and areas have been defined via aerial imagery and through site visits with reference to the guidelines outlined in Section 4.1.

5.5 Drying & Flooding Depths

Drying and flooding depths of 0.0002 m were adopted. These values were selected in order to mitigate the risk of mass errors and are compliant with TUFLOW modelling guidelines for SGS modelling.

5.6 Critical Duration Assessment

The critical duration assessment was conducted as part of the original Precinct 1 FIA (URB0001-FIA). NCE have continued to adopt the long and short critical durations. To reduce the number of maps presented as part of this report, the maximum results for the two durations has been calculated, where differences between the durations are noted and are important to distinguish for the impact assessment, NCE have provided

specific commentary. NCE note that whilst the development site is generally contained within the short critical duration area the inclusion of the development has resulted in peak WSLs being generated in the long critical duration in some areas such as through the upstream drainage paths.

5.7 Sensitivity Analysis

NCE have not rerun the sensitivity analysis that were conducted as part of the previous FIA. The climate change and 100% blockage scenarios have been modelled to assess the robustness of the development to worst-case scenarios. The outcomes of those assessments are provided in Section 6.0.

6.0 FINDINGS, RESULTS AND DISCUSSION

Due to the nature of ROG results and to provide some clarity, the final maps have been filtered such that areas predicted to experience water depths less than 0.05 m and water velocities less than 0.5 m/s are shown free from flooding. This aligns with TCC's historical filtering requirements.

Table 6-1 below summarises results of the hydraulic modelling that have been mapped and provided in the following appendices:

- Appendix A – General Flood Model Mapping
- Appendix B –Afflux Mapping (All Events WSL, Velocity Afflux)
- Appendix C – Depth Mapping (100- and 2-year ARI)
- Appendix D – Velocity Mapping (100- and 2-year ARI)
- Appendix E – WSL Mapping (100- and 2-year ARI)
- Appendix F – Hazard Mapping (100-year ARI only)

Table 6-2 below summarises the results of the staged hydraulic modelled that have been mapped and provided in the following appendices. For each stage scenario the 100-year and 2-year ARI WSL afflux and depth results have been provided. NCE note that interim events are not required as each stage is considered temporary and the impacts are to be resolved as part of the final development.

- Appendix G – Stage 1 Mapping

Table 6-3 below summarises the sensitivity results from the hydraulic modelling that have been mapped and provided in the following appendix:

- Appendix H – Sensitivity and Climate Change Mapping (WSL Afflux and Depth for select cases)

NCE note that provided results are "low-resolution" results and therefore the extent of inundation may be overstated due to the cell size utilised. Low-resolution results are utilised as TUFLOW cannot process the full set of high-resolution results and thus post-processing of results such as filtering cannot be completed.

Table 6-1 Result map plots

Scenario	Event (ARI)	Flood Characteristic			
		WSL	Depth	Velocity	Hazard
Baseline	100	✓	✓	✓	✓
	50	x	x	x	x
	20	x	x	x	x
	10	x	x	x	x
	5	x	x	x	x
	2	✓	✓	✓	x
Developed	100	✓	✓	✓	✓
	50	x	x	x	x
	20	x	x	x	x
	10	x	x	x	x
	5	x	x	x	x
	2	✓	✓	✓	x
Afflux	100	✓	x	✓	x
	50	✓	x	x	x
	20	✓	x	x	x
	10	✓	x	x	x
	5	✓	x	x	x
	2	✓	x	✓	x

Table 6-2 Staged assessment

Scenario	Event (ARI)	Flood Characteristic	
		Depth	Afflux (WSL)
Stage 1	100	✓	✓
	2	✓	✓

Table 6-3 Sensitivity result map plots

Scenario	Event (ARI)	Flood Characteristic	
		WSL Afflux	Depth
100% Blockage	100	x	✓
Climate Change	100	✓	✓

6.1 Development Mitigation

All measures additional to the mitigation provided as part of the Precincts 1 & 2 development are outlined below, inclusive of any alterations to the originally required mitigation. The development mitigation is contained within the surface model created by Empower which has been iteratively altered by NCE to achieve a non-worsening outcome for all events. The combined mitigation measures are as follows:

- Back of lot drain connecting through to the Pinnacle Drive / Sorghum Street road extension. Drain runs south to north along the back of proposed lots 204 and 205. Drain connects through to east to west drain through lot 206 and 207 connecting through to the new road.
    - Back of lot drain at 15 wide with a 5m wide base, grades at approximately 0.65%.
    - Through lot drain at 15m wide with a 5m wide base, grades at approximately 0.65%.

- Extension of Pinnacle Drive / Sorghum Street to create new road connection.
    - Sag point aligning with development drainage to discharge road runoff into adjacent drains.

  - Sag point also allows for minor overtopping over road to relieve flows in the major event.
  - Culverts under sag point 3/1200x300 modelled at 20% blockage.

- North drainage channel connecting the culverts under the Pinnacle Drive / Sorghum Street connection to the existing drainage path downstream. Drain extends the full length of the northern boundary.
  - Approximately 9.5m wide drain with a 3.5m wide base, grades at 0.3%.
  - Minor overtopping of the drain occurs during major events which extends into the adjacent private road allowing for additional conveyance / storage.
  - The adjacent minor road has one-way crossfall to direct runoff into the adjacent drain.

- Southern minor drainage channel connecting Resolution Street tee-head and internal roads to the existing drainage path downstream. Drain extents from Resolution Street along the south-western boundary to the northern drainage channel on the western boundary of Lot 907.
  - Approximately 10m wide drain (varies with batter height) 2m wide base, grades at 0.3%.
  - Extend drain eastward towards the tee head to provide sufficient capacity for flows from Resolution Street.

- Internal private roads in Lot 907 are utilised to direct overland flows into adjacent drains and to provide storage for direct runoff. No internal pit and pipe systems is provided with the intent that all flows are free draining overland.

- 3 downstream flow restriction weirs with DN375 low flow pipes:
  - Flow restriction 1 – directly downstream of Lot 907. 19.75m AHD (~0.9m tall) weir level.
  - Flow restriction 2 – located directly between Sida Way and Nolina Street overland flow drain connections. 19.45m AHD (~0.95m tall) weir level.
  - Flow restriction 3 – upstream of the Precinct 1 sediment basin. 18.95m AHD (~0.9m tall) weir level.

The proposed mitigation measures and any details can be seen in Map A07. Following an extensive series of model iterations with a combination of the above measures, mitigation of the increase in run-off from the altered developed flow configuration for all events has been achieved. NCE note that some minor, highly isolated afflux which is considered inconsequential are generated by directing flows to west to Beck Drive. It is noted that future development stages will redirect flows to the north alleviating any minor interim afflux.

6.2 WSL Afflux

Afflux is defined as the relative change in a flooding characteristic, namely water surface level (WSL) or velocity, between the baseline and developed scenario. This is determined by subtracting the baseline peak results from the developed peak results, where a positive value represents an increase in the flood characteristic and a negative value is a decrease. The afflux results for each AEP event are provided in Appendix B. It is noted that due to the high-resolution results output by the SGS model, flood mapping quality is enhanced allowing a more accurate assessment of the site.

Map B01 depicts the extent of WSL afflux for the 100-year ARI event, this includes the peak WSLs from the 60-minute and 6-hour durations. The afflux generated by the development is contained to within the development site. Generally, the developed lots through precinct one is mapped as “Was wet now dry” which indicates the immunity of the lots to the DFE. Some areas internal to both lot 907 and the lots to the east of the proposed road contain afflux, these values are generally contained to private roads and drainage easements and will not impact on proposed dwellings. The internal roads of Lot 907 also show an increase in WSL where water flows through the roads, however these values are exaggerated due to the level of fill across the development compared to existing surface. WSL decreases are noted upstream of Precinct 4 to

the east on the adjacent lot and to the north-east through the adjacent sections of Pinnacle Drive and Stephanie Street. The main drains through the upstream lots and along the north and south of Lot 907 result in local decreases to WSLs as the drains are in cut. Some minor localised increases in afflux are noted across the development which are considered non-actionable and are inconsequential and not considered further. These are noted on the adjacent lot to the northeast along Pinnacle Drive where existing water ponds on an undeveloped lot, this would be resolved upon development of the lot. Further impacts are noted at the end of Sida Way although are only generated within the roadway and do not alter the flood hazard level within the existing road reserve.

Map B06 depicts the extent of afflux for the 2-year ARI event. The combined WSLs from both of the minor event durations shows some minor afflux downstream of Beck Drive through the drain. Afflux is minor, localised and contained within the drain and is therefore considered non-actionable. Additionally, NCE note that the downstream afflux will be resolved once flows are directed to the north as part of future development stages.

Across all other interim events and durations NCE consider that development does not generate any actionable afflux. Other highly isolated areas show minor, non-actionable afflux which are inconsequential and not considered further. NCE note that any minor afflux noted will likely be resolved as part of future development stages which will supersede the temporary downstream mitigation measures.

While it is acknowledged that there are some minor isolated increases in WSL, there is generally no actionable impacts offsite. The outcome is considered to achieve all the objectives of the City Plan flood hazard planning scheme policy SC6.7.

6.3 Flood Depth and Inundation Extent

Appendix C contains the flooding depth and inundation extent for the base-line and developed case scenario for the major and minor (100- and 2-year ARI respectively) events. The most critical depths for the development are from the 100-year ARI event, shown in Map C02.

The developed depth mapping in the 100-year ARI shows that the inundation across the development site is generally restricted to the open drains and through the minor roads. Generally, NCE have attempted minimise the extent and magnitude of ponding through the new development areas and note that no underground pit and pipe network is proposed as part of the development. All areas are graded to flow freely overland to the proposed open drains inclusive of the proposed new road. The depth of ponding across the development site and internal roads does not exceed ~240mm in the worst-case scenario at the Resolution Street tee head. Internal private roads and the proposed connection of Pinnacle Drive and Sorghum Street do not exceed depths of 200mm. No ponding occurs across the development site that does not have stormwater infrastructure to provide drainage to the area. The intent is to ensure that all lots are free from any inundation caused by ponding through internal roads and that the lots have been built to a level that is at or above the 100-year ARI flood level. Where ponding reaches the edge of a proposed lot, any habitable FFL will be set a minimum of 300mm above the 1% AEP WSL in both the adjacent major drains and the local runoff within the internal roads.

NCE note that due to the 5m grid resolution of results some lots appear to be inundated in the major flood event in particular due to flooding of the internal roads in Lot 907. Interrogation of water levels in these areas indicates that lots are free of inundation and flooding indicated in mapping is due to the coarse flood model grid size.

6.4 Peak Velocity

Appendix D contains the peak velocity for the baseline and developed case scenarios for the major and minor storms. In reference to the 100-year ARI base-line assessment (Map D01), it is evident that the velocity is generally <0.5m/s through the areas of sheet flow whereas the existing table drains and open drains exceed 0.6m/s in some areas.

As expected, the average velocities in the developed case (Map D02) are generally less than 0.5m/s in areas of ponding. The table drains and open drains are still higher with values up to 0.6m/s generally. Similar observations have been made for the other storm durations and for the minor event scenarios. NCE note that generally no significant afflux is noted around or adjacent to the development. Some localised peaks in flood velocity are noted at the downstream low flow weirs where overtopping occurs in major events, velocities peak at approximately 1m/s at the furthest downstream weir. NCE note the temporary nature of the low-flow weirs suggests that scour protection may not be necessary despite the velocity being around 1m/s. The inclusion of scour protection is at the discretion of the design engineers with all channels and locations of high velocity subject to a separate erosion, scour and stability assessment as part of the operational works.

6.5 Change in Velocity

The change in the peak velocities is shown in Appendix B and has been determined by subtracting the base-line velocity results from the developed scenario results.

The criteria adopted for changes beyond the extents of the proposed development for this assessment is as follows:

- Any change below 0.1 m/s has no cause for concern and is an acceptable outcome;
- 0.1 m/s to 0.3 m/s is generally acceptable may be considered unacceptable following a review of the pre and post velocities;
- 0.3 m/s to 0.5 m/s may require further investigation to determine if additional mitigation measures are required;
- Above 0.5 m/s requires an in-depth investigation into the potential erosion impacts as well identifying mitigation measures.

Map B07 depicts the extent of velocity afflux for the 100-year ARI event. There are generally no significant increases off-site, however, there are some slight increases noted at the very upstream end of the development to the east and at the boundary with the existing portion of section of Pinnacle Drive to the north. These increases are very minor in both extent and magnitude and are isolated while values do not exceed an increase of 0.2m/s. Additionally, these values do not align with any increases in flood depth, nor do they correlate with a change in the hazard classification. Therefore, NCE consider these impacts to be non-actionable and inconsequential and fully acceptable.

6.6 Peak Flood Levels

Appendix E contains the peak water surface levels (WSL) for the base-line and developed case scenarios. The 100-year ARI flood levels vary with the natural topography of the site.

To ensure immunity to the defined flood event (100-year ARI as nominated in TCC's planning scheme), each lot is required to have a portion of the site at or above the 100-year ARI flood level. As the lots are free from inundation in any event the intent is for the proposed lots finished levels to be at or above the maximum WSL in the 100-year ARI event through the open drains and roads.

Table 6-4 provides a summary of the 100-year ARI flood levels through the adjacent open drains and roads at the locations indicated in Map A07. These are the minimum levels the adjacent lots and roads need to be designed to in order to comply with TCC's planning scheme. Note that all flood levels are taken at Stage 2 of the development as this is considered to be the worst-case scenario and considered the fully complete scenario. All provided levels are in metres AHD and rounded to the nearest 10mm. Some areas are noted as without flooding as they have been filtered out to in accordance with TCC standard procedure, these areas are indicated in the below table with a Not Applicable (N.A.) label.

Table 6-4 Peak flood level summary at key locations

Location	100yr ARI MAX WSL
Road Extension 01	20.48
Road Extension 02	20.46
Road Extension 03	20.47
Road Extension 04	20.63
Road Extension 05	N.A.
Stage 1 Internal Road 01	20.16
Stage 1 Internal Road 02	20.25
Stage 1 Internal Road 03	20.23
Stage 1 Internal Road 04	20.38
Stage 1 Internal Road 05	20.45
Stage 1 Internal Road 06	20.57
Stage 1 Internal Road 07	N.A.
Stage 1 Internal Road 08	N.A.
Stage 1 Internal Road 09	20.55
Stage 1 Internal Road 10	20.73
Stage 1 Internal Road 11	N.A.
Stage 1 Main Drain 01	20.12
Stage 1 Main Drain 02	20.13
Stage 1 Main Drain 03	20.14
Stage 1 Main Drain 04	20.15
Stage 1 Main Drain 05	20.18
Stage 1 Main Drain 06	20.21
Stage 1 Main Drain 07	20.26
Stage 1 Main Drain 08	20.29
Stage 1 Side Drain 01	20.14
Stage 1 Side Drain 02	20.20
Stage 1 Side Drain 03	20.27
Stage 2 Main Drain 01	20.47
Stage 2 Main Drain 02	20.50
Stage 2 Main Drain 03	20.52
Stage 2 Main Drain 04	20.56
Stage 2 Main Drain 05	20.59

All finished floor levels (FFL's) are to be calculated as the adjacent 100-year WSL plus 300mm of freeboard or where there is no adjacent flooding a minimum of 300mm above the finished surface level (FSL) of the lot. Flood model WSL results rasters can be provided upon request to help define exact adjacent WSLs.

6.7 Hazard Assessment (VD Product)

A safety hazard assessment has been undertaken, primarily focusing on the velocity x depth (VD) product across the development. Flood hazard results have been mapped as per the ARR2019 General Flood Hazard Curves – Figure 6.7.9. For reference to the thresholds and levels of safety provided by the ratings refer to the Figure 6-1 which shows the curves and their description.

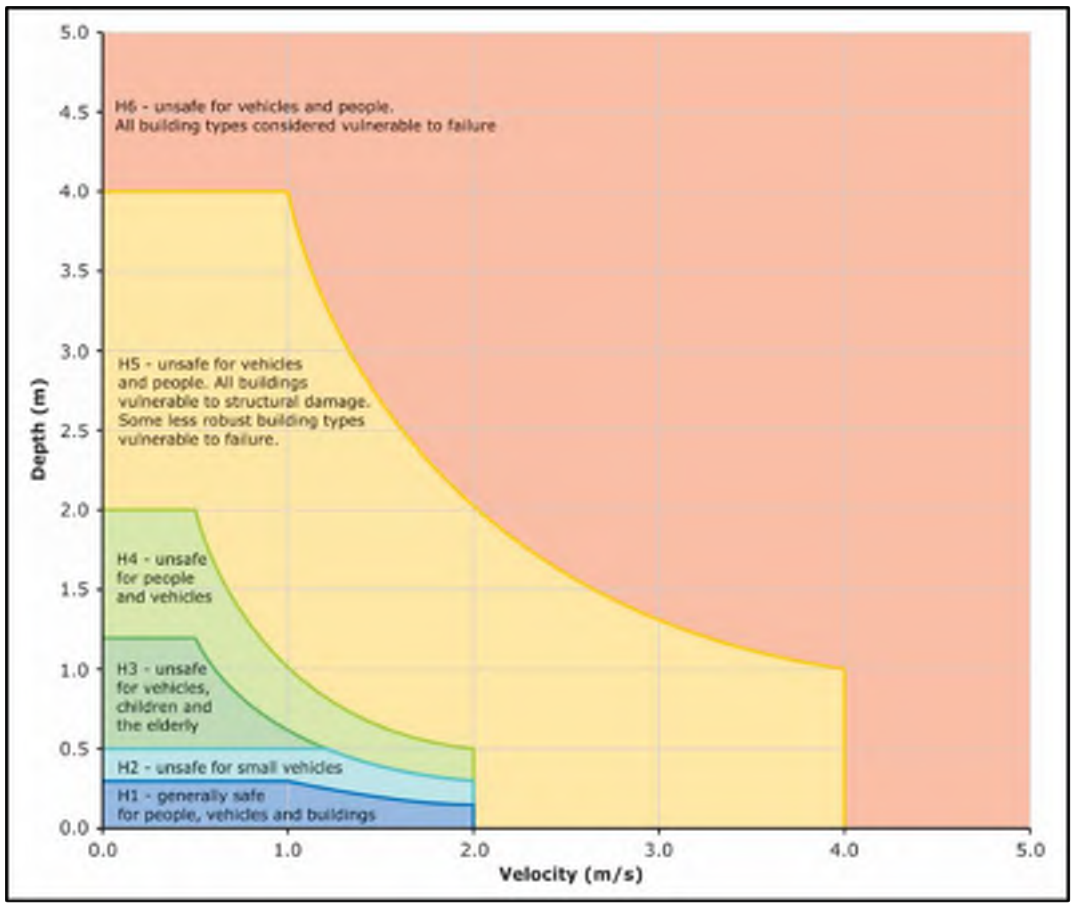

Figure 6-1 ARR2019 Figure 6.7.9 excerpt – combined flood hazard curves

Map F02 depicts the flood hazard classifications for the worst-case 100-year ARI event. It was observed in the 1% AEP event that the VD product generally remains within acceptable limits.

In reference to Figure 6-1, it can be seen that the maximum VD product for all trafficable areas, lots and pedestrian pathways does not exceed the limits for H1 – indicating it is generally safe for people, vehicles and buildings. The only areas that exceed the limits for H2 are the open drains where flows are significantly deeper. NCE note that some areas of the drainage easements exceed H2 and these areas will need to ensure appropriate safety measures are in place to maintain safety for people and vehicles during major events.

6.8 Staged Development Assessment

All of the above information is provided in relation to the expected full development. The following section provides information specifically in relation to the interim Stage 1 development as shown in Figure 1-1.

6.8.1 Stage 1

All mapping in reference to Stage 1 of the development is contained within Appendix G. The Stage 1 extent and development is outlined in Map A07.

Stage 1 essentially excludes the residential subdivision to the east of the proposed road extension. The road is excluded from Stage 1 in the provided plans however, to provide access to the new allotment the road extension will be required. In order to facilitate the future subdivision as part of Stage 2 and to direct flows west under the proposed road connection the major culvert under the road will need to be installed as part of Stage 1. Additionally, drainage will be required along the eastern side of the road to ensure no runoff from upstream catchments ponds against the roadway. NCE have modelled a v-cut table drain with 1 in 5 batters along the eastern edge of the road. The longitudinal grade modelled is at a minimum of 0.5% but does increase up to approximately 1.75% to match existing falls an ensure the table drain is not too deep. The topography can be seen in Map A07. It is noted that the downstream low flow restrictions are to be installed as start of the initial stage as well.

Afflux mapping in Appendix G shows afflux for both the major (100 year ARI) and minor (2 year ARI) events shows no additional afflux generated off site in comparison to the fully developed event. Afflux is generated upstream in the major event due to the limited drainage of the v-cut table drain. However, any generated afflux is limited to within the development lot and does not impact on any adjacent lots. NCE consider this acceptable and not no actionable afflux is generated.

involves the development / extension of the existing Gambia Drive, Parsonia Drive and Maria Street to facilitate the development of a further 24 residential lots. The development of Stage 3C will generally utilise the approved earthworks development of Precinct 2 for mitigation measures. The development of Stage 3C will provide additional internal stormwater pit and pipe network to drain the proposed road extensions. Back of lot drainage is required for the new lots to be developed along the Parsonia Drive extension. This drainage is required as an existing sump along the back of the Teresa Street lots is proposed to be filled to facilitate the development of additional lots. The culverts under Maria Street and back of lot drains provide sufficient drainage to ensure no afflux is generated on the existing Maria Street / Teresa Street lots. NCE note there is afflux generated downstream of Beck Drive in the minor 2-year ARI event as a result of the additional development area and updates to the downstream basin. NCE consider this acceptable as it is the minor event and is generally contained within the drainage channel and by the final stage of development this afflux will be resolved.

6.9 Blockage Sensitivity

NCE have assessed the sensitivity of the proposed development to the blockage of the developed culvert structures by modelling the combined maximum flood depths with 100% blockage of development culvert structures. The combined maximum flood depth for the 100-year ARI is shown in Map H01.

Flooding as a result of overtopping generated by the blockage of the internal pipe network is generally contained to within adjacent roadways and drains. Overtopping of the Pinnacle Drive and Sorghum Street connection occurs over the top of the proposed culvert. Due to the free draining design, flood depths do not exceed ~220mm in the roadway. Overtopping of major drainage channels does not result in flooding over any proposed or existing lots and does not alter the flood hazard on roadways or pedestrian paths above the allowable level.

6.10 Climate Change

The climate change assessment was carried out for the 100-year ARI combined maximum duration storm as it is the critical DFE. As per the 2020 “Review of Hydrological Methods for the Townsville Region” Phase 4 report, the climate change assessment has been based on a Representative Concentration Pathway (RCP) 8.5 scenario for the year 2090. A 15% increase to present-day rainfall and upstream inflows has been applied in this scenario.

The outcomes of these assessments are shown in Map H02 and Map H03 which show the climate change flood depths and the afflux from the climate change developed WSL scenario minus the climate change baseline WSL scenario respectively. These maps demonstrate that whilst there are increased water levels and flood extents generally across the entire model, there is very little difference in flood outcomes overall and the increase in WSL through the development results in little to no change in immunity for the lots. Impacts on the site due to climate change are generally restricted to flow corridors with increases through the internal roads.

Afflux generated by the development in the climate change scenario generally does not generate impacts on any adjacent lots with only very minor afflux generated on the adjacent Pinnacle Drive lot to the north-east and through Resolution Street. The proposed development shows good immunity to future increases in flooding due to climate change and does not negatively impact on the resilience of the community to impacts of climate change.

6.11 Flood Hazard Overlay Code 8.2.6

The purpose to this is to manage development in flood hazard areas so that risk to life, property, community, economic activity and the environment during future flooding events is minimised and to minimise potential damage on-site or to adjacent properties.

Results from this assessment indicate that the proposed development is not expected to cause any adverse flooding impacts to adjacent or downstream properties. This is supported by the results and discussions in Section 6.0.

Table 6-5 below has been provided to demonstrate that the proposed development complies (where applicable) with the performance outcomes (PO) of TCC's flood hazard overlay code 8.2.6.

Table 6-5 TCC flood hazard overlay code (8.2.6) assessment

Performance Outcome (PO)	Acceptable Outcome (AO)	Compliance with PO
PO1 Development in medium and high hazard areas is designed and located to minimise susceptibility to and potential impacts of flooding.	AO1.1 Where the development is located within an area shown on overlay map OM-06.1 or 06.2 as medium hazard — further investigation area, new buildings containing habitable rooms: a) are sited on a part of the site which is outside the medium hazard — further investigation area; or b) are sited on the highest part of the site. OR AO1.2 Where development is located within another hazard area shown on overlay map OM-06.1 or 06.2: a) floor levels of all habitable rooms are a minimum of 300mm above the defined flood level;	The development is primarily located within the medium hazard area. The proposal is based on the City Plan provision and includes earthworks with final development levels that allow compliance with AO1.2. Performance Outcome achieved

Performance Outcome (PO)	Acceptable Outcome (AO)	Compliance with PO
	b) floor levels of all non-habitable rooms (other than class 10 buildings) are above the defined flood event; c) car parking spaces associated with non-residential development are located outside the high hazard areas identified on overlay map OM-06.1 or 06.2; and d) underground car parks are designed to prevent the intrusion of flood waters by the incorporation of a bund or similar barrier with a minimum height of 300mm above the defined flood level.	
PO2 Development in high hazard areas does not significantly impede the flow of flood waters through the site or worsen flood flows external to the site.	AO2.1 Development in high hazard areas do not involve: a) filling with a height greater than 150mm; or b) block or solid walls or solid fences; or c) garden beds or other structures with a height more than 150mm; or d) the planting of dense shrub hedges.	There are no works proposed in high hazard areas. Performance Outcome achieved
PO3 Development does not intensify use in high hazard areas, in order to avoid risks to people and property.	AO3.1 New buildings are located outside high hazard areas identified on overlay map OM-06.1 or 06.2. AO3.2 New lots or roads are not created within high hazard areas identified on overlay map OM-06.1 or 06.2. AO3.3 Sites for non-permanent accommodation such as tents, cabins or caravans (whether intended for short or long-term accommodation) are located outside the high hazard areas identified on overlay map OM-06.1 or 06.2.	There are no works proposed in high hazard areas. Performance Outcome achieved
PO4 Siting and layout of development maintains the safety of people and property in medium hazard areas.	On existing lots AO4.1 Floor levels for residential buildings are 300mm above the defined flood level.	The proposed development layout maintains the safety of people and property. The Velocity x Depth product mapping is provided herein and demonstrates the

Performance Outcome (PO)	Acceptable Outcome (AO)	Compliance with PO
	AO4.2 Floor levels of non-residential buildings (other than class 10 buildings) are above the defined flood level. AO4.3 Underground car parks are designed to prevent the intrusion of flood waters by the incorporation of a bund or similar barrier with a minimum height of 300mm above the defined flood level. AO4.4 Development for non-permanent accommodation such as tents, cabins or caravans (whether intended for short or long-term accommodation) are located outside the medium hazard areas identified on overlay map OM-06.1 or 06.2. Where reconfiguring a lot AO4.5 Where reconfiguring a lot, new lots contain designated building envelopes (whether or not for residential purposes) outside the medium hazard areas identified on overlay map OM-06.1 or 06.2 and those building envelopes are of a sufficient size to accommodate buildings associated with the development AO4.6 In new subdivisions, arterial, sub-arterial or major collector roads are located above the 2% AEP flood level. AO4.7 Reconfiguration of lots does not involve cul-de-sacs or dead end streets within medium hazard areas identified on overlay map OM-06.1 or 06.2.	flooding remains within acceptable limits. All new allotments will be located above the DFE extent or will ensure a building envelope above the DFE. Public roads maintain trafficability in all extents and flood depths are limited to acceptable levels. There are no cul-de-sacs located in areas with lots that are not above the DFE. There are no public dead end streets to be constructed. Performance Outcome achieved
PO5 Signage is provided within high and medium hazard areas to alert residents and visitors to the flood hazard	AO5 Signage is provided on-site (regardless of whether land will be public or private ownership) to indicate depth at key hazard points, such as at floodway crossings, entrances to low-lying reserves or car parks.	The proposed development does not result in flooding in excess of the appropriate overlay code or flood hazard PSP acceptable design criteria relating to flooding. No signage is warranted.

Performance Outcome (PO)	Acceptable Outcome (AO)	Compliance with PO
		Not applicable
PO6 Development within high and medium hazard areas ensures any changes to the depth, duration, velocity of flood waters are contained within the site.	No acceptable outcome is nominated.	Results indicate a non-worsening outcome. Refer to the report and VD Mapping results. Performance Outcome achieved
PO7 Development within high and medium hazard areas does not directly, indirectly or cumulatively worsen flood characteristics outside the development site, having regard to: a) increased scour and erosion; or b) loss of flood storage; or c) loss of or changes to flow paths; or d) flow acceleration or retardation; or e) reduction in flood warning times	No acceptable outcome is nominated.	Results indicate that the proposed development does not directly, indirectly or cumulatively worsen flood characteristics outside the development site. Furthermore, changes in flood storage have been accounted for demonstrating a non-worsening outcome outside the development site and without impact on the flood warning times. Additionally, NCE note that further updates to the development will provide further benefit as flows will be directed to the north. Performance Outcome achieved
PO8 Facilities with a role in emergency management and vulnerable community services are able to function effectively during and immediately after flood events.	AO8 The development is provided with the level of flood immunity set out in Table 8.2.6.3(b).	No community or emergency management services are proposed within the development. Furthermore, access by emergency services to each lot is maintained during a 1% AEP event as compliance with the safety hazard criteria (VD product) has been demonstrated. Performance Outcome achieved
PO9 Public safety and the environment are not adversely affected by the detrimental	AO9.1 Development does not involve the manufacture or storage of hazardous materials within a high flood	No manufacture or storage of hazardous materials proposed with the development.

Performance Outcome (PO)	Acceptable Outcome (AO)	Compliance with PO
impacts of flooding on hazardous materials manufactured or stored in bulk	hazard area identified on overlay map OM-06.1 or 06.2. AO9.2 Within the low or medium flood hazard area identified on overlay map OM-06.1 or 06.2, structures used for the manufacture or storage of hazardous materials in bulk are designed to prevent the intrusion of flood waters up to at least a 0.2% AEP flood event.	Not applicable

7.0 SUMMARY AND CONCLUSION

A flood impact assessment (FIA) has been undertaken for the proposed Somers & Hervey Estate, Rassmussen, Precinct 4, Stage 12A. The assessment was completed with the development of a fine scale 2D model using TUFLOW software.

With the inclusion of the open channels, detention storage and low-level weirs, the increase in run-off associated with the channelisation and change in impervious area of the development can be adequately mitigated to provide a non-worsening / non-actionable outcome.

The WSL and flows adjacent to the development in all directions, are generally reduced but shown to increase solely in the 50-year and 2-year ARI event. These observations are attributed to the fine model scale, increased detention incorporated into the developed model and flow diversions / restrictions. The afflux results indicated the only afflux offsite is generally only immediately downstream of Beck Drive and maintained within the existing drainage channel. Other areas of afflux are noted but are considered highly isolated, minor, non-actionable which are inconsequential and have not been considered further. It is also noted that future development will direct flows to the north and likely resolve any minor afflux. Table 6-4 provides a summary of the flood levels in the drains and roads adjacent to the development which control the required FFL for the proposed lots and dwellings as depicted in Appendix K.

A hazard assessment was undertaken which demonstrated suitable outcomes at all roads and allotment areas during the 100-year ARI. The velocity*depth (VD) product criteria were adopted and resulted in flood hazard classifications acceptable for the proposed development roads, pathways and lots. Some areas of the open channels within proposed drainage reserves are subject to higher values as expected.

As part of the operational works design, all mitigation measures, levels and culvert sizing will be assessed and confirmed to ensure they appropriately address the outcomes of this FIA.

Areas with high velocities will be subject to a separate erosion, scour and stability assessment with stabilisation measures incorporated to ensure compliance with TCC revegetation requirements.

Based on the discussion above and the findings within Section 6.0, this report has demonstrated that the proposed development complies with the Townsville City Council's flood hazard overly code. The proposed development is not expected to increase the risk to life, property, community, economic activity or increase the potential for flood damage on-site or to adjacent and downstream properties. Furthermore, the development is not anticipated to be significantly impacted by increased rainfall intensity due to climate change. Table 7-1 provides a summary of the FIA flood mapping.

Table 7-1 Summary of the FIA flood mapping

Map Number	Description
Appendix A	
Map A01	BASELINE LAND USE AND ROUGHNESS
Map A02	DEVELOPED LAND USE AND ROUGHNESS
Map A03	BASELINE DIGITAL TERRAIN MODEL (DTM)
Map A04	DEVELOPED DIGITAL TERRAIN MODEL (DTM)
Map A05	DEVELOPED CONFIGURATION AND MITIGATION MEASURES
Map A06	DEVELOPED WSL RESULTS POINTS
Map A07	DEVELOPMENT STAGE 1 MODEL
Appendix B	
Map B01	100yr ARI WSL AFFLUX
Map B02	50yr ARI WSL AFFLUX
Map B03	20yr ARI WSL AFFLUX
Map B04	10yr ARI WSL AFFLUX
Map B05	5yr ARI WSL AFFLUX
Map B06	2yr ARI WSL AFFLUX
Map B07	100yr ARI VELOCITY AFFLUX
Map B08	2yr ARI VELOCITY AFFLUX
Appendix C	
Map C01	100yr ARI BASELINE FLOOD DEPTHS
Map C02	100yr ARI DEVELOPED FLOOD DEPTHS
Map C03	2yr ARI BASELINE FLOOD DEPTHS
Map C04	2yr ARI DEVELOPED FLOOD DEPTHS
Appendix D	
Map D01	100yr ARI BASELINE FLOOD VELOCITY
Map D02	100yr ARI DEVELOPED FLOOD VELOCITY
Map D03	2yr ARI BASELINE FLOOD VELOCITY
Map D04	2yr ARI DEVELOPED FLOOD VELOCITY
Appendix E	
Map E01	100yr ARI BASELINE FLOOD WSL
Map E02	100yr ARI DEVELOPED FLOOD WSL
Map E03	2yr ARI BASELINE FLOOD WSL
Map E04	2yr ARI DEVELOPED FLOOD WSL
Appendix F	
Map F01	100yr ARI BASELINE FLOOD HAZARD
Map F02	100yr ARI DEVELOPED FLOOD HAZARD
Appendix G	
Map G01	100yr ARI FLOOD DEPTH – STAGE 3C
Map G02	2yr ARI FLOOD DEPTH – STAGE 3C
Map G03	100yr ARI WSL AFFLUX – STAGE 3C
Map G04	2yr ARI WSL AFFLUX – STAGE 3C
Appendix H	
Map H01	100% BLOCKAGE DEVELOPED SCENARIO – FLOOD DEPTH
Map H02	CLIMATE CHANGE DEVELOPED SCENARIO – 100yr ARI WSL AFFLUX
Map H03	CLIMATE CHANGE DEVELOPED SCENARIO – FLOOD DEPTH

8.0 REFERENCES

Townsville City Council, 2014, Townsville City Plan.

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2019

Australian Rainfall and Runoff: A Guide to Flood Estimation, © Commonwealth of Australia (Geoscience Australia).

Australian Institute for Disaster Resilience, Attorney-General's Department, 2017, *Australian Disaster Resilience Handbook Collection, Flood Hazard*, Guideline 7-3, Australian Institute for Disaster Resilience, Knowledge Hub, Melbourne.

APPENDIX A

General Flood Model Mapping

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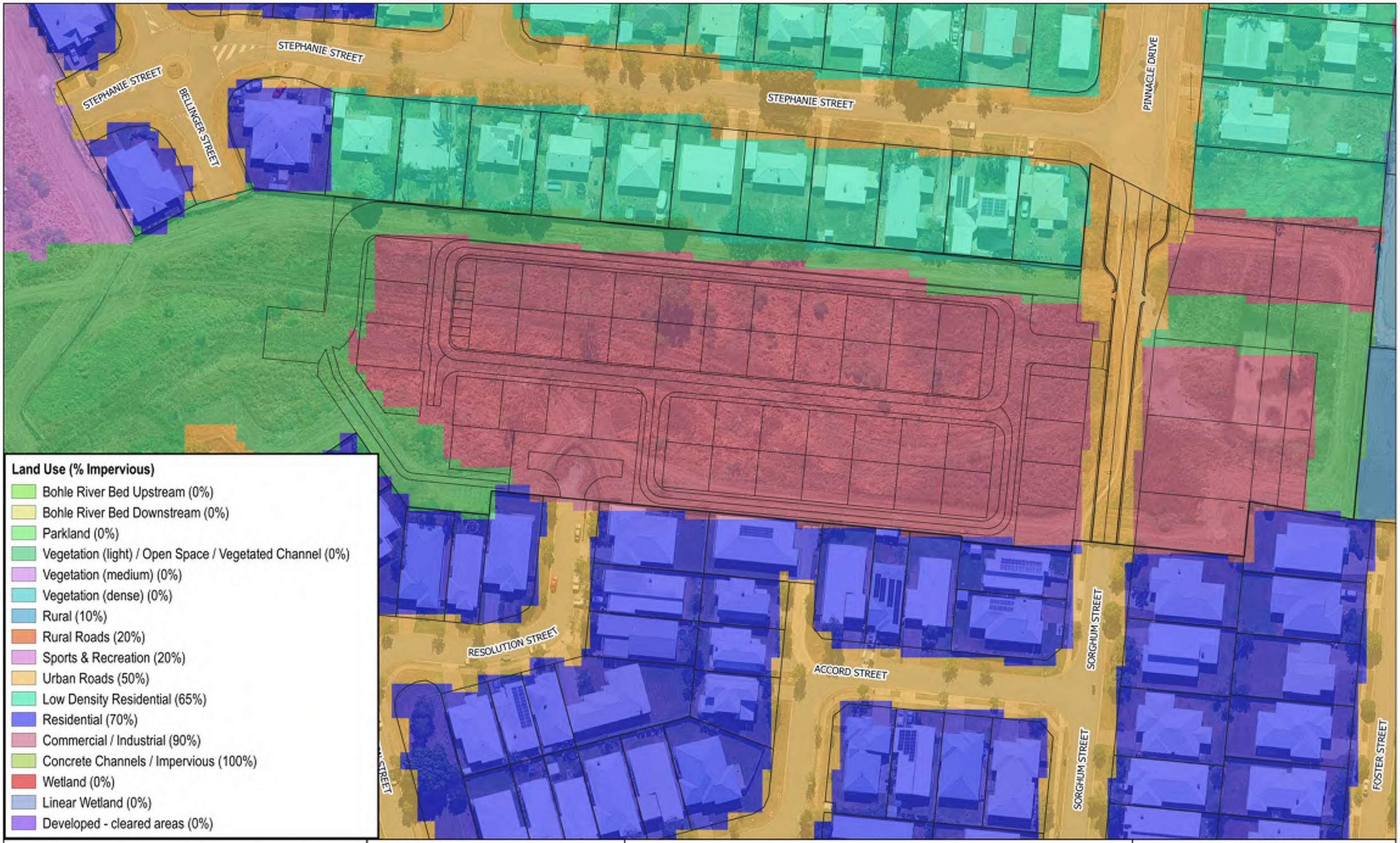
0 10 20 30 40 50 m
1:1,000

N

Legend
TCC Land Parcels
Development Area

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A
BASELINE LAND USE AND ROUGHNESS

Prepared By: BB	Date: 18/12/2025	Size	Map
Reviewed by: AW	Revision: A	A3	A01
	NCE Ref: URB0001-P4		



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0 10 20 30 40 50 m
1:1,000

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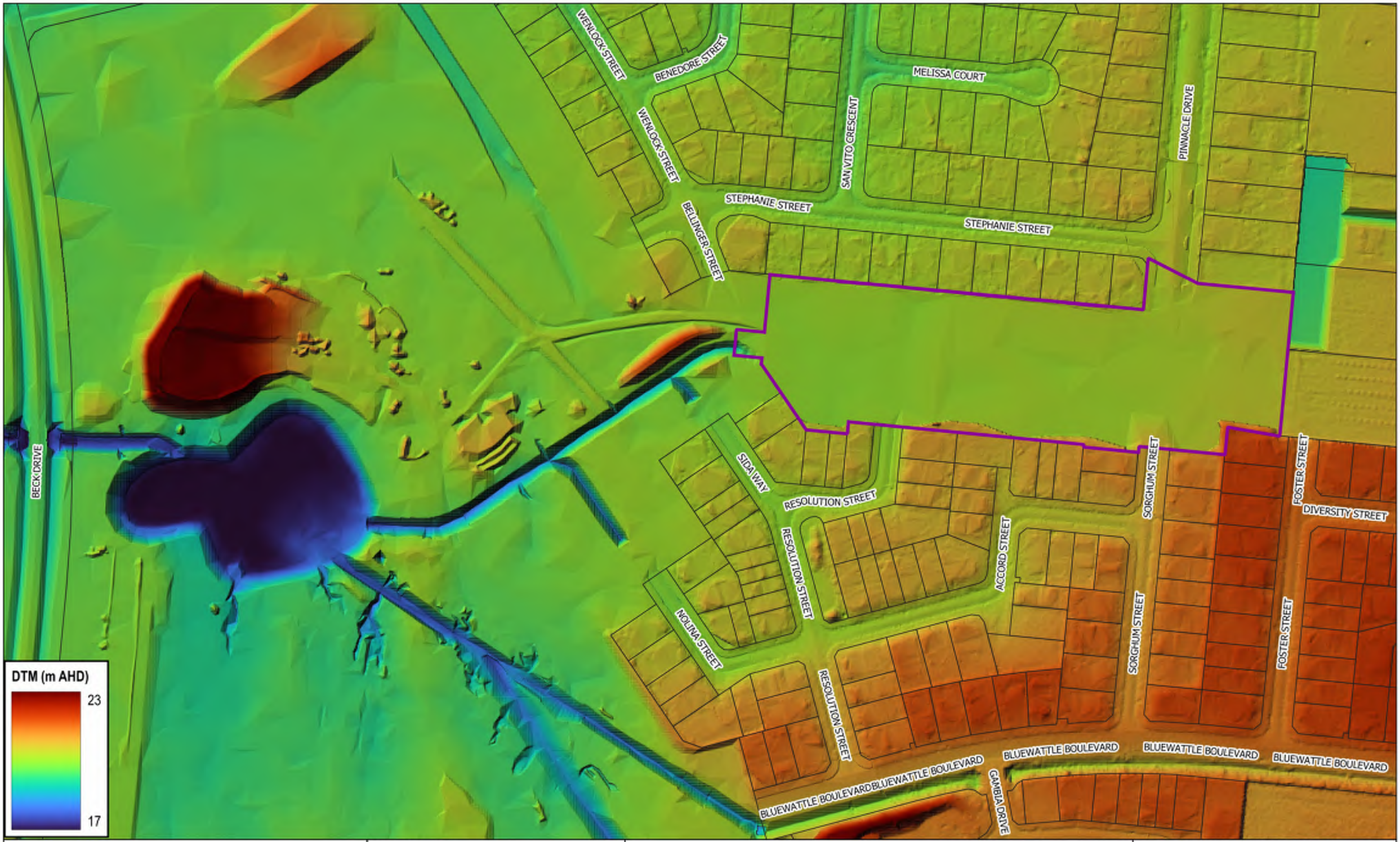
Legend
TCC Land Parcels
Stage 12 Lots

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A

DEVELOPED LAND USE AND ROUGHNESS

Prepared By: BB Reviewed by: AW	Date: 18/12/2025 Revision: A NCE Ref: URB0001-P4	Size A3	Map A02



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0 25 50 75 100 m
1:2,000

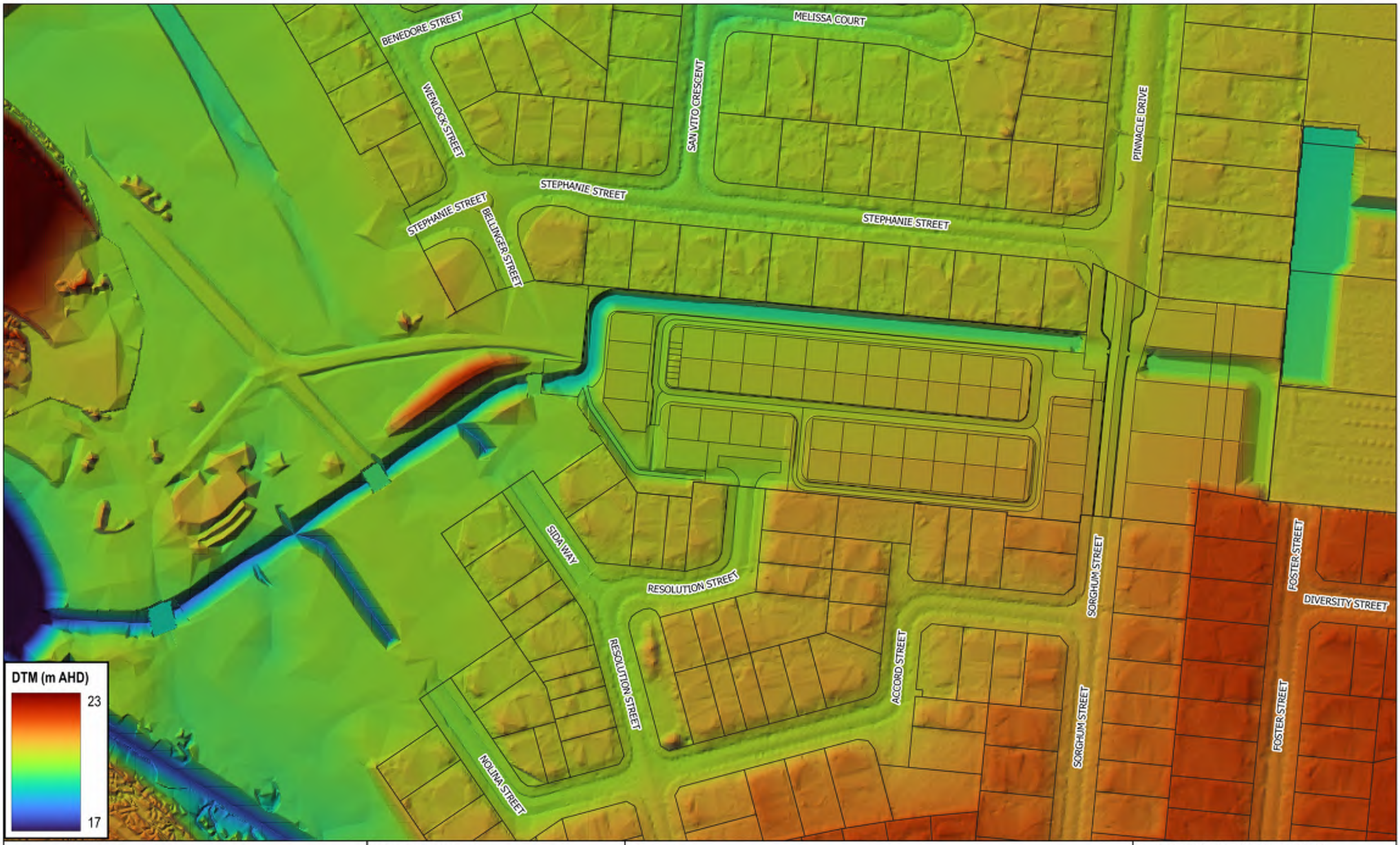
N

Legend
TCC Land Parcels
Development Area

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A

BASELINE DIGITAL TERRAIN MODEL (DTM)

Prepared By: BB	Date: 18/12/2025	Size	Map
Reviewed by: AW	Revision: A	A3	A03
	NCE Ref: URB0001-P4		



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Legend
TCC Land Parcels
Stage 12 Lots

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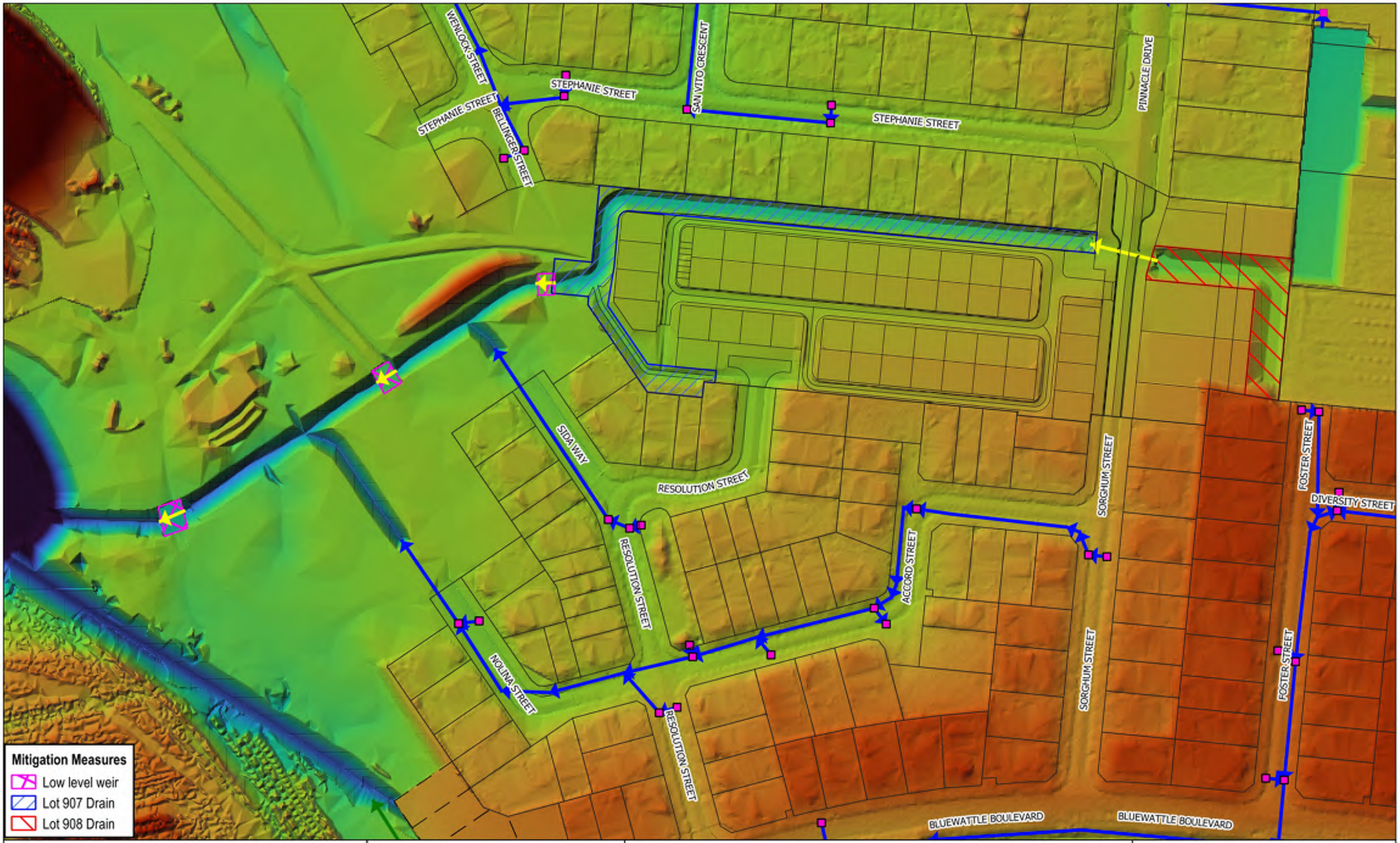
PRECINCT 4 - STAGE 12A
DEVELOPED DIGITAL TERRAIN MODEL (DTM)

Prepared By: BB	Date: 18/12/2025	Size	Map
Reviewed by: AW	Revision: A		
	NCE Ref: URB0001-P4	A3	A04



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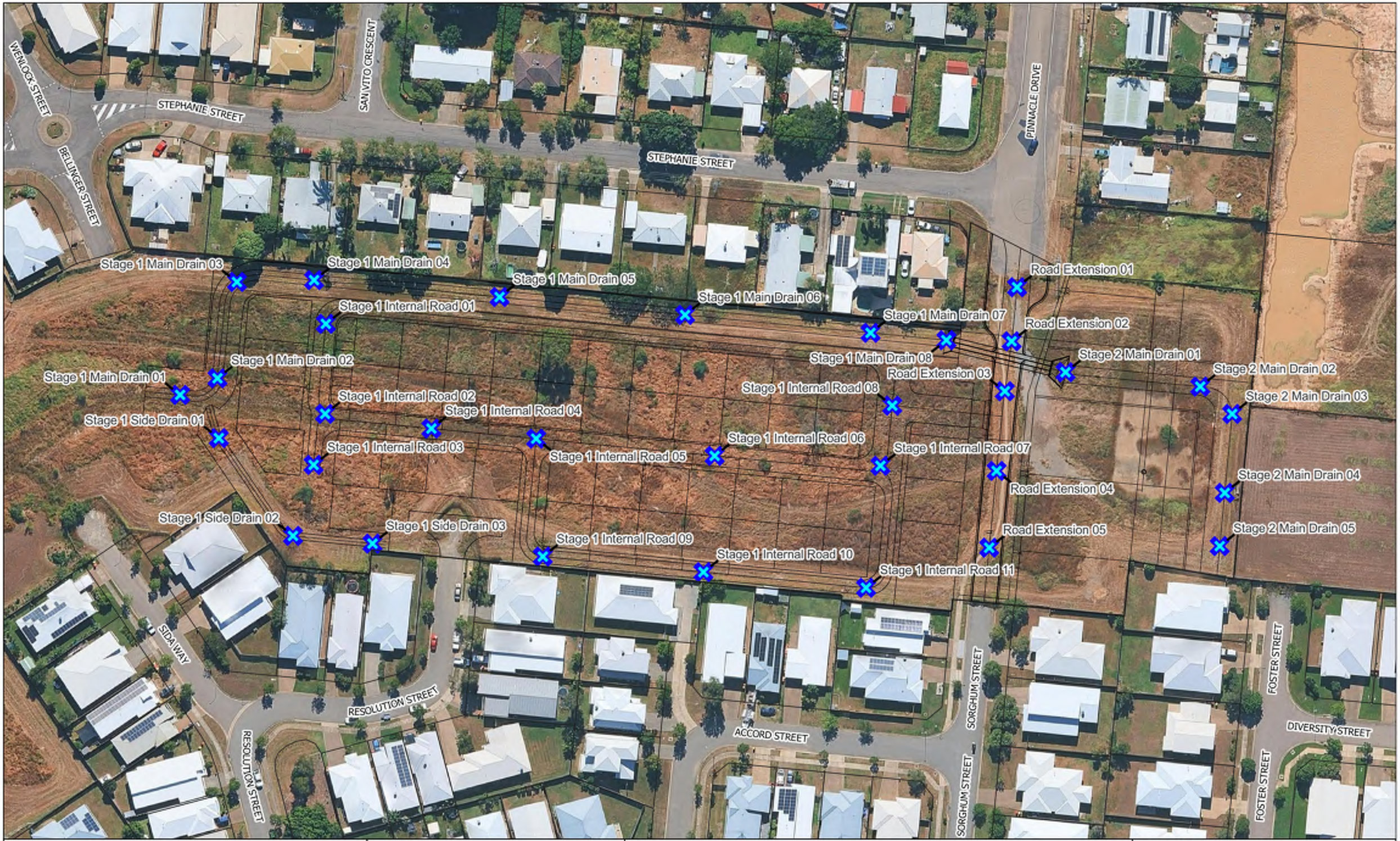
N

Legend

- TCC Land Parcels
- Stage 12 Lots
- Existing Pits
- Existing Culverts
- Previous Development Pits
- Previous Development Culverts
- Proposed Development Culverts

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A
DEVELOPED CONFIGURATION AND MITIGATION MEASURES

Prepared By: BB Reviewed by: AW	Date: 18/12/2025 Revision: A NCE Ref: URB0001-P4	Size A3	Map A05



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Legend

TCC Land Parcels

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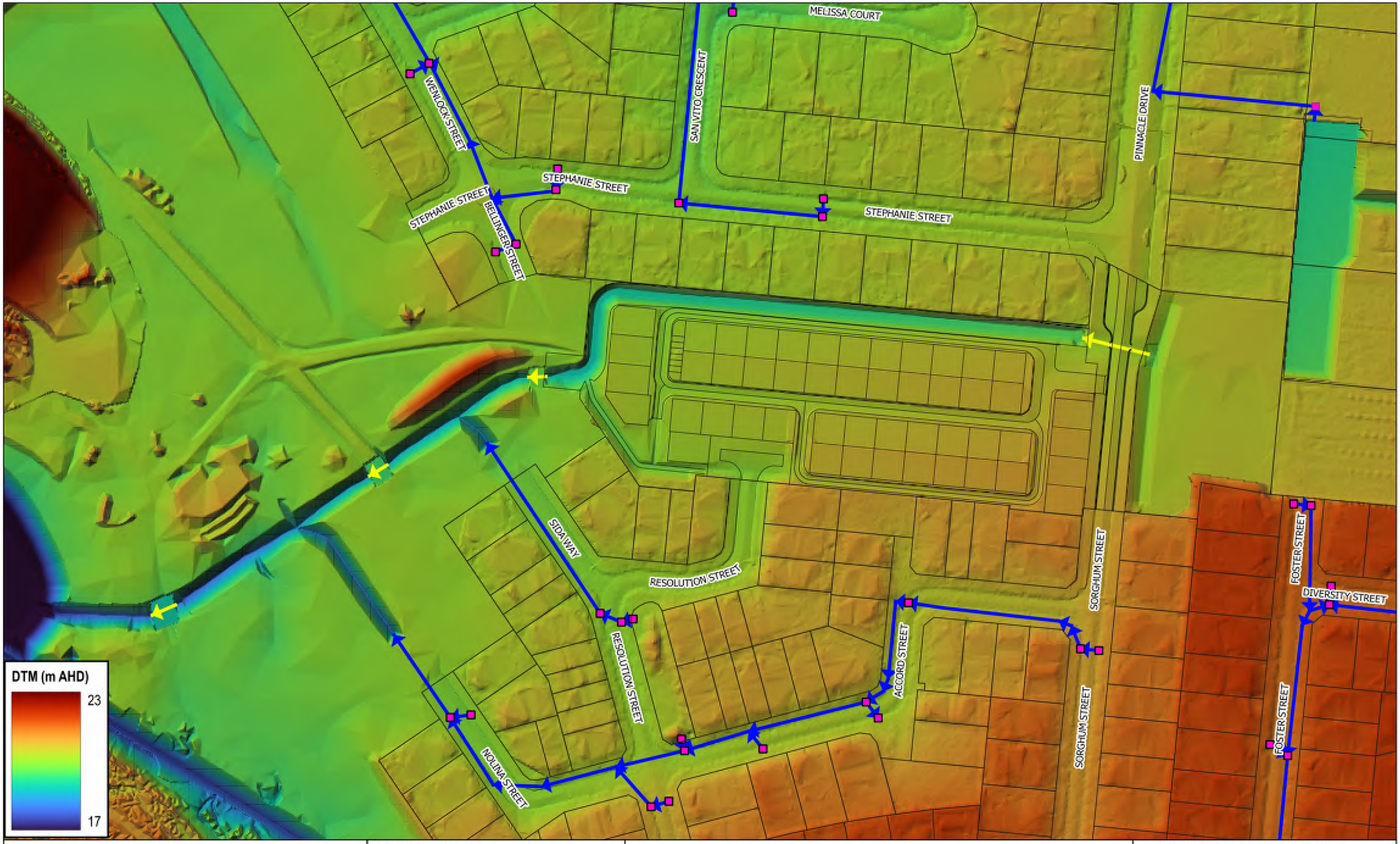
PRECINCT 4 - STAGE 12A

DEVELOPED WSL RESULTS POINTS

Prepared By: BB	Date: 18/12/2025	Size	Map
Reviewed by: AW	Revision: A	A3	A06
	NCE Ref: URB0001-P4		



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Legend

- TCC Land Parcels
- Stage 12A - Stage 1 Lots
- Existing Pits
- Existing Culverts
- Previous Development Pits
- Previous Development Culverts
- Proposed Development Culverts

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A

DEVELOPMENT STAGE 1 MODEL

Prepared By: BB	Date: 18/12/2025	Size	Map
Reviewed by: AW	Revision: A	A3	A07
	NCE Ref: URB0001-P4		

APPENDIX B

Afflux Mapping – All Events WSL and Velocity Afflux

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0 20 40 60 80 m
1:1,500

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Legend
- TCC Land Parcels
- Stage 12 Lots
- Existing Pits
- Existing Culverts
- Previous Development Pits
- Previous Development Culverts
- Proposed Development Culverts

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A
100yr ARI WSL AFFLUX

Prepared By: BB
Reviewed by: AW
Date: 18/12/2025
Revision: A
NCE Ref: URB0001-P4
Size: A3
Map: B01

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0 20 40 60 80 m
1:1,500

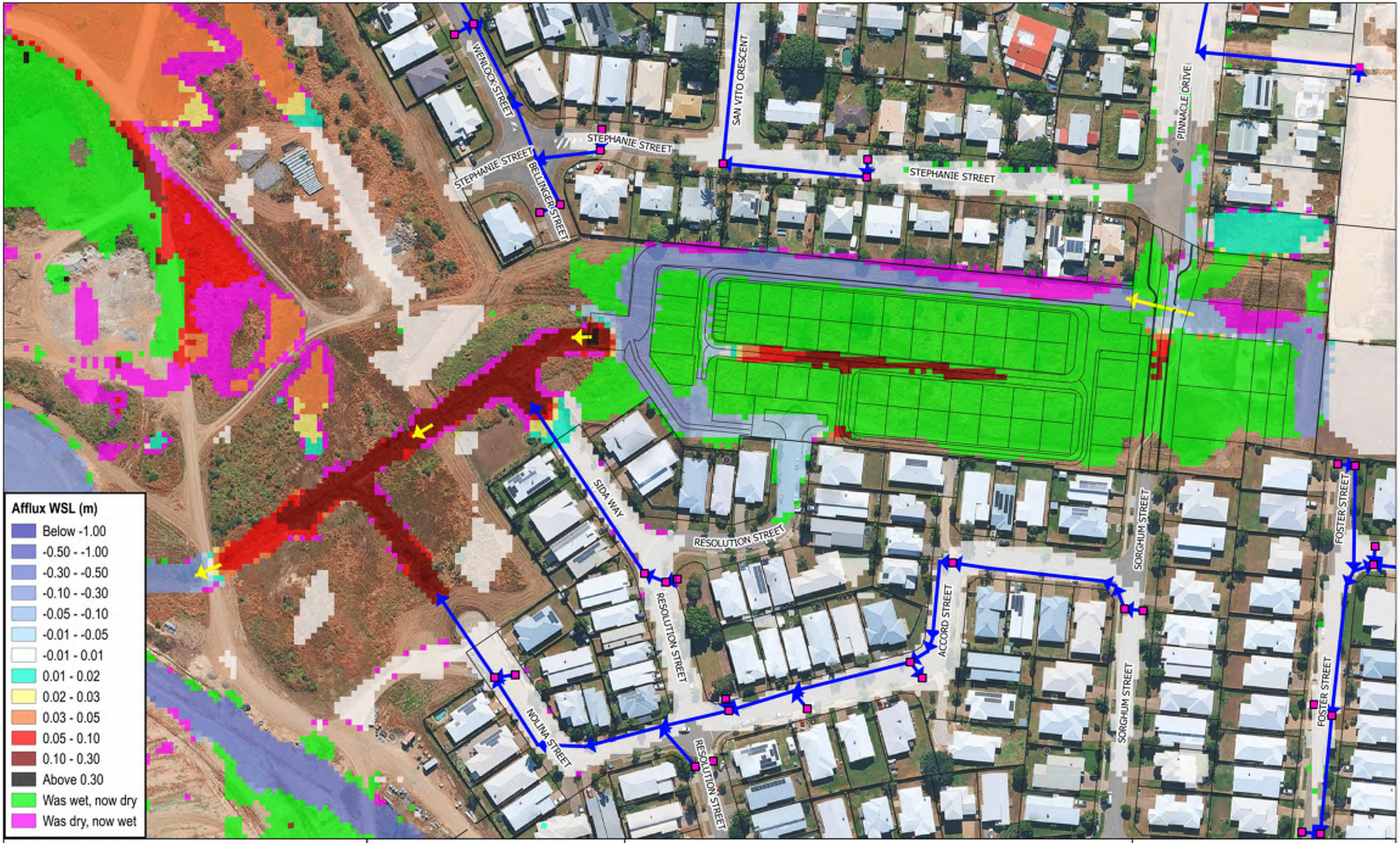
N

Legend
- TCC Land Parcels
- Stage 12 Lots
- Existing Pits
- Existing Culverts
- Previous Development Pits
- Previous Development Culverts
- Proposed Development Culverts

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A

50yr ARI WSL AFFLUX

Prepared By: BB	Date: 18/12/2025	Size	Map
Reviewed by: AW	Revision: A	A3	B02
	NCE Ref: URB0001-P4		



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0 20 40 60 80 m
1:1,500

N

Legend
- TCC Land Parcels
- Stage 12 Lots
- Existing Pits
- Existing Culverts
- Previous Development Pits
- Previous Development Culverts
- Proposed Development Culverts

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A

20yr ARI WSL AFFLUX

Prepared By: BB	Date: 18/12/2025	Size	Map
Reviewed by: AW	Revision: A	A3	B03
	NCE Ref: URB0001-P4		

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0 20 40 60 80 m
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N

Legend
- TCC Land Parcels
- Stage 12 Lots
- Existing Pits
- Existing Culverts
- Previous Development Pits
- Previous Development Culverts
- Proposed Development Culverts

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A

10yr ARI WSL AFFLUX

Prepared By: BB	Date: 18/12/2025	Size	Map
Reviewed by: AW	Revision: A	A3	B04
	NCE Ref: URB0001-P4		

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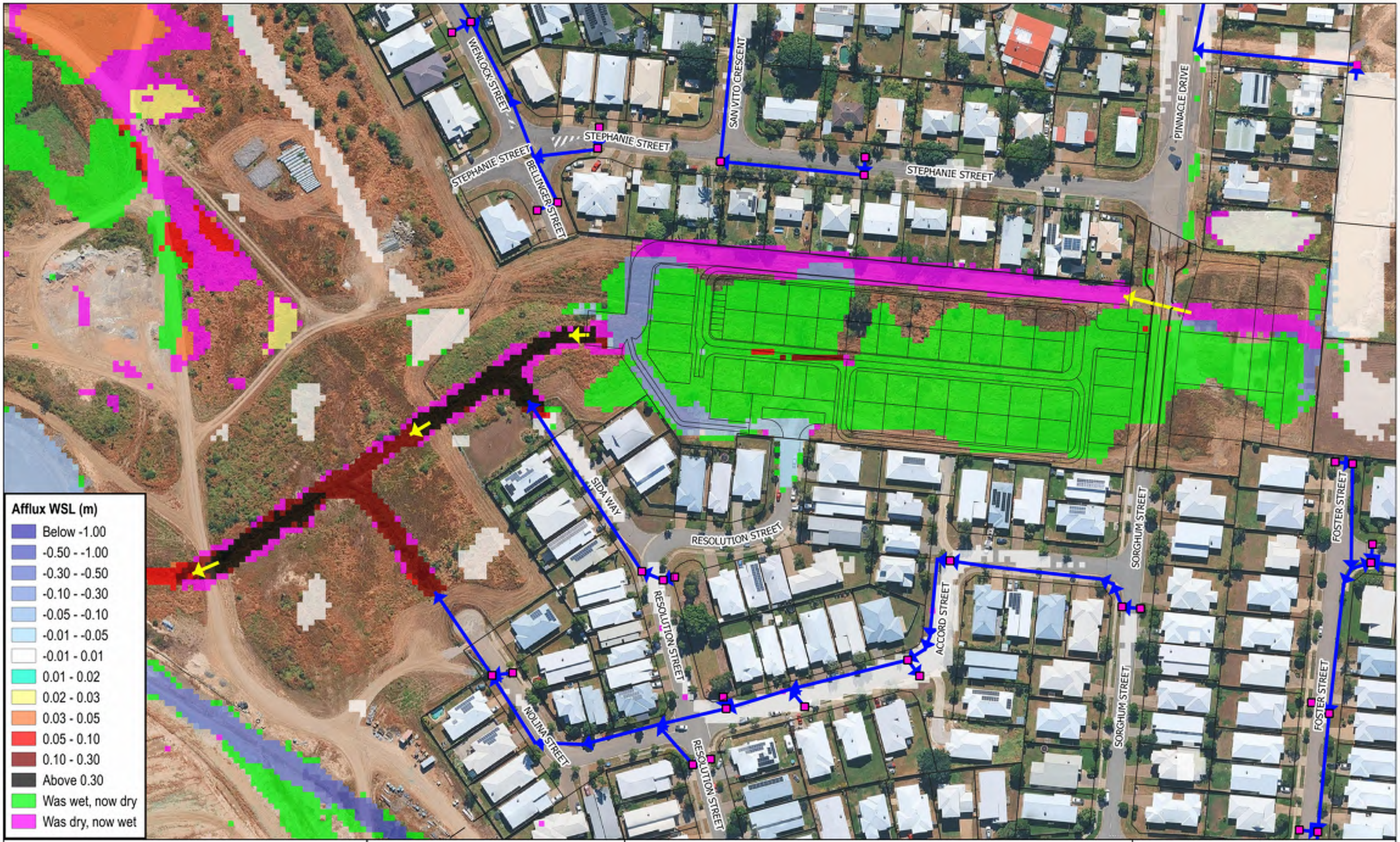
N

Legend
- TCC Land Parcels
- Stage 12 Lots
- Existing Pits
- Existing Culverts
- Previous Development Pits
- Previous Development Culverts
- Proposed Development Culverts

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A
5yr ARI WSL AFFLUX

Prepared By: BB
Reviewed by: AW
Date: 18/12/2025
Revision: A
NCE Ref: URB0001-P4
Size: A3
Map: B05



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0 20 40 60 80 m
1:1,500

N

Legend
- TCC Land Parcels
- Stage 12 Lots
- Existing Pits
- Existing Culverts
- Previous Development Pits
- Previous Development Culverts
- Proposed Development Culverts

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A

2yr ARI WSL AFFLUX

Prepared By: BB Reviewed by: AW	Date: 18/12/2025 Revision: A NCE Ref: URB0001-P4	Size A3	Map B06

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0 20 40 60 80 m
1:1,500

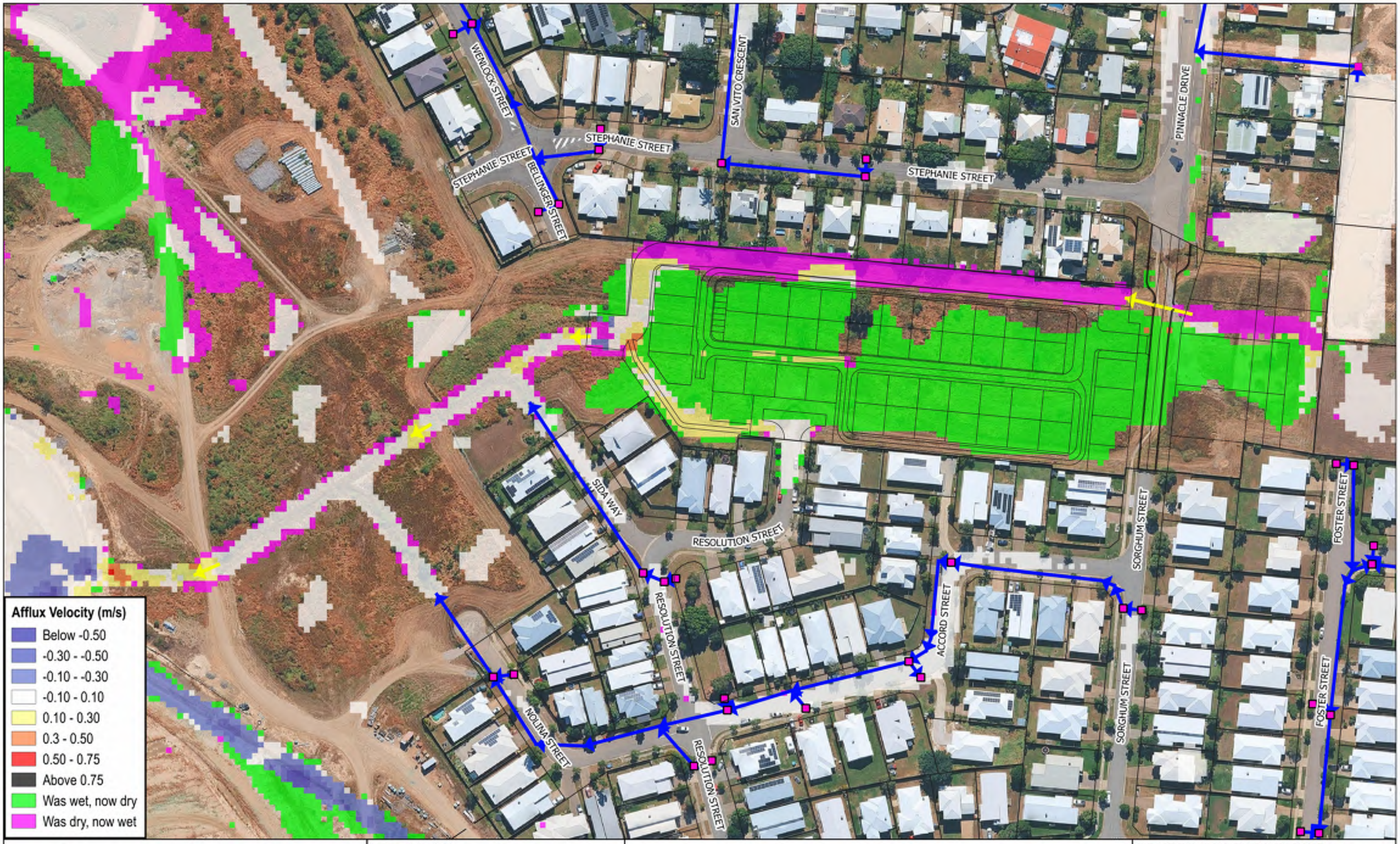
N

Legend
- TCC Land Parcels
- Stage 12 Lots
- Existing Pits
- Existing Culverts
- Previous Development Pits
- Previous Development Culverts
- Proposed Development Culverts

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A

100yr ARI VELOCITY AFFLUX

Prepared By: BB Reviewed by: AW	Date: 18/12/2025 Revision: A NCE Ref: URB0001-P4	Size A3	Map B07



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0 20 40 60 80 m
1:1,500

N

Legend
- TCC Land Parcels
- Stage 12 Lots
- Existing Pits
- Existing Culverts
- Previous Development Pits
- Previous Development Culverts
- Proposed Development Culverts

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A

2yr ARI VELOCITY AFFLUX

Prepared By: BB	Date: 18/12/2025	Size	Map
Reviewed by: AW	Revision: A	A3	B08
	NCE Ref: URB0001-P4		

APPENDIX C

Depth Mapping 100- and 2- year ARI

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0 20 40 60 80 m
1:1,500

N

Legend
- TCC Land Parcels
- Existing Culverts
- Existing Pits

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A

100yr ARI BASELINE FLOOD DEPTHS

Prepared By: BB	Date: 19/12/2025	Size	Map
Reviewed by: AW	Revision: A	A3	C01
	NCE Ref: URB0001-P4		

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0 20 40 60 80 m
1:1,500

N

Legend
- TCC Land Parcels
- Stage 12 Lots
- Existing Pits
- Existing Culverts
- Previous Development Pits
- Previous Development Culverts
- Proposed Development Culverts

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A

100yr ARI DEVELOPED FLOOD DEPTHS

Prepared By: BB	Date: 19/12/2025	Size	Map
Reviewed by: AW	Revision: A	A3	C02
	NCE Ref: URB0001-P4		

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0 20 40 60 80 m
1:1,500

N

Legend
- TCC Land Parcels
- Existing Culverts
- Existing Pits

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A

2yr ARI BASELINE FLOOD DEPTHS

Prepared By: BB	Date: 19/12/2025	Size	Map
Reviewed by: AW	Revision: A	A3	C03
	NCE Ref: URB0001-P4		

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Traffic | Flood Modelling
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W: www.nceng.com.au

In Association With:
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0 20 40 60 80 m
1:1,500

N

Legend
- TCC Land Parcels
- Stage 12 Lots
- Existing Pits
- Existing Culverts
- Previous Development Pits
- Previous Development Culverts
- Proposed Development Culverts

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A

2yr ARI DEVELOPED FLOOD DEPTHS

Prepared By: BB Reviewed by: AW	Date: 19/12/2025 Revision: A NCE Ref: URB0001-P4	Size A3	Map C04

APPENDIX D

Velocity Mapping – 100- and 2-year ARI

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0 20 40 60 80 m
1:1,500

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Legend
- TCC Land Parcels
- Existing Pits
- Existing Culverts

SOMERS & HERVEY ESTATE
PRECINCT 4 - STAGE 12A

100yr ARI BASELINE FLOOD VELOCITY

Prepared By: BB	Date: 19/12/2025	Size	Map
Reviewed by: AW	Revision: A	A3	D01
	NCE Ref: URB0001-P4		