ENGINEERS PLANNERS SURVEYORS ENVIRONMENTAL PROJECT MANAGEMENT

# FLOODING ASSESSMENT AND MITIGATION REPORT

## 31 ALIDENES ROAD, WILSONS CREEK

**LOT 38 DP 1059938**

Submission to:

Byron Shire Council

for:

St Saviour Investment Pty Ltd

September 2018


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# Document Control Sheet

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## Executive Summary

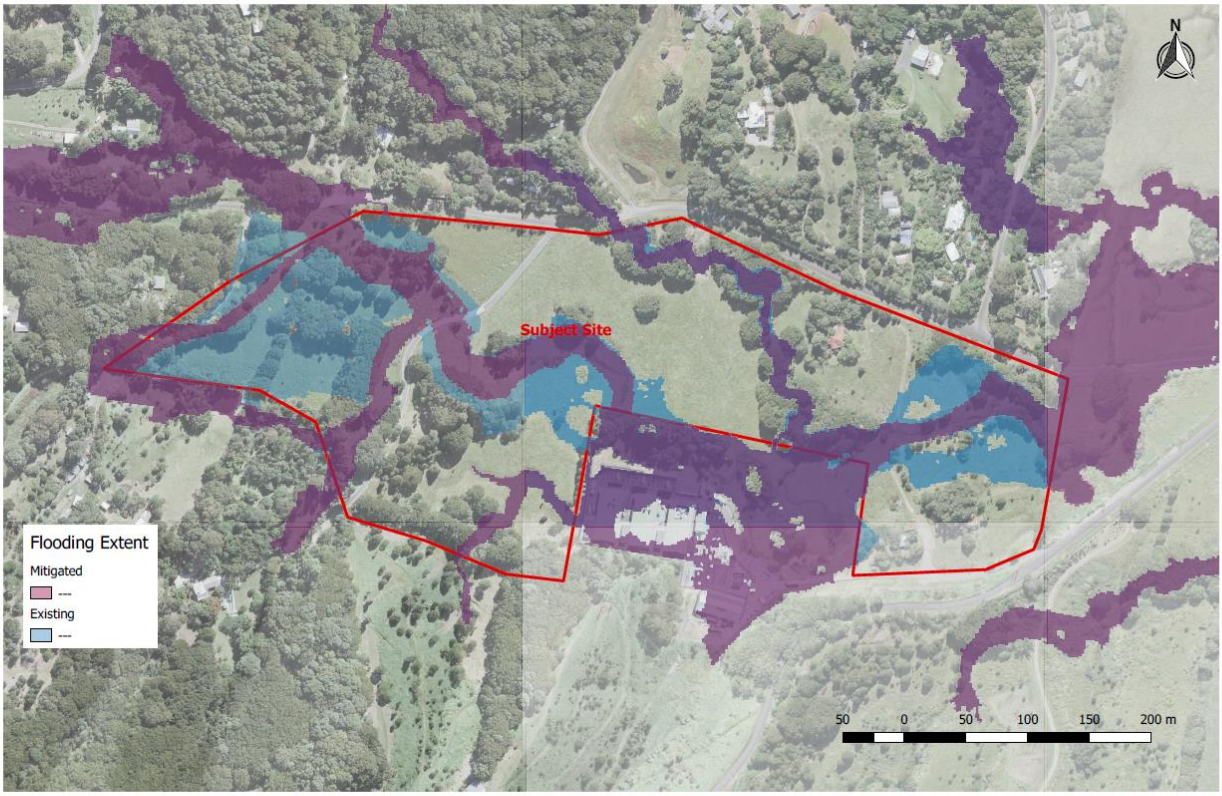
This study aims to identify the flood immune and developable areas at 31 Alidenes Road, Wilsons Creek for planning purposes and to address Byron Shire Council's (Council) request for a flooding impact assessment. This flood assessment has been performed for a range of design events between 5% to 1% AEP and taken advantage of 2D hydraulic modelling for investigating the flooding extent and flow characteristics.

For this study the 350ha study catchment was split into 20 sub-catchments and included in a DRAINS model.

The modelling results help identify the developable parts of the site. The study shows that:

- The majority of the site is not flood prone and will be suitable for development with no flooding issues.
- Parts of the site are flood prone but will still be developable. Construction levels for these areas can be extracted from the hydraulic model and provided to the developers for future planning and designs
- Parts of the site can be made flood immune with relatively minor cut earthworks within the on-site flow paths and localised fill earthworks mainly along the flow paths left and right banks. This flooding mitigation works can be undertaken in future development stages.

A comparison between the pre and post mitigation flooding extent for the design 1% AEP event is shown in the figure below. It is proposed that the site development master plan is prepared based on the flooding extent in the mitigated condition.



# 1. Introduction

Ardill Payne and Partners (APP) has been commissioned by St Saviour Investment Pty Ltd to undertake a flood assessment and mitigation report to support the rezoning application of a 12.27ha property located at 31 Alidenes Road, Wilsons Creek, NSW. Location of the property is shown in Figure 1.1.

This study aims to identify the flood immune and developable areas within the property for planning purposes and to address Byron Shire Council's (Council) request for a flooding impact assessment.

With consideration of the nature of the study, the assessment has been performed for three design events of 5%, 2% and 1% AEP. The flooding information provided in the report in regards to the 1% AEP event will be used for planning of the development and defining the number and arrangement of future developable lots. In future development stages, the flooding information will be used for detailed designs including defining the building floor levels. The results provided for the smaller 2% and 5% AEP events only applies to designs for non-habitable areas.

This report contains the approach and results of the hydrology and hydraulic study undertaken for this flood assessment. DRAINS rainfall-runoff computer software was used in the hydrology study for quantification of the site design flow hydrographs. TUFLOW hydraulic model was used to assess the extent and patterns of the quantified flows and provision of flood mitigation strategies.

**Figure 1.1: Location of the subject property**

## 2. Hydrology Assessment

The site is located at the foothill of a relatively steep 227ha catchment. For the hydrological assessment, a larger 350ha catchment was used and extended downstream of the site to ensure all the inflows reaching the site and the effectual downstream channel were included and accurately modelled. The study catchment is shown in Figure 2.1.

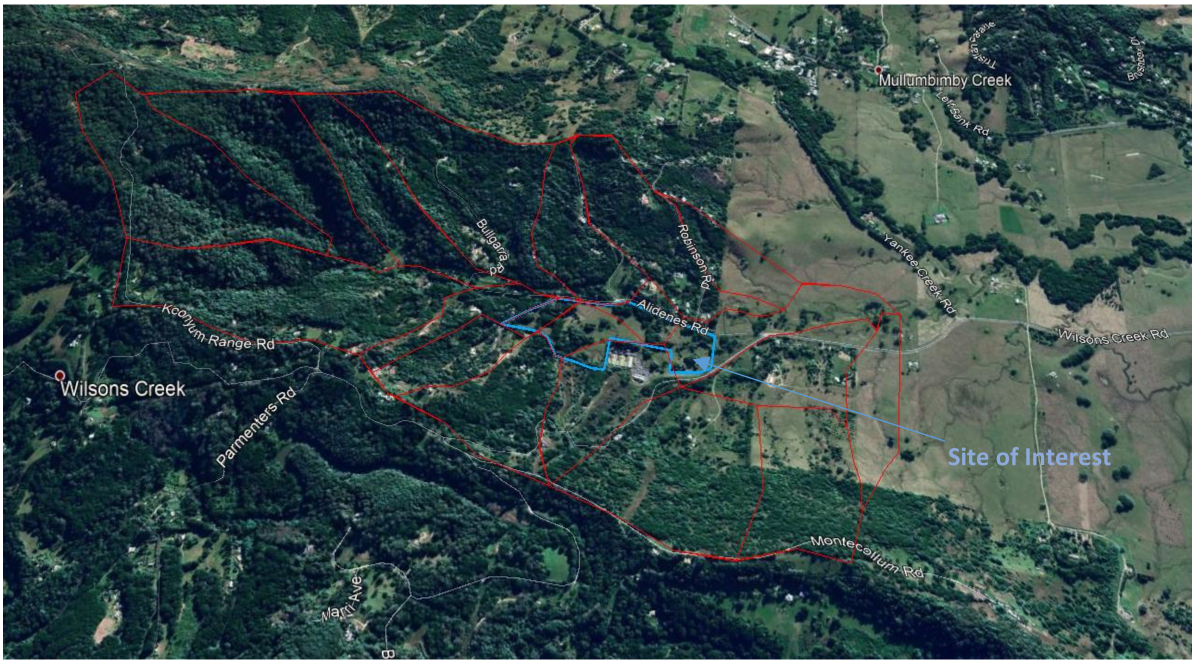



**Figure 2.1: Site of interest and study catchment**

The study catchment was delineated based on available Lidar data and other GIS information regarding the regional contours and flow paths. The catchment was then divided into a number of sub-catchments to identify the flow quantities entering the site at different locations. The identified sub-catchments are shown in Figure 1, Attachment 1. The site flow paths are shown in Figure 2, Attachment 1. As shown in the figure there are several flow entry points to the site. All need to be considered in planning the development.

A DRAINS rainfall-runoff model was setup to quantify the design flow hydrographs for each of the contributing sub-catchments. The main parameters used in modelling are shown in Table 2.1. The percent impervious of each sub-catchment was estimated based on the aerial photos. The model layout and results for the target events are shown in Attachment 2 of the report.

The design rainfall quantities and temporal patterns were extracted from the Bureau of Meteorology website and ARR 2016 Data Hub for the location of the site. The hydrologic modelling was undertaken for a range of rainfall durations between 15 minutes to 12 hours.

Comparison of the results showed that the 1hr rainfall would be the critical rainfall duration for the catchment and create the highest peak discharge.

The initial and continuous loss method was adopted for calculation of the rainfall losses. The loss parameters were defined within the conventional recommended values as follows:

**Impervious:** IL=2mm , CL= 0

**Pervious:** IL=20mm , CL 3mm/hr

Based on the intense vegetation cover of the catchment the estimated initial loss is anticipated to be conservative.

The peak flows computed for the sub-catchments are presented in Table 2.2.

**Table 2.1: Sub-Catchment details included in DRAINS model**

| Catchment Name | Total Area (ha) | Impervious Area % | Waterway Length (m) | Catchment Slope % |
|---|---|---|---|---|
| Sub14 | 32.75 | 0 | 1050 | 25 |
| Sub13 | 23.93 | 0 | 950 | 20 |
| Sub12 | 41.93 | 0 | 1350 | 14 |
| Sub11 | 19.62 | 0 | 820 | 25 |
| Sub9 | 34.77 | 0 | 1200 | 16 |
| Site2 | 8.06 | 5 | 800 | 15 |
| Site 1 | 9.49 | 10 | 540 | 15 |
| Site 5 | 16.2 | 0 | 540 | 14 |
| Sub 7-1 | 6.18 | 10 | 750 | 12 |
| Site 3 | 15.53 | 0 | 750 | 10 |
| Sub 4 | 21.99 | 5 | 1200 | 6 |
| Sub 3 | 9.36 | 0 | 600 | 6 |
| Site 4 | 4.32 | 0 | 270 | 2 |
| Site 6 | 4.62 | 0 | 270 | 2 |
| Sub 15 | 31.61 | 0 | 620 | 15 |
| Sub 16 | 19.55 | 0 | 640 | 20 |
| Sub 1 | 10.52 | 0 | 800 | 7 |
| Sub 2 | 14.99 | 5 | 750 | 2 |
| Sub 5 | 13.95 | 0 | 900 | 1.2 |
| Sub 7-2 | 10 | 10 | 750 | 12 |
| **Total Catchment** | **350** | **1.38** | **3400** | **6** |

**Table 2.2: Sub-Catchments peak flows for the targeted events**

| Sub-Catchment Name | Loading point in hydraulic model | Qmax 5% AEP | Qmax 2% AEP | Qmax 1% AEP |
|---|---|---|---|---|
| | | ($m^3/s$) | ($m^3/s$) | ($m^3/s$) |
| Sub14 | I19 | 5.259 | 7.059 | 8.574 |
| Sub13 | I19 | 3.818 | 5.126 | 6.226 |
| Sub12 | I20 | 4.999 | 6.723 | 8.175 |
| Sub11 | I18 | 3.599 | 4.688 | 5.524 |
| Sub9 | I2 | 4.592 | 6.172 | 7.503 |
| Site2 | I1 | 1.305 | 1.741 | 2.086 |
| Site 1 | I5 | 1.83 | 2.347 | 2.754 |
| Site 5 | I6 | 3.161 | 3.988 | 4.675 |
| Sub 7-1 | I7 | 0.991 | 1.298 | 1.56 |
| Site 3 | I3 | 2.334 | 3.134 | 3.808 |
| Sub 4 | I4 | 2.289 | 3.048 | 3.679 |
| Sub 3 | I12 | 1.382 | 1.856 | 2.255 |
| Site 4 | I14 | 0.73 | 0.98 | 1.169 |
| Site 6 | I16 | 0.781 | 1.048 | 1.25 |
| Sub 15 | I9 | 5.872 | 7.571 | 8.935 |
| Sub 16 | I10 | 3.831 | 4.824 | 5.653 |
| Sub 1 | I3 | 1.383 | 1.859 | 2.26 |
| Sub 2 | I11 | 1.498 | 1.997 | 2.411 |
| Sub 5 | I13 | 1.044 | 1.407 | 1.713 |
| Sub 7-2 | I8 | 1.603 | 2.1 | 2.525 |

# 3. Hydraulic Modelling

## 3.1 Model Setup

To assess flooding characteristics at and adjacent to the site, a 2D hydrodynamic TUFLOW model was setup. TUFLOW is an industry accepted model in which flood flows can be simulated in any direction within the terrain surface. This gives a clear indication of distribution of flows in the study area.

Flow hydrographs from the hydrologic study were included in the hydraulic model as flow boundary conditions. The loading point of the flow hydrographs to the hydraulic model is shown in Table 2.2. The location of the loading points are shown in Figure 3, Attachment 1. The location of the flow boundary condition was selected with consideration of the sub-catchments structure in the DRAINS model to minimise the flow reductions due to double routing of flows in the hydrology and hydraulic models.

The site downstream flow depths were estimated as 'normal' in defining the water level boundary condition at the model discharge point. The modelling area was extended to a long distance upstream and downstream of the site to ensure the flow condition at the site were not influenced by assumptions made in locating the flow and water level boundary conditions. The hydraulic model extent and location of the boundary conditions are shown in Figure 3, Attachment 1.

The changes in the Manning's n roughness across the modelling area was considered in setup of the hydraulic model. The Manning's coefficients of the modelling surface were selected as an appropriate value based on the current land application as road, vegetated area, flow path etc.

The modelling was performed for the site existing condition and a condition with earthworks to mitigate existing flooding extent.

## 3.2 Existing Flooding Condition

### 3.2.1 Hydraulic modelling

A base hydraulic model was setup to represent the existing condition of the site and assess the site current flooding condition. The surface digital elevation model (DEM) required for 2D hydraulic modelling was generated based on the Lidar data acquired earlier from Council. A 2m grid size DEM was generated from the data to best represent localised changes in the topography and the existing flow paths.

There are two sets of existing culverts within the modelling area. As shown in Figure 2, Attachment 1, these culverts are located along the site boundary with Alidenes Road and under the site internal road. After the first trial run it was decided to not include these culverts in the model and instead modify the model DEM to lower the roads level at the channel crossings. As such, necessary adjustments were made at the location of the roads crossings to not create any flow impediment by the roads. Elimination of the roads at the channel crossings, produce a slightly higher flow rate through the subject site and is therefore a conservative approach. The existing culverts within the site has to be upgraded as part of the development in accordance to the current drainage design guidelines.

### 3.2.2 Modelling Results

The inundation depths and flow patterns of the 1% AEP, 2% AEP and 5% AEP flood events are shown in Figures 4 to 6 in Attachment 1. Figures 7 to 9 present the flow heights and Figures 10 to 12 show the V.D product of the same events. V.D product is a flooding hazard index with higher values showing higher flooding hazard for people and travelling vehicles. A V.D of higher than 0.6$m^2$/s is considered to be hazardous to pedestrians and vehicles.

Some of the modelling results are extracted from the model at the points and lines shown in Figure 9, Attachment 1 and presented in Table 3.1. These results are presented for a 1% AEP design event.

**Table 3.1: Measured flow characteristics at the points and lines shown in Figure 9 for the 1% AEP design event**

| Measured Parameter | Location | Maximum Value | Time of Incidence (Hour) |
|---|---|---|---|
| Flow | Q1 | 42.02 $m^3$/s | 1.12 |
| Flow | Q2 | 32.52 $m^3$/s | 1.05 |
| Flow | Q3 | 28.49 $m^3$/s | 1.03 |
| Water Level | P1 | 39.72 m AHD | 0.86 |
| Velocity | P1 | 0.57 m/s | 0.86 |
| Water Level | P2 | 26.99 m AHD | 1.04 |
| Velocity | P2 | 1.83 m/s | 1.04 |
| Water Level | P3 | 25.62 m AHD | 1.05 |
| Velocity | P3 | 0.48 m/s | 1.04 |
| Water Level | P4 | 28.91 m AHD | 0.89 |
| Velocity | P4 | 1.59 m/s | 0.89 |
| Water Level | P5 | 25.07 m AHD | 0.99 |
| Velocity | P5 | 0.80 m/s | 1.13 |
| Water Level | P6 | 22.87 m AHD | 1.05 |
| Velocity | P6 | 1.06 m/s | 1.09 |
| Water Level | P7 | 20.15 m AHD | 1.09 |
| Velocity | P7 | 1.10 m/s | 1.05 |
| Water Level | P9 | 19.21 m AHD | 1.10 |
| Velocity | P9 | 2.34 m/s | 1.08 |
| Water Level | P10 | 18.27 m AHD | 1.12 |
| Velocity | P10 | 1.55 m/s | 1.10 |

### 3.2.3 Review and Discussion

With reference to Figure 3.1:

1- The majority of the site flows (approximately 35$m^3$/s in a 1 in 100 year event) are sourced from Yankee Creek entering the site at location shown as '1' in Figure 3.1.

2- A major part of the currently flood prone areas labelled as '2' in the figure is developable if building floor levels are located above the current surface. These areas may become flood immune with some cut and fill earthworks as explained in the next section of the report.

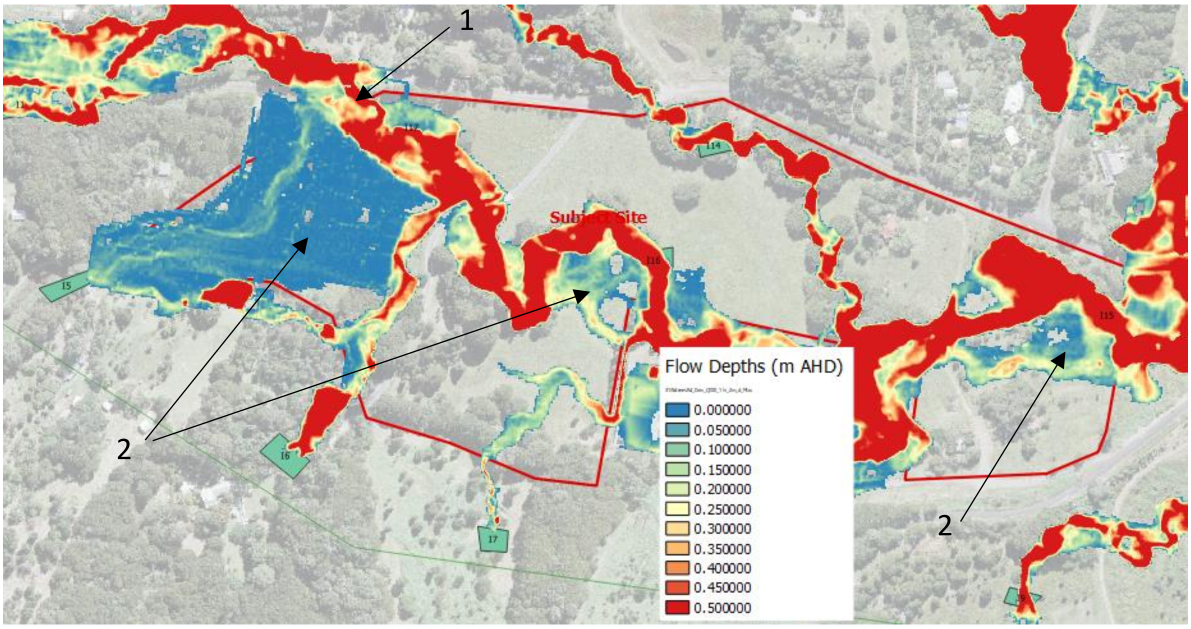



**Figure 3.1: Flow depths for a 1% AEP event**

## 3.3 Mitigated Flooding Condition

### 3.3.1 Hydraulic modelling

The modelling results for the existing condition illustrated that a large part of the site is subject to shallow depth, low velocity flooding. Further hydraulic assessments for improving the site flooding immunity showed that:

- Parts of the existing flow paths are currently blocked and/or not established enough to convey the flows generated in large flood events. Increasing the flow paths capacity through cut earthworks will significantly improve the on-site flooding condition.

- The on-site areas outside of the flow paths can become flood immune with localised fill earthworks. Part of the fill material can be provided from the cut earthworks at the flow paths.

The above cut and fill earthworks were incorporated and optimised in the hydraulic model by manipulating the site base DEM generated in modelling the existing condition. The location of the proposed earthworks and the refined DEM is shown in Figure 13. The figure can be compared with Figure 2 for inspection of the localised changes made to the site topography.

A different representation of the changes made to the site levels is shown in Figure 3.2. The proposed earthworks should be considered preliminary. In future design stages a more detailed earthwork plan will be proposed utilising a civil design software.

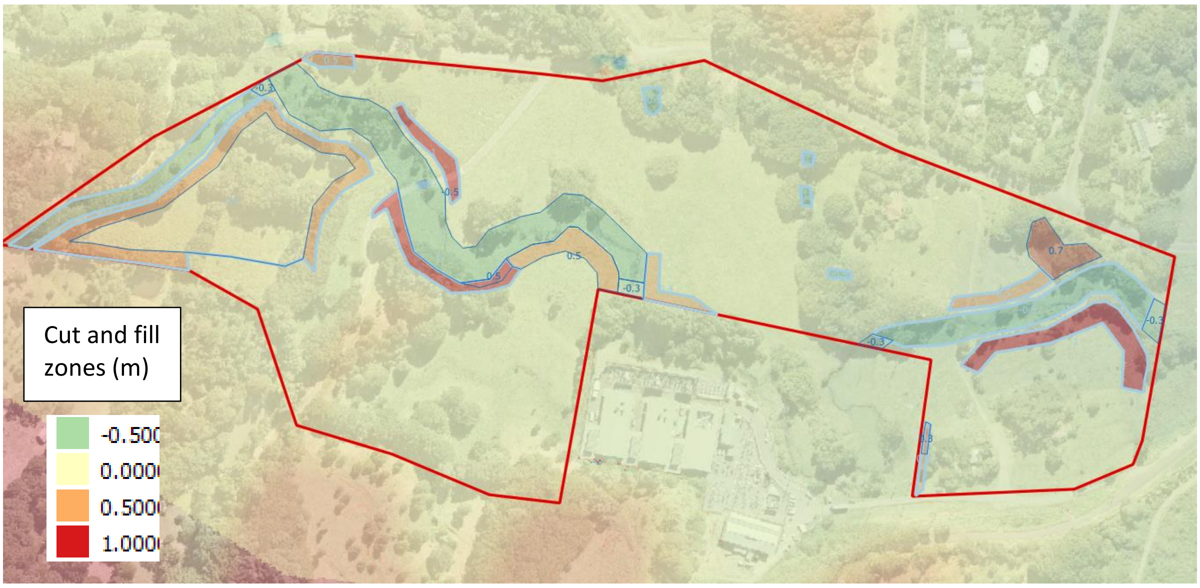



**Figure 3.2: Proposed cut and fill to mitigate on-site flooding condition-preliminary**

### 3.3.2 Modelling Results

The inundation depths and flow patterns for the 1% AEP flood event is shown in Figure 14, Attachment 1. Figure 15 presents the flood heights and Figure 16 the V.D product of the same event.

As shown the proposed earthworks improve the on-site flooding condition. Further investigations showed that the proposed works does not cause any adverse impact to the neighbouring properties. The changes to the water levels within and at the site boundaries is presented in Figure 17. The figure has been generated by subtraction of the existing condition water levels from the water levels in mitigated condition. Negative values indicate a reduction in water levels in the mitigated condition. The reduction in flow depths in the majority of the modelling area is created by the proposed cut earthworks within the waterway improving the flow conveyance.

A comparison between the flooding extent in existing and mitigated condition is shown in Figure 18. As shown. In the mitigated condition, the on-site flooding extent has reduced with no noticeable increase in off-site flooding extent.

# 4. Scope of Engagement

This report has been prepared by Ardill Payne & Partners (APP) at the request of Saint Saviour Investment Pty Ltd for the purpose of flood assessments and mitigation at 31 Alidenes Road, Wilsons Creek and is not to be used for any other purpose or by any other person or corporation.

This report has been prepared from the information provided to us and from other information obtained as a result of enquiries made by us. APP accepts no responsibility for any loss or damage suffered howsoever arising to any person or corporation who may use or rely on this document for a purpose other than that described above.

No part of this report may be reproduced, stored or transmitted in any form without the prior consent of APP.

APP declares that it does not have, nor expects to have, a beneficial interest in the subject project.

To avoid this advice being used inappropriately it is recommended that you consult with APP before conveying the information to another who may not fully understand the objectives of the report. This report is meant only for the subject site/project and should not be applied to any other.

# 5. Attachments

| | |
|---|---|
| Attachment 1 | Figures |
| Attachment 2 | DRAINS Modelling |

**Attachment 1:** Figures

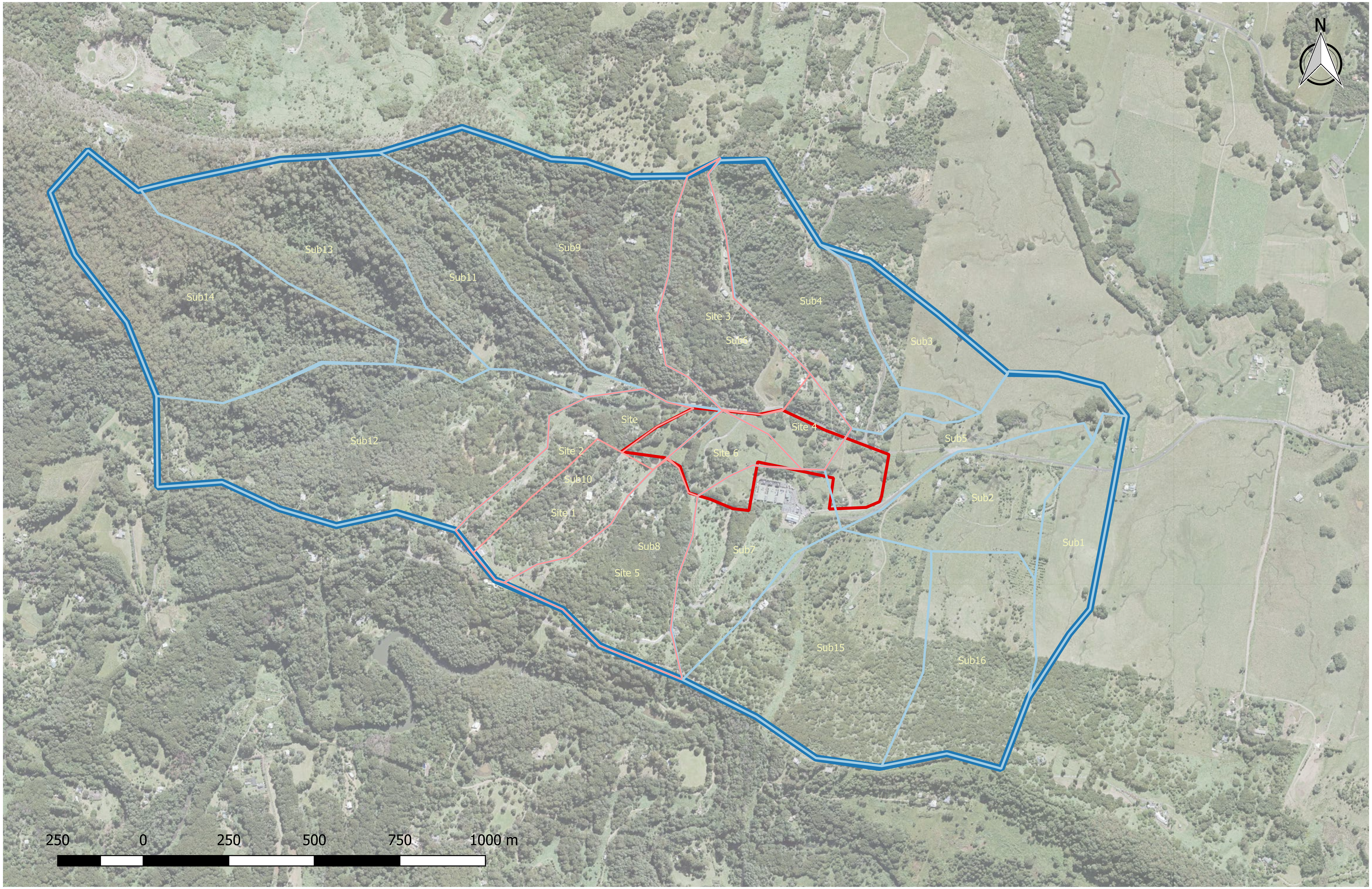



**Figure 1: Subject site locality and Study Catchment**

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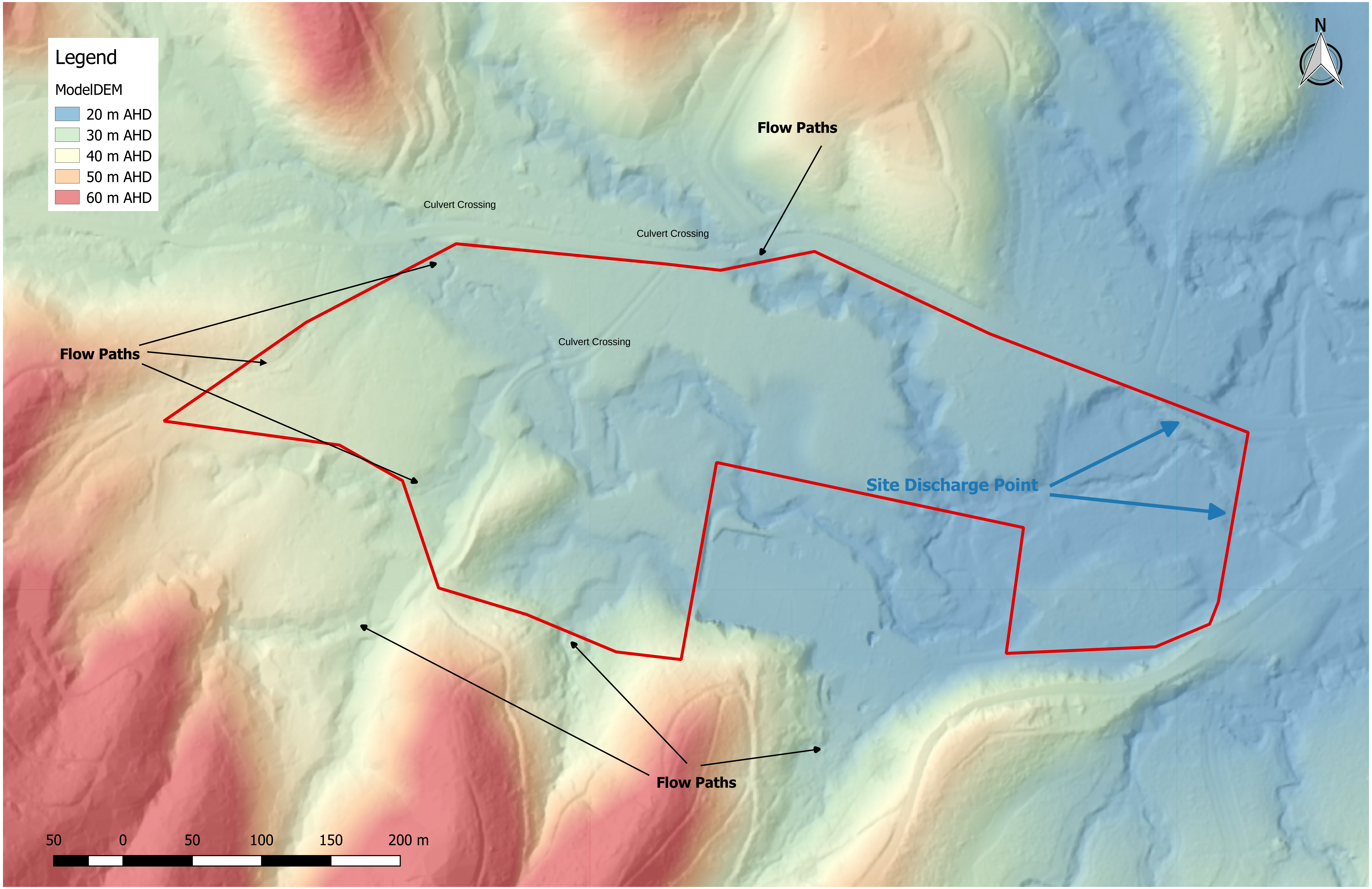


**Figure 2: Site DEM and identifued flow paths**

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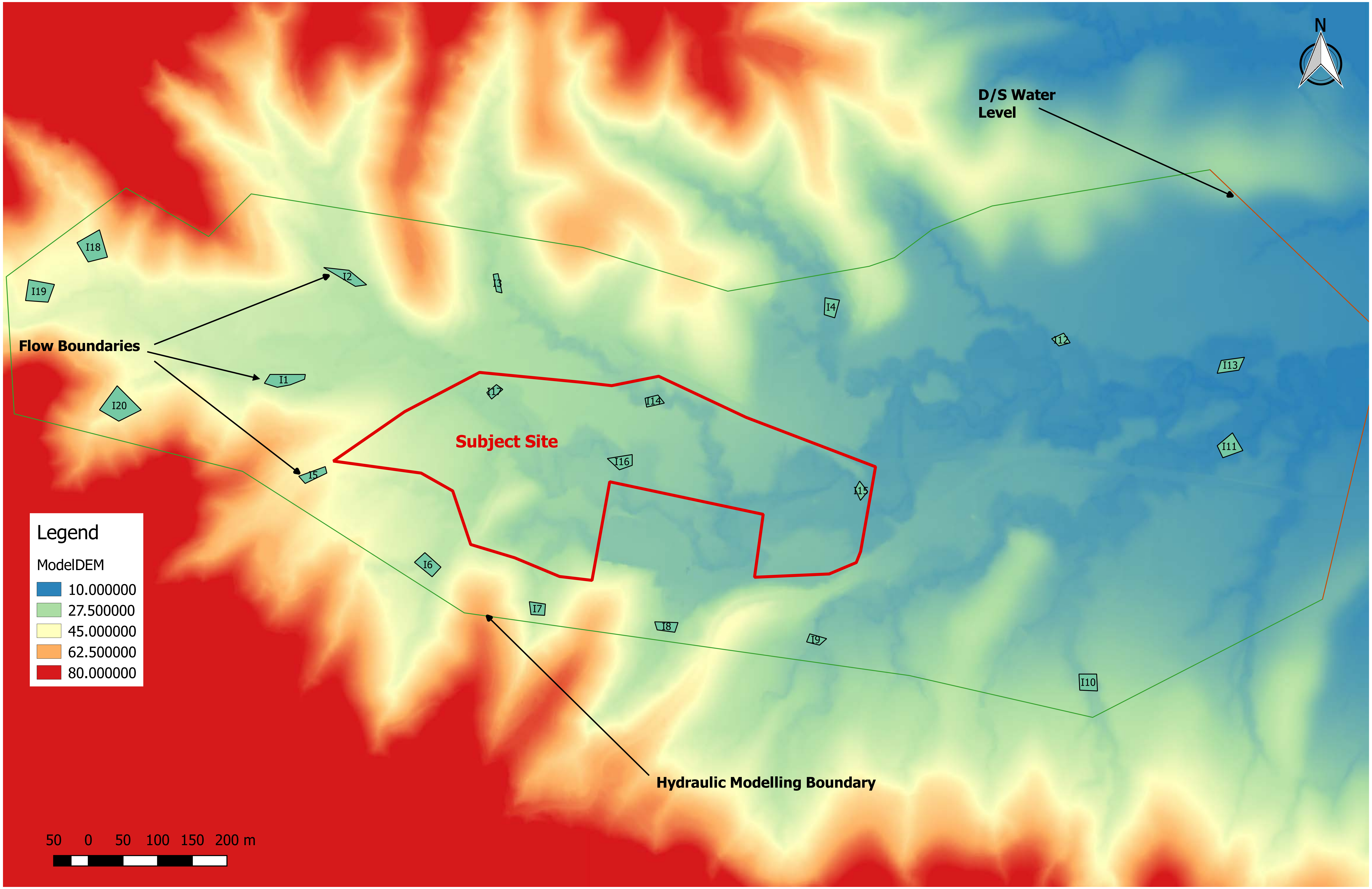


**Figure 3: Hydraulic modelling boundary and location of the flow and water level boundaries**

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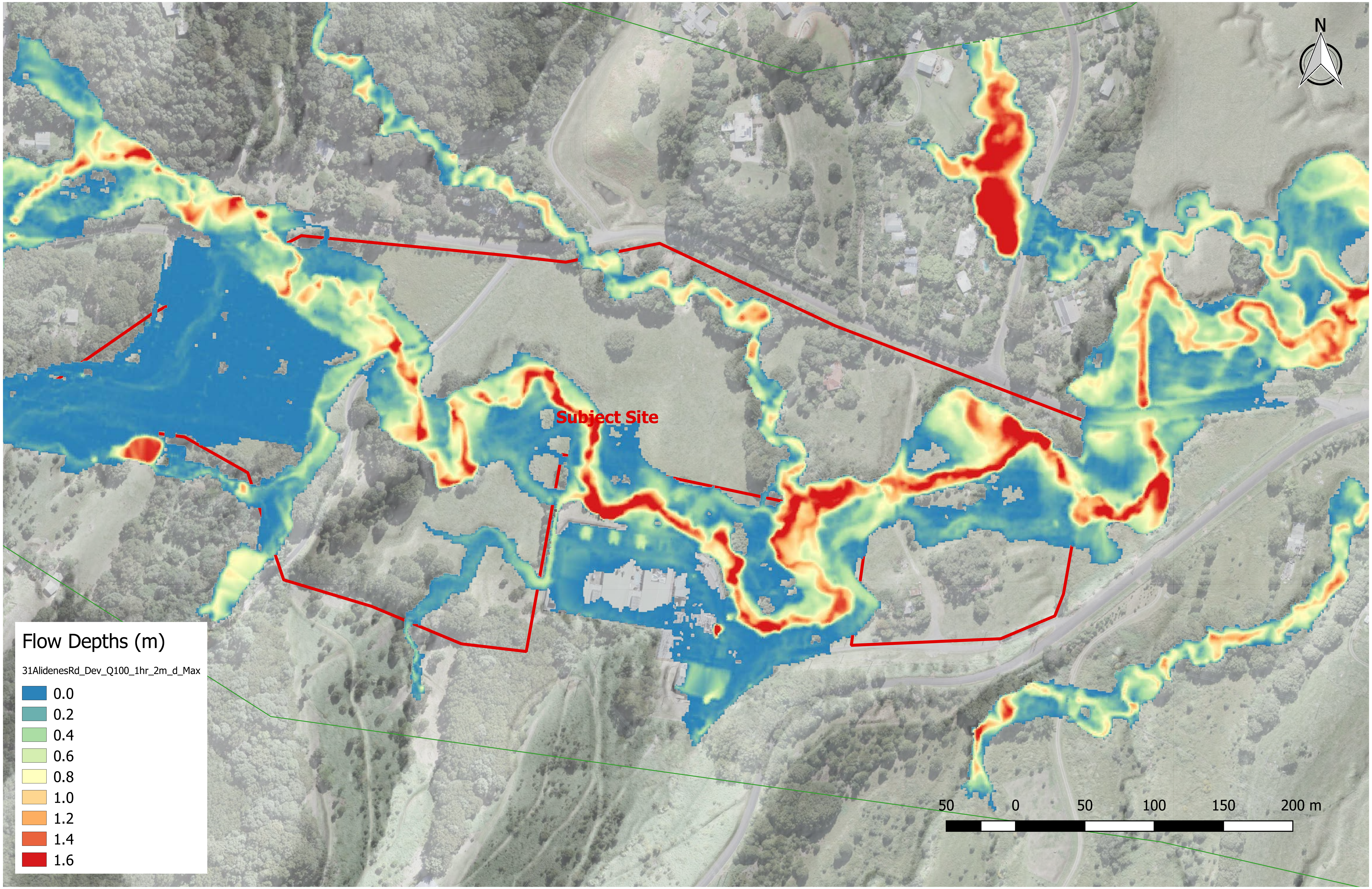


**Figure 4: Flow patterns and depths for 1% AEP design storm event**

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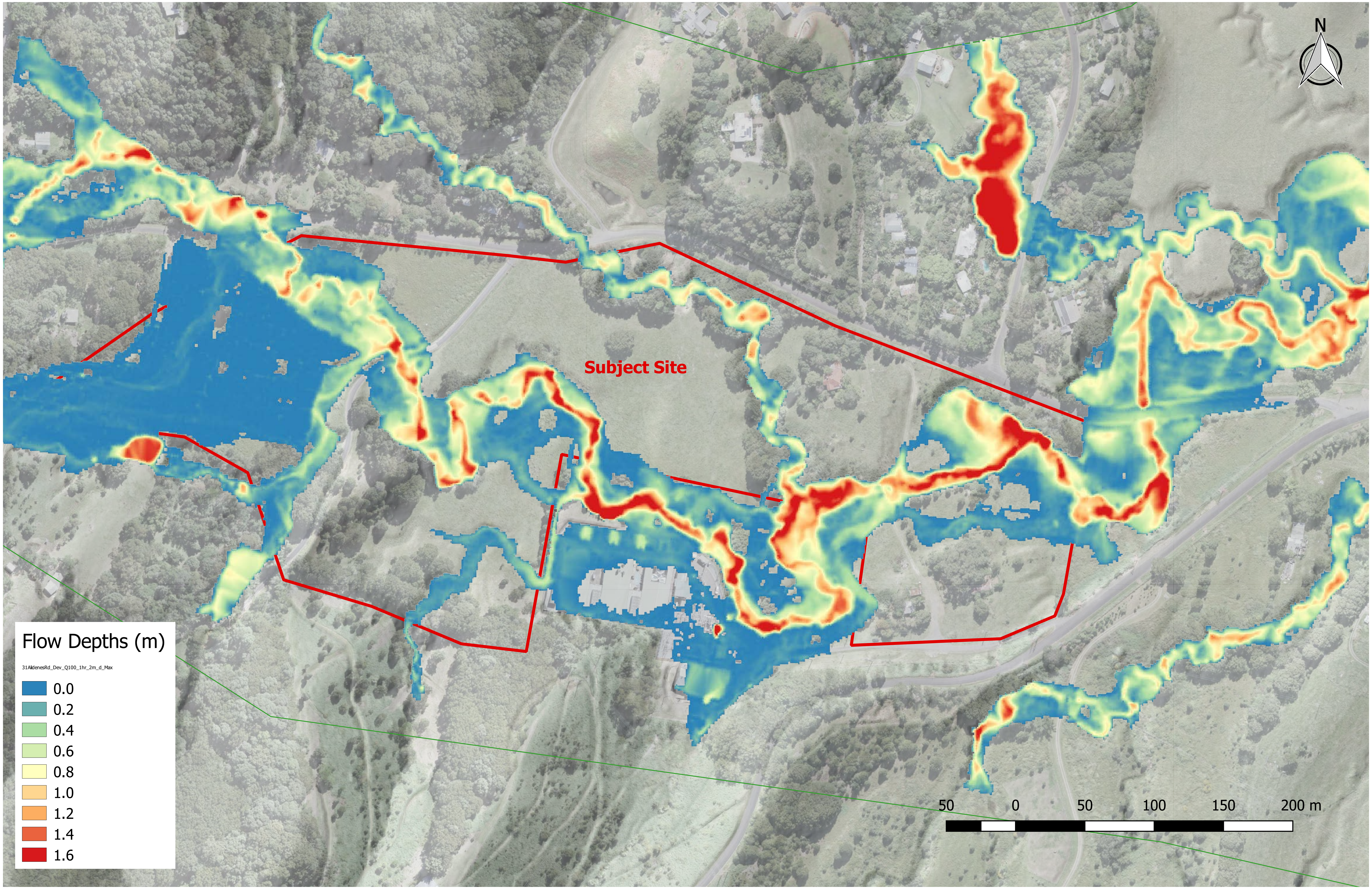


**Figure 5: Flow patterns and depths for 2% AEP design storm event**

Ardill Payne & PARTNERS

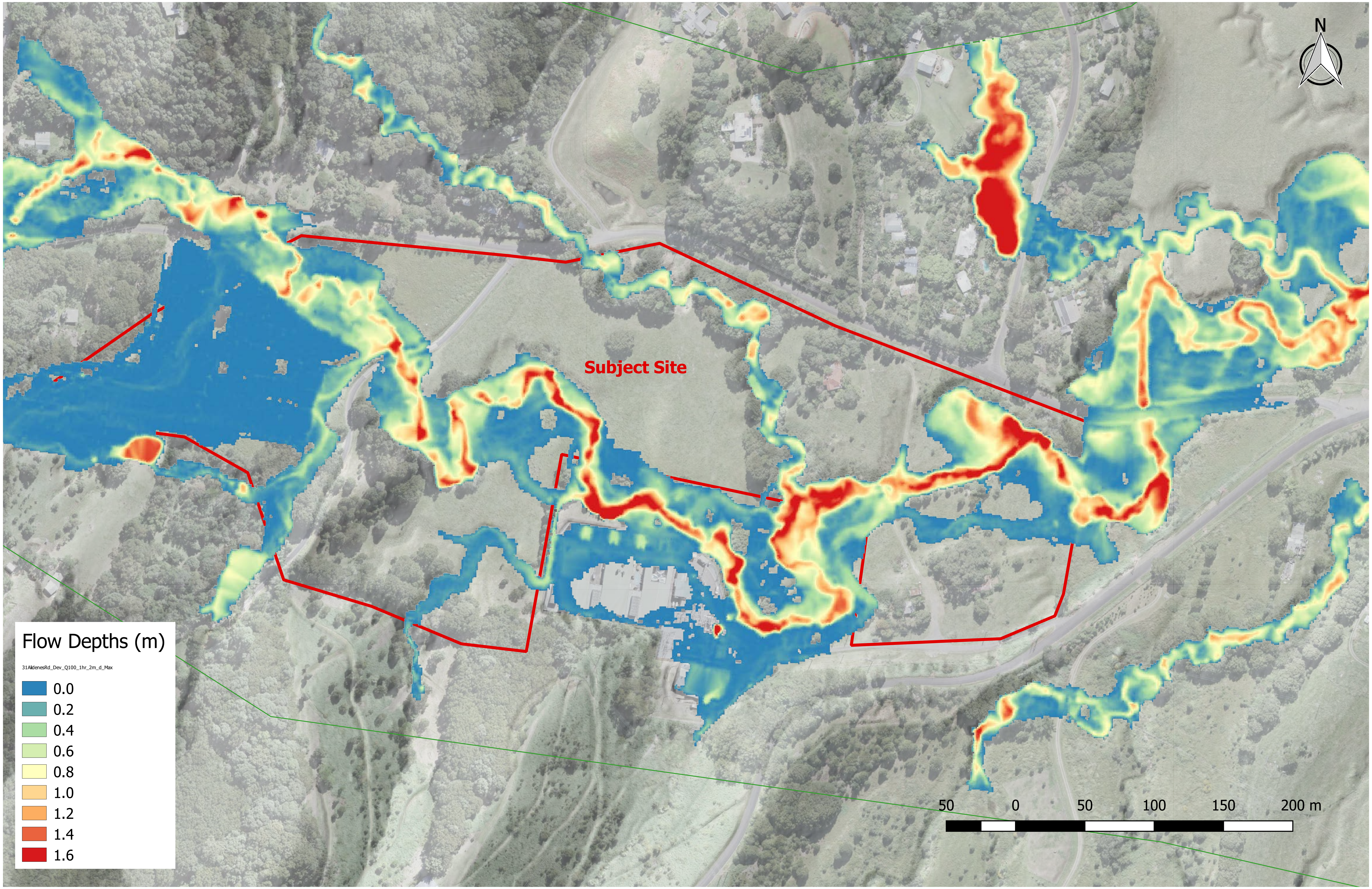


**Figure 6: Flow patterns and depths for 5% AEP design storm event**

Ardill Payne & PARTNERS

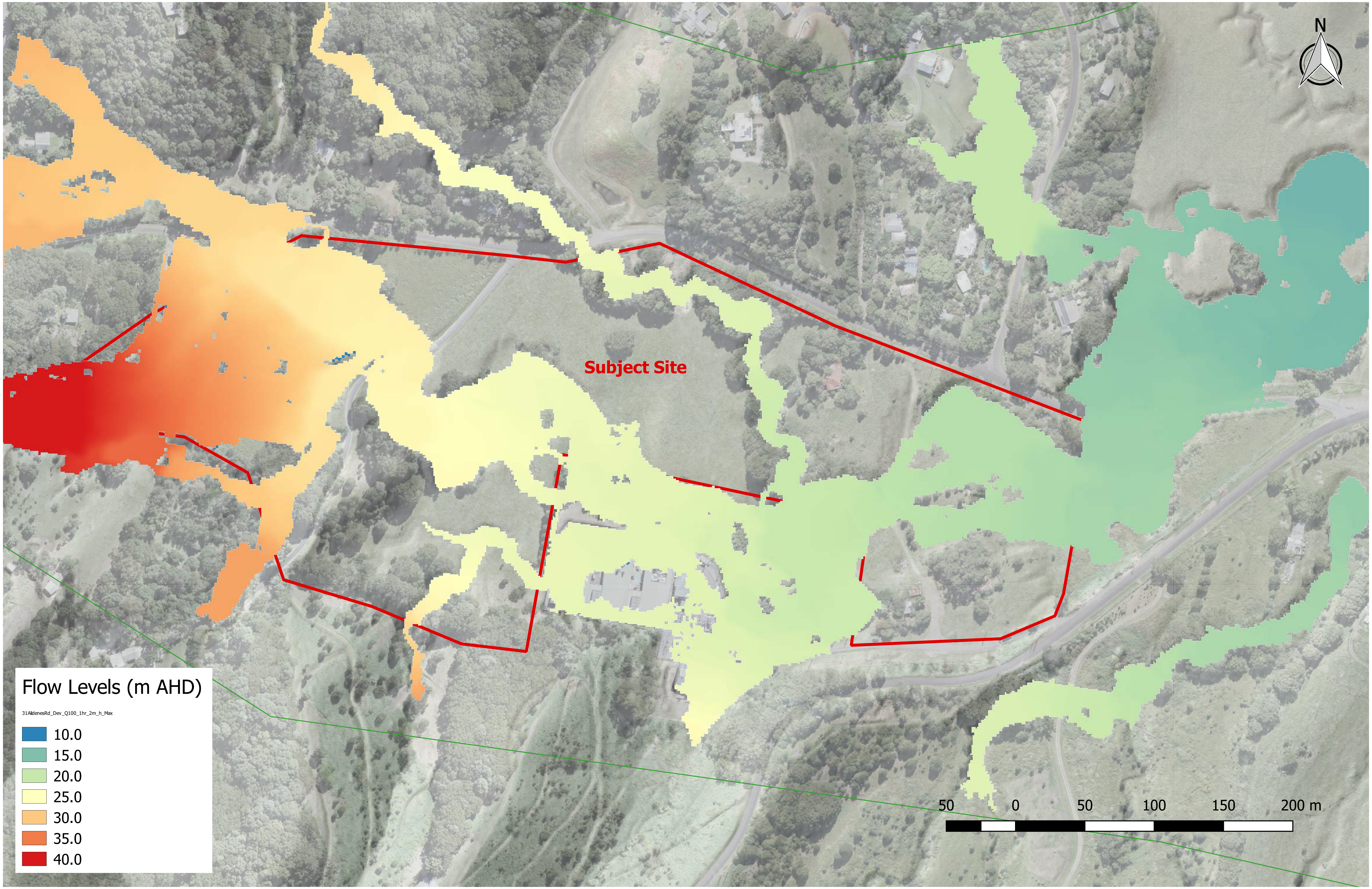


**Figure 7: Flood levels for 1% AEP design storm event**

Ardill Payne & PARTNERS

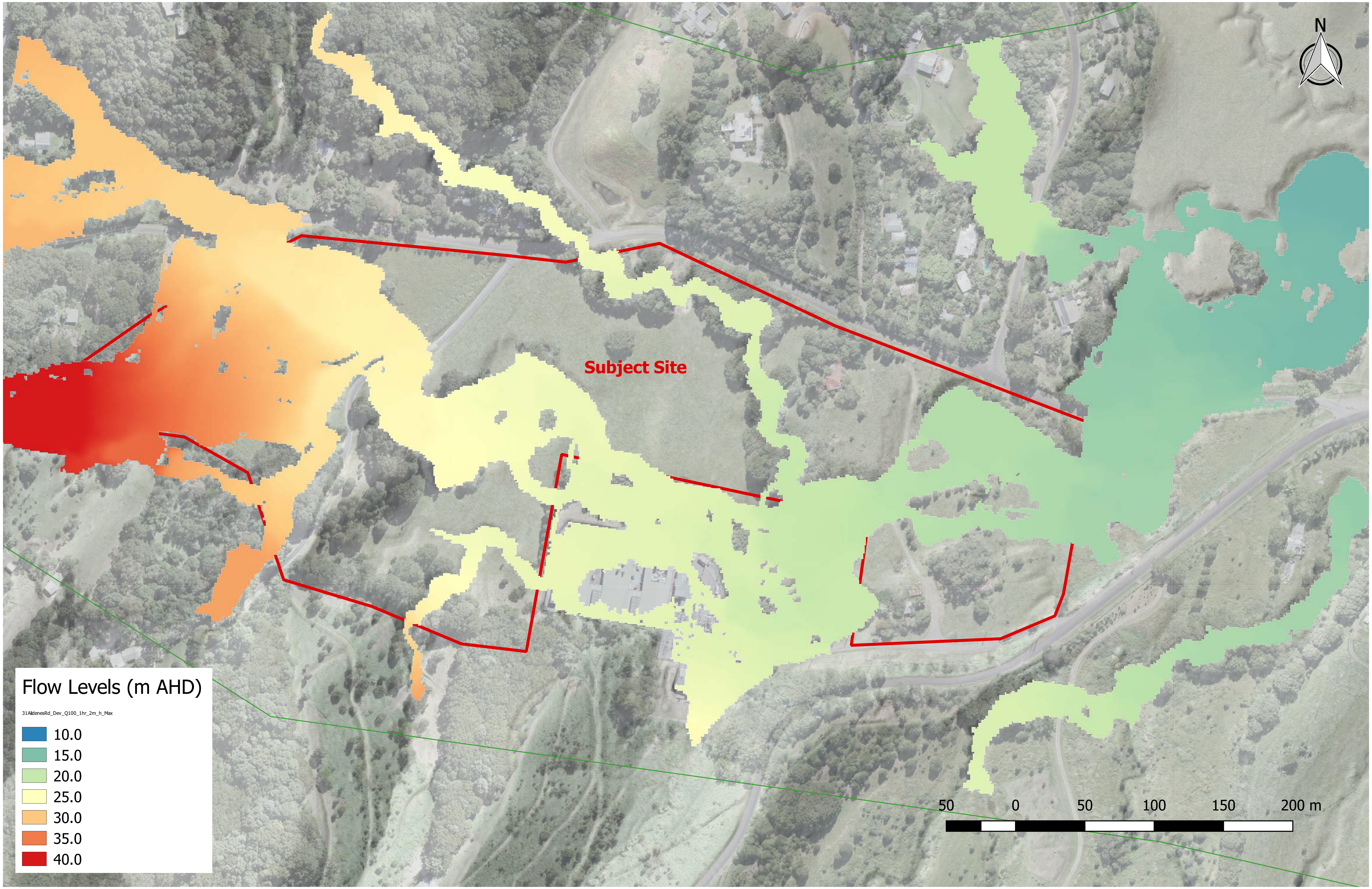


**Figure 8: Flood levels for 2% AEP design storm event**

Ardill Payne & PARTNERS

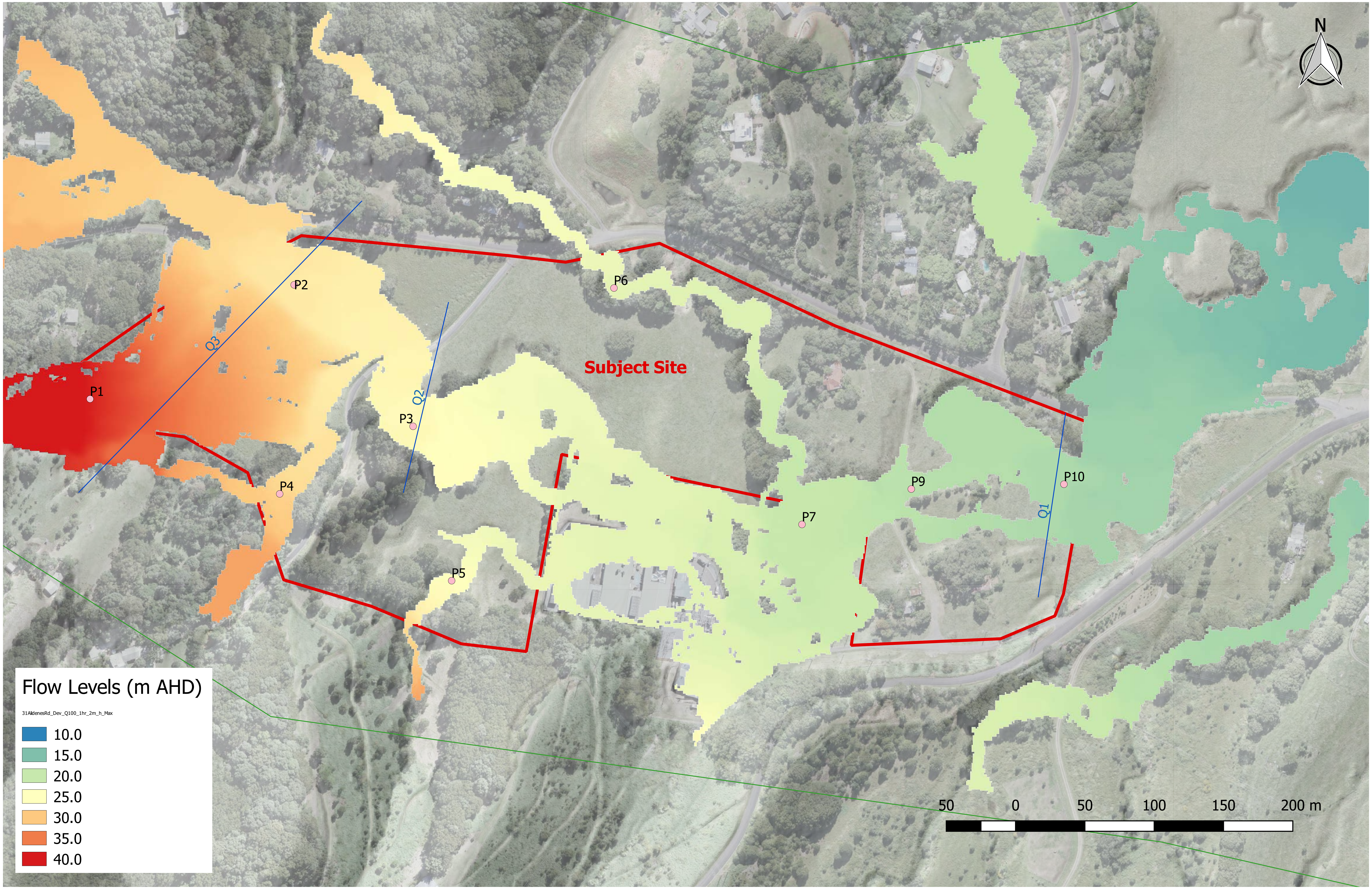


**Figure 9: Flood levels for 5% AEP design storm event and location of the points and lines in Table 3.1 of the report**

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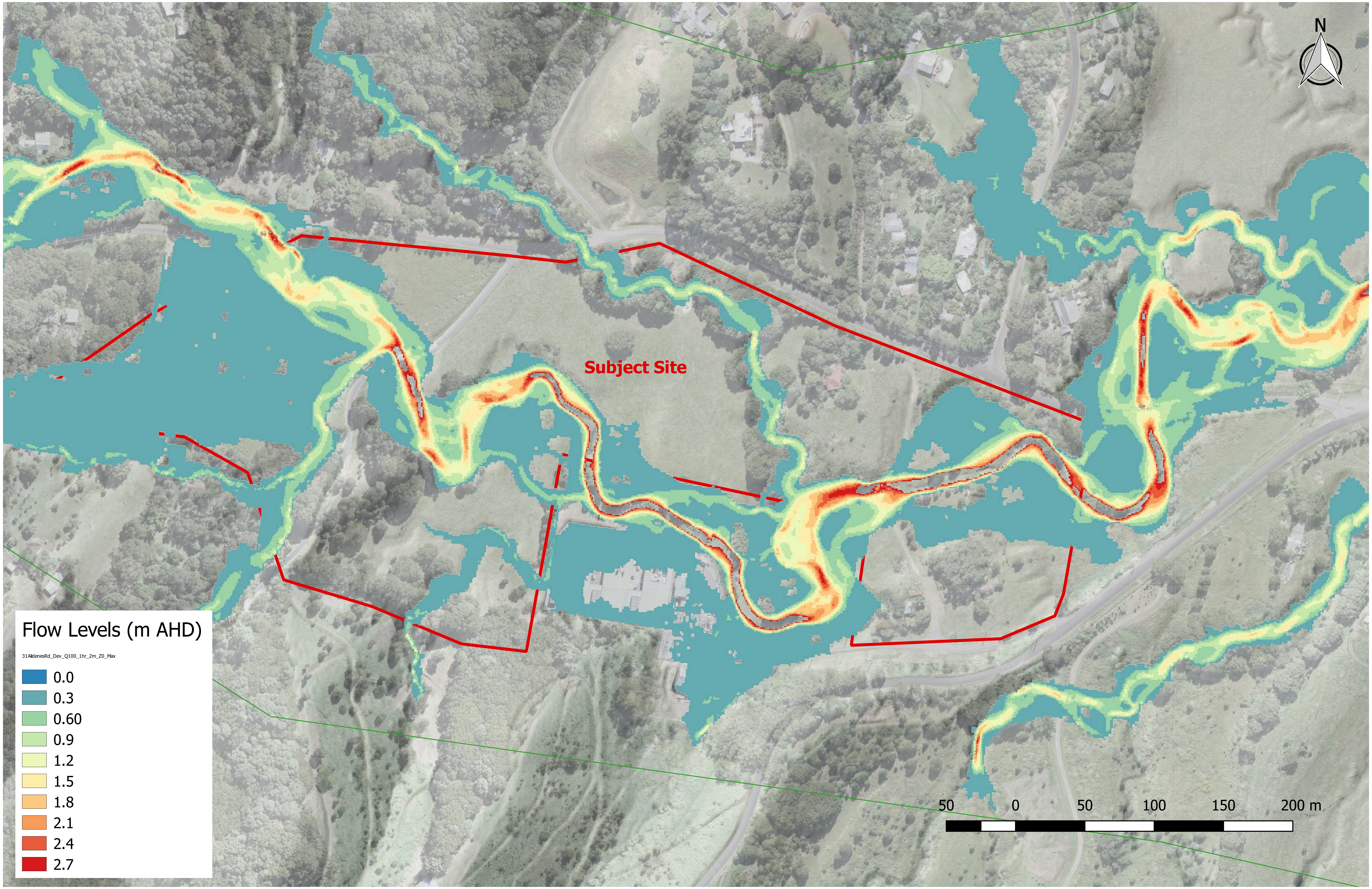


**Figure 10: Velocity.Depth product for 1% AEP design storm event**

Ardill Payne & PARTNERS

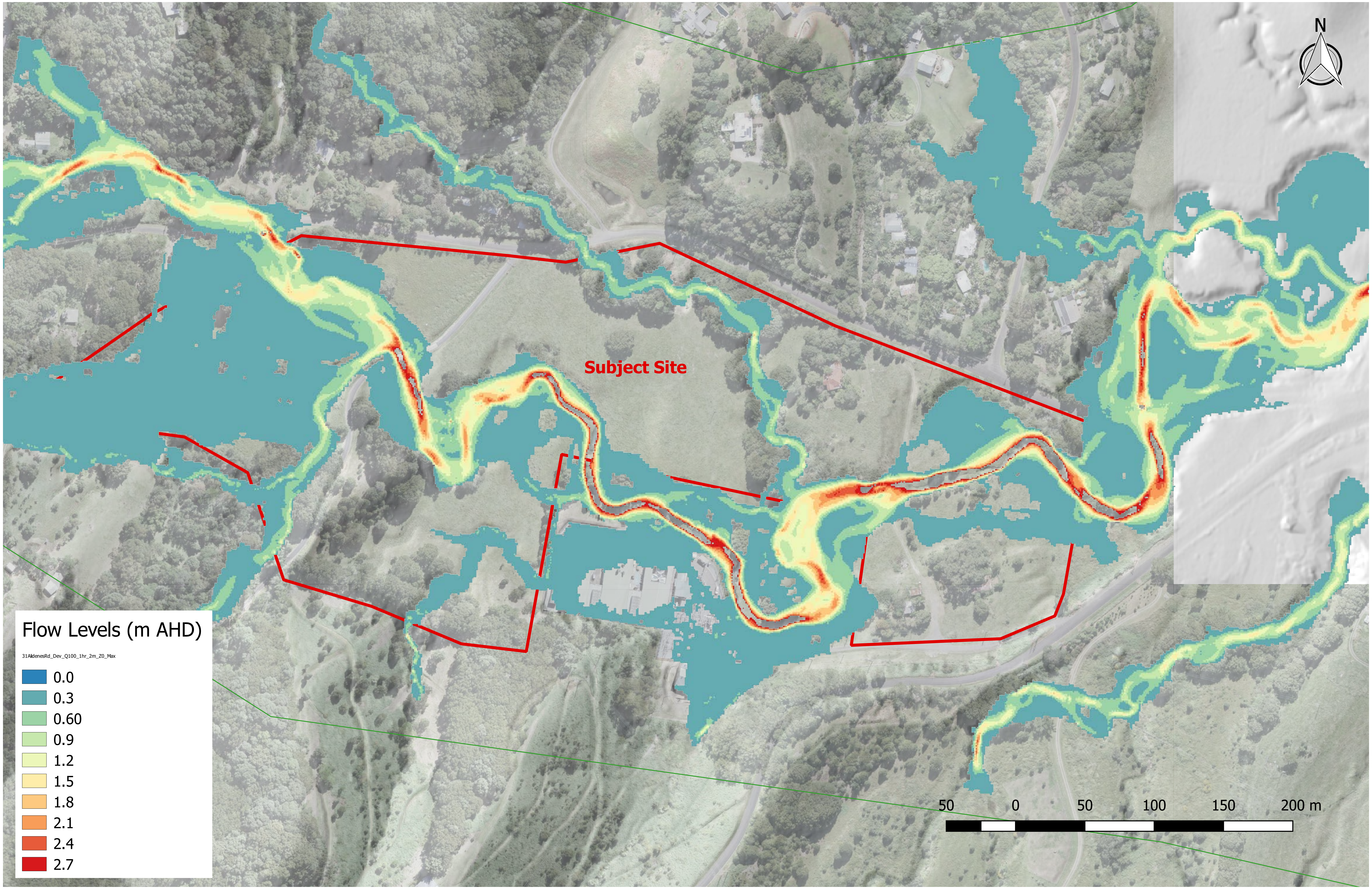


**Figure 11: Velocity.Depth product for 2% AEP design storm event**

Ardill Payne & PARTNERS

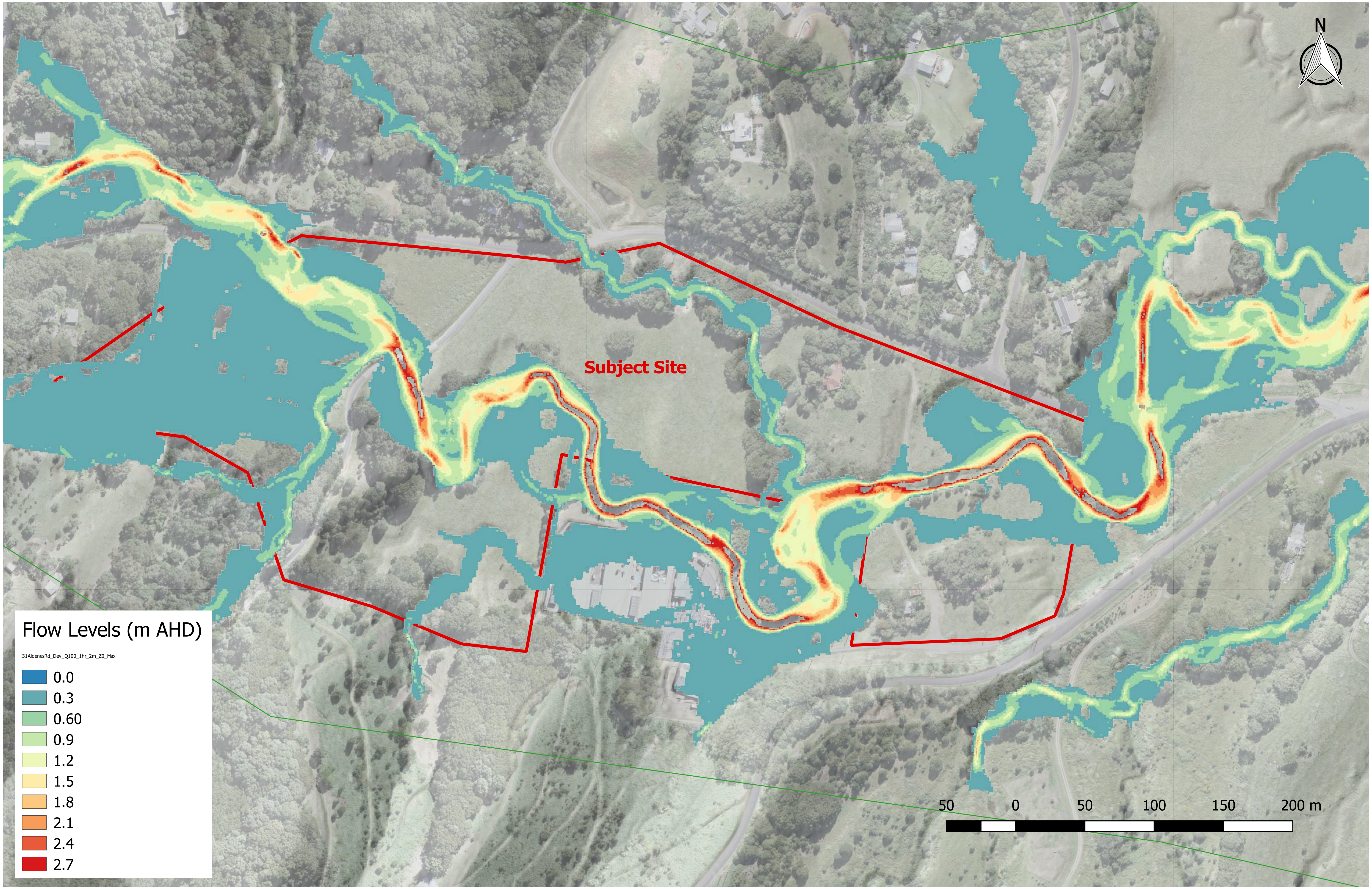


**Figure 12: Velocity.Depth product for 5% AEP design storm event**

Ardill Payne & PARTNERS

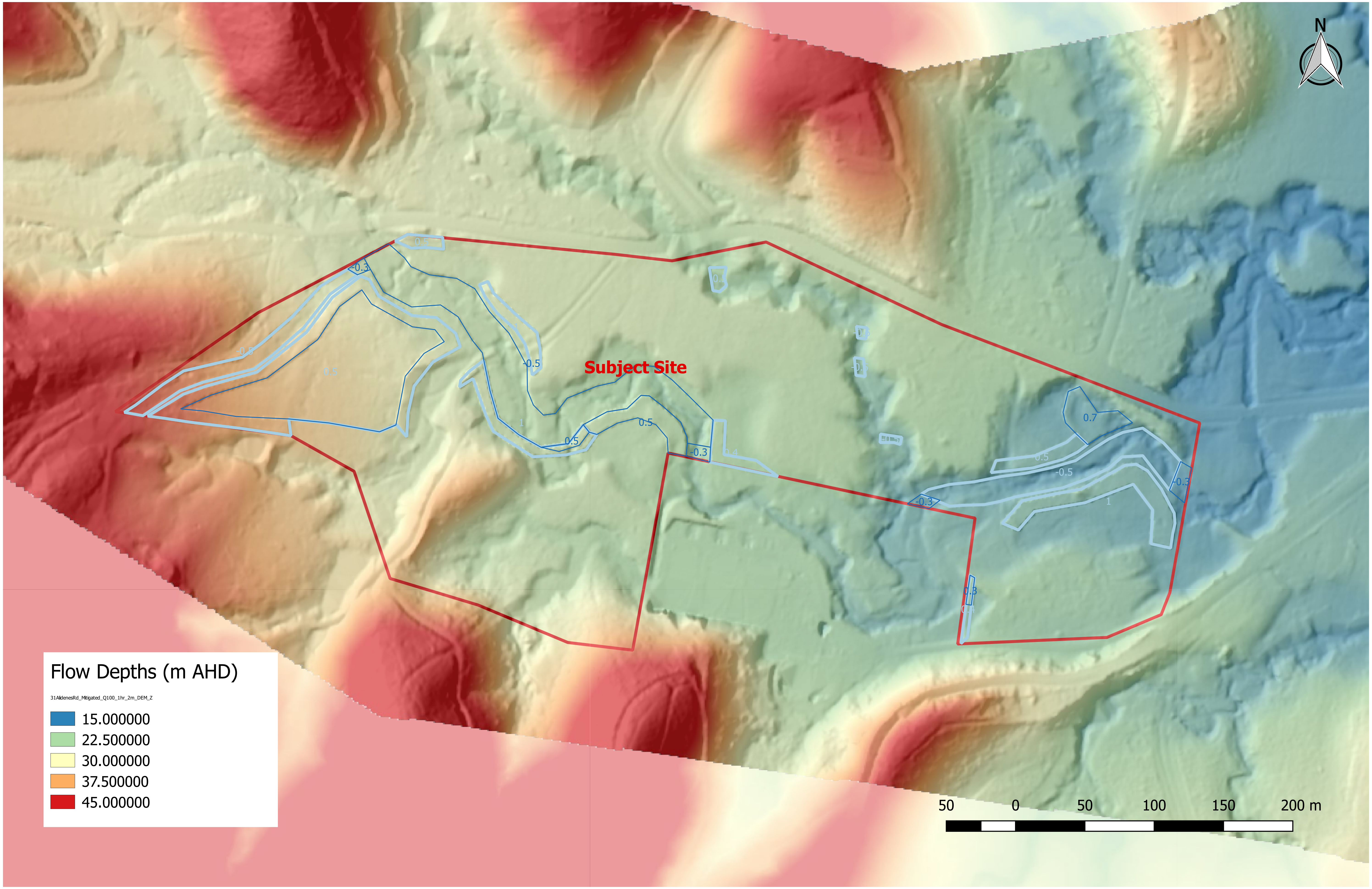


**Figure 13: Site topography with proposed cut and fill. The amount of localised cut and fill shown at some locations are in metre.**

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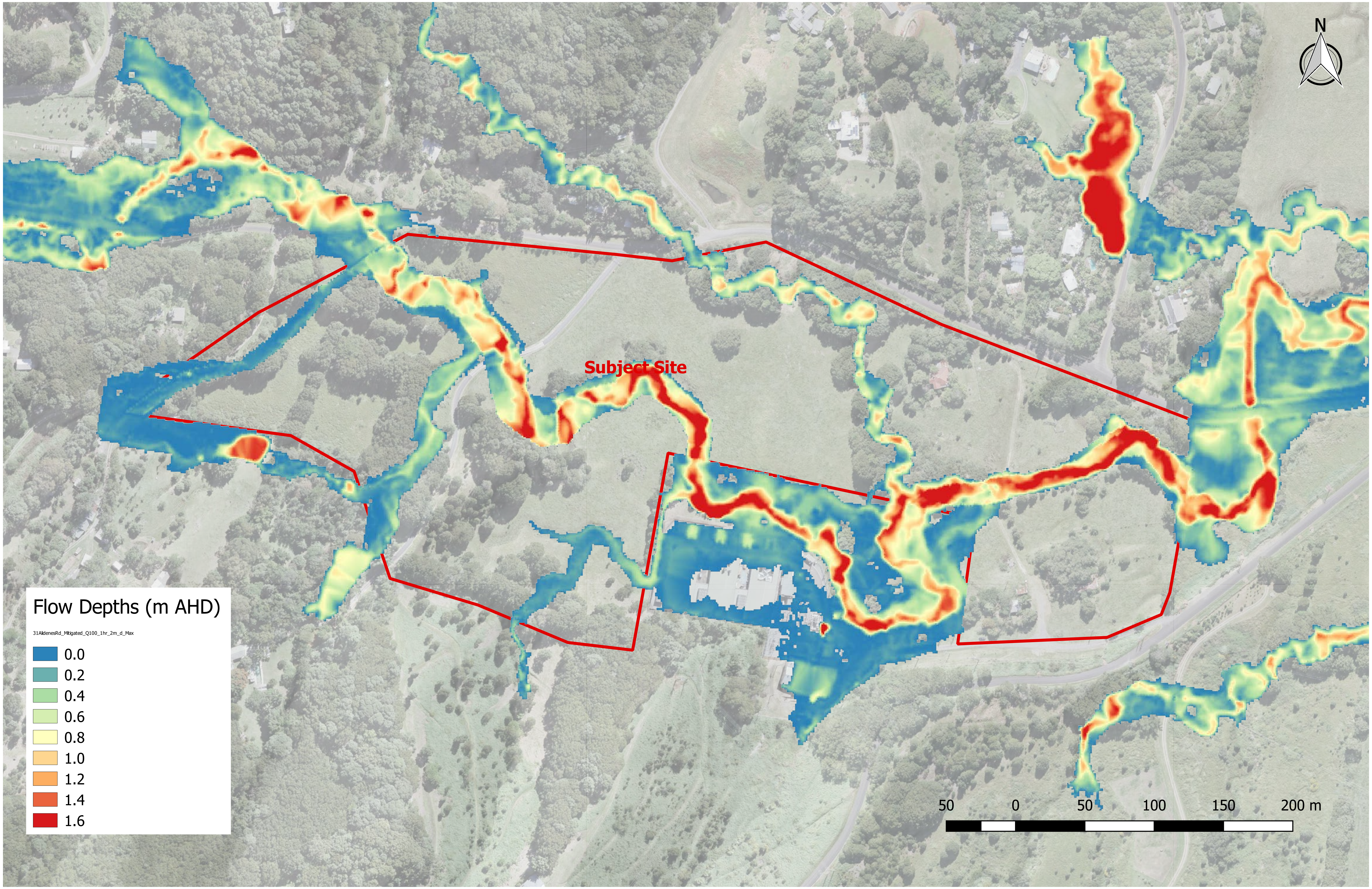


**Figure 14: Flow patterns and depths for 1% AEP design storm event**

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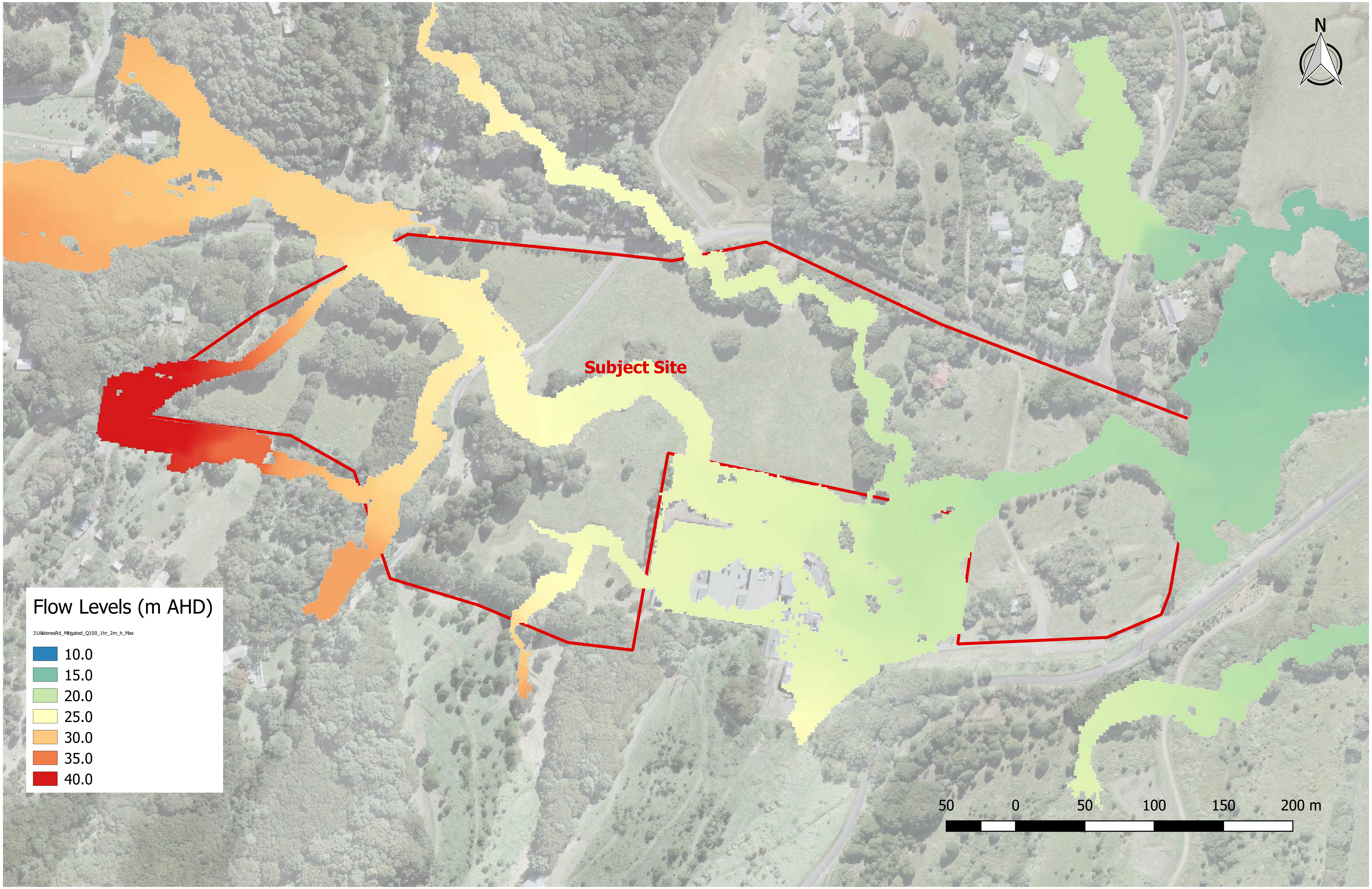


**Figure 14: Flood levels for 1% AEP design storm event - Mitigated Condition**

Ardill Payne & PARTNERS

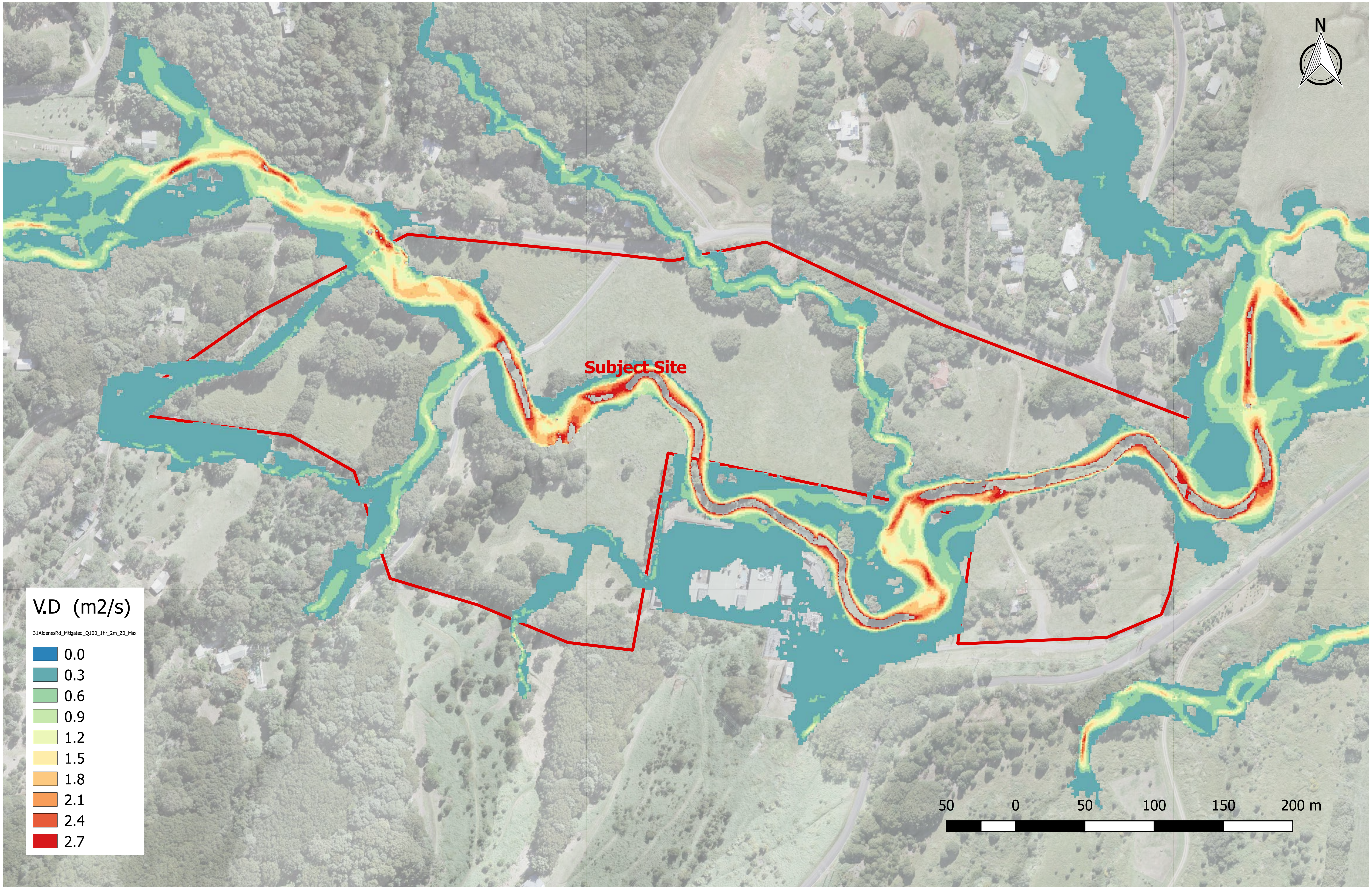


**Figure 16: Velocity.Depth product for 1% AEP design storm event - Mitigated Condition**

Ardill Payne & Partners

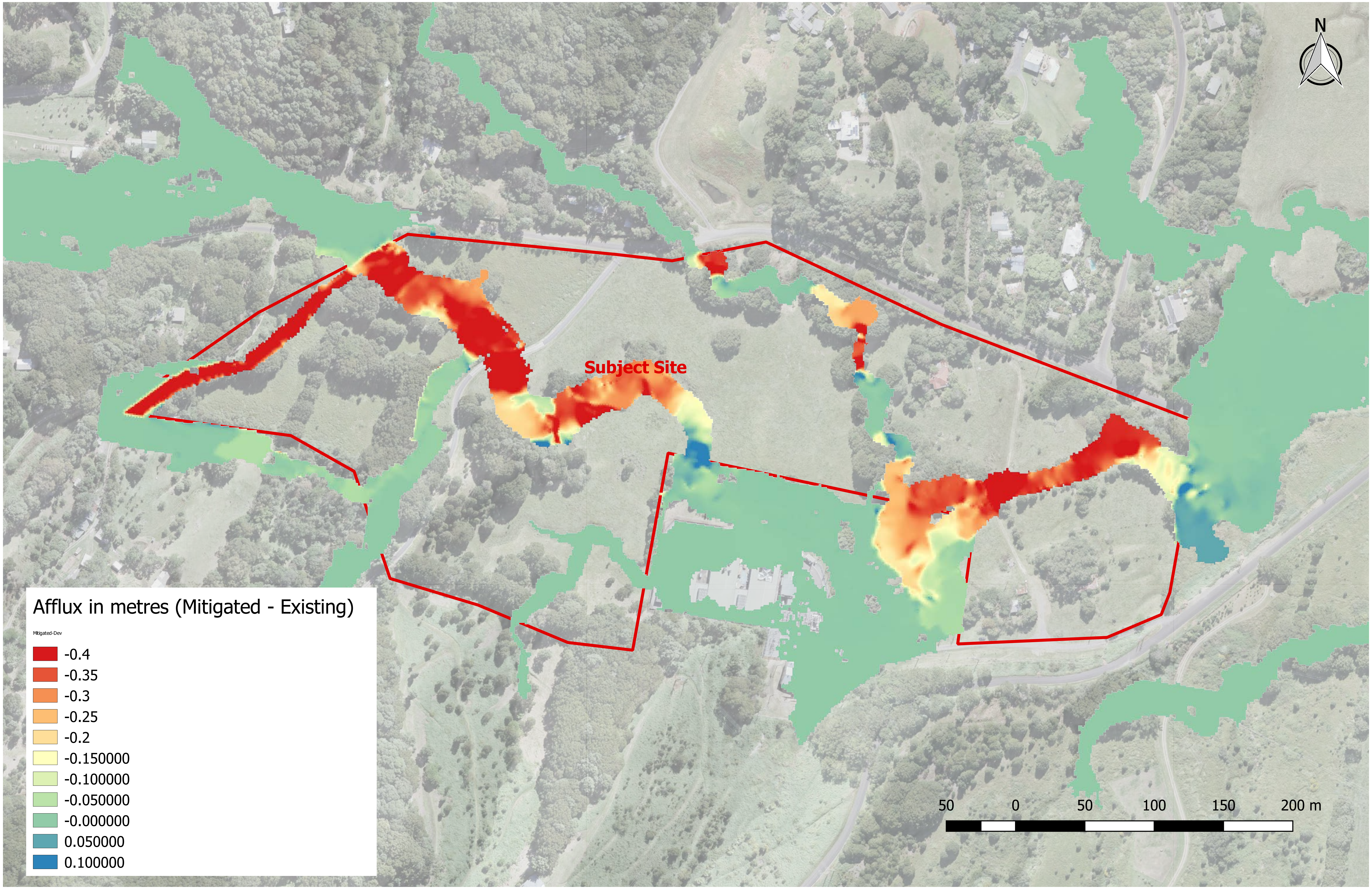


**Figure 17: Afflux generated within and at the site boundaries in post mitigated condition**

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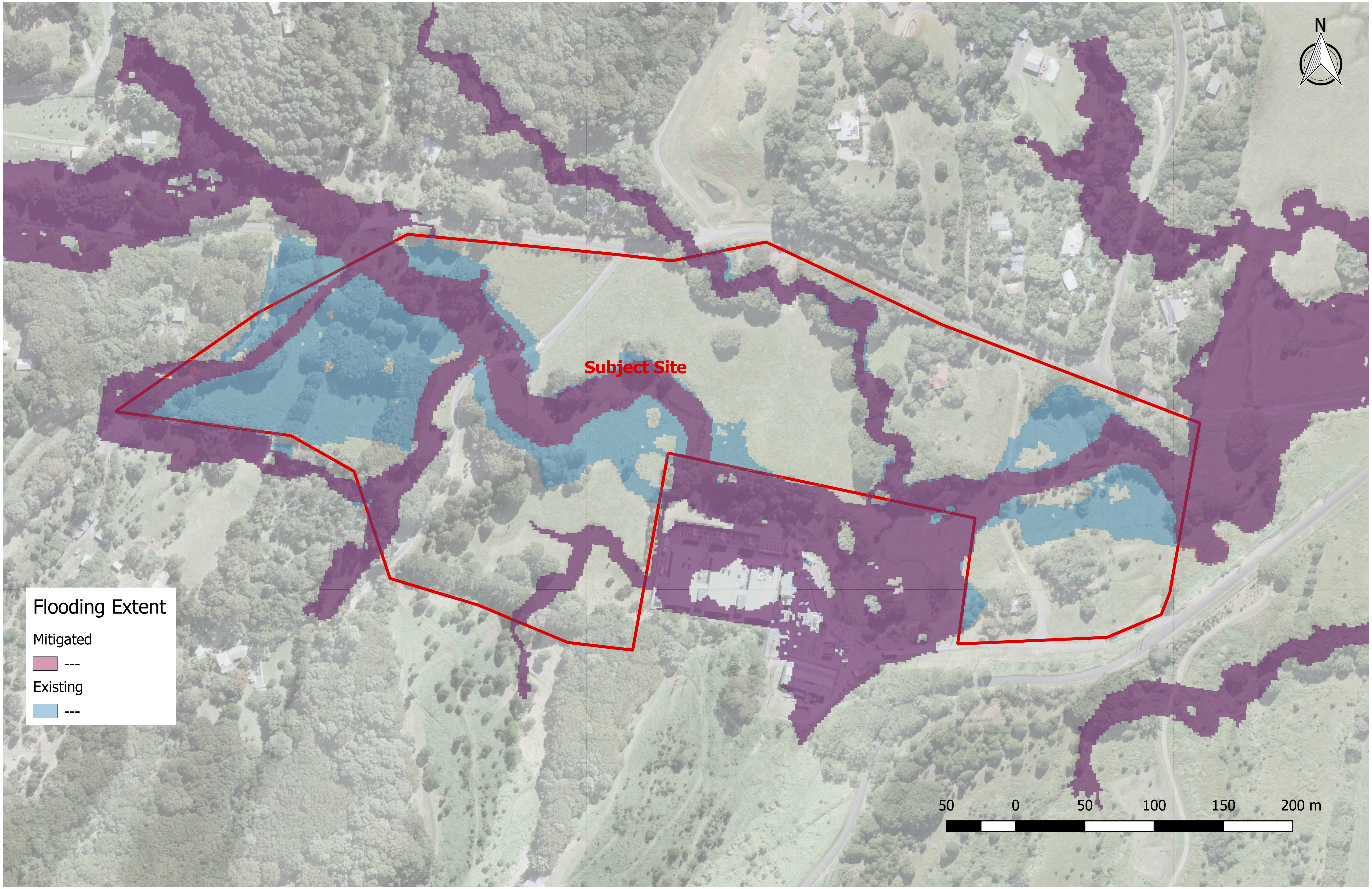


**Figure 18: Comparison between the 1% AEP flooding extent in Existing and Mitigated condition**

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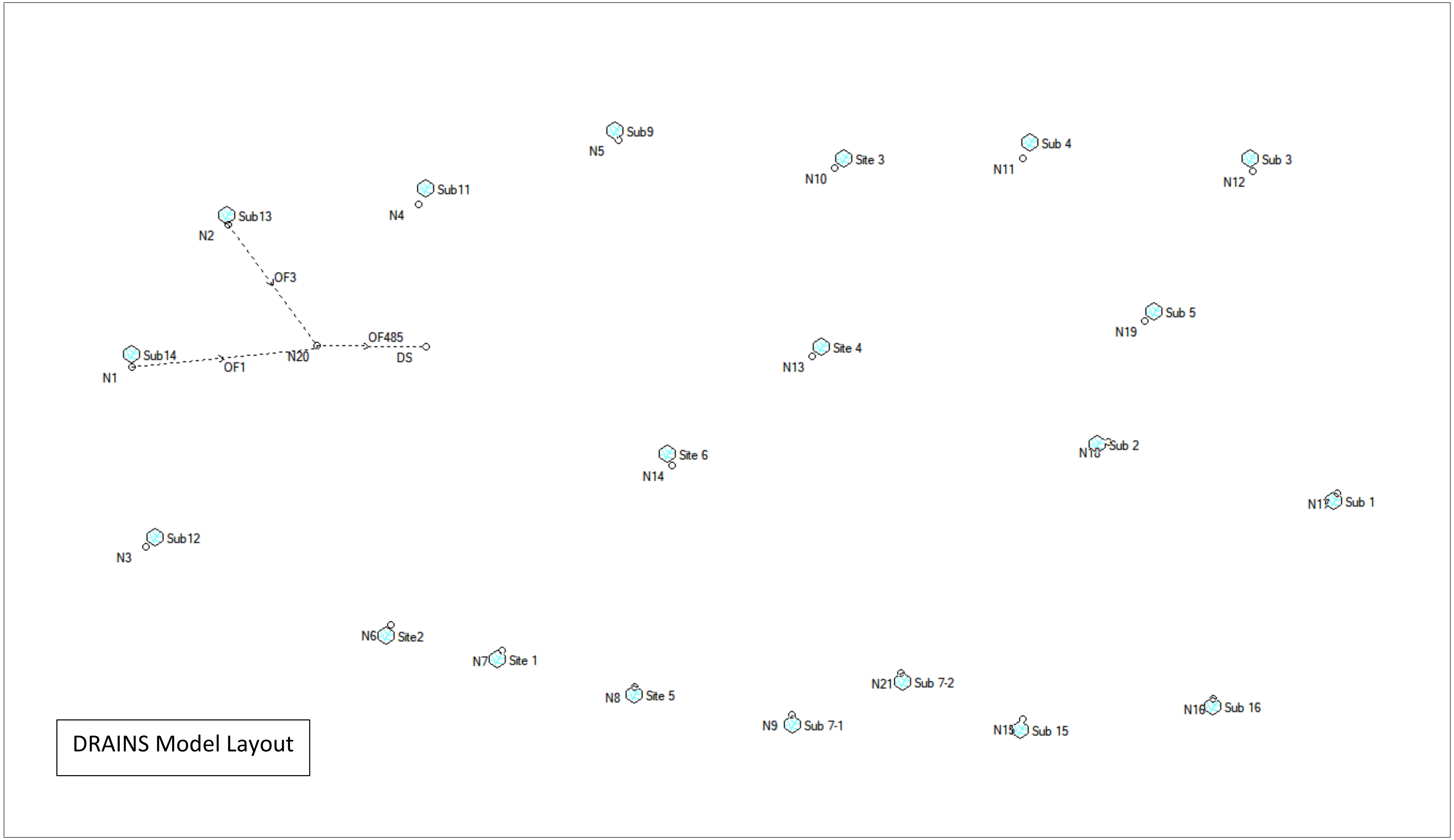
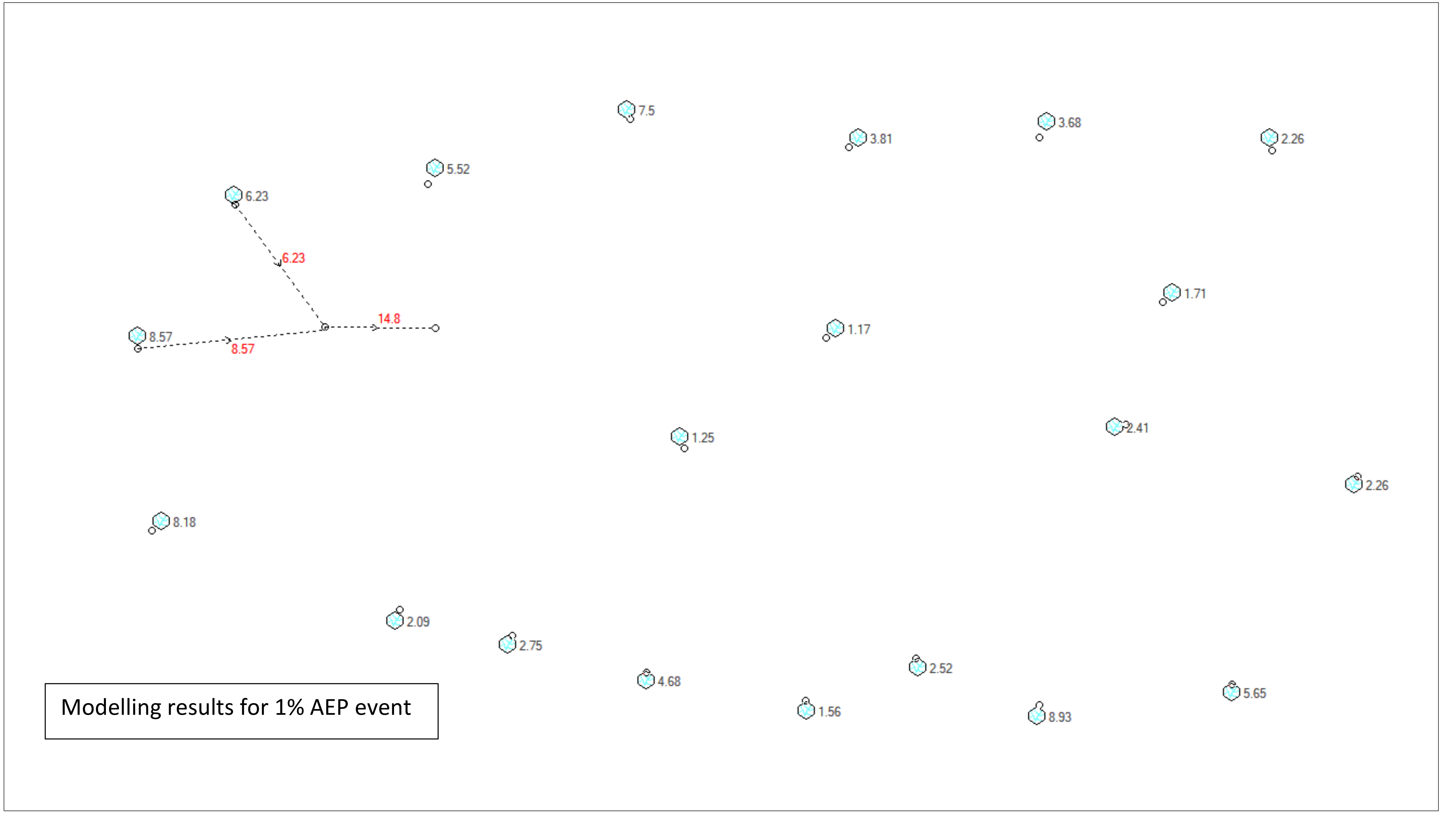
# ATTACHMENT 2

**Attachment 2:** DRAINS Modelling

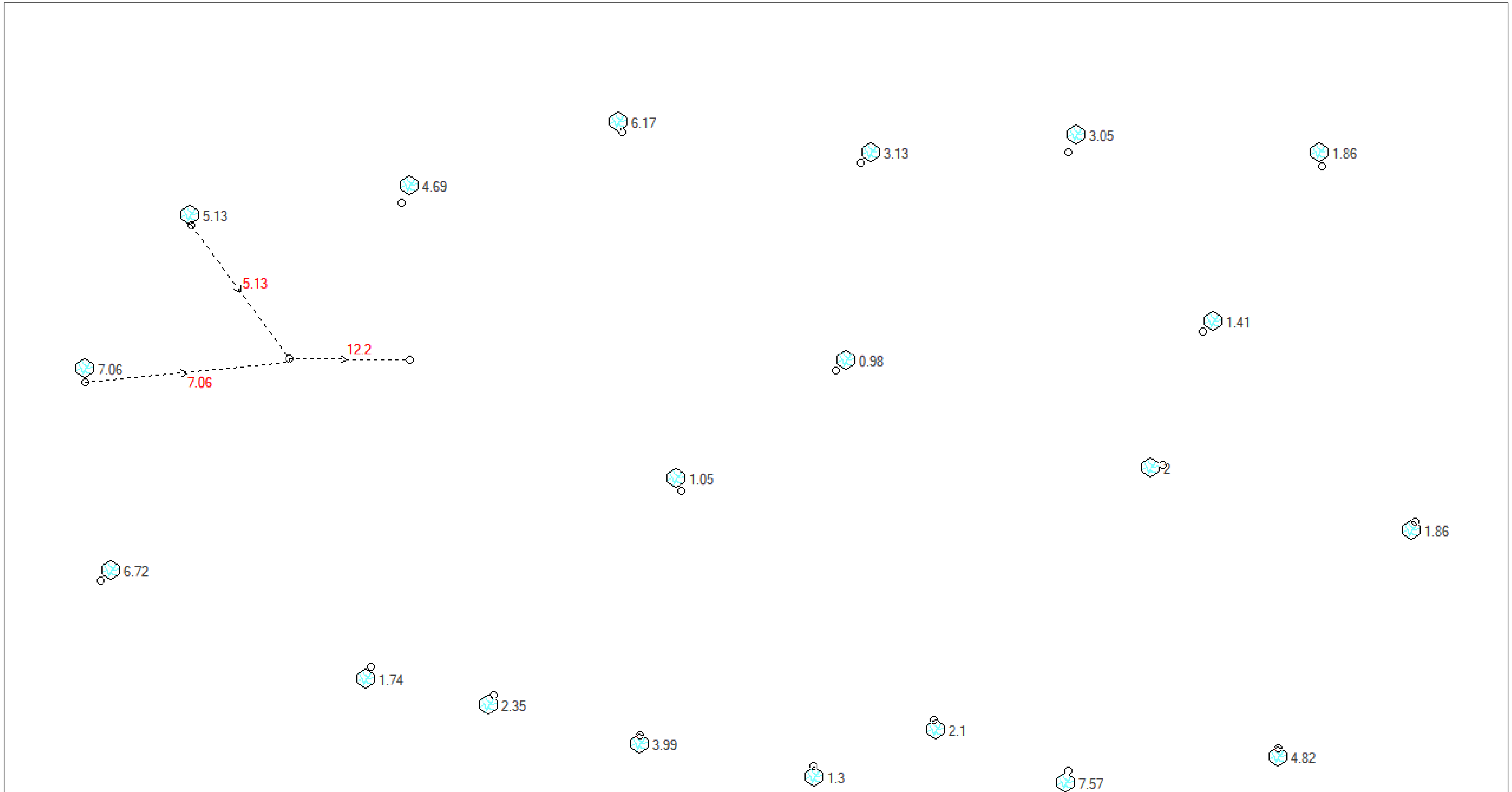
Ardill Payne & PARTNERS



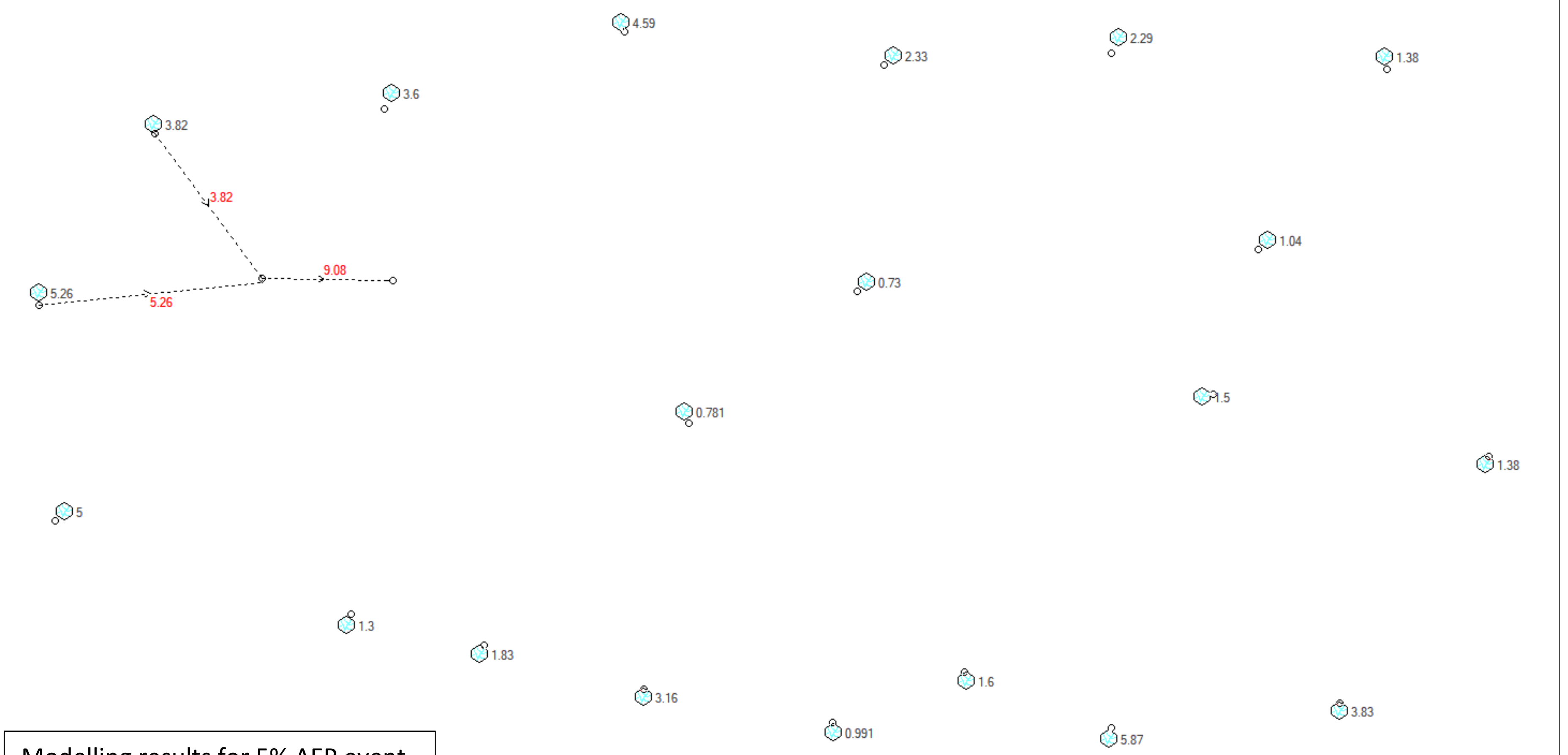

DRAINS Model Layout




Modelling results for 1% AEP event




Modelling results for 2% AEP event




Modelling results for 5% AEP event