Strategic Environmental & Engineering Consulting

Preliminary Flood Assessment

For Proposed Subdivision at
11 Southdown Road, Marulan

Prepared for:

Laterals Planning

Prepared by:
Riley Johnson
SEEC

SEEC Reference 23000043-FS-01 REV01

24 January 2024

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Document Certification

This report has been developed based on agreed requirements as understood by SEEC at the time of investigation. It applies only to a specific task on the nominated lands. Other interpretations should not be made, including changes in scale or application to other projects.

Any recommendations contained in this report are based on an honest appraisal of the opportunities and constraints that existed at the site at the time of investigation, subject to the limited scope and resources available. Within the confines of the above statements and to the best of my knowledge, this report does not contain any incomplete or misleading information.

Riley Johnson
Civil Engineer
SEEC
24 January 2024

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Version Register

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1 INTRODUCTION

Strategic Environmental and Engineering Consulting (SEEC) has been commissioned by Eddy Ismael (on behalf of Big Merino Investments Pty Ltd) to prepare this preliminary Flood Assessment. This report is to be provided to Goulburn Mulwaree Council as part of a Development Application for a proposed seven lot subdivision at 11 Southdown Road, Marulan (Lot 11 on DP 1271846).

This report describes the expected hydraulic conditions on the existing site by estimating the expected extent of inundation for the proposed lots for the 100-year Average Recurrence Interval (ARI) (1% Annual Exceedance Probability) flood flows and predicted watercourse levels. Note that proposed roads and dwellings may alter the flow path from local catchments to the adjacent waterway.

This report has been prepared in accordance with the following guidelines and recommendations:

- ***Australian Rainfall & Runoff – A Guide to Flood Estimation 2016***;
- ***Goulburn Mulwaree Council Local Environmental Plan 2010, WLEP 2009;***
- ***Goulburn Mulwaree Council's Development Control Plan 2009;***
- ***Goulburn Mulwaree Council's Standards for Engineering Works – Design Specifications 2013.***
- ***NSW Government Flood Plain Management Manual: The Management of Flood Liable Land.***

This flood study includes:

(i) A general description of the site and the surrounding catchment area;

(ii) Catchment flow calculations for 20% (5-year ARI) and 1% (100-year ARI) Annual Exceedance Probability (AEP) events;

(iii) Flood calculations and results using TUFLOW (Version 2023-03-AA), a computer program for simulating depth-averaged, one and two-dimensional free-surface flows.

(iv) The 20% (5-year ARI) and 1% (100-year ARI) AEP flood levels and extents;

(v) Conclusions and recommendations based on the flood results.

This flood study is based on a desktop study that involved a visual interpretation of the upstream catchment area and NSW Government – Spatial Services LiDAR, sourced from ELVIS (Geoscience Australia, 2021), of the subdivision location. In preparing this report, SEEC has relied upon, and presumed accurate, certain information (or absence thereof) provided by our client and other sources. Except as otherwise stated in the report, SEEC has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate, or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

2 PROPOSED DEVELOPMENT

It is proposed to subdivide the existing site into seven large lot residential (R5 Zoned) lots. The lots range in size from approximately 2,000 to 3,000m^2 in area. The new lots are to be accessed by a new internal road and cul-de-sac from Southdown Road.

2.1 General Location

The subject property (11 Southdown Road, Marulan) is a semi-rural property of approximately 1.7 Ha in area. It is located amongst existing semi-rural properties (see **Figure 1**). It is located approximately 2.2 km southeast of the main centre of Marulan.

2.2 Topography and Drainage

The terrain within the proposed subdivision is described as moderately undulating. The subject watercourse is wide with a defined shallow erosion gully located wholly within the adjoining northern lots (Lots 14 & 30 DP 1271846). The watercourse flows in a north easterly direction and discharges into Jaorimin Creek, 1.2 km to the northeast and eventually into the Wollondilly River located approximately 8.8 km downstream of the property to the north. The closest pipe crossing within the watercourse is located under Southdown Road, which will likely have a backwater effect on flood levels adjacent to the site. **Figures 1 and 2** below shows the site location and proposed development layout. Concept stormwater drainage plans for the development have also been prepared by SEEC. Refer to drawings 23000043_P01_C000 to C702 for details.

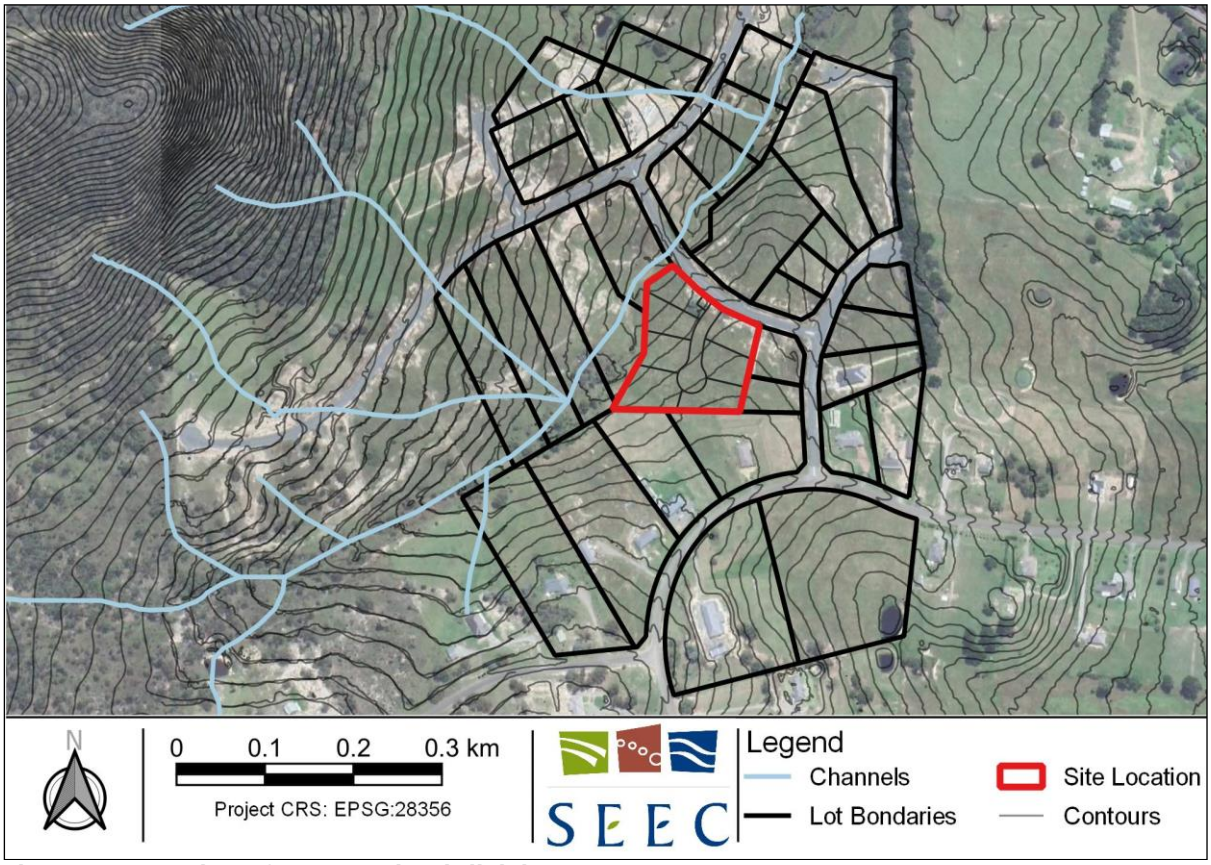

Figure 1 - Location of Proposed Subdivision.

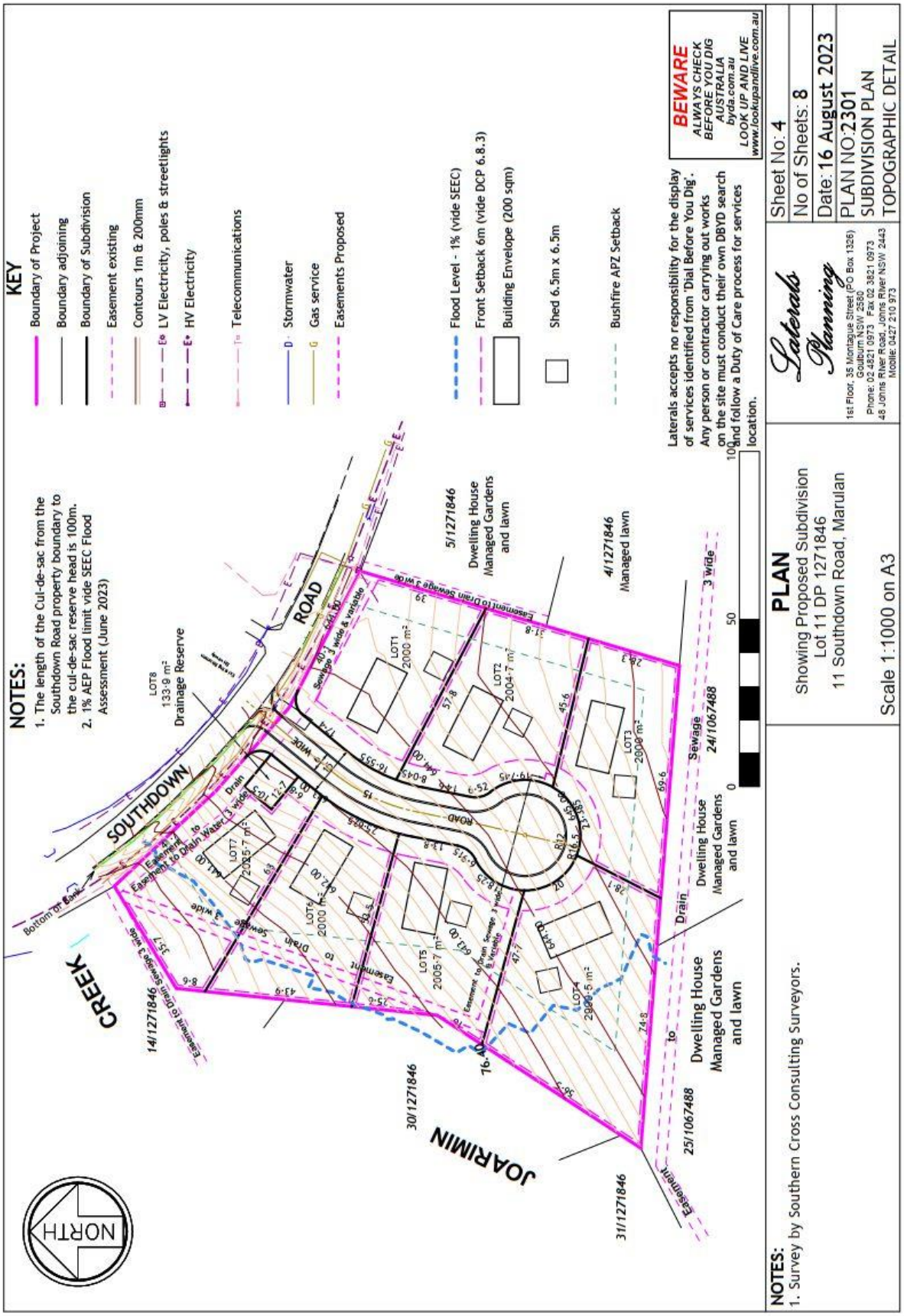

Figure 2- Proposed Subdivision Development Plan.

3 HYDROLOGY

A DRAINS model was developed to estimate flow hydrographs for input into the TUFLOW model (Schematic shown in **Appendix A**). The flows are expected to be representative of the expected landuse after development.

The catchment is predominantly rural residential and natural forest based on the existing land uses as shown on a recent NEARMAP image. Sub-catchment areas were calculated for the site using topography from the NSW Government – Spatial Services LiDAR, sourced from ELVIS (Geoscience Australia, 2021). The sub-catchment areas are provided in **Table 1** below and are shown in **Figure 2**.

Areas where development is evident including the proposed lots, have an assumed 15% fraction imperviousness. Existing forested areas have been assumed to have 1% fraction imperviousness.

Table 1: Sub-Catchment characteristics used in DRAINS.

			% Land Use Breakdown			Time of Concentration	
Sub-Catchment	**Area (ha)**	**Landuse**	**Paved**	**Supple-mentary**	**Grassed**	**Paved (mins)**	**Grass (mins)**
CA_01	82.5	Forest/Rural Residential	1	0	99	23.8	36.2
CA_02	26.4	Rural-Residential	10	0	90	15.9	24.7
CA_03	20.4	Rural-Residential	5	0	95	15	22.5
CA_04	10.4	Rural-Residential	15	0	85	10	19
CA_05	4.5	Rural-Residential	15	0	85	10	21
Total Area	**144.2**						

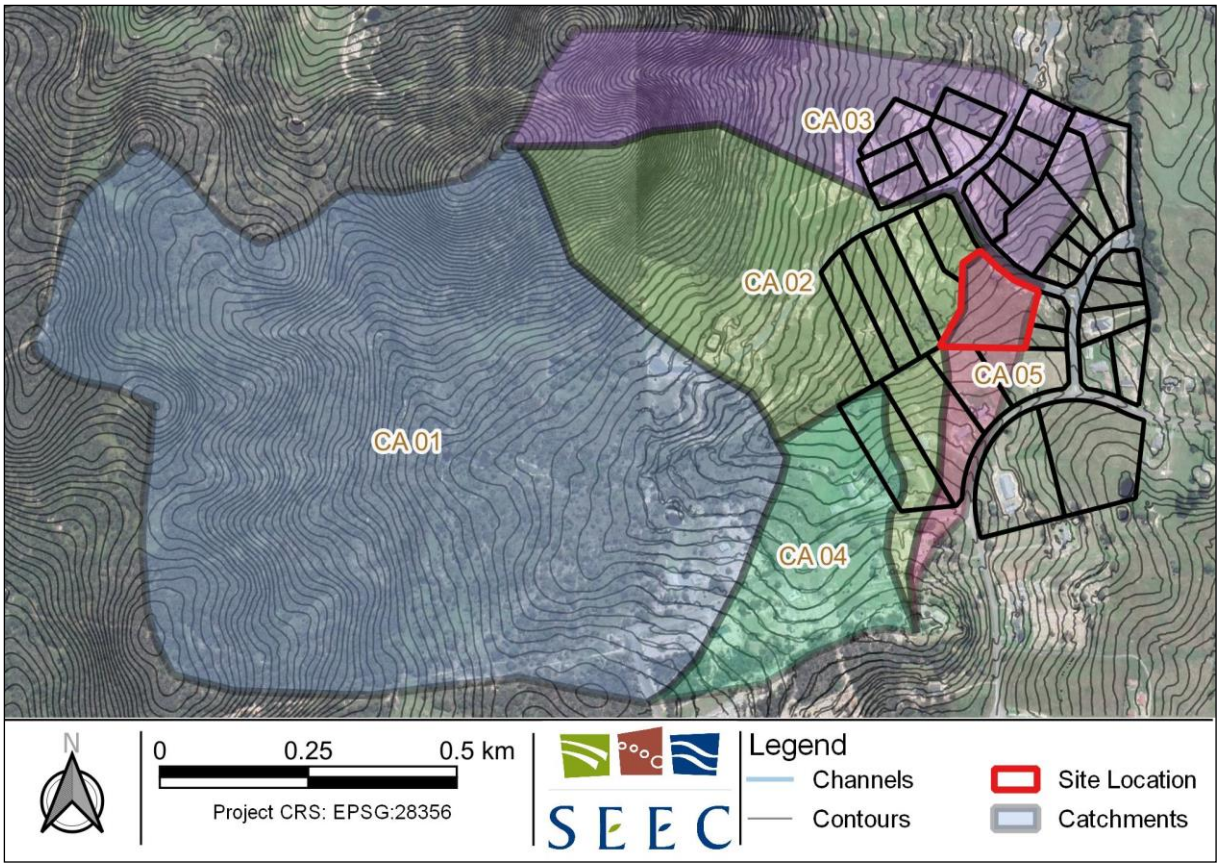

Figure 2: DRAINS model sub-catchments – existing scenario.

The DRAINS model was set-up using the ILSAX hydrological model to simulate storm events ranging from 20% AEP to the 1% AEP:

- Australian Runoff and Rainfall 2016 IFD and temporal patterns;
- Paved (impervious) area depression storage (mm) = 1;
- Supplementary area depression storage (mm) = 1;
- Grassed (pervious) area depression storage (mm) = 5;
- Soil Type = 3
- AMC (Antecedent Moisture Condition) = 3
- Sub-catchment areas
- Sub-catchment slopes
- Time of Concentration averaged from the Friends Equation for overland flow and an assumed channel flow velocity.

The DRAINS model ran multiple temporal pattern ensembles for storms of durations ranging from 10 minutes to 24 hours and selected the estimated peak flow rate from the median value of each duration ensemble. These hydrographs were input into the TUFLOW hydraulic model at the locations shown in **Figure 5**. The adopted hydrographs for the 1% AEP and 20% AEP storm event are provided below in **Figure 3** and **Figure 4**.

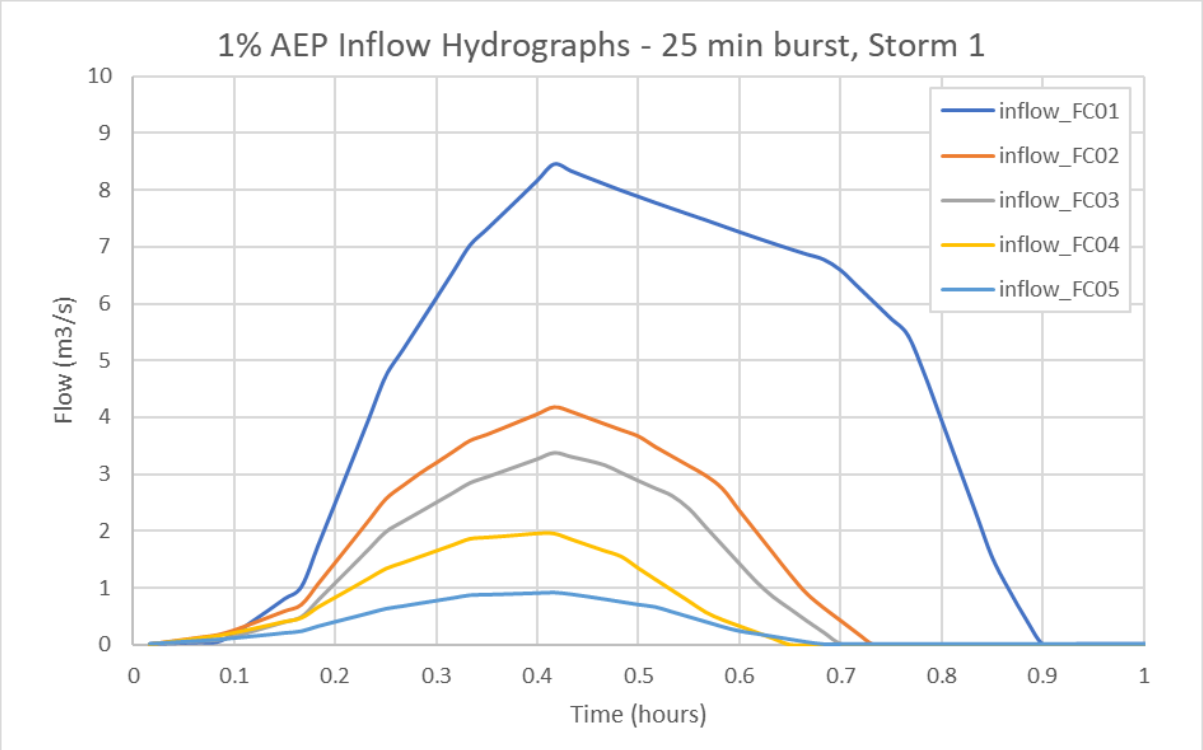

Figure 3: DRAINS hydrographs for the 1% AEP (25 min burst, storm 1).

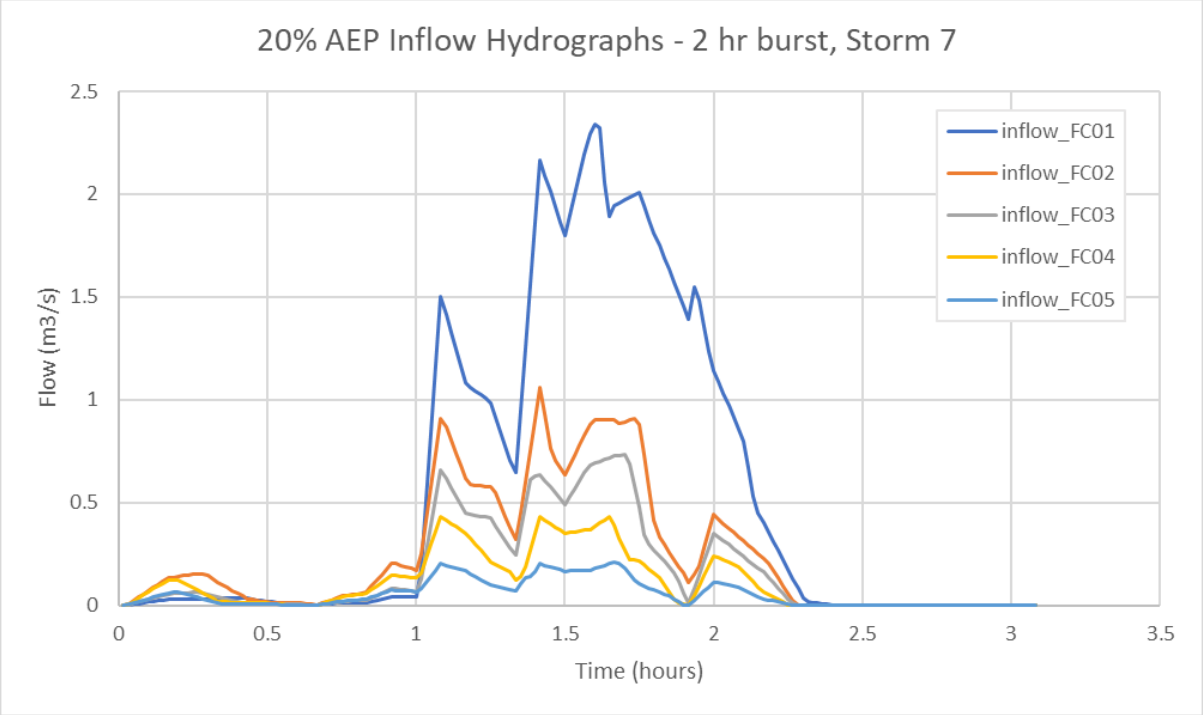

Figure 4: DRAINS hydrographs for the 20% AEP (2 hour burst, storm 7).

4 HYDRAULICS

A TUFLOW model was developed for the property and adjacent catchment. The model domain included a 2m grid that extended over an area of 700m x 1000m as highlighted in **Figure 5**. The existing ground levels were obtained from the NSW Government – Spatial Services LiDAR.

The land uses were defined based on the NEARMAP aerial imagery and **Table 2** presents the correlation between land use and adopted Manning's 'n' roughness values. The default roughness land use is short grass with a Manning's roughness 0.04.

Table 2: TUFLOW model roughness details

Material	Roughness	Land use
1	0.06	Pasture/grass
2	0.022	Roads
3	0.1	Buildings
4	0.03	Ponds and water
5	0.04	Grassed - short
10	0.08	Vegetated waterway
11	0.15	Heavily vegetated waterway

The existing culvert under Southdown Road is included in the model as provided in **Table 3** below.

Table 3: Hydraulic structures modelled in TUFLOW.

ID	Type	Length (m)	US Invert (m AHD)	DS Invert (m AHD)	Width or Dia (m)	Height (m)	Number
C01	RCBC	11	639.12	638.44	2.1	1.05	1

The culvert has been assessed assuming a 0%, 50% and 100% blockage factor and Mannings roughness value of 0.015.

The downstream boundary as shown in **Figure 5** (DC) was modelled as a normal depth head boundary.

No allowance was made for climate change.

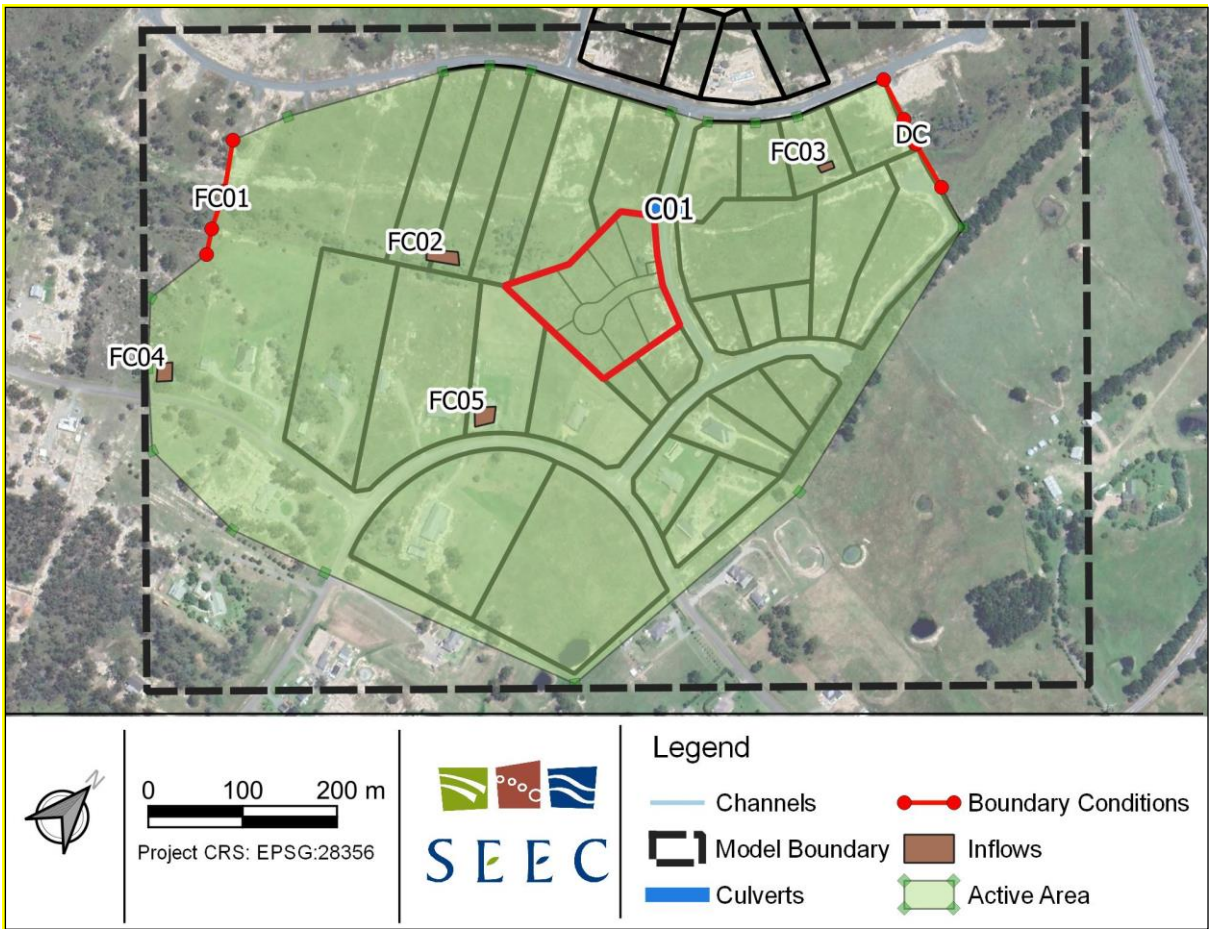

Figure 5: TUFLOW model extents, inflow and culvert locations.

5 RESULTS

The flood extents across the site for the 1% AEP (100-year ARI) storm event have been estimated and are displayed in **Appendix B**. It can be seen that this major storm event partially encroaches on the site in the north-western corner within proposed Lots 6 & 7 (refer to **Figure 2**), with the highest predicted 1% AEP flood level adjacent to Lot 6 being 640.44m AHD and Lot 7 being 640.62m AHD. An overland flow path is also evident through Lot 4, as shown in **Figure 6** and throughout **Appendix B**.

It is recommended that the floor level of any future dwellings in Lots 6 and 7 are set 0.5m above the predicated 1% AEP flood level and not cut into the existing natural surface. Therefore, the minimum floor levels for future dwellings on Lots 6 and 7 should be set no lower than 640.94m AHD and 641.12m AHD respectively based on our preliminary assessment. It is also recommended that future dwellings in Lot 4 are not within the overland flow path. Additional drainage elements such as a diversion drain or bund could be adopted to limit overland flow in Lot 4 and confine flows to a defined flow path.

A summary of the modelling results, at the locations in **Figure 6,** are shown in **Table 4** and **Table 5** below for the 1% AEP (100 Year ARI) and 20% AEP (5 Year ARI) storm events.

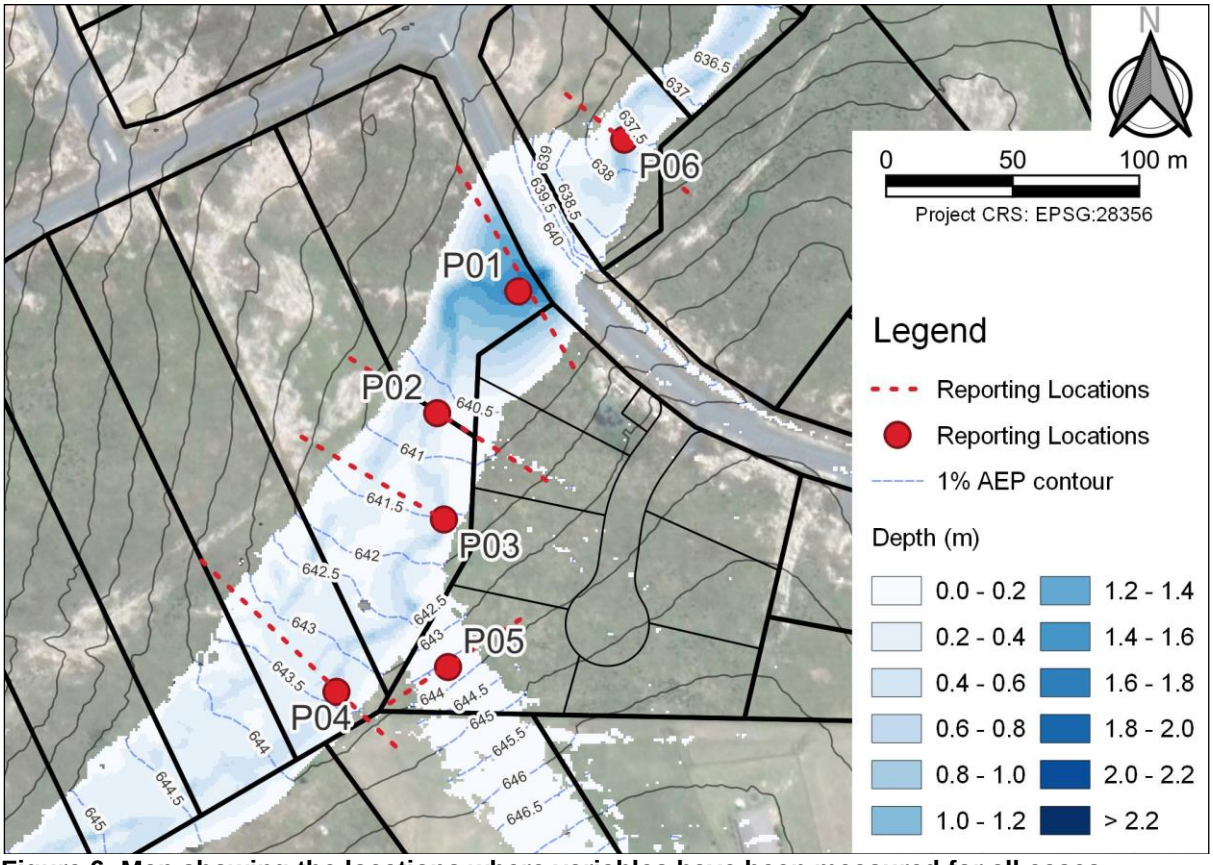

Figure 6: Map showing the locations where variables have been measured for all cases.

Table 4: 1% AEP (100 Year ARI)

Blockage (%)	Variable	Location					
		P01	P02	P03	P04	P05	P06
0	Elevation (m)	640.37	640.62	641.58	643.38	643.64	637.61
	Velocity (m/s)	0.31	1.07	0.86	1.02	0.72	2.54
	Flow (m^3/s)	15.05	15.02	14.97	14.28	0.68	15.05
50	Elevation (m)	640.40	640.62	641.58	643.38	643.65	637.61
	Velocity (m/s)	0.31	1.07	0.86	1.01	0.72	2.55
	Flow (m^3/s)	15.02	15.00	14.96	14.27	0.68	15.04
100	Elevation (m)	640.44	640.62	641.58	643.38	643.64	637.61
	Velocity (m/s)	0.31	1.06	0.86	1.01	0.72	2.55
	Flow (m^3/s)	15.04	15.00	14.96	14.26	0.68	15.04

Table 5: 20% AEP (5 Year ARI).

Blockage (%)	Variable	Location					
		P01	P02	P03	P04	P05	P06
0	Elevation (m)	640.13	640.44	641.44	643.26	643.61	637.28
	Velocity (m/s)	0.13	0.86	0.61	0.67	0.36	1.65
	Flow (m^3/s)	3.76	3.85	3.81	3.63	0.18	3.81
50	Elevation (m)	640.19	640.44	641.44	643.26	643.61	637.29
	Velocity (m/s)	0.13	0.86	0.61	0.67	0.35	1.65
	Flow (m^3/s)	3.88	3.85	3.80	3.62	0.18	3.91
100	Elevation (m)	640.24	640.44	641.44	643.26	643.61	637.29
	Velocity (m/s)	0.13	0.86	0.61	0.67	0.36	1.65
	Flow (m^3/s)	3.89	3.85	3.80	3.62	0.18	3.94

Note that these predicted flood levels do not consider climate change, blockage of the waterway (e.g vegetation, debris, logs etc.) or any physical changes to the waterway shape. Any amendments to the models' assumptions will alter the predicted flood levels, area of inundation and adopted minimum floor levels.

6 CONCLUSION

Section 5 and the plan in **Appendix B** of this report detail the predicated flood assessment results. They illustrate the flood extents within the site and critical flow details for the existing catchment conditions, with the proposed development, 1% AEP (100 Year ARI) flood event.

The modelling has estimated flow rates based on the current level of development within the catchment. The proposed lots have been assumed to be 15% impervious in line with surrounding rural residential development. The flood model included existing topography only and flood levels may change after the proposed development which will include roads and underground drainage which will alter discharge locations and flow timings.

The results show the extent of the 1% AEP (100 Year ARI) flood event within the existing watercourse adjacent to the proposed development would have a partial encroachment into the site along the western boundary of proposed Lots 6 and 7. An overland flow path is also evident through a section of Lot 4.

It is recommended that the floor level of any future dwellings in Lots 6 and 7 are set at least 0.5m above the 1% AEP flood level and not cut into the existing natural surface. It is also recommended that future dwellings in Lot 4 are not within the overland flow path.

Therefore, the minimum floor levels for future dwellings on Lots 6 and 7 should be set no lower than 640.94 AHD and 641.12 AHD respectively based on our preliminary assessment.

Additional drainage elements such as a diversion drain or bund could be adopted to limit overland flow in Lot 4 and confine flows to a defined flow path.

7 REFERENCES

BMT Commercial Australia Pty Ltd (2018)*: TUFLOW Classic/HPC User Manual*;

Commonwealth of Australia (Geoscience Australia) 2021: Elvis - Elevation and Depth - Foundation Spatial Data;

The Institution of Engineers Australia (1987): *Australian Rainfall and Runoff, A Guide to Flood Estimation, Volume 1 and Volume 2*;

Goulburn Mulwaree Council (2009): *Local Environmental Plan*;

Goulburn Mulwaree Council (2009): *Goulburn Mulwaree Development Control Plan 2009*;

Goulburn Mulwaree Council (2013): *Standards for Engineering Works Design Specifications.*

8 APPENDICES

Appendix A – DRAINS Model Schematic

Figure 7 shows the DRAINS model layout for modelling TUFLOW inflow hydrographs.

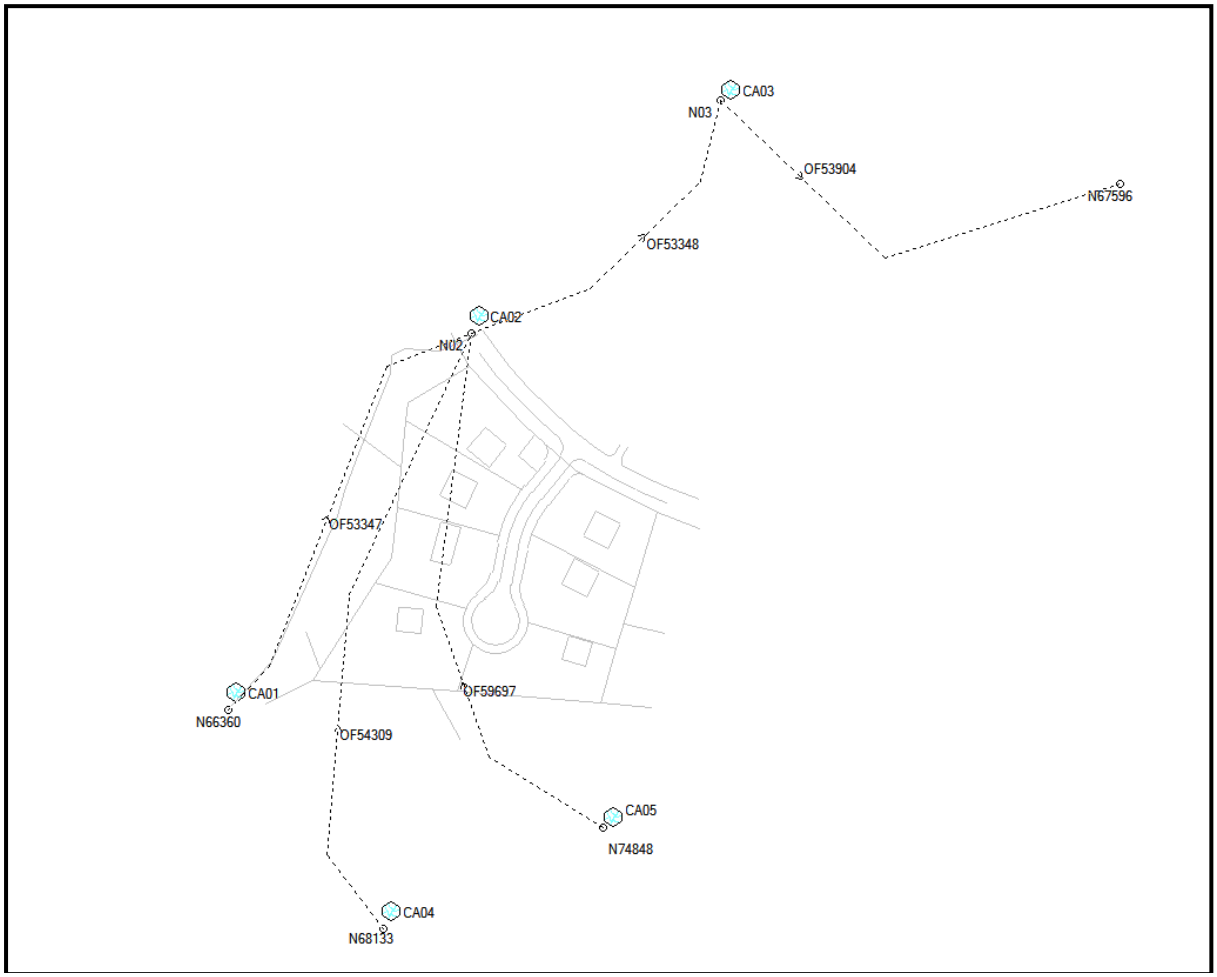

Figure 7: DRAINS model schematic.

Appendix B – Flood Assessment Plans

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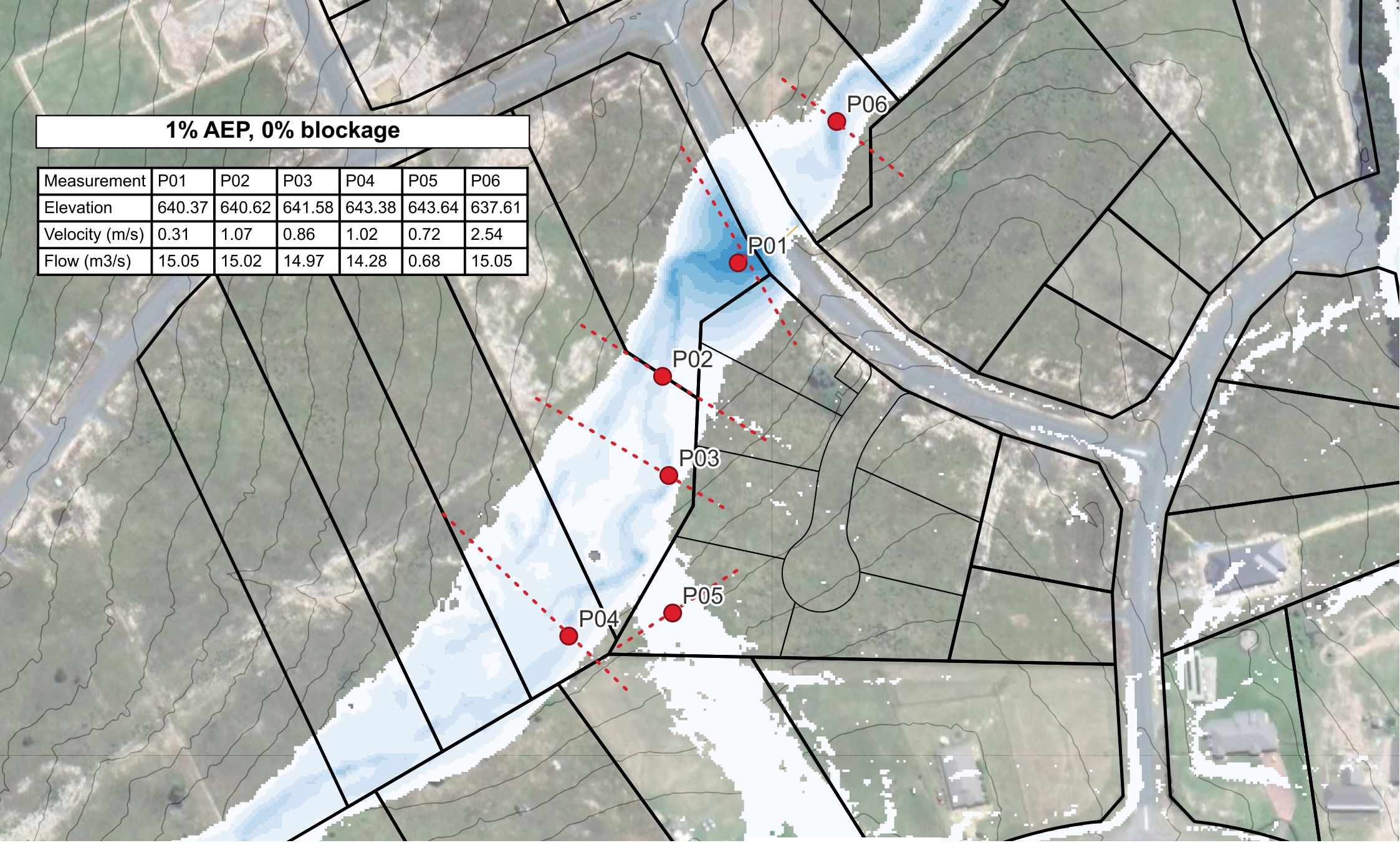

1% AEP, 0% blockage

Measurement	P01	P02	P03	P04	P05	P06
Elevation	640.37	640.62	641.58	643.38	643.64	637.61
Velocity (m/s)	0.31	1.07	0.86	1.02	0.72	2.54
Flow (m3/s)	15.05	15.02	14.97	14.28	0.68	15.05

N

0 25 50 m

Project CRS: EPSG:28356

SEEC

Legend

- Reporting Location
- Reporting Location

Depth (m)

0.0 - 0.2	0.6 - 0.8	1.2 - 1.4	1.8 - 2.0
0.2 - 0.4	0.8 - 1.0	1.4 - 1.6	2.0 - 2.2
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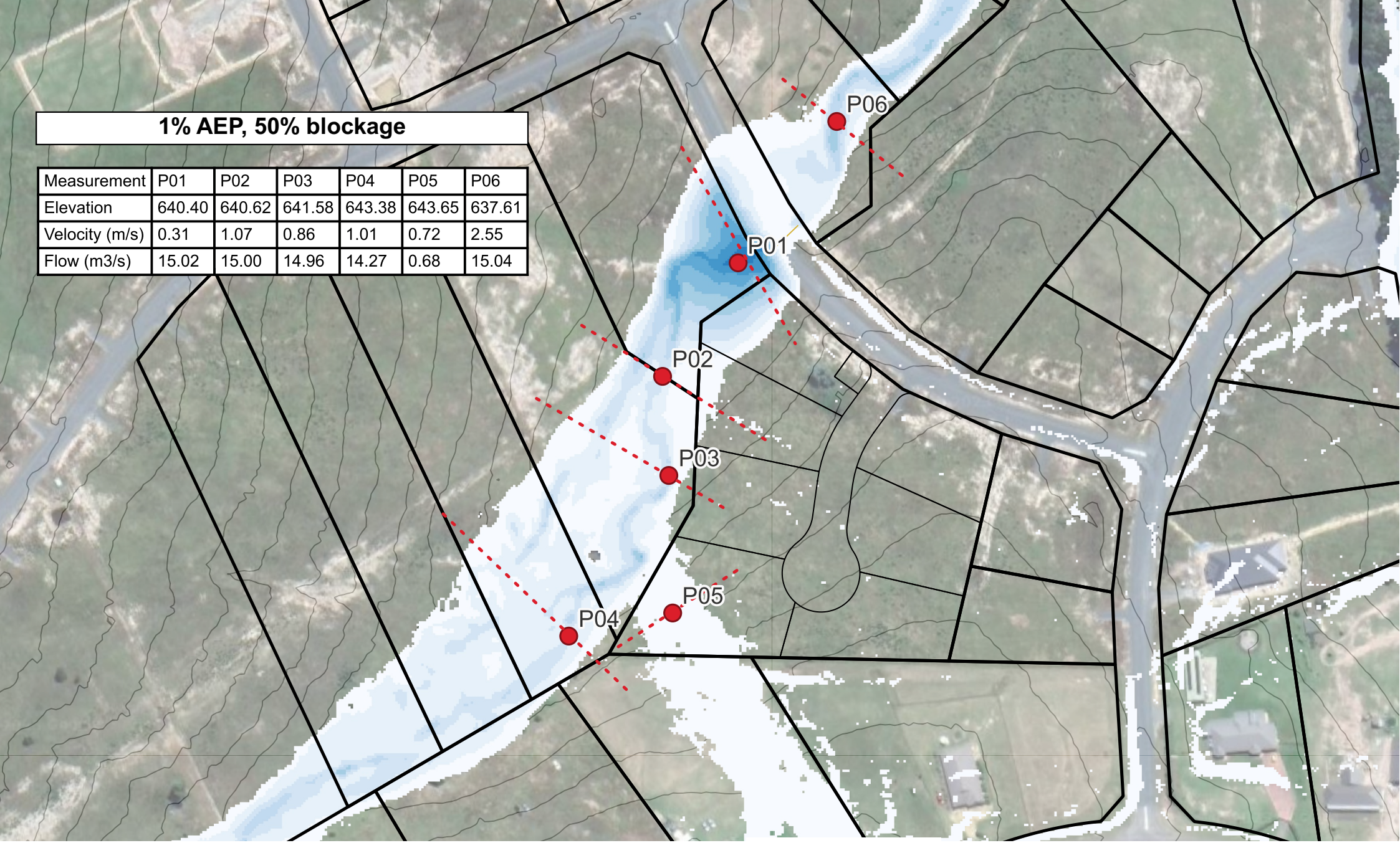

Measurement	P01	P02	P03	P04	P05	P06
Elevation	640.40	640.62	641.58	643.38	643.65	637.61
Velocity (m/s)	0.31	1.07	0.86	1.01	0.72	2.55
Flow (m3/s)	15.02	15.00	14.96	14.27	0.68	15.04

N

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Project CRS: EPSG:28356

SEEC

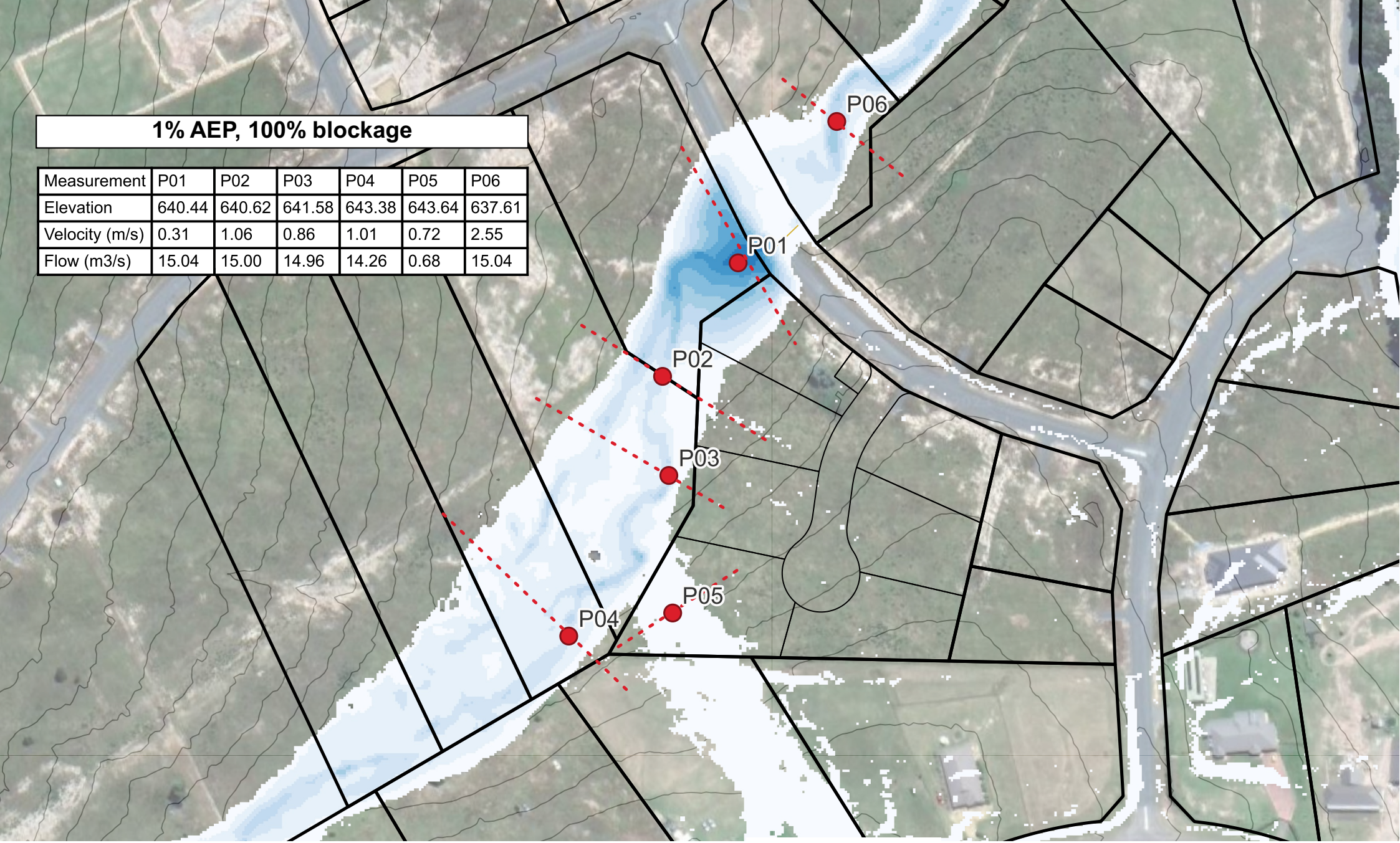
Legend

Reporting Location

Reporting Location

Depth (m)

0.0 - 0.2	0.6 - 0.8	1.2 - 1.4	1.8 - 2.0
0.2 - 0.4	0.8 - 1.0	1.4 - 1.6	2.0 - 2.2
0.4 - 0.6	1.0 - 1.2	1.6 - 1.8	> 2.2



Measurement	P01	P02	P03	P04	P05	P06
Elevation	640.44	640.62	641.58	643.38	643.64	637.61
Velocity (m/s)	0.31	1.06	0.86	1.01	0.72	2.55
Flow (m3/s)	15.04	15.00	14.96	14.26	0.68	15.04

N

0 25 50 m

Project CRS: EPSG:28356

SEEC

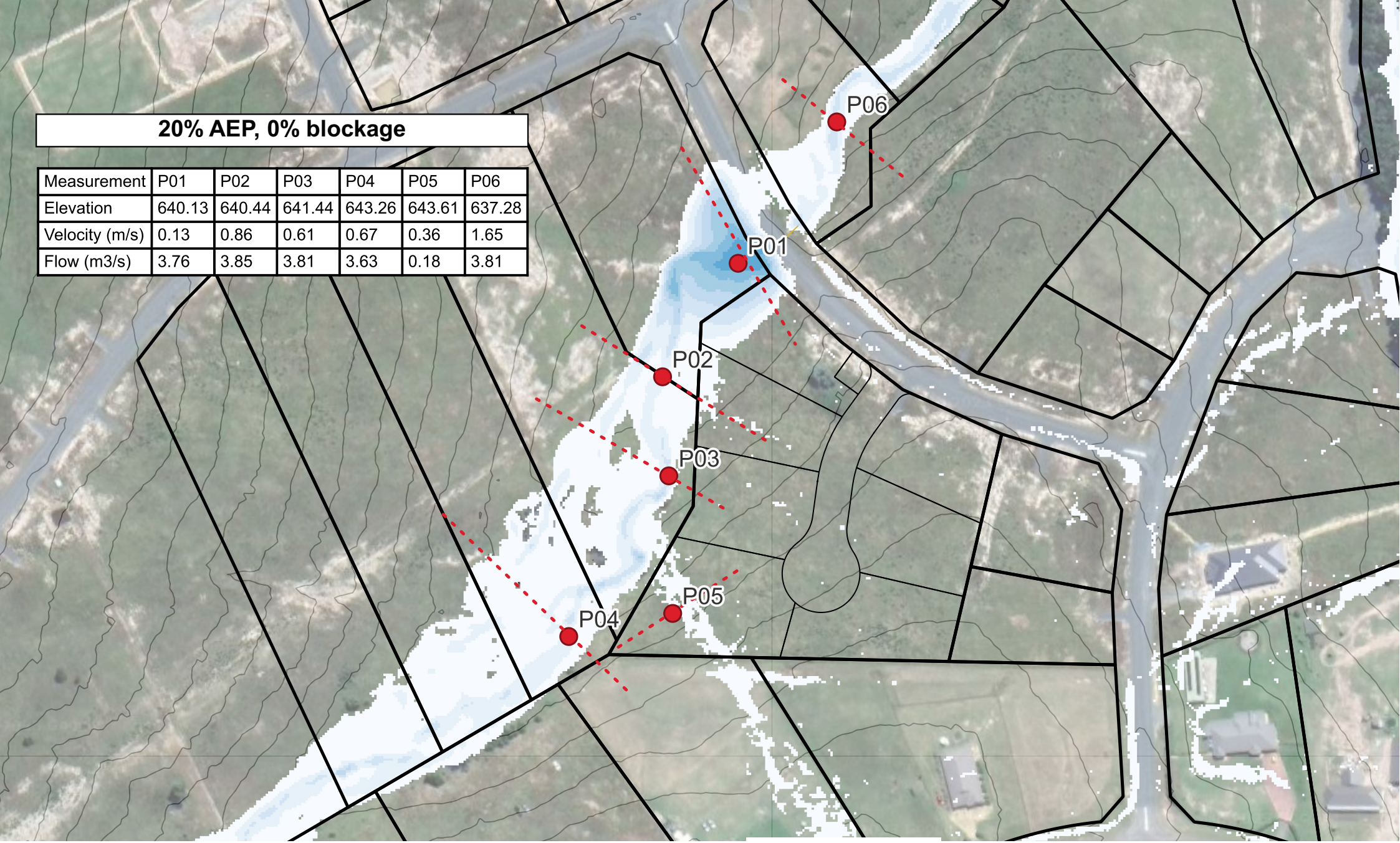
Legend

Reporting Location

Reporting Location

Depth (m)

0.0 - 0.2	0.6 - 0.8	1.2 - 1.4	1.8 - 2.0
0.2 - 0.4	0.8 - 1.0	1.4 - 1.6	2.0 - 2.2
0.4 - 0.6	1.0 - 1.2	1.6 - 1.8	> 2.2



N

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Project CRS: EPSG:28356

SEEC

Legend

Reporting Location

Reporting Location

Depth (m)

0.0 - 0.2	0.6 - 0.8	1.2 - 1.4	1.8 - 2.0
0.2 - 0.4	0.8 - 1.0	1.4 - 1.6	2.0 - 2.2
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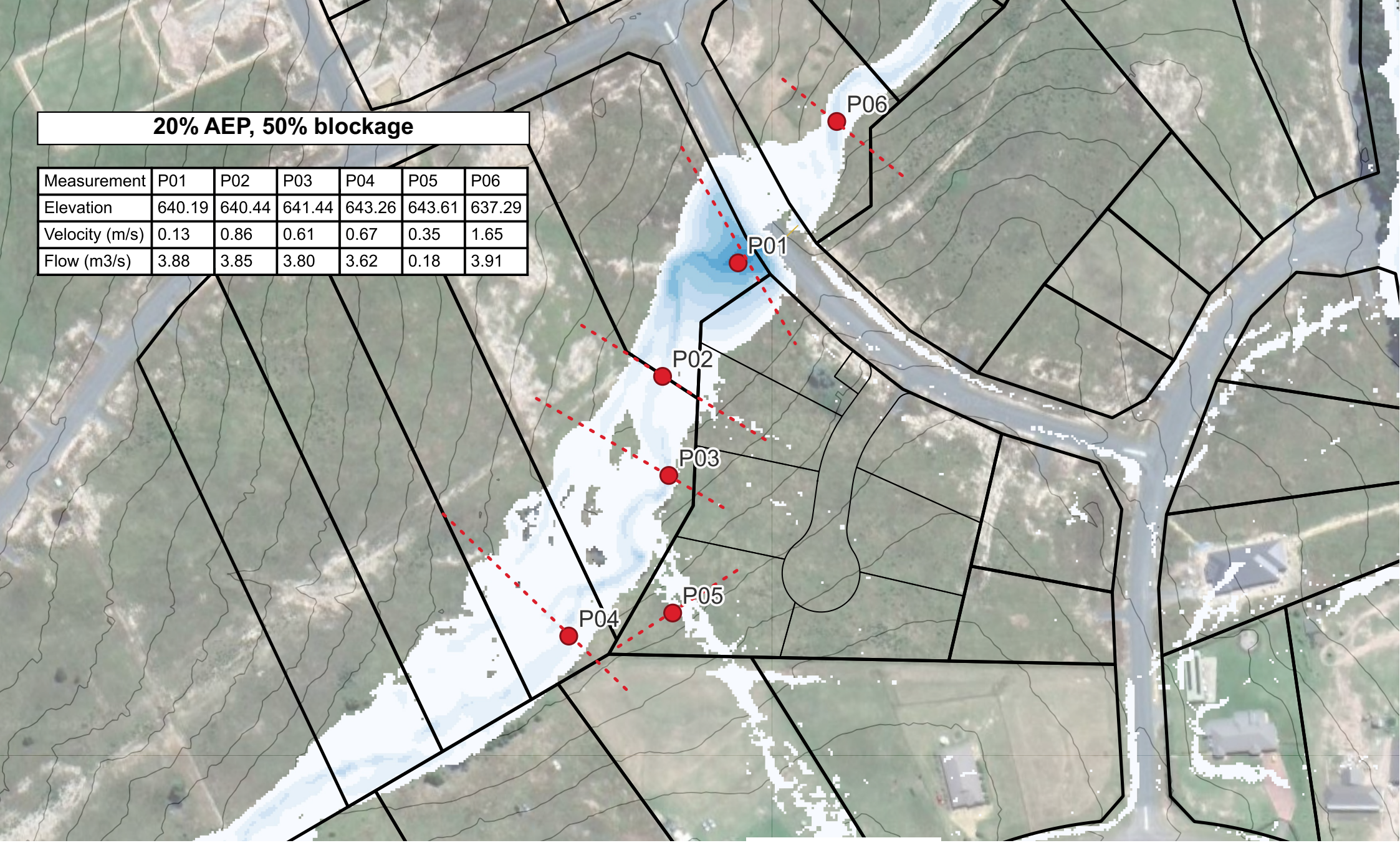

Measurement	P01	P02	P03	P04	P05	P06
Elevation	640.19	640.44	641.44	643.26	643.61	637.29
Velocity (m/s)	0.13	0.86	0.61	0.67	0.35	1.65
Flow (m3/s)	3.88	3.85	3.80	3.62	0.18	3.91

N

0 25 50 m

Project CRS: EPSG:28356

SEEC

Legend

Reporting Location

Reporting Location

Depth (m)

0.0 - 0.2	0.6 - 0.8	1.2 - 1.4	1.8 - 2.0
0.2 - 0.4	0.8 - 1.0	1.4 - 1.6	2.0 - 2.2
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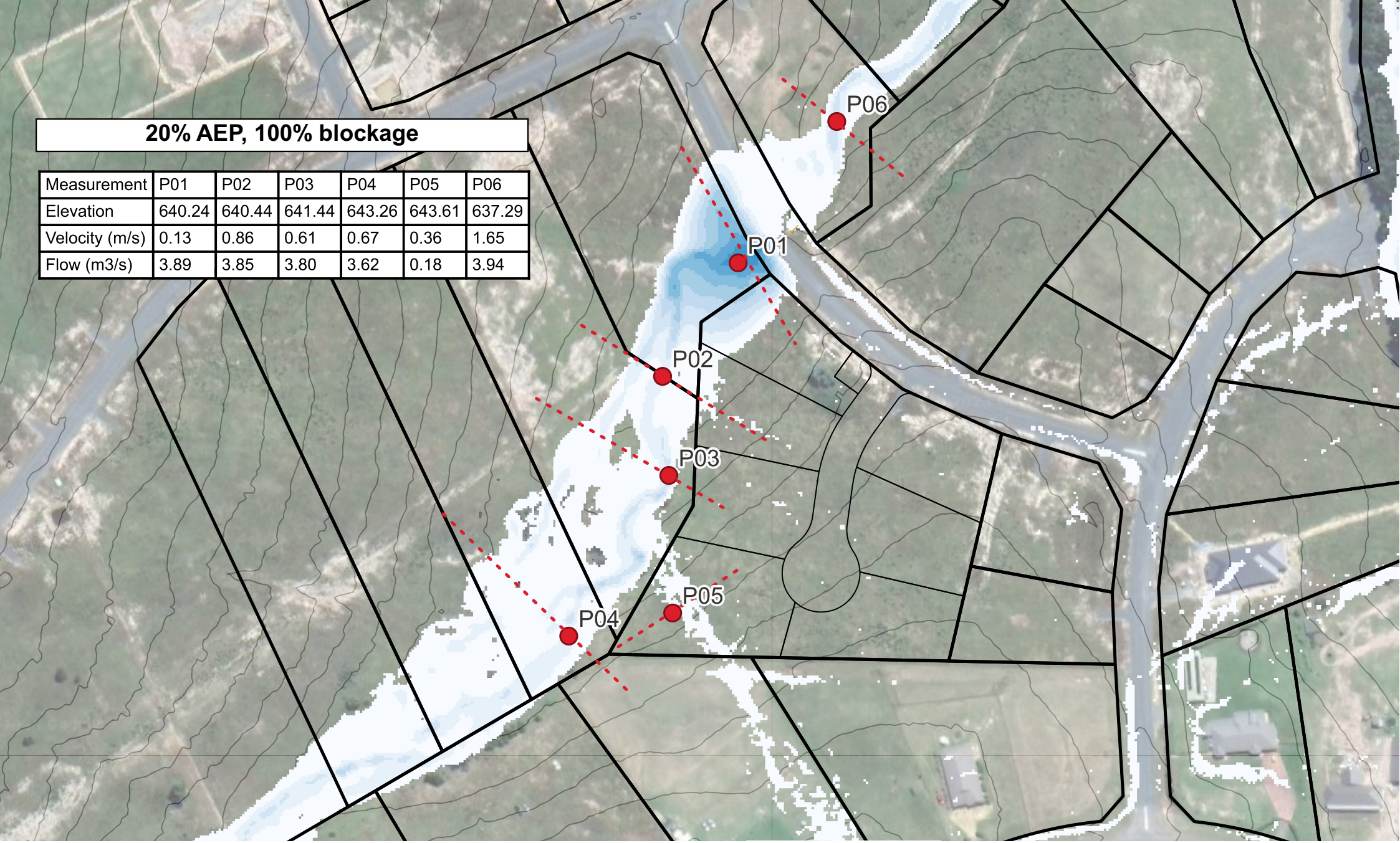

Measurement	P01	P02	P03	P04	P05	P06
Elevation	640.24	640.44	641.44	643.26	643.61	637.29
Velocity (m/s)	0.13	0.86	0.61	0.67	0.36	1.65
Flow (m3/s)	3.89	3.85	3.80	3.62	0.18	3.94

N

0 25 50 m

Project CRS: EPSG:28356

SEEC

Legend

Reporting Location

Reporting Location

Depth (m)

0.0 - 0.2	0.6 - 0.8	1.2 - 1.4	1.8 - 2.0
0.2 - 0.4	0.8 - 1.0	1.4 - 1.6	2.0 - 2.2
0.4 - 0.6	1.0 - 1.2	1.6 - 1.8	> 2.2