Attachments

Attachment A

Detailed methodology – hydrology and hydraulic analysis

Runoff routing approach and rainfall data

The assessment adopted the rainfall on grid modelling approach which routes the rainfall within the hydrological model. Given the size of the study area, gridded rainfall sourced from the Bureau of Methodology (BoM) was utilised as the design rainfall data format, as opposed to point rainfall. This data was also pre-processed using the aerial temporal pattern increments, which in combination improves the overall accuracy of the rainfall spatial variability. Given the scale of model areal reduction has not been adopted, however will provide a more conservative results and is fit for purpose for this methodology.

Temporal patterns

The ensemble method was adopted for this assessment with the patterns extracted from BoM. A combination of areal and point temporal patterns were used as gridded rainfall data is only available for durations ranging from 12 hours to 72 hours. Some gauged catchments within the study area demonstrated to have critical durations shorter than 12 hours therefore adopting point temporal patterns for these locations. Table A-1 below presents the summary of adopted temporal characteristics.

With the east to west project footprint extending from Wagga Wagga to Bannaby, two different temporal pattern regions have been taken into consideration. The Murrumbidgee and Lachlan River study area catchments fall within the Murray Darling Basin temporal pattern region and the Wollondilly River catchment is within the East Coast South temporal pattern region (Ball J, 2019).

Table A-1 Summary of Adopted Rainfall Increments

Area I Temporal pattern Events (12 hours – 72 hours)			
Catchment	**Temporal pattern region**	**Catchment area**	**Adopted temporal pattern area**
Murrumbidgee	Murray Darling Basin	26,927 km^2	20,000 km^2
Lachlan	Murray Darling Basin	2,251 km^2	2,500 km^2
Wollondilly	East Coast South	4,720 km^2	5,000 km^2

Point Temporal Pattern Events (10 min – 9 hours)		
Catchment	**Temporal pattern region**	**AEP Frequency (for 1% AEP)**
Murrumbidgee	Murray Darling basin	Intermediate
Lachlan	Murray Darling basin	Intermediate
Wollondilly	East Coast South	Intermediate

Loss model

The assessment adopted probability neutral losses for the hydraulic modelling. Each gauge catchment had unique default initial and continuous loss parameters for each duration as derived from ARR. Table A-2 below summarises default loss values for 1% AEP event. Refer to below section for the adjusted loss values modified through the model calibration process.

Given the size of the Murrumbidgee catchment, the extraction of loss values was split into an upper and lower section. This was to capture the variability between the steeper upper regions and the flatter lower regions.

Table A-2 Critical Duration and adopted loss value for 1% AEP

Catchment name	Gauge ID	Critical durations	Loss Type	Probability neutral loss value
Regional Model				
41000269	41000269	540 minutes	Initial loss	6.8
			Continuous loss	1.7
410043	41004	540 minutes	Initial loss	7.5
			Continuous loss	1.7
410047	410047	720 minutes	Initial loss	7.3
			Continuous loss	2.2
410048	410048	540 minutes	Initial loss	7.7
			Continuous loss	1.8
410061	410061	540 minutes	Initial loss	6.6
			Continuous loss	2.1
410176	410176	2,880 minutes	Initial loss	12.9
			Continuous loss	1.5
410199	410199	1,440 minutes	Initial loss	7.2
			Continuous loss	1.6
Murrumbidgee Lower	412068	2,880 minutes	Initial loss	17.8
			Continuous loss	1.7
Murrumbidgee Upper			Initial loss	14.3
			Continuous loss	3.1
412065	412065	1,440 minutes	Initial loss	10.3
			Continuous loss	1.6
212270	212270	2,880 minutes	Initial loss	10.9
			Continuous loss	1.2

Flow calibration data

The Murrumbidgee, Lachlan and Wollondilly catchments have several flow gauging stations across the study area (refer to Section 4.3.3 for selected flow gauge details). Over time these gauges have been analysed via a FFA by various entities. The results of these analyses were extracted where available and used to guide the regional model calibration process. The sources of flow data included:

- BoM FFA data (http://www.bom.gov.au/waterdata/)
- Regional Flood Frequency Estimation (RFFE) (https://rffe.arr-software.org/)
- Regional Flood Frequency Estimation at site FFA (ie RFFE Nearby data) (https://data.arr-software.org/catchmentlosses/map).

Additionally, flood frequency fitting to a Log-Pearson III distribution was undertaken utilising the gauge flow data extracted from WaterNSW. This involved using both unfiltered raw data and filtered data (poor quality data filtered out from raw data) to appreciate the range of values without undergoing a forensic investigation of the data.

The resulting 1% AEP peak flow from the different sources indicated some consistency and variability across each source. Investigation into the variability was not undertaken given the intent (ie flood risk and relative impact assessment) and scope of the assessment.

The adopted 1% AEP peak flow value used in the calibration process was derived by initially excluding any outlying values followed by simply averaging the values from the remaining sources. Table A-3 summarises the relevant FFA 1% AEP flow data for each gauge catchment and the subsequently adopted peak flow.

Table A-3 Flood Frequency Analysis summary

Gauge ID	At site FFA (RFFE Nearby data) (m^3/s)	BoM FFA (m^3/s)	RFFE model (m^3/s)	Aurecon flood frequency fitting		Adopted FFA 1% AEP flow (m^3/s)
				Raw Data	Filtered Data[1]	
410199	N/A	290	2080	598	609*	609
41000269	N/A	406*	235	82	84	406
410043	N/A	1456*	380	1542*	2119*	1706
410047	N/A	714*	528*	705*	628*	644
410048	290*	400*	244*	568*	431*	387
410061	302*	259*	156*	250*	199*	233
410176	N/A	1479*	2660	1510*	2343*	1777
410068	N/A	4,479*	8170*	4712*	896*	4564
212270	N/A	9,291*	5830	9841	6838*	8064
412065	N/A	1881*	2260	1859	1906*	1893

Notes:

N/A indicates no available data
* Used in derivation of adopted flow
1 Poor quality filtered FFA data based on data tag provided by WaterNSW

Base hydraulic model development

The hydraulic analysis of flood behaviour across the project was undertaken using the hydrodynamic modelling software TUFLOW. TUFLOW is an industry accepted software capable of simulating complex two-dimensional flood behaviour.

As discussed in Section 4.5, both the regional and local flood risk were investigated through two different scale models. This was required to capture the flood risk commensurate with the sensitivity of the infrastructure and the likely impact the infrastructure would have on flooding. This section outlines the development of the hydraulic models used in this assessment.

Model resolution

The project footprint covers approximately 360 kilometres in longitudinal distance crossing a study area (catchment area) of 33,898 square kilometres. The study area was represented using a 100 metre grid resolution sampling the available hydro enforced SRTM data. The grid size was selected balancing catchment area coverage represented in the model and the resulting model simulation time.

Closer to the project footprint, the 100 metre grid resolution was considered too coarse for the assessment of flood behaviour where the flood risk was greater. The model resolution was increased in these areas using the Quadtree feature in TUFLOW to a grid size of 12.5 metre.

The areas requiring higher resolution were based on waterway intersections with the project that were up to a 3rd stream order based on the Hack's stream order analysis method. The stream orders were manually determined and based on a "bottom up" hierarchy that allocates the mainstream of every catchment as the 1st order, and consequently all its tributaries receive order 2, their tributaries receive order 3 etc. The list of stream orders that were analysed and modelled can be found at Table 7-1 . The mainstream orders for the adopted study area are: Murrumbidgee River for Murrumbidgee River catchment, Lachlan River for upstream area of Lachlan River gauge station and Wollondilly River for upstream area of Wollondilly River gauge station.

Model domain

As discussed in Section 4.2 the study area covered three catchments (Murrumbidgee, Lachlan and Wollondilly) representing the regional model extent. Separate model domains were created for each catchment as a single hydraulic model. For both the regional and local model, the catchment extents defined the domain boundaries, which were based on the SRTM topography or the available LiDAR data. Refer to Figure 4-1 for regional model domain extents.

Structures

Initial sensitivity analysis identified structures such as bridges and road embankments do not have a major impact on flood behaviour in the regional model. This was attributed to the low grid resolution (ie 100 metres with 50 metre sampling) which was not able to capture these sub grid scale hydraulic controls. Notwithstanding that hydraulic structure information was not available, structures have not been represented in the hydraulic model.

At a local model scale, a critical culvert structure was identified at the Snowy Mountains Highway compound (C02). The culvert crosses the Snowy Mountains Highway immediately downstream of the compound and drains the proposed compound site. This structure was included in the local modelling based on assumed parameters adopted in the absence of survey information. A review of survey information would be required at design stage to confirm impacts.

Materials

Materials and roughness values were determined based on aerial imagery. A default Manning's roughness value of 0.05 was applied across the study area where more specific definitions have not been delineated. Table A-4 summarises the materials and Manning's roughness coefficients that were adopted across the study area.

Table A-4 Adopted Manning's roughness

Manning's roughness value	Description
0.03	Waterbody without vegetation
0.055	Intermediate length grass
0.11	Forest (1.5 – 2 m tree spacing)
0.175	Dense forest (1 m tree spacing)
0.05	Open space area
0.15	Low density residential area
0.25	High density residential area
0.05	Compound extents

Storages

Multiple water storages within the study area have been identified. Initial model runs indicated that the influence of storage areas on flood behaviour varied. A review of model topography identified that most of the water storage area does not require an initial water level (IWL) due the resolution of the SRTM data or that they were full at the time of capture. Where they had an impact on the flood modelling results, the modelling adopted an IWL, conservatively assuming the dams to be full.

No detailed outlet structures were represented in the modelling due to focus of the assessment and limited data availability. The natural representation of the dams is considered satisfactory given the modelling was calibrated to the flow gauges downstream, which largely captured the dam's influence on flows. Table A-5 summarises the identified named storages within the study area and the adopted initial water levels for the modelling or whether there was a need to include one.

Table A-5 Identified water storages

Dam/Reservoir name	Operating authority	Main catchment	Adopted initial water level (mAHD)
Bendora Dam	ACTEW Corporation (Icon Water)	Murrumbidgee River catchment	795.0
Blowering Dam	Snowy Hydro Limited	Murrumbidgee River catchment	357.0
Burrinjuck Dam	Snowy Hydro Limited	Murrumbidgee River catchment	352.5
Corin Dam	ACTEW Corporation (Icon Water)	Murrumbidgee River catchment	Not required for the model
Cotter Dam	ACTEW Corporation (Icon Water)	Murrumbidgee River catchment	Not required for the model
Googong Dam	Commonwealth of Australia	Murrumbidgee River catchment	Not required for the model
Happy Jacks Dam	Snowy Hydro Limited	Murrumbidgee River catchment	Not required for the model
Jounama Dam	Snowy Hydro Limited	Murrumbidgee River catchment	Not required for the model
Scrivener Dam	National Capital Authority	Murrumbidgee River catchment	Not required for the model
Talbingo Dam	Snowy Hydro Limited	Murrumbidgee River catchment	Not required for the model
Tantangara Dam	Snowy Hydro Limited	Murrumbidgee River catchment	1209.00
Tumut Pond Dam	Snowy Hydro Limited	Murrumbidgee River catchment	Not required for the model
Pejar Dam	Goulburn Mulwaree Council	Wollondilly River catchment	Not required for the model

Snowy Hydro/ Snowy scheme

The Snowy Scheme consists of nine power stations connecting major dams across the Kosciuszko National Park. The scheme includes two main developments which are the Snowy Tumut Development on north and the Snowy Murray Development to the south. The Snowy Tumut Development falls within the upstream extent of catchment of Tumut River gauge station at upstream Nimbo offtake (410199).

The power for Snowy Tumut development is generated by diverting water from Lake Eucumbene via Tumut pond to the downstream power stations located at Talbingo reservoir, Jounama reservoir and Blowering Dam. Water from Lake Eucumbene, which is located outside the catchment extent of Tumut River gauge station at upstream Nimbo offtake (Gauge ID 410199), is diverted through an underground tunnel system to Tumut Pond Dam, which is located within the catchment of Tumut River gauge station at upstream Nimbo offtake (410199). It is assumed that the FFA would account for any additional water flow entering into the gauge catchment by the underground tunnel during a flood event.

The power for Snowy Murray Development is generated by diverting the Snowy River at Guthega Dam through Guthega Power Station to a downstream power station such as Murray 1 and Murray 2. The Snowy Murray Development is located just south of Tumut River gauge station at upstream Nimbo offtake (410199) which does not have any impact on the study area.

Regional model critical duration analysis

The total gridded rainfall data obtained from BoM was pre-processed based on relevant rainfall region temporal pattern increments as inputs into the hydraulic model. The model was then simulated for durations ranging between two hours to 72 hours for all 10 ensemble temporal patterns.

The critical temporal pattern was determined based on the upper median peak flow rather than peak flood level. This approach was adopted given that the calibration of the models was against the flow gauge data. Table A-6 presents the critical duration for each gauged catchment.

Table A-6 Adopted regional model critical duration

Gauge ID	Max Flow (m^3/s)	Min Flow (m^3/s)	Critical flow (m^3/s) (upper median)	Critical duration (min)	Critical temporal pattern ID
41000269	698.4	352.8	531.3	540	4059
410043	1418.0	987.0	1201.1	540	4063
410047	2148.0	1766.4	1870.5	720	5421
410048	447.7	211.4	345.7	540	4063
410061	504.0	324.9	421.0	540	4063
410176	1902.7	1525.3	1715.5	2880	5782
410199	2474.0	1185.5	1840.2	1440	5603
412065	2498.0	1823.6	2207.5	2880	5574
410068	8471.2	7038.1	7828.1	2880	5783
212270	4805.5	3691.4	4354.9	2880	418

Regional model calibration and flow summary

The calibration of the regional hydraulic model was carried out through adjustment of the loss values to converge the modelled peak flows to the adopted FFA flows to within ± 20%. This was done based on identified critical event.

The final loss values for some gauge catchments are low, however considering the scale of the assessment, this method is considered acceptable to identify general flood risk.

For the Wollondilly catchment (gauge catchment 212270), a rainfall grid multiplier of 1.15 was used to increase the rainfall depth of the catchment. This was done as the losses could not be adjusted any further. Table A-7 summarise the achieved calibrated flow compared to adopted FFA flow.

Table A-7 Default and adopted loss parameters for model calibration

Catchment	Gauge ID	Critical Duration	Loss Type	Probability neutral loss value	Adopted calibrated loss value
Murrumbidgee	41000269	540 minutes	Initial loss	6.8	6.8
			Continuous loss	1.7	4.2
Murrumbidgee	410043	540 minutes	Initial loss	7.5	0.5
			Continuous loss	1.7	0.5
Murrumbidgee	410047	720 minutes	Initial loss	7.3	18.0
			Continuous loss	2.2	5.0
Murrumbidgee	410048	540 minutes	Initial loss	7.7	23.3
			Continuous loss	1.8	4.5
Murrumbidgee	410061	540 minutes	Initial loss	6.6	25.0
			Continuous loss	2.1	5.0
Murrumbidgee	410176	2,880 minutes	Initial loss	12.9	0.5
			Continuous loss	1.5	0.5
Murrumbidgee	410199	1,440 minutes	Initial loss	7.2	25.0
			Continuous loss	1.6	5.0
Murrumbidgee (Murrumbidgee Lower)	412068	2,880 minutes	Initial loss	17.8	17.8
			Continuous loss	1.7	1.9

Catchment	Gauge ID	Critical Duration	Loss Type	Probability neutral loss value	Adopted calibrated loss value
Murrumbidgee (Murrumbidgee Upper)			Initial loss	14.3	17
			Continuous loss	3.1	2.1
Lachlan	412065	1,440 minutes	Initial loss	10.3	10.3
			Continuous loss	1.6	2.1
Wollondilly	212270*	2,880 minutes	Initial loss	10.9	0.5
			Continuous loss	1.2	0.5

Note:

*Additional rainfall factoring by 1.15 required to achieve calibration

The resulting calibration performance for the 1% AEP event is presented in Table A-8. All locations achieved the target calibration within a reasonable range.

Table A-8 Calibration performance in the 1% AEP event

Catchment	Gauge name	Gauge ID	Adopted FFA flow (m^3/s)	Modelled 1% AEP peak flow (Calibrated) (m^3/s)	Difference %
Murrumbidgee	Brungle Creek at Red Hill no.2	41000269	406	416	2.5%
Murrumbidgee	Hillas Creek at Mount Adrah	410043	1706	1706	0.0%
Murrumbidgee	Tarcutta Creek at Old Borambola	410047	644	668	3.7%
Murrumbidgee	Kyeamba Creek at Ladysmith	410048	387	370	-4.4%
Murrumbidgee	Adelong Creek at Batlow Road	410061	233	257	10.1%
Murrumbidgee	Yass river at u/s Burrinjuck dam (riverview)	410176	1777	1578	-11.2%
Murrumbidgee	Tumut River at upstream Nimbo offtake	410199	609	672	10.3%
Murrumbidgee	Murrumbidgee River at Glendale	410068	4564	4945	8.4%
Lachlan	Lachlan River at Narrawa	412065	1893	1988	5.0%
Wollondilly	Wollondilly River at Jooriland	212270	8064	8377	3.9%

Ancillary infrastructure models (Local flood models)

Multiple local hydraulic models were created to assess the flood impacts for the relevant construction compounds and telecommunication huts. An initial desktop assessment of the local flood risk was undertaken using the results of the regional scale modelling and a review of the local topography. This process informed the risk of flooding and whether a local flood model was required or not to assess the flood risk and impact of the project. Outcomes of this screening process is presented in Table A-9.

Table A-9 Local model screening assessment

Name	ID	Catchment Area	Assessment	Local model developed?
Construction Compounds				
Wagga 330 kV substation compound	C01	Murrumbidgee Catchment	Located near Boiling Down Creek. Potential local flood risk	Yes
Snowy Mountains Highway compound	C02	Murrumbidgee Catchment	Evident overland flow paths through the compound. Potential local flood risk	Yes
Snubba Road compound	C03	Murrumbidgee Catchment	Located on high ground. No regional flood risk. Unlikely at risk of local flooding	No

Name	ID	Catchment Area	Assessment	Local model developed?
Maragle 500 kV substation compound	C05	Murrumbidgee Catchment	Located near Yorkers Creek and New Zealand gully. Potential local flood risk	Yes
Gregadoo Road compound	C06	Murrumbidgee Catchment	Located near O'Briens Creek. Potential local flood risk	Yes
Honeysuckle Road compound	C07	Murrumbidgee Catchment	Located on high ground. No regional flood risk. Unlikely at risk of local flooding	No
Red Hill Road compound	C08	Murrumbidgee Catchment	Located on high ground. No regional flood risk. Unlikely at risk of local flooding	No
Adjungbilly Road compound	C09	Murrumbidgee Catchment	Located on high ground. No regional flood risk. Unlikely at risk of local flooding	No
Yass substation compound	C10	Murrumbidgee Catchment	Located near Booroo Ponds gully. Potential local flood risk	Yes
Woodhouselee Road compound	C11	Wollondilly Catchment	Located near Pejar Dam. Potential local flood risk	Yes
Bannaby 500 kV substation compound	C12	Wollondilly Catchment	Located on high ground. No regional flood risk. Unlikely at risk of local flooding	No
Memorial Avenue compound	C14	Murrumbidgee Catchment	Evident overland flow paths through the compound. Potential local flood risk	Yes
Bowmans Lane compound	C15	Murrumbidgee Catchment	Evident overland flow paths through the compound. Potential local flood risk	Yes
Snubba Road compound	C16	Murrumbidgee Catchment	Evident overland flow paths through the compound. Potential local flood risk	Yes
Tumbarumba Accommodation Facility	AC1	No Regional Catchment	Evident overland flow paths through the compound. Potential local flood risk	Yes
Operational Infrastructure				
Telecommunications hut	Hut01	Murrumbidgee Catchment	Located near Killimicat Creek. Potential local flood risk	Yes

Local model resolution

The local models used a finer LiDAR data for model topography with grid sizes of eight metres, five metres and two metres. The eight metre grid models adopted a finer resolution of two metres using TUFLOW's Quadtree feature to improve the representation of flood behaviour local to the compound. The summary of local model grid sizes is provided in Table A-10.

Table A-10 Summary of local model grid size

Local Model	Grid Size	Quadtree grid size
Wagga 330 kV substation compound (C01)	5m	No quadtree applied
Snowy Mountains Highway compound (C02)	2m	No quadtree applied
Snubba Road compound (C03)	No modelling undertaken. Desktop assessment only	No quadtree applied
Maragle 500 kV substation compound (C05)	2m	No quadtree applied
Gregadoo Road compound (C06)	Modelling not required (modelling done by Lyall & Associates)	No quadtree applied
Honeysuckle Road compound (C07)	No modelling undertaken. Desktop assessment only	No quadtree applied
Red Hill Road compound (C08)	No modelling undertaken. Desktop assessment only	No quadtree applied
Adjungbilly Road compound (C09)	No modelling undertaken. Desktop assessment only	No quadtree applied
Yass substation compound (C10)	5m	No quadtree applied

Local Model	**Grid Size**	**Quadtree grid size**
Woodhouselee Road compound (C11)	5m	No quadtree applied
Bannaby 500 kV substation compound (C12)	2m	No quadtree applied
Bannaby substation modification	2m	No quadtree applied
Memorial Avenue compound (C14)	8m	2m
Bowmans Lane compound (C15)	8m	2m
Snubba Road compound (C16)	5m	No quadtree applied
Tumbarumba Accommodation Facility (AC1)	2m	No quadtree applied
Telecommunications Hut (Hut01)	8m	2m

Local model critical duration analysis

The total gridded rainfall data obtained from BoM was pre-processed based on relevant rainfall region temporal pattern increments as inputs into the hydraulic model. The model was then simulated for Multiple durations for all 10 ensemble temporal patterns. The critical temporal pattern was determined based on the upper median peak flow rather than peak flood level.

Table A-11 Summary of local model critical duration analysis

<table>
<tr><th colspan="2">Local model</th><th>ID</th><th>Event Modelled</th><th>Max Flow (m^3/s)</th><th>Min Flow (m^3/s)</th><th>Critical flow (m^3/s) (upper median)</th><th>Critical duration (min)</th><th>Critical temporal pattern ID</th></tr>
<tr><td colspan="2" rowspan="3">Wagga 330 kV substation compound</td><td rowspan="3">C01</td><td>1% AEP</td><td>159.0</td><td>95.3</td><td>131.4</td><td>120 minutes</td><td>3913</td></tr>
<tr><td>5% AEP</td><td>106.0</td><td>66.5</td><td>87.1</td><td>120 minutes</td><td>3943</td></tr>
<tr><td>PMF</td><td>1664.1</td><td>999.7</td><td>1471.7</td><td>180 minutes</td><td>DA74</td></tr>
<tr><td colspan="2">Snowy Mountains Highway compound</td><td>C02</td><td>5% AEP</td><td>26.8</td><td>4.8</td><td>15.4</td><td>540 minutes</td><td>4060</td></tr>
<tr><td rowspan="2">Maragle 500 kV substation compound</td><td>Northern Catchment</td><td rowspan="2">C05</td><td rowspan="2">5% AEP</td><td>19.5</td><td>3.7</td><td>11.4</td><td rowspan="2">540 minutes</td><td rowspan="2">4060</td></tr>
<tr><td>South catchment</td><td>10.7</td><td>1.6</td><td>4.6</td></tr>
<tr><td colspan="2">Yass substation compound</td><td>C10</td><td>5% AEP</td><td>147.1</td><td>89.4</td><td>125.5</td><td>120 minutes</td><td>3901</td></tr>
<tr><td colspan="2">Woodhouselee Road compound</td><td>C11</td><td>5% AEP</td><td>20.3</td><td>12.3</td><td>17.6</td><td>60 minutes</td><td>4568</td></tr>
<tr><td colspan="2" rowspan="2">Bannaby 500 kV substation modification</td><td rowspan="2">N\A</td><td>1% AEP</td><td>66.2</td><td>57.3</td><td>60.2</td><td>45 minutes</td><td>4542</td></tr>
<tr><td>PMF</td><td>558.9</td><td>260.5</td><td>424.4</td><td>180 minutes</td><td>ME72</td></tr>
<tr><td colspan="2">Bannaby 500 kV substation compound</td><td>C12</td><td>5% AEP</td><td>37.1</td><td>27.1</td><td>34.1</td><td>60 minutes</td><td>4573</td></tr>
<tr><td colspan="2">Memorial Avenue compound</td><td>C14</td><td>5% AEP</td><td rowspan="2">102.3</td><td rowspan="2">18.8</td><td rowspan="2">65.4</td><td rowspan="2">540 minutes</td><td rowspan="2">4061</td></tr>
<tr><td colspan="2">Bowmans Lane compound</td><td>C15</td><td>5% AEP</td></tr>
<tr><td colspan="2">Snubba Road compound</td><td>C03</td><td>5% AEP</td><td>69.8</td><td>17.2</td><td>49.6</td><td>540 minutes</td><td>4060</td></tr>
<tr><td colspan="2">Telecommunications hut 1</td><td>Hut01</td><td>1% AEP</td><td>453.0</td><td>191.0</td><td>300.5</td><td>540 minutes</td><td>1063</td></tr>
<tr><td colspan="2">Tumbarumba Accommodation Facility</td><td>AC1</td><td>2% AEP</td><td>21.5</td><td>14.5</td><td>19.4</td><td>120 minutes</td><td>3944</td></tr>
</table>

Local model critical duration, loss parameters flow summary

The local hydraulic models were setup based on the adopted loss values as per Table A-12 for 1% AEP event. The probability neutral loss values were extracted for 5% AEP and 2% AEP events and modified as per the same calibrated scale ratio as shown in Table A-12.

The Tumbarumba Accommodation Facility (AC1) is located outside the extent of the regional model. This model used the default probability neutral loss for flood impact assessment. The critical duration of the catchments was identified as discussed in the earlier respective section. No loss parameters were used for PMF. Summary of loss values and critical duration of the local models are provided in Table A-12.

Table A-12 Compounds, substation and telecommunication hut critical duration

Local model	ID	Event Modelled	Critical Duration	Loss Type	Probability neutral loss value	Adopted calibrated loss value
Wagga 330 kV substation compound	C01	1% AEP	120 minutes	Initial loss	17.8	17.8
				Continuous loss	1.7	1.9
		5% AEP	120 minutes	Initial loss	12.1	12.1
				Continuous loss	1.7	1.9
Snowy Mountains Highway compound	C02	5% AEP	540 minutes	Initial loss	11.3	39.2
				Continuous loss	1.6	5.0
Maragle 500 kV substation compound	C05	5% AEP	540 minutes	Initial loss	11.3	39.2
				Continuous loss	1.6	5.0
Yass substation compound	C10	5% AEP	120 minutes	Initial loss	11.1	0.4
				Continuous loss	1.5	0.5
Woodhouselee Road compound	C11	5% AEP	60 minutes	Initial loss	9.7	0.4
				Continuous loss	1.2	0.5
Bannaby 500 kV substation compound	C12	1% AEP	45 minutes	Initial loss	10.9	0.5
				Continuous loss	1.2	0.5
Memorial Avenue compound	C14	5% AEP	540 minutes	Initial loss	11.3	39.2
				Continuous loss	1.6	5.0
Bowmans Lane compound	C15	5% AEP	540 minutes	Initial loss	11.3	39.2
				Continuous loss	1.6	5.0
Snubba Road compound	C03	5% AEP	540 minutes	Initial loss	11.3	39.2
				Continuous loss	1.6	5.0
Telecommunication hut 1	Hut01	1% AEP	540 minutes	Initial loss	17.8	17.8
				Continuous loss	1.7	1.9
Tumbarumba Accommodation Facility	AC1	2% AEP	120 minutes	Initial loss	10.3	10.3
				Continuous loss	2.3	2.3

The local model flow values were checked with the online Regional Flood Frequency Estimation (RFFE) models (Australian Rainfall & Runoff, 2022). The summary of local model flow comparison is provided in Table A-13.

Table A-13 local model flow comparison with RFFE flows

Name		ID	Event	Critical Flow	RFFE Values		
					Discharge	Lower Confidence Limit	Upper Confidence Limit
Wagga 330 kV substation compound		C01	1% AEP	109.27	33.7	12.2	93.4
			5% AEP	67.0	26.9	9.88	73.6
Snowy Mountains Hwy compound		C02	5% AEP	15.91	9.72	3.34	28.2
Snowy Mountains Highway compound	North Catchment	C05	5% AEP	13.43	11	4.63	26.9
	South Catchment			7.01	3.95	1.7	9.47
Yass substation compound		C10	5% AEP	132.54	85.4	32.7	224
Woodhouselee Road compound		C11	5% AEP	18.46	6.26	3.03	13.2
Bannaby 500 kV substation modification		N/A	1% AEP	65.08	28	10.2	77.4
Bannaby 500 kV substation compound		C12	5% AEP	35.6	13.7	5.21	36.4
Memorial Avenue compound		C14	5% AEP	81.64	48.2	16.9	137
Bowmans Lane compound		C15	5% AEP				
Snubba Road compound		C03	5% AEP	35.0	34.9	12.4	98.8
Telecommunications hut		Hut01	1% AEP	325.4	136	44.9	417
Tumbarumba Accommodation Facility		AC1	2% AEP	20.40	13.8	4.91	39.2

As per Table A-11 most of the critical flow values for the local model are within the lower and upper confidence limit. However, the Wagga 330 kV substation compound and Woodhouselee Road compound (C11) experiences a larger critical flow that the upper RFFE confidence limit.

Even though the critical flow values for the Woodhouselee Road compound (C11) catchment exceeds the upper confidence limit of the RFFE values is still free from any flood impacts as discussed in Section 6.3.2.6. This conservative approach concludes that Woodhouselee Road compound will also be flood free in the reduced flow scenario as per the RFFE limits.

The Wagga 330 kV substation compound (C01) catchment produces a critical flow higher than the RFFE upper confidence limit. Additional review of Draft Wagga Wagga Major Overland Flow Floodplain Risk Management Study and Plan (2021) (WMA Water, 2021) identified that initial loss of 9.6 mm and a continuing loss of 1.88 mm/hr was used in the flood assessment. As discussed in Table A-11, the Wagga 330 kV substation compound (C01) assessment adopted a 17.8 mm and a continuing loss of 1.9 mm/hr. The adaptation of the flood study loss values was considered unsuitable as it would further increase the outflow for the Wagga 330 kV substation compound (C01) catchment.

Further review on flow values was undertaken by analysing Wagga Wagga Major Overland Flow Flood Study ([Author], 2011), which is an existing flood study for the area of interest. Table 19 of this study indicates that the Gregadoo Road (west) which is approximately 1.6 kilometres downstream of Wagga 330 kV substation compound (C01) experiences a 1% AEP flow of 42.3 m^3/s and noted that the flood study used 1987 point rainfall data. The comparison between 1987 total point rainfall data and the 2016 point rainfall data (which was utilised for this assessment) indicated 1987 total rainfall values were almost half of the 2016 total rainfall data. Therefore, flow values of 2016 rainfall data could be expected to be higher.

Even though the critical flow values for the Wagga 330 kV substation compound (C01) exceeds the upper confidence limit, the flood results (refer to Section 6.3.2.1) show that only local catchment ponding is seen around the site with no notable flow paths or drainage lines impacting the site and as such the proposed construction compound or activities at this location is not expected to be impacted by flooding. This conservative approach concludes that Wagga 330 kV substation compound (C01) catchment will also be flood free in the reduced flow scenario as per the RFFE limits.

PMP estimations

The PMP depths were estimated based on the PMP estimation guidelines prepared by BoM. The appropriate method for estimating long duration PMP values was selected based on the location and area of the catchment. In case, the catchment size was less than 1000 km^2, short duration PMP values were also calculated using Generalised Short-Duration method (GSDM).

For upstream catchments less than 1000 km^2, short duration PMP values (<6 hours) were estimated using the GSDM. The standard short durations include 1, 2, 3 and 6 hours. The GSDM PMP estimates for the catchments were calculated using the equation:

$$PMP\ Value = (S * D_s + R * D_R) * MAF * EAF$$

Where,

S	is the percentage of Smooth terrain within the catchment
D_s	is the initial PMP depths for the smooth terrain
R	is the percentage of Rough terrain within the catchment
D_R	is the initial PMP depths for the rough terrain
MAF	is Moisture Adjustment Factor
EAF	is the Elevation Adjustment Factor

Spatial distribution of short duration PMP values was undertaken using the GSDM ellipses. In this method, rainfall is considered more intense at the centre of the thunderstorm and the intensity gradually decreases by moving outward. To distribute PMP depths over time, the GSDM temporal patterns ((Jordan, et al., 2005) were adopted. For short durations, eleven temporal patterns (refer to Table A-14) were extracted from (Jordan, et al., 2005).

Table A-14 Tabulated values of the Bulletin 53 design temporal pattern and top ten temporal patterns

Time	BOM2003	DA74	BR97	ME72	SM98	TO98	SY84	MK75	DAR74B	AS66	ME54
0	0	0	0	0	0	0	0	0	0	0	0
0.1	10	6.1	4.9	3.6	8	9.3	2	6.7	9.8	7.2	27
0.2	25	17.4	28.3	10.3	17	38.5	16	12.8	13.2	14.4	38.9
0.3	39	33.6	44.3	20.7	23.9	52.9	41	25.2	22.8	27.4	54.1
0.4	52	51.2	53.5	42.8	37.5	57.7	55.5	36.1	32.5	40.5	57.8
0.5	64	65.1	73.1	58.4	46.2	70.1	61.9	45.5	51.9	53.6	63.4
0.6	75	77.5	78.3	73.1	53	78.9	68.2	55.5	71.7	66.7	73.8
0.7	85	87.7	90.1	83.6	65.1	87	77.3	66	71.9	79.8	78.1
0.8	92	94.2	96.1	91.1	80.5	92.5	83.3	76.1	72.6	92.9	92.8
0.9	97	97.3	99.4	96.3	92.1	97.1	92.3	86.6	90.2	96.4	98.2
1.0	100	100	100	100	100	100	100	100	100	100	100

PMP depths were also spatially distributes using the spatial patterns. However, due to the different spatial distribution methods for short and long durations (as described above), it was decided to use a uniform rainfall over the subareas for short durations.

Table A-13 PMF flow summary

Name	ID	Critical duration	Critical Flow (m^3/s)
Wagga 330 kV substation compound	C01	180 minutes	1512.0
Bannaby 500 kV substation modification	N/A	180 minutes	428.21

The Wagga Wagga Major Overland Flow Flood Study (WMOFFS) (2011) (WMAWater, 2011) undertook PMF calculation based on GSDM method. Table 19 of WMOFFS (2011) indicates that the Gregadoo road (west) which is approximately 1.6 kilometres downstream of Wagga 330 kV substation compound (C01) catchment outlet experiences a PMF flow of 239.6 m^3/s. However, the local model of Wagga 330 kV substation compound (C01) outputs a PMF flow of 1512 m^3/s.

A possible explanation for the flow differences would be the location of the Wagga 330 kV substation compound (C01) compared to that of the WMOFFS area. The Wagga 330kV substation is within the upstream area of the Lake Albert catchment away from the Wagga Wagga urban area, which was the focus of the WMOFFS (2011). The GSDM method uses ellipses to derive PMP values of a catchments. The ellipses represent the design spatial distribution for convective storm PMP. It assumes a virtually stationary storm and can be oriented in any direction with respect to the catchment. The ellipses are positioned in a way where the centre has higher rainfall depth and lesser rainfall near the edges. Due to a larger catchment area, it is likely that the GSDM ellipse as would not have been centred at Wagga 330 kV substation compound (C01) causing lesser flow at Gregadoo Road (west) in comparison to the WMOFFS (2011).

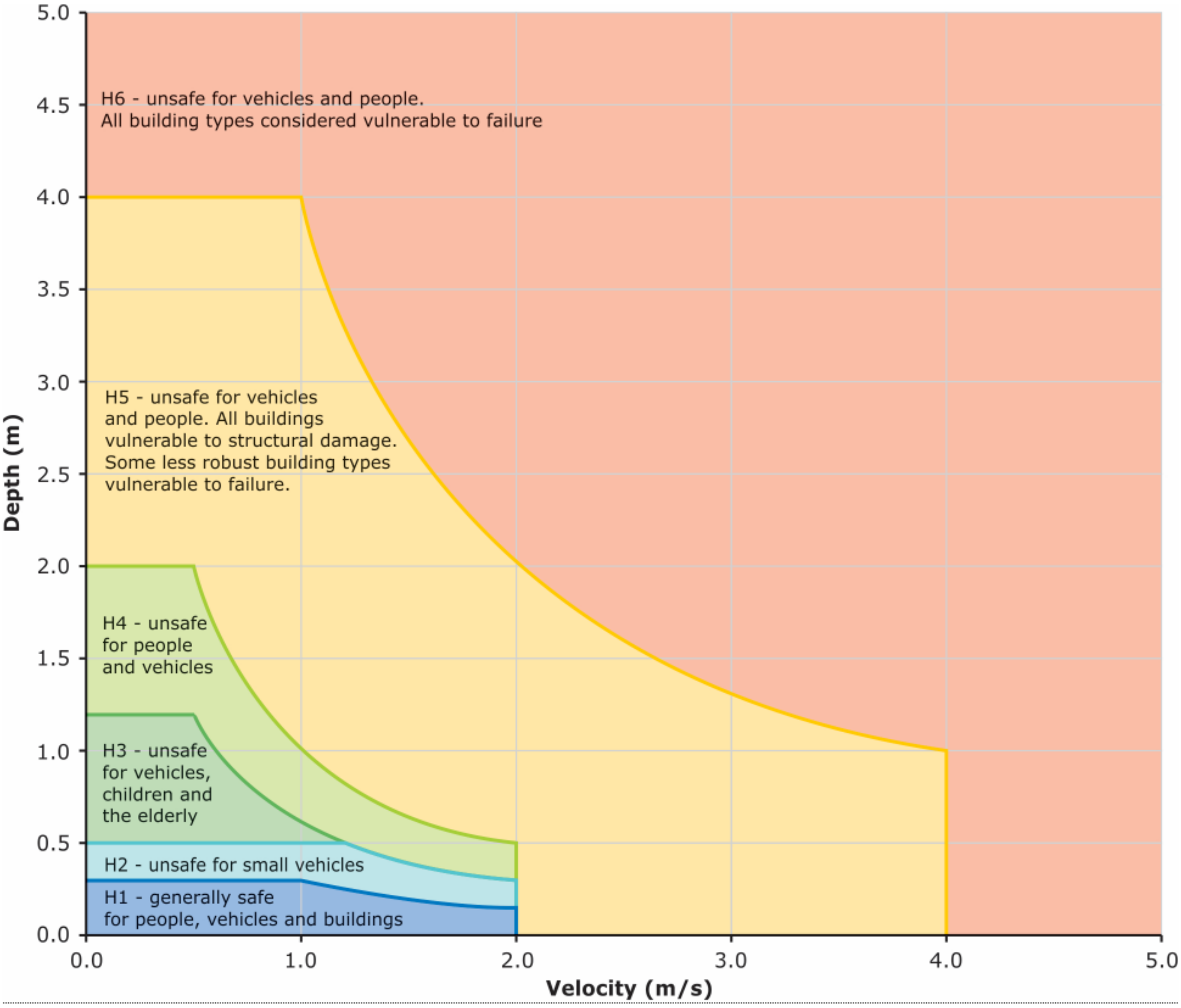
Assumptions and limitations

The following assumptions and limitations related to this assessment include the following:

- The regional model topography was based on SRTM data and limited to the resolution and accuracy of this dataset. Where the regional model has been refined at key locations along the project, freely available LiDAR data has been used. No detailed survey data for the project footprint has been represented.
- A sampling distance of 50 metres has been adopted in the modelling. This will likely limit the representation of smaller hydraulic features such as small channels and hydraulic controls. From a regional flooding context, these features are not considered critical. Review of the definition of the smaller hydraulic features should be undertaken during the detailed design stage should the modelling be further refined.
- Structures such as bridges, road embankments or culverts have not been explicitly represented due to limited structure data availability across the study area. Where the representation of drainage structures is required, engineering judgment has been adopted for the determination of the structure size.
- The proposed access roads have been assumed to be at grade and have not been explicitly modelled due to scale and definition compared to the regional model. Should the roads require earthworks, the current alignments are located in remote locations with no adjacent development. Any resulting impact on flooding would be considered negligible given the remote location of the roads and the width of the project footprint. However, appropriate local drainage design would be required to manage any local flood impacts on the road infrastructure.
- No areal reduction factors have been applied in the regional modelling based on the outcomes of the calibration performance.
- Hydraulic modelling assumes existing case catchment development conditions.
- All results presented are subject to the limitations of the modelling packages and currency of best practice methods adopted and applied. It is acknowledged that these methods may change over time.

Attachment B

ARR 2019 Flood Hazard Classification



Attachment C

Regional Model Flood Maps

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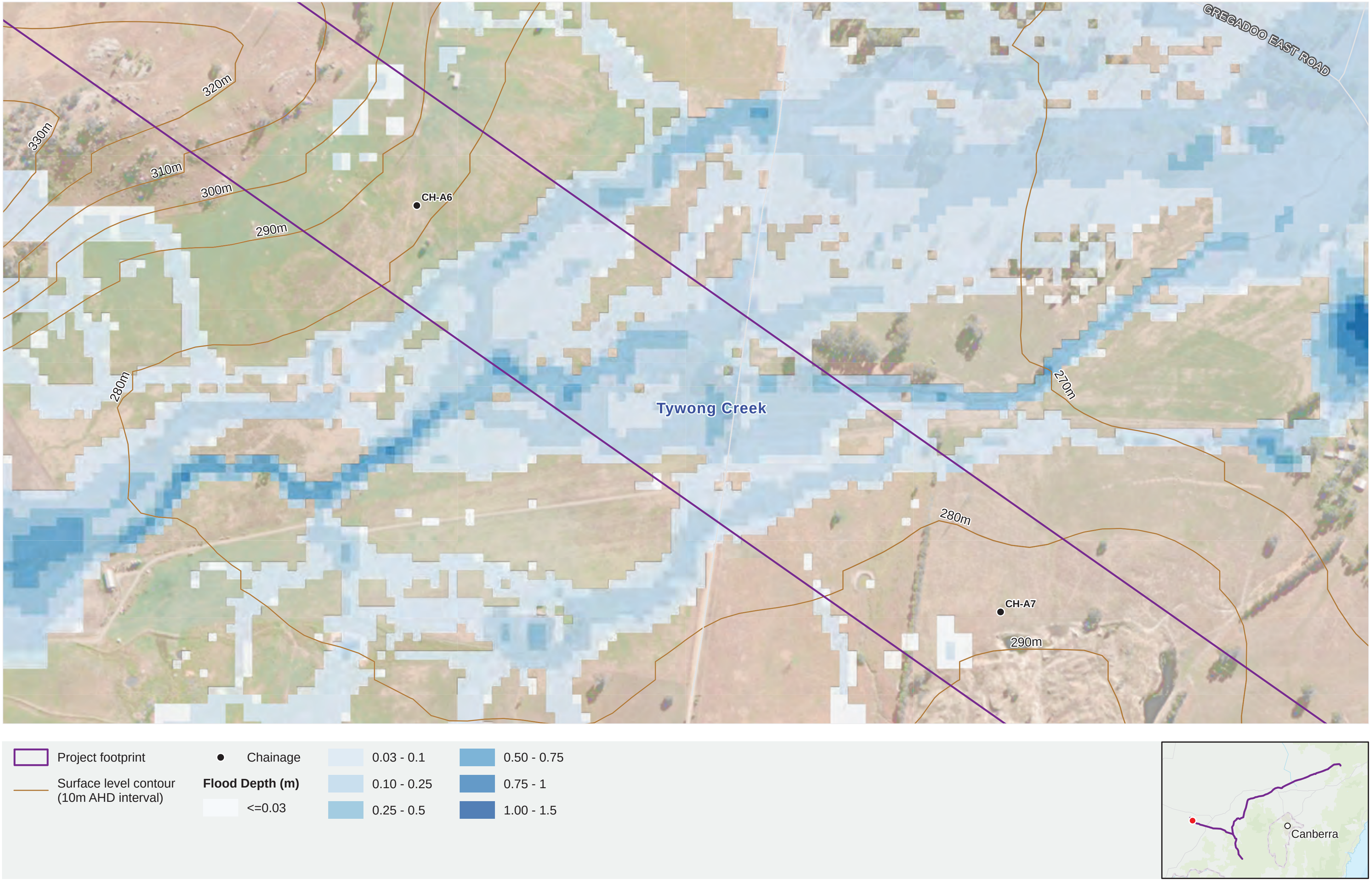

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 1a: 1% AEP flood depth (m) at Tywong Creek - Murumbidgee Catchment

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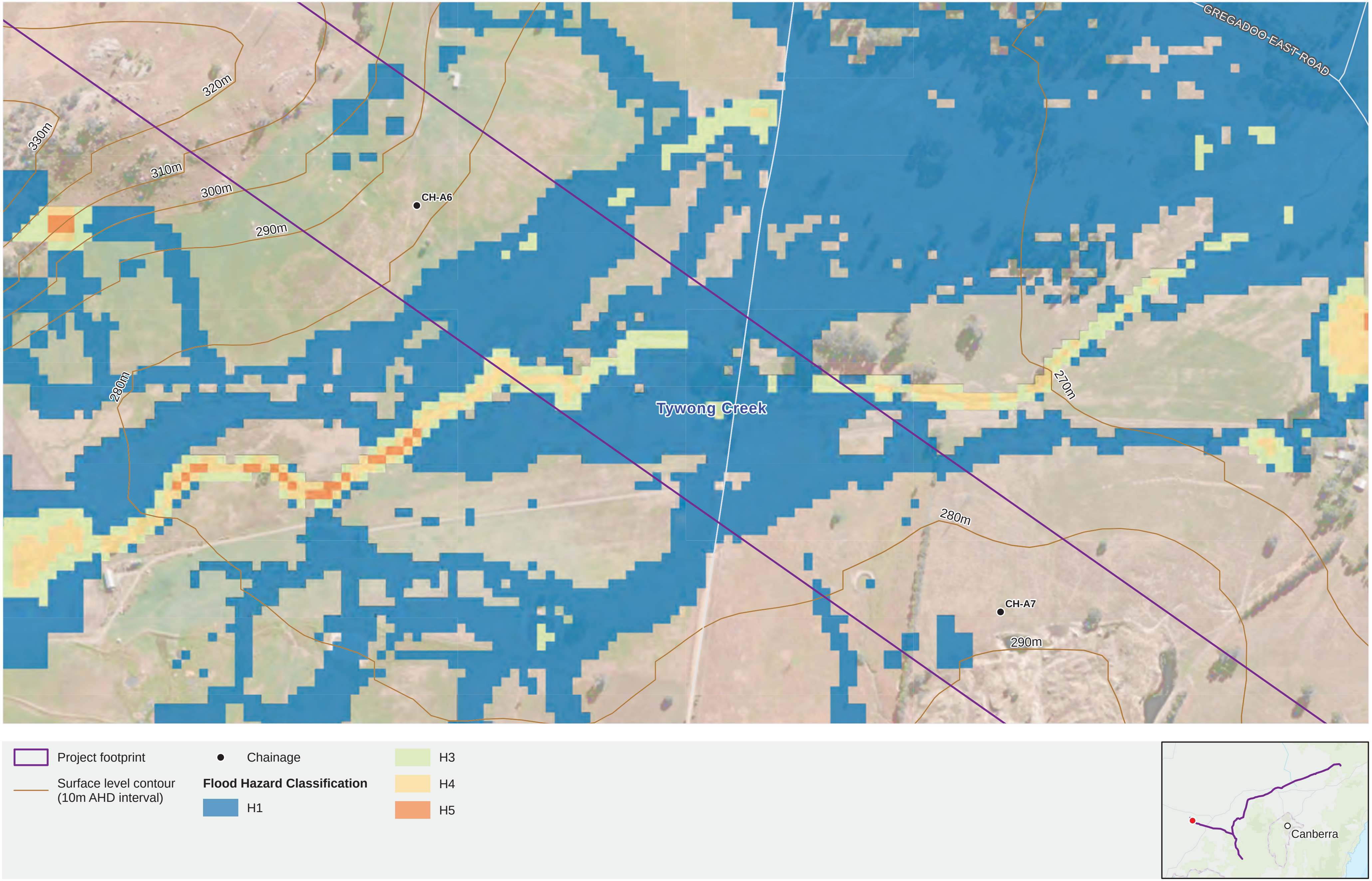


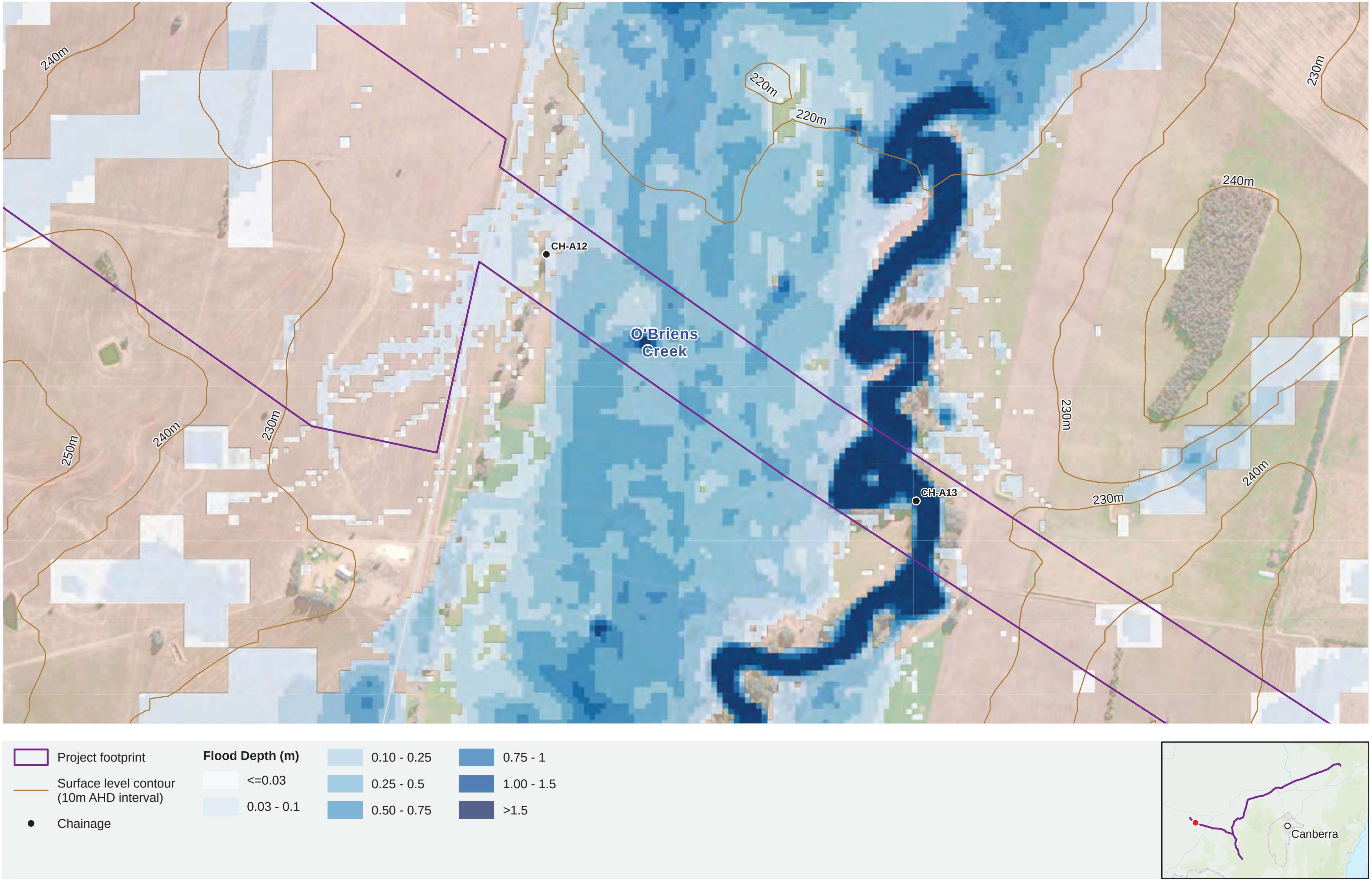
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 1b: ARR 2019 Flood Hazard Classification at Tywong Creek - Murumbidgee Catchment



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

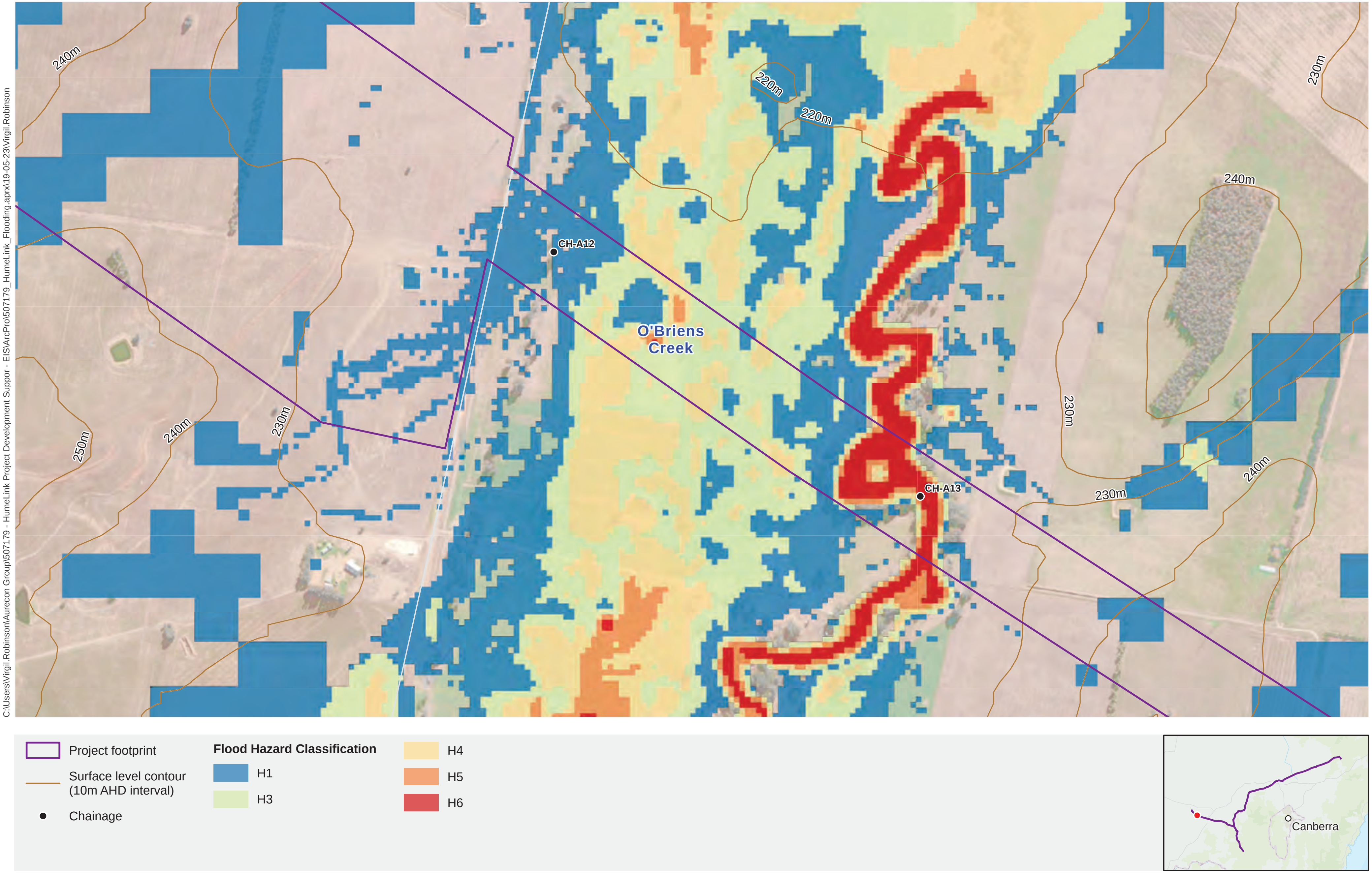
1:8,000

0 180 360m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 2a: 1% AEP flood depth (m) at O'Briens Creek - Murumbidgee Catchment



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 2b: ARR 2019 Flood Hazard Classification at O'Briens Creek - Murumbidgee Catchment

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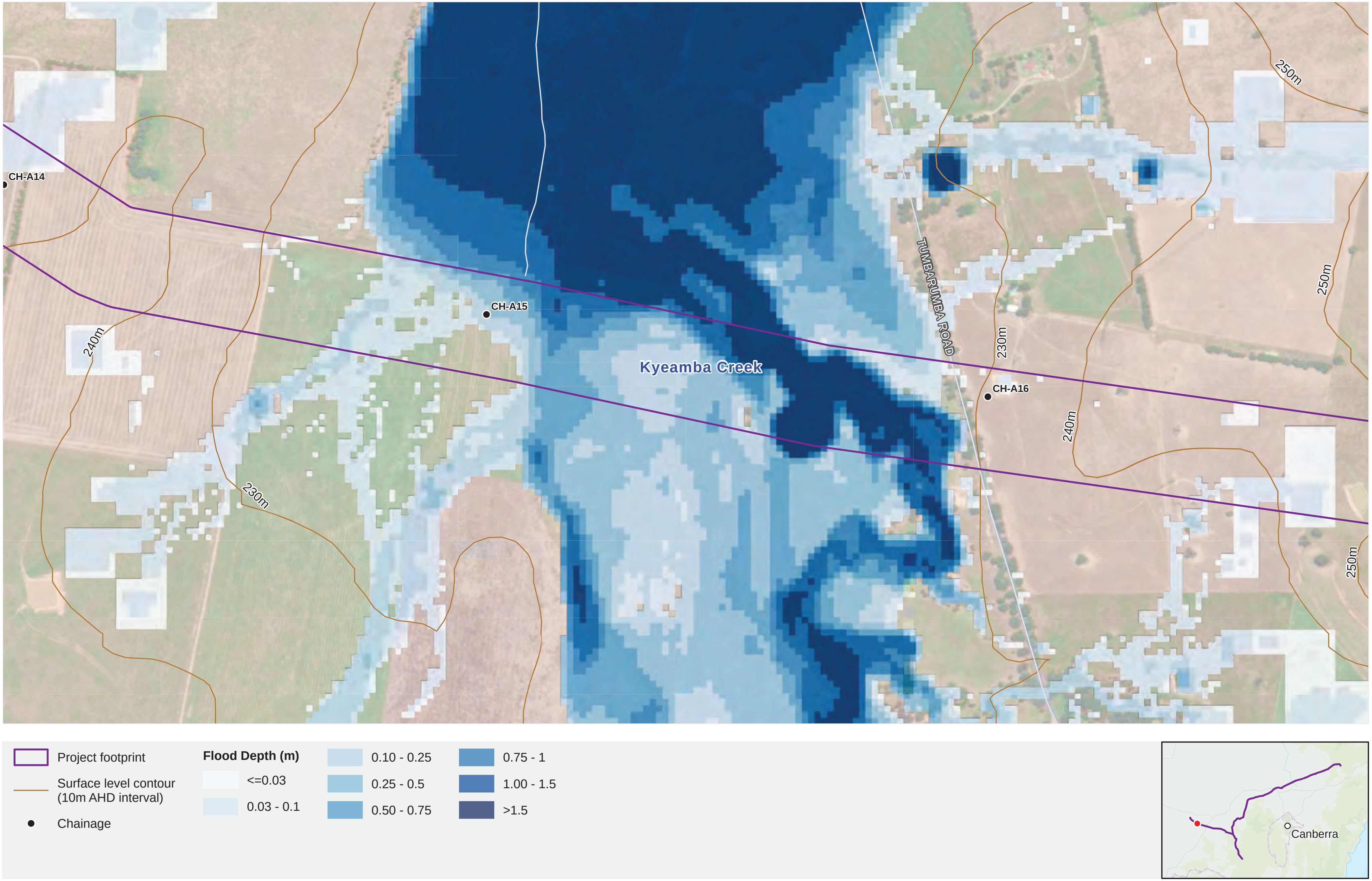

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:7,000

0 160 320m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 3a: 1% AEP flood depth (m) at Kyeamba Creek - Murumbidgee Catchment

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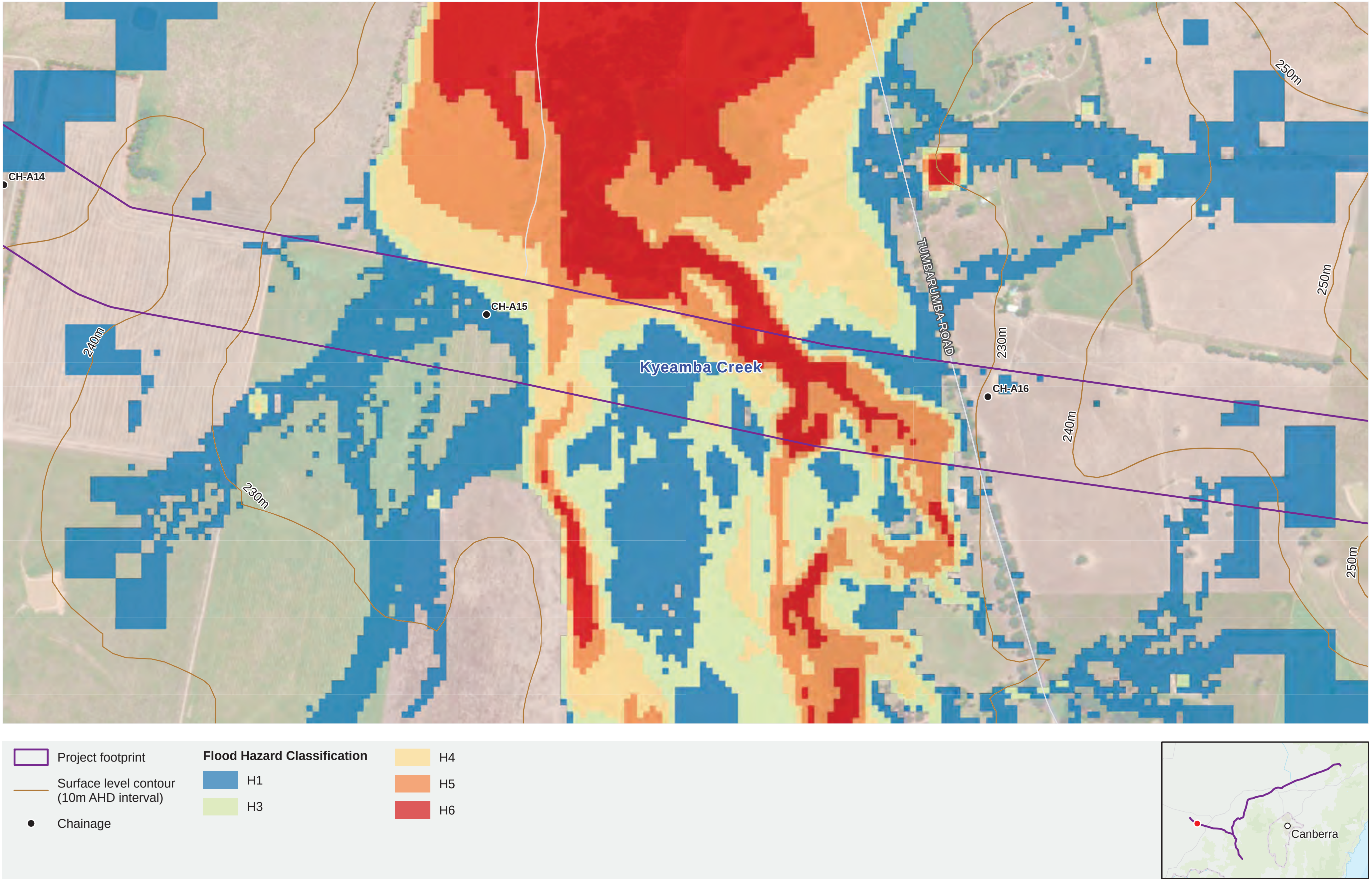

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:7,000

0 160 320 m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 3b: ARR 2019 Flood Hazard Classification at Kyeamba Creek - Murumbidgee Catchment

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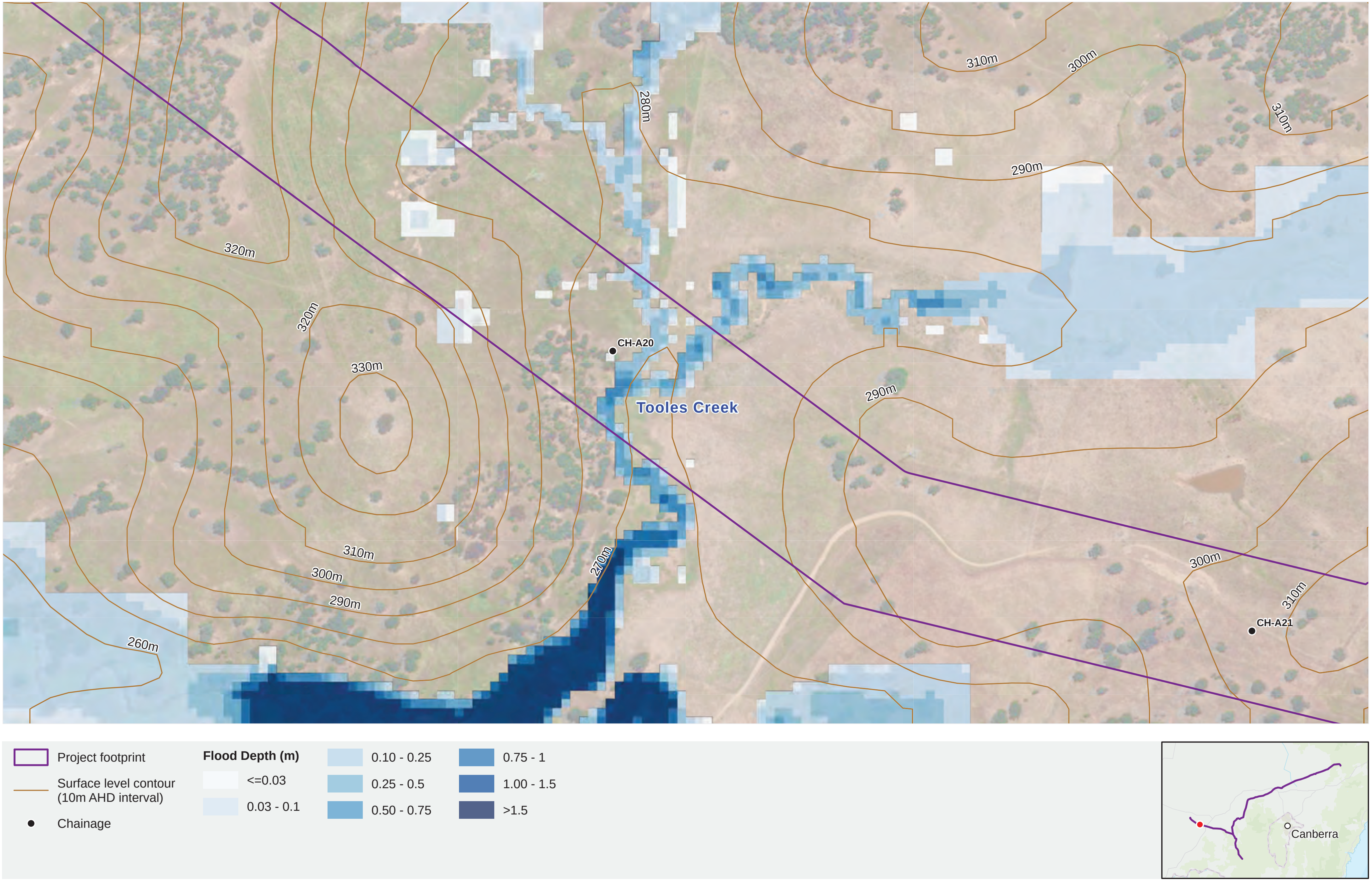

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 4a: 1% AEP flood depth (m) at Tooles Creek - Murumbidgee Catchment

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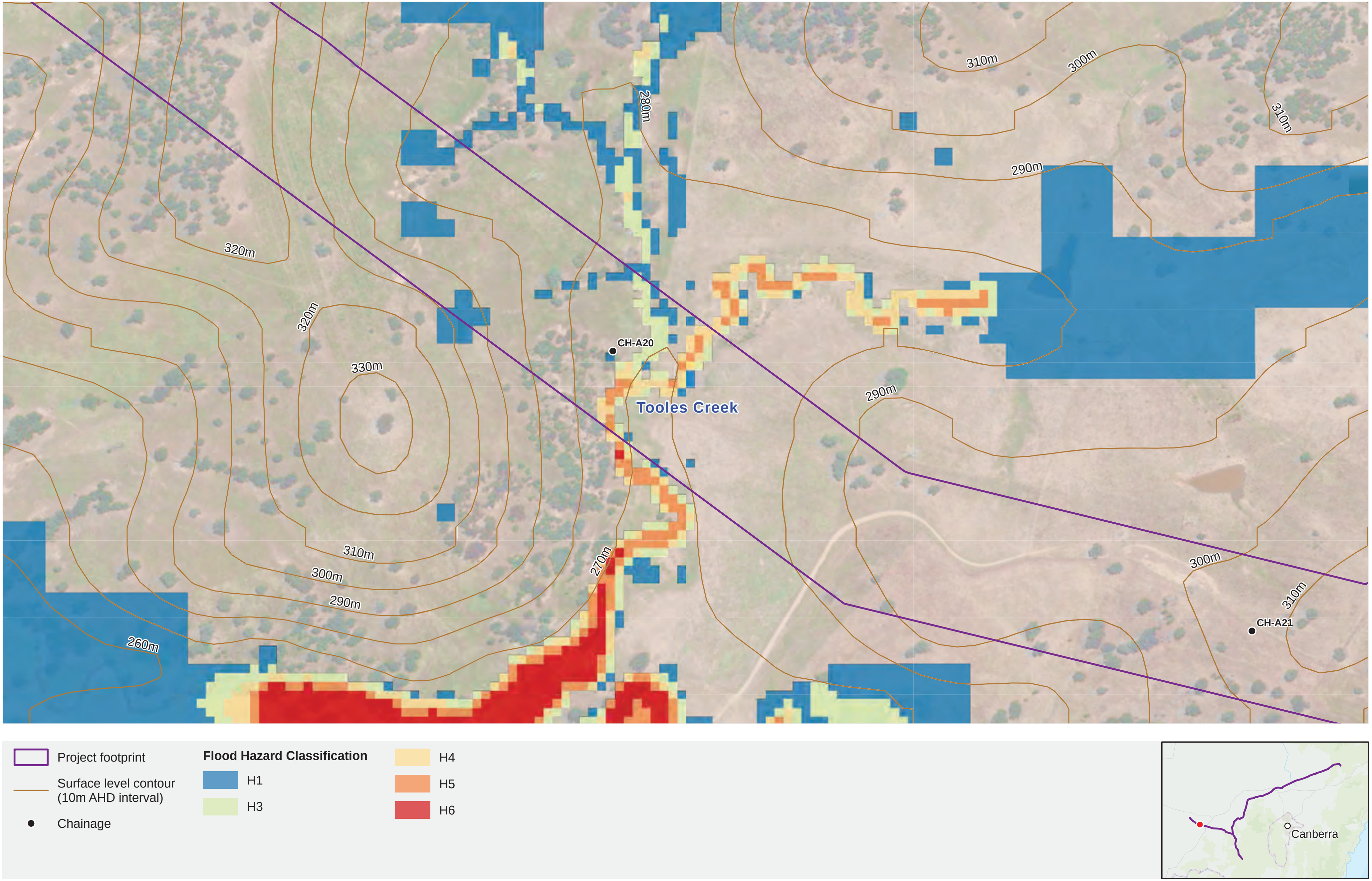

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 4b: ARR 2019 Flood Hazard Classification at Tooles Creek - Murumbidgee Catchment

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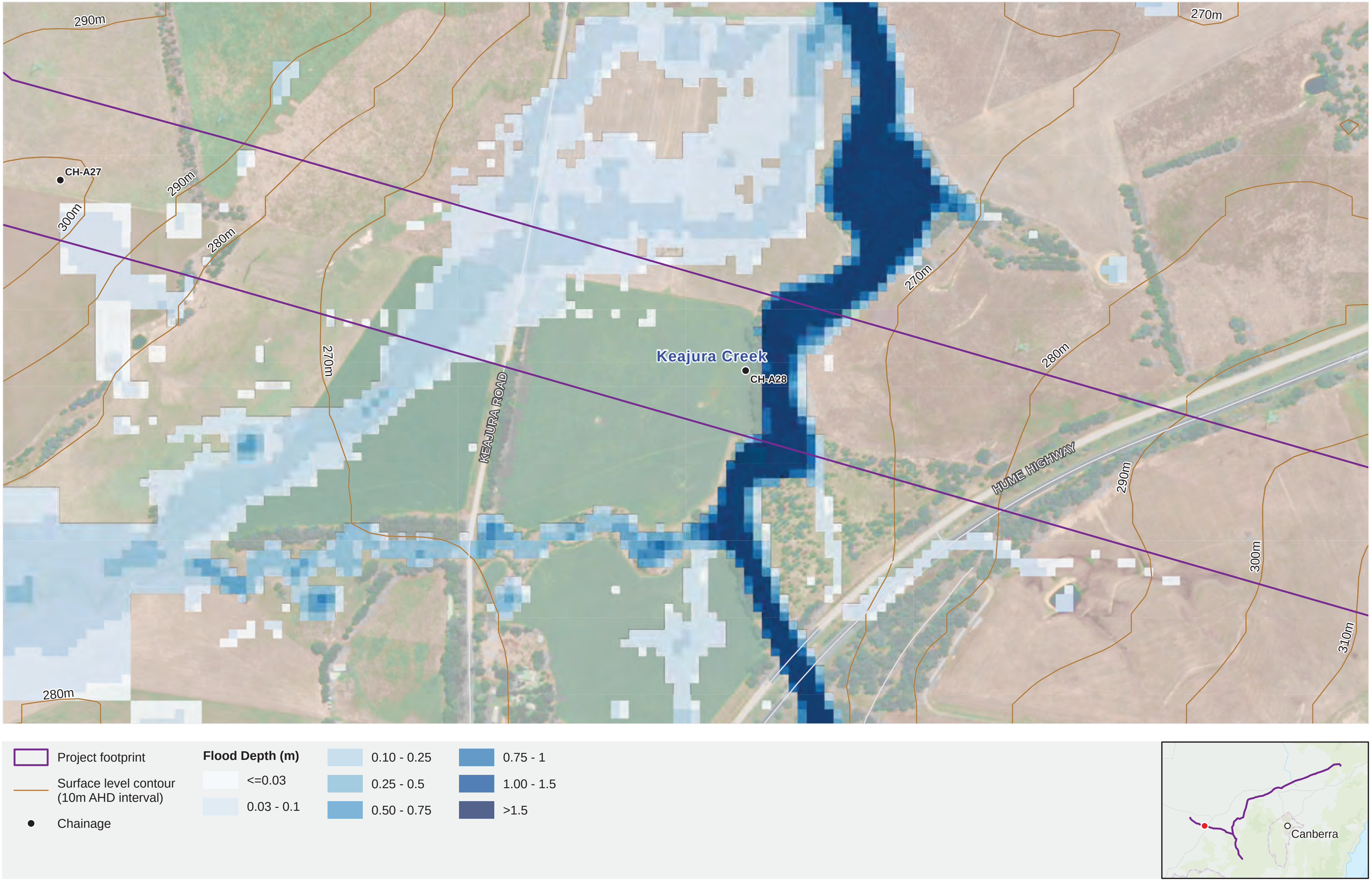

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 5a: 1% AEP flood depth (m) at Keajura Creek - Murumbidgee Catchment

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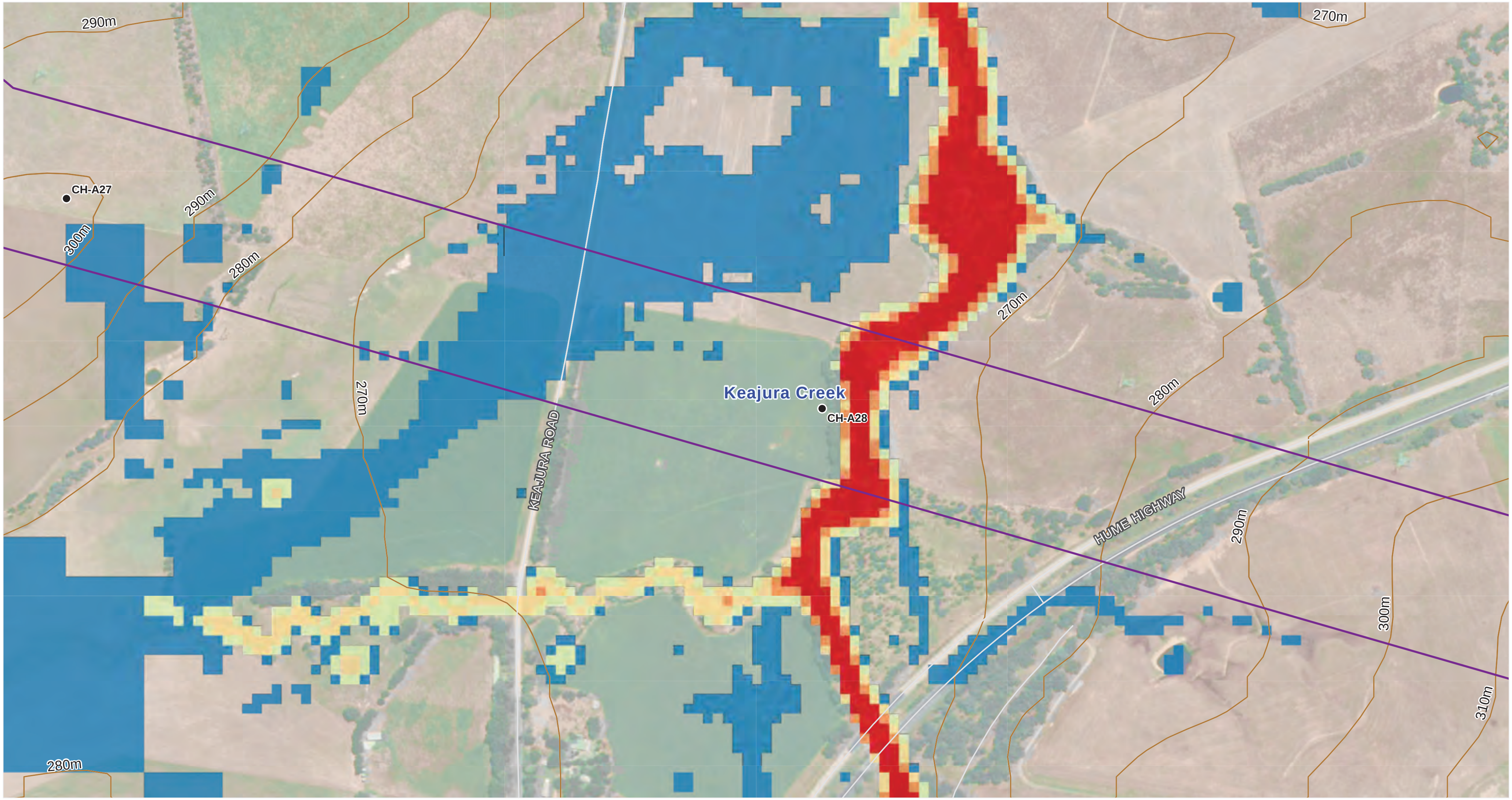
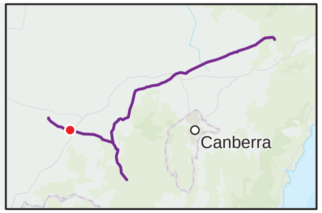


- ▭ Project footprint
- — Surface level contour (10m AHD interval)
- ● Chainage

Flood Hazard Classification

- 🟦 H1
- 🟩 H3
- 🟨 H4
- 🟧 H5
- 🟥 H6



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 5b: ARR 2019 Flood Hazard Classification at Keajura Creek - Murumbidgee Catchment

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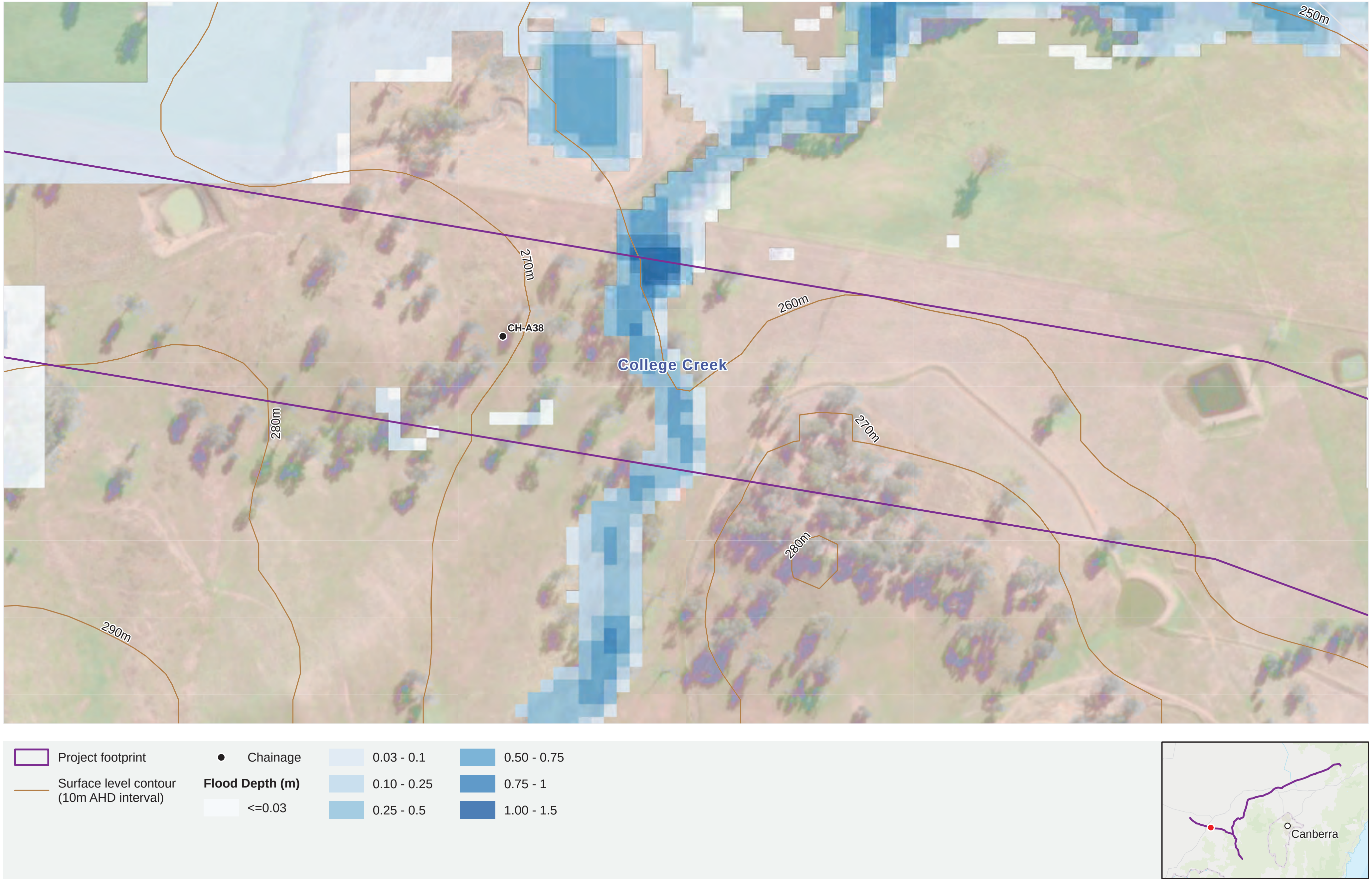

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:3,500
0 80 160 m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 6a: 1% AEP flood depth (m) at College Creek - Murumbidgee Catchment

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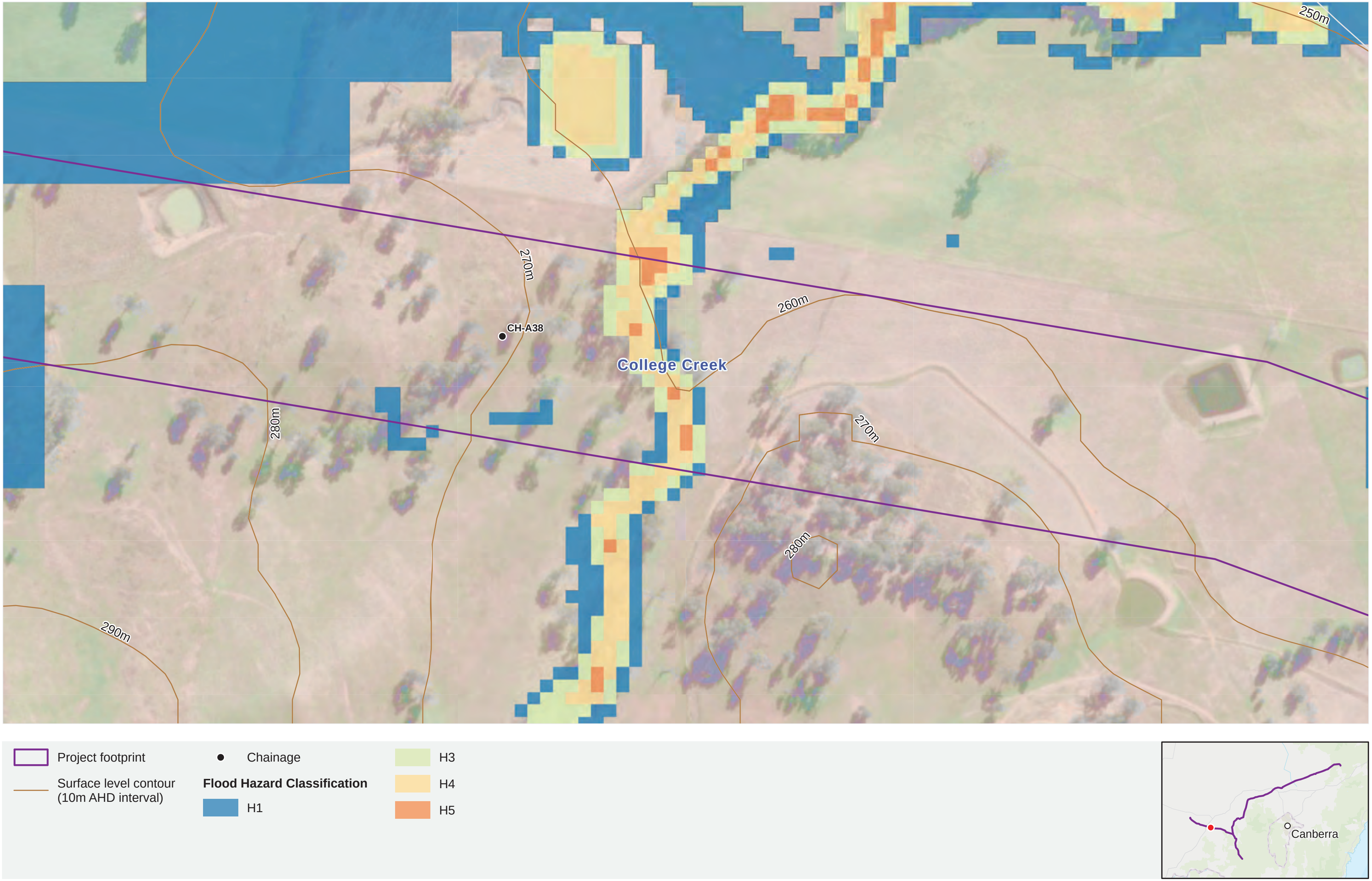

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:3,500

0 80 160m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 6b: ARR 2019 Flood Hazard Classification at College Creek - Murumbidgee Catchment

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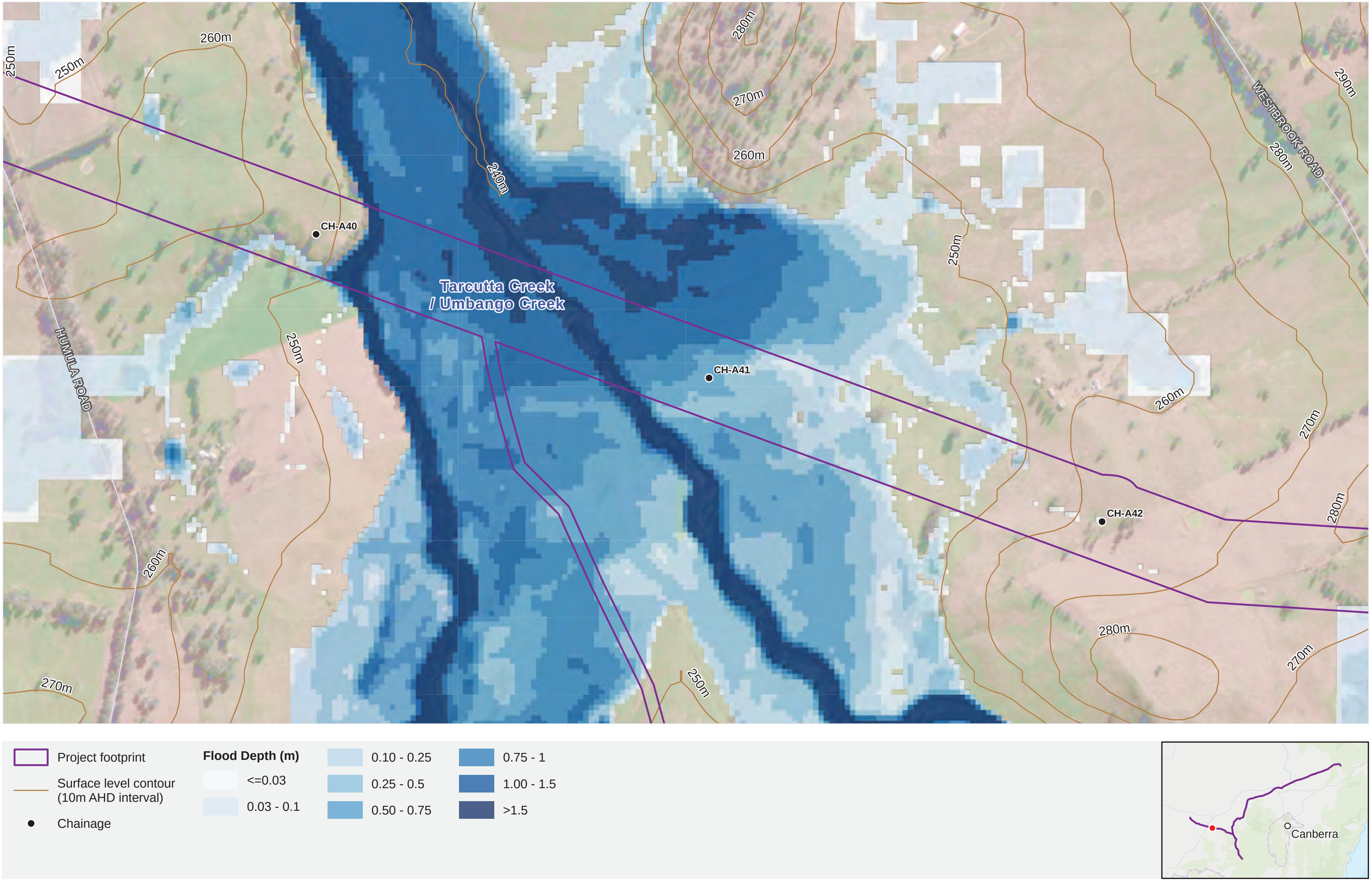

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:8,500

0 200 400m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 7a: 1% AEP flood depth (m) at Tarcutta Creek / Umbango Creek - Murumbidgee Catchment

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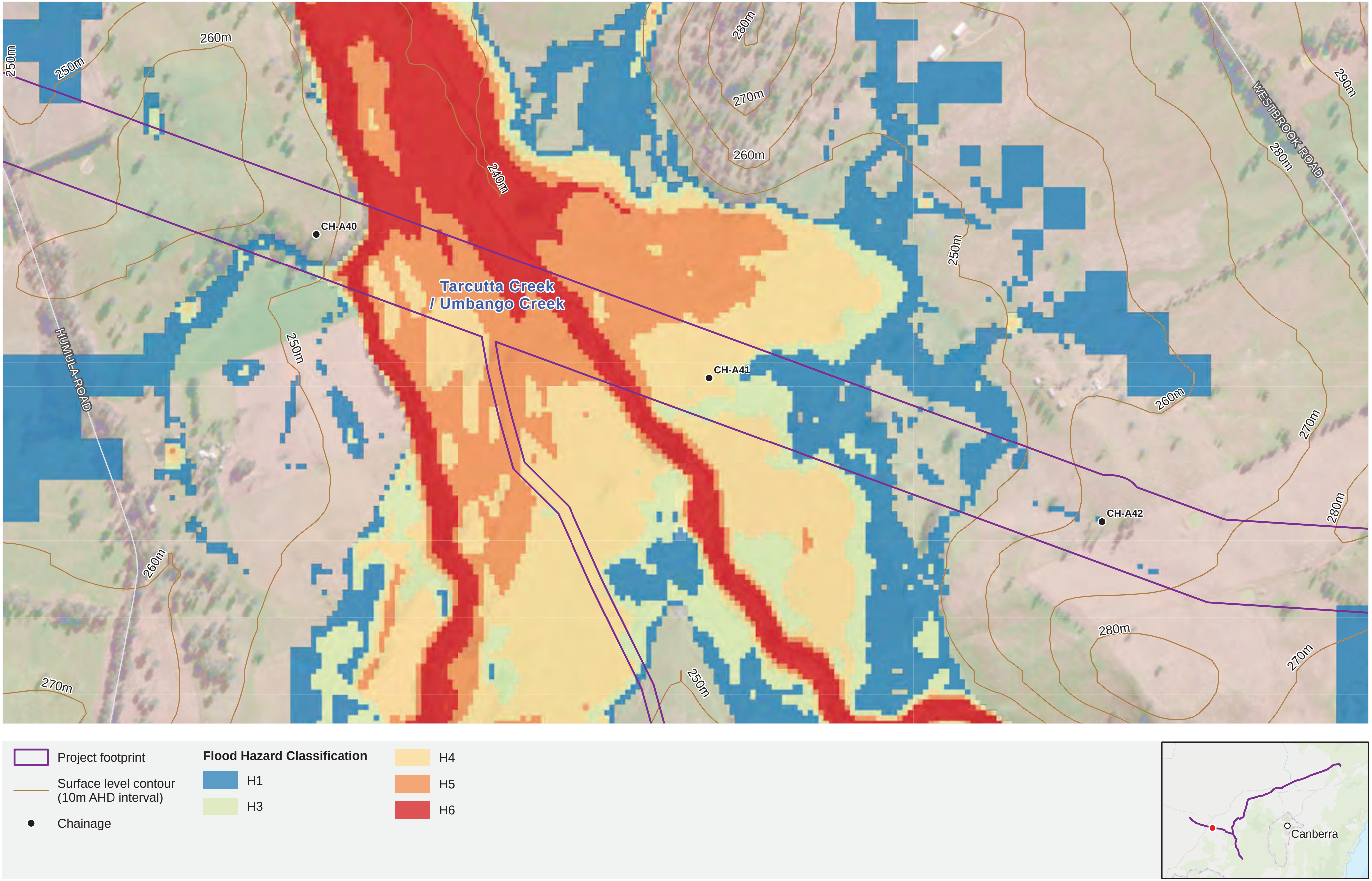

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:8,500

0 200 400m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 7b: ARR 2019 Flood Hazard Classification at Tarcutta Creek / Umbango Creek - Murumbidgee Catchment

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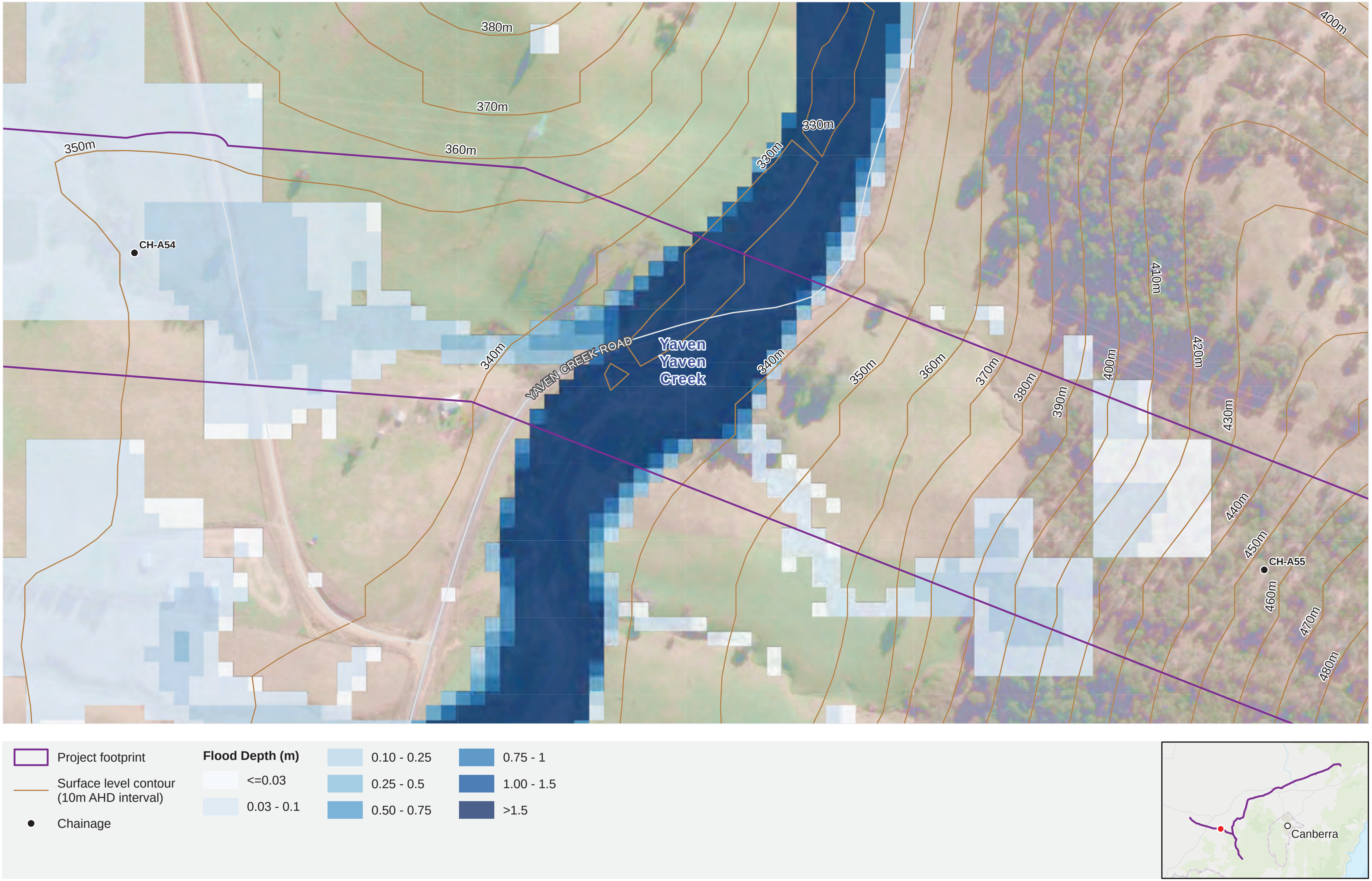

▭	Project footprint	**Flood Depth (m)**		▨	0.10 - 0.25	▨	0.75 - 1
—	Surface level contour (10m AHD interval)	▨	<=0.03	▨	0.25 - 0.5	▨	1.00 - 1.5
●	Chainage	▨	0.03 - 0.1	▨	0.50 - 0.75	▨	>1.5

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:3,000

0 70 140m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 8a: 1% AEP flood depth (m) at Yaven Yaven Creek - Murumbidgee Catchment

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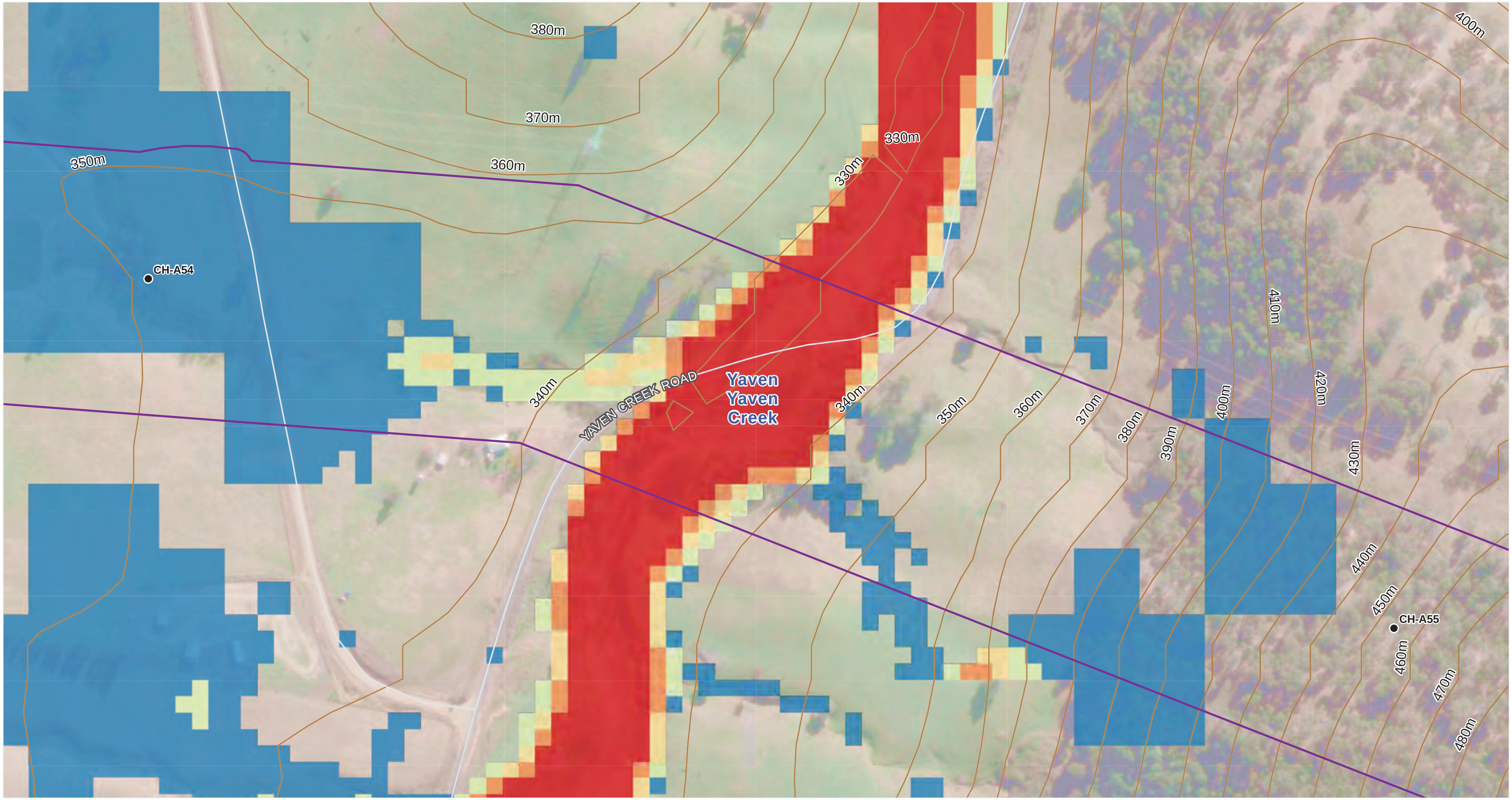


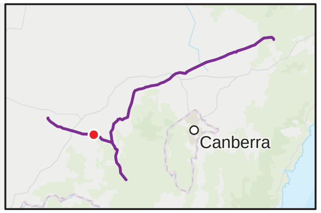
▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Hazard Classification

- 🟦 H1
- 🟩 H3
- 🟨 H4
- 🟧 H5
- 🟥 H6



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:3,000

0 70 140m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 8b: ARR 2019 Flood Hazard Classification at Yaven Yaven Creek - Murumbidgee Catchment

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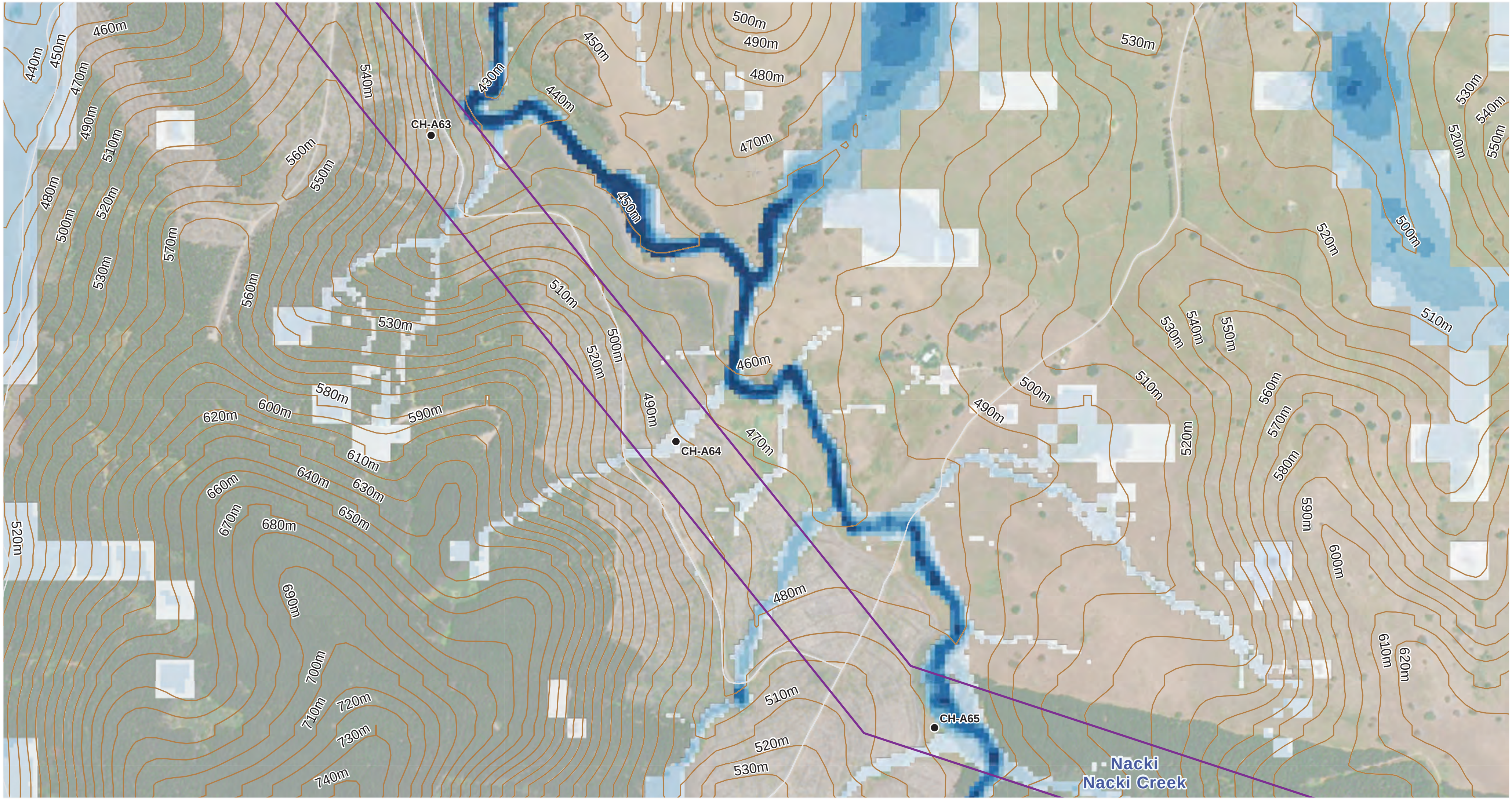


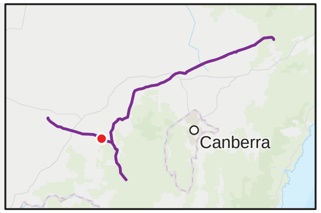
Project footprint

Surface level contour (10m AHD interval)

● Chainage

Flood Depth (m)

▢	<=0.03
▢	0.03 - 0.1
▢	0.10 - 0.25
▢	0.25 - 0.5
▢	0.50 - 0.75
▢	0.75 - 1
▢	1.00 - 1.5
▢	>1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:10,000

0 230 460m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 9a: 1% AEP flood depth (m) at Nacki Nacki Creek - Murumbidgee Catchment

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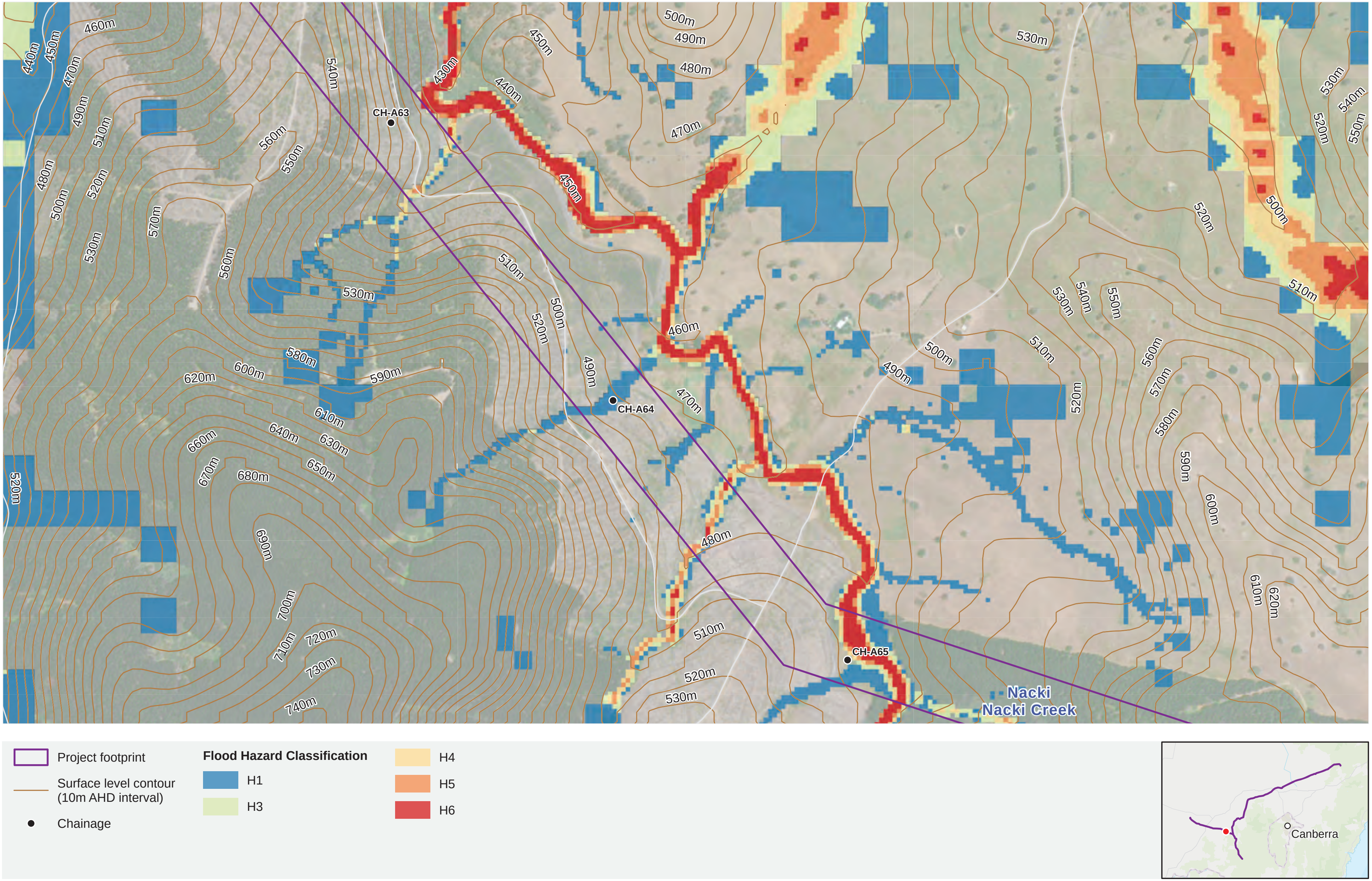
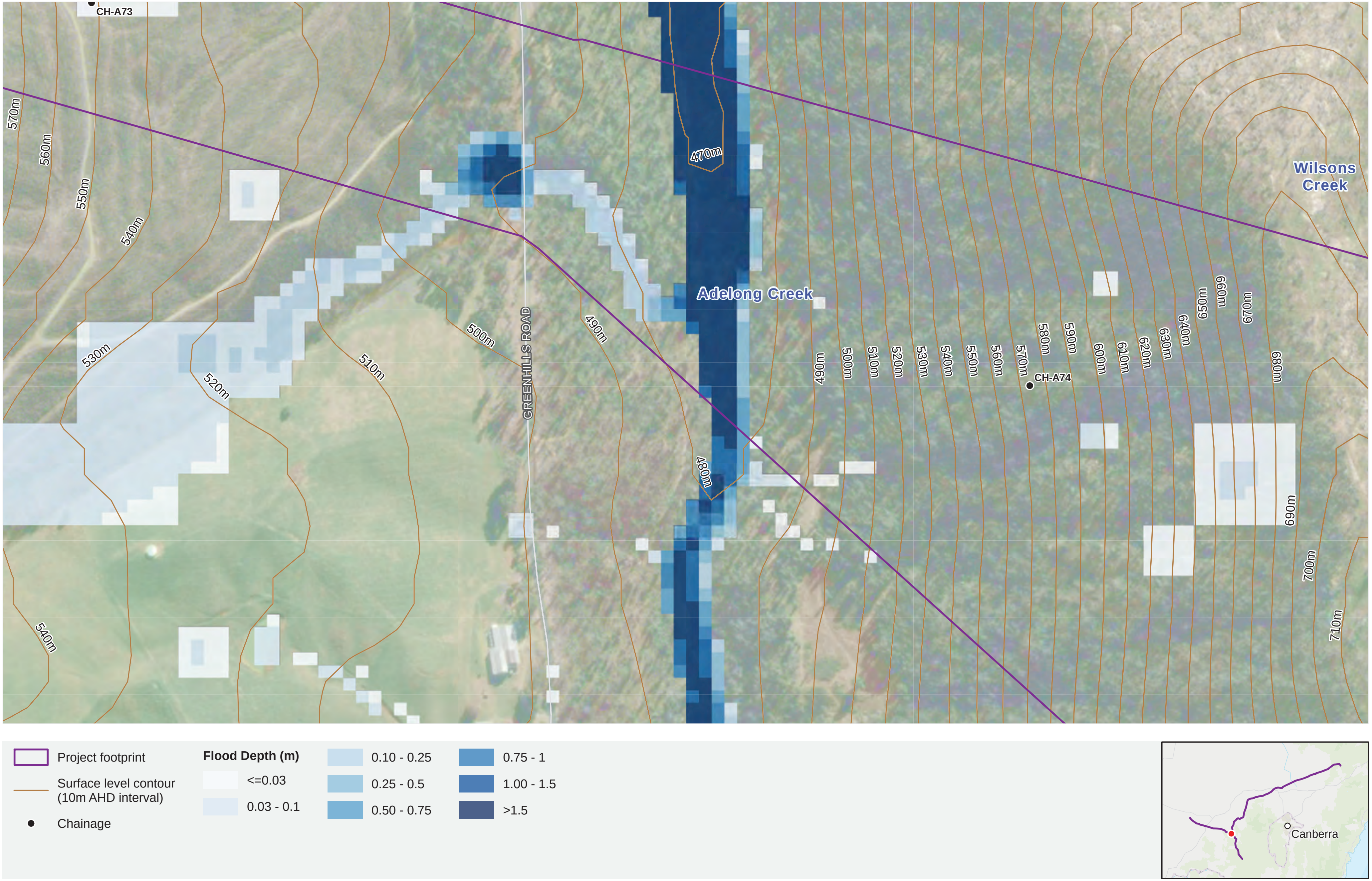


Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 9b: ARR 2019 Flood Hazard Classification at Nacki Nacki Creek - Murumbidgee Catchment



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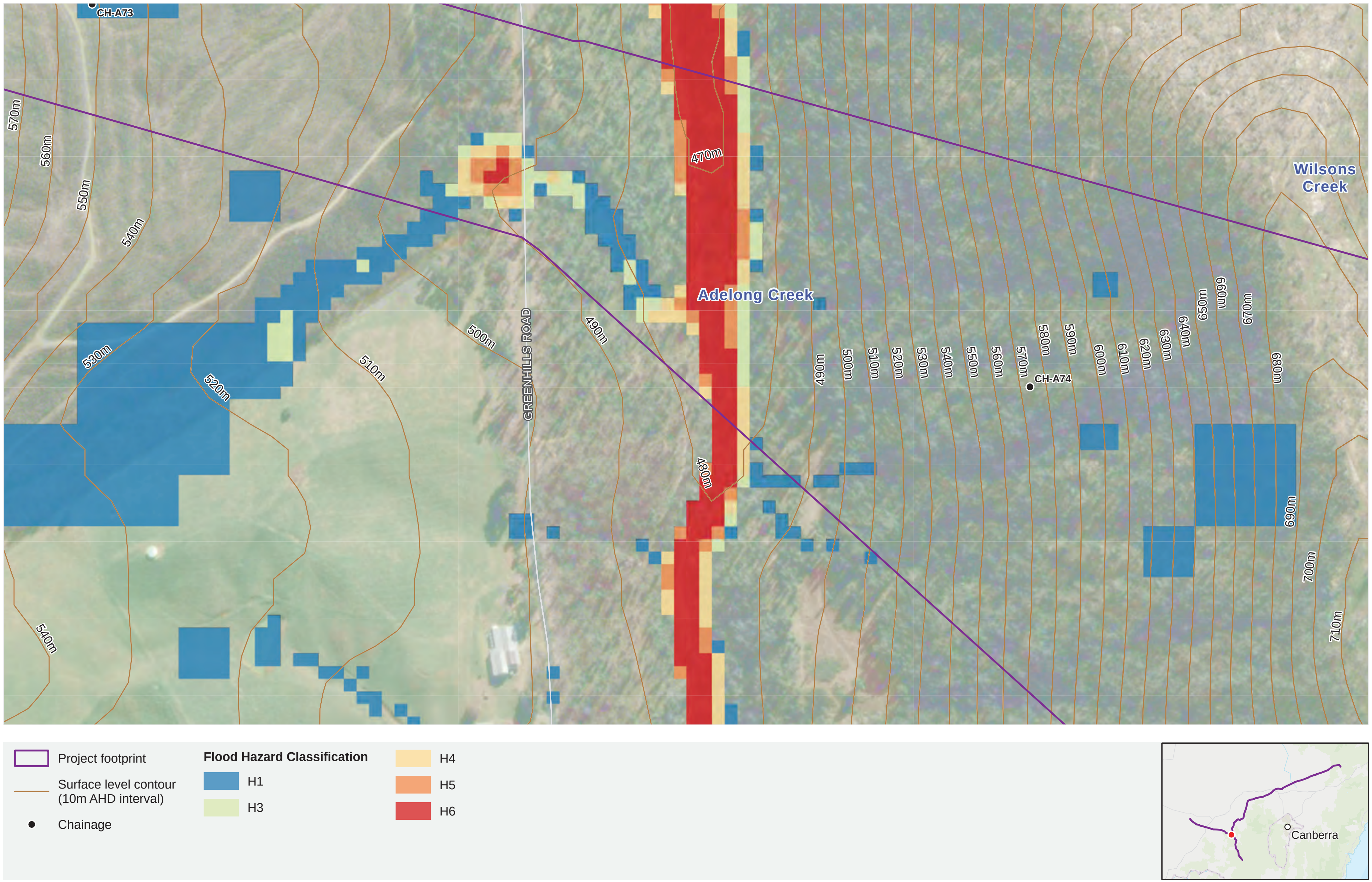
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:3,500

0 80 160m

Projection: GDA 1994 MGA Zone 55

Map 10a: 1% AEP flood depth (m) at Adelong Creek - Murumbidgee Catchment



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Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:3,500

0 80 160m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 10b: ARR 2019 Flood Hazard Classification at Adelong Creek - Murumbidgee Catchment

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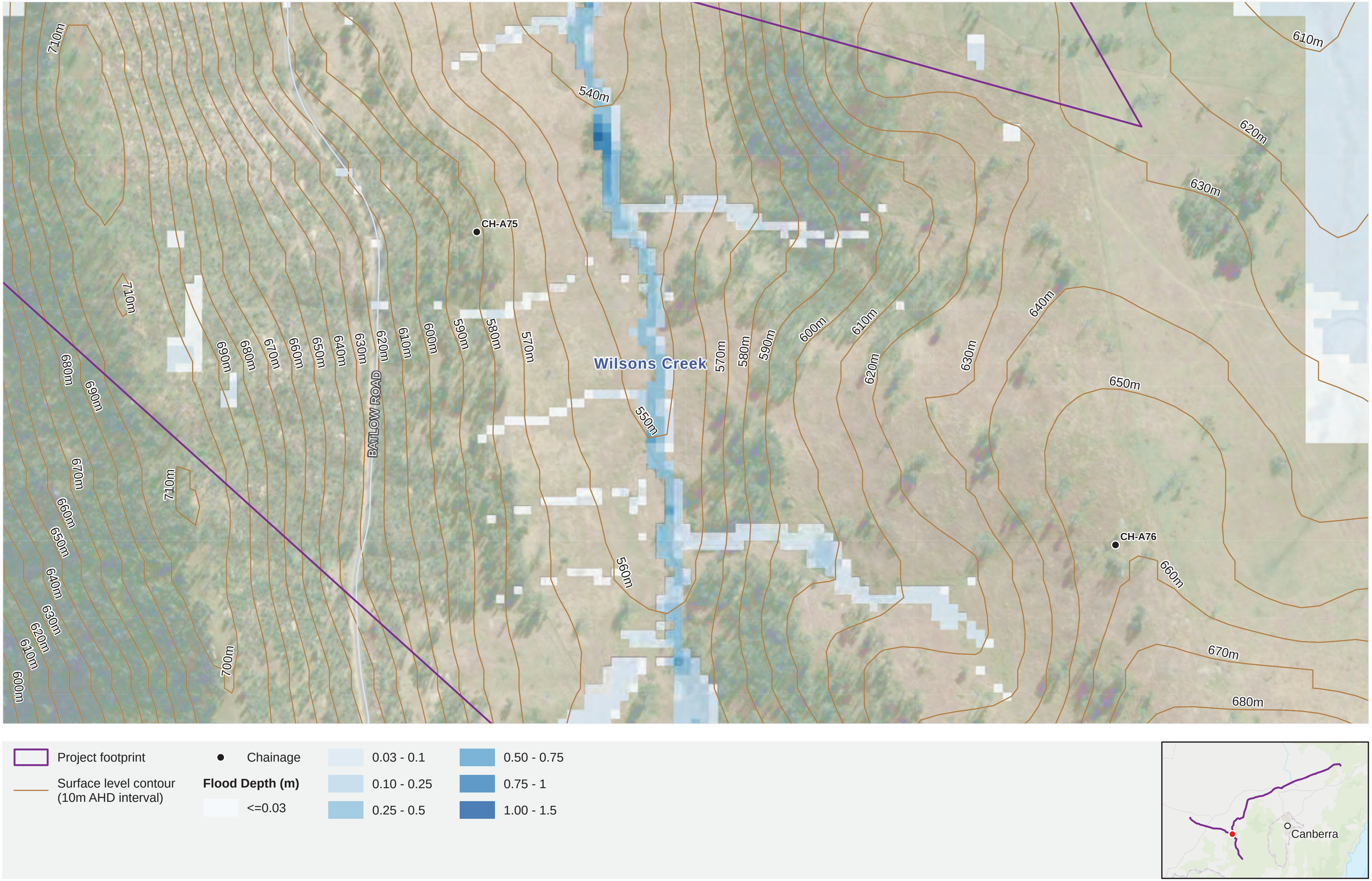

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 11a: 1% AEP flood depth (m) at Wilsons Creek - Murumbidgee Catchment

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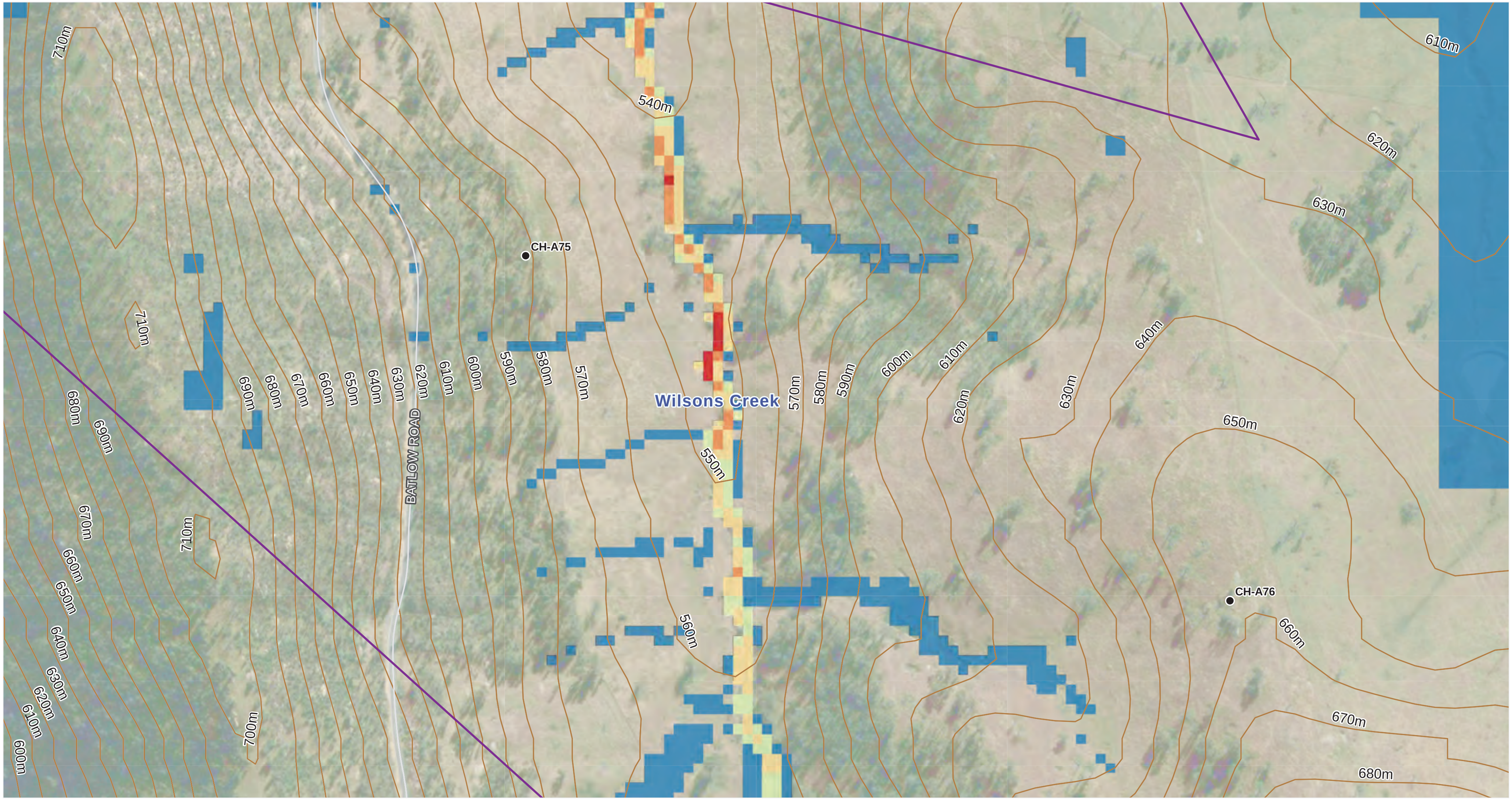


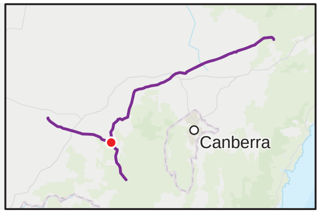
▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Hazard Classification

🟦	H1
🟩	H3
🟨	H4
🟧	H5
🟥	H6



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 11b: ARR 2019 Flood Hazard Classification at Wilsons Creek - Murumbidgee Catchment

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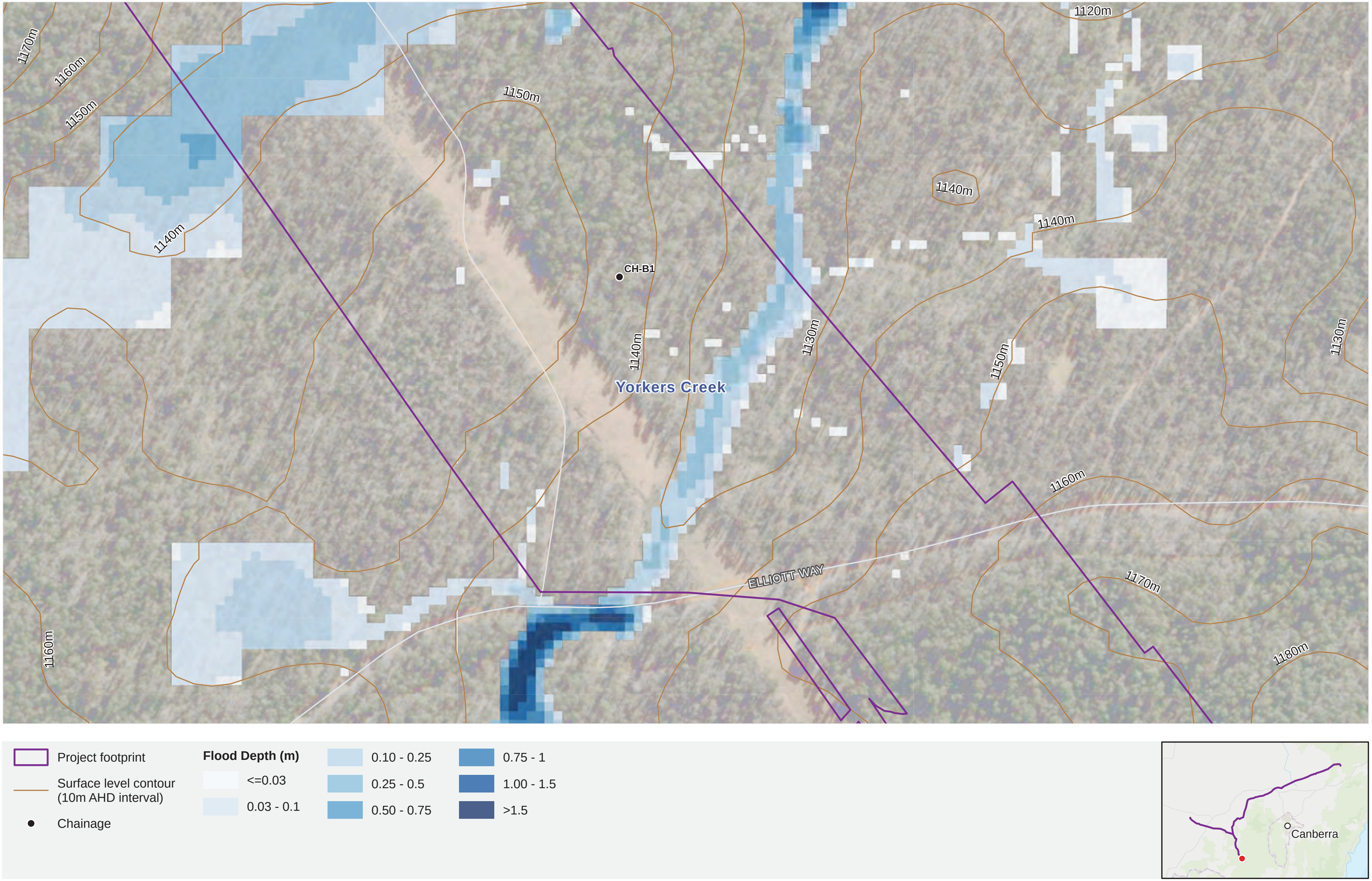


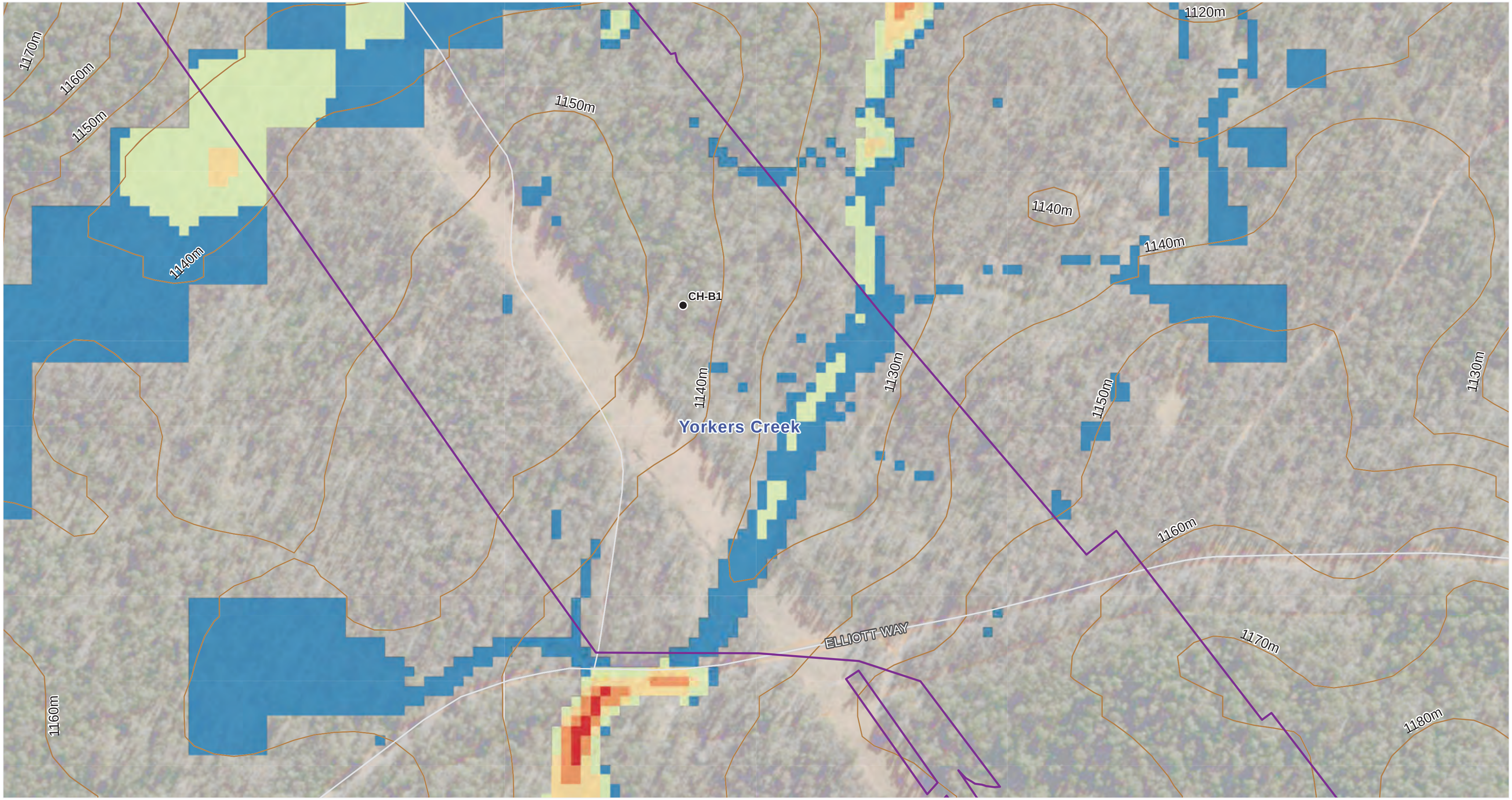
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 12a: 1% AEP flood depth (m) at Yorkers Creek - Murumbidgee Catchment



▭ Project footprint

Surface level contour (10m AHD interval)

● Chainage

Flood Hazard Classification

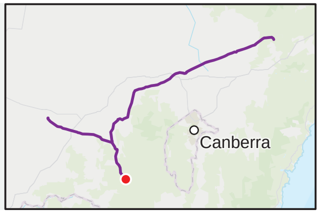
🟦 H1

🟩 H3

🟨 H4

🟧 H5

🟥 H6



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 12b: ARR 2019 Flood Hazard Classification at Yorkers Creek - Murumbidgee Catchment

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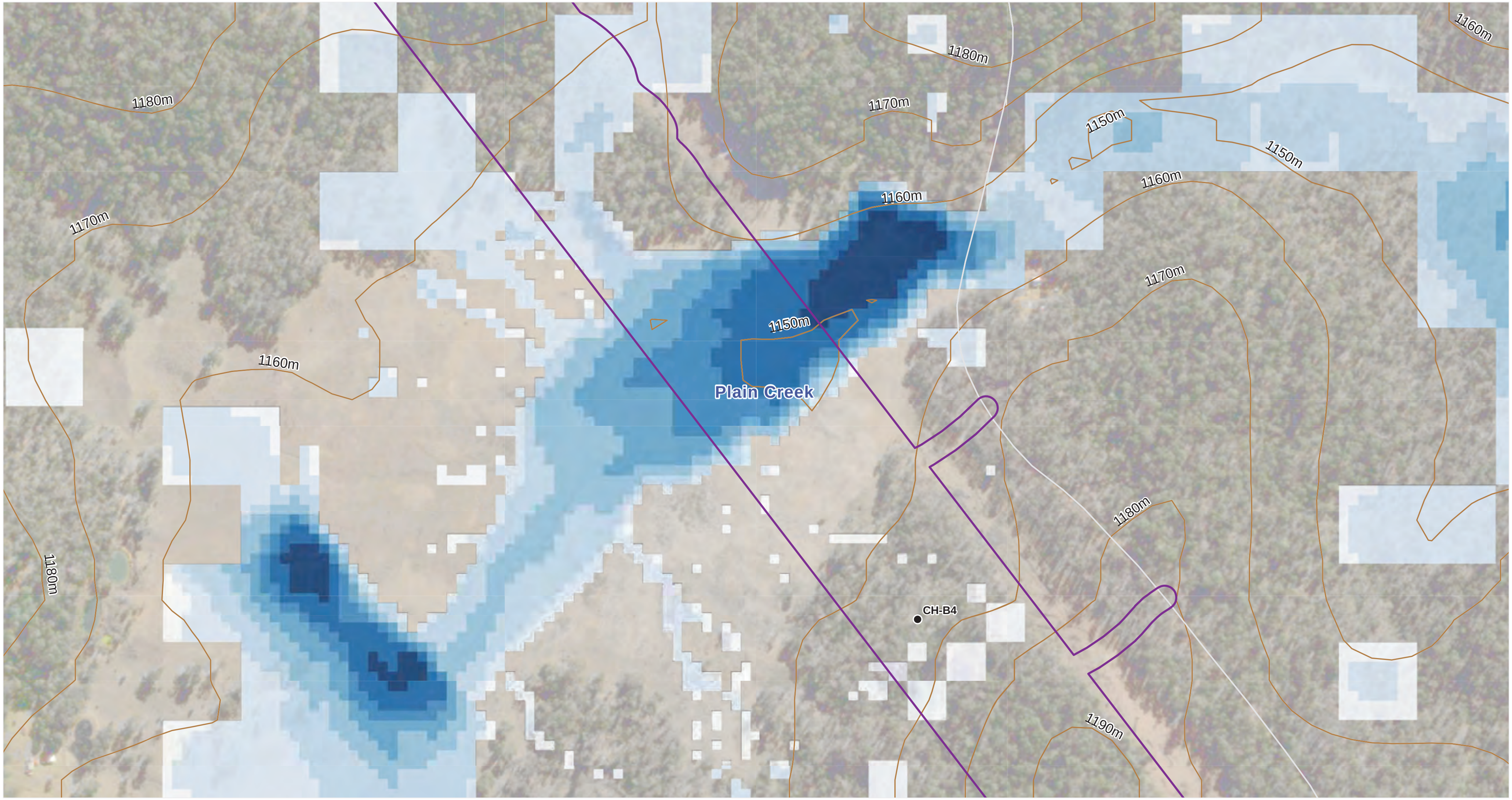


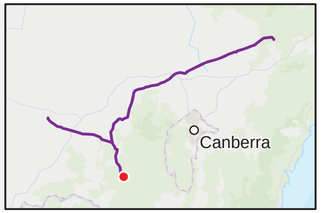
🟪 Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Depth (m)

▢	<=0.03
▢	0.03 - 0.1
🟦	0.10 - 0.25
🟦	0.25 - 0.5
🟦	0.50 - 0.75
🟦	0.75 - 1
🟦	1.00 - 1.5
🟦	>1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 13a: 1% AEP flood depth (m) at Plain Creek - Murumbidgee Catchment

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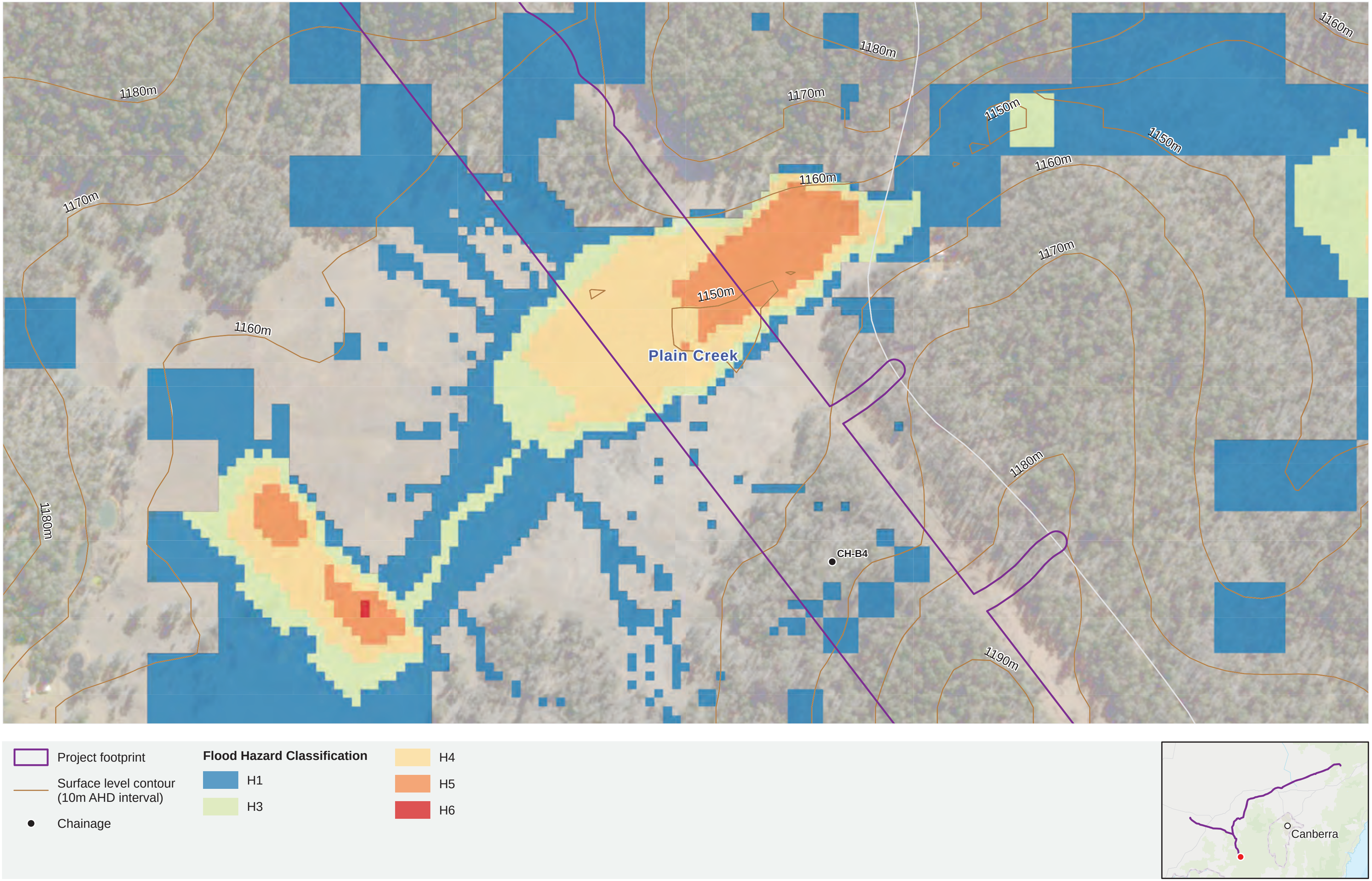

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 13b: ARR 2019 Flood Hazard Classification at Plain Creek - Murumbidgee Catchment

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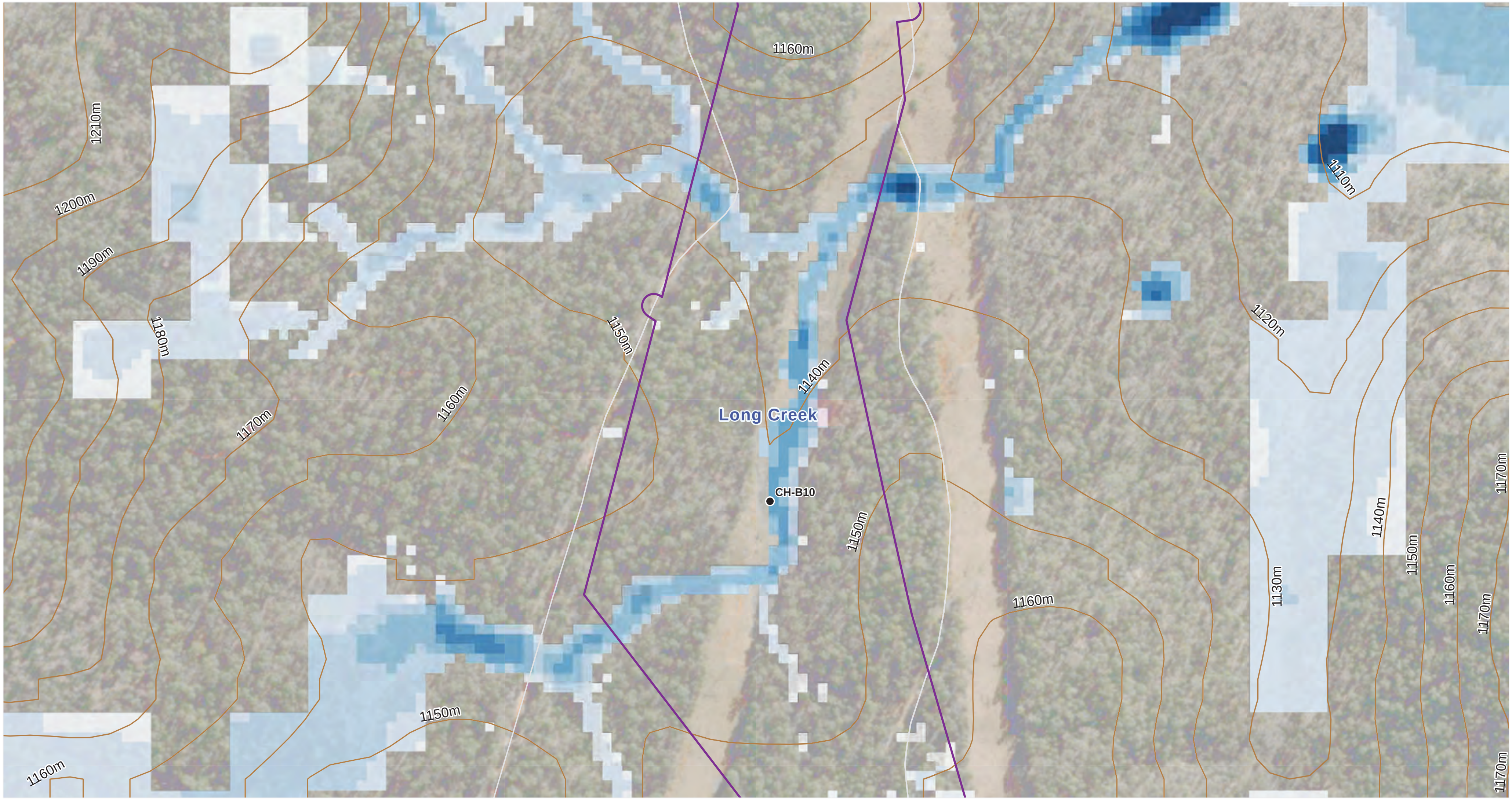


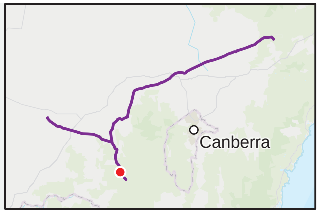
□ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Depth (m)

- ▢ <=0.03
- ▢ 0.03 - 0.1
- ▢ 0.10 - 0.25
- ▢ 0.25 - 0.5
- ▢ 0.50 - 0.75
- ■ 0.75 - 1
- ■ 1.00 - 1.5
- ■ >1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 14a: 1% AEP flood depth (m) at Long Creek - Murumbidgee Catchment

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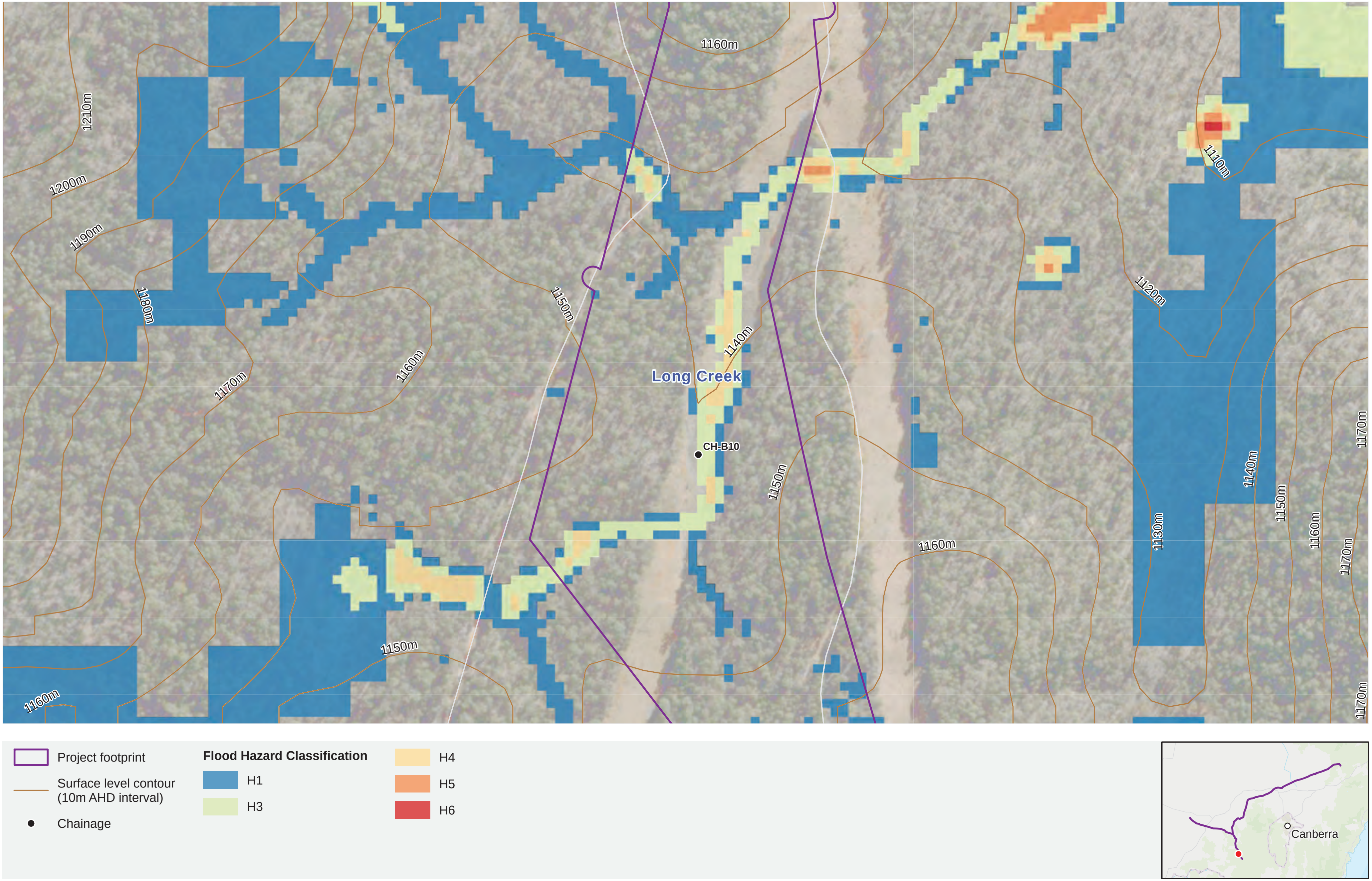

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 14b: ARR 2019 Flood Hazard Classification at Long Creek - Murumbidgee Catchment

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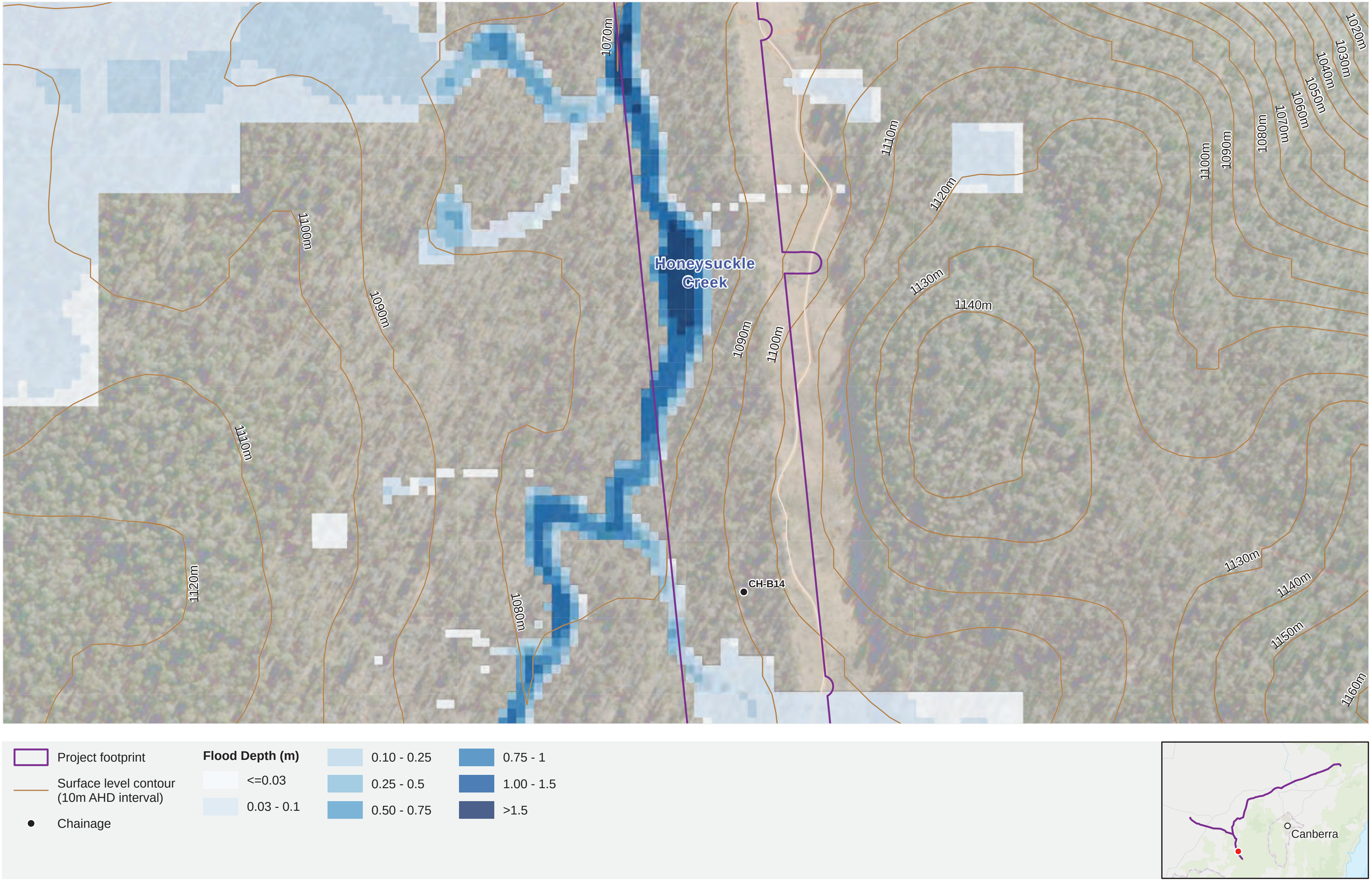

▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Depth (m)

▢	<=0.03
▢	0.03 - 0.1
▢	0.10 - 0.25
▢	0.25 - 0.5
▢	0.50 - 0.75
▢	0.75 - 1
▢	1.00 - 1.5
▢	>1.5

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 15a: 1% AEP flood depth (m) at Honeysuckle Creek - Murumbidgee Catchment

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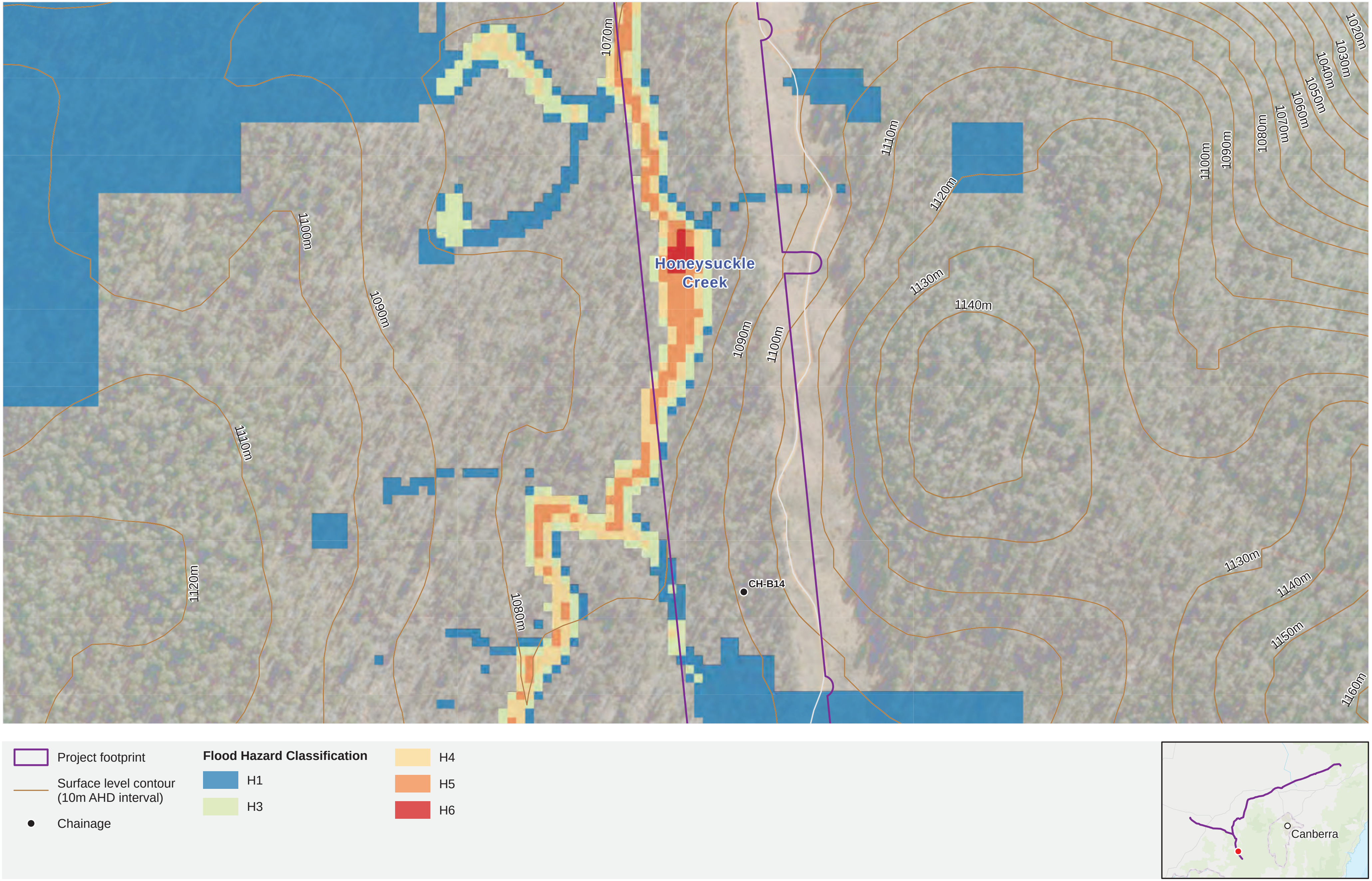

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 15b: ARR 2019 Flood Hazard Classification at Honeysuckle Creek - Murumbidgee Catchment

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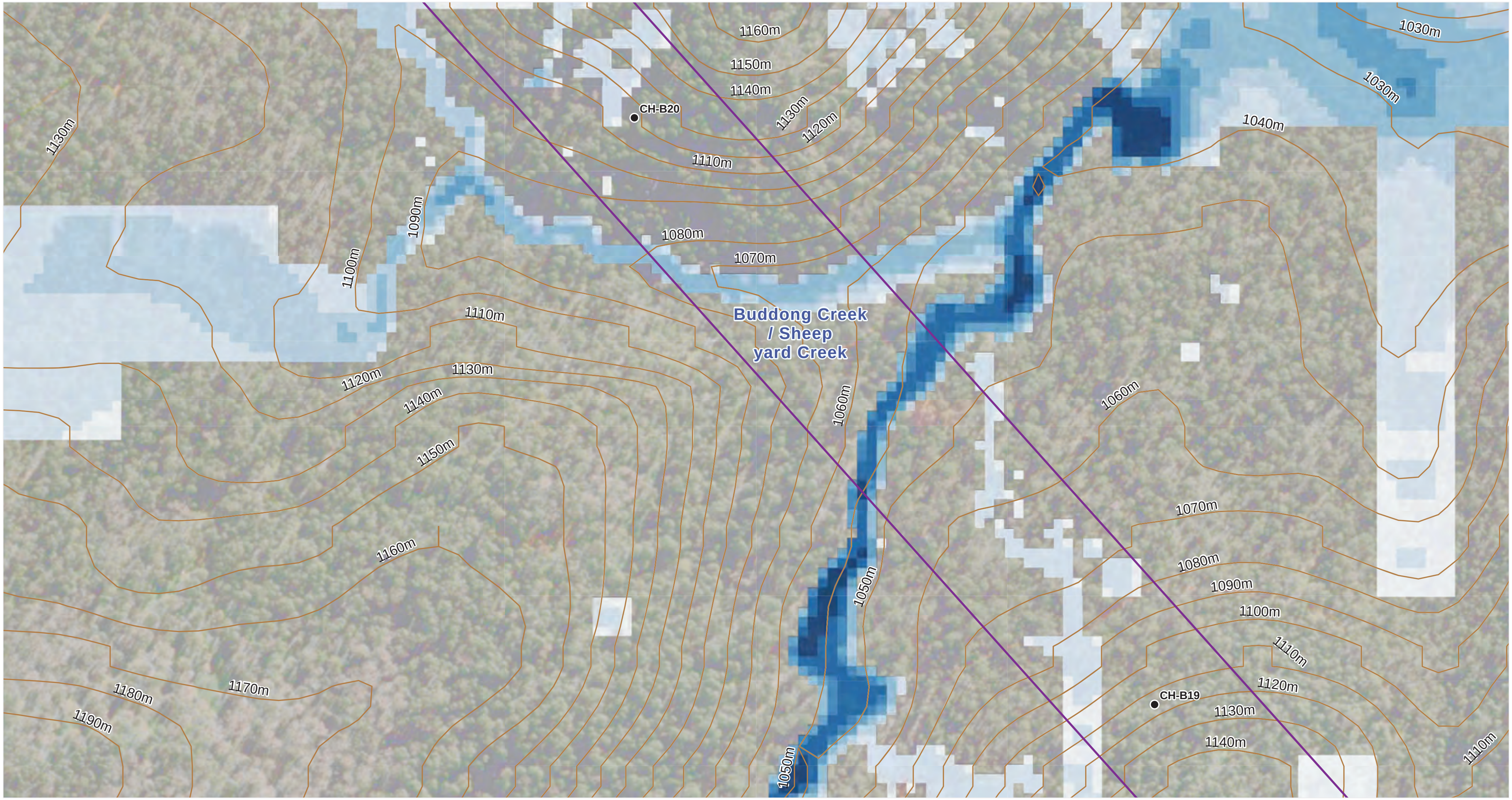


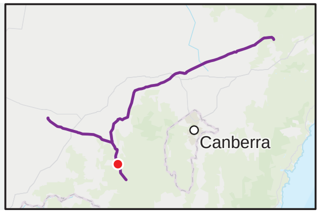
▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Depth (m)

⬜	<=0.03
⬜	0.03 - 0.1
🟦	0.10 - 0.25
🟦	0.25 - 0.5
🟦	0.50 - 0.75
🟦	0.75 - 1
🟦	1.00 - 1.5
🟦	>1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 16a: 1% AEP flood depth (m) at Buddong Creek / Sheep yard Creek - Murumbidgee Catchment

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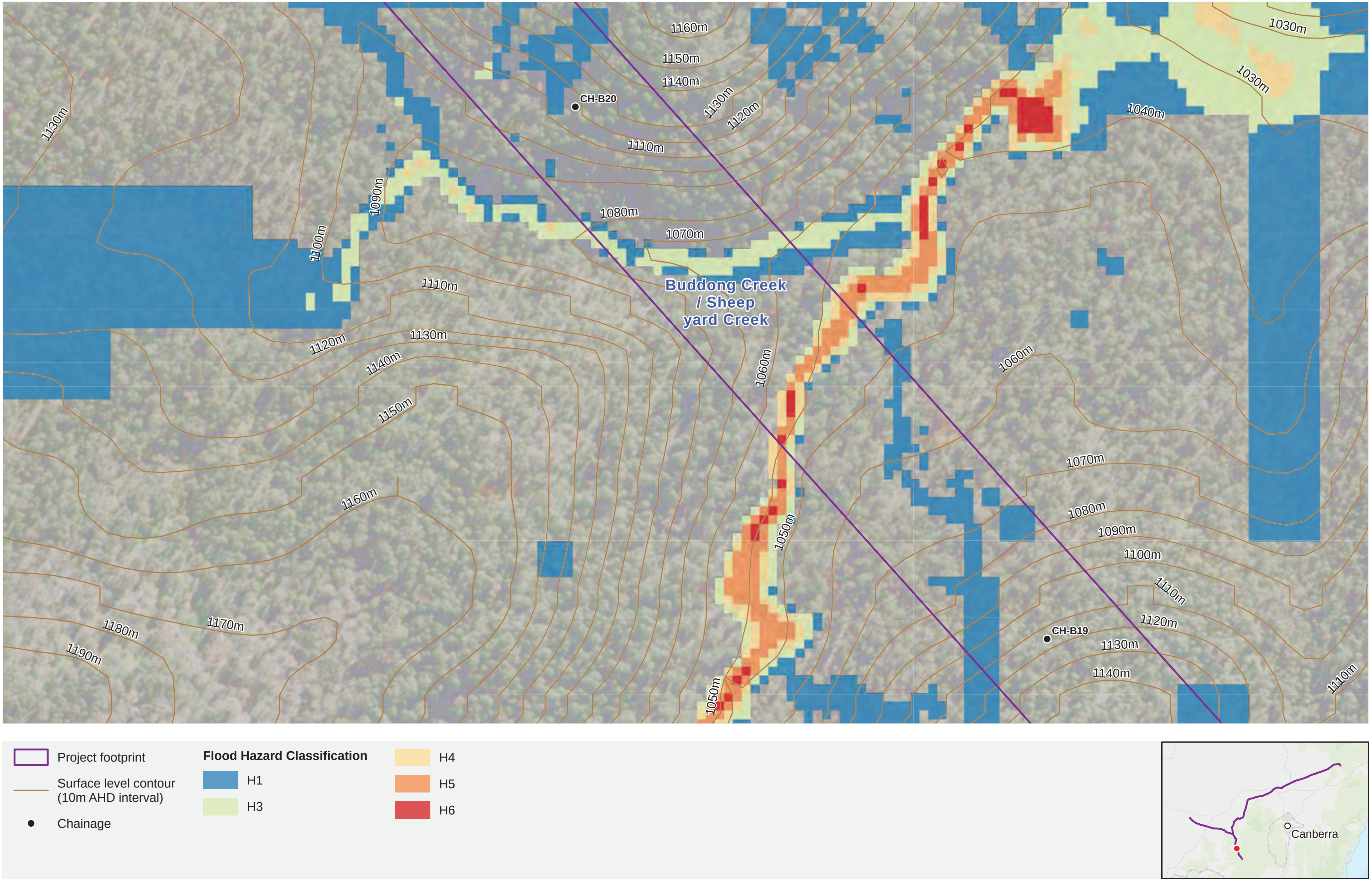

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 16b: ARR 2019 Flood Hazard Classification at Buddong Creek / Sheep yard Creek - Murumbidgee Catchment

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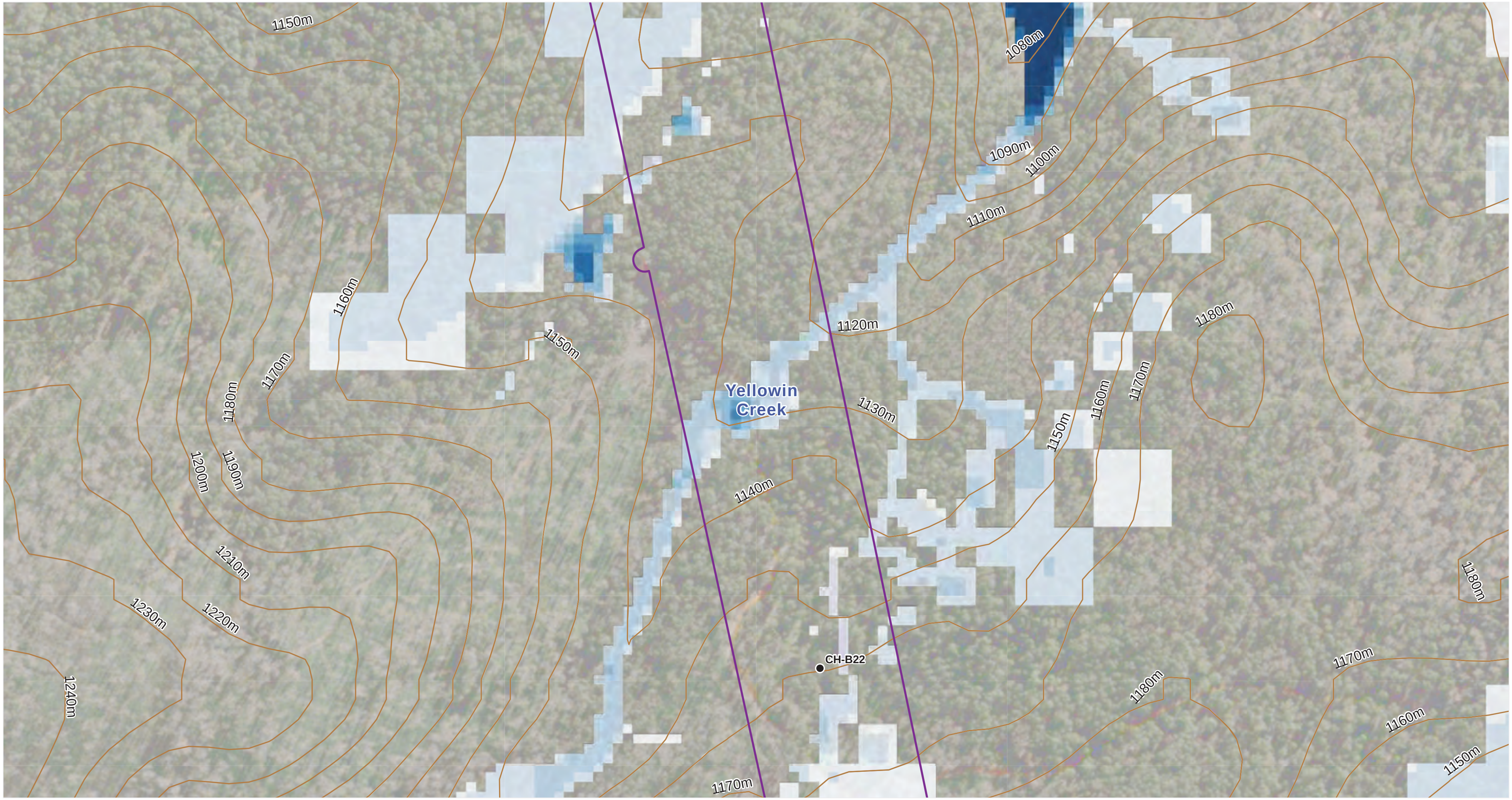
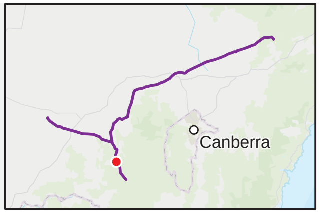


- ▭ Project footprint
- — Surface level contour (10m AHD interval)
- ● Chainage

Flood Depth (m)

- ▨ <=0.03
- ▨ 0.03 - 0.1
- ▨ 0.10 - 0.25
- ▨ 0.25 - 0.5
- ▨ 0.50 - 0.75
- ▨ 0.75 - 1
- ▨ 1.00 - 1.5
- ▨ >1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

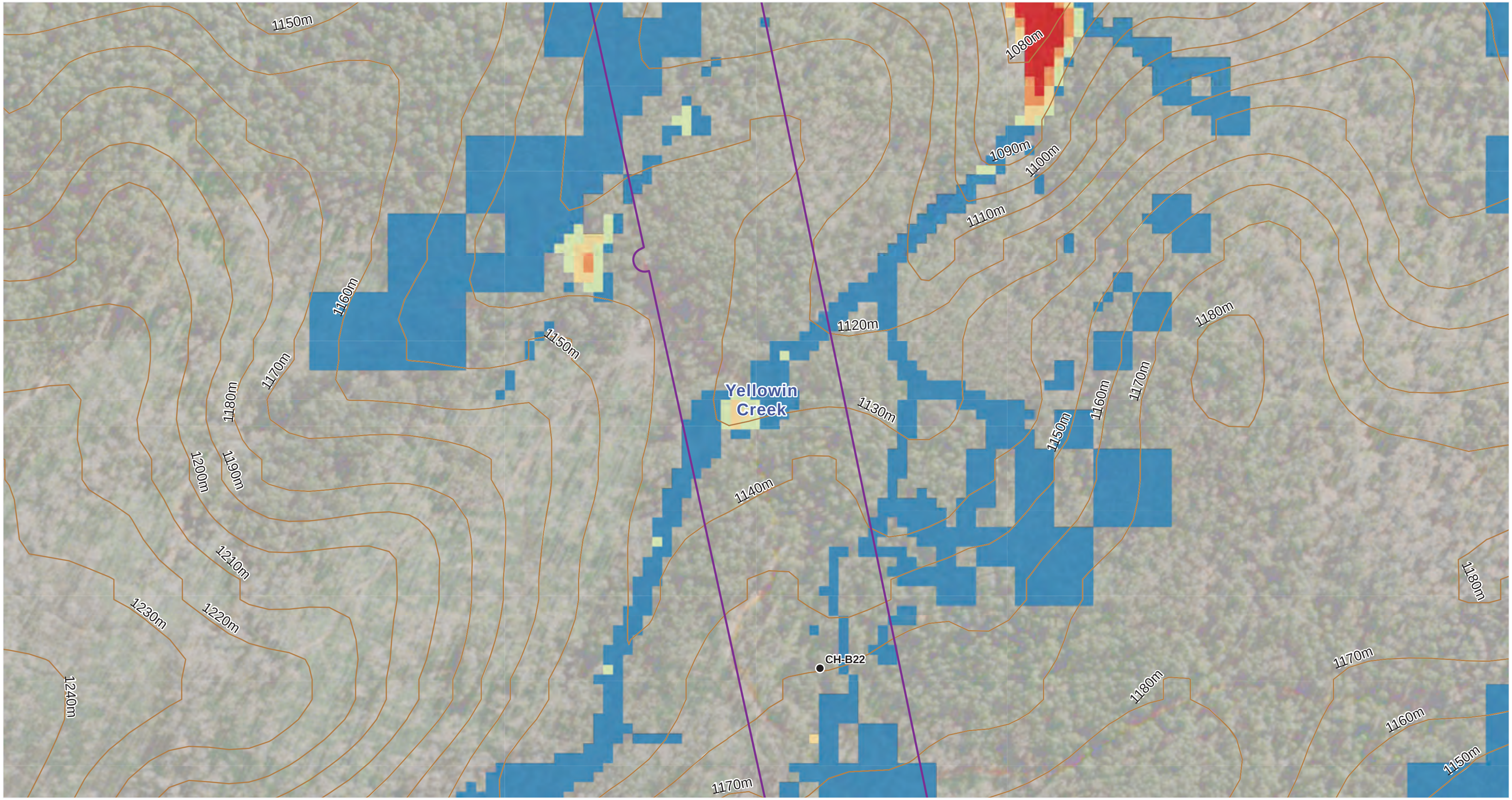
1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 17a: 1% AEP flood depth (m) at Yellowin Creek - Murumbidgee Catchment



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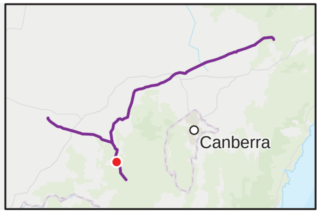
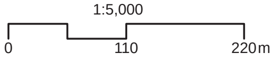
▭	Project footprint
—	Surface level contour (10m AHD interval)
●	Chainage

Flood Hazard Classification

🟦	H1
🟩	H3
🟨	H4
🟧	H5
🟥	H6



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*



Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 17b: ARR 2019 Flood Hazard Classification at Yellowin Creek - Murumbidgee Catchment

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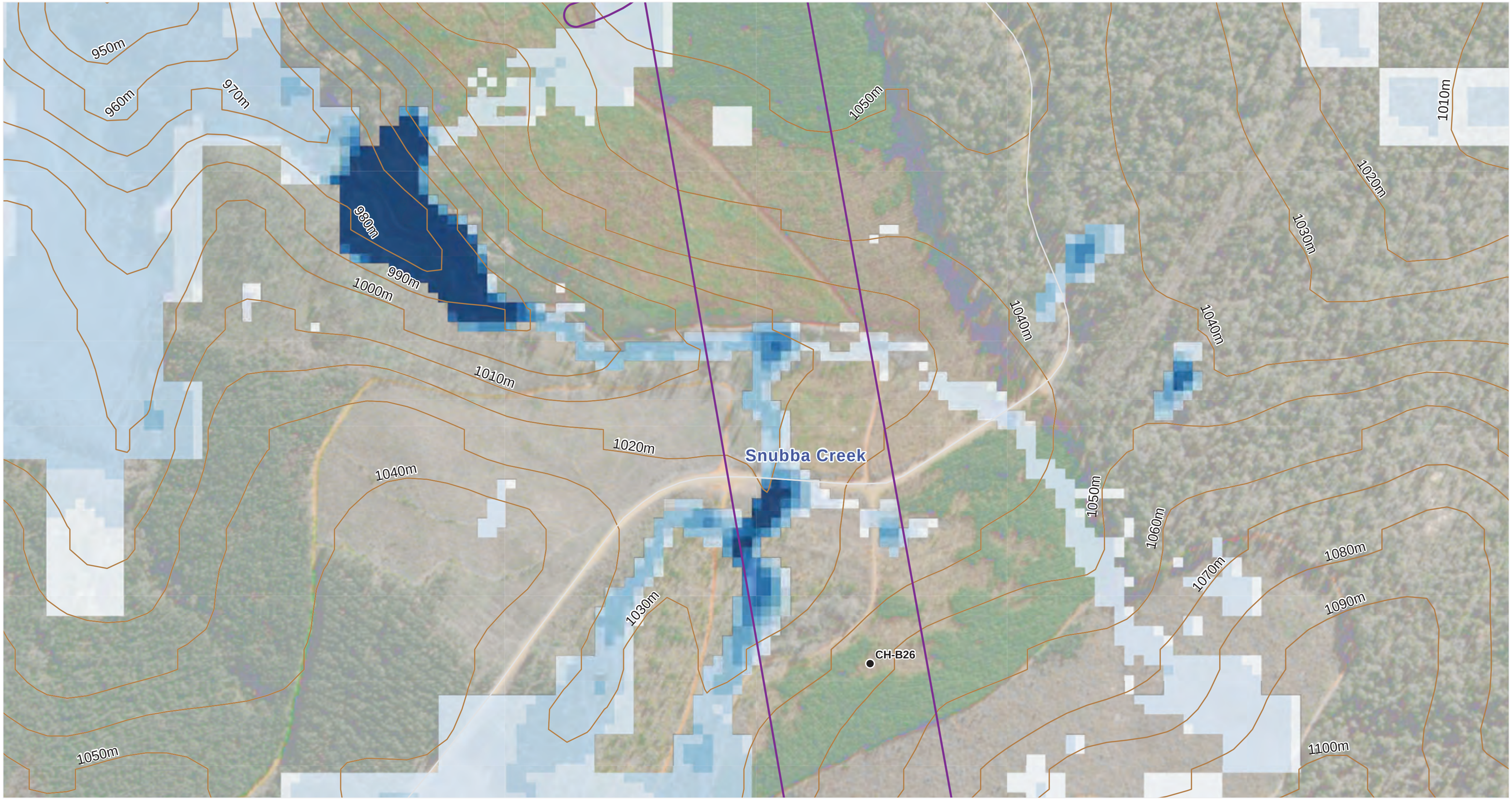


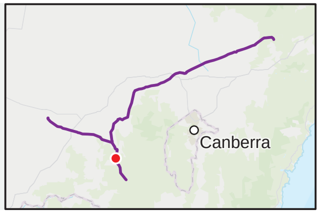
▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Depth (m)

- ▨ <=0.03
- ▨ 0.03 - 0.1
- ▨ 0.10 - 0.25
- ▨ 0.25 - 0.5
- ▨ 0.50 - 0.75
- ▨ 0.75 - 1
- ▨ 1.00 - 1.5
- ▨ >1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 18a: 1% AEP flood depth (m) at Snubba Creek - Murumbidgee Catchment

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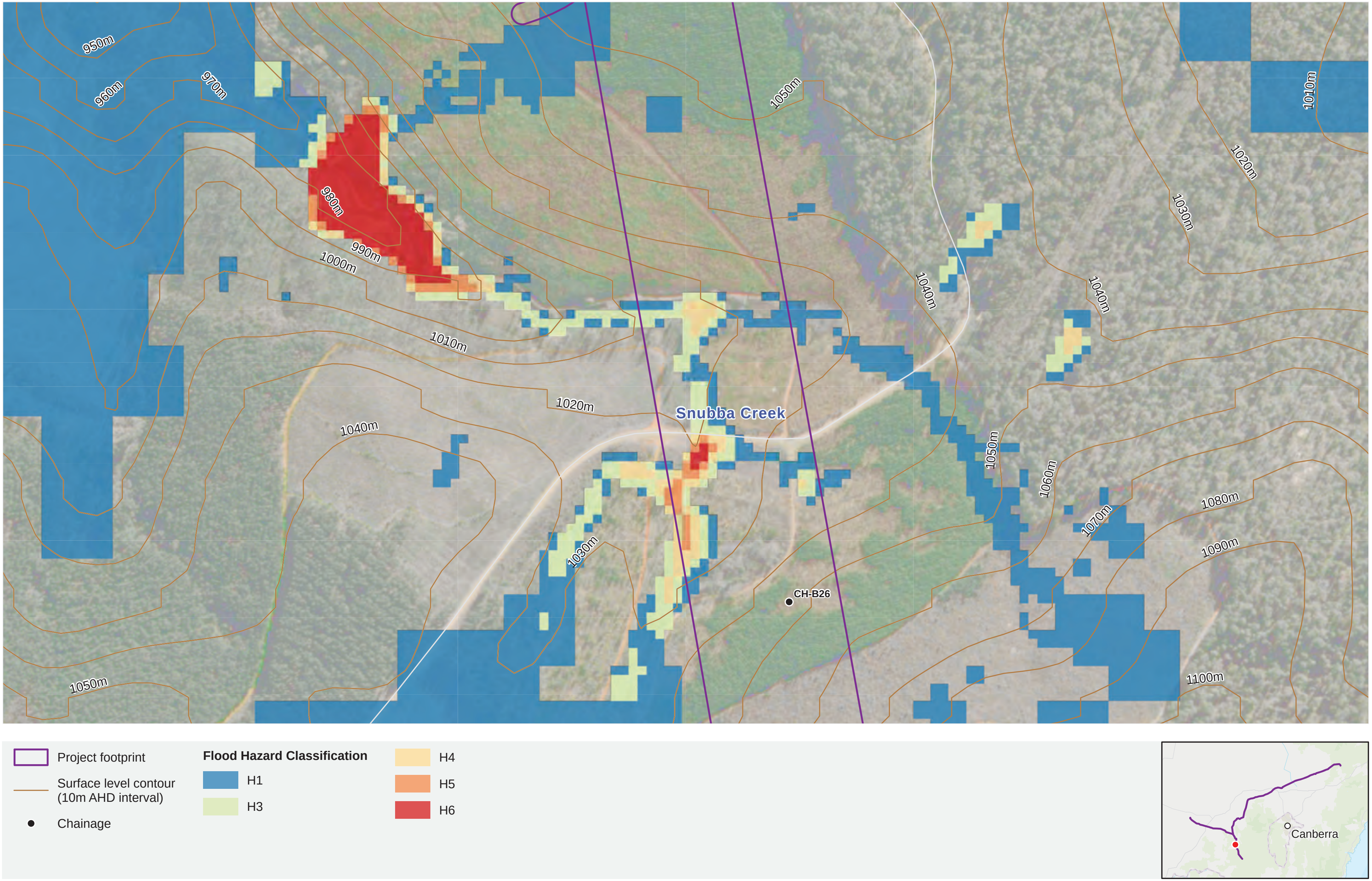

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 18b: ARR 2019 Flood Hazard Classification at Snubba Creek - Murumbidgee Catchment

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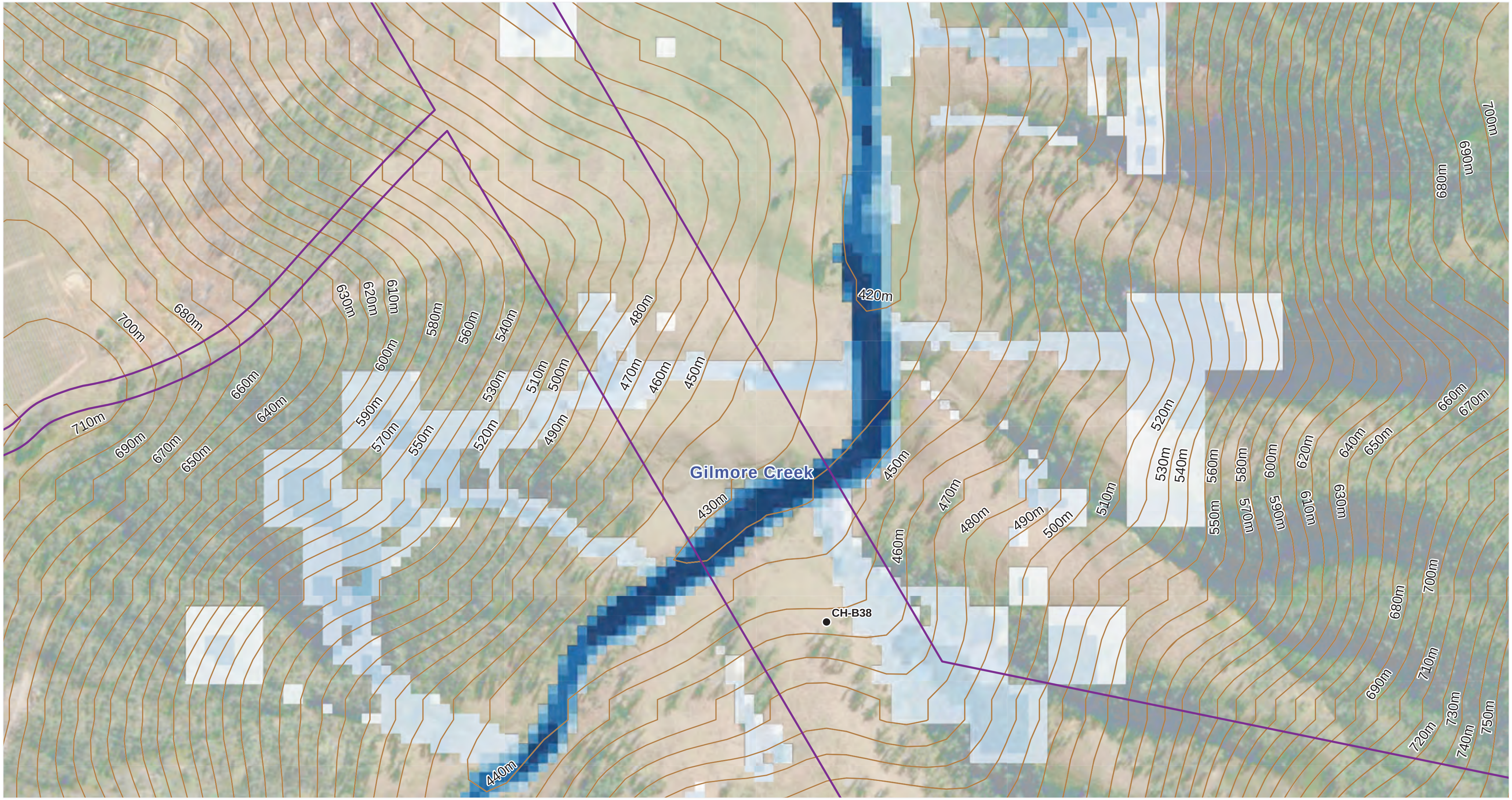
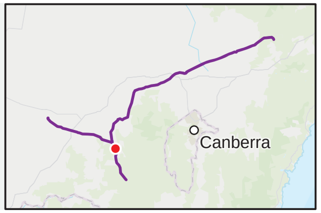


▭	Project footprint
—	Surface level contour (10m AHD interval)
●	Chainage

Flood Depth (m)

▢	<=0.03
▢	0.03 - 0.1
▢	0.10 - 0.25
▢	0.25 - 0.5
▢	0.50 - 0.75
▢	0.75 - 1
▢	1.00 - 1.5
▢	>1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 19a: 1% AEP flood depth (m) at Gilmore Creek - Murumbidgee Catchment

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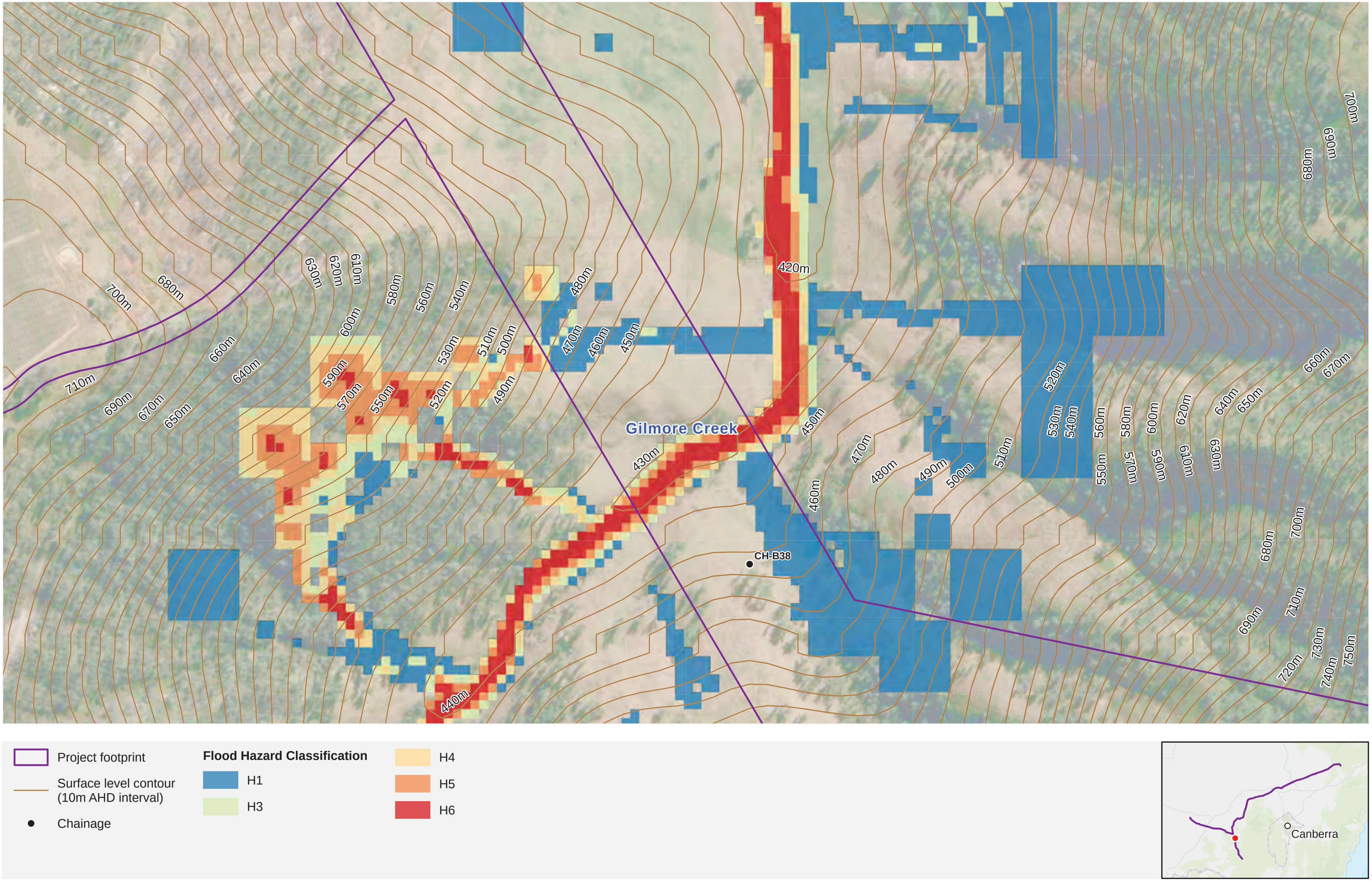


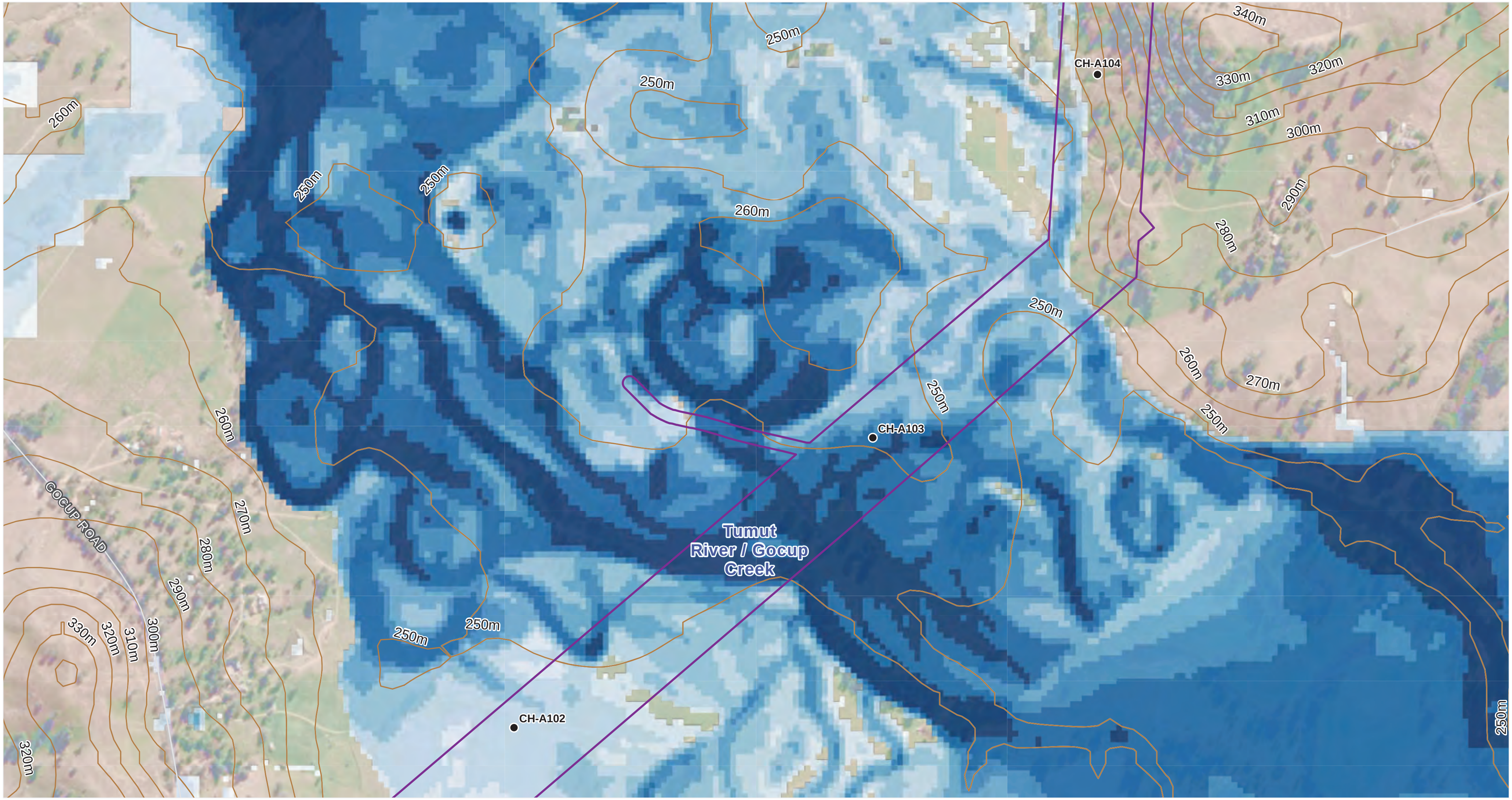
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

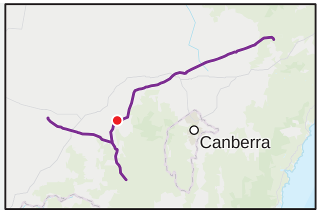
Map 19b: ARR 2019 Flood Hazard Classification at Gilmore Creek - Murumbidgee Catchment



▭	Project footprint
—	Surface level contour (10m AHD interval)
●	Chainage

Flood Depth (m)

▨	<=0.03
▨	0.03 - 0.1
▨	0.10 - 0.25
▨	0.25 - 0.5
▨	0.50 - 0.75
▨	0.75 - 1
▨	1.00 - 1.5
▨	>1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

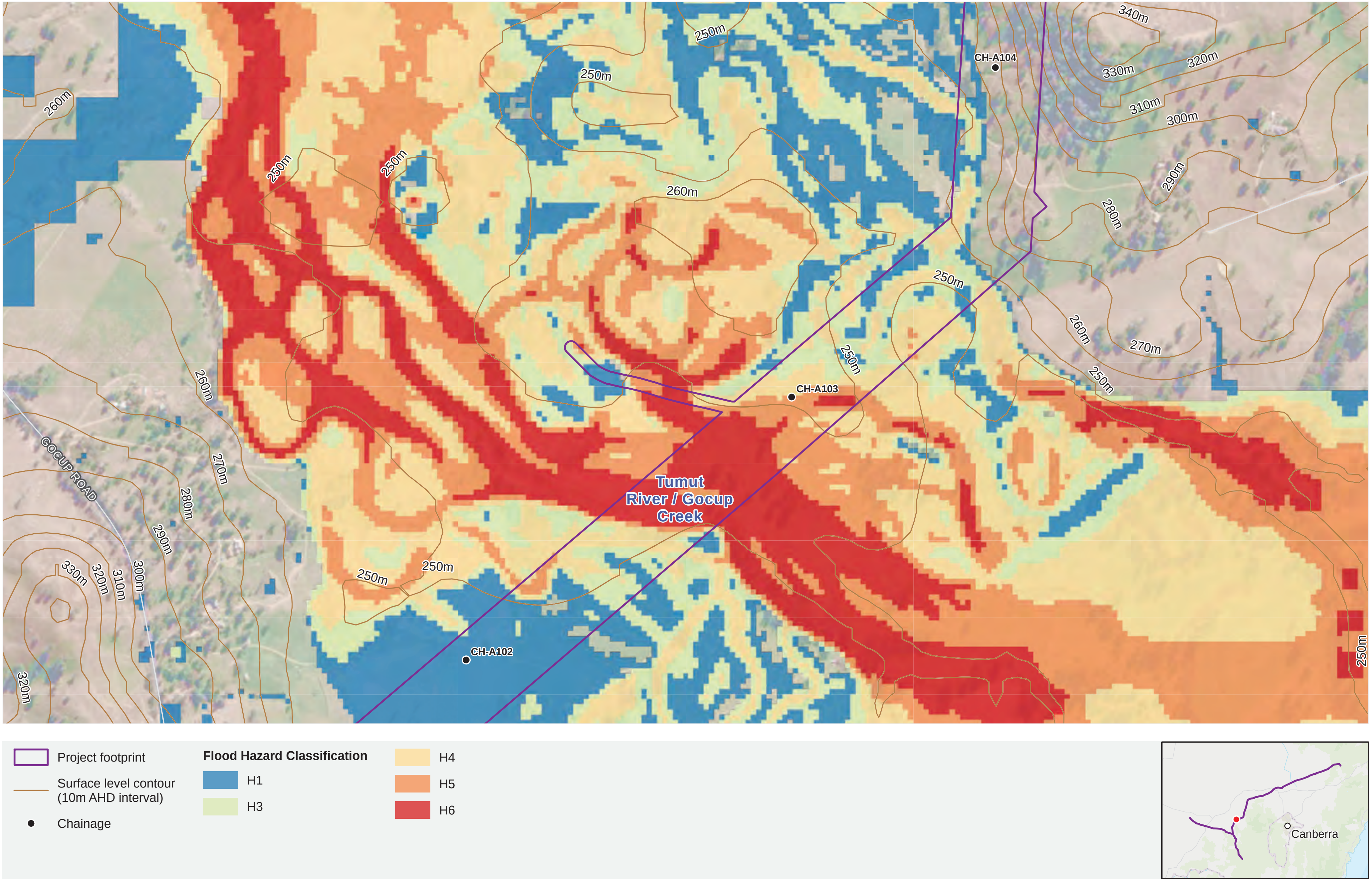
1:8,500

0 200 400m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 20a: 1% AEP flood depth (m) at Tumut River / Gocup Creek - Murumbidgee Catchment



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Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:8,500

0 200 400m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 20b: ARR 2019 Flood Hazard Classification at Tumut River / Gocup Creek - Murumbidgee Catchment

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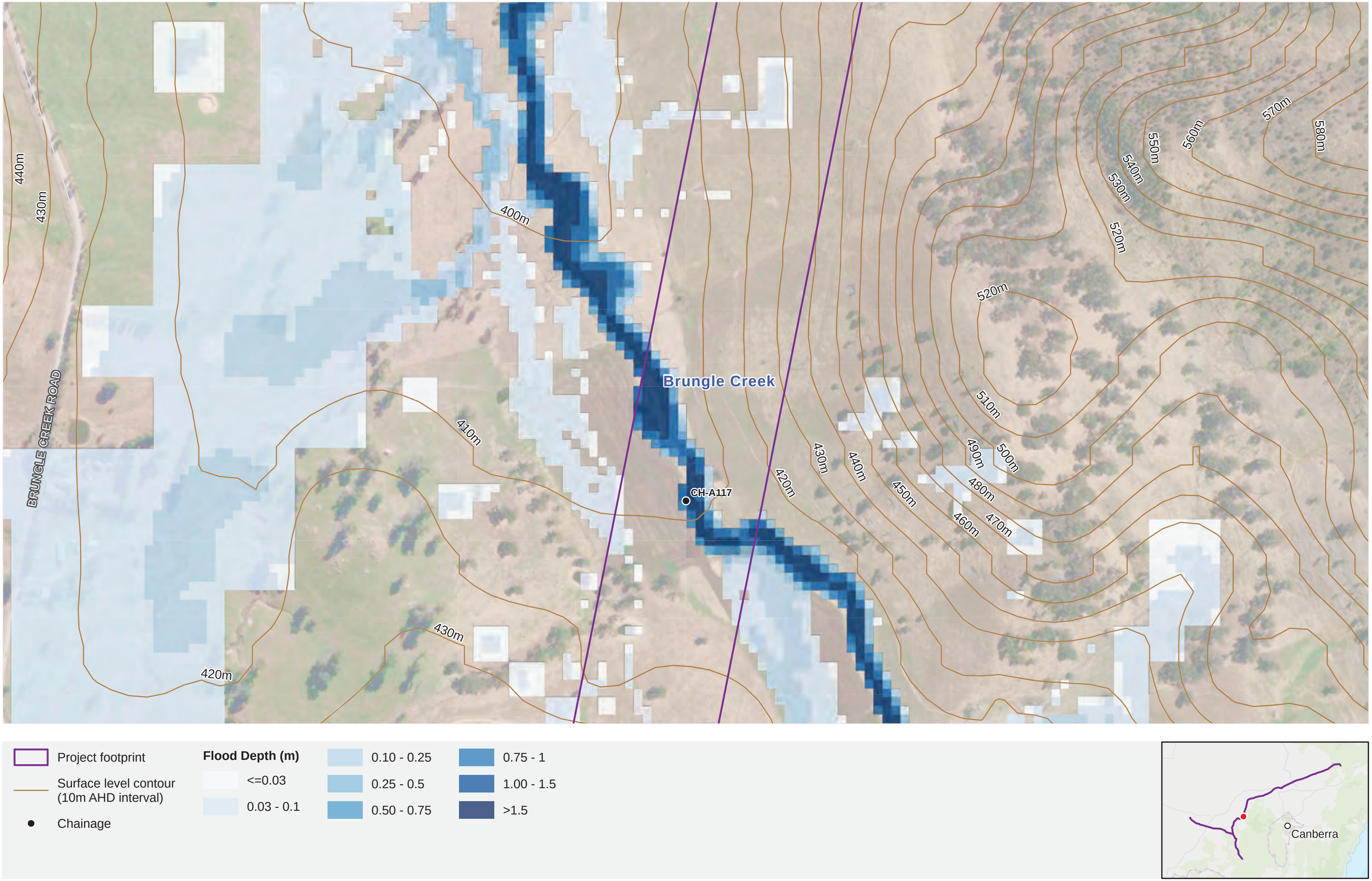

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 21a: 1% AEP flood depth (m) at Brungle Creek - Murumbidgee Catchment

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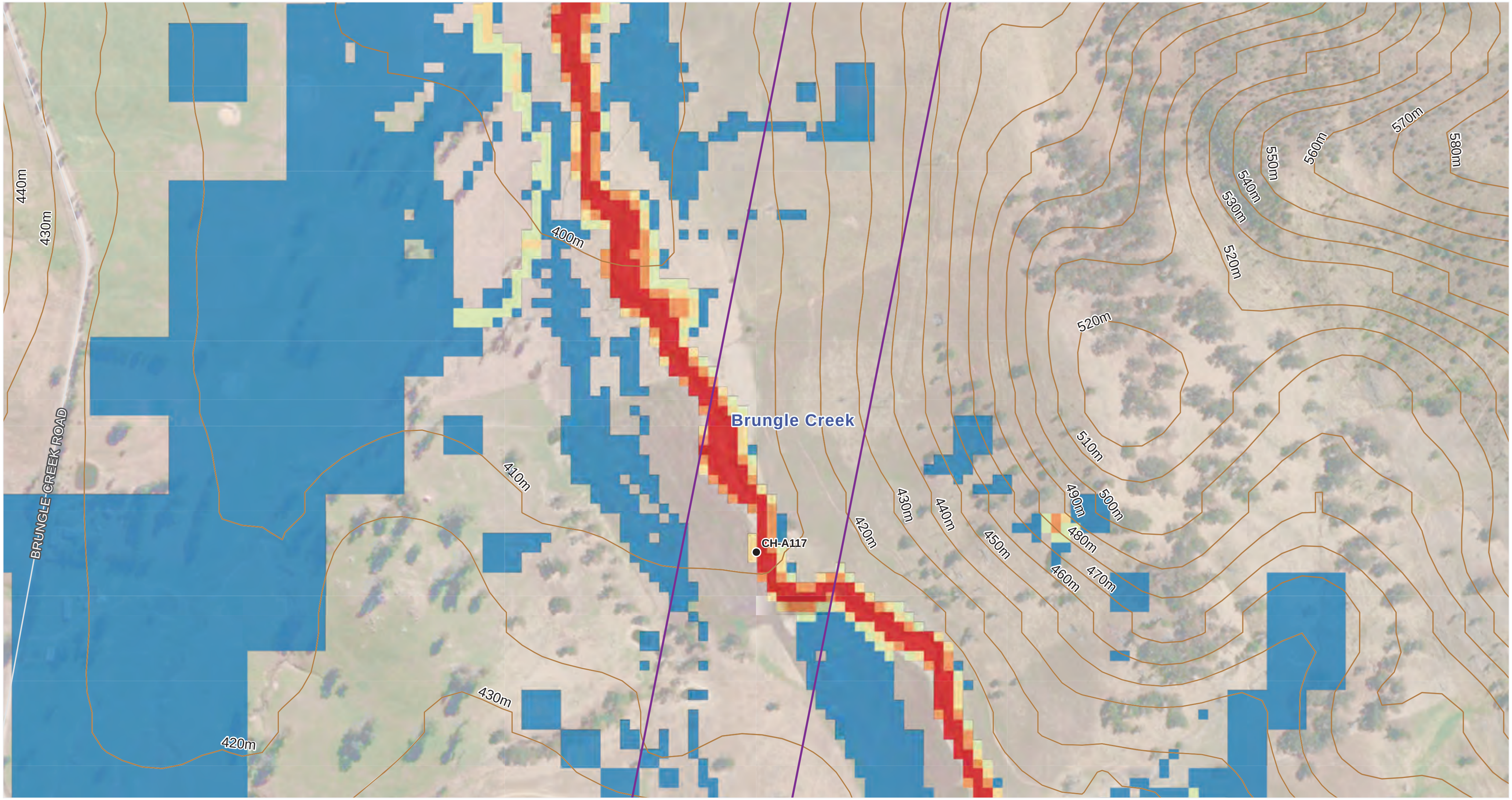


□ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Hazard Classification

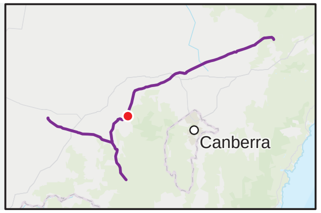
🟦 H1

🟩 H3

🟨 H4

🟧 H5

🟥 H6



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 21b: ARR 2019 Flood Hazard Classification at Brungle Creek - Murumbidgee Catchment

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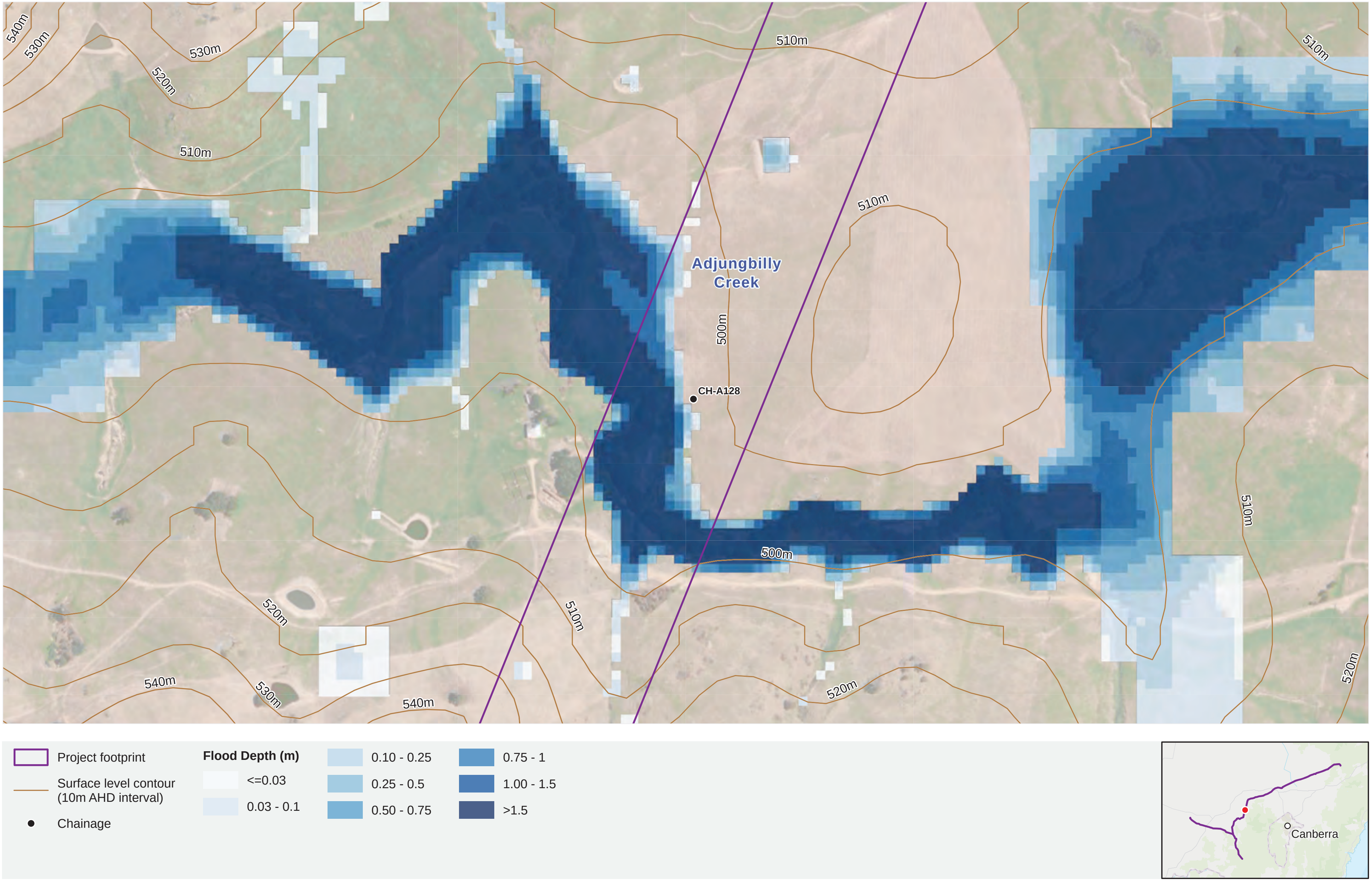

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 22a: 1% AEP flood depth (m) at Adjungbilly Creek - Murumbidgee Catchment

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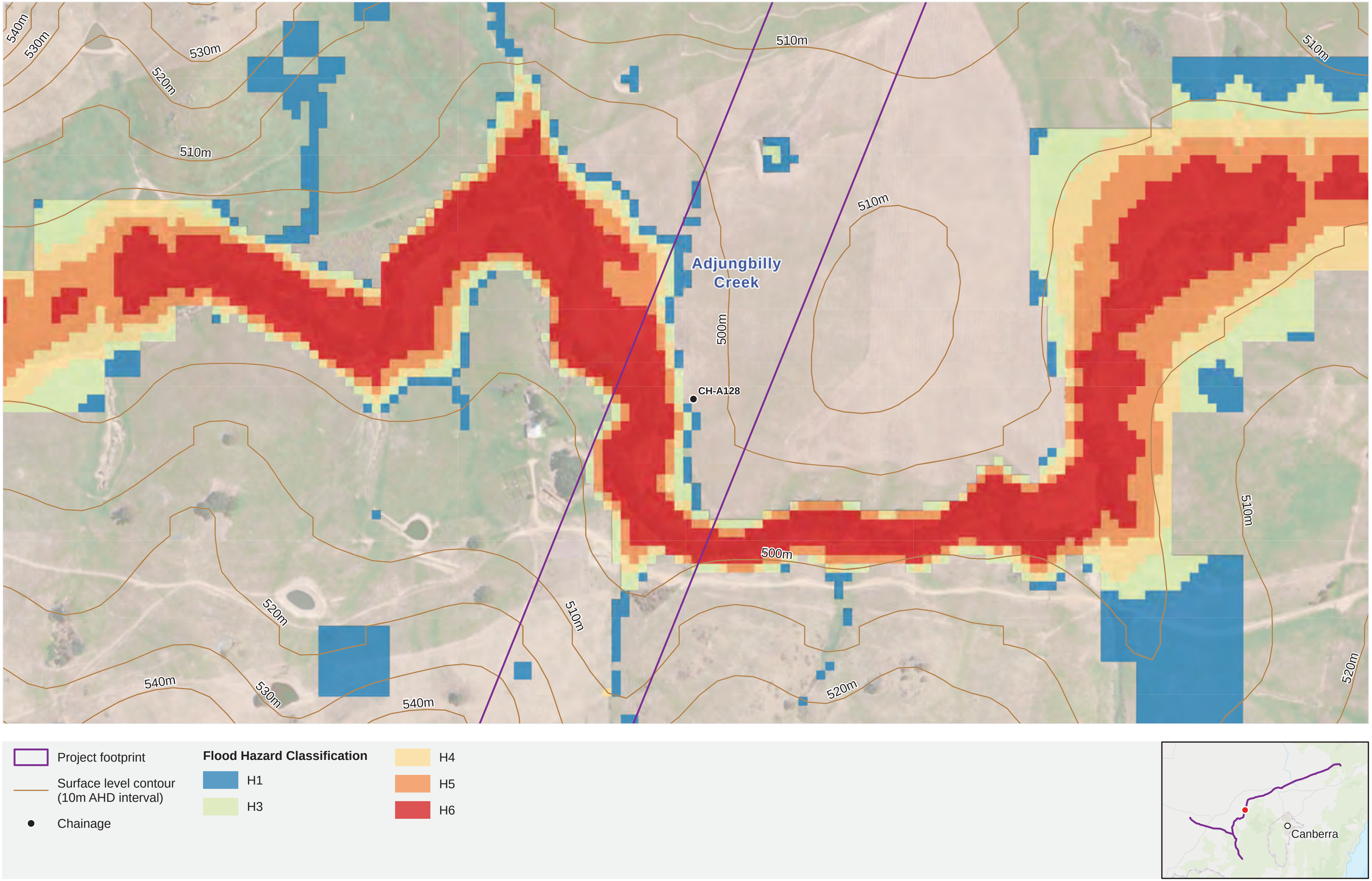

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

HumeLink **Hydrology and Flooding**

Projection: GDA 1994 MGA Zone 55

Map 22b: ARR 2019 Flood Hazard Classification at Adjungbilly Creek - Murumbidgee Catchment

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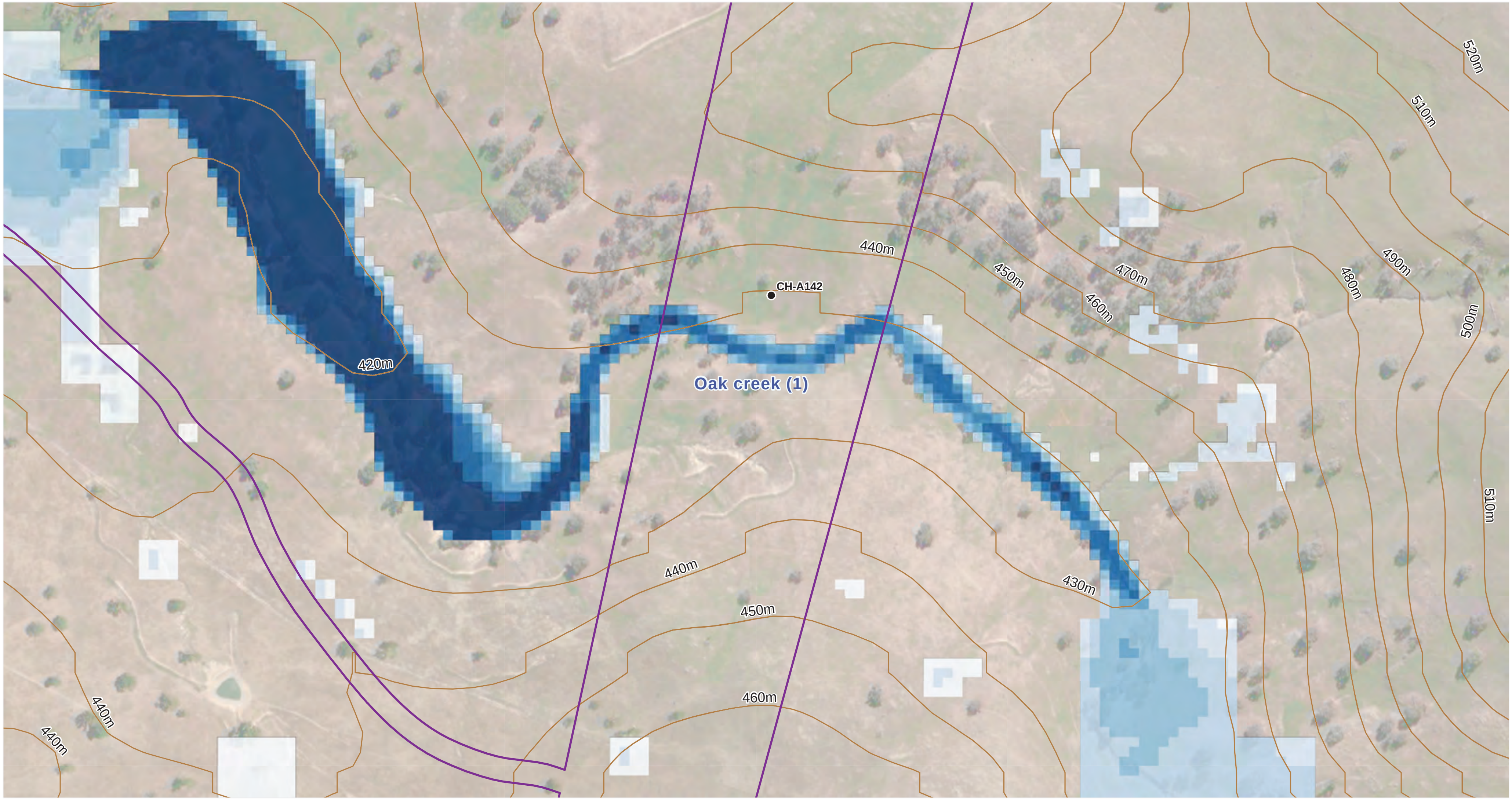


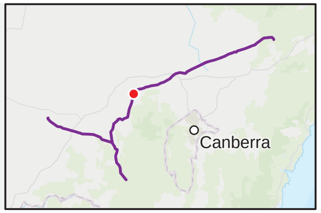
▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Depth (m)

- ▢ <=0.03
- ▢ 0.03 - 0.1
- 🟦 0.10 - 0.25
- 🟦 0.25 - 0.5
- 🟦 0.50 - 0.75
- 🟦 0.75 - 1
- 🟦 1.00 - 1.5
- 🟦 >1.5



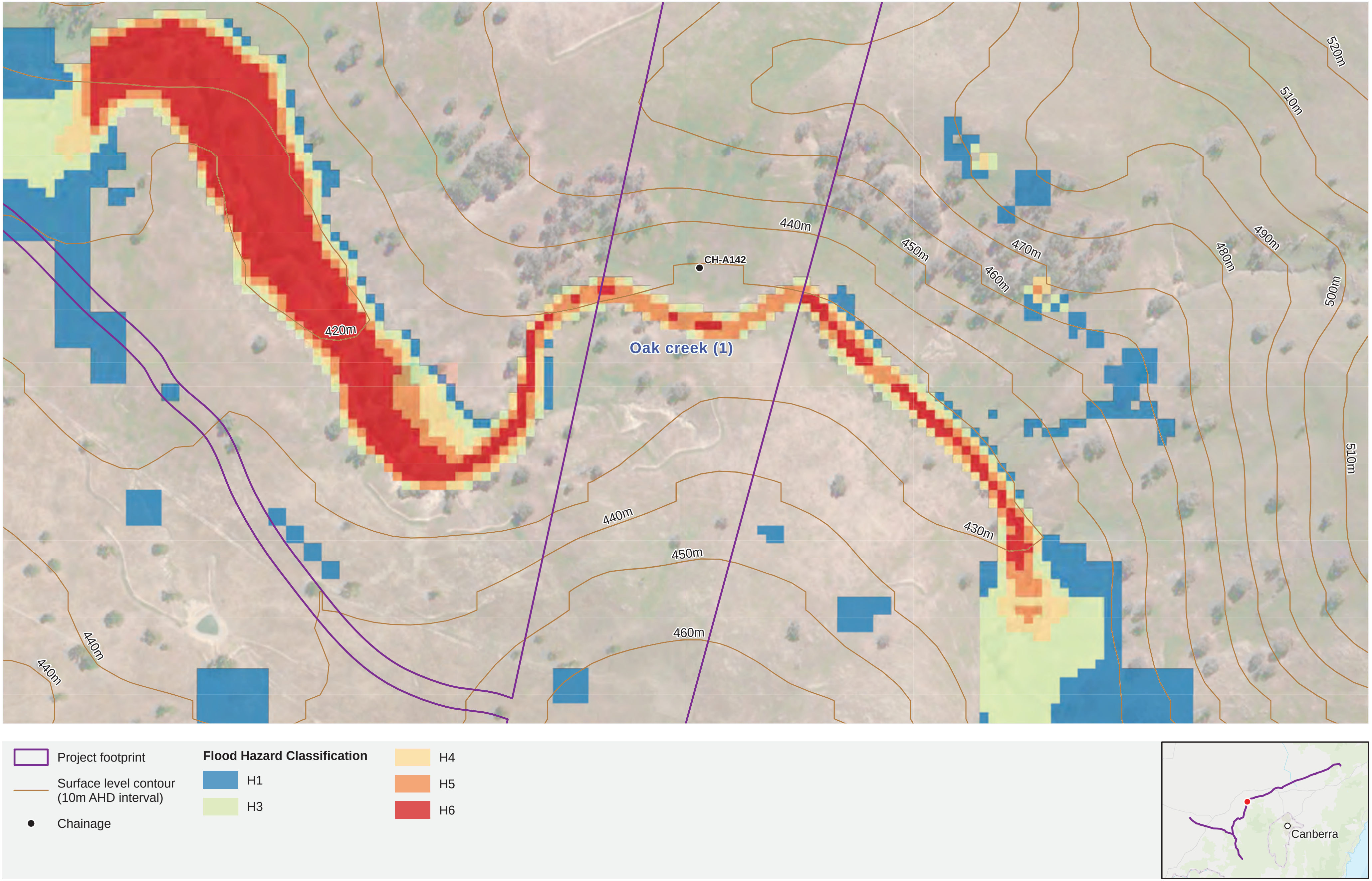
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 23a: 1% AEP flood depth (m) at Oak creek (1) - Murumbidgee Catchment



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Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 23b: ARR 2019 Flood Hazard Classification at Oak creek (1) - Murumbidgee Catchment

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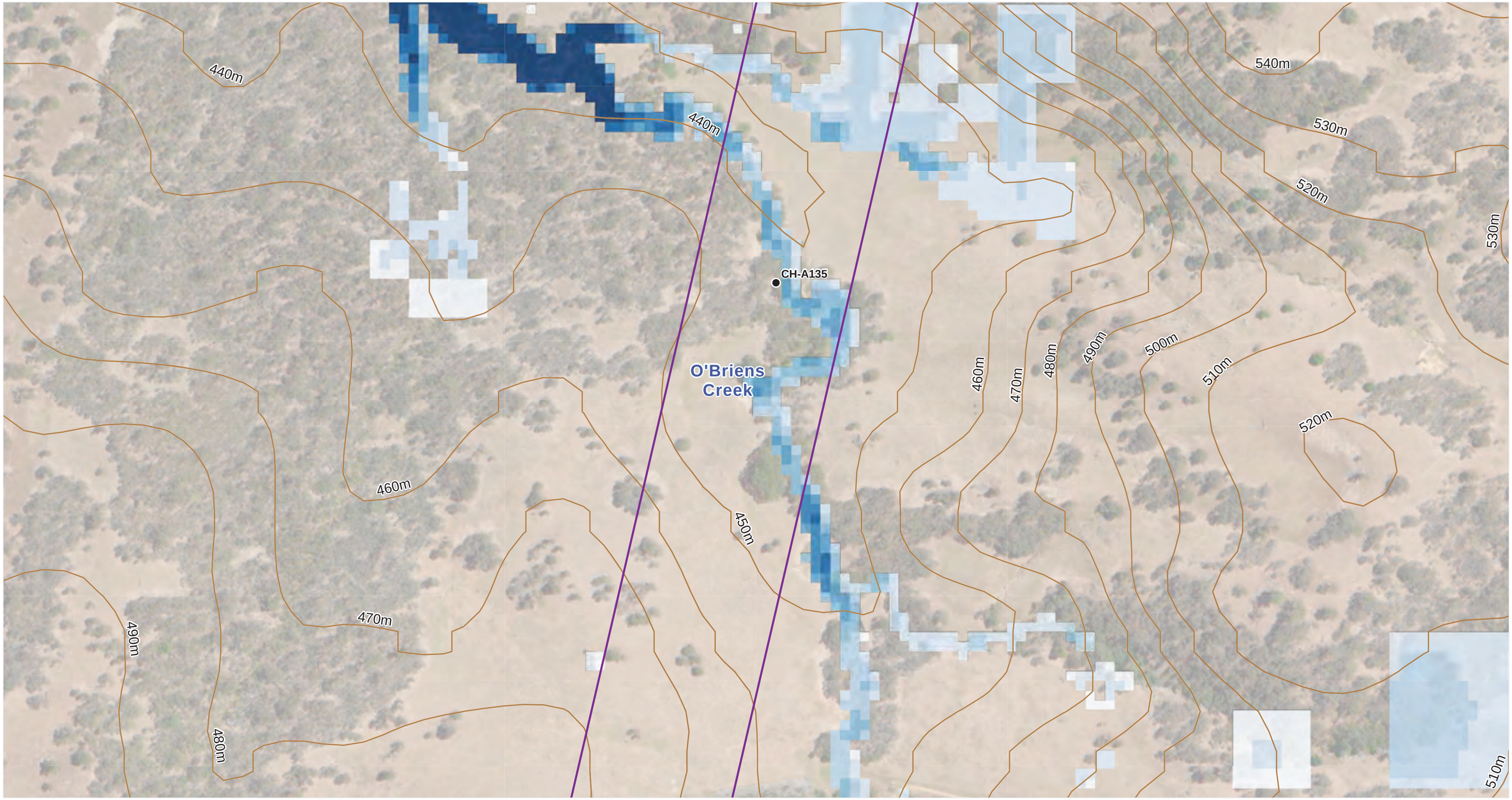


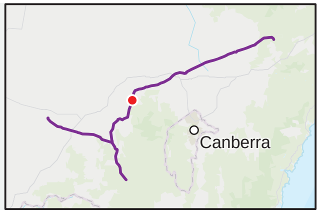
▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Depth (m)

- <=0.03
- 0.03 - 0.1
- 0.10 - 0.25
- 0.25 - 0.5
- 0.50 - 0.75
- 0.75 - 1
- 1.00 - 1.5
- >1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 24a: 1% AEP flood depth (m) at O'Briens Creek - Murumbidgee Catchment

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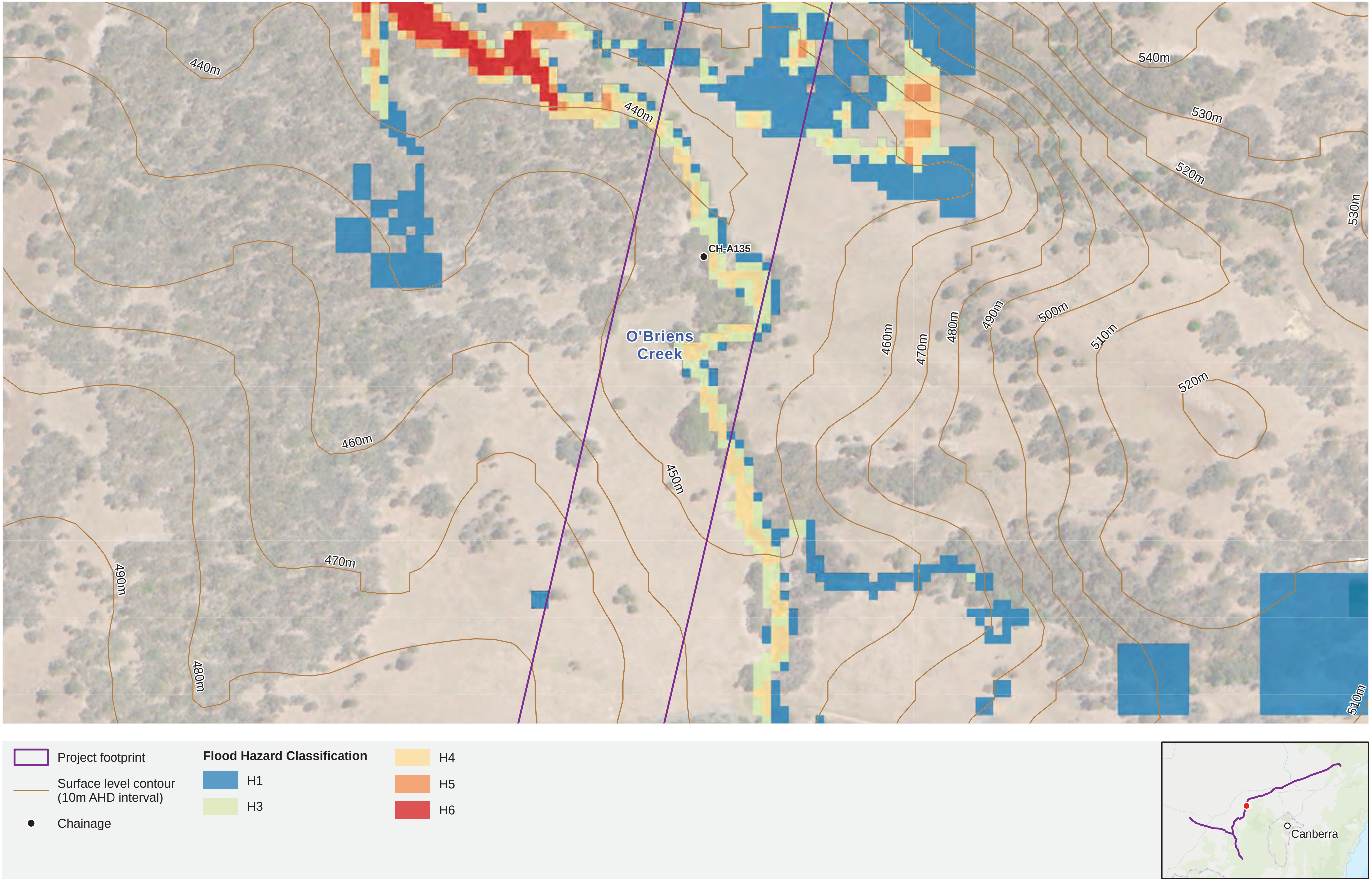


Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

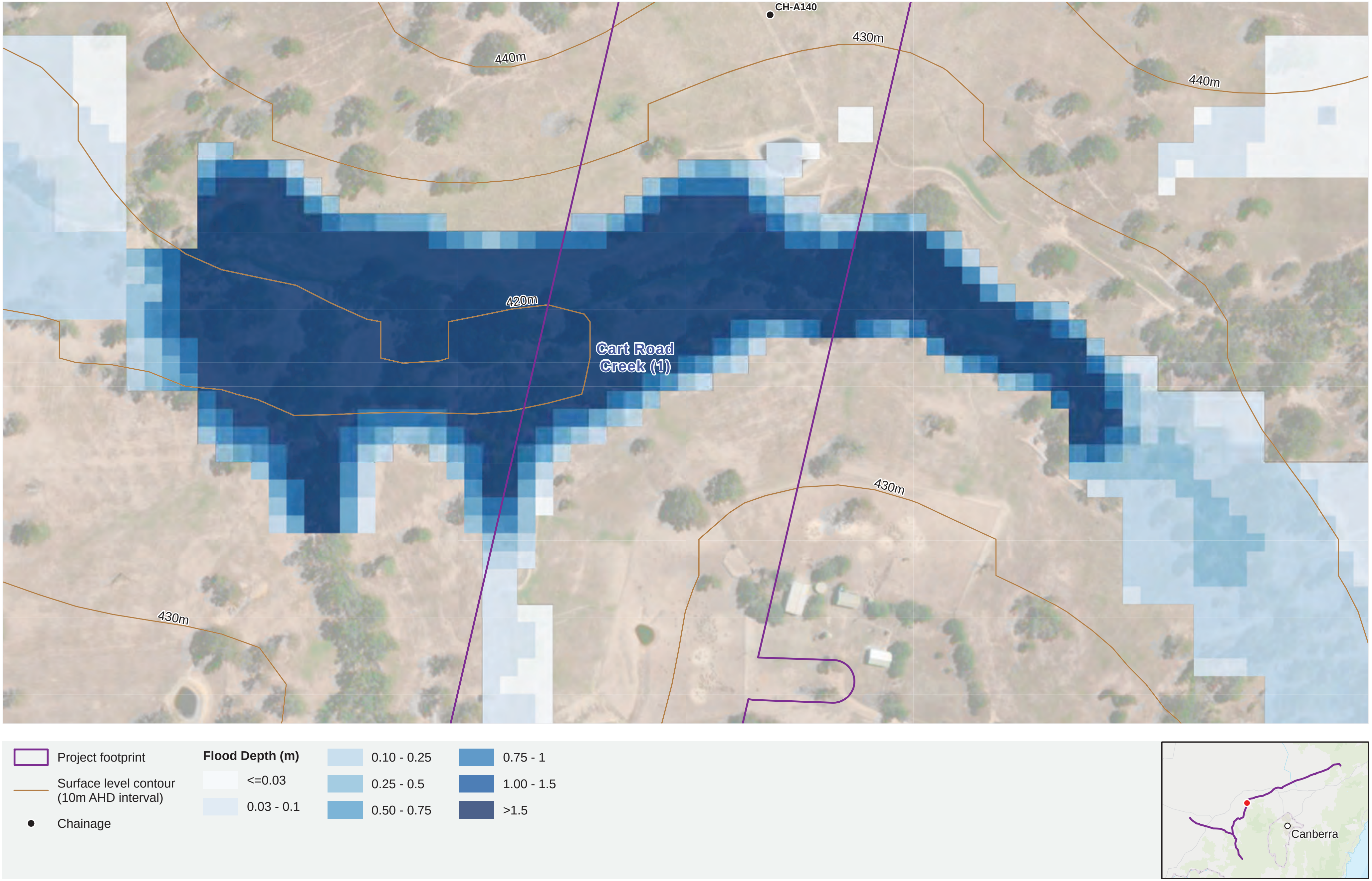
1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 24b: ARR 2019 Flood Hazard Classification at O'Briens Creek - Murumbidgee Catchment



Project footprint
Surface level contour (10m AHD interval)
● Chainage

Flood Depth (m)
<=0.03
0.03 - 0.1
0.10 - 0.25
0.25 - 0.5
0.50 - 0.75
0.75 - 1
1.00 - 1.5
>1.5

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

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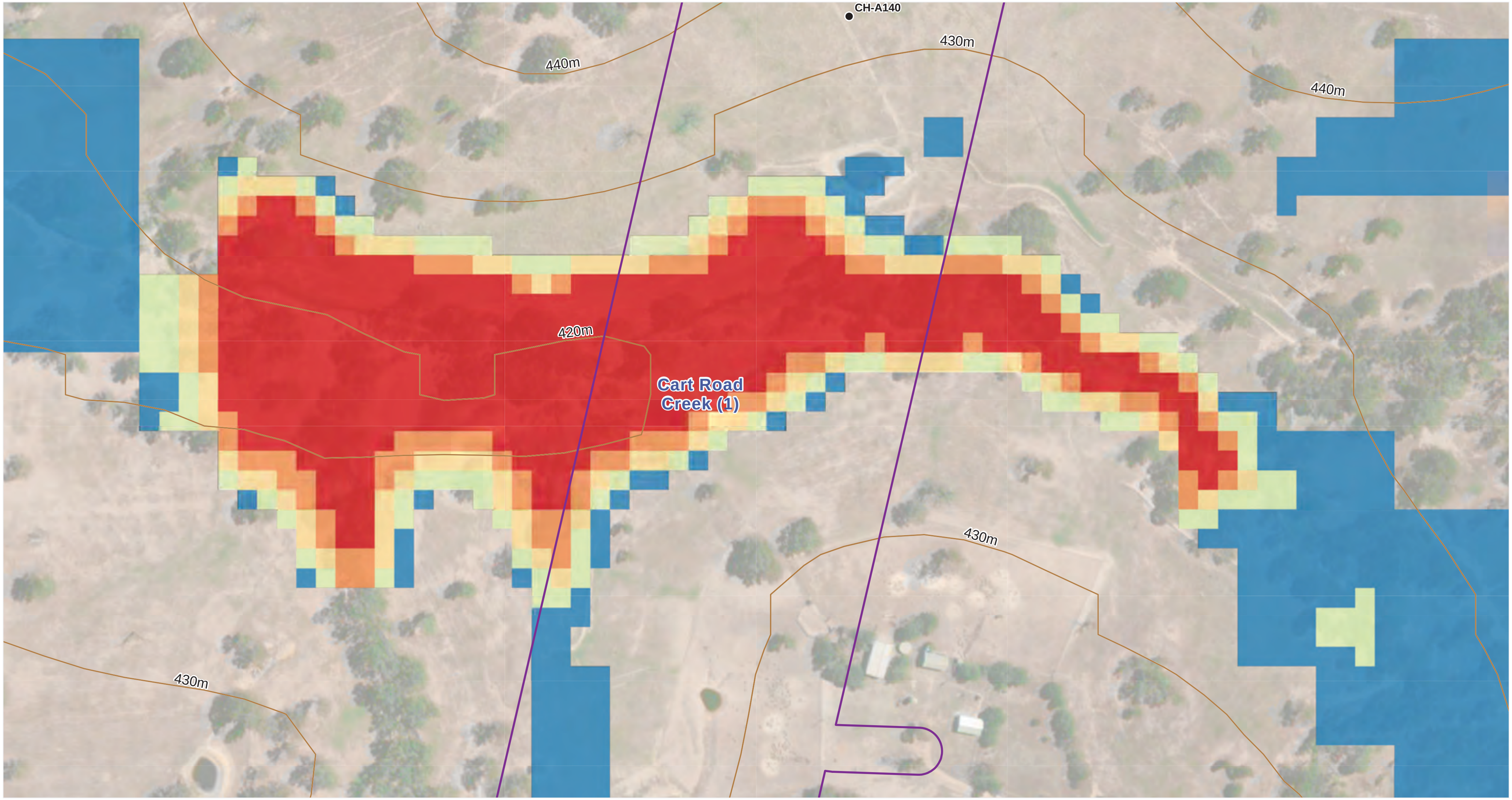
1:2,500
0 50 100m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 25a: 1% AEP flood depth (m) at Cart Road Creek (1) - Murumbidgee Catchment



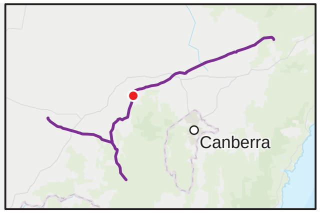
▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Hazard Classification

- 🟦 H1
- 🟩 H3
- 🟨 H4
- 🟧 H5
- 🟥 H6



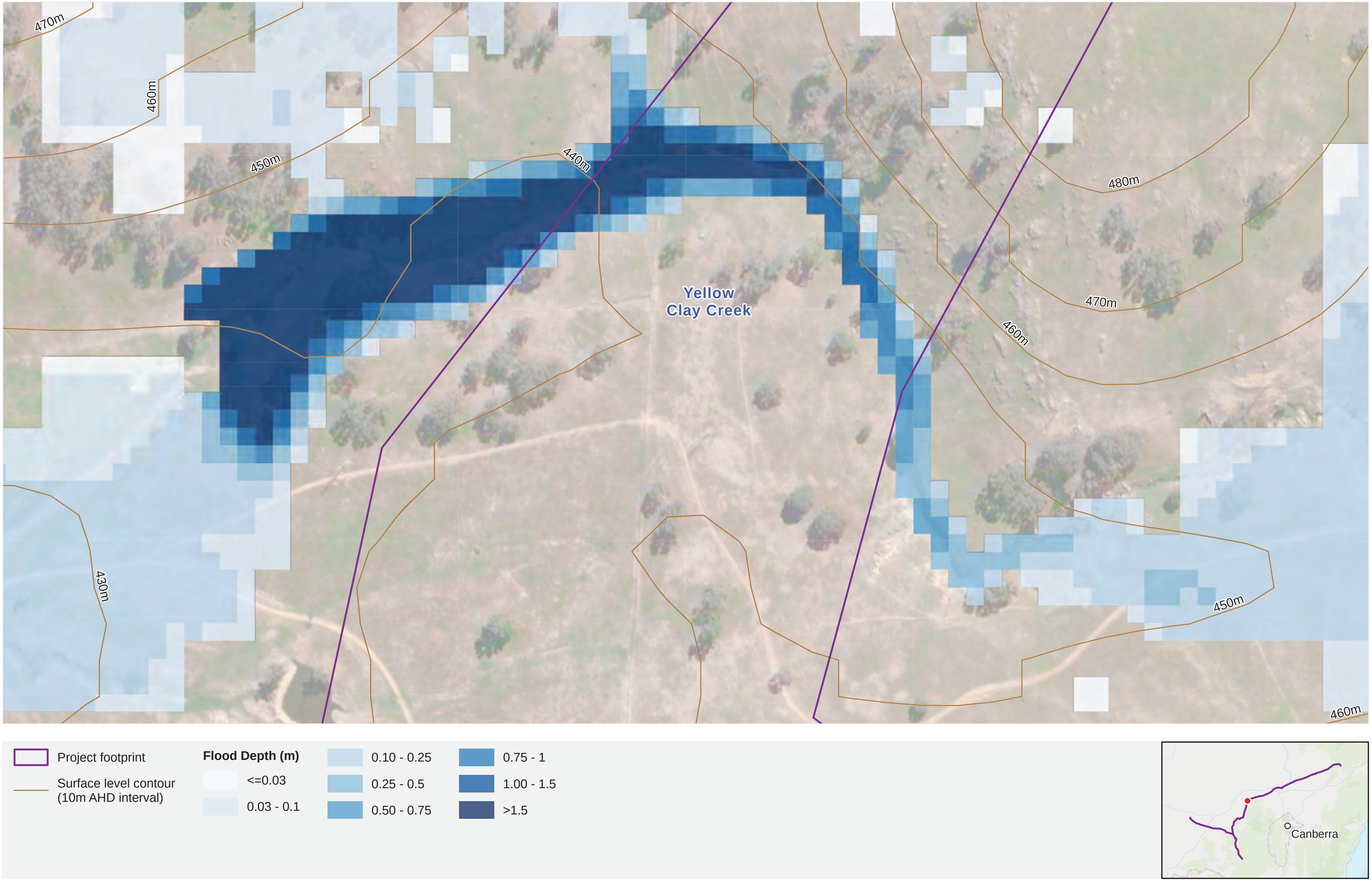
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:2,500
0 50 100m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 25b: ARR 2019 Flood Hazard Classification at Cart Road Creek (1) - Murumbidgee Catchment



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:2,500

0 50 100m

Projection: GDA 1994 MGA Zone 55

Map 26a: 1% AEP flood depth (m) at Yellow Clay Creek - Murumbidgee Catchment

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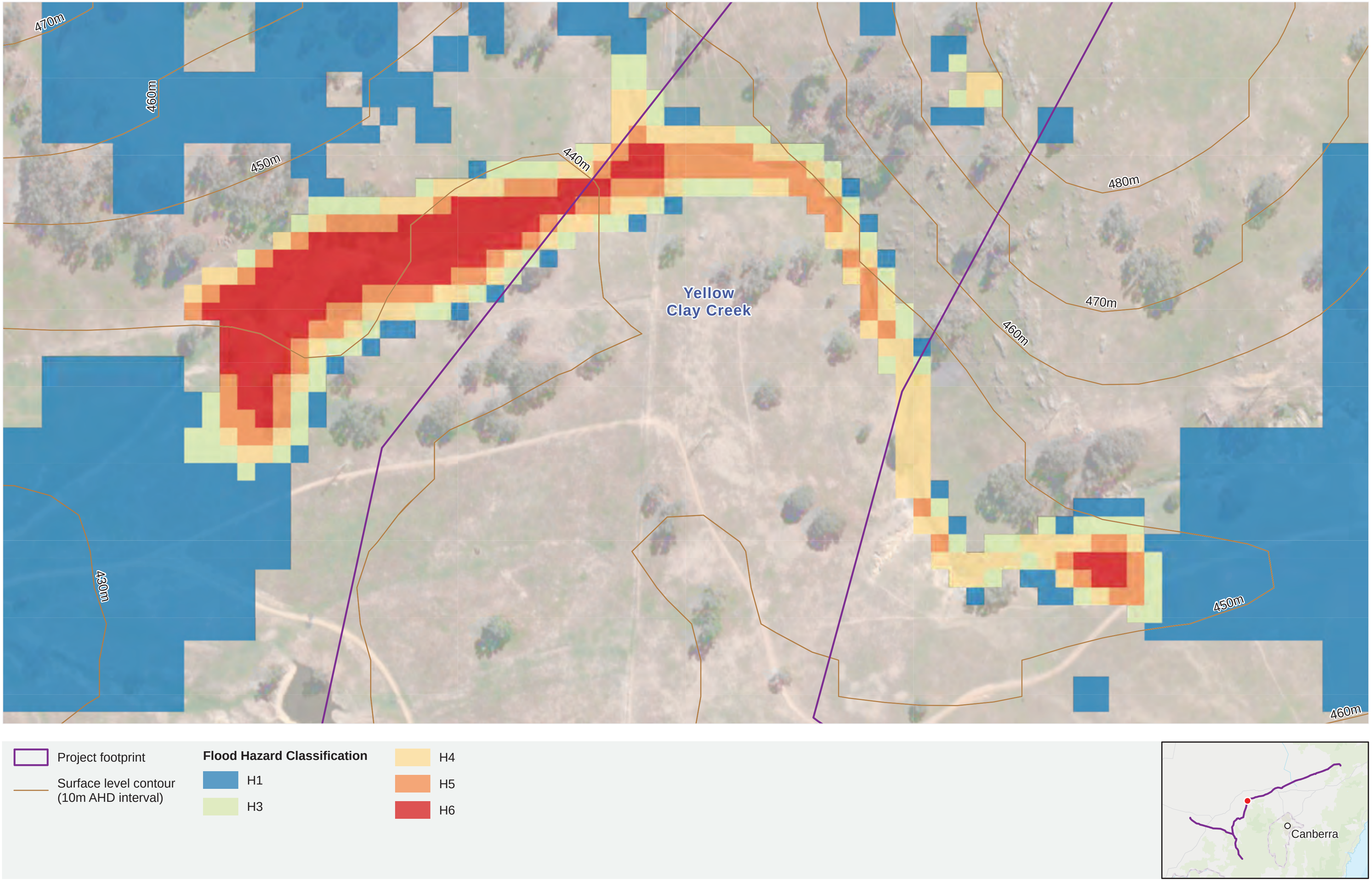


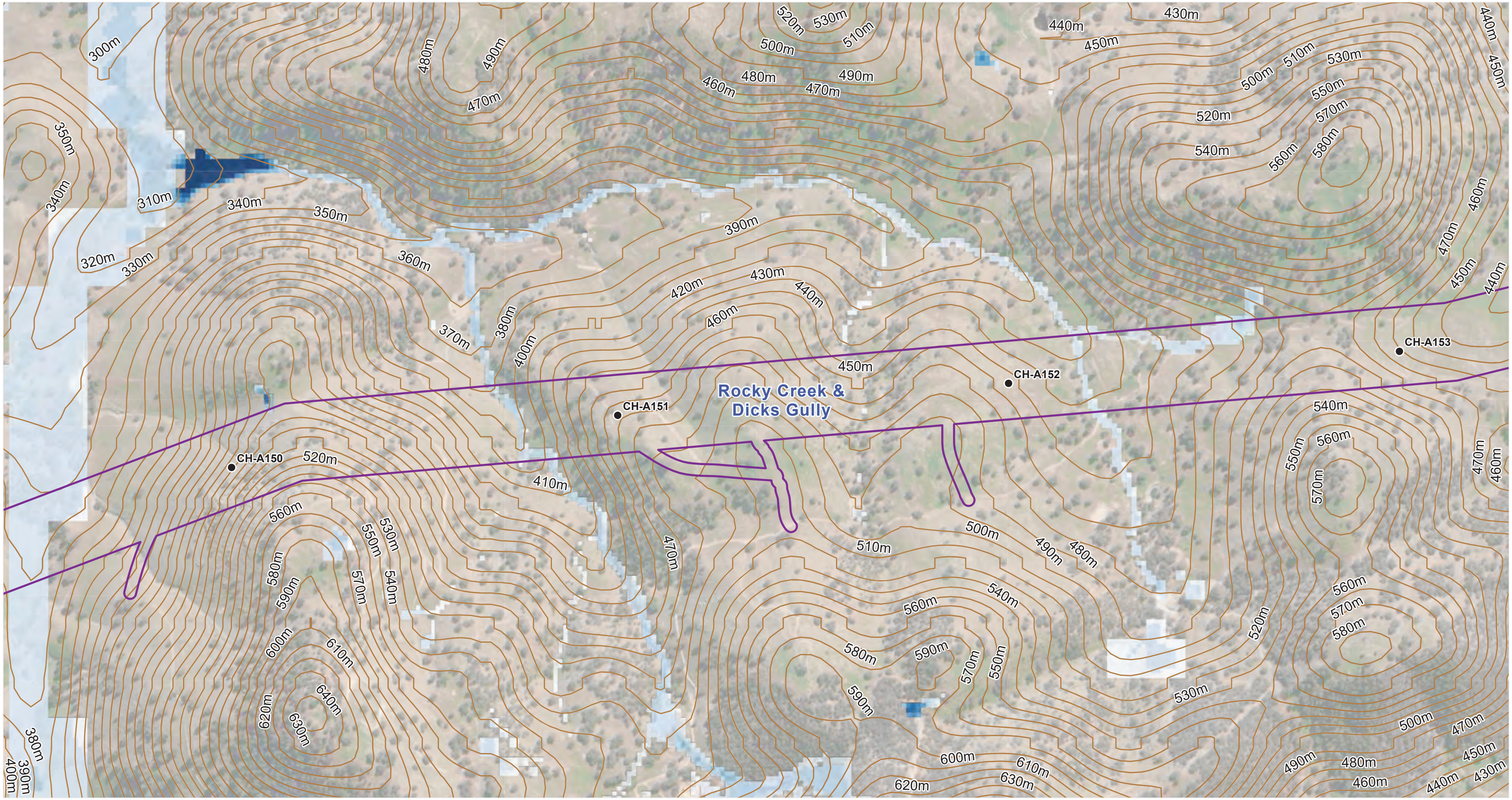
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:2,500
0 50 100m

HumeLink **Hydrology and Flooding**

Projection: GDA 1994 MGA Zone 55

Map 26b: ARR 2019 Flood Hazard Classification at Yellow Clay Creek - Murumbidgee Catchment



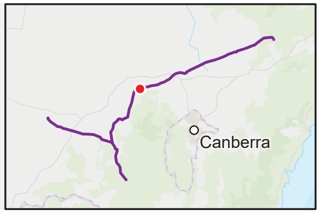
▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Depth (m)

▭	<=0.03
▭	0.03 - 0.1
▭	0.10 - 0.25
▭	0.25 - 0.5
▭	0.50 - 0.75
▭	0.75 - 1
▭	1.00 - 1.5
▭	>1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:10,000

0 230 460m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 27a: 1% AEP flood depth (m) at Rocky Creek & Dicks Gully - Murumbidgee Catchment

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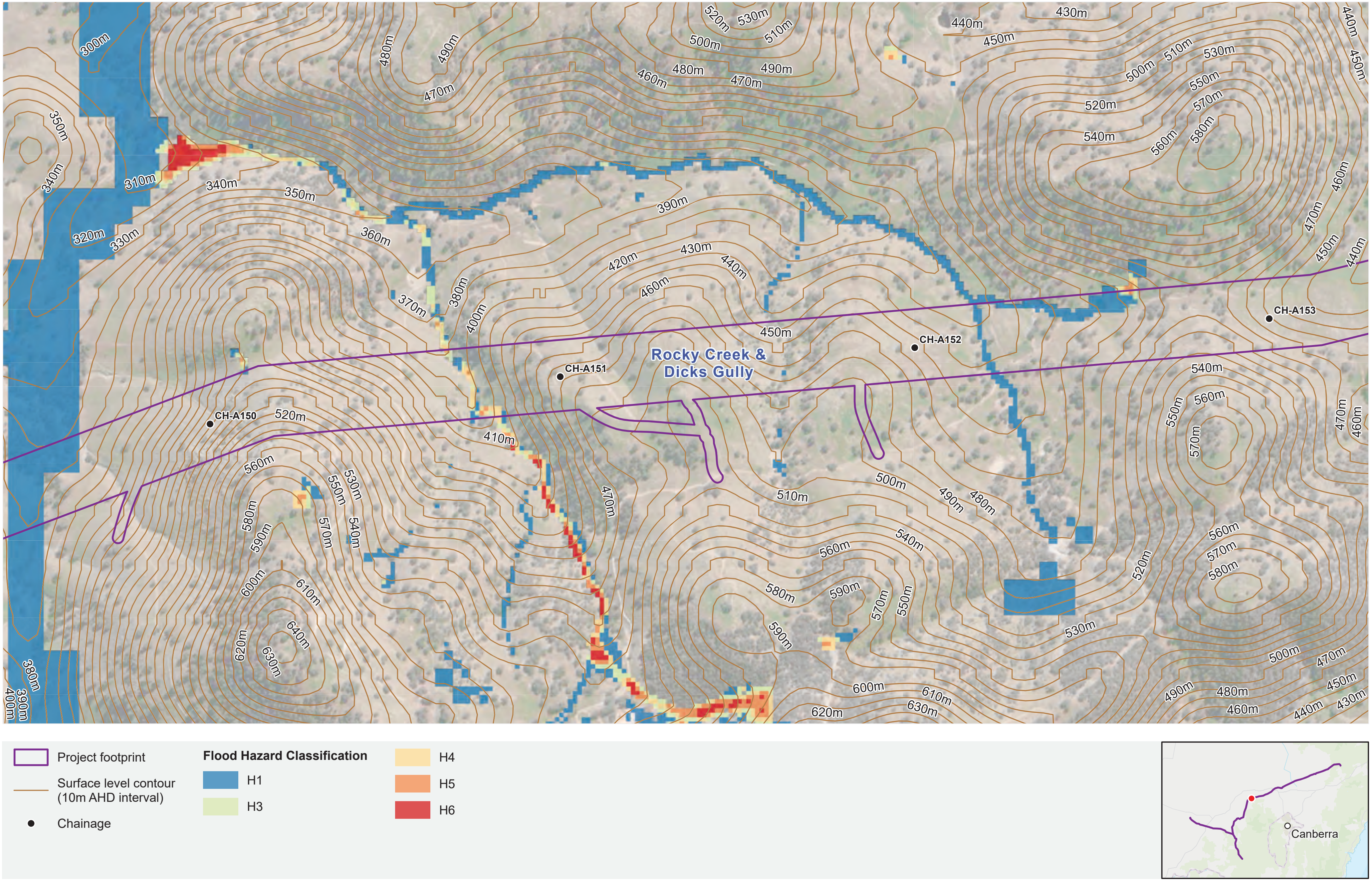

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 27b: ARR 2019 Flood Hazard Classification at Rocky Creek & Dicks Gully - Murumbidgee Catchment

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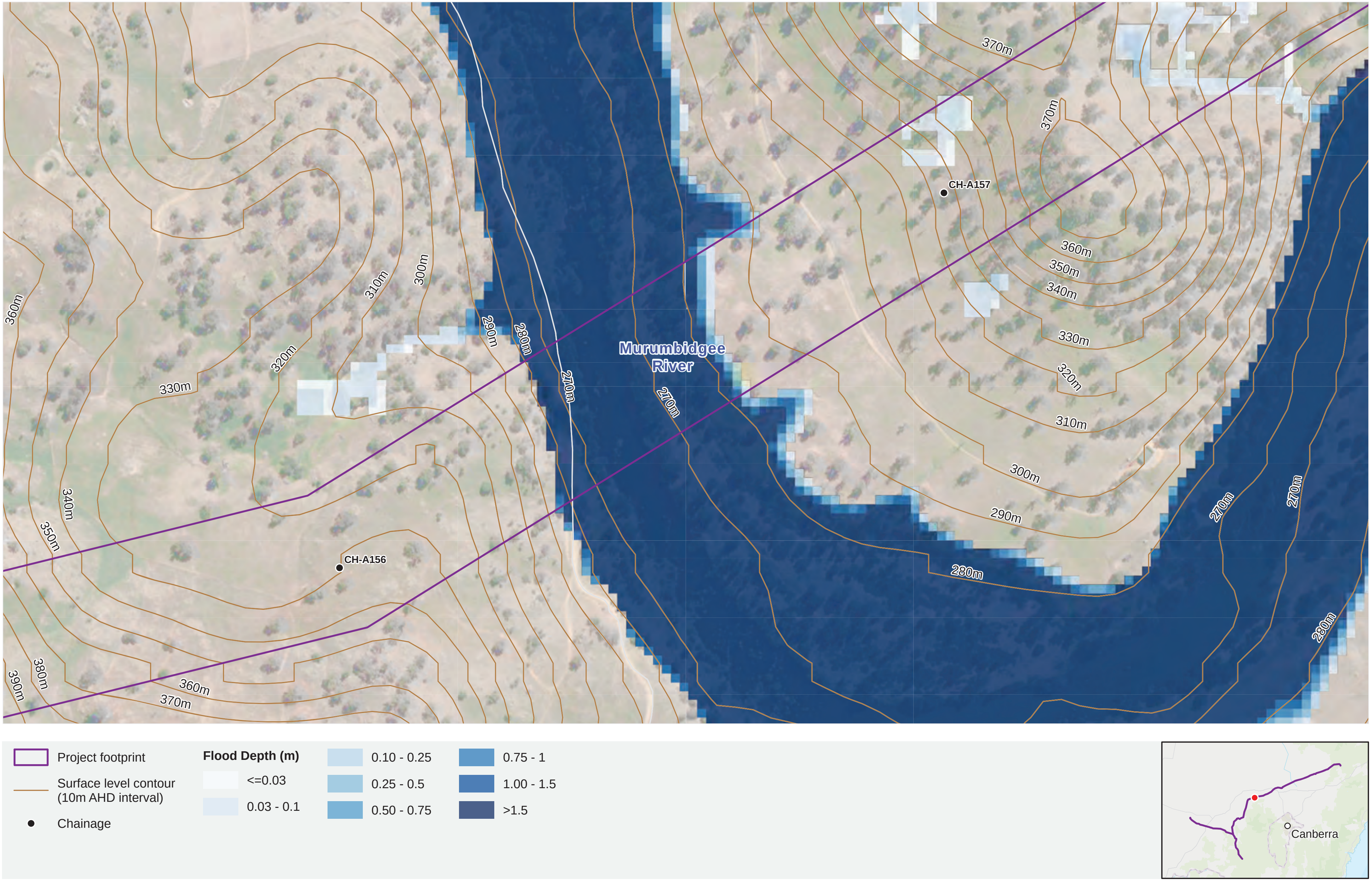


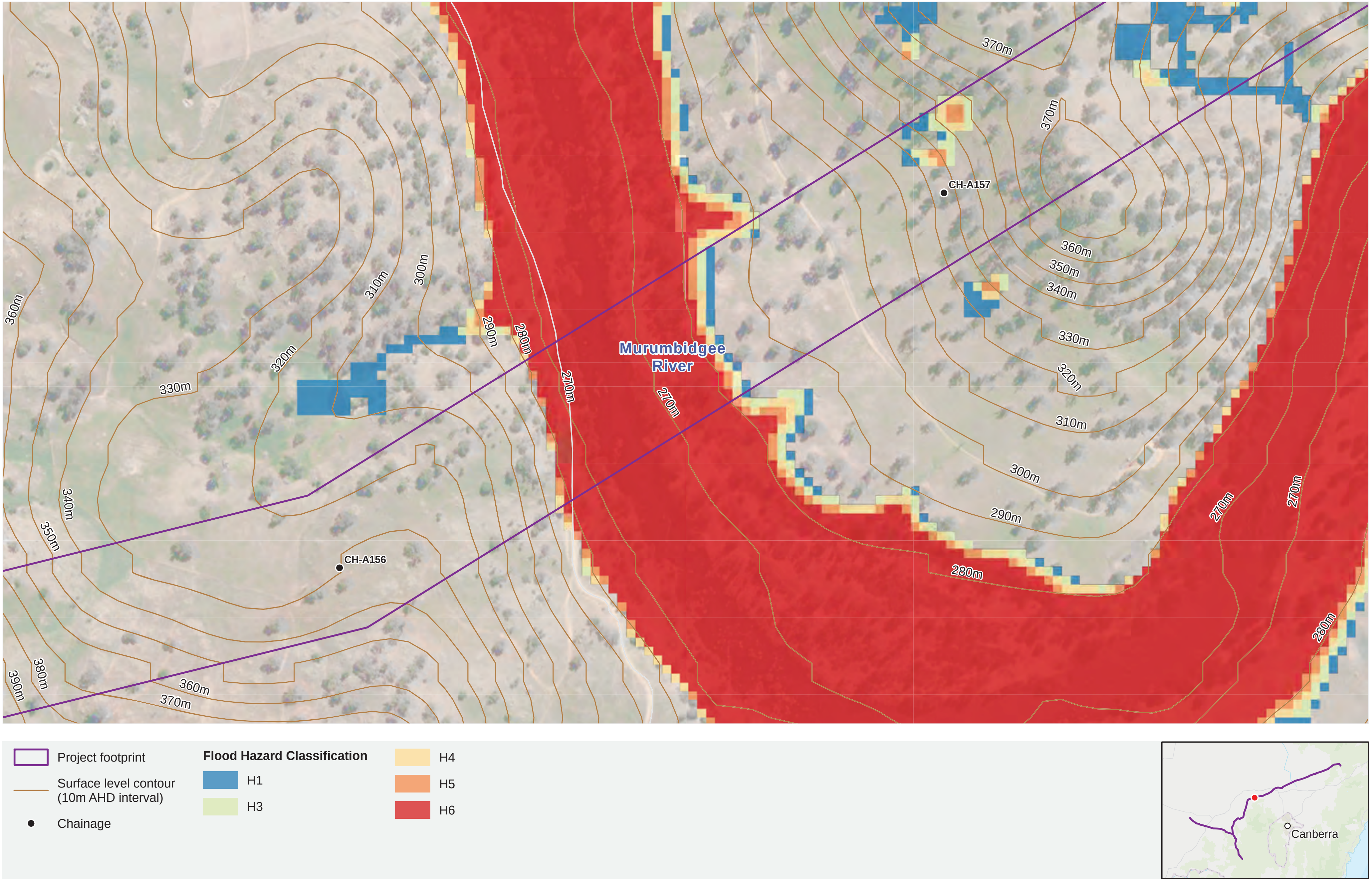
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 28a: 1% AEP flood depth (m) at Murumbidgee River - Murumbidgee Catchment



▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Hazard Classification

🟦 H1

🟩 H3

🟨 H4

🟧 H5

🟥 H6

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

HumeLink **Hydrology and Flooding**

Projection: GDA 1994 MGA Zone 55

Map 28b: ARR 2019 Flood Hazard Classification at Murumbidgee River - Murumbidgee Catchment

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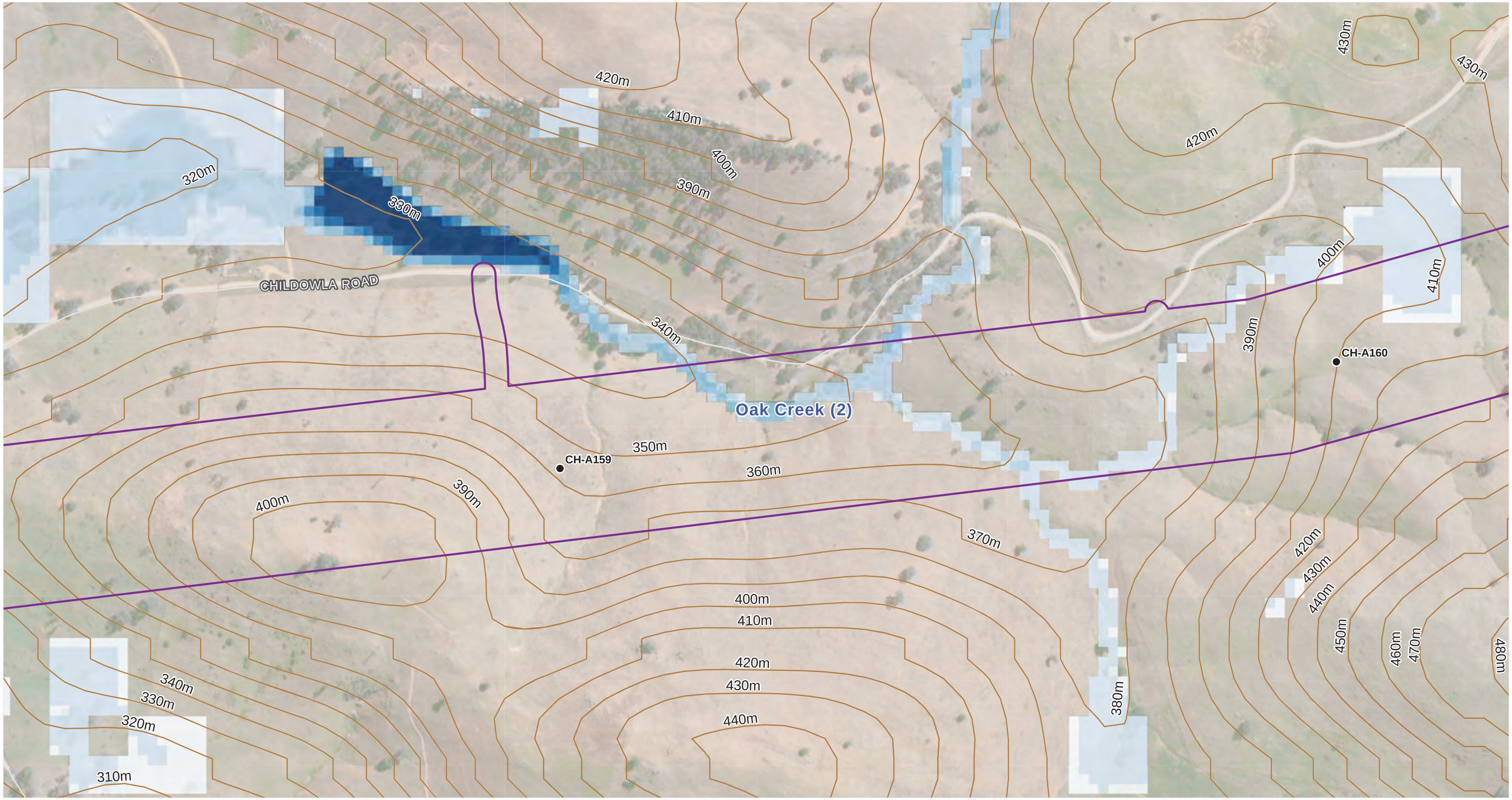
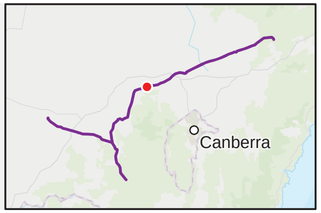


▭	Project footprint	**Flood Depth (m)**			
—	Surface level contour (10m AHD interval)	▢	<=0.03	▨	0.10 - 0.25
●	Chainage	▢	0.03 - 0.1	▨	0.25 - 0.5
				▨	0.50 - 0.75
				▨	0.75 - 1
				▨	1.00 - 1.5
				▨	>1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 29a: 1% AEP flood depth (m) at Oak Creek (2) - Murumbidgee Catchment

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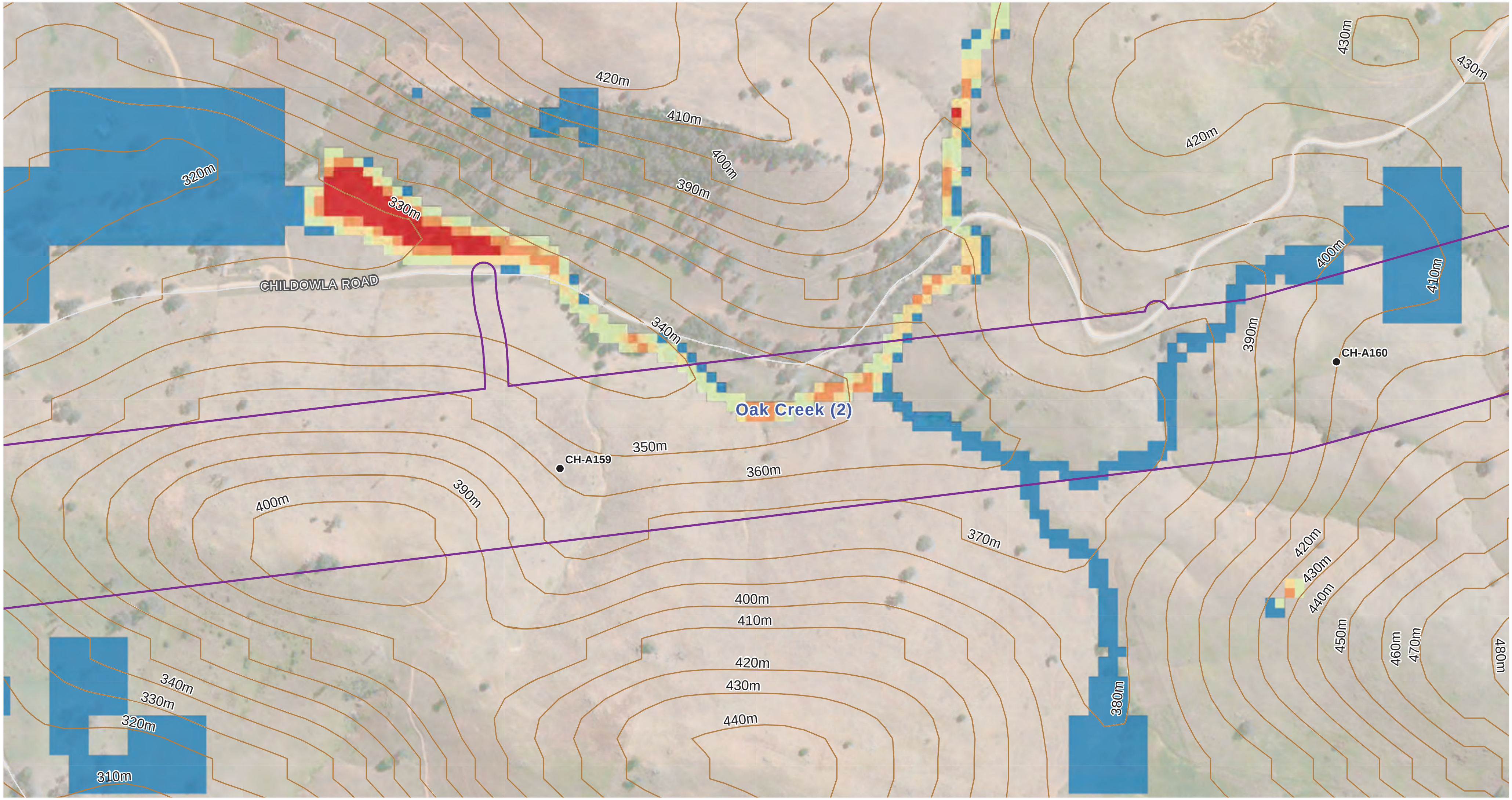
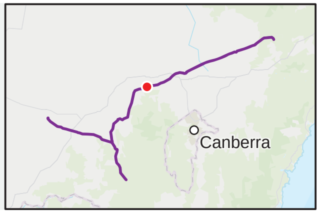


▭ Project footprint	**Flood Hazard Classification**	🟨 H4
— Surface level contour (10m AHD interval)	🟦 H1	🟧 H5
● Chainage	🟩 H3	🟥 H6



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 29b: ARR 2019 Flood Hazard Classification at Oak Creek (2) - Murumbidgee Catchment

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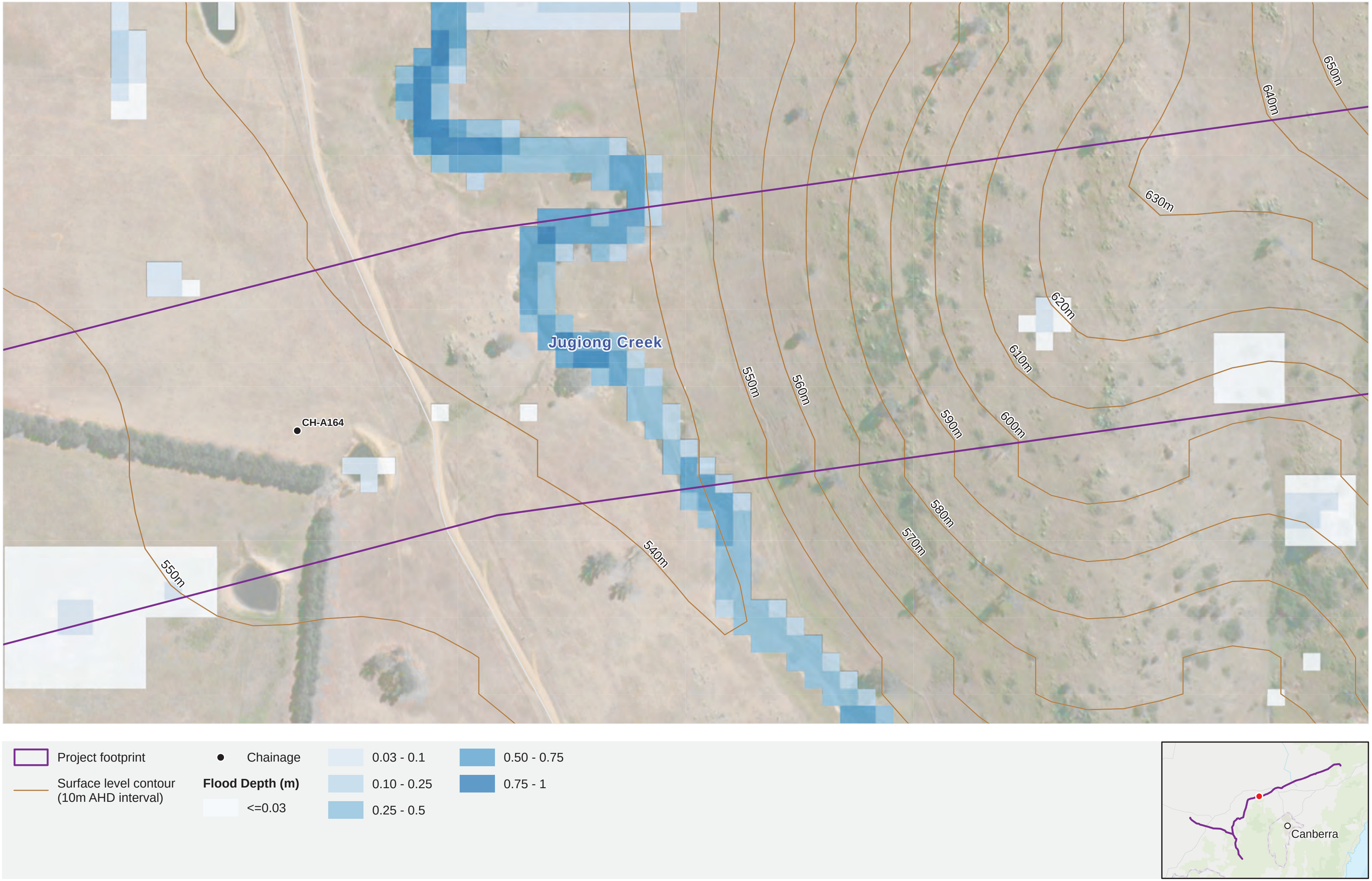

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:2,500

0 50 100m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 30a: 1% AEP flood depth (m) at Jugiong Creek - Murumbidgee Catchment

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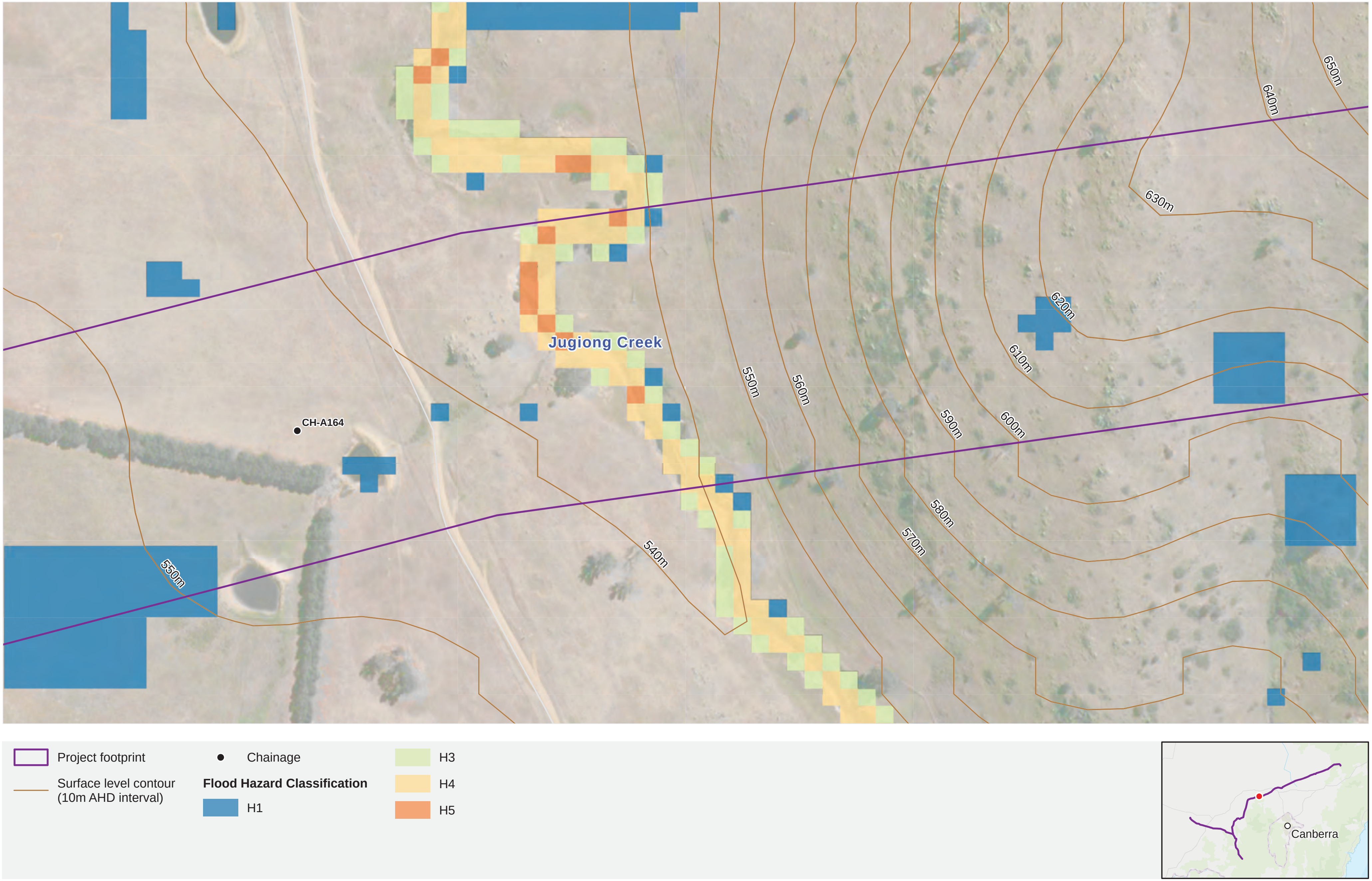

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 30b: ARR 2019 Flood Hazard Classification at Jugiong Creek - Murumbidgee Catchment

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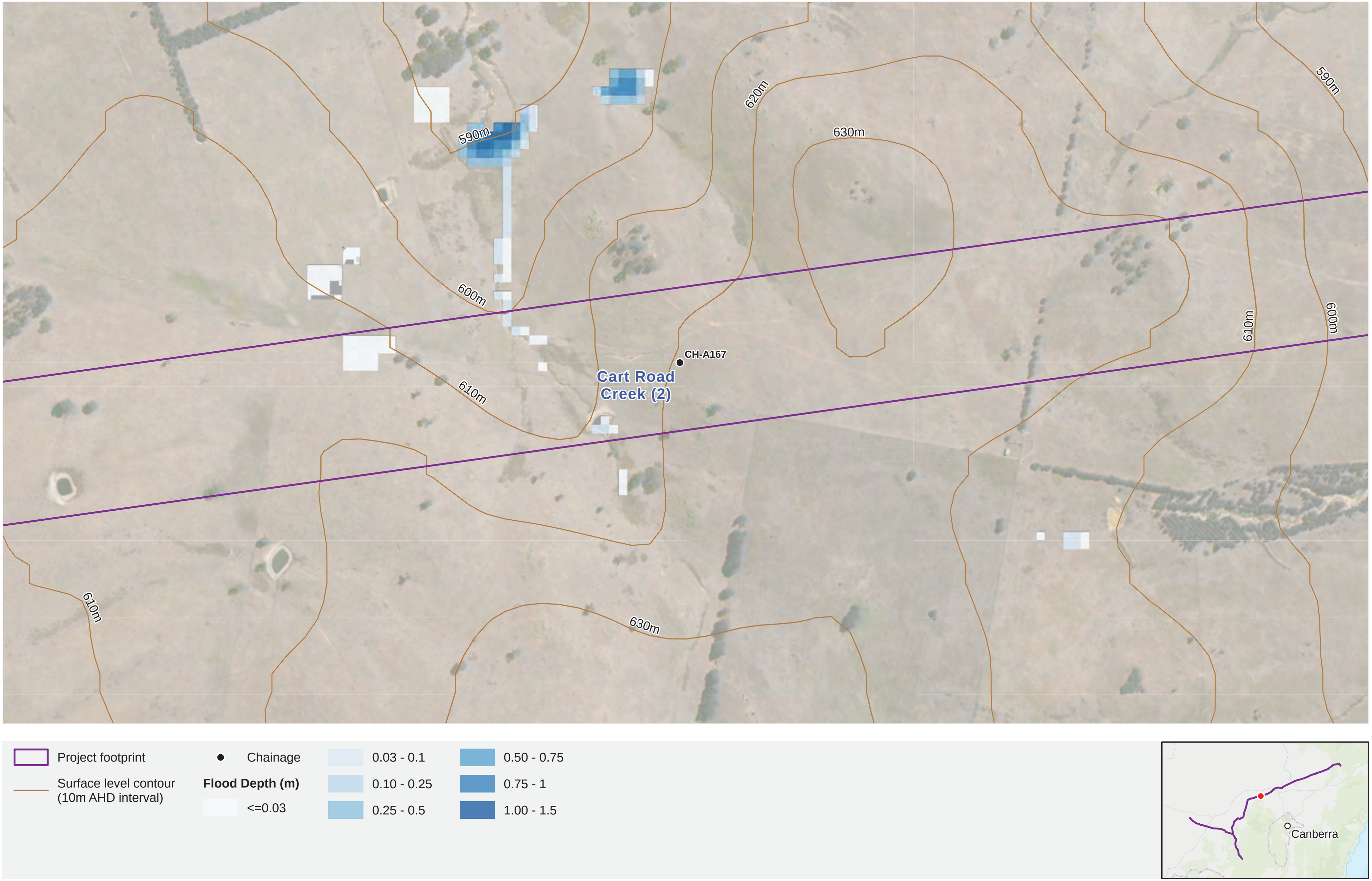

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 31a: 1% AEP flood depth (m) at Cart Road Creek (2) - Murumbidgee Catchment

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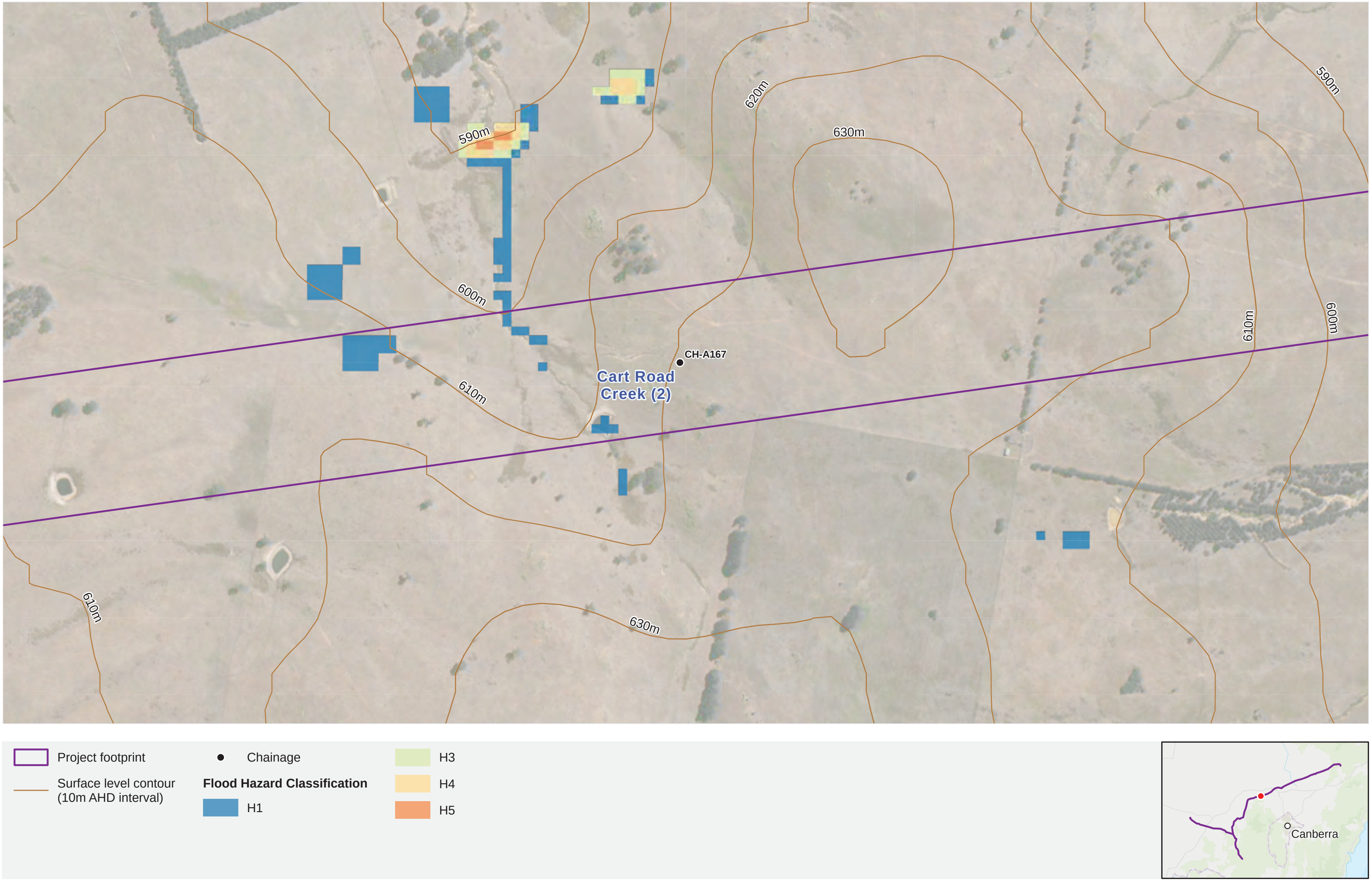

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 31b: ARR 2019 Flood Hazard Classification at Cart Road Creek (2) - Murumbidgee Catchment

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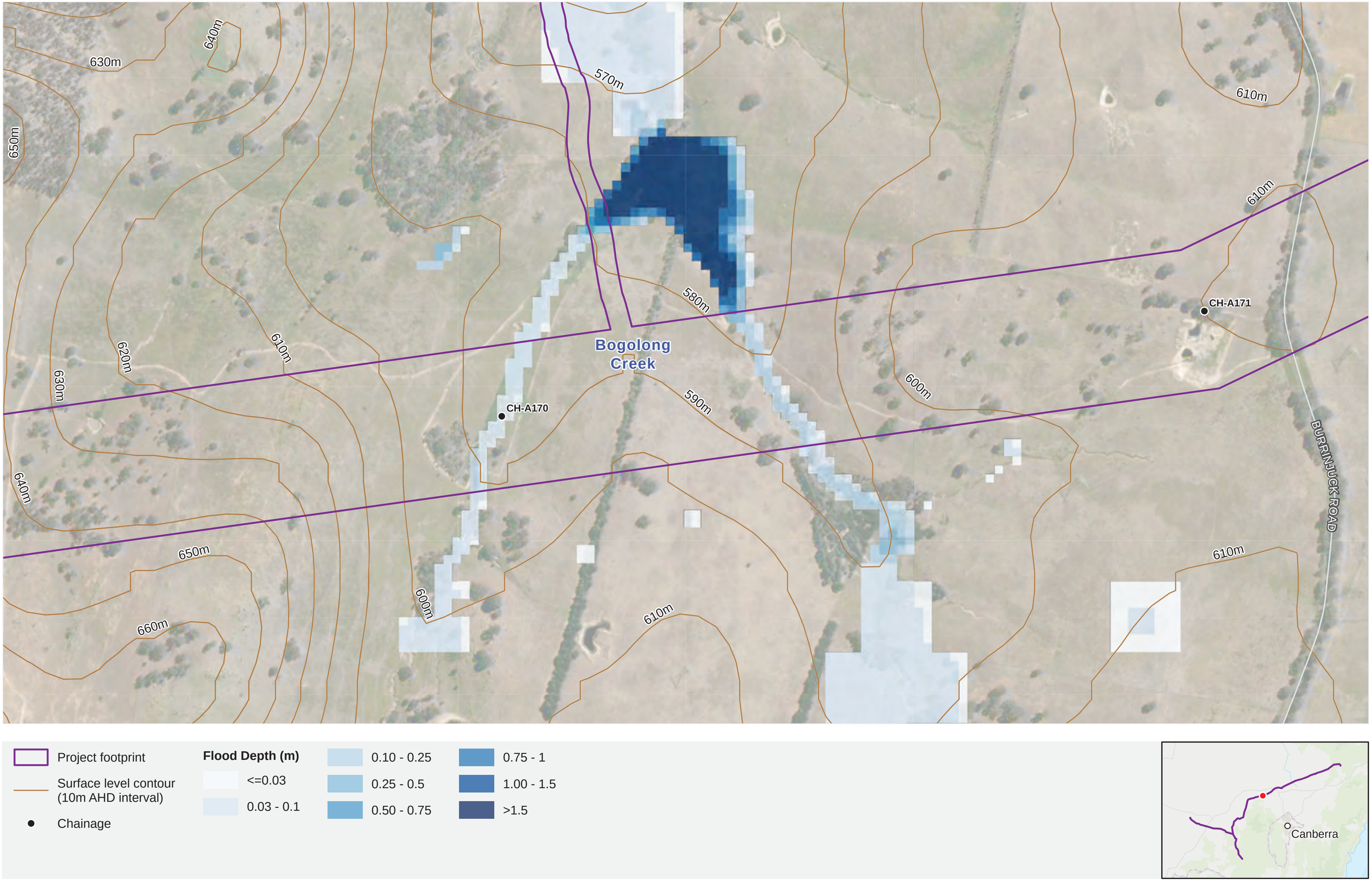

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 32a: 1% AEP flood depth (m) at Bogolong Creek - Murumbidgee Catchment

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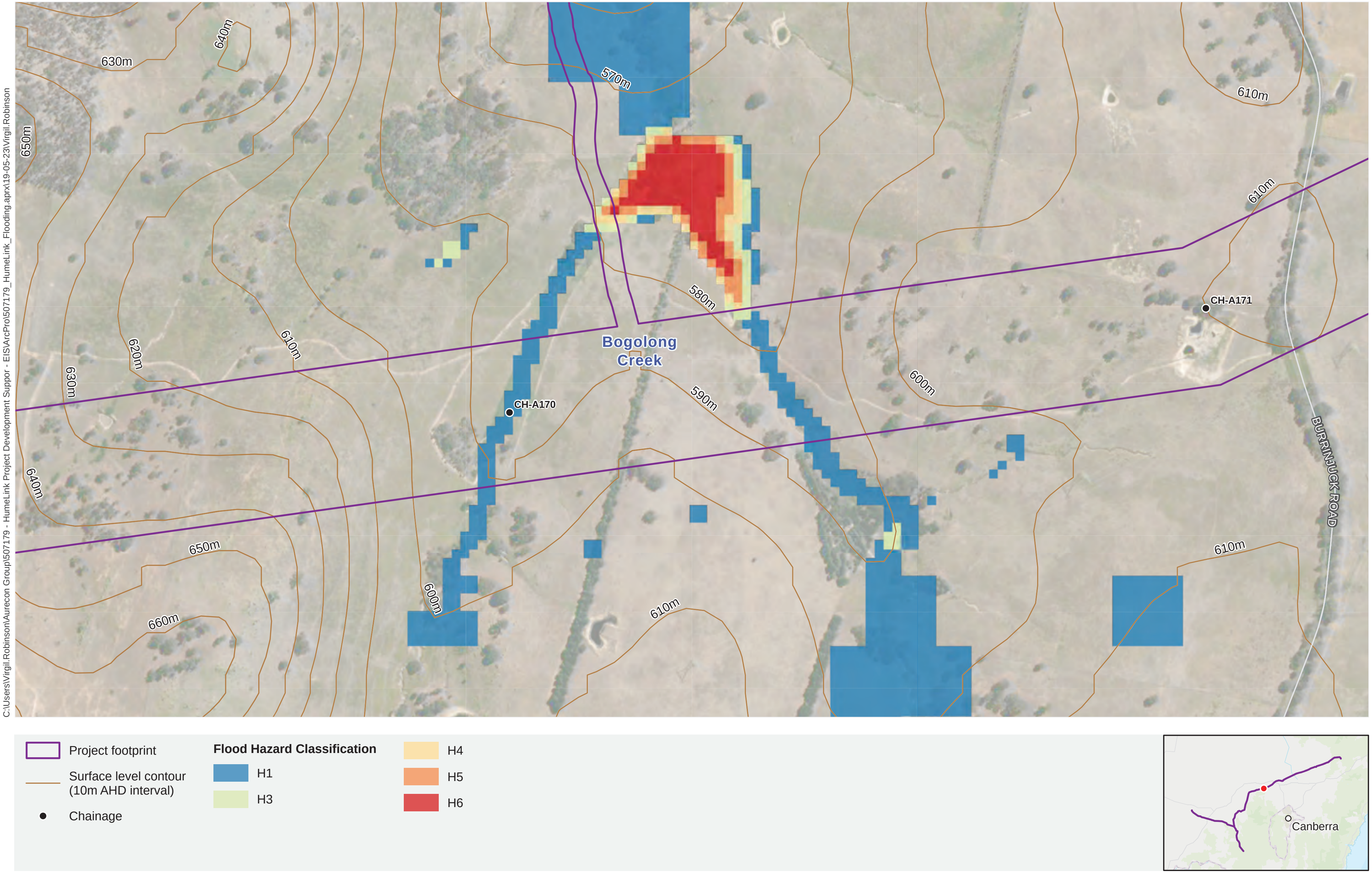

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 32b: ARR 2019 Flood Hazard Classification at Bogolong Creek - Murumbidgee Catchment

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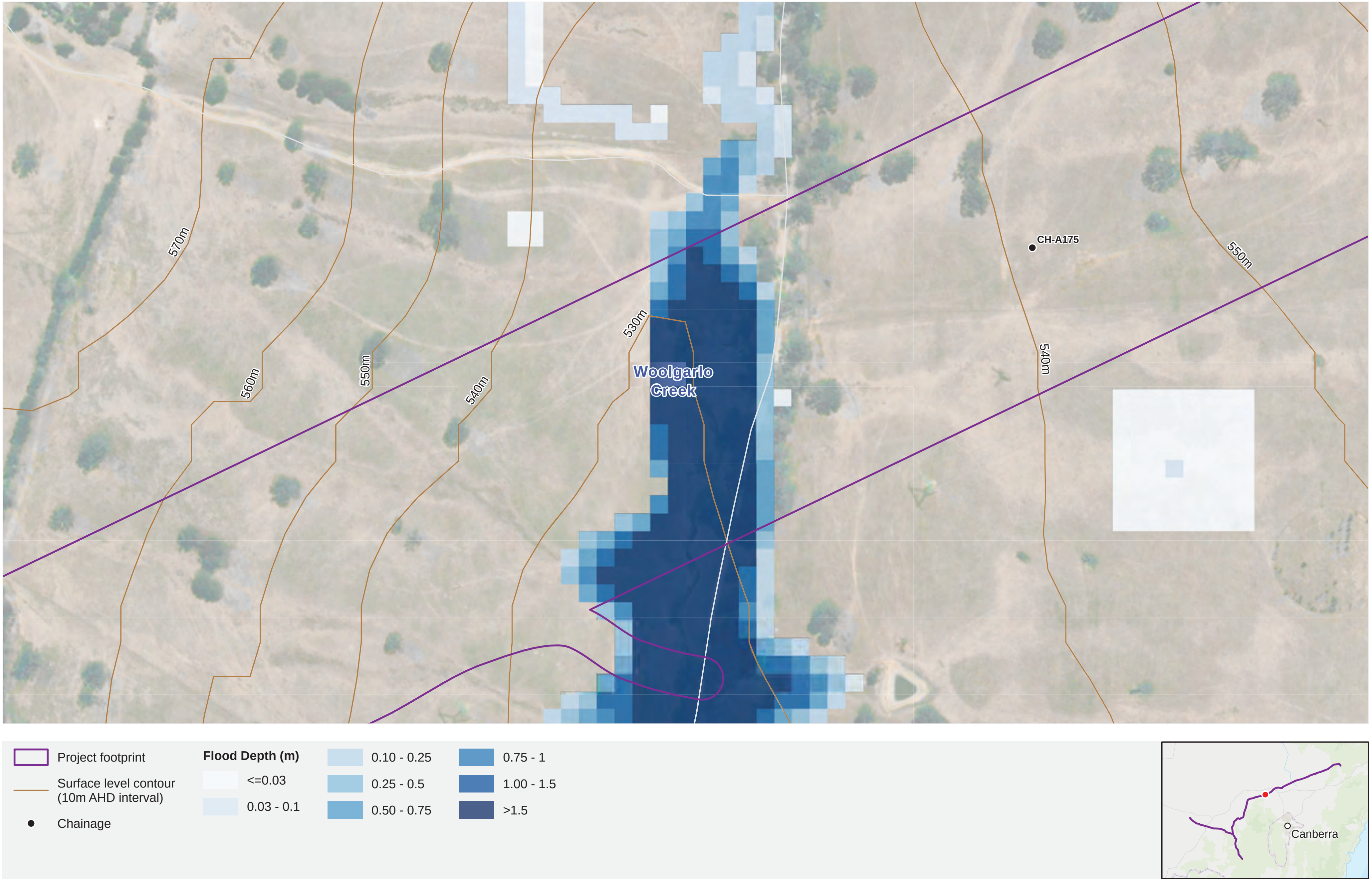

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:2,500
0 50 100m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 33a: 1% AEP flood depth (m) at Woolgarlo Creek - Murumbidgee Catchment

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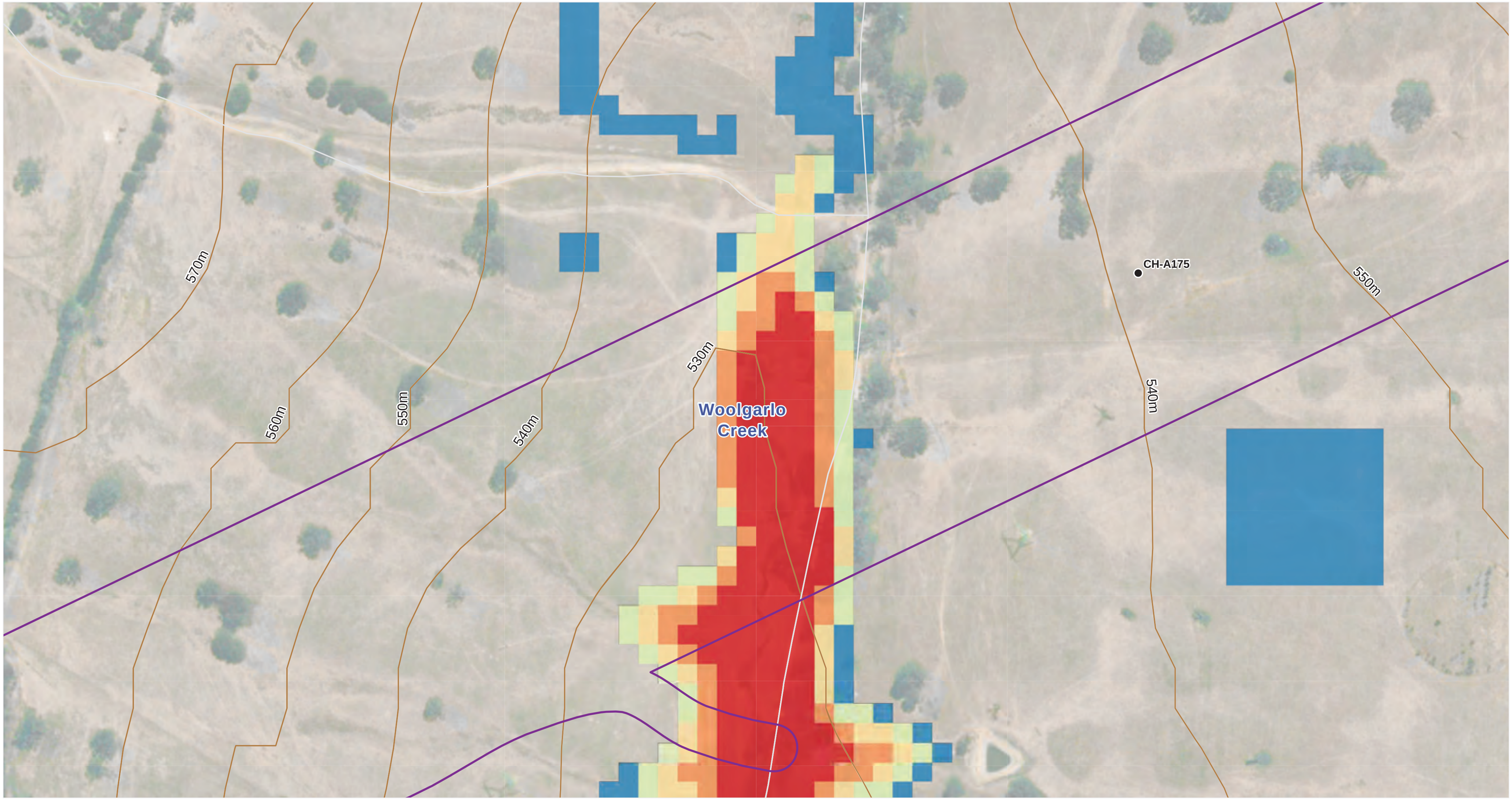


▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Hazard Classification

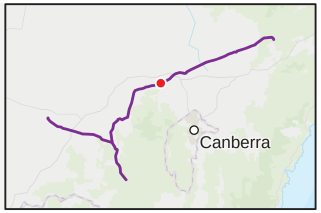
🟦 H1

🟩 H3

🟨 H4

🟧 H5

🟥 H6



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:2,500

0 50 100m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 33b: ARR 2019 Flood Hazard Classification at Woolgarlo Creek - Murumbidgee Catchment

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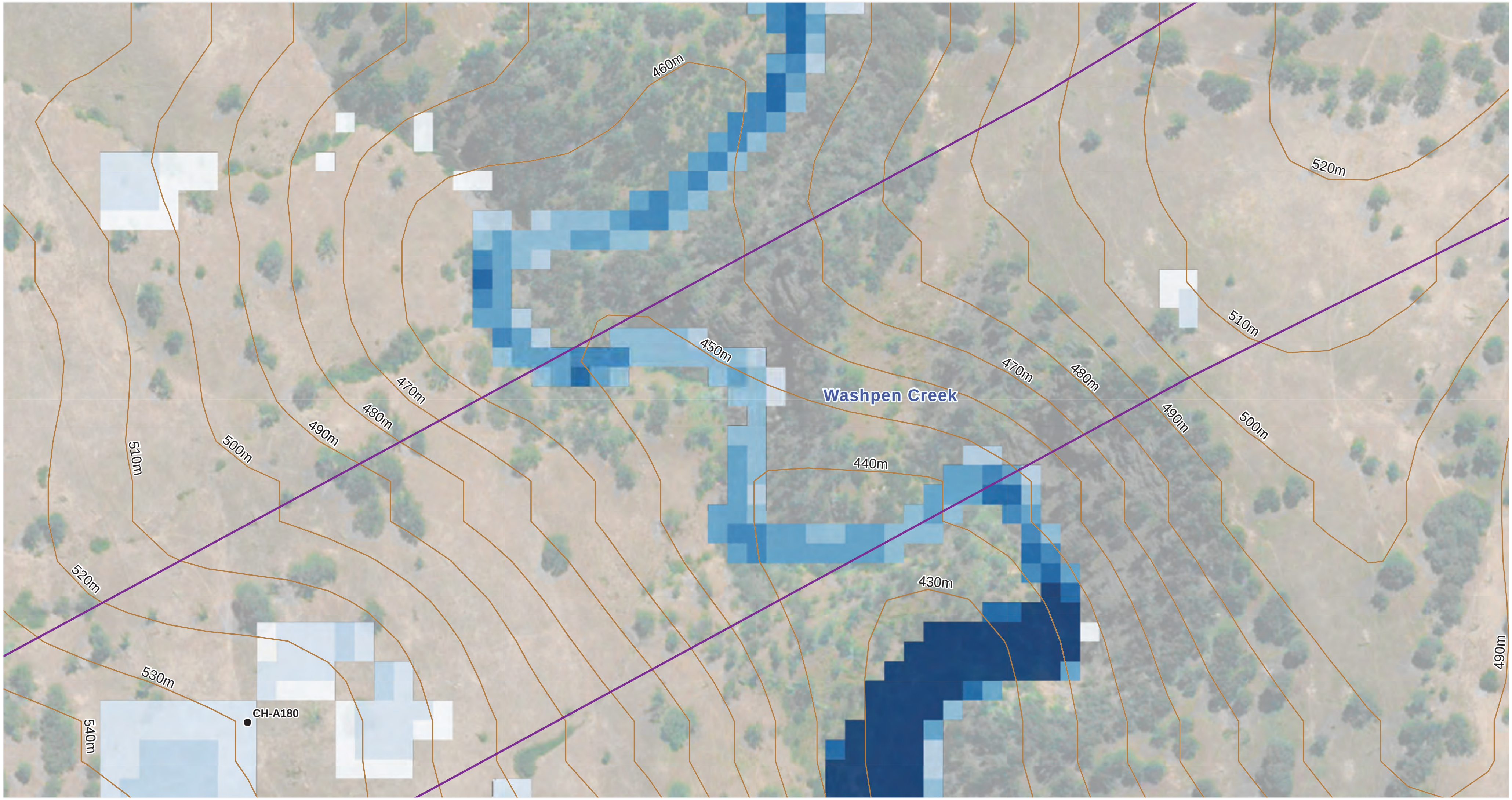
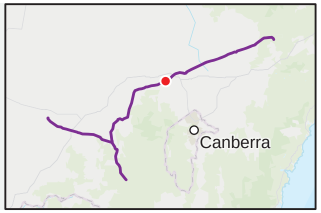


▭ Project footprint	**Flood Depth (m)**	0.10 - 0.25	0.75 - 1
— Surface level contour (10m AHD interval)	<=0.03	0.25 - 0.5	1.00 - 1.5
● Chainage	0.03 - 0.1	0.50 - 0.75	>1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

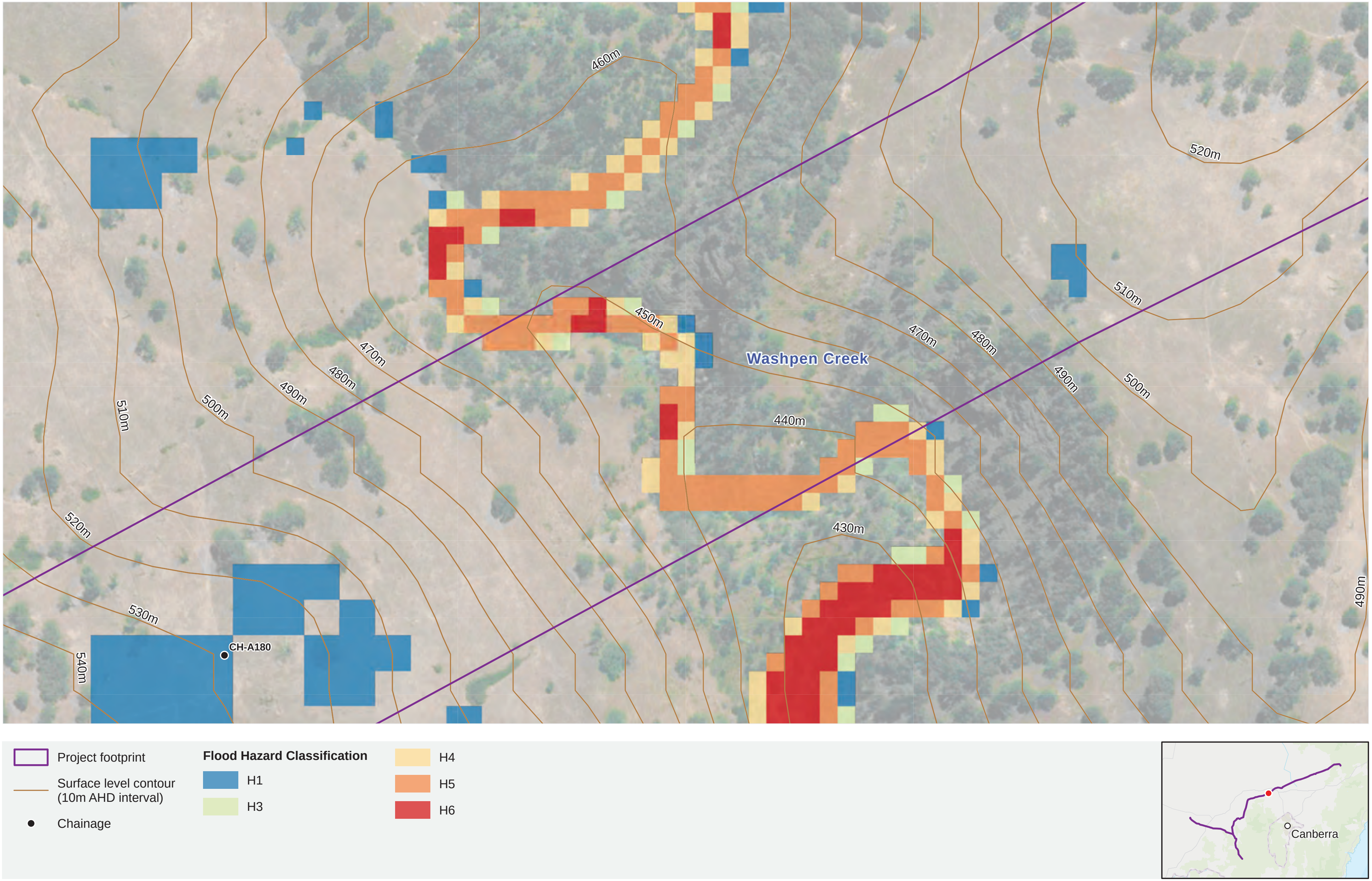
1:2,500

0 50 100m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 34a: 1% AEP flood depth (m) at Washpen Creek - Murumbidgee Catchment



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Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:2,500

0 50 100m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 34b: ARR 2019 Flood Hazard Classification at Washpen Creek - Murumbidgee Catchment

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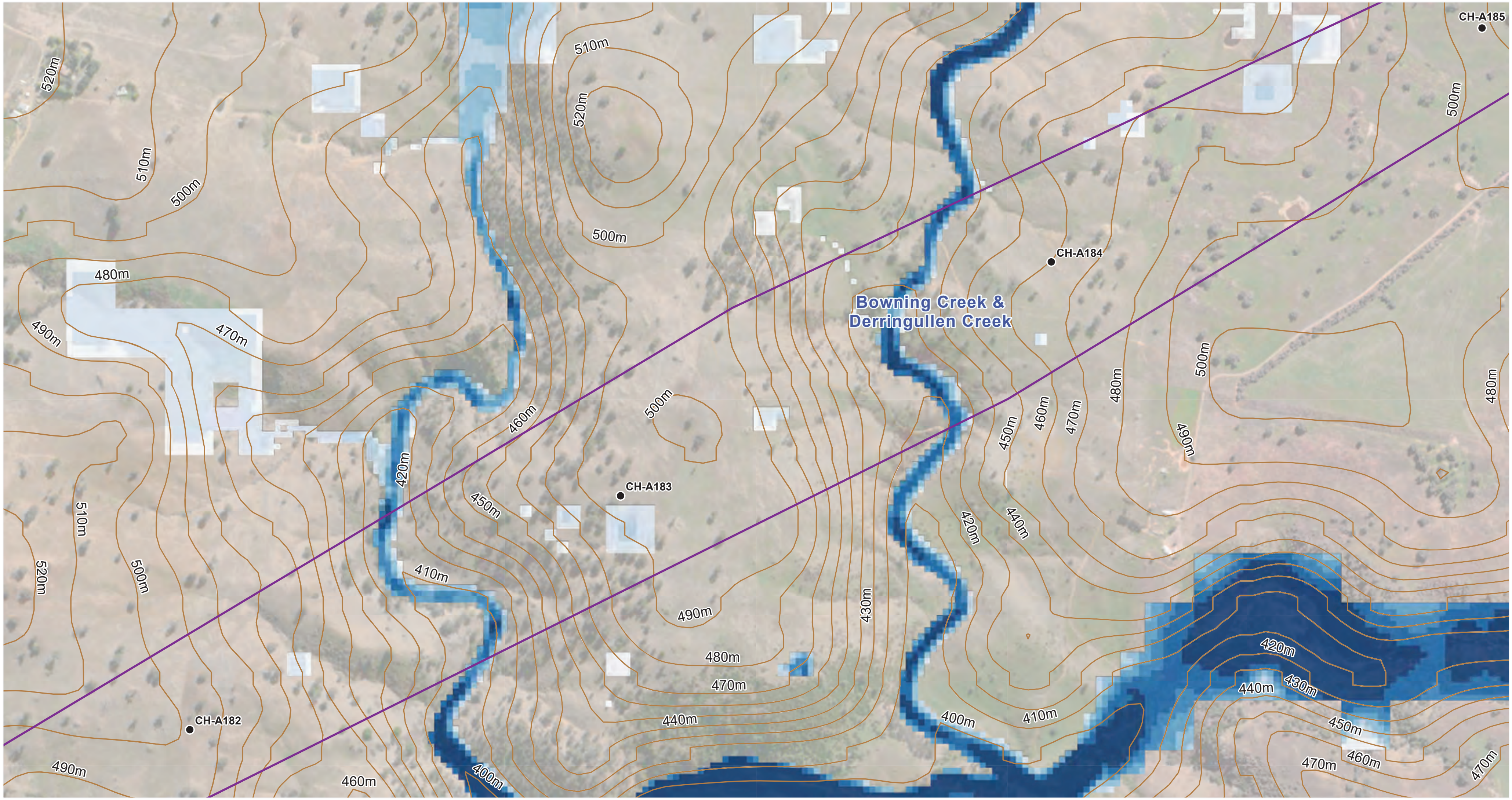
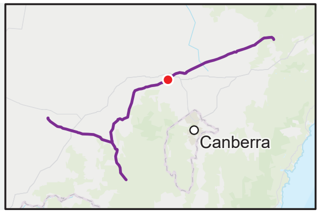


▭ Project footprint	**Flood Depth (m)**			
— Surface level contour (10m AHD interval)	▨ <=0.03	▨ 0.10 - 0.25	▨ 0.75 - 1	
● Chainage	▨ 0.03 - 0.1	▨ 0.25 - 0.5	▨ 1.00 - 1.5	
		▨ 0.50 - 0.75	▨ >1.5	



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

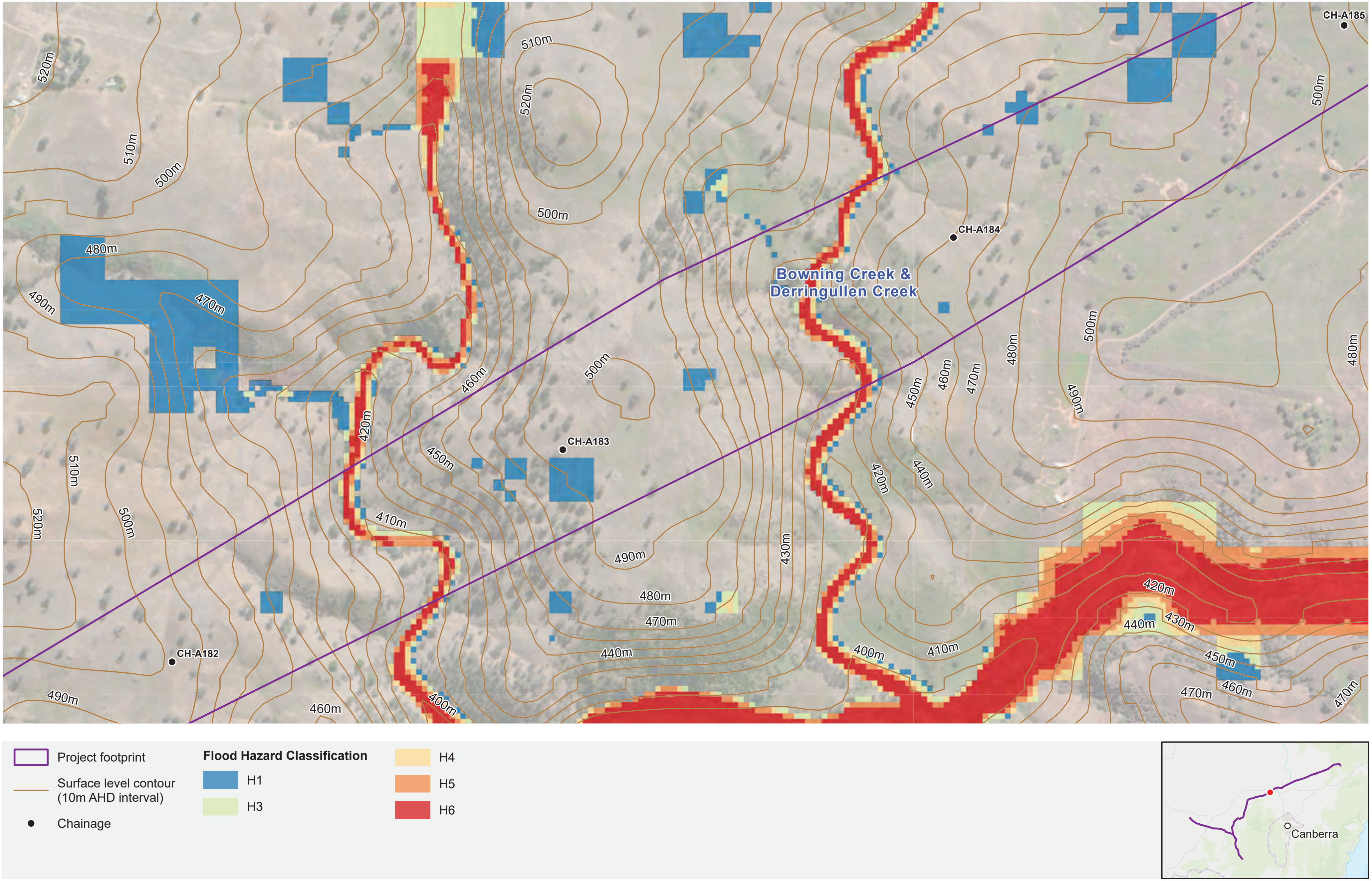
1:8,000

0 180 360m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 35a: 1% AEP flood depth (m) at Bowning Creek & Derringullen Creek - Murumbidgee Catchment



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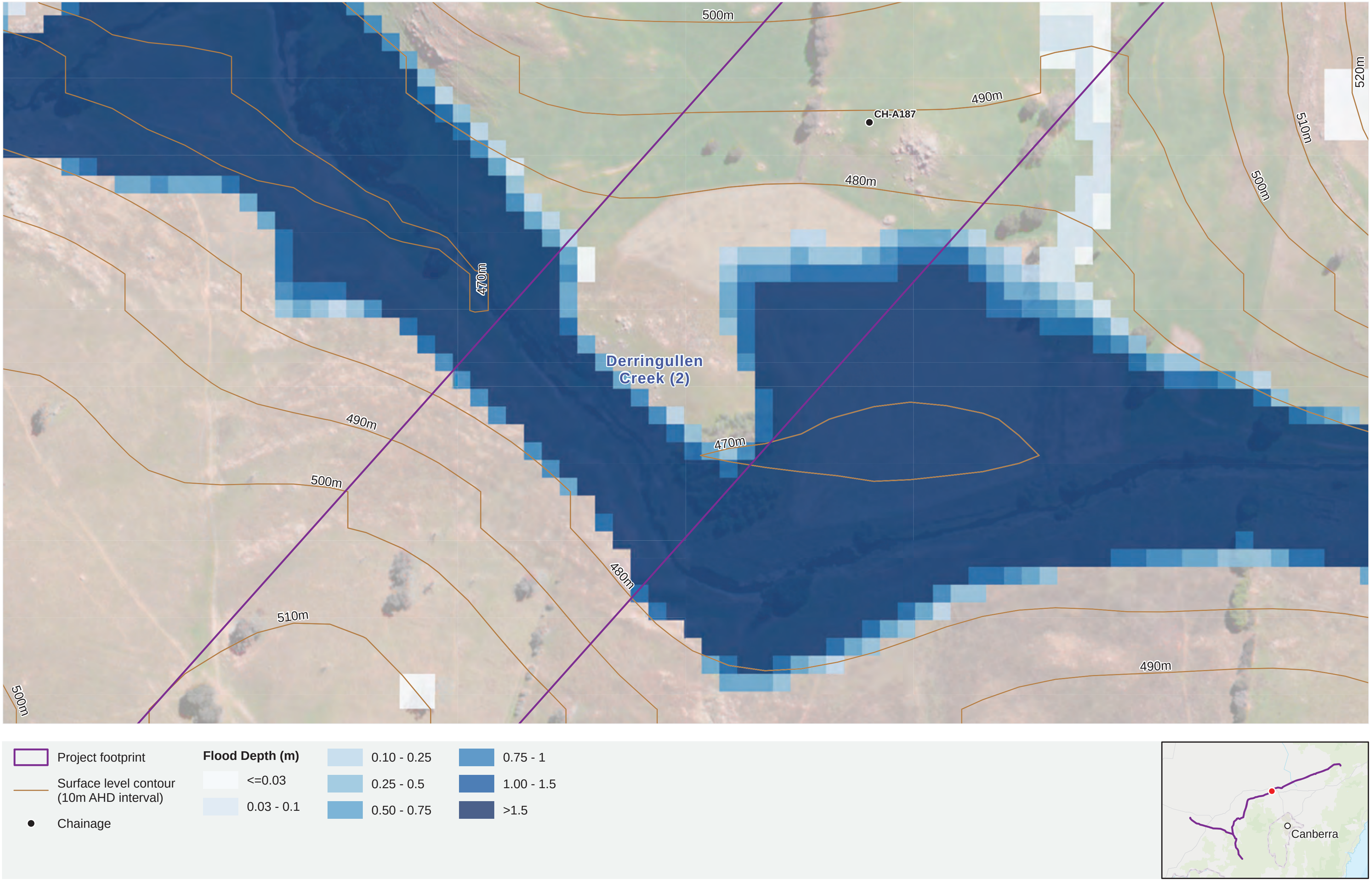
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:8,000

0 180 360m

HumeLink **Hydrology and Flooding**

Map 35b: ARR 2019 Flood Hazard Classification at Bowning Creek & Derringullen Creek - Murumbidgee Catchment



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Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

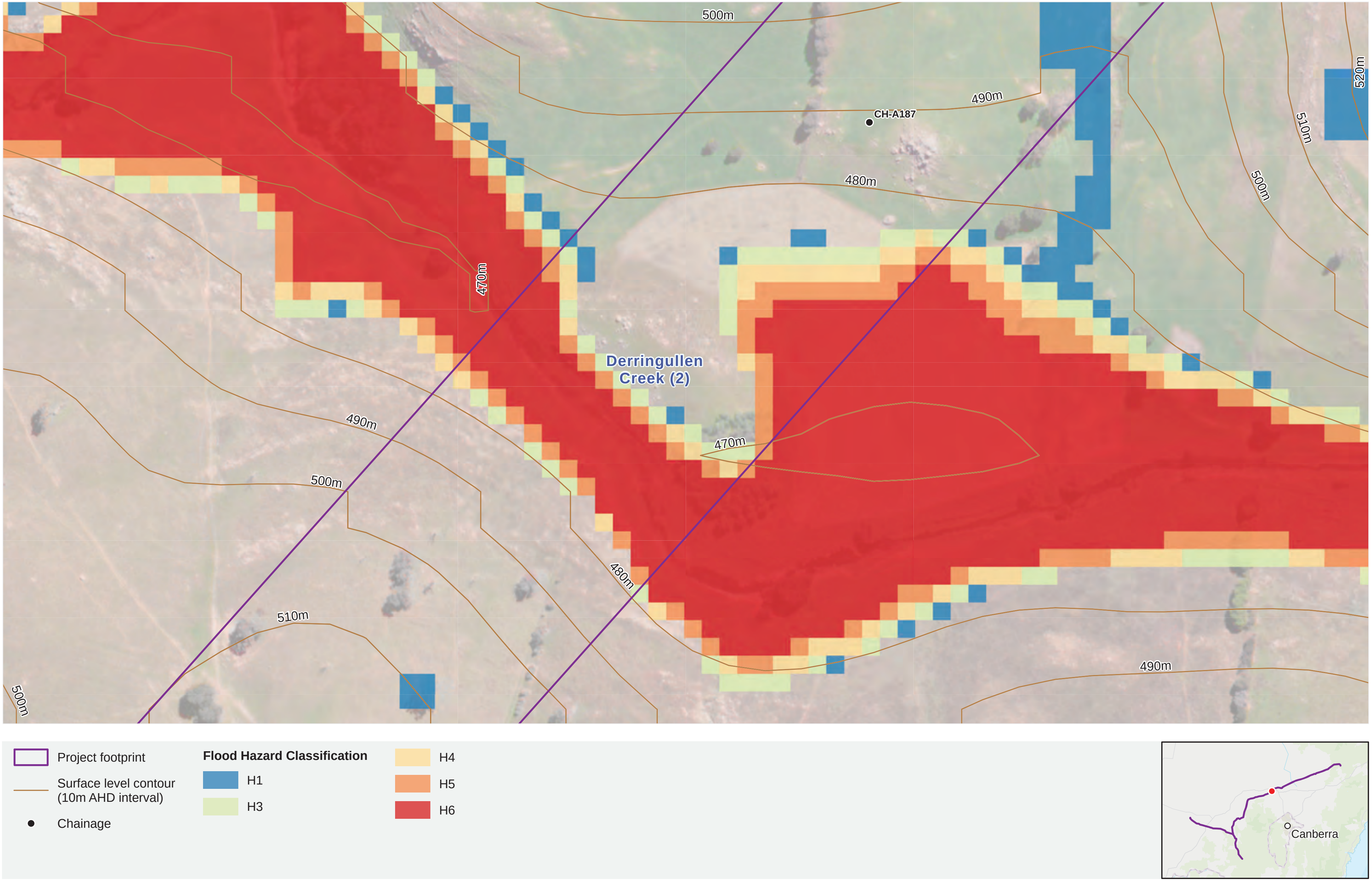
1:2,500

0 50 100m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 36a: 1% AEP flood depth (m) at Derringullen Creek (2) - Murumbidgee Catchment



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Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:2,500

0 50 100m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 36b: ARR 2019 Flood Hazard Classification at Derringullen Creek (2) - Murumbidgee Catchment

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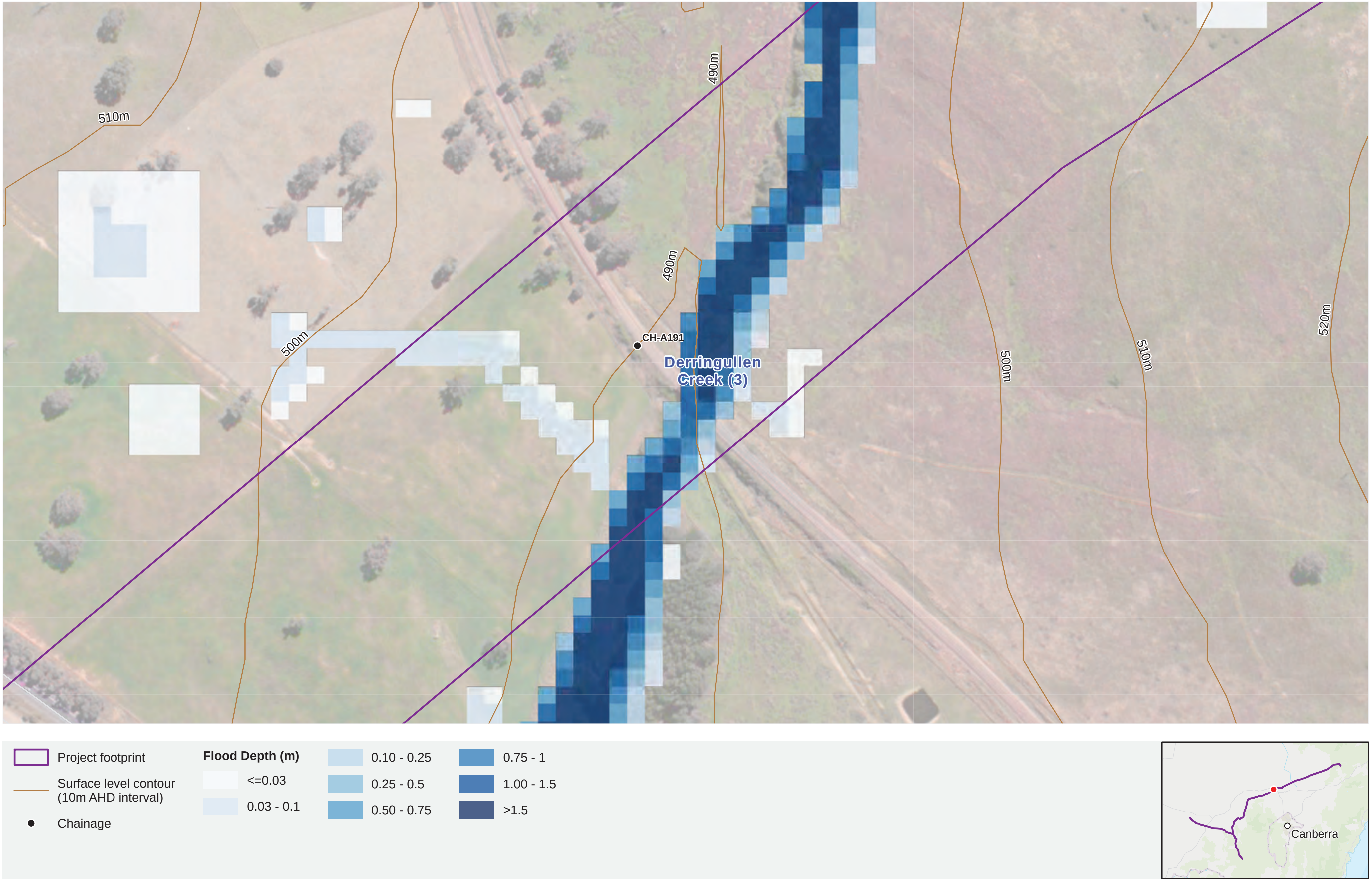

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:2,500

0 50 100m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 37a: 1% AEP flood depth (m) at Derringullen Creek (3) - Murumbidgee Catchment

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Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:2,500
0 50 100m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 37b: ARR 2019 Flood Hazard Classification at Derringullen Creek (3) - Murumbidgee Catchment

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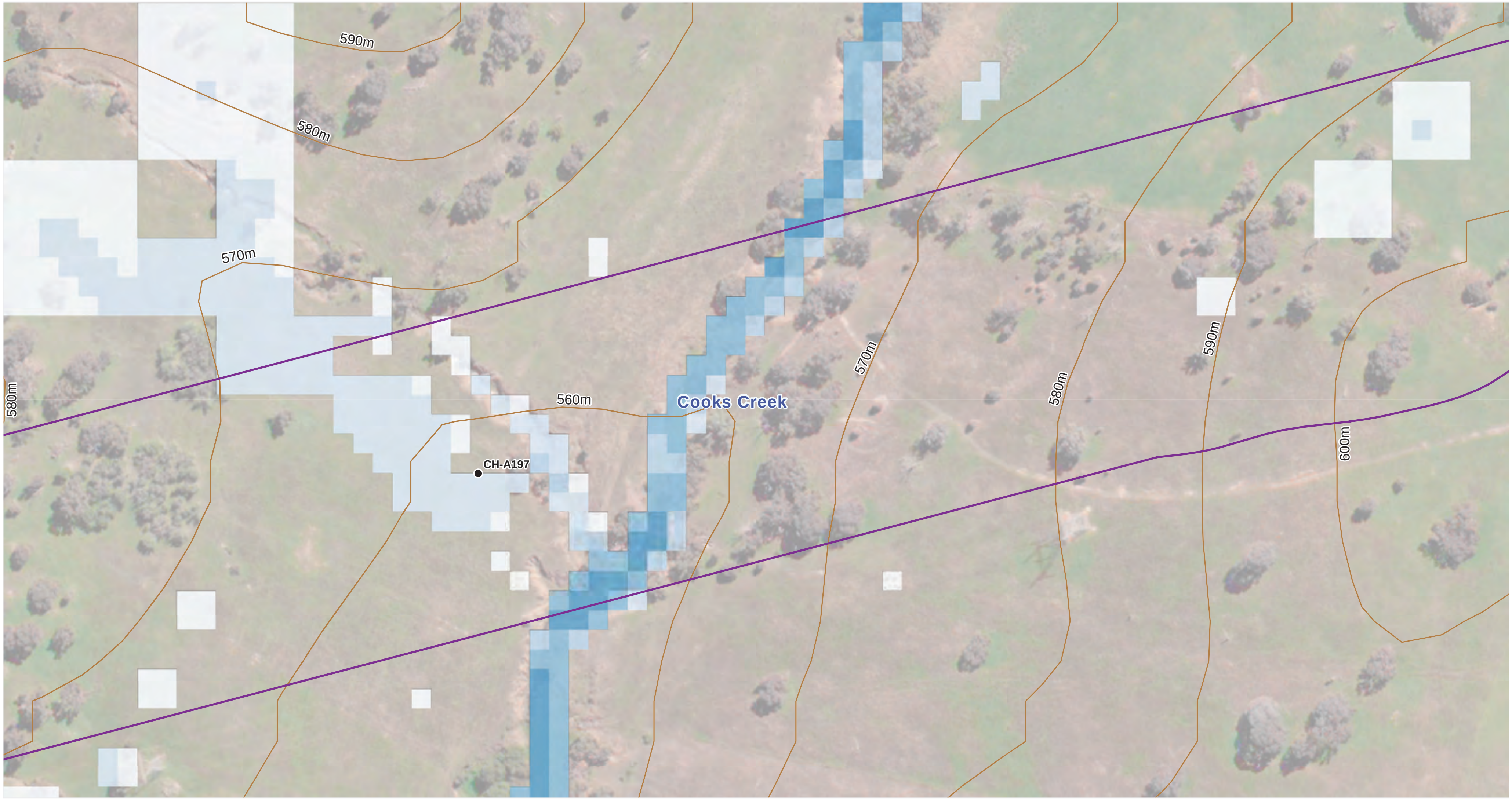


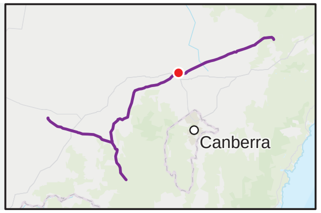
▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Depth (m)

- <=0.03
- 0.03 - 0.1
- 0.10 - 0.25
- 0.25 - 0.5
- 0.50 - 0.75



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

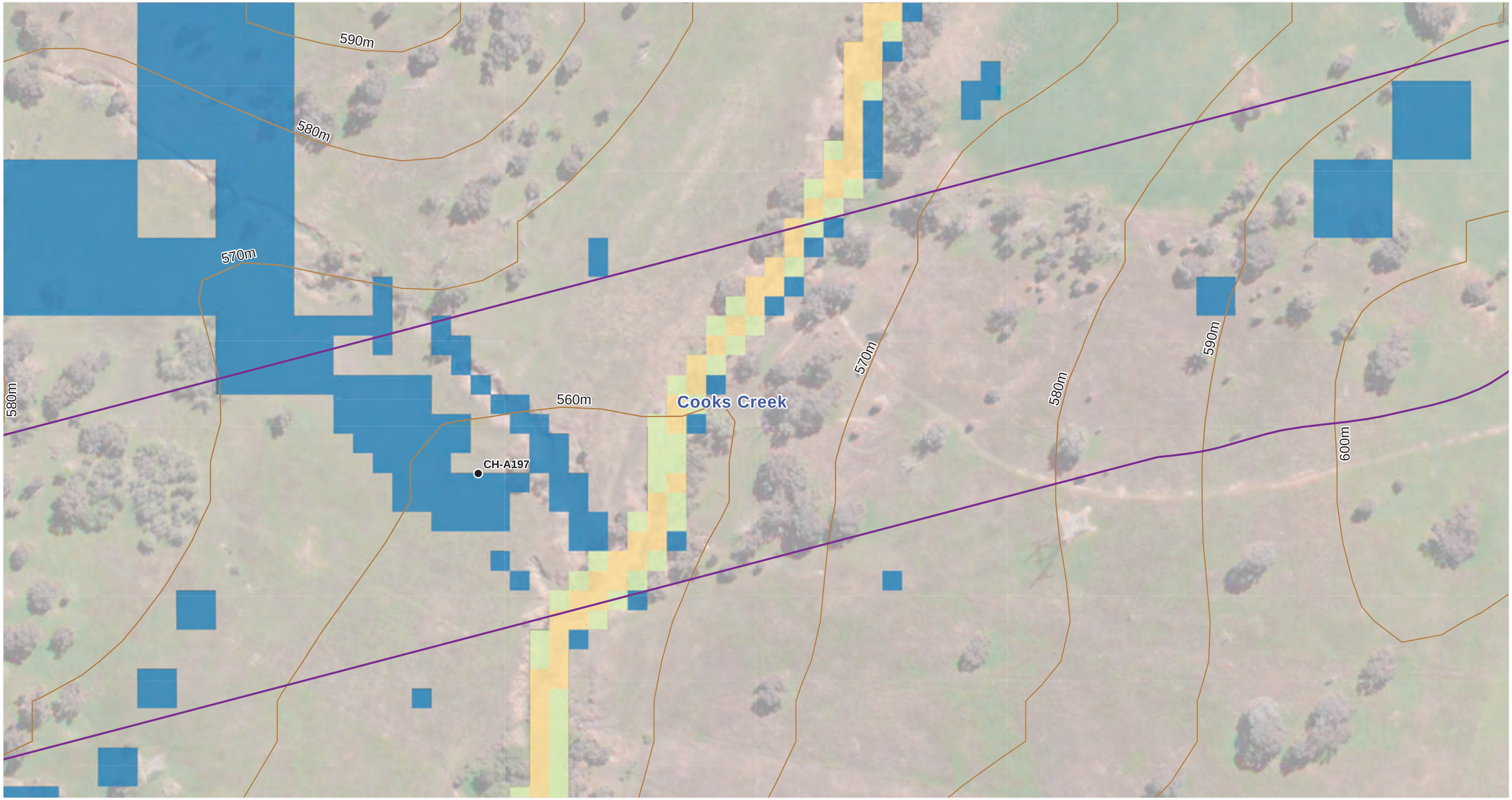
1:2,500

0 50 100m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 38a: 1% AEP flood depth (m) at Cooks Creek - Murumbidgee Catchment



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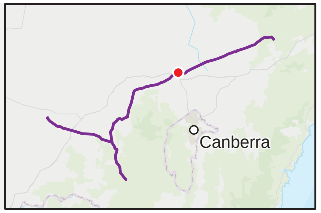
▭	Project footprint	●	Chainage	🟩	H3
—	Surface level contour (10m AHD interval)	**Flood Hazard Classification**		🟨	H4
		🟦	H1		



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:2,500
0 50 100m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 38b: ARR 2019 Flood Hazard Classification at Cooks Creek - Murumbidgee Catchment

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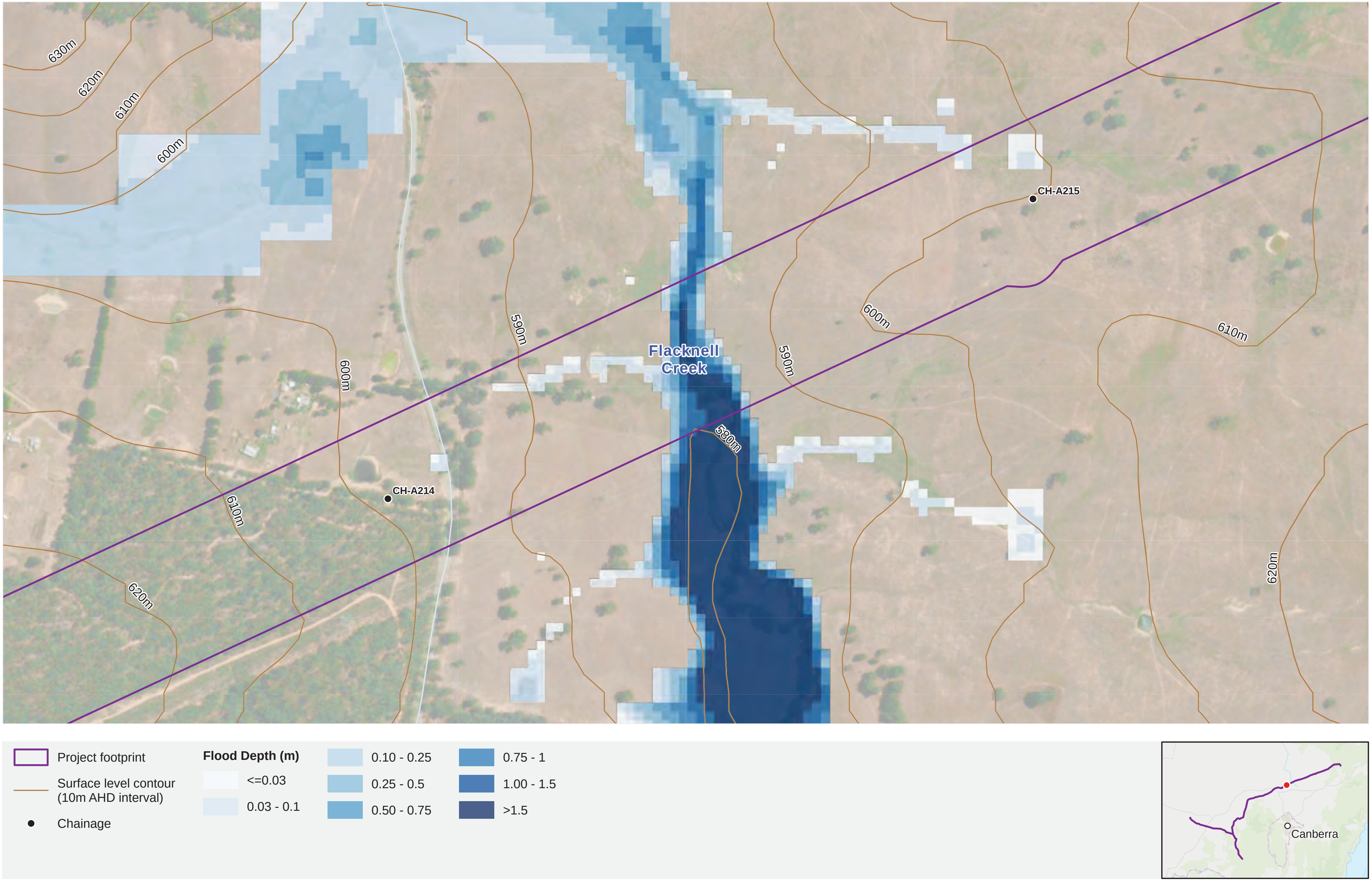

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 39a: 1% AEP flood depth (m) at Flacknell Creek - Lachlan Catchment

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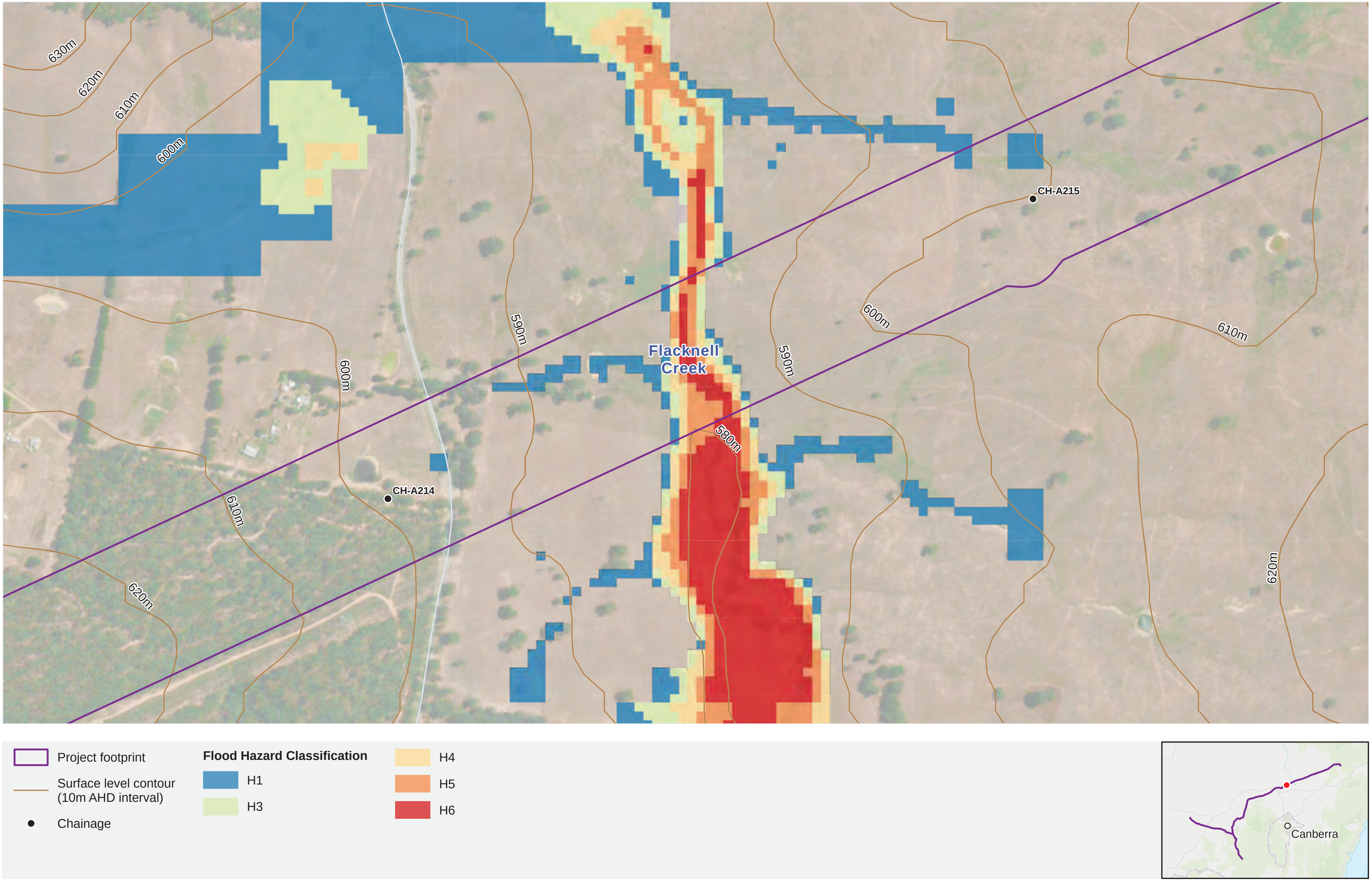

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220 m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 39b: ARR 2019 Flood Hazard Classification at Flacknell Creek - Lachlan Catchment

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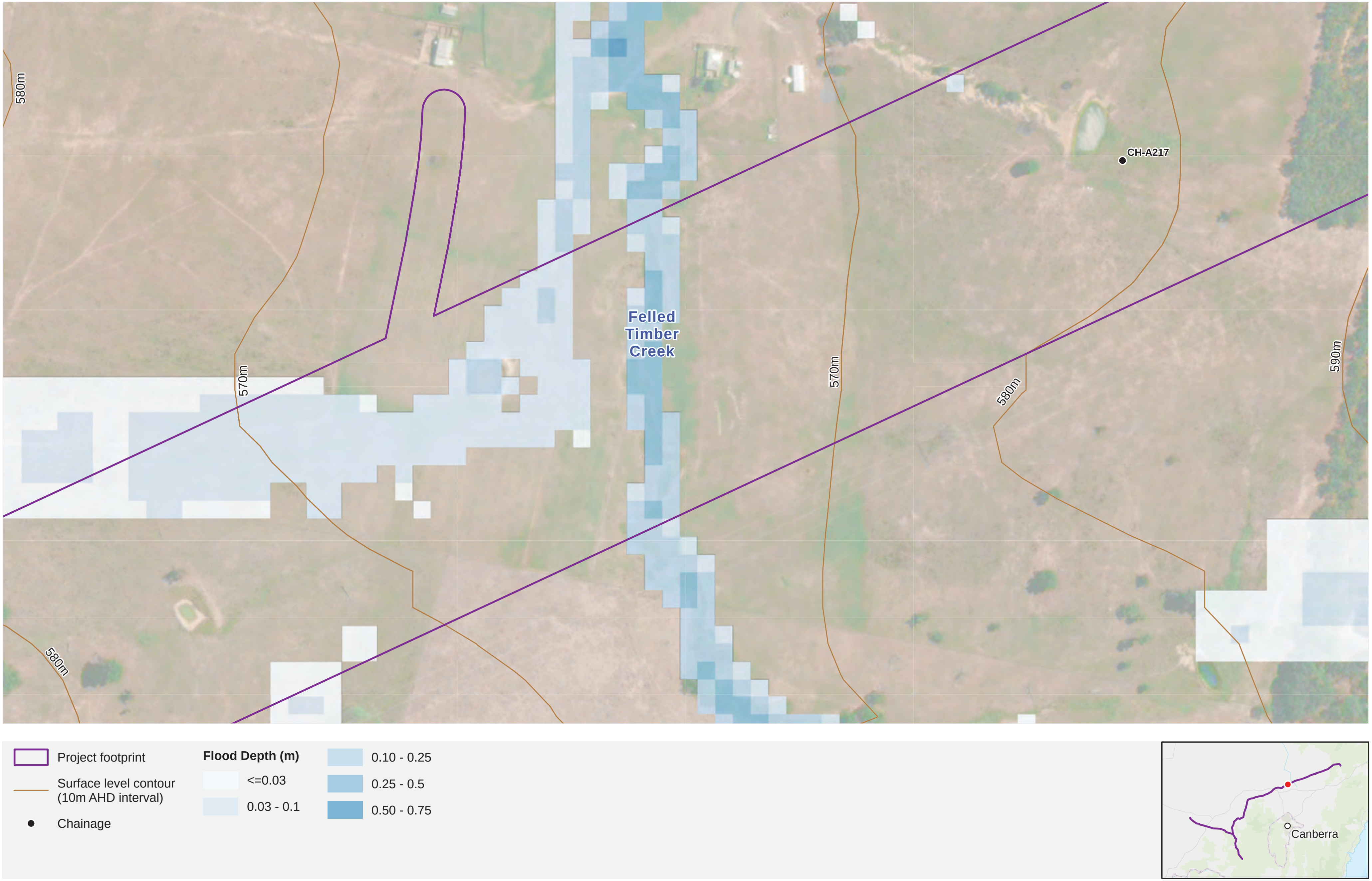

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:2,500
0 50 100m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 40a: 1% AEP flood depth (m) at Felled Timber Creek - Lachlan Catchment

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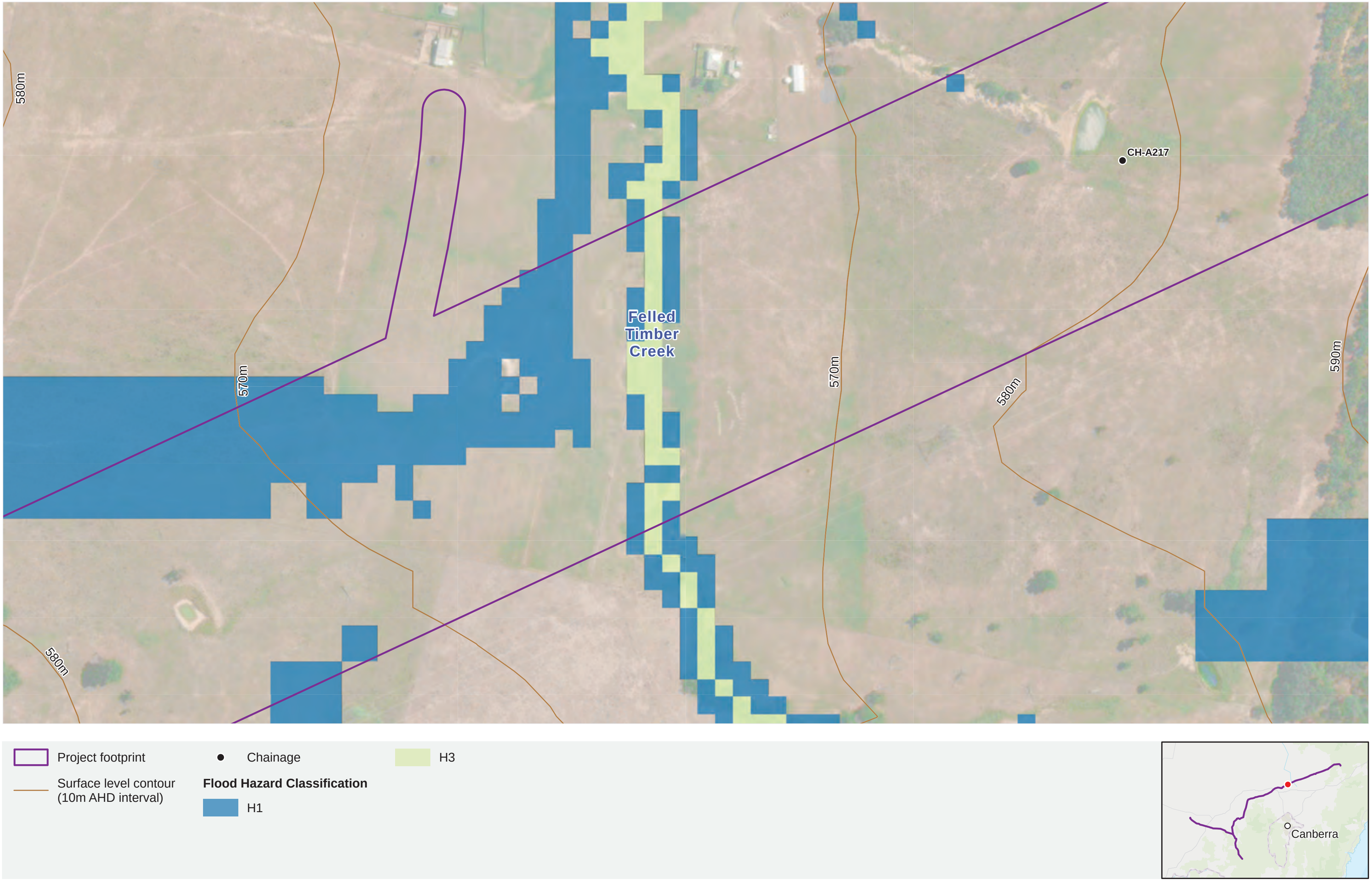

▭ Project footprint

● Chainage

🟩 H3

Surface level contour (10m AHD interval)

Flood Hazard Classification

🟦 H1

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 40b: ARR 2019 Flood Hazard Classification at Felled Timber Creek - Lachlan Catchment

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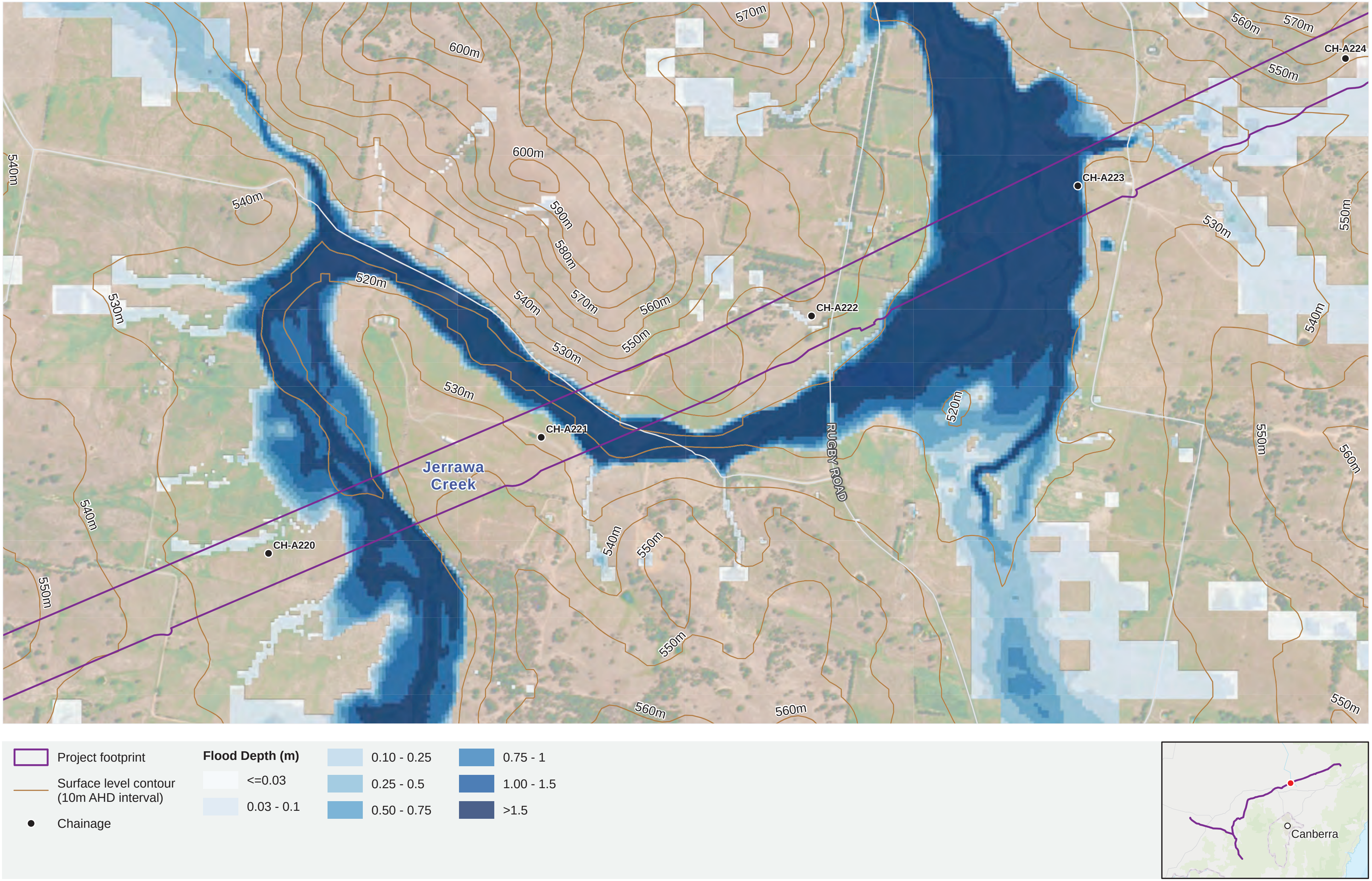


Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

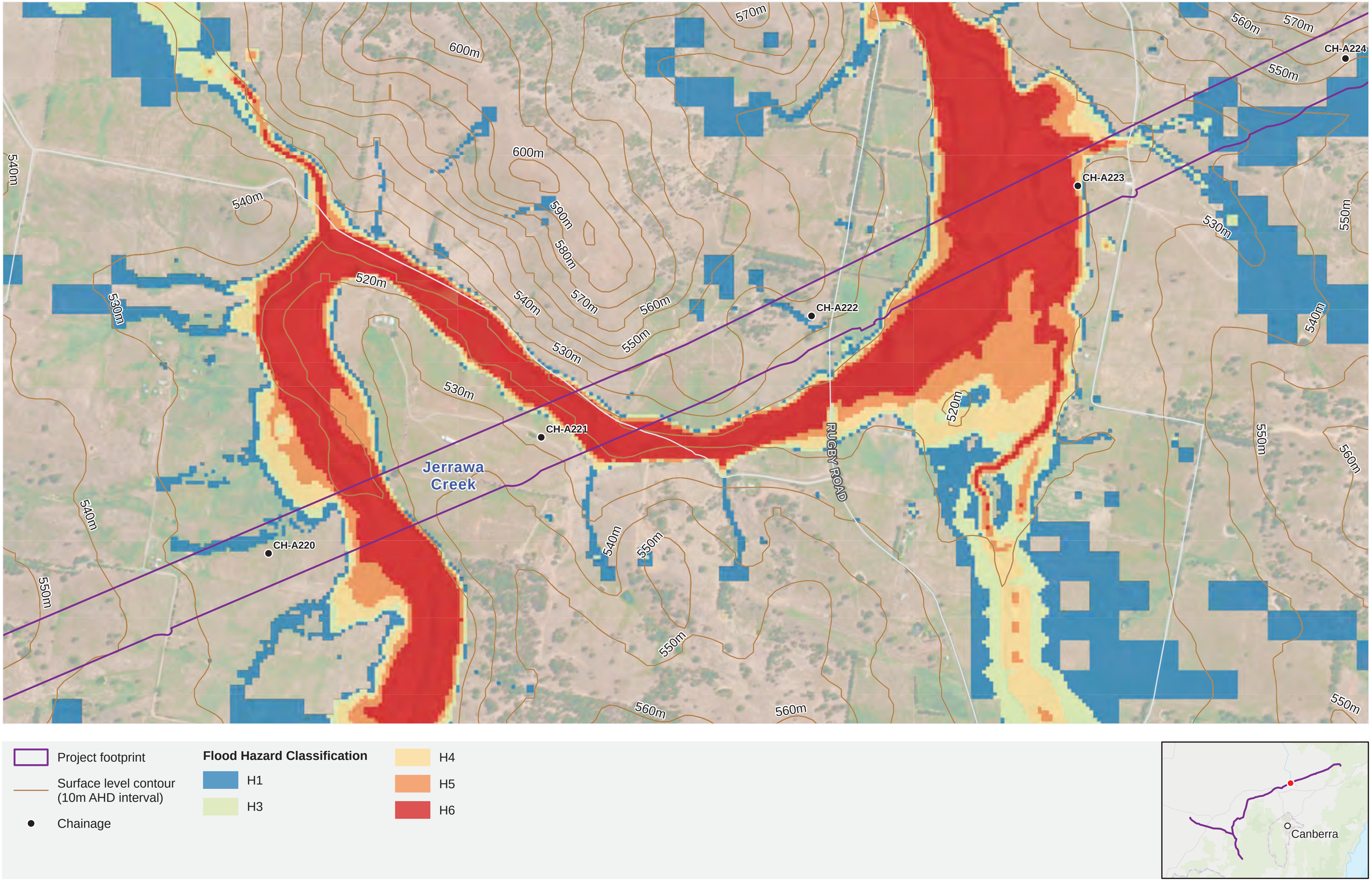
1:12,000

0 280 560 m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 41a: 1% AEP flood depth (m) at Jerrawa Creek - Lachlan Catchment



C:\Users\Virgil.Robinson\Aurecon Group\507179 - HumeLink Project Development Suppor - EIS\ArcPro\507179_HumeLink_Flooding.aprx\19-05-23\Virgil.Robinson

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

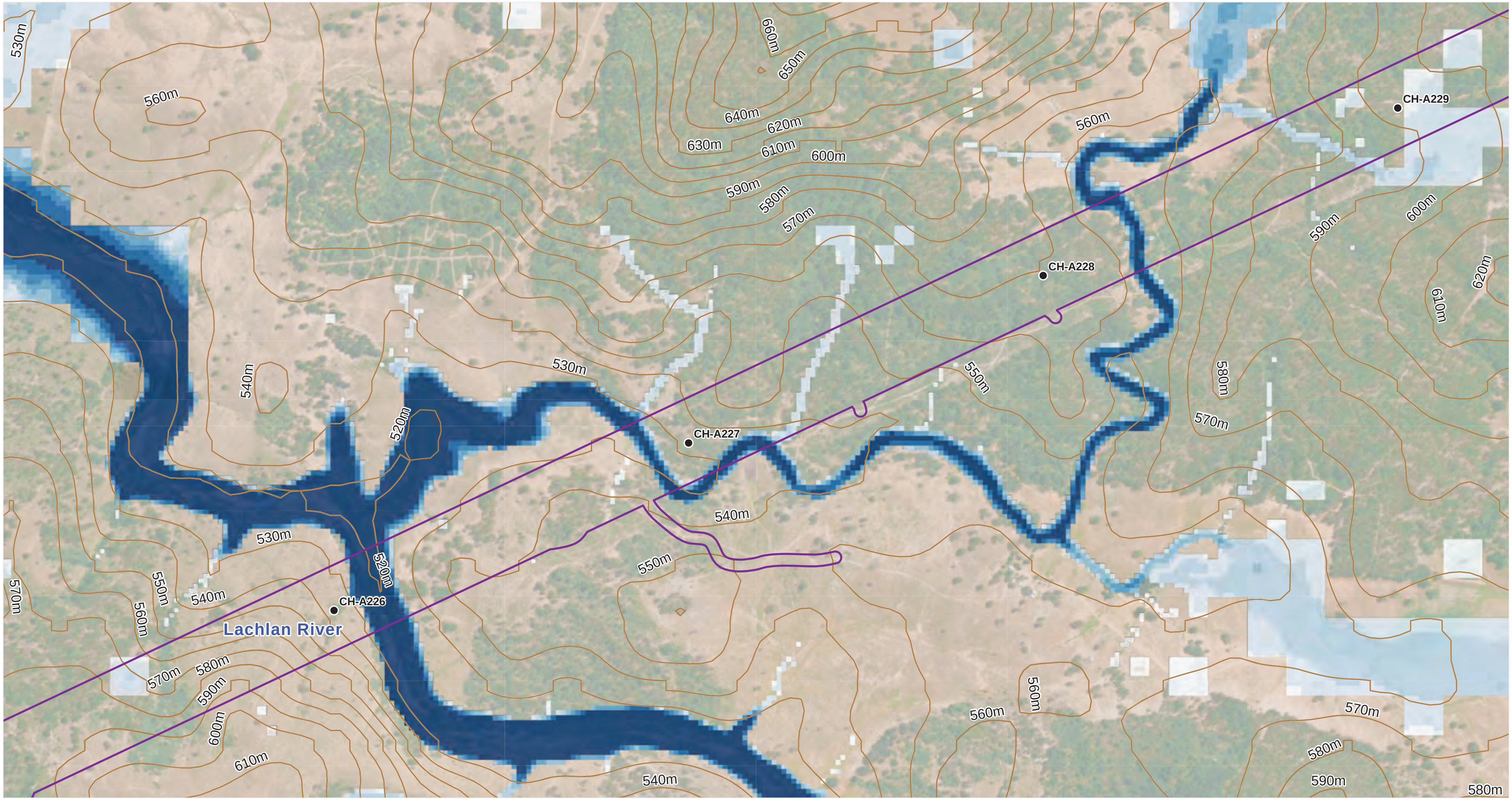
1:12,000

0 280 560m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 41b: ARR 2019 Flood Hazard Classification at Jerrawa Creek - Lachlan Catchment



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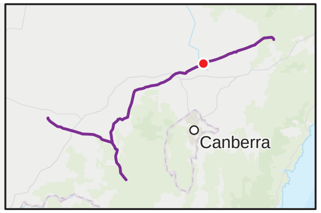
▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Depth (m)

▢	<=0.03	▨	0.10 - 0.25	▨	0.75 - 1
▢	0.03 - 0.1	▨	0.25 - 0.5	▨	1.00 - 1.5
		▨	0.50 - 0.75	▨	>1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:10,000

0 230 460m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 42a: 1% AEP flood depth (m) at Lachlan River - Lachlan Catchment

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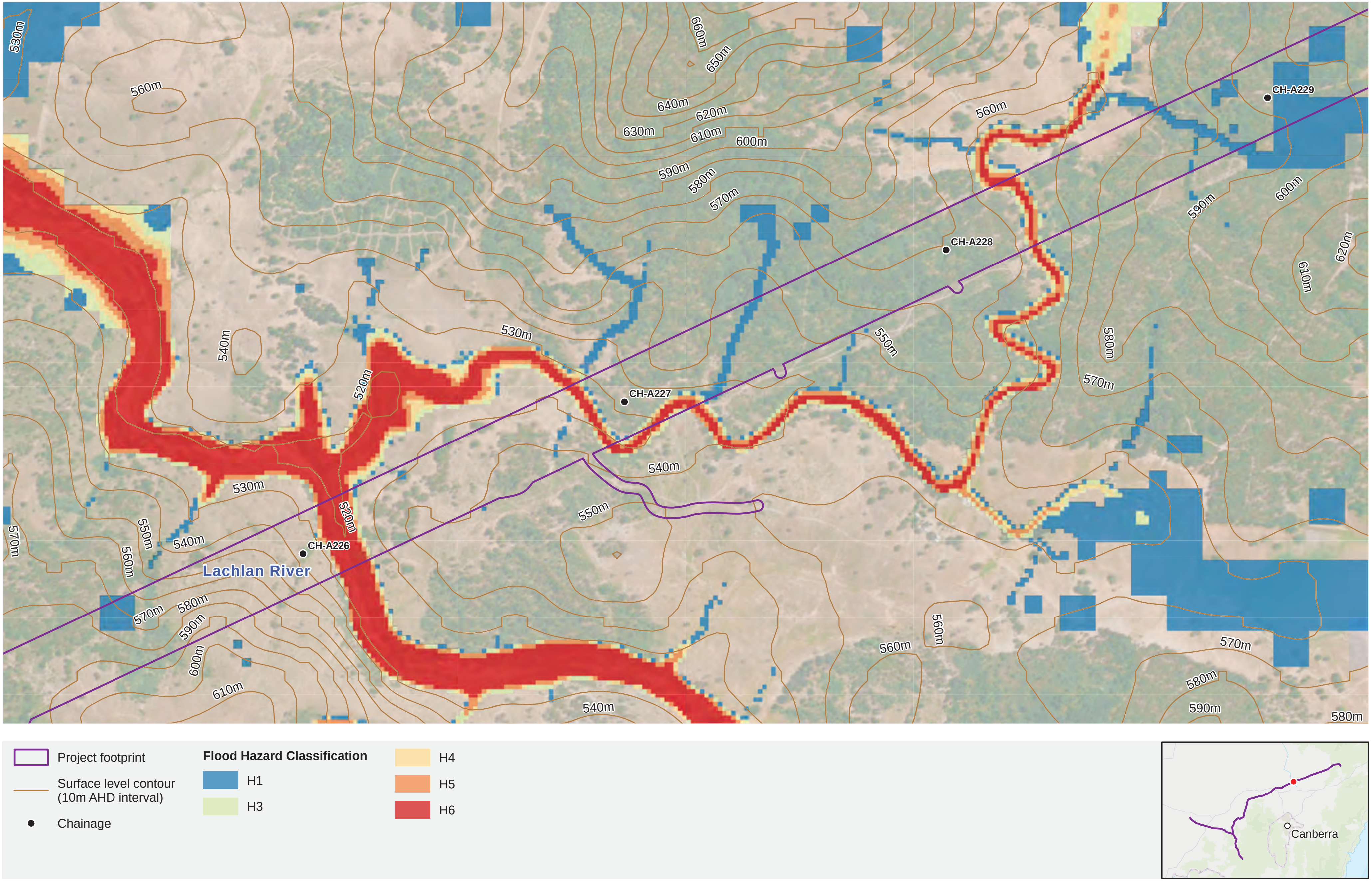


Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

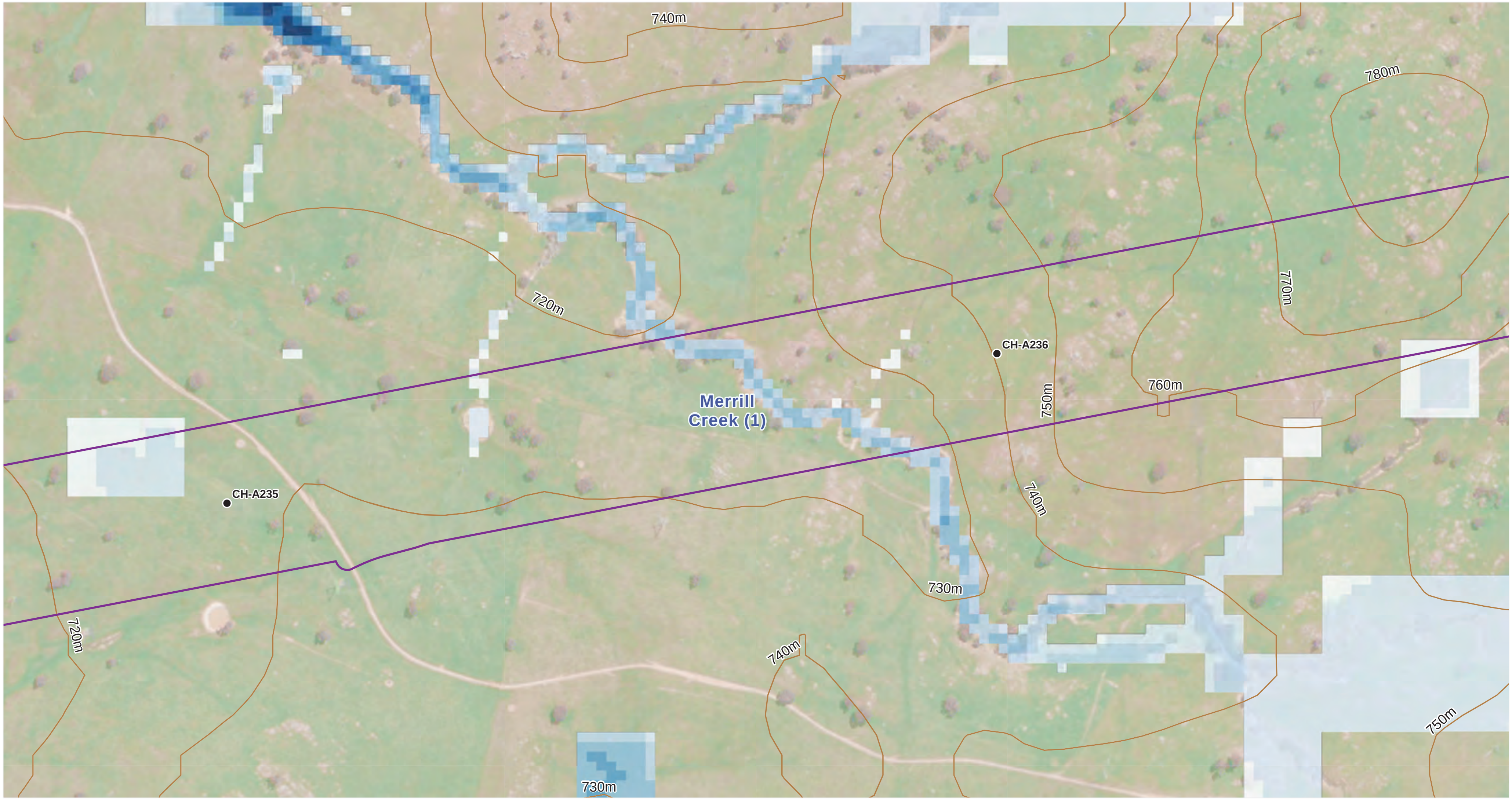
1:10,000

0 230 460 m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 42b: ARR 2019 Flood Hazard Classification at Lachlan River - Lachlan Catchment



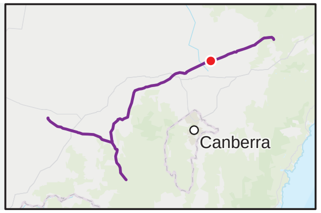
▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Depth (m)

▢	<=0.03
▢	0.03 - 0.1
▢	0.10 - 0.25
▢	0.25 - 0.5
▢	0.50 - 0.75
▢	0.75 - 1
▢	1.00 - 1.5
▢	>1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 43a: 1% AEP flood depth (m) at Merrill Creek (1) - Lachlan Catchment

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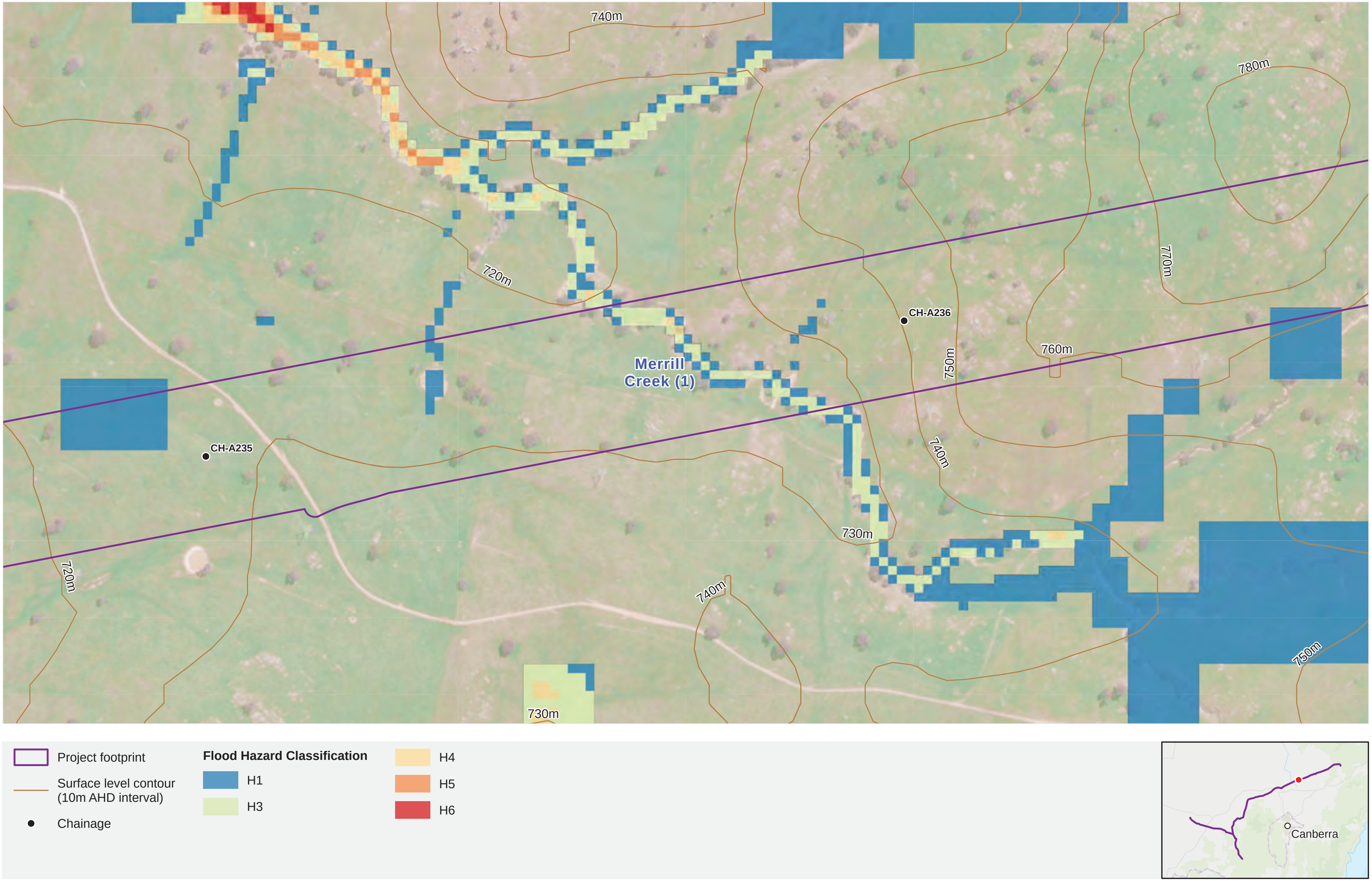

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 43b: ARR 2019 Flood Hazard Classification at Merrill Creek (1) - Lachlan Catchment

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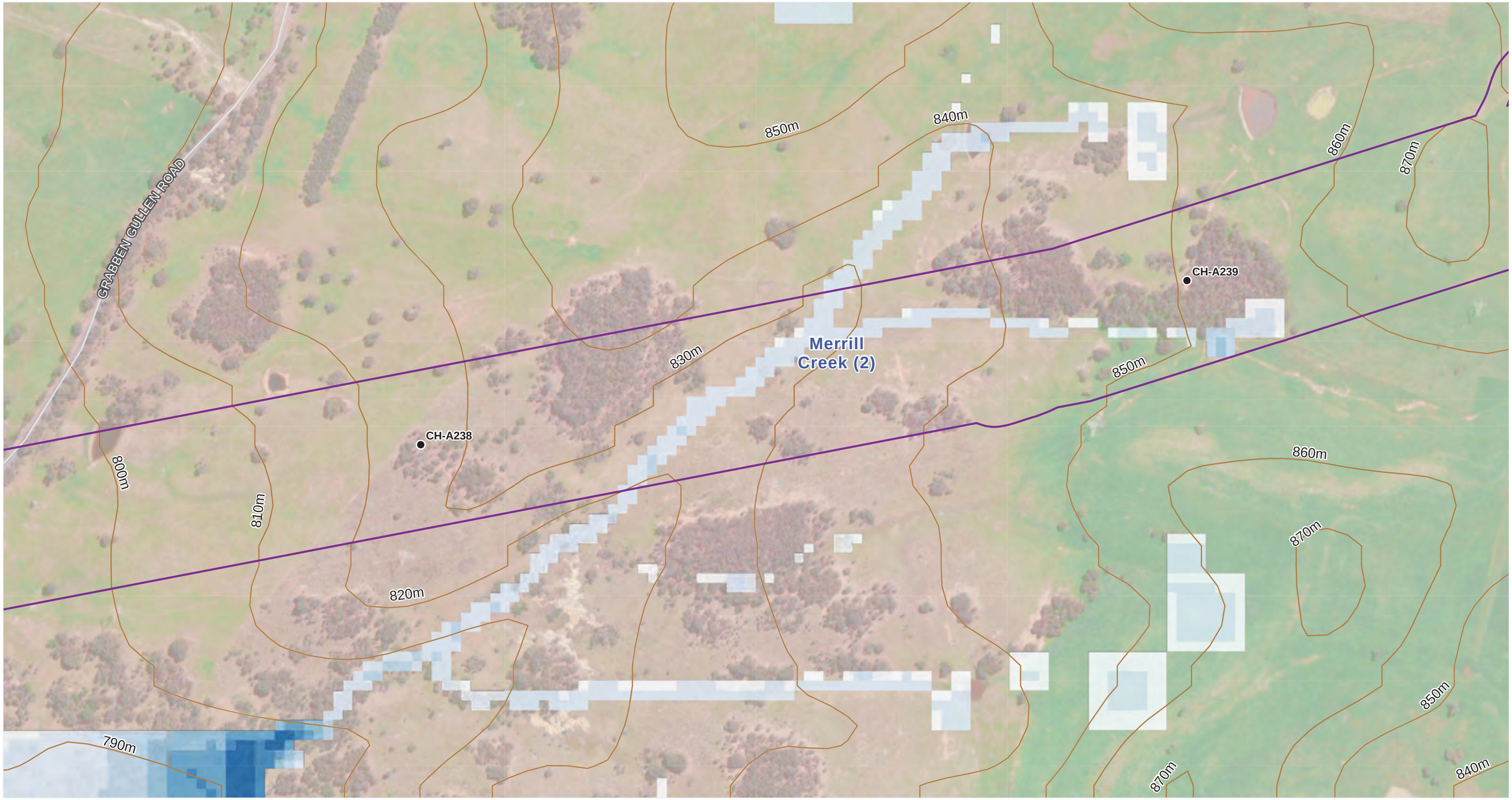


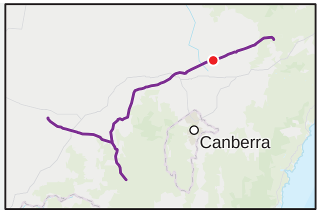
▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Depth (m)

▭	<=0.03
▭	0.03 - 0.1
▭	0.10 - 0.25
▭	0.25 - 0.5
▭	0.50 - 0.75
▭	0.75 - 1
▭	1.00 - 1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

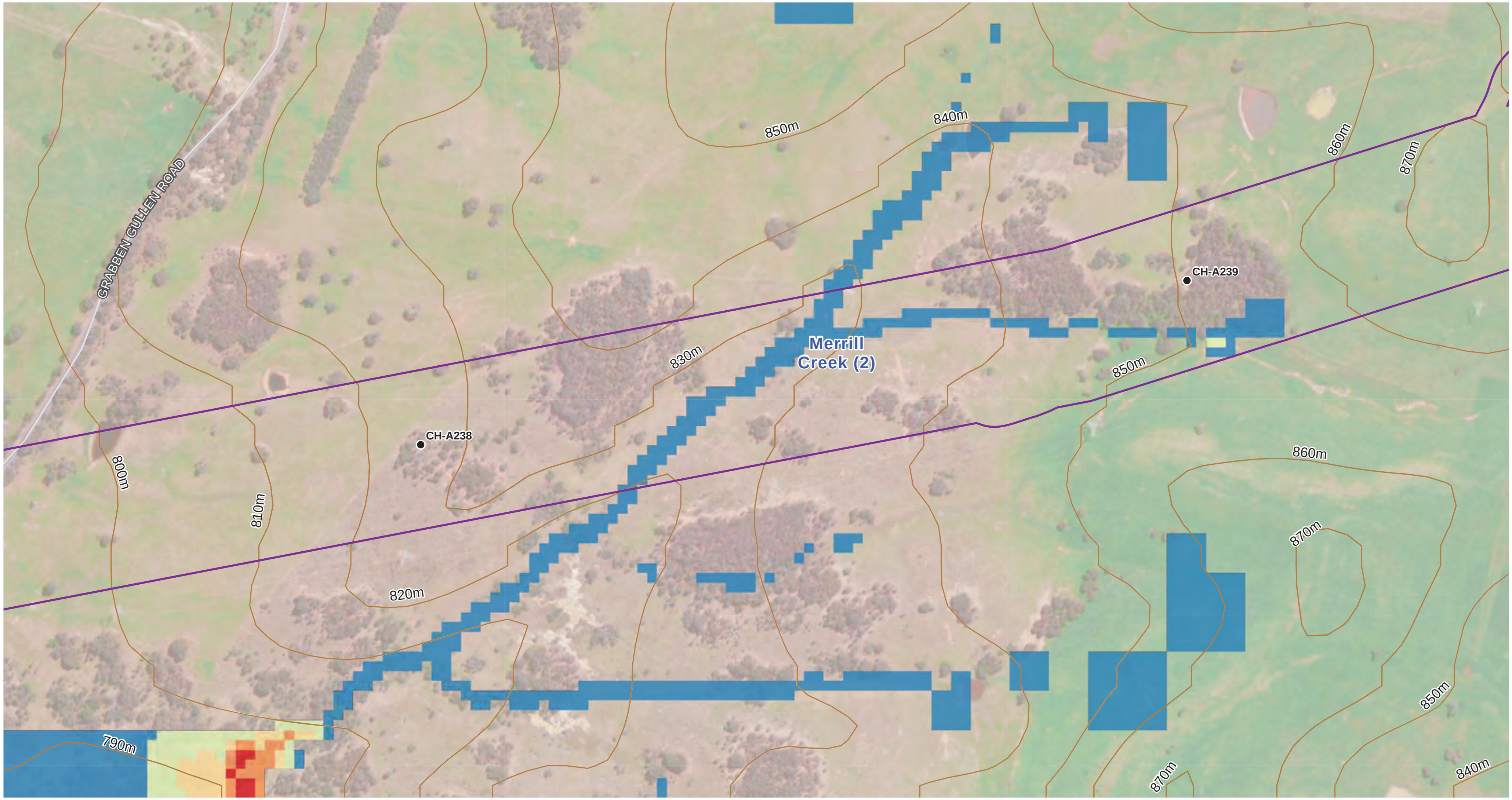
1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 44a: 1% AEP flood depth (m) at Merrill Creek (2) - Lachlan Catchment



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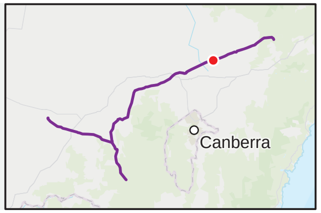
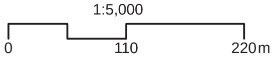
▭	Project footprint
—	Surface level contour (10m AHD interval)
●	Chainage

Flood Hazard Classification

🟦	H1
🟩	H3
🟨	H4
🟧	H5
🟥	H6



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*



Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 44b: ARR 2019 Flood Hazard Classification at Merrill Creek (2) - Lachlan Catchment

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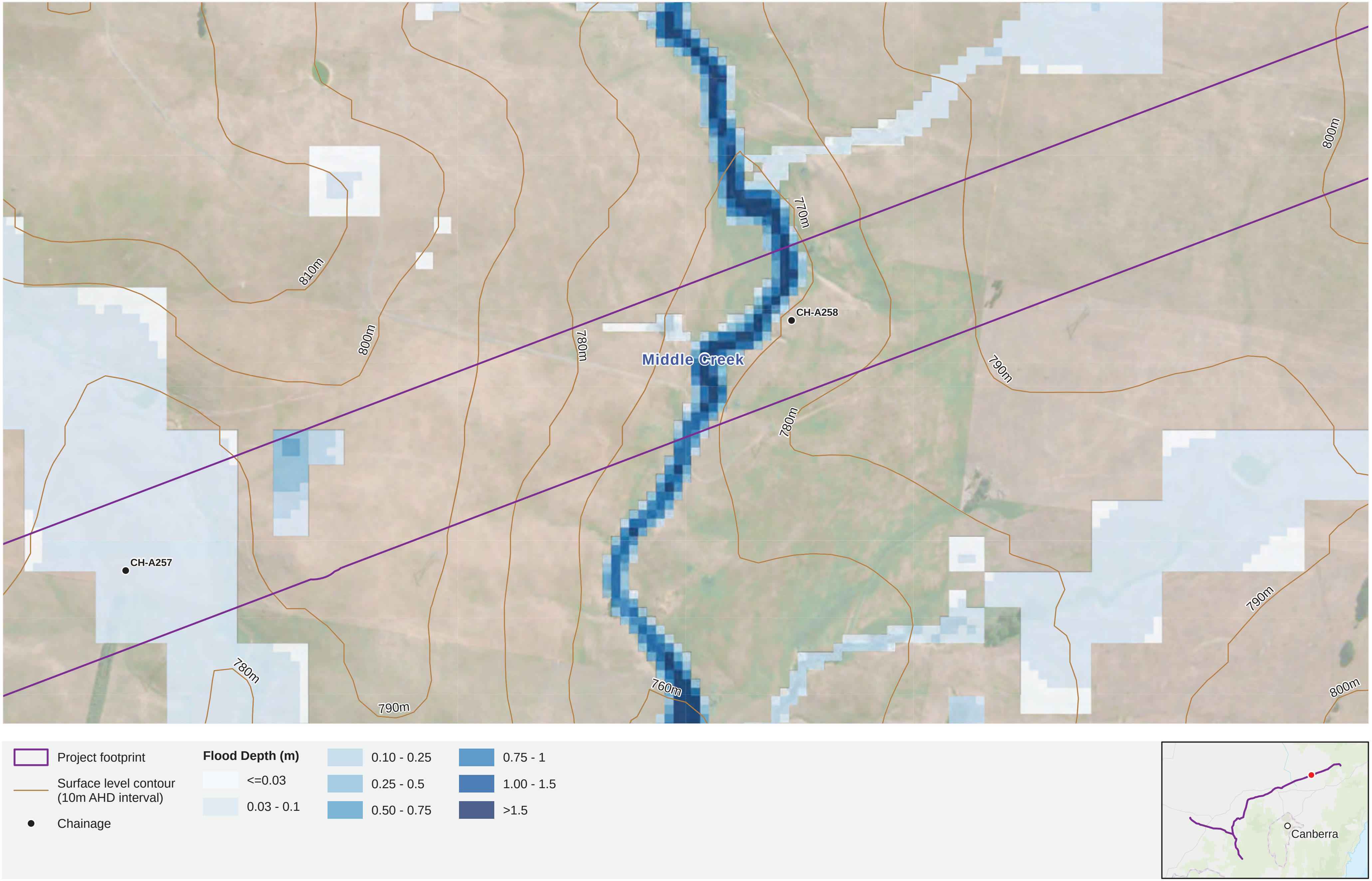

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 45a: 1% AEP flood depth (m) at Middle Creek - Lachlan Catchment

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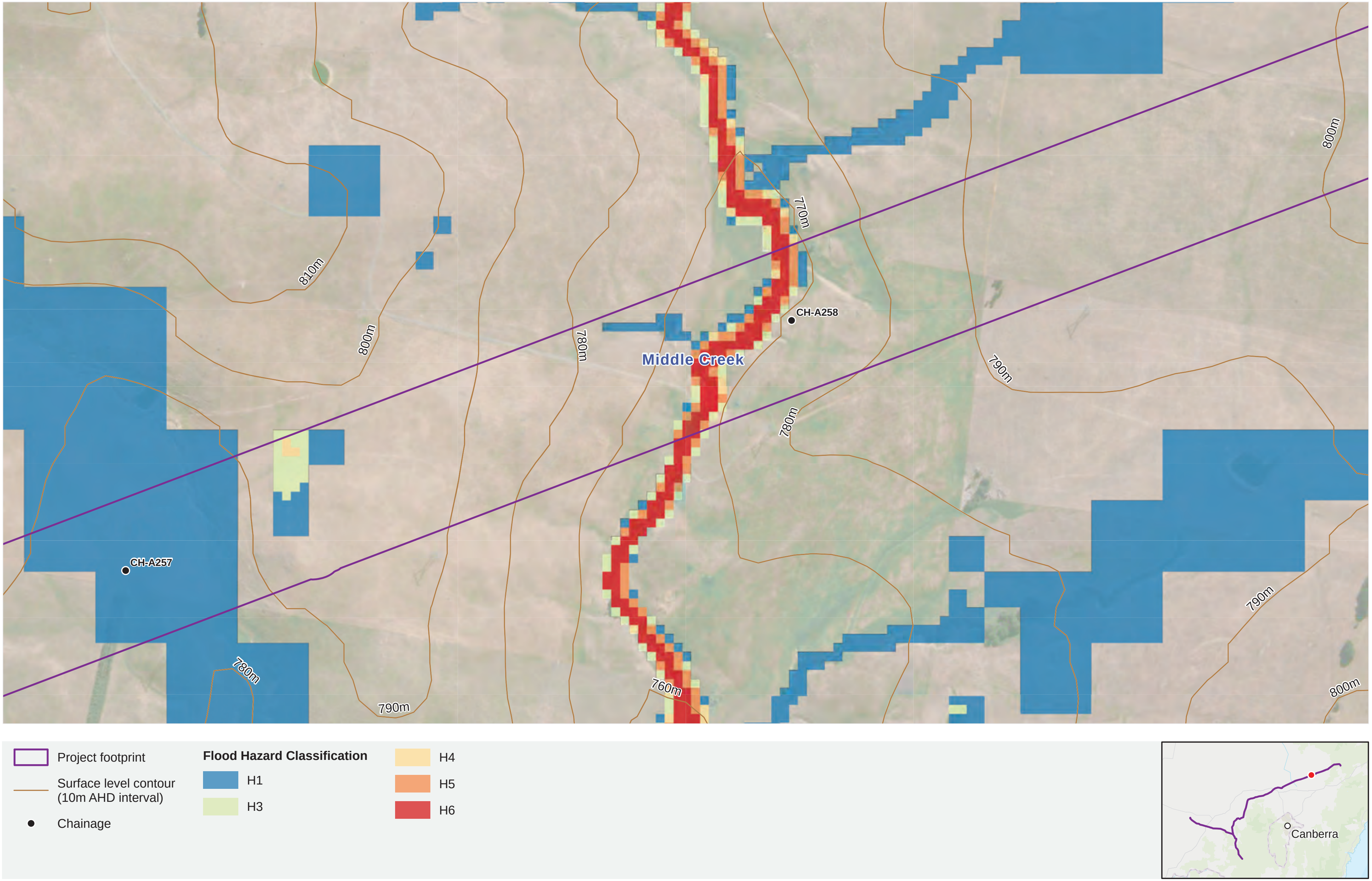


Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

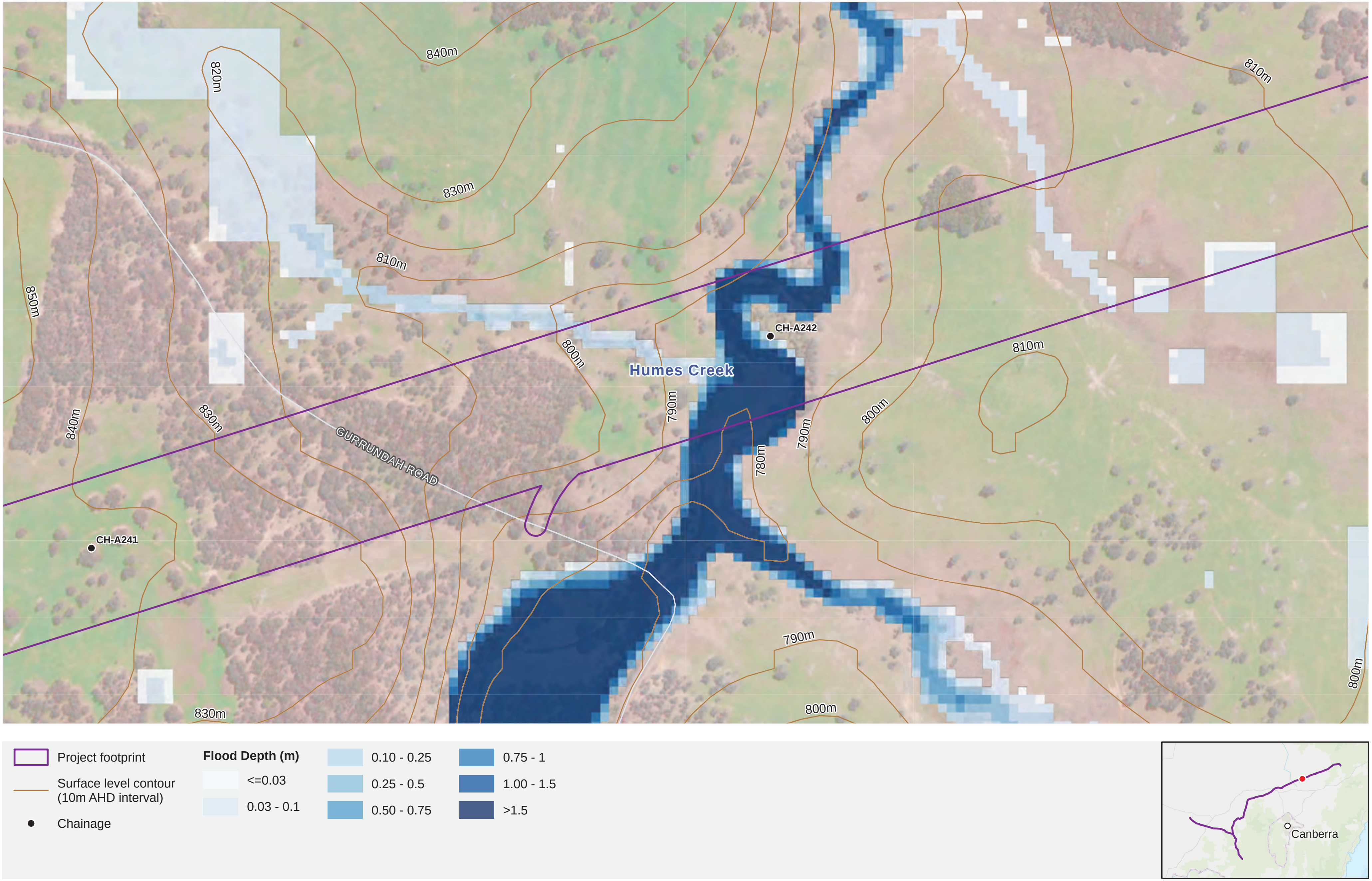
1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 45b: ARR 2019 Flood Hazard Classification at Middle Creek - Lachlan Catchment



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Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 46a: 1% AEP flood depth (m) at Humes Creek - Lachlan Catchment

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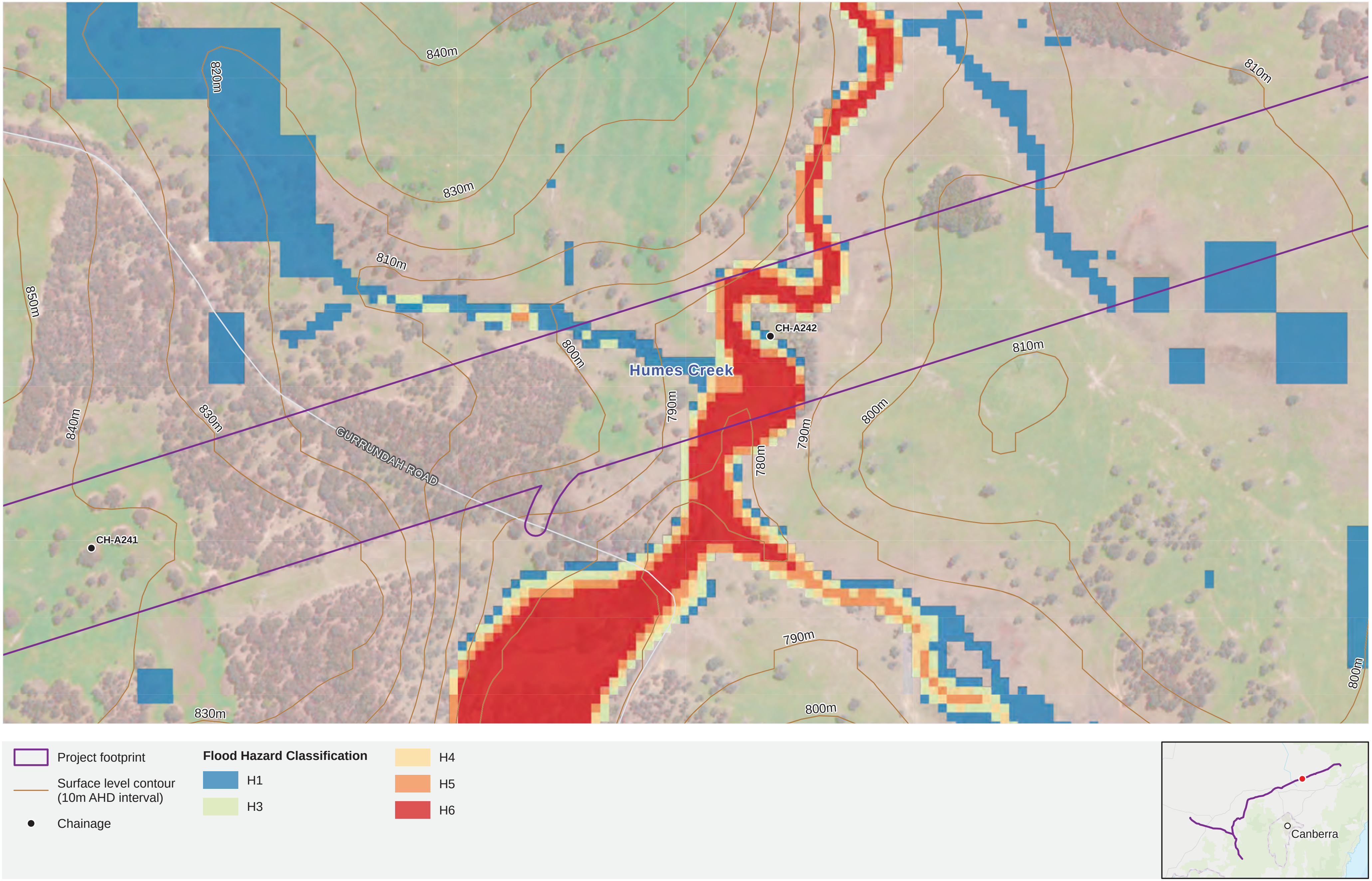

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 46b: ARR 2019 Flood Hazard Classification at Humes Creek - Lachlan Catchment

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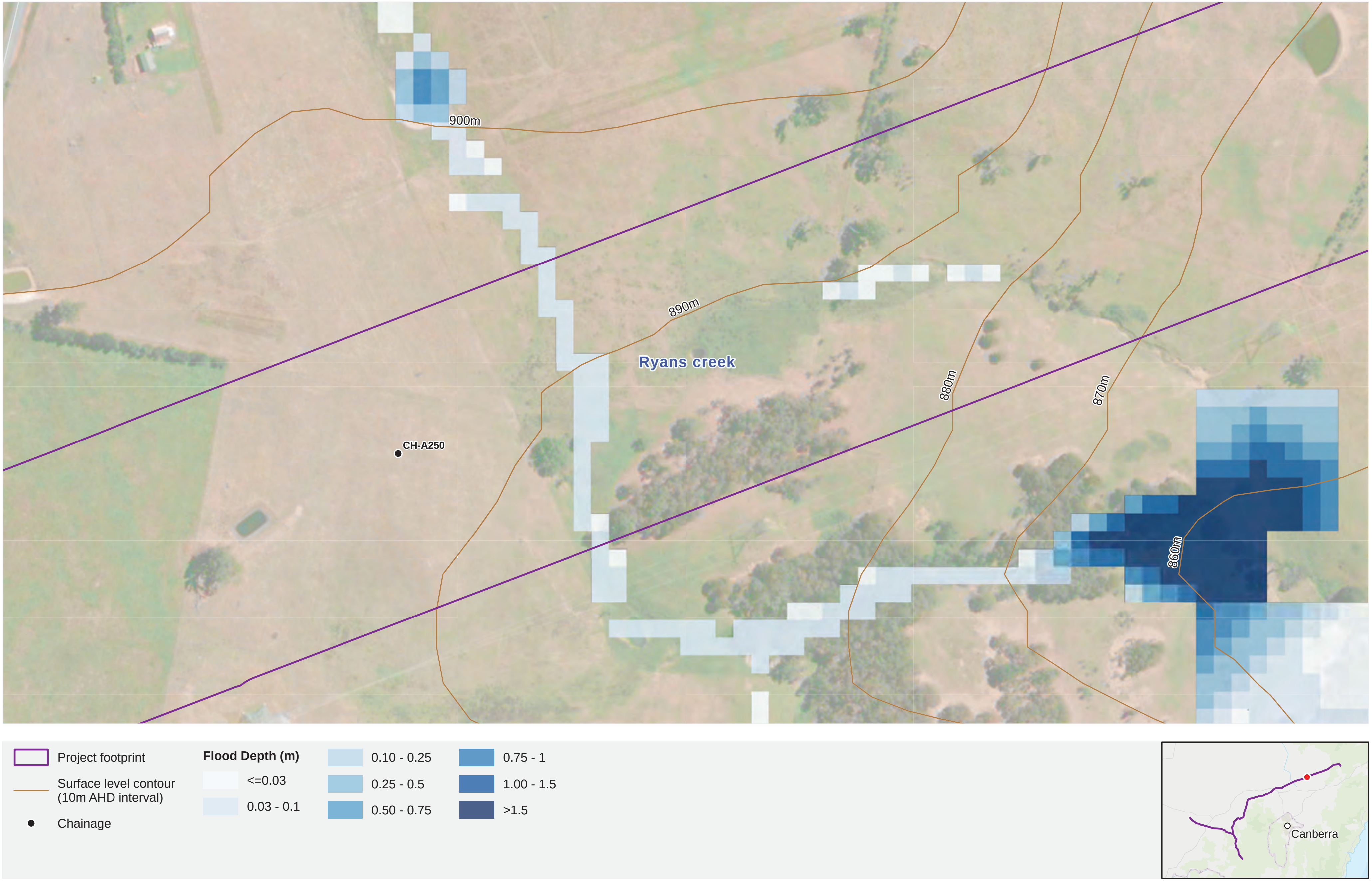

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:2,500

0 50 100m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 47a: 1% AEP flood depth (m) at Ryans creek - Wollondilly Catchment

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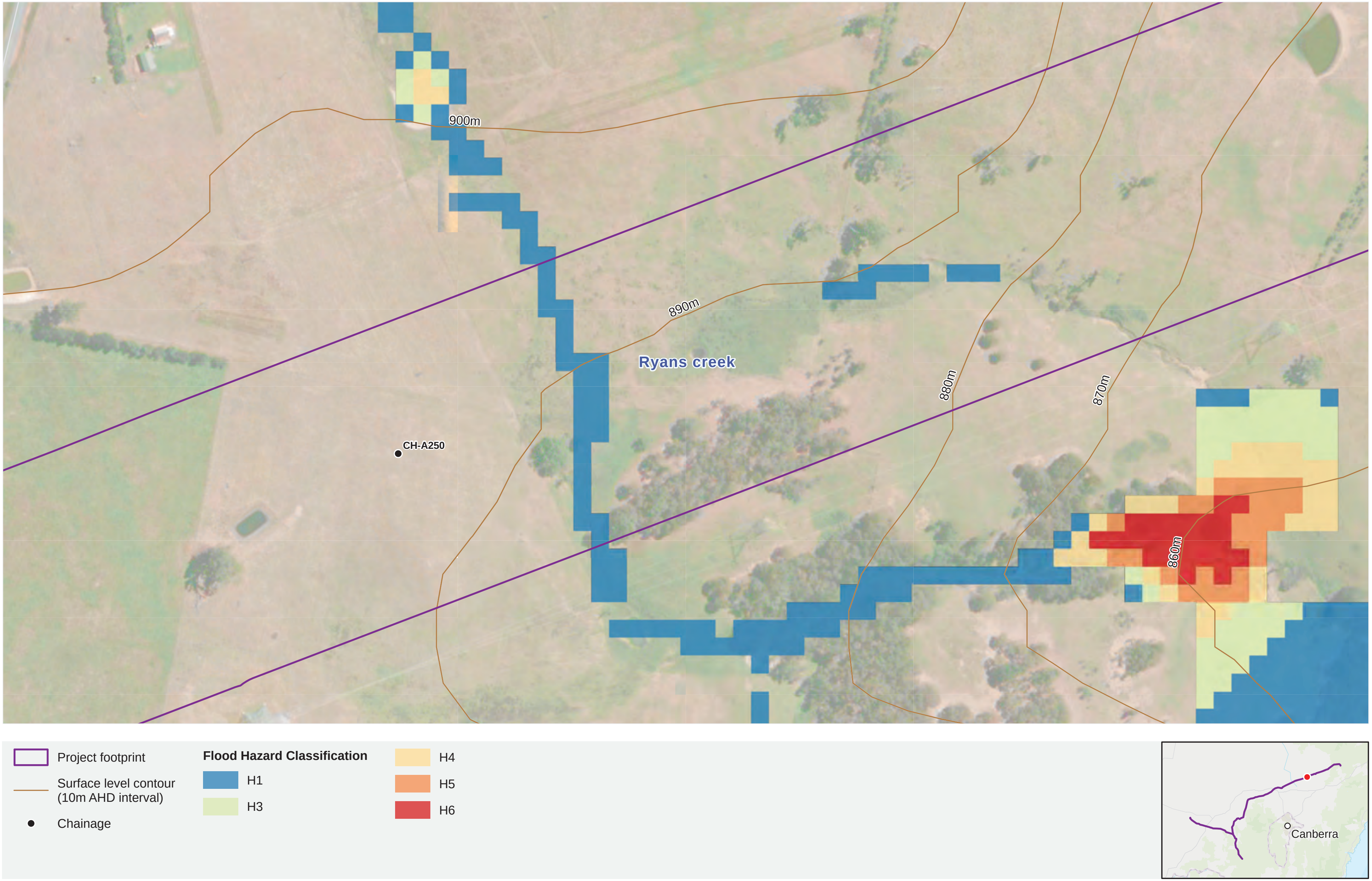


- ▭ Project footprint
- Surface level contour (10m AHD interval)
- ● Chainage

Flood Hazard Classification

- 🟦 H1
- 🟩 H3
- 🟨 H4
- 🟧 H5
- 🟥 H6

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

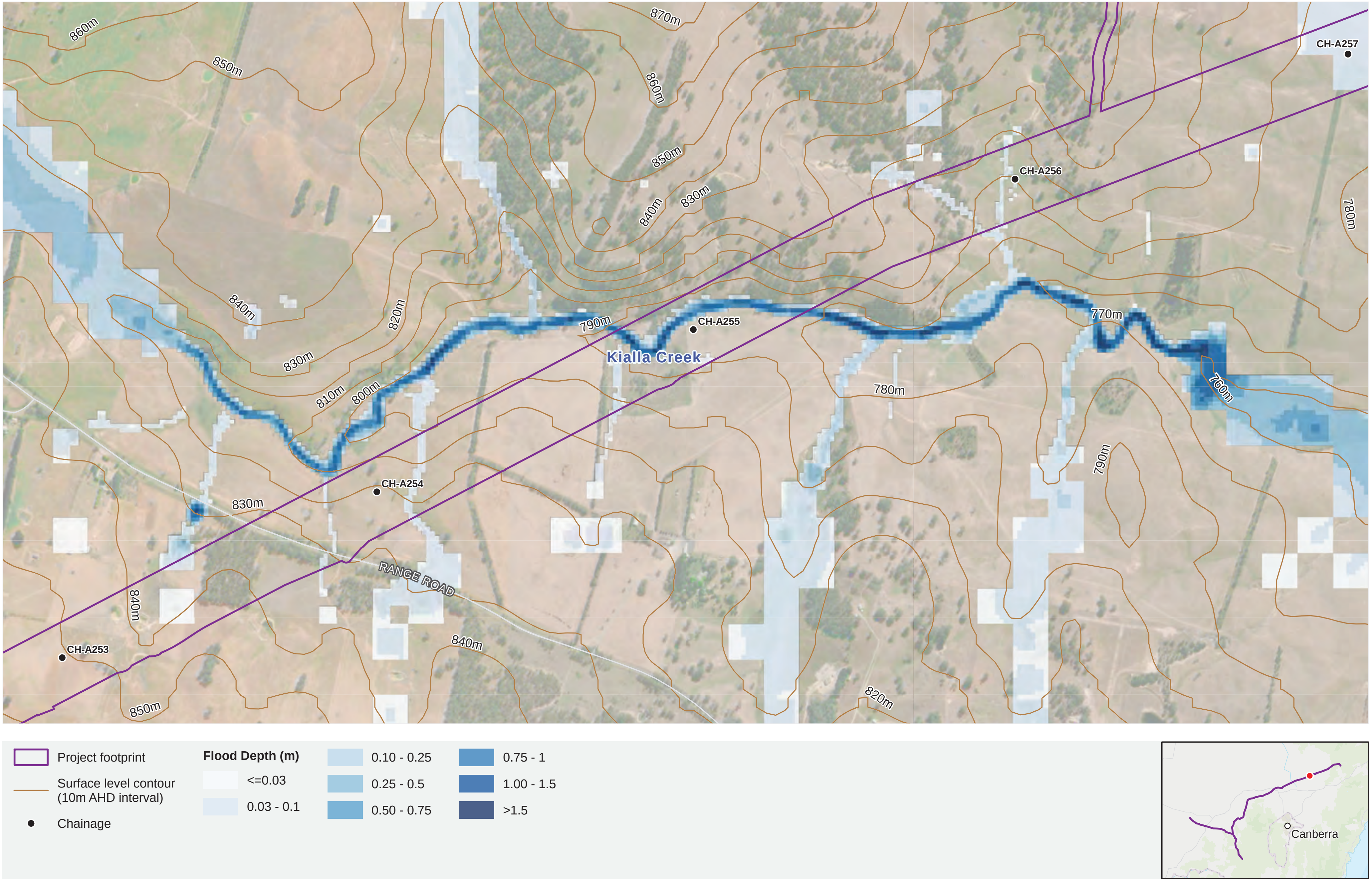
1:2,500

0 50 100m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 47b: ARR 2019 Flood Hazard Classification at Ryans creek - Wollondilly Catchment



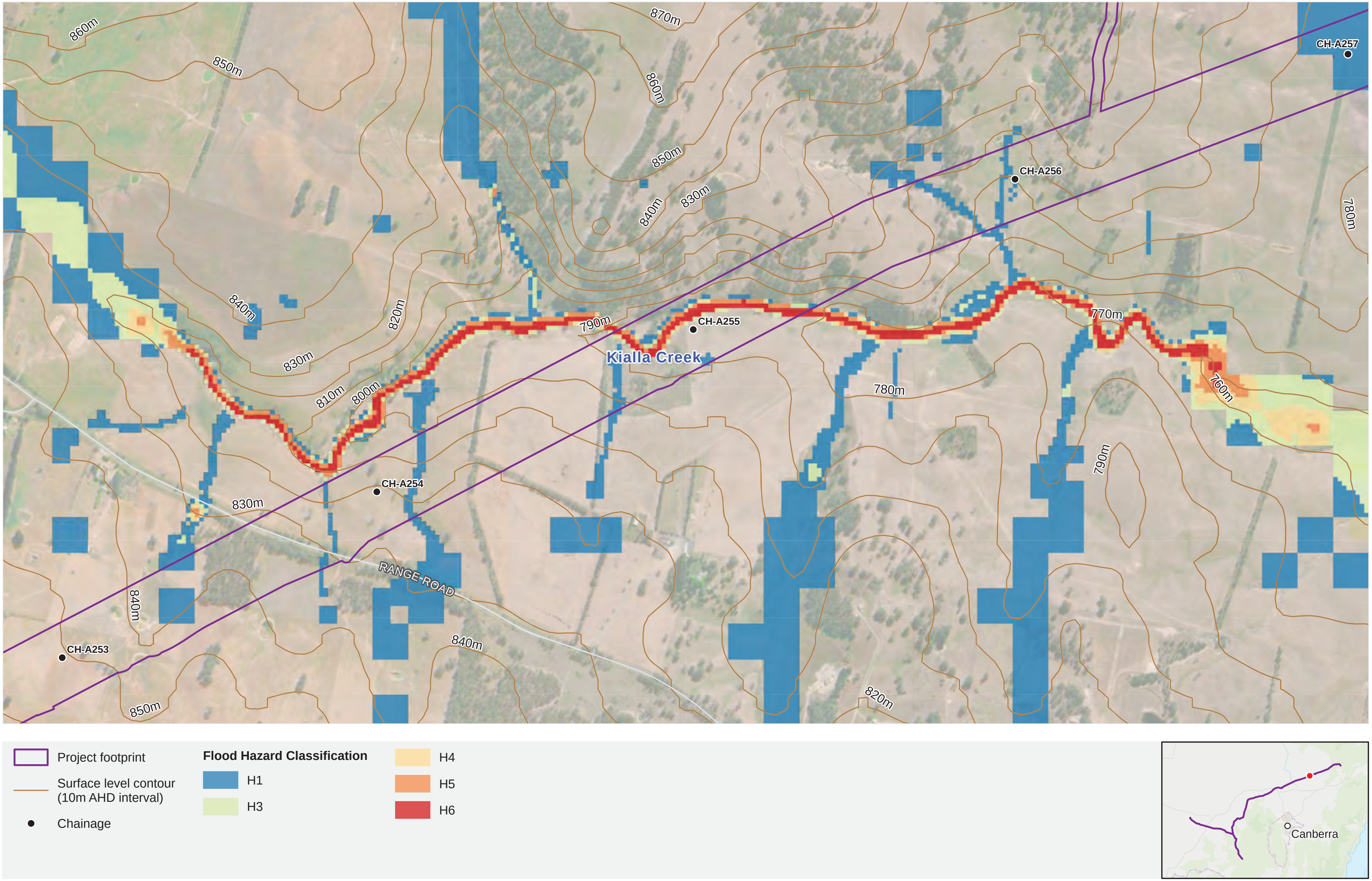
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:10,000

0 230 460m

Projection: GDA 1994 MGA Zone 55

Map 48a: 1% AEP flood depth (m) at Kialla Creek - Wollondilly Catchment



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Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

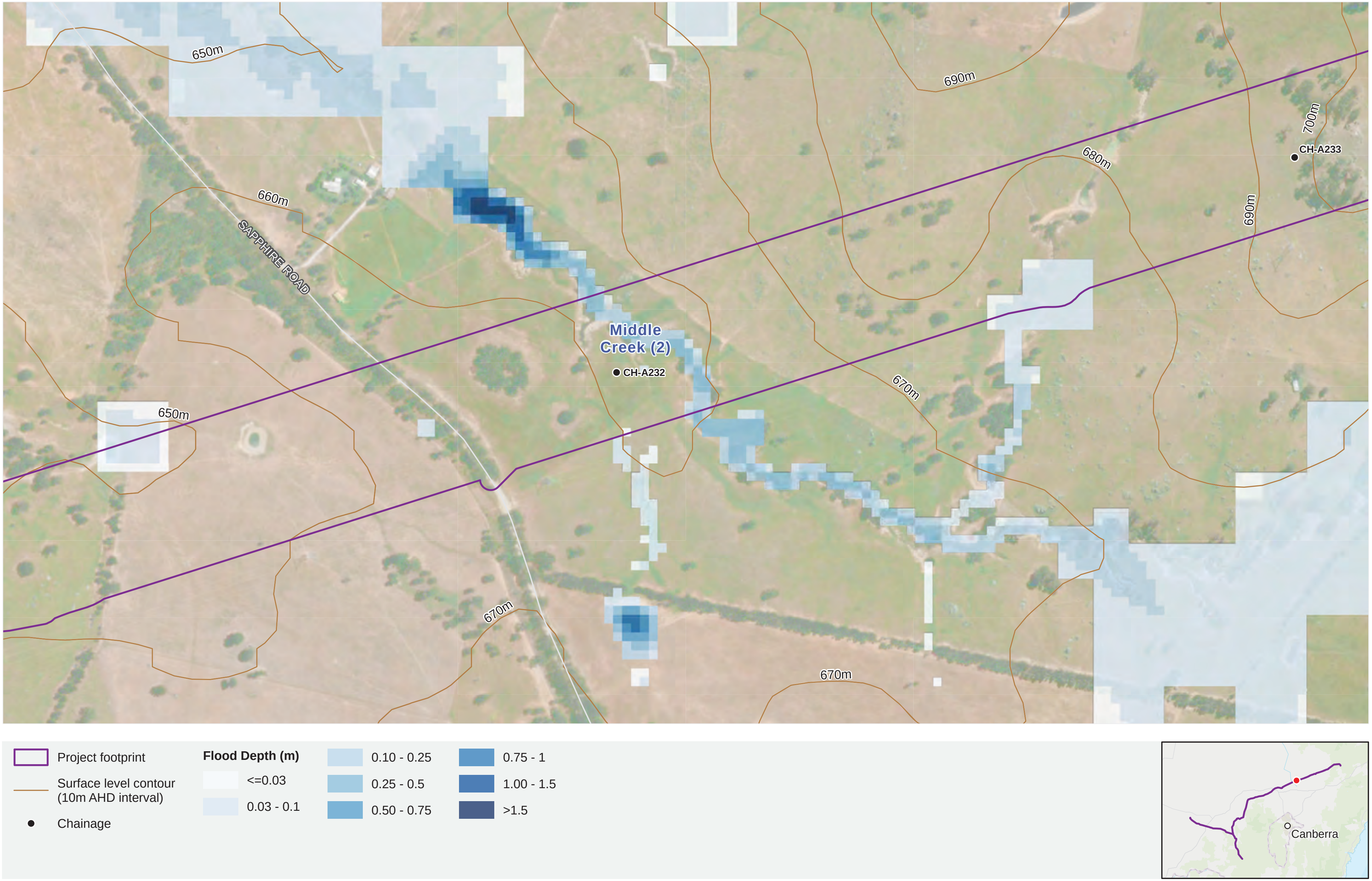
1:10,000

0 230 460 m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 48b: ARR 2019 Flood Hazard Classification at Kialla Creek - Wollondilly Catchment



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Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 49a: 1% AEP flood depth (m) at Middle Creek (2) - Wollondilly Catchment

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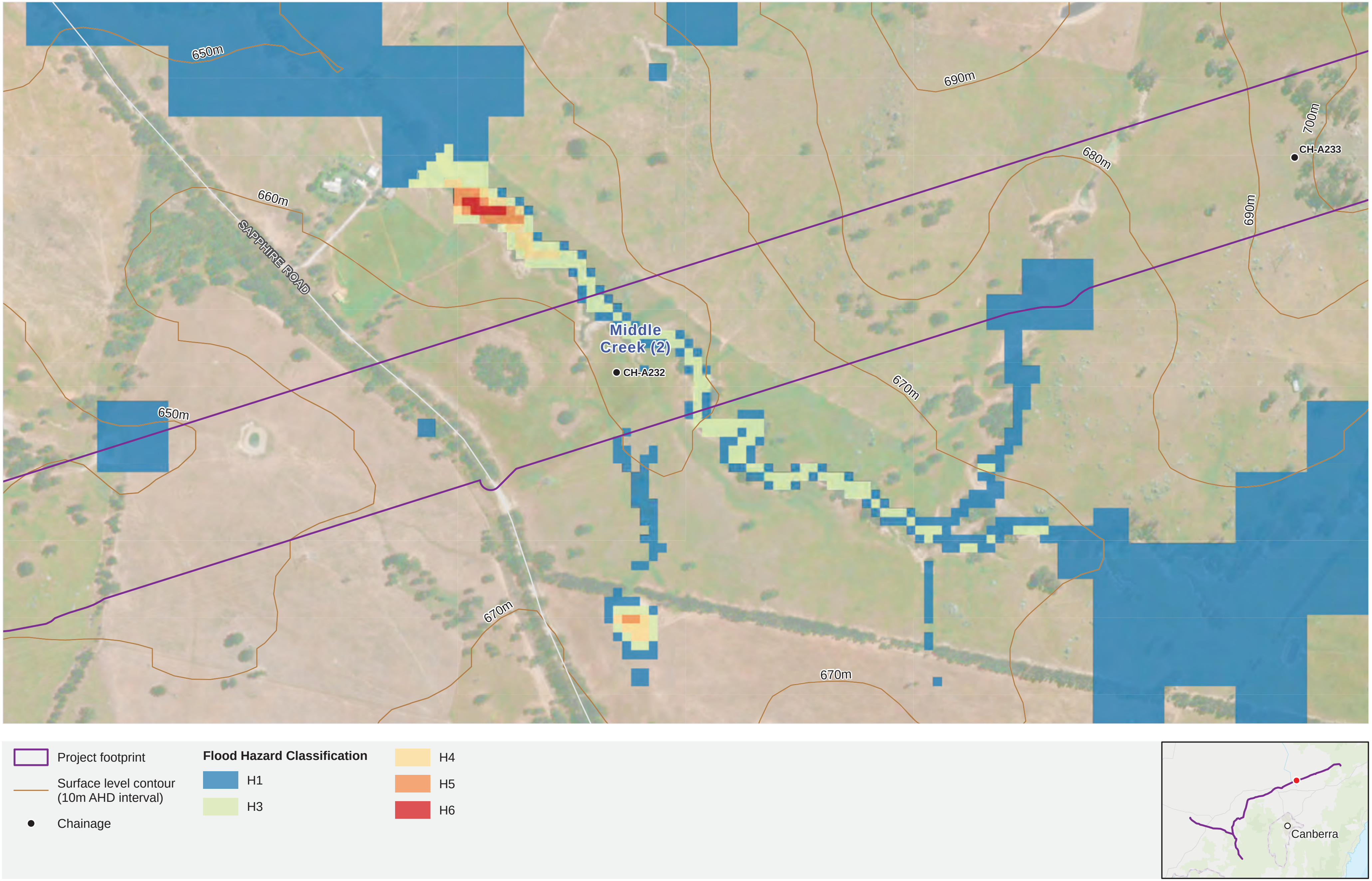

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 49b: ARR 2019 Flood Hazard Classification at Middle Creek (2) - Wollondilly Catchment

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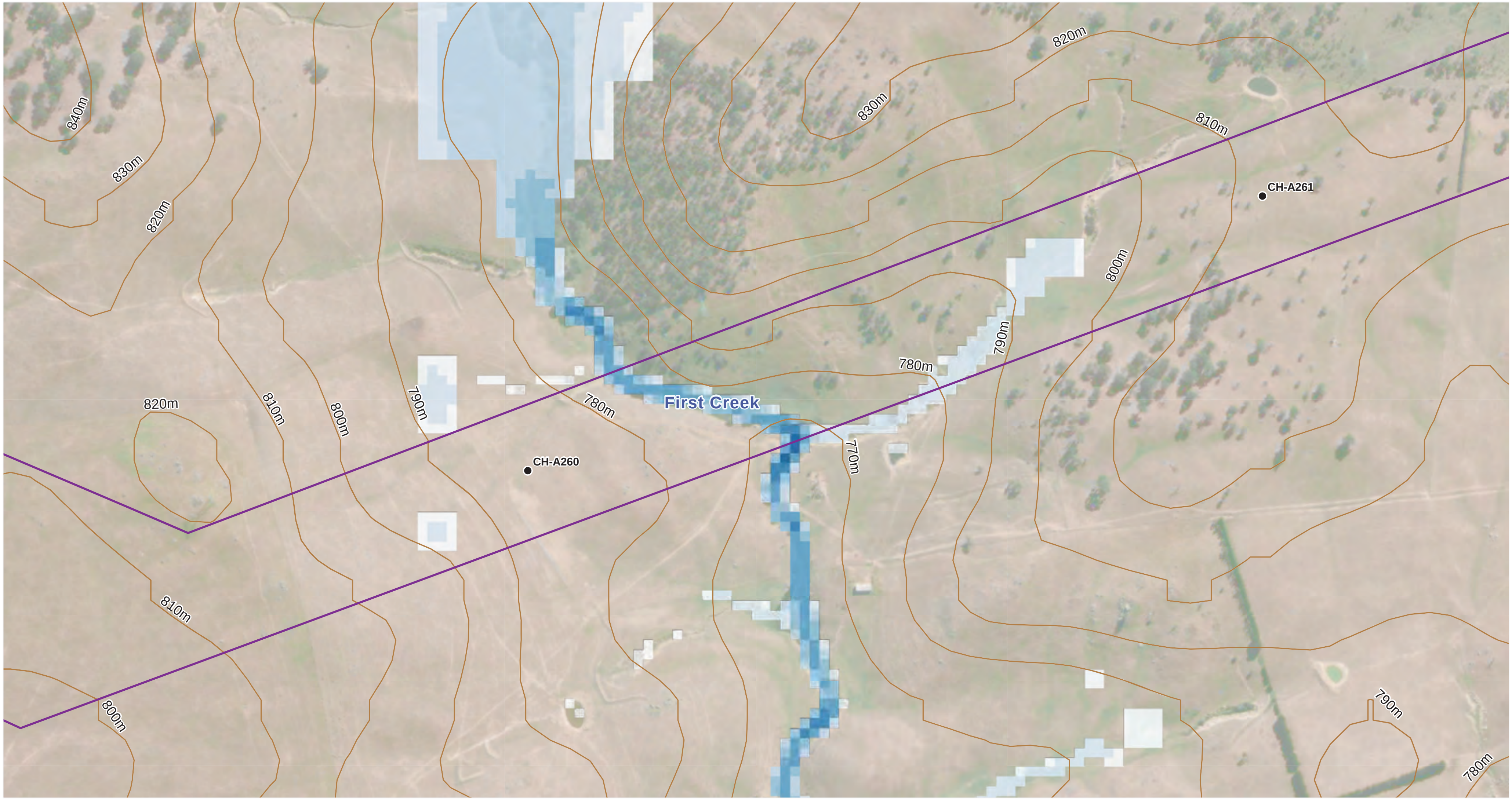
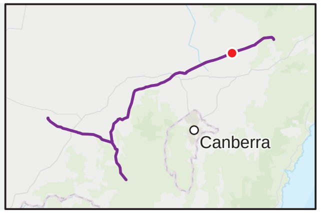


▭ Project footprint	● Chainage	0.03 - 0.1	0.50 - 0.75
Surface level contour (10m AHD interval)	**Flood Depth (m)**	0.10 - 0.25	0.75 - 1
	<=0.03	0.25 - 0.5	1.00 - 1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 50a: 1% AEP flood depth (m) at First Creek - Wollondilly Catchment

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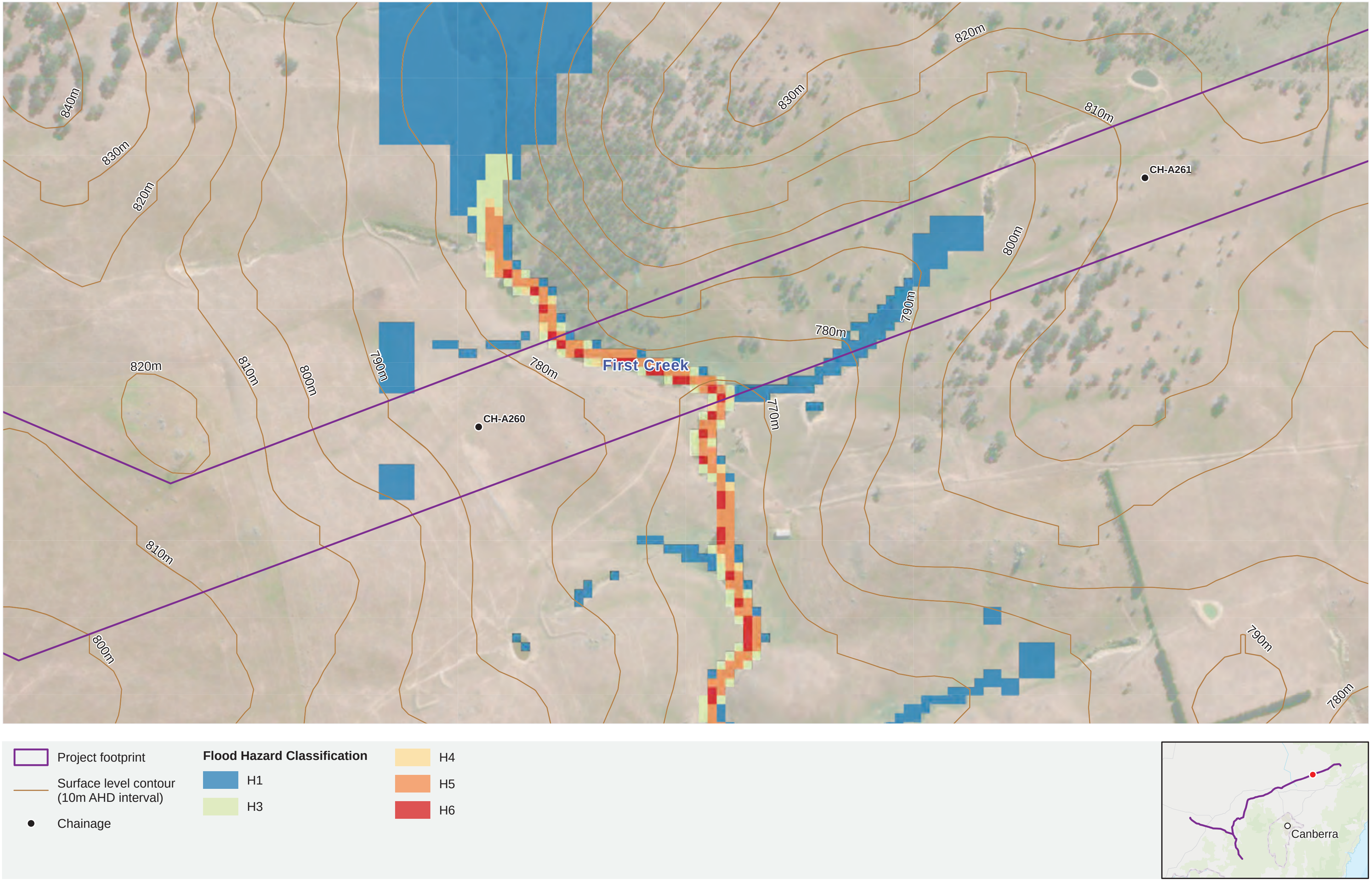

▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Hazard Classification

🟦 H1

🟩 H3

🟨 H4

🟧 H5

🟥 H6

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 50b: ARR 2019 Flood Hazard Classification at First Creek - Wollondilly Catchment

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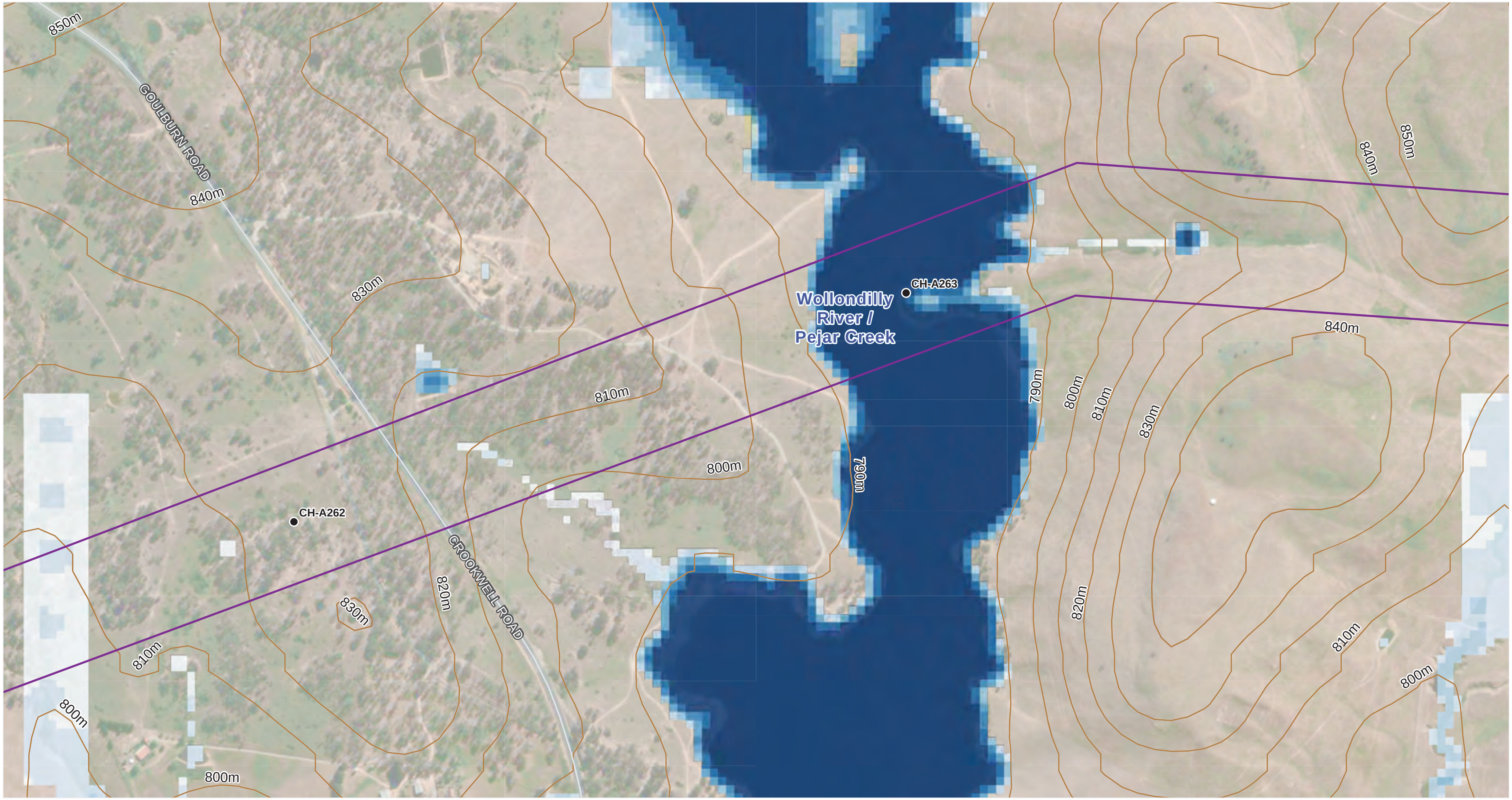


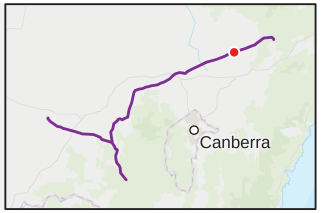
Project footprint

Surface level contour (10m AHD interval)

● Chainage

Flood Depth (m)

- <=0.03
- 0.03 - 0.1
- 0.10 - 0.25
- 0.25 - 0.5
- 0.50 - 0.75
- 0.75 - 1
- 1.00 - 1.5
- >1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:6,000

0 140 280m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 51a: 1% AEP flood depth (m) at Wollondilly River / Pejar Creek - Wollondilly Catchment

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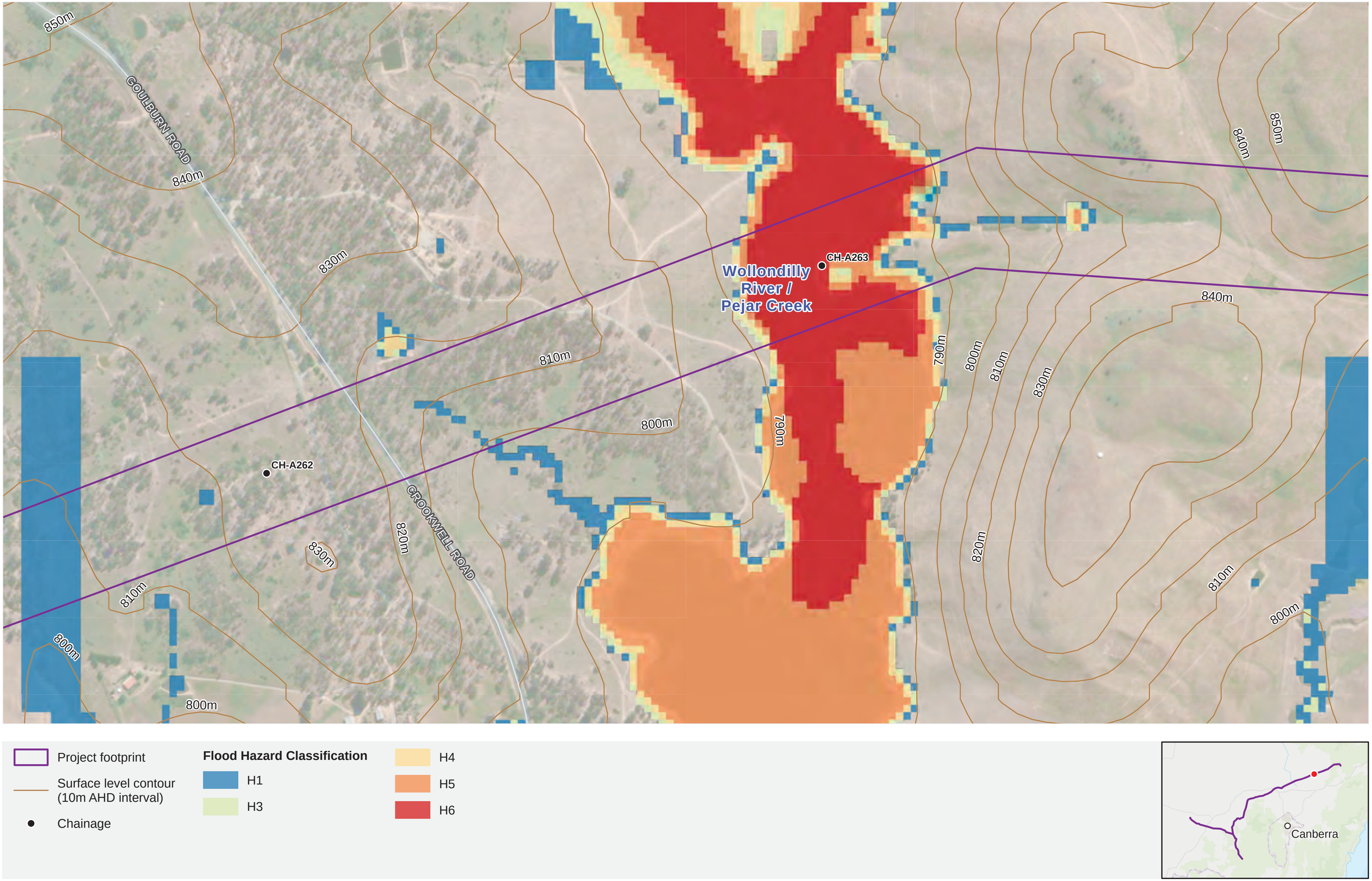

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:6,000
0 140 280m

Projection: GDA 1994 MGA Zone 55

Map 51b: ARR 2019 Flood Hazard Classification at Wollondilly River / Pejar Creek - Wollondilly Catchment

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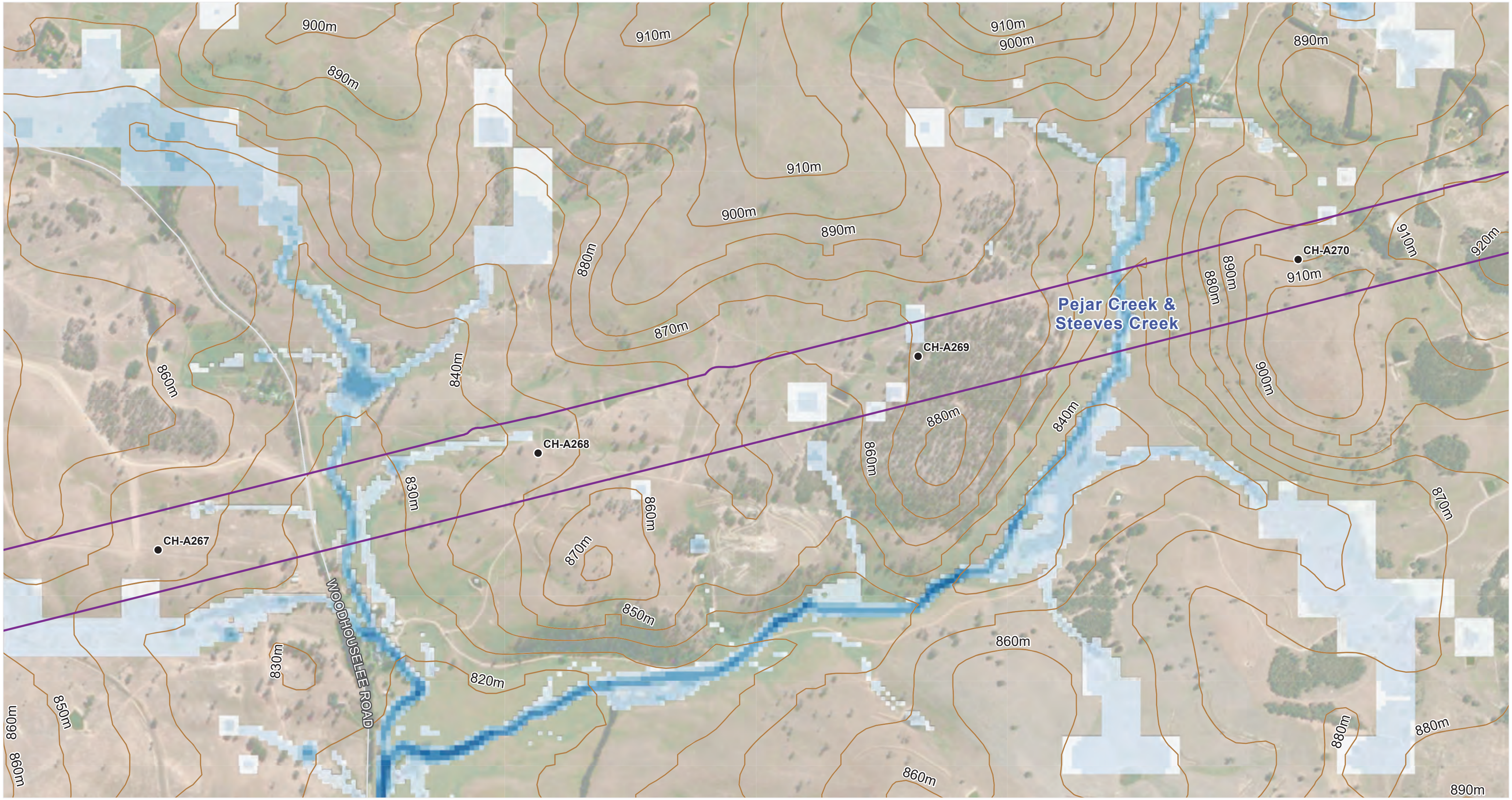


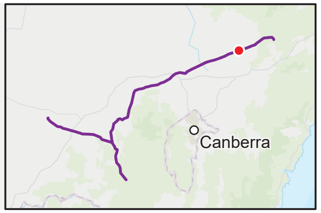
▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Depth (m)

▭	<=0.03
▭	0.03 - 0.1
▭	0.10 - 0.25
▭	0.25 - 0.5
▭	0.50 - 0.75
▭	0.75 - 1
▭	1.00 - 1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

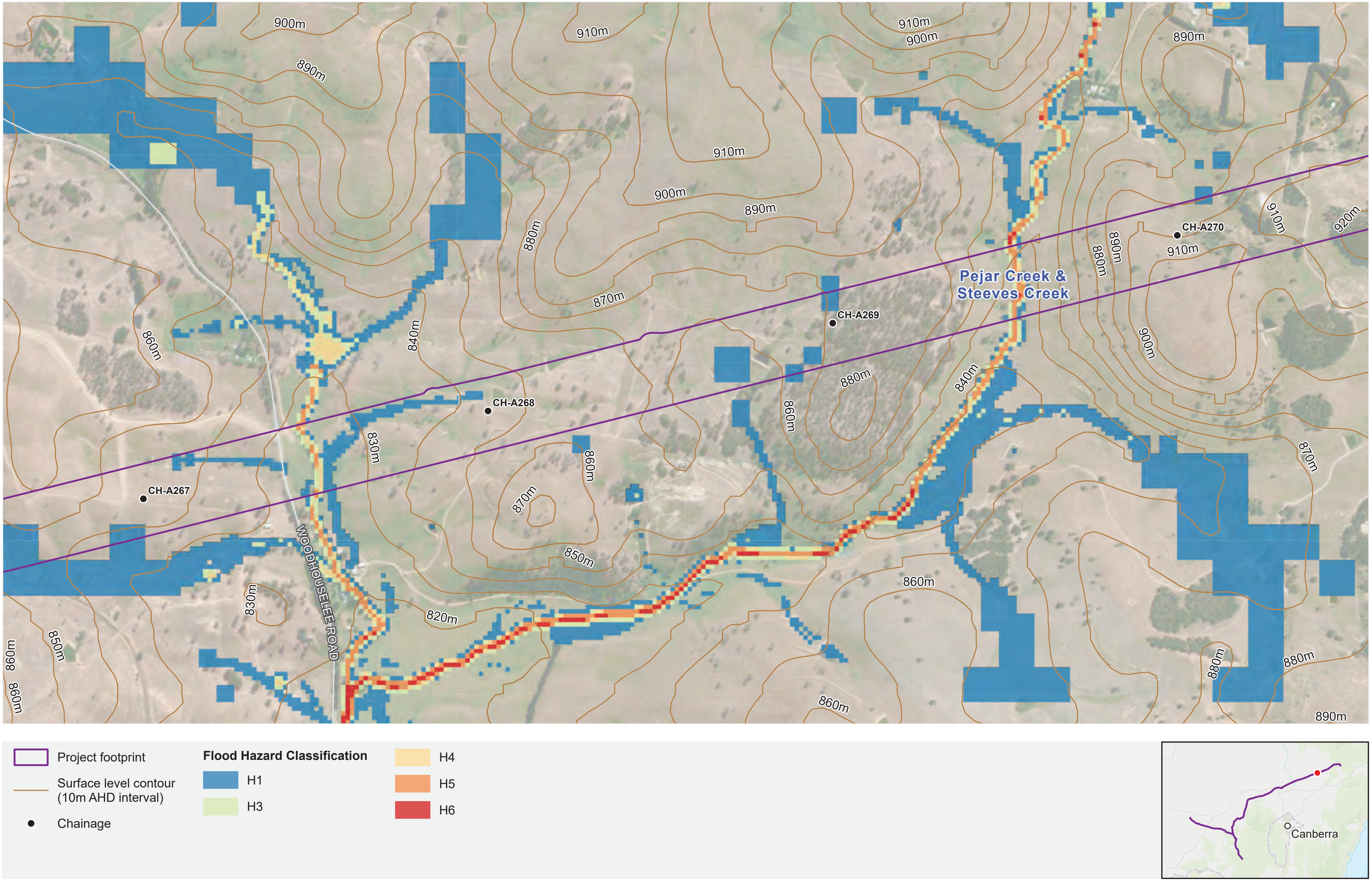
1:10,000

0 230 460 m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 52a: 1% AEP flood depth (m) at Pejar Creek & Steeves Creek - Wollondilly Catchment



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:10,000

0 230 460 m

Projection: GDA 1994 MGA Zone 55

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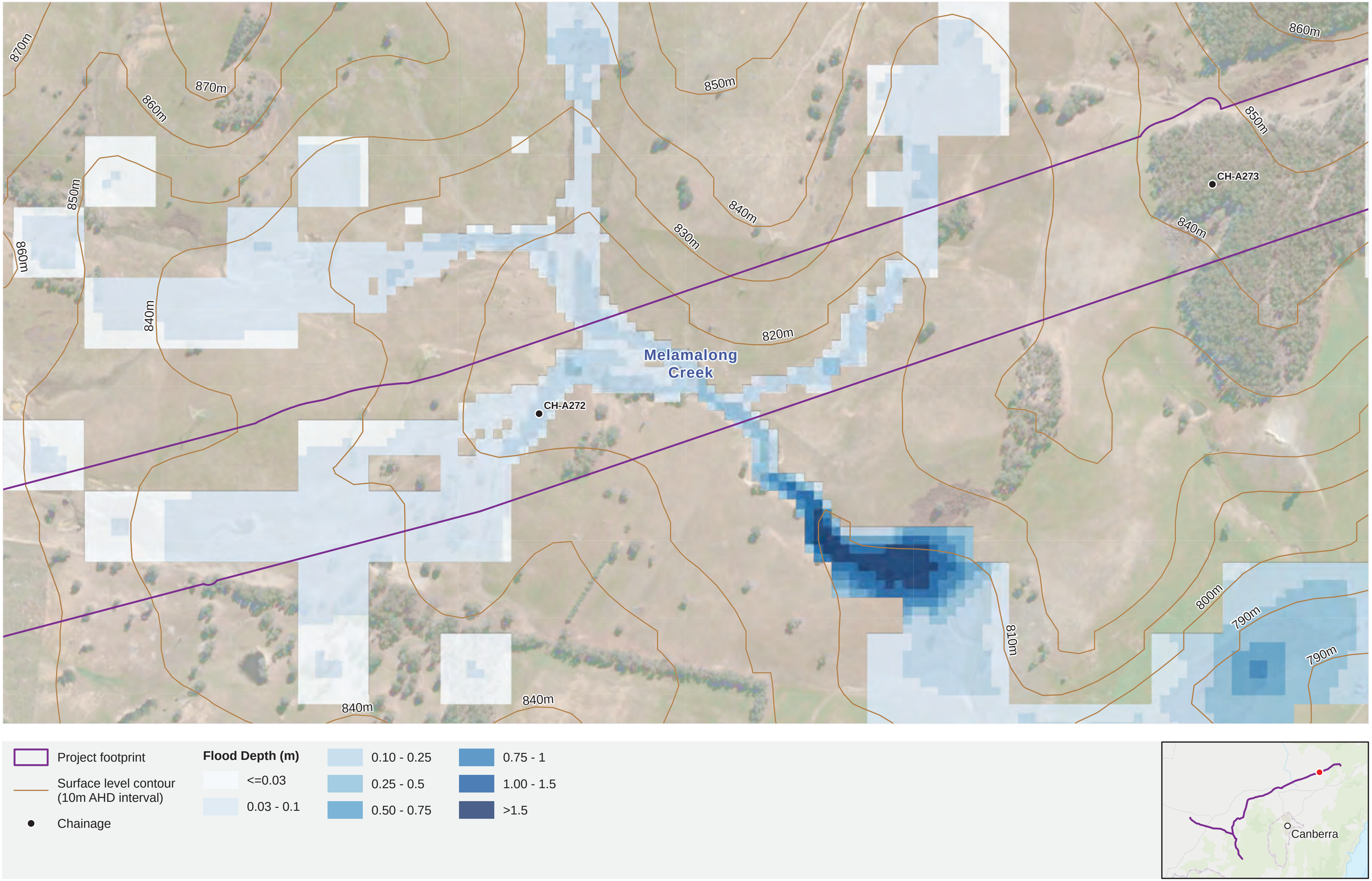
HumeLink **Hydrology and Flooding**

Map 52b: 1ARR 2019 Flood Hazard Classification at Pejar Creek & Steeves Creek - Wollondilly Catchment



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 53a: 1% AEP flood depth (m) at Melamalong Creek - Wollondilly Catchment

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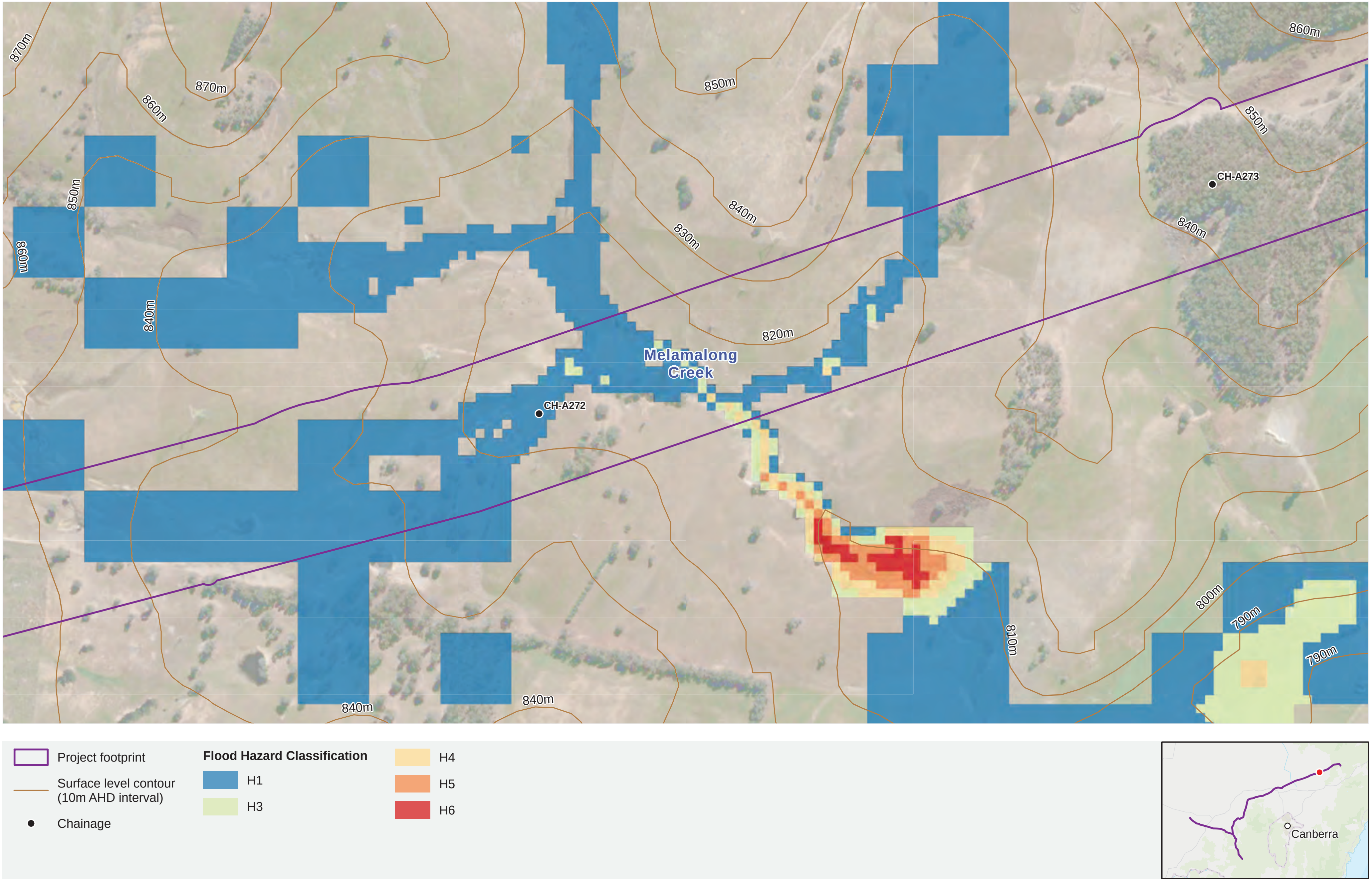

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 53b: ARR 2019 Flood Hazard Classification at Melamalong Creek - Wollondilly Catchment

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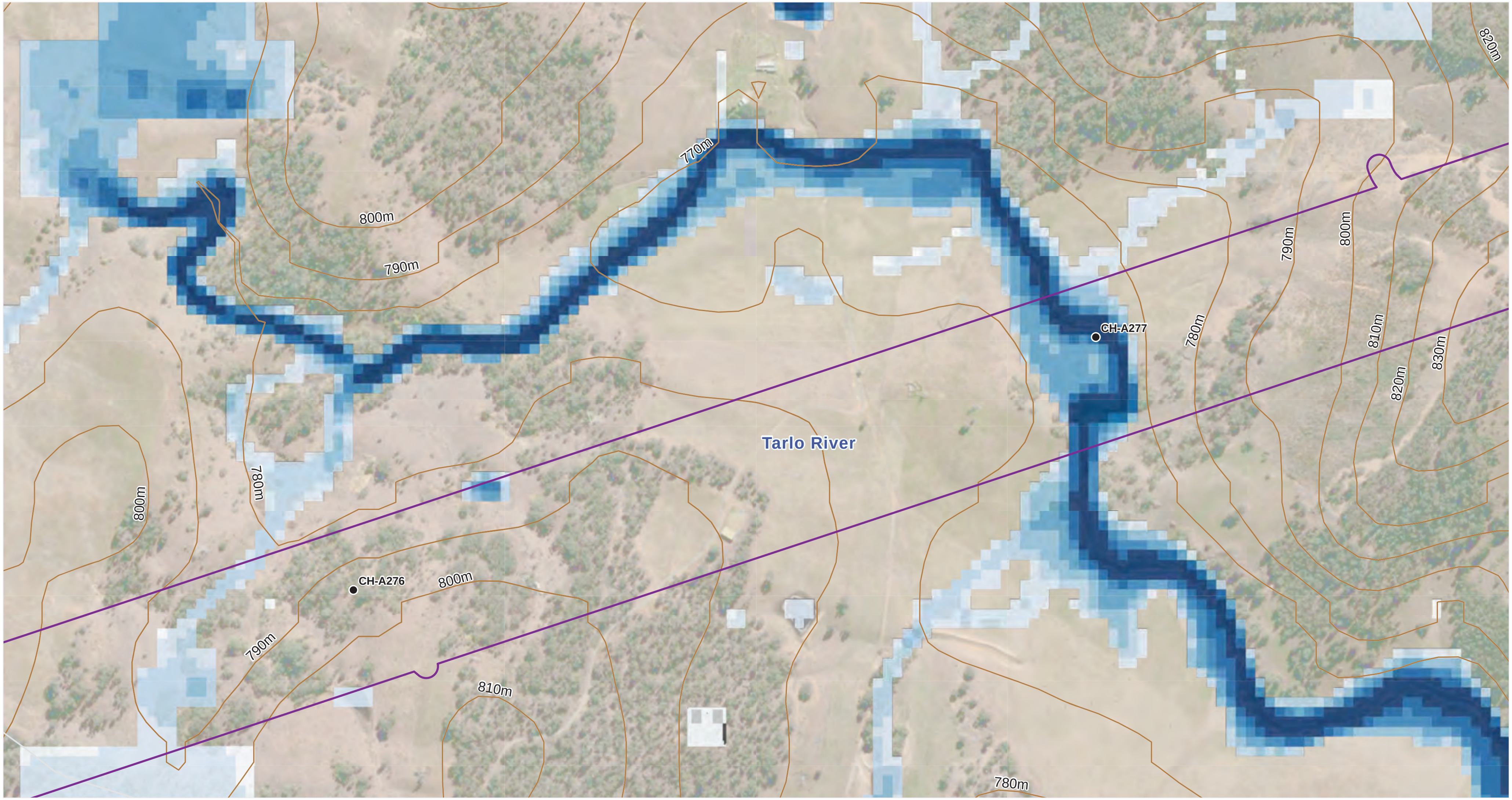


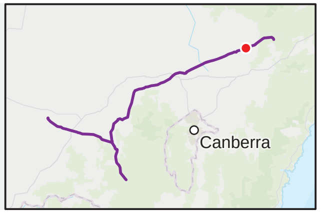
▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Depth (m)

- ▢ <=0.03
- ▢ 0.03 - 0.1
- ▢ 0.10 - 0.25
- ▢ 0.25 - 0.5
- ▢ 0.50 - 0.75
- ▢ 0.75 - 1
- ▢ 1.00 - 1.5
- ▢ >1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

HumeLink **Hydrology and Flooding**

Projection: GDA 1994 MGA Zone 55

Map 54a: 1% AEP flood depth (m) at Tarlo River - Wollondilly Catchment

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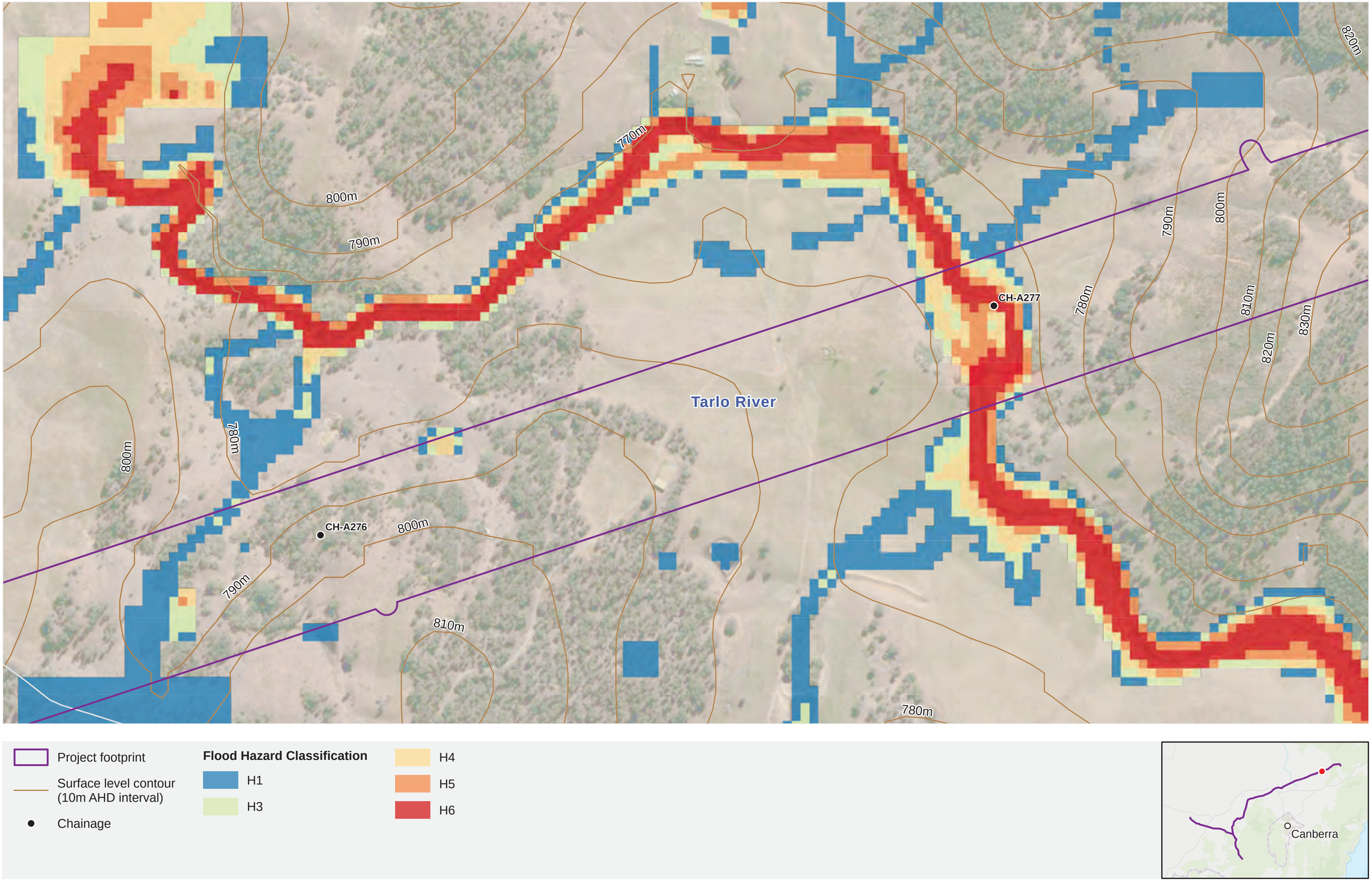

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 54b: ARR 2019 Flood Hazard Classification at Tarlo River - Wollondilly Catchment

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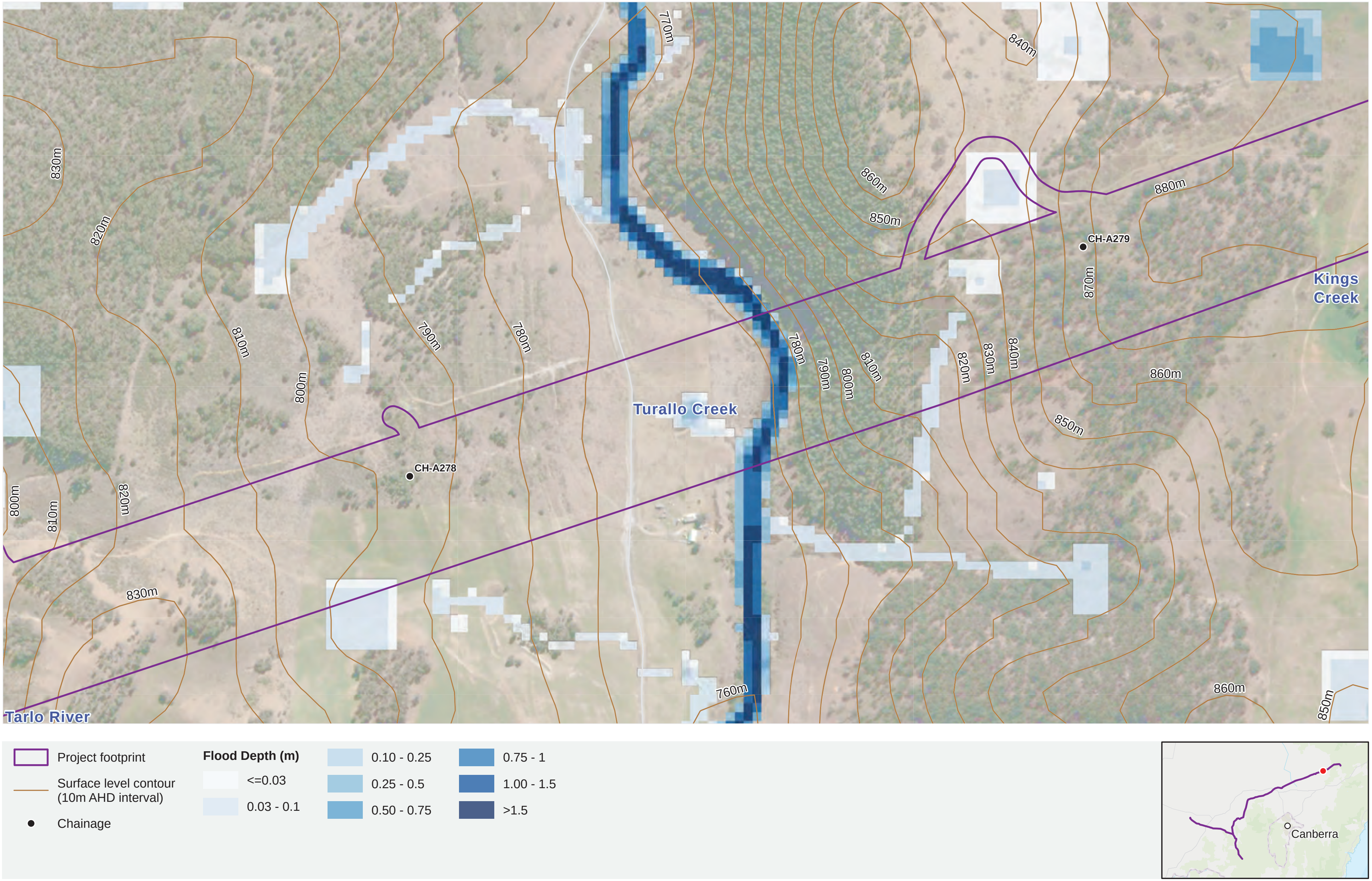

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 55a: 1% AEP flood depth (m) at Turallo Creek - Wollondilly Catchment

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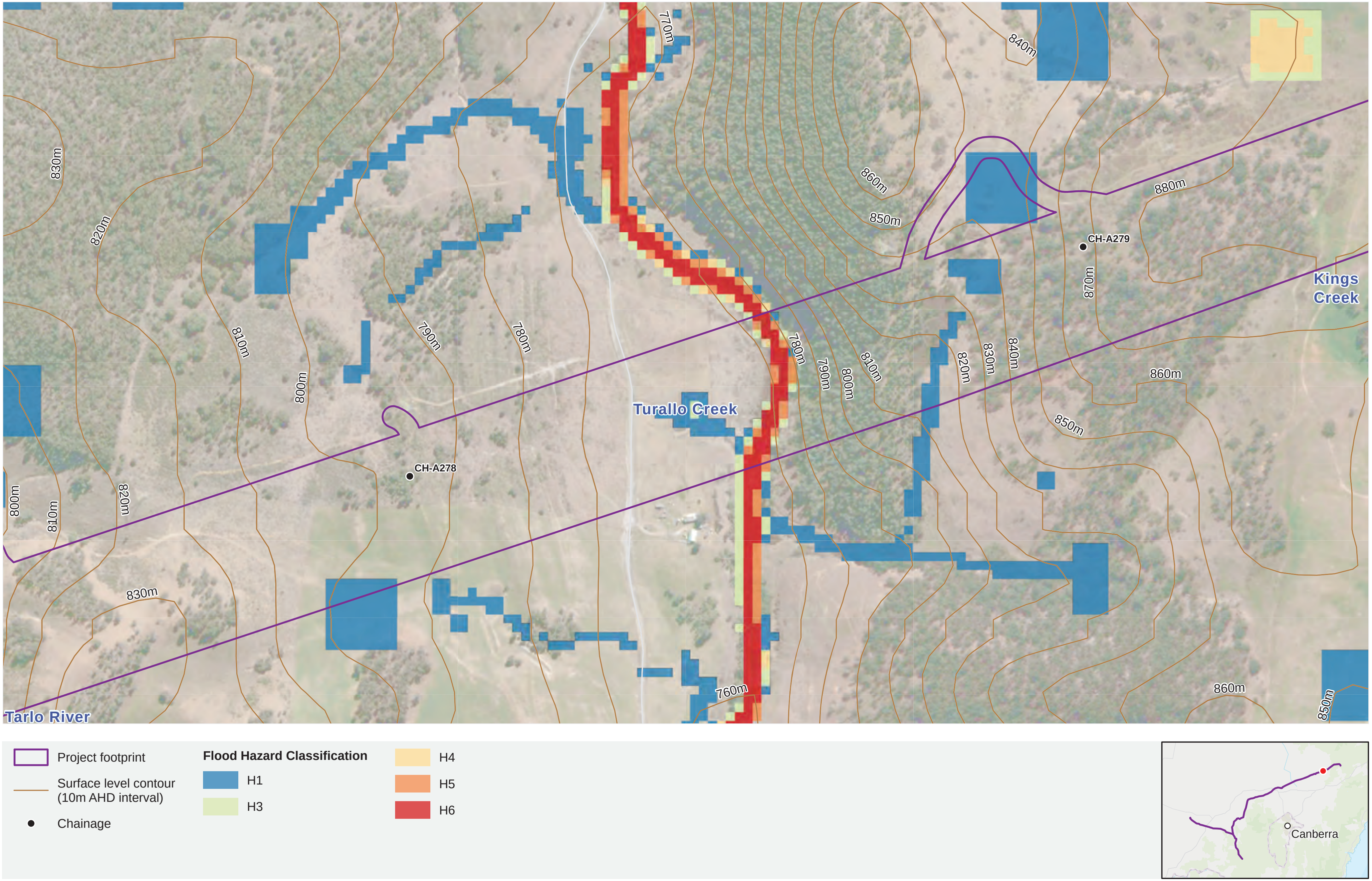

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 55b: ARR 2019 Flood Hazard Classification at Turallo Creek - Wollondilly Catchment

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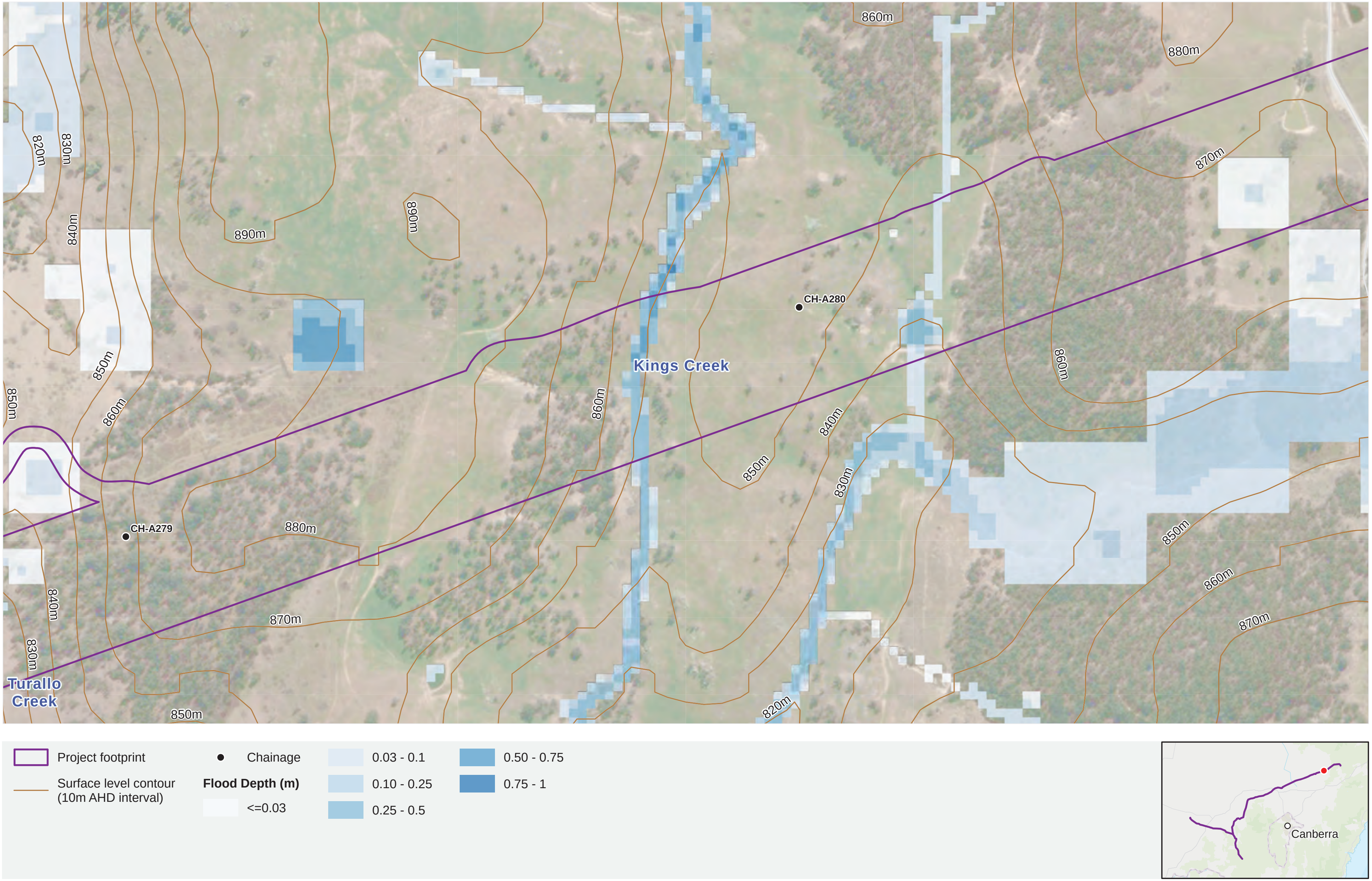

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 56a: 1% AEP flood depth (m) at Kings Creek - Wollondilly Catchment

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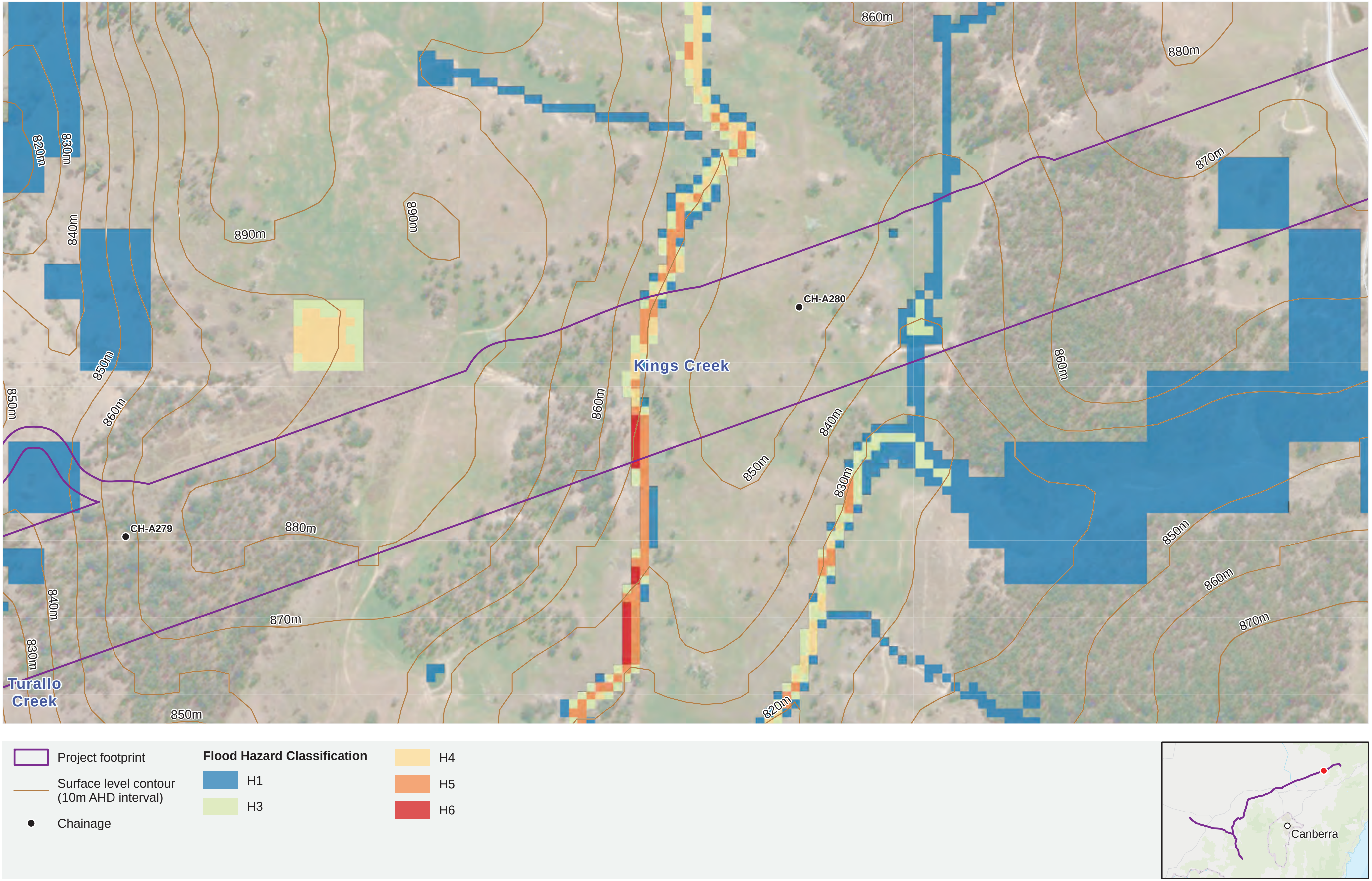


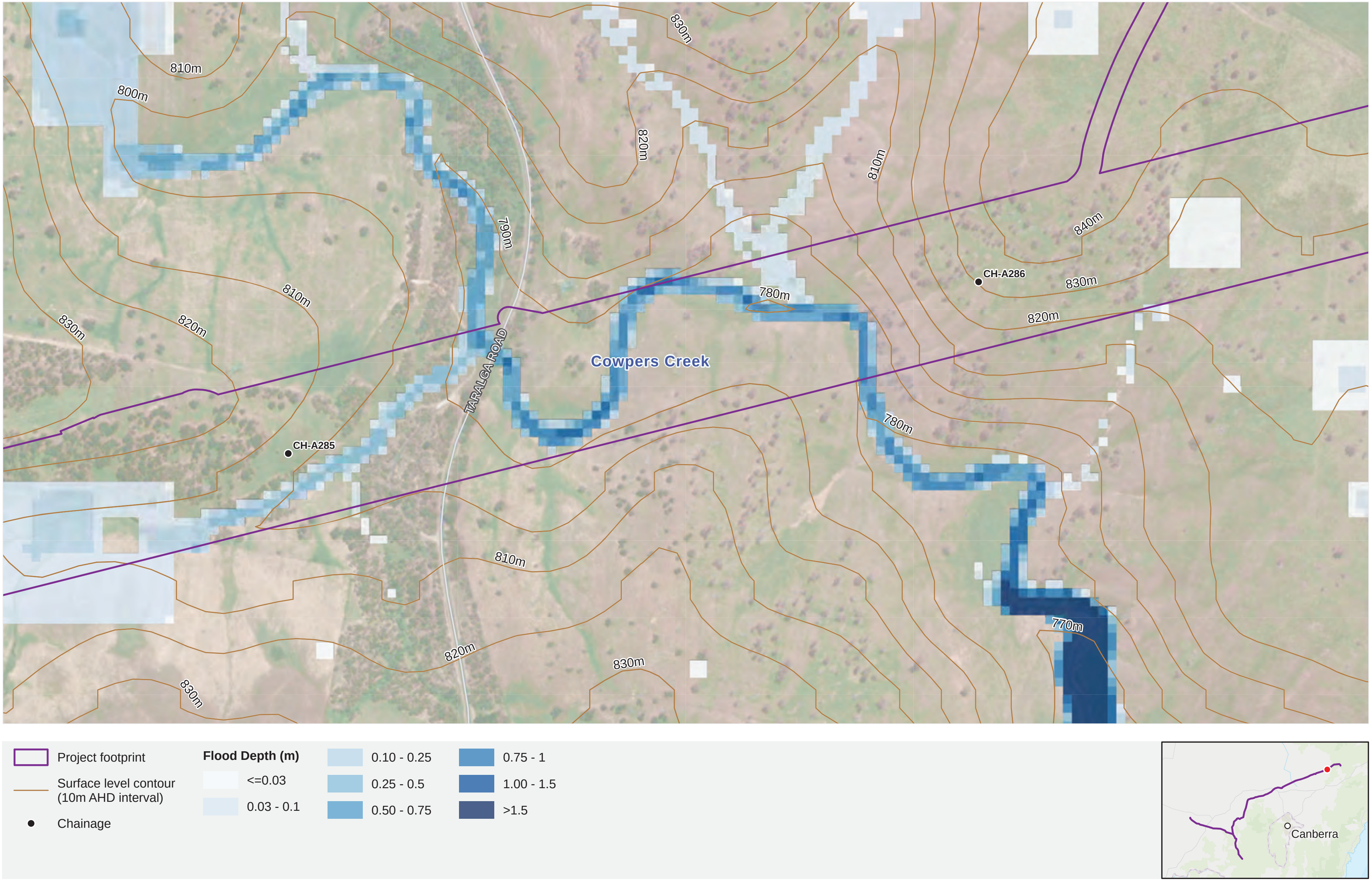
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 56b: ARR 2019 Flood Hazard Classification at Kings Creek - Wollondilly Catchment



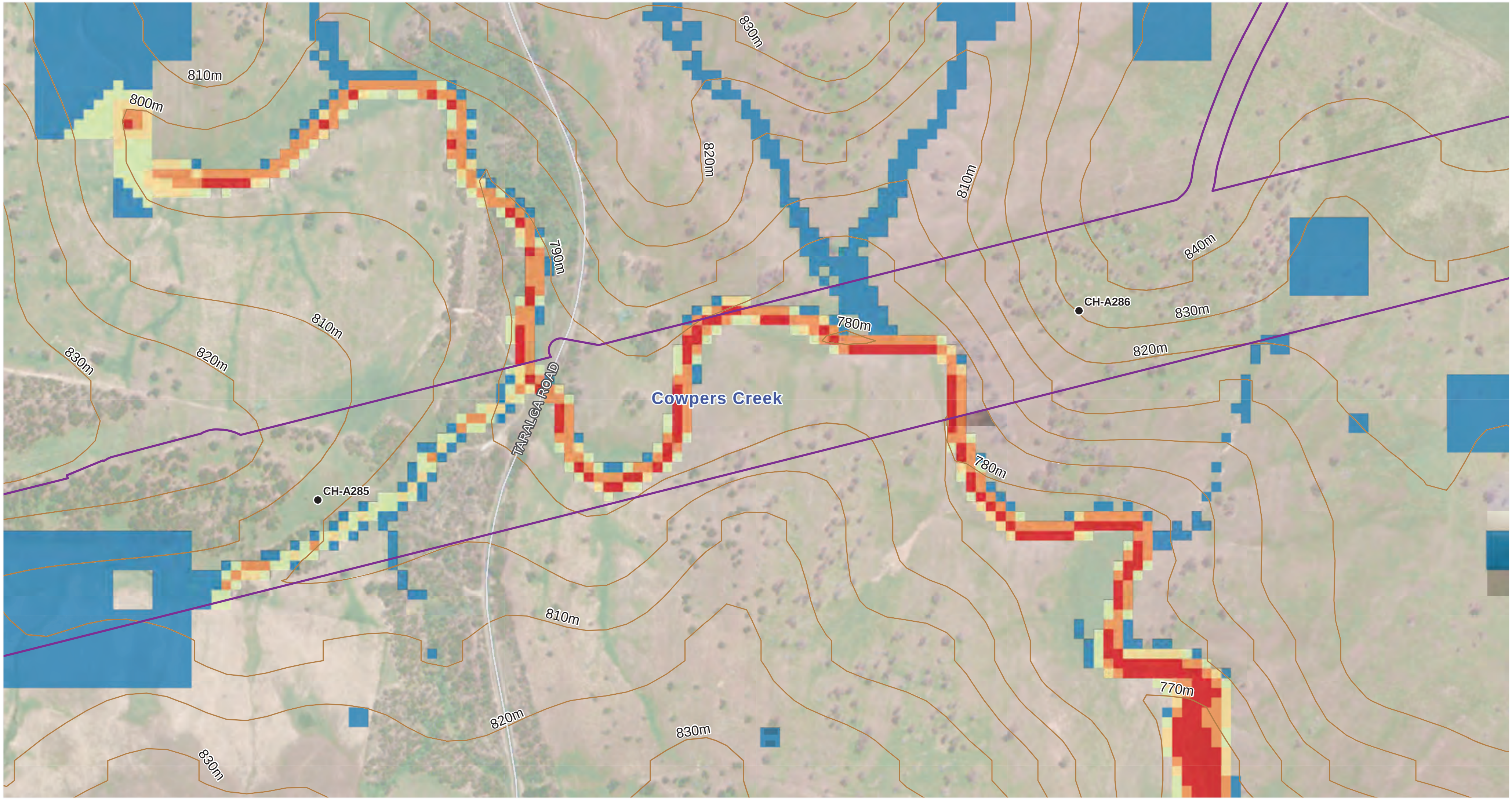
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000
0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 57a: 1% AEP flood depth (m) at Cowpers Creek - Wollondilly Catchment



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▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Hazard Classification

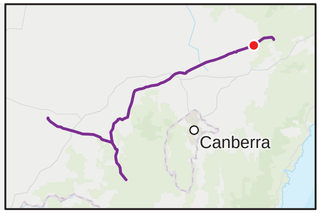
🟦 H1

🟩 H3

🟨 H4

🟧 H5

🟥 H6



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 57b: ARR 2019 Flood Hazard Classification at Cowpers Creek - Wollondilly Catchment

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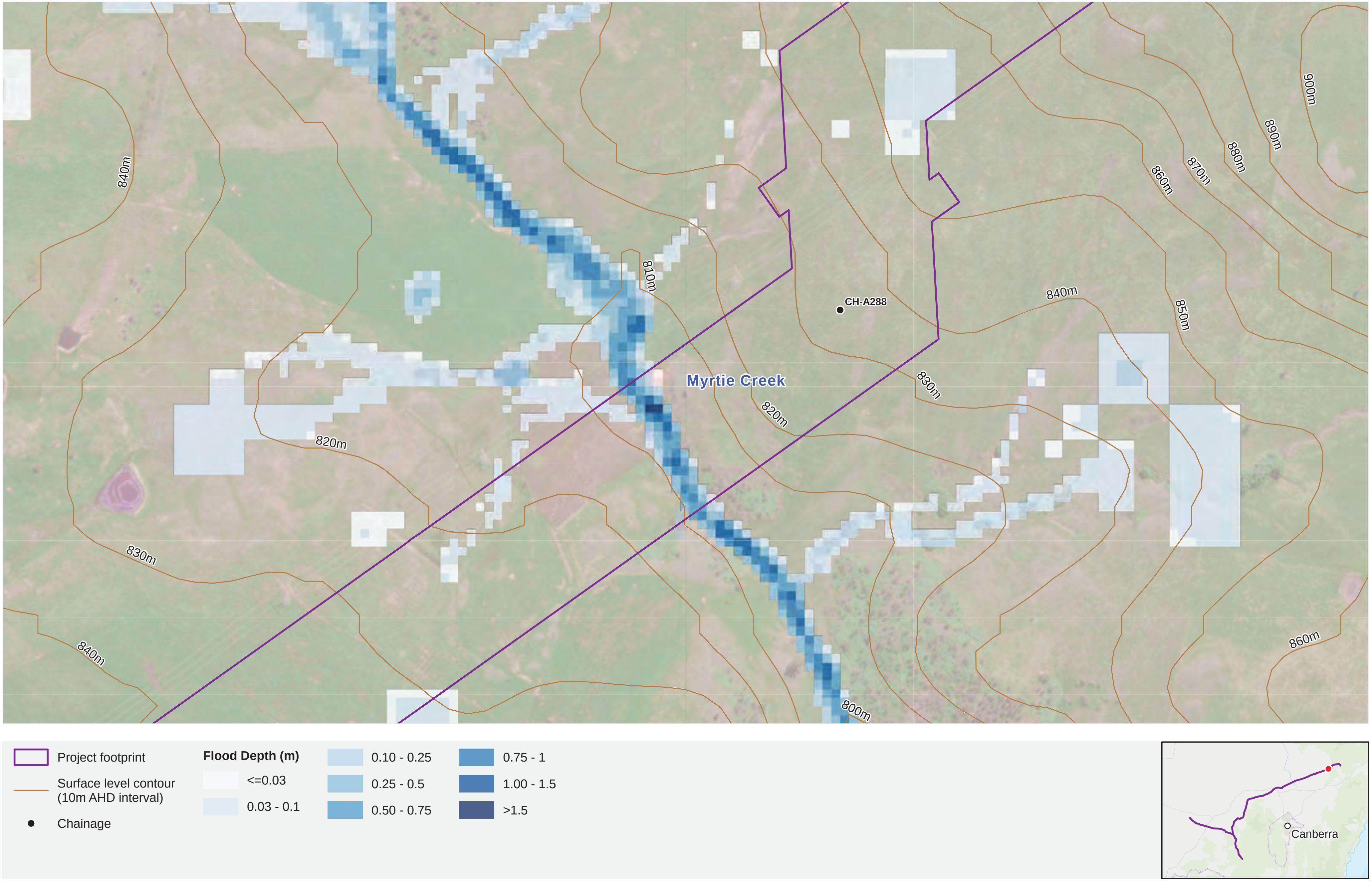

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 58a: 1% AEP flood depth (m) at Myrtie Creek - Wollondilly Catchment

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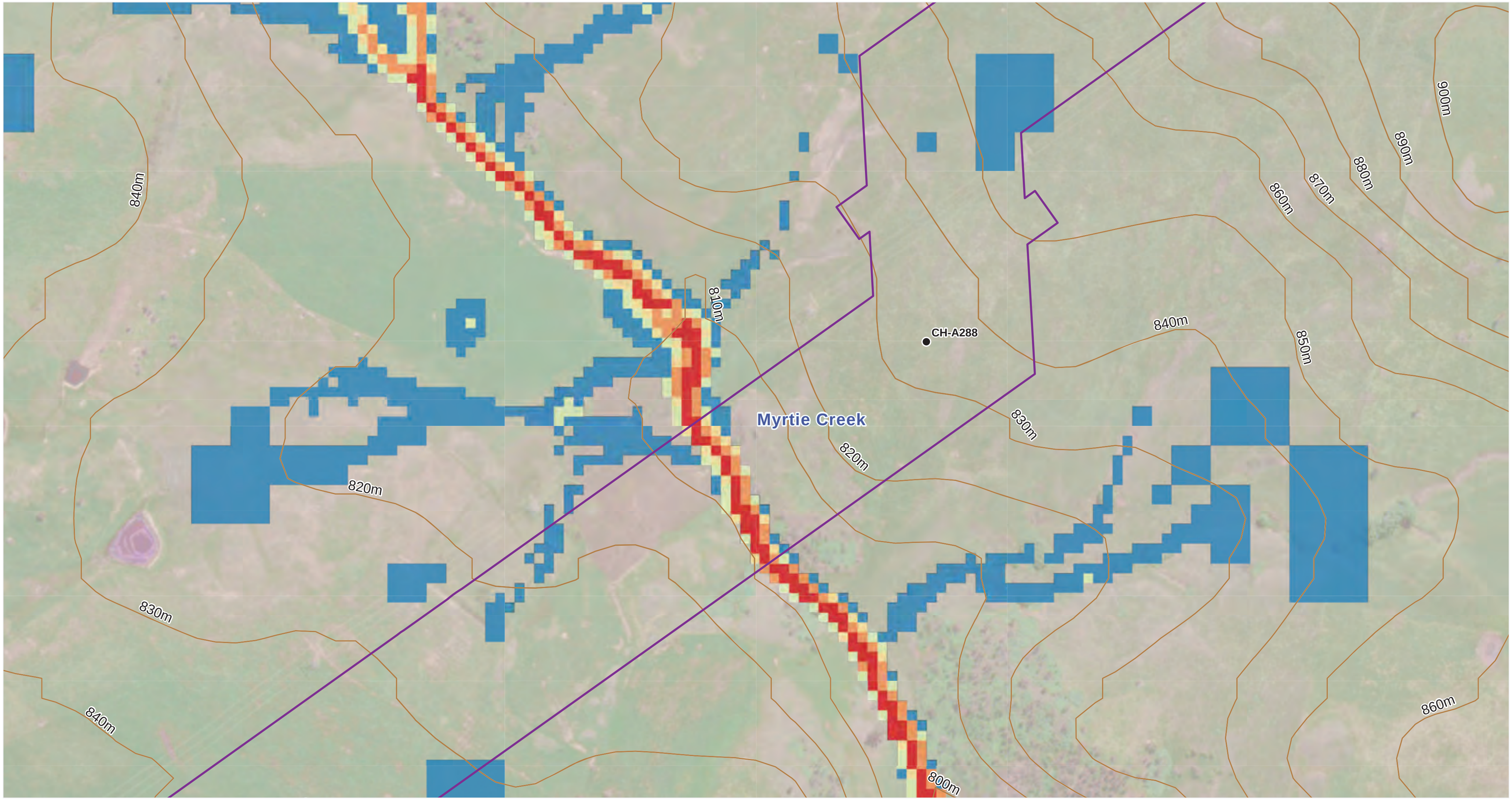


▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Hazard Classification

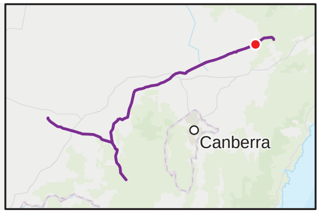
🟦 H1

🟩 H3

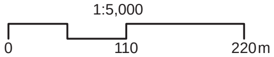
🟨 H4

🟧 H5

🟥 H6



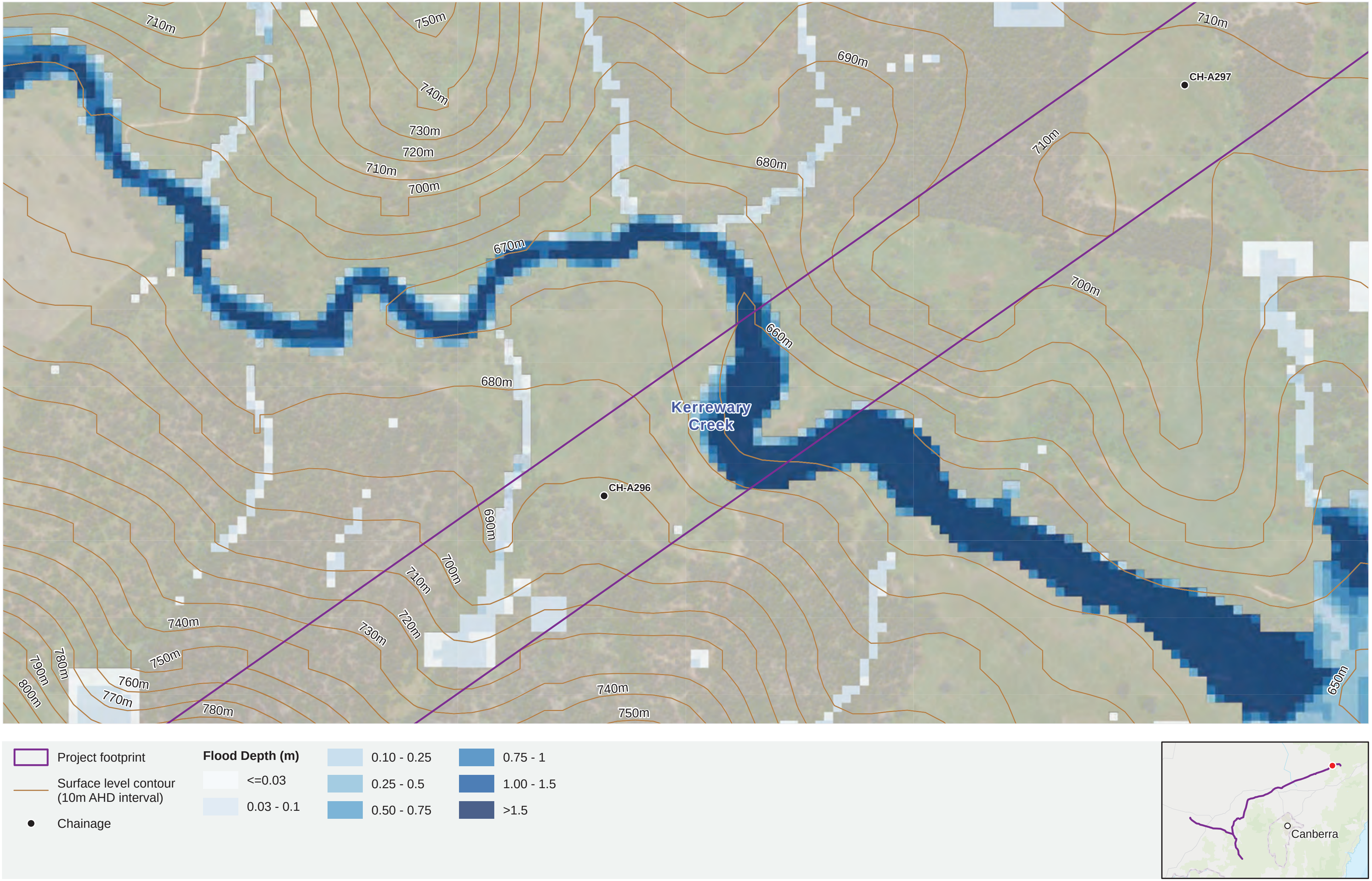
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*



Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 58b: ARR 2019 Flood Hazard Classification at Myrtie Creek - Wollondilly Catchment



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Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

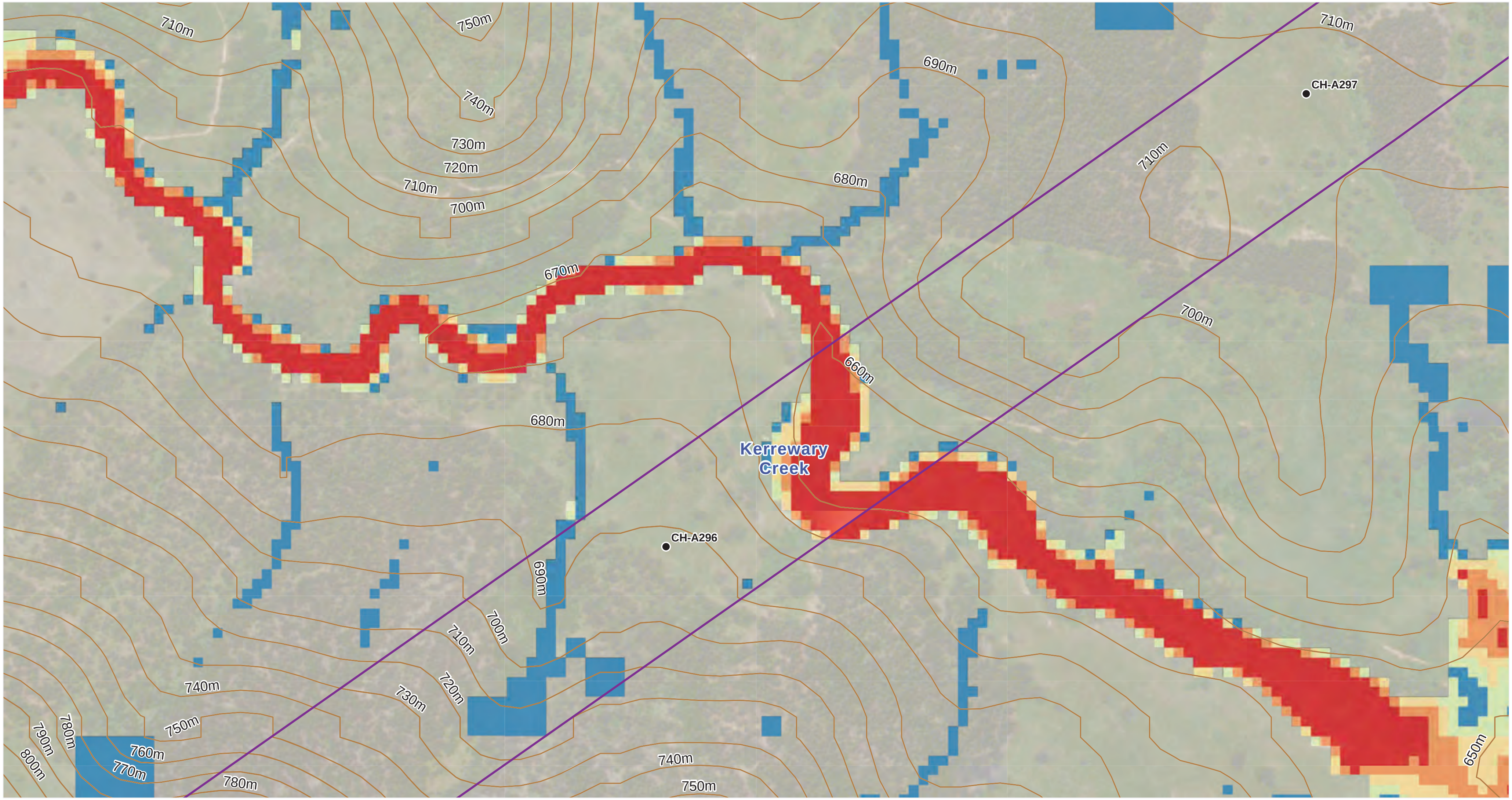
1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 59a: 1% AEP flood depth (m) at Kerreway Creek - Wollondilly Catchment



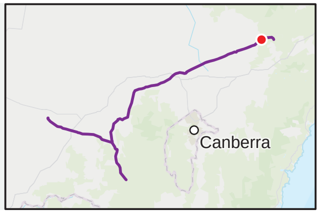
▭ Project footprint

— Surface level contour (10m AHD interval)

● Chainage

Flood Hazard Classification

🟦	H1
🟩	H3
🟨	H4
🟧	H5
🟥	H6



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

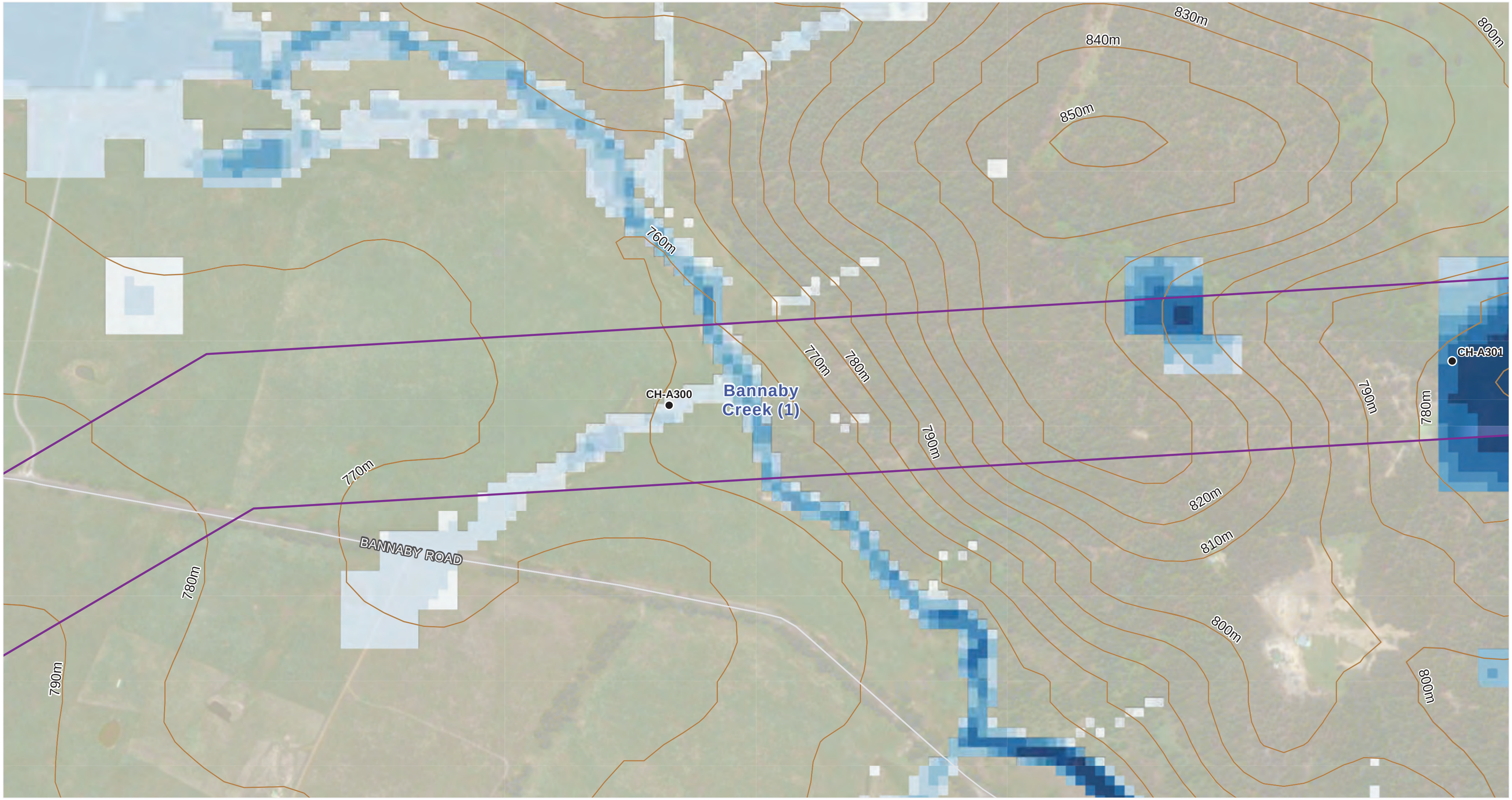
1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

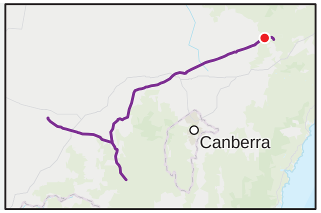
Map 59b: ARR 2019 Flood Hazard Classification at Kerreway Creek - Wollondilly Catchment



▭	Project footprint
—	Surface level contour (10m AHD interval)
●	Chainage

Flood Depth (m)

▨	<=0.03
▨	0.03 - 0.1
▨	0.10 - 0.25
▨	0.25 - 0.5
▨	0.50 - 0.75
▨	0.75 - 1
▨	1.00 - 1.5
▨	>1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 60a: 1% AEP flood depth (m) at Bannaby Creek (1) - Wollondilly Catchment

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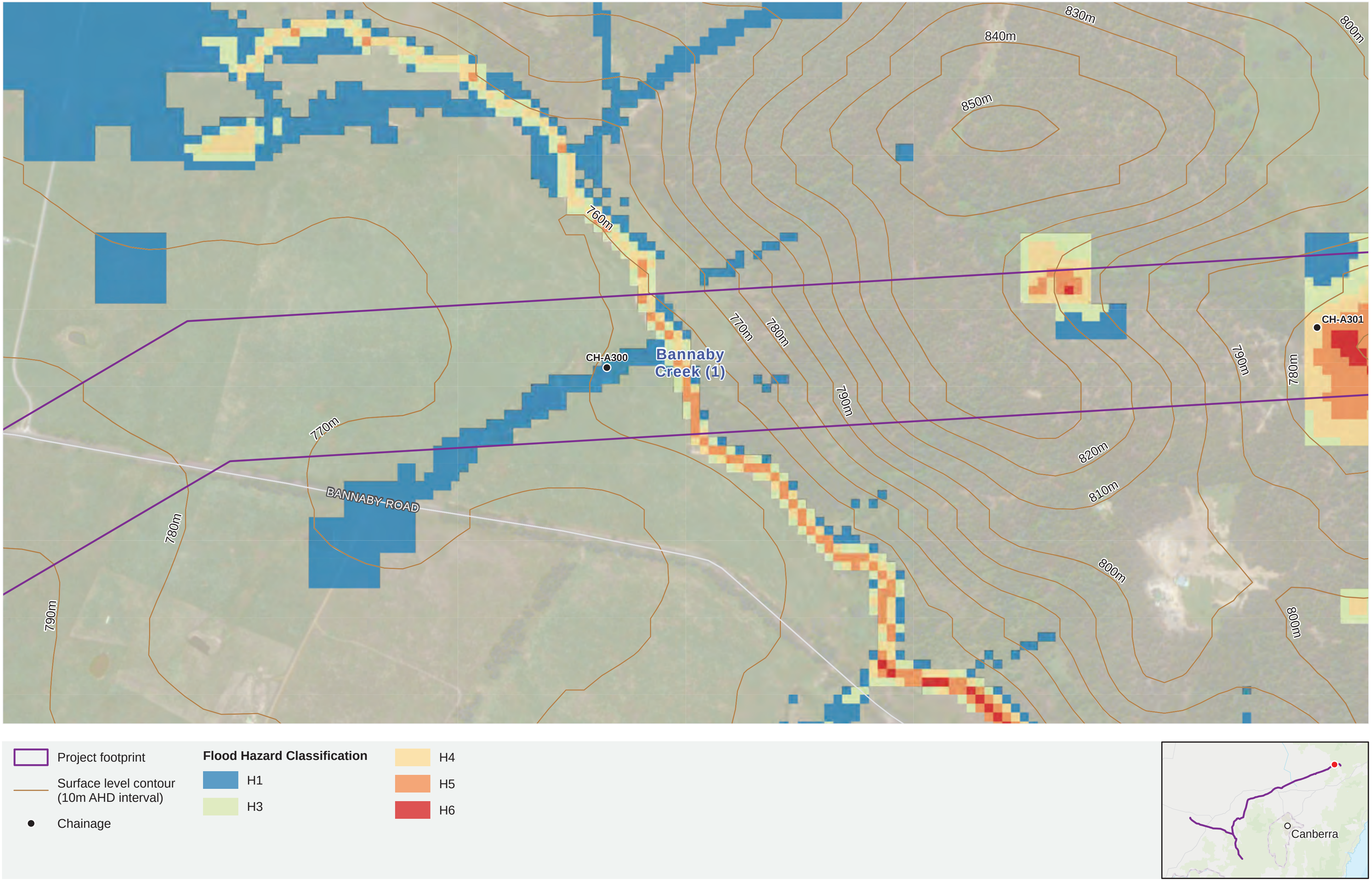

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

Map 60b: ARR 2019 Flood Hazard Classification at Bannaby Creek (1) - Wollondilly Catchment

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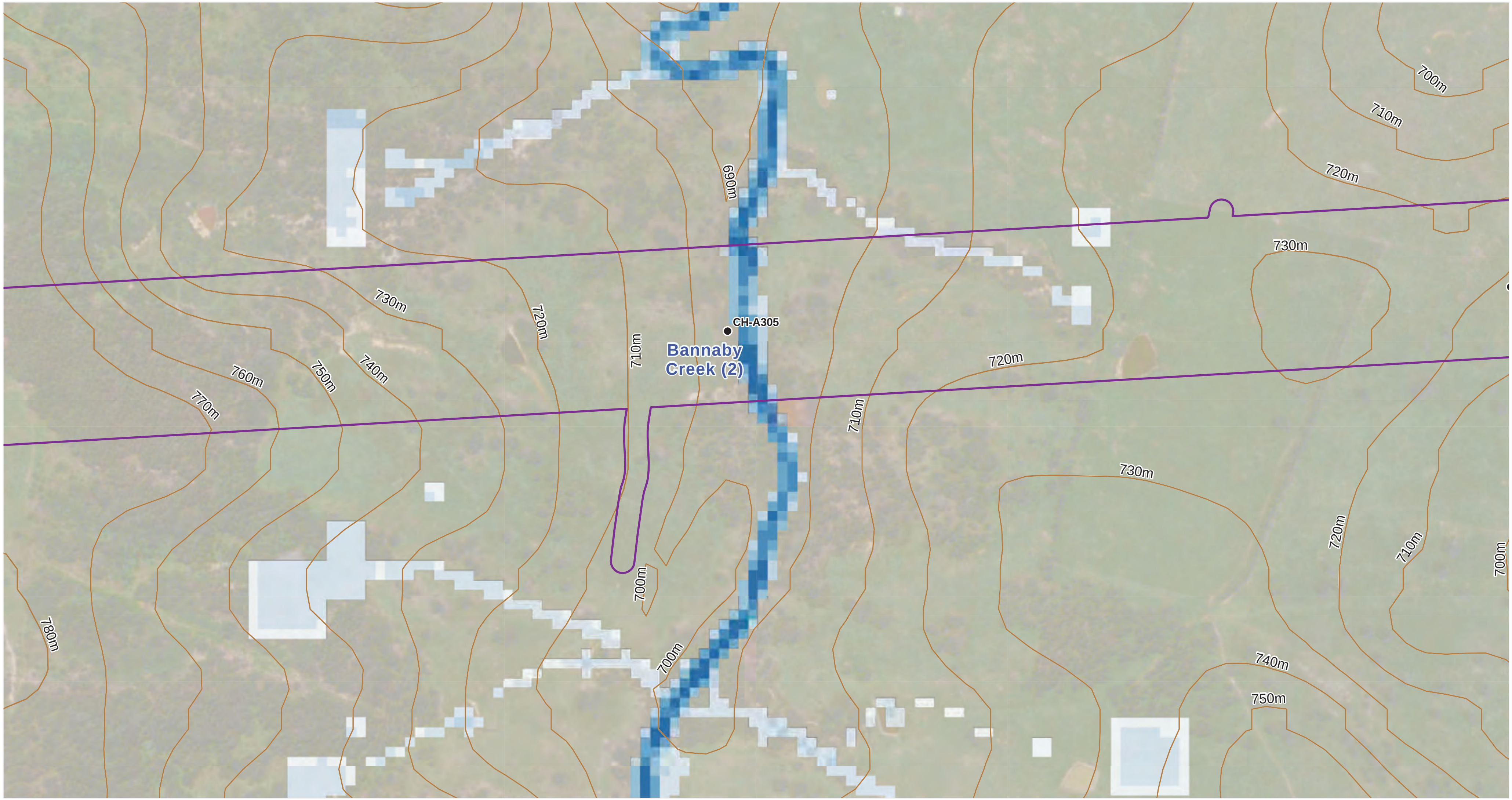


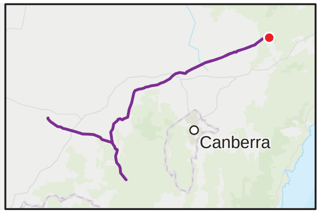
▭ Project footprint

● Chainage

— Surface level contour (10m AHD interval)

Flood Depth (m)

- ▢ <=0.03
- ▢ 0.03 - 0.1
- ▢ 0.10 - 0.25
- ▢ 0.25 - 0.5
- ▢ 0.50 - 0.75
- ▢ 0.75 - 1
- ▢ 1.00 - 1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 61a: 1% AEP flood depth (m) at Bannaby Creek (2) - Wollondilly Catchment

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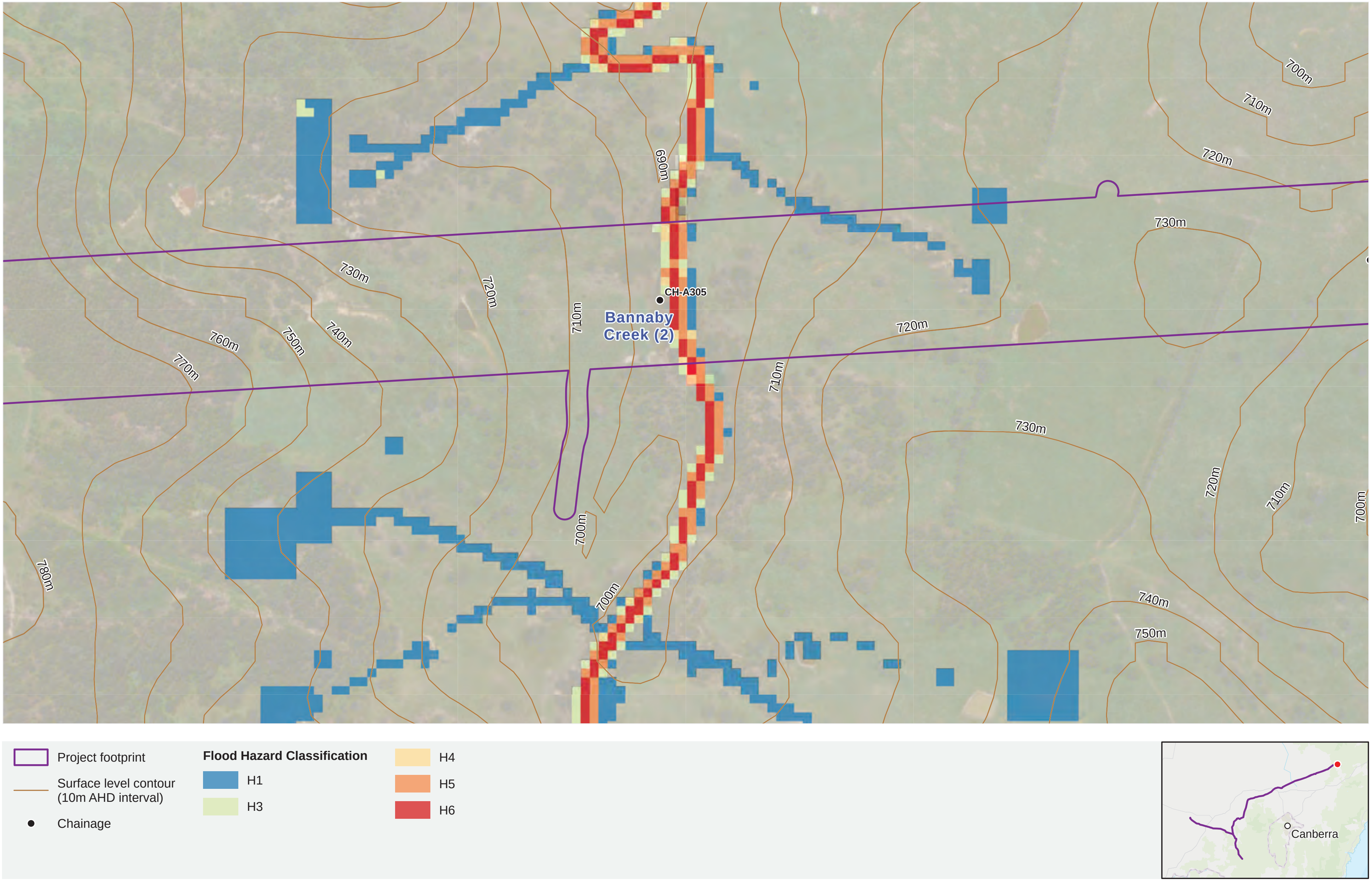


Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

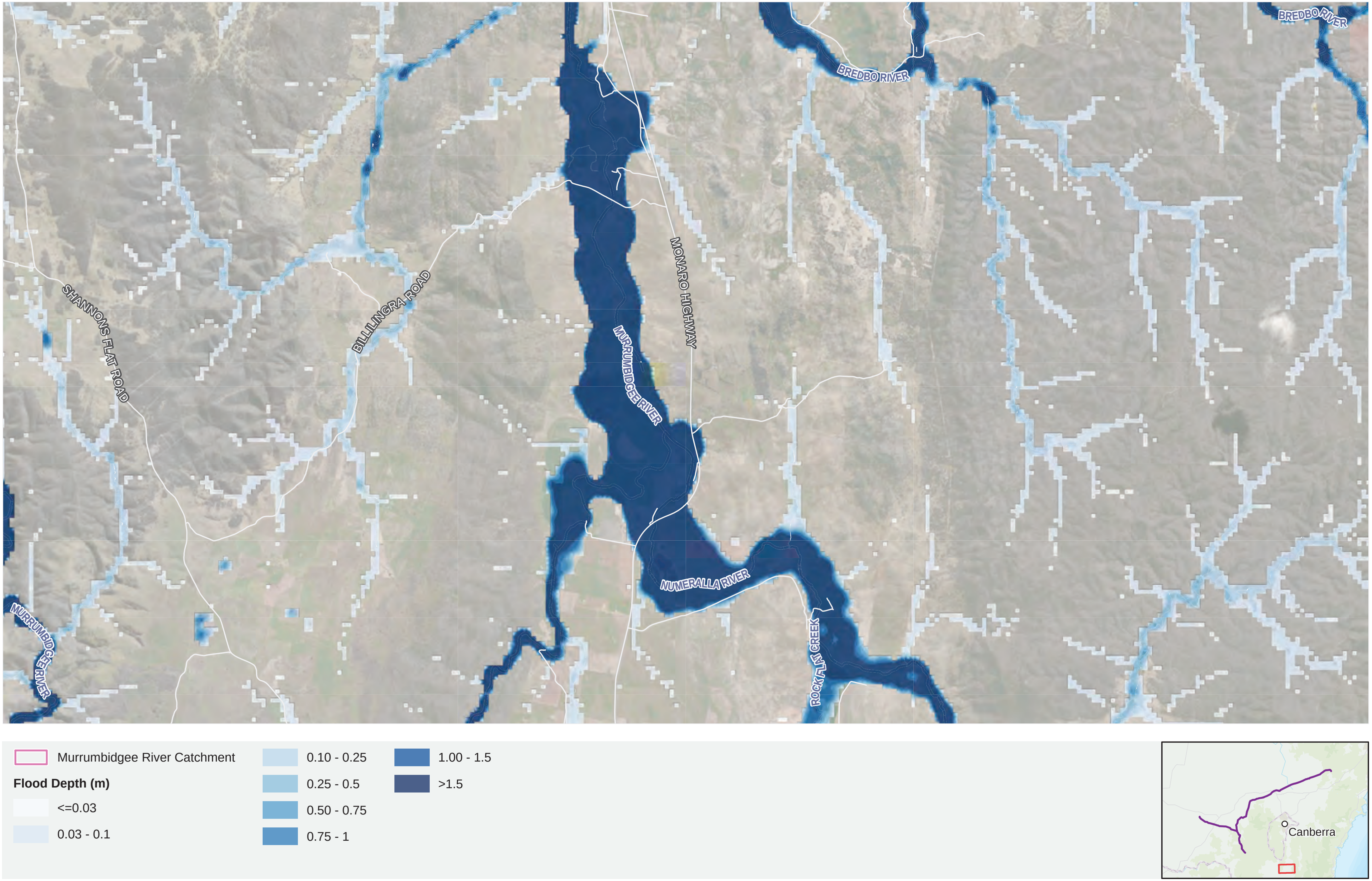
1:5,000

0 110 220m

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 61b: ARR 2019 Flood Hazard Classification at Bannaby Creek (2) - Wollondilly Catchment



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:75,000

0 1.5 3km

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 62a: 1% AEP flood depth (m) at Billilingra - Murrumbidgee Catchment

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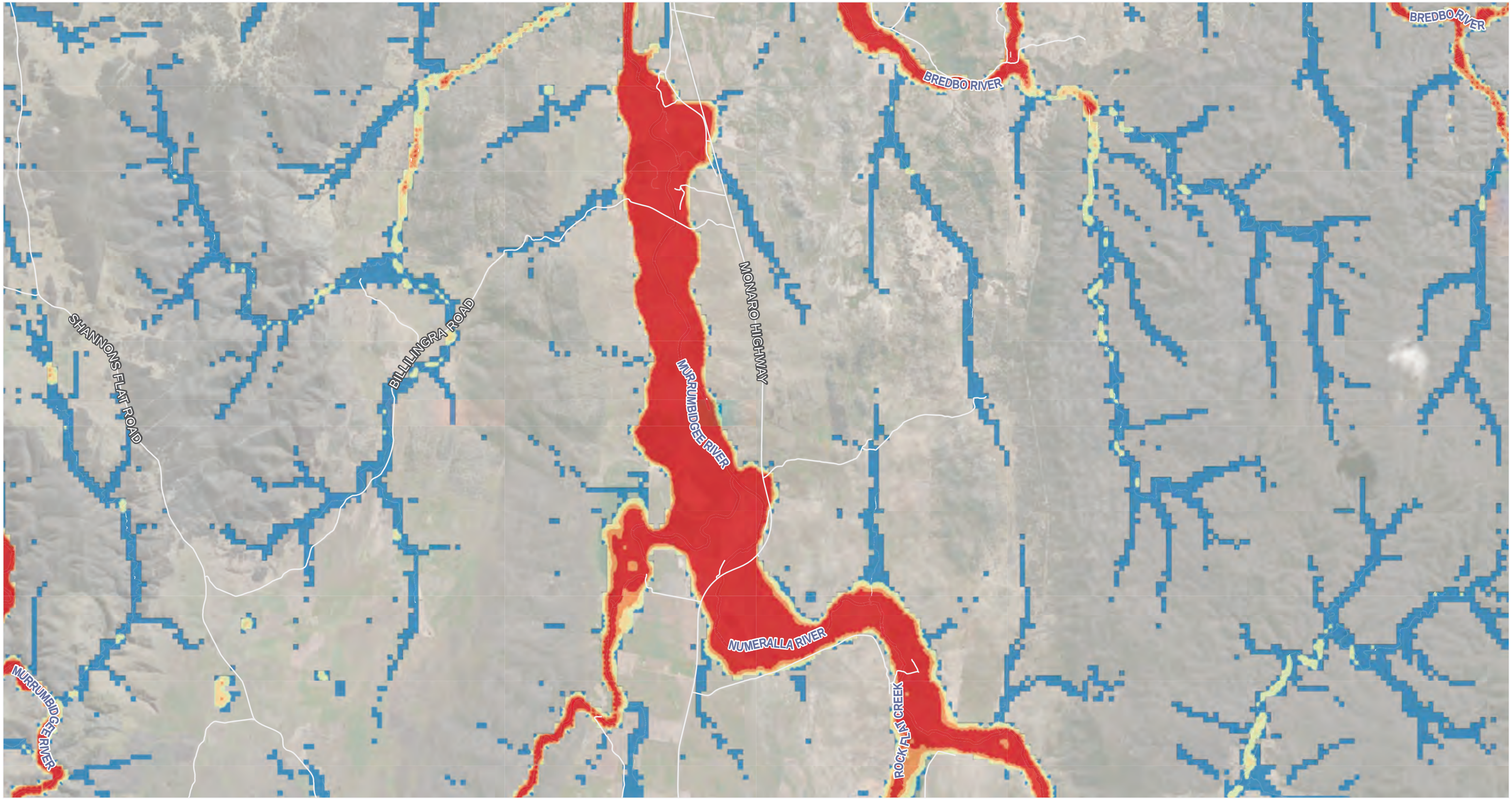
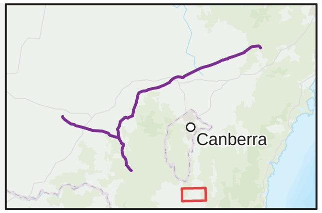


▭	Murrumbidgee River Catchment

Flood Hazard Classification

🟦	H1
🟩	H3
🟨	H4
🟧	H5
🟥	H6



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:75,000

0 1.5 3km

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 62b: ARR 2019 Flood Hazard Classification at Billilingra - Murrumbidgee Catchment

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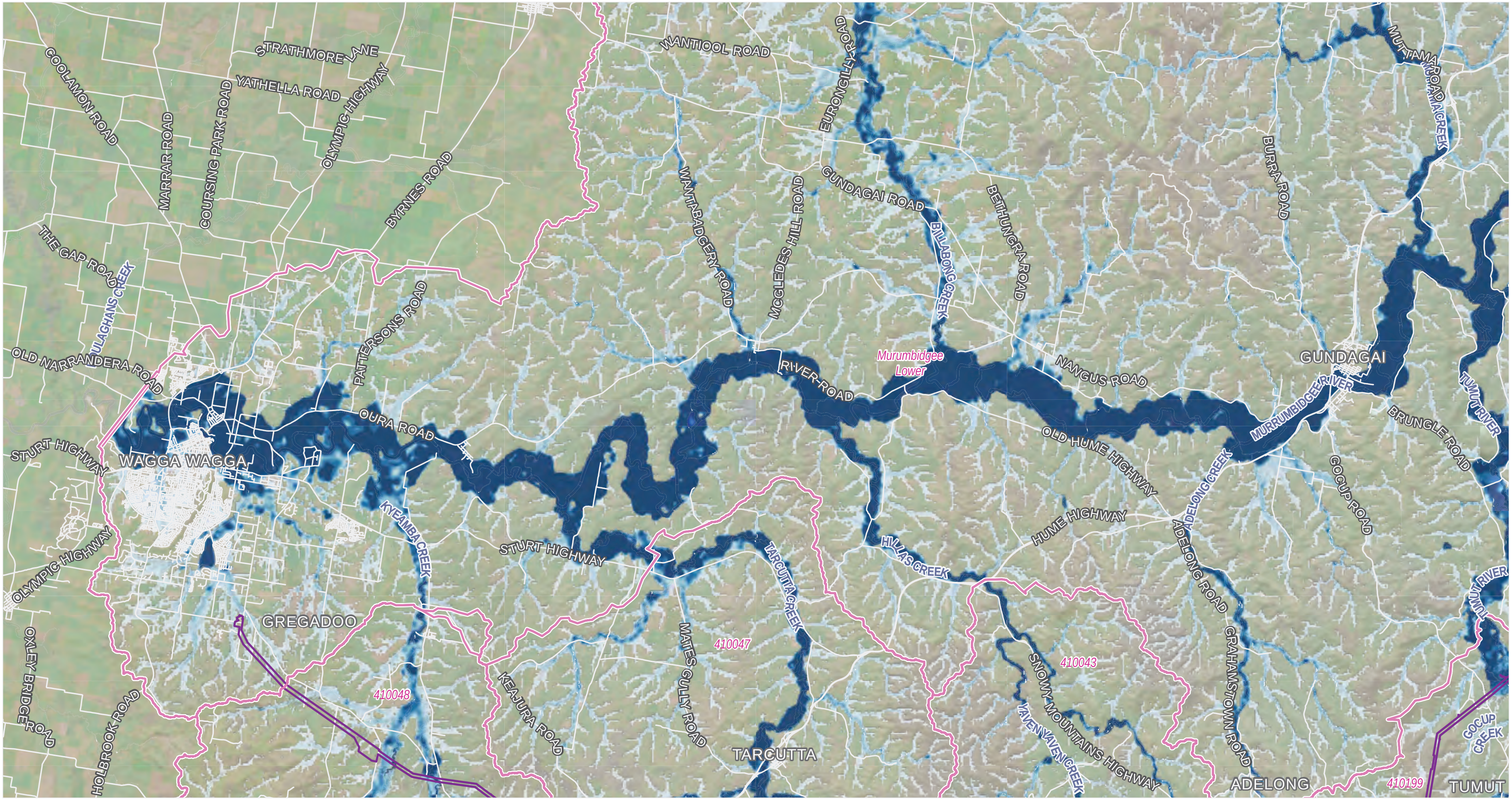


▭ Project footprint

▭ Murrumbidgee River Catchment

Flood Depth (m)

<=0.03

0.03 - 0.1

0.10 - 0.25

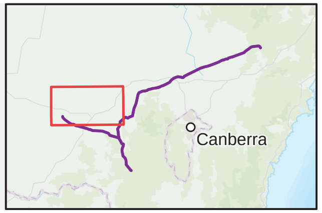
0.25 - 0.5

0.50 - 0.75

0.75 - 1

1.00 - 1.5

>1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:230,000

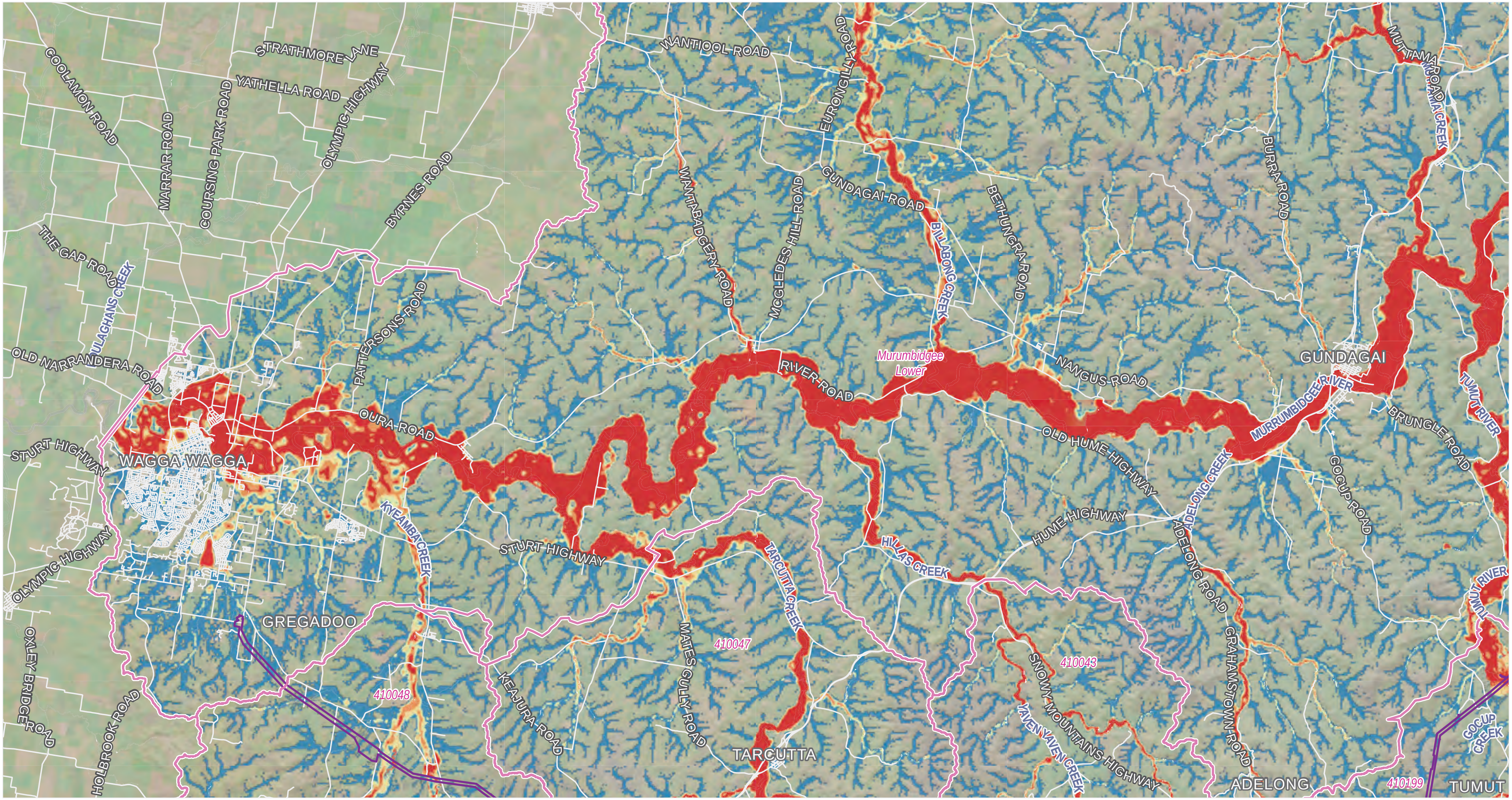
0 5 10 km

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 63a: 1% AEP flood depth (m) at Gundagai to Wagga Wagga - Murrumbidgee Catchment

C:\Users\Virgil.Robinson\Aurecon Group\507179 - HumeLink Project Development Suppor - EIS\ArcPro\507179_HumeLink_Flooding.aprx\22-05-23\Virgil.Robinson



☐ Project footprint

☐ Murrumbidgee River Catchment

Flood Hazard Classification

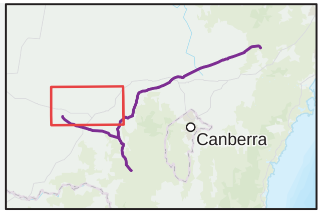
🟦 H1

🟩 H3

🟨 H4

🟧 H5

🟥 H6



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:230,000

0 5 10km

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 63b: ARR 2019 Flood Hazard Classification at Gundagai to Wagga Wagga - Murrumbidgee Catchment

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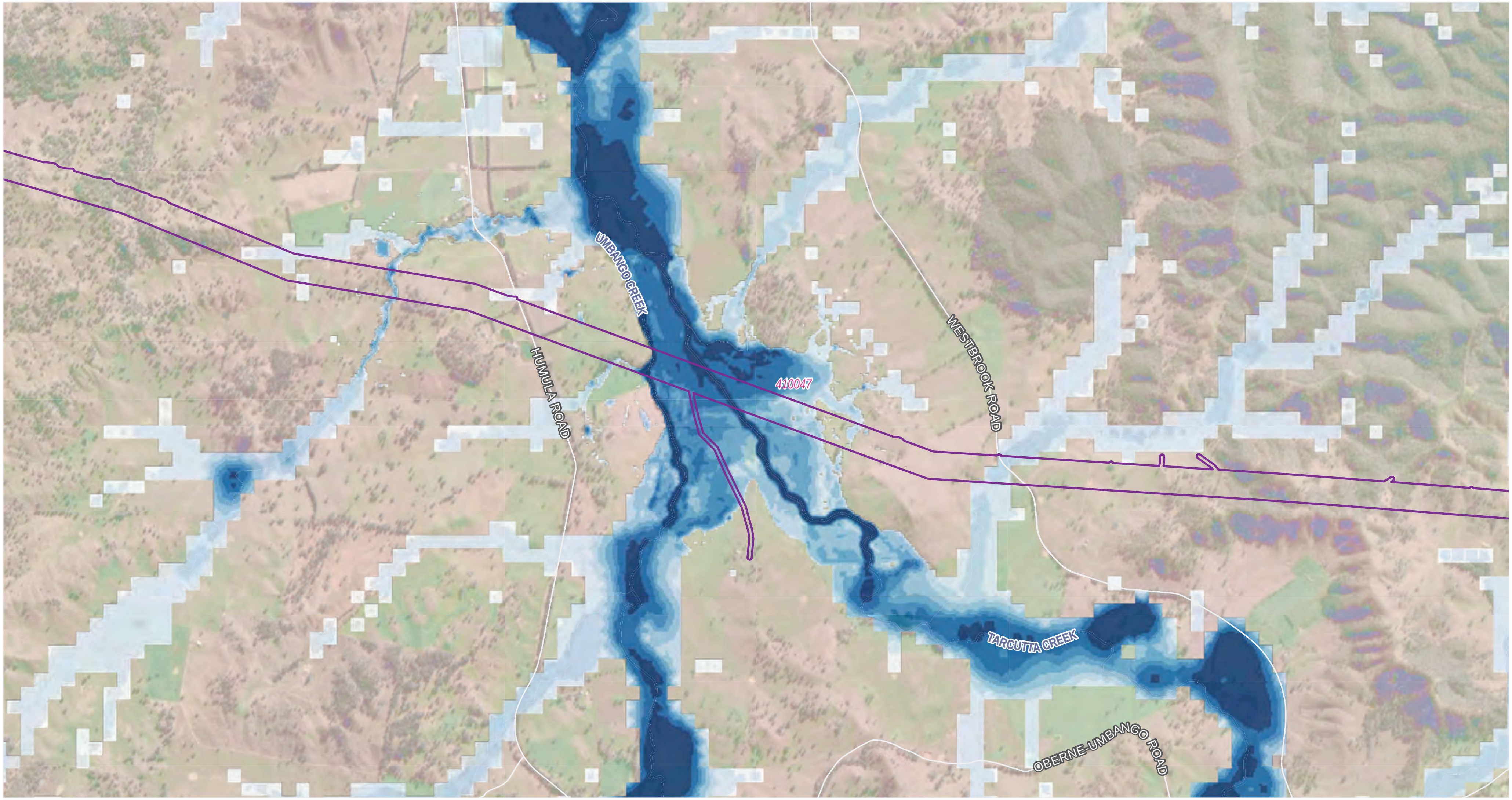
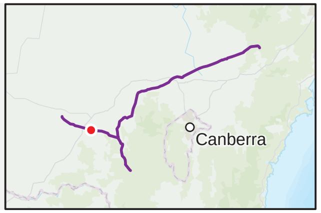


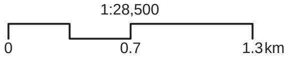
☐	Project footprint
☐	Murrumbidgee River Catchment

Flood Depth (m)

▨	<=0.03	▨	0.75 - 1
▨	0.03 - 0.1	▨	1.00 - 1.5
▨	0.10 - 0.25	▨	>1.5
▨	0.25 - 0.5		
▨	0.50 - 0.75		



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

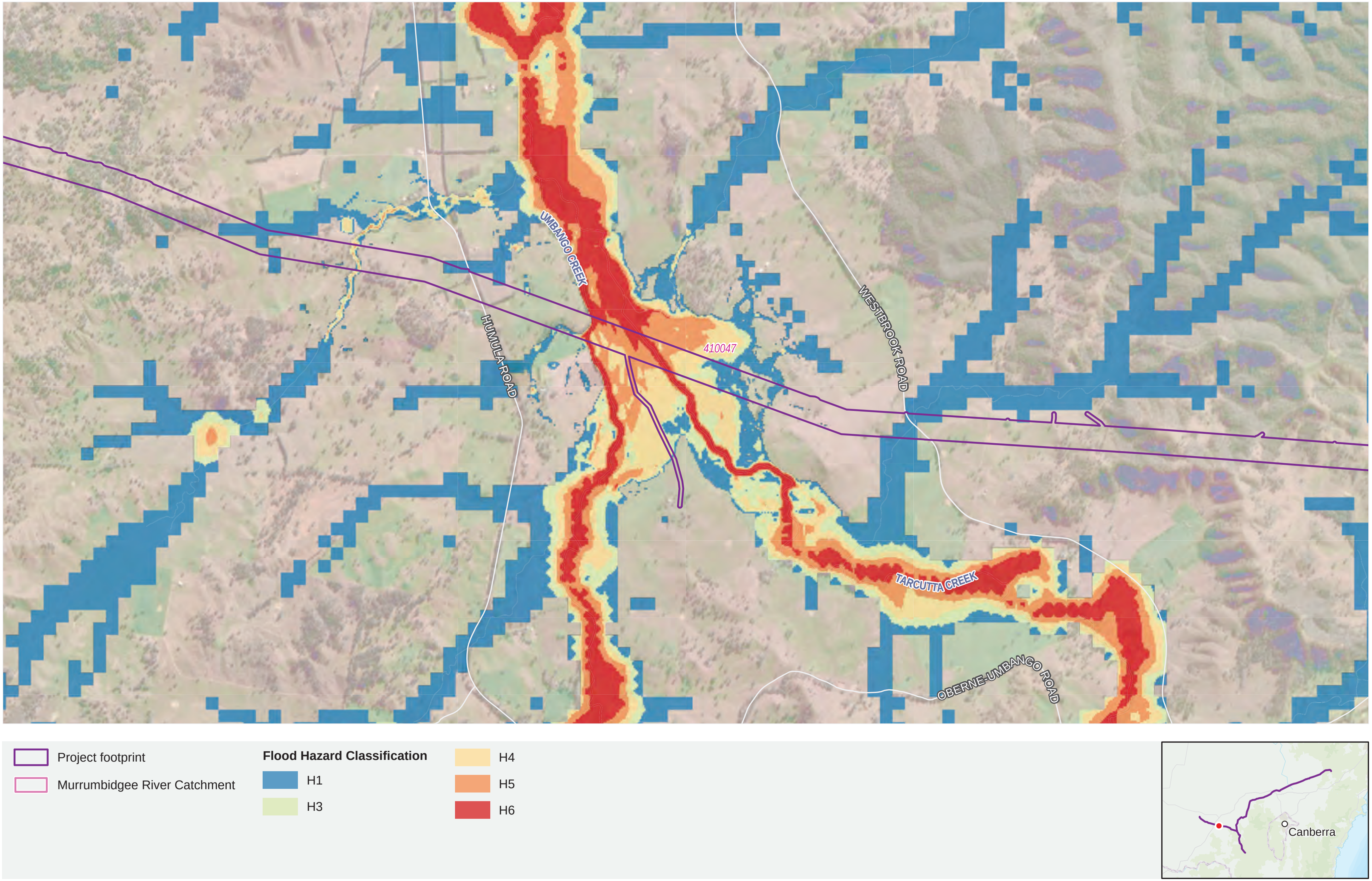


Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 64a: 1% AEP flood depth (m) at Tarcutta Creek / Umbango Creek - Murumbidgee Catchment

C:\Users\Virgil.Robinson\Aurecon Group\507179 - HumeLink Project Development Suppor - EIS\ArcPro\507179_HumeLink_Flooding.aprx\23-05-23\Virgil.Robinson



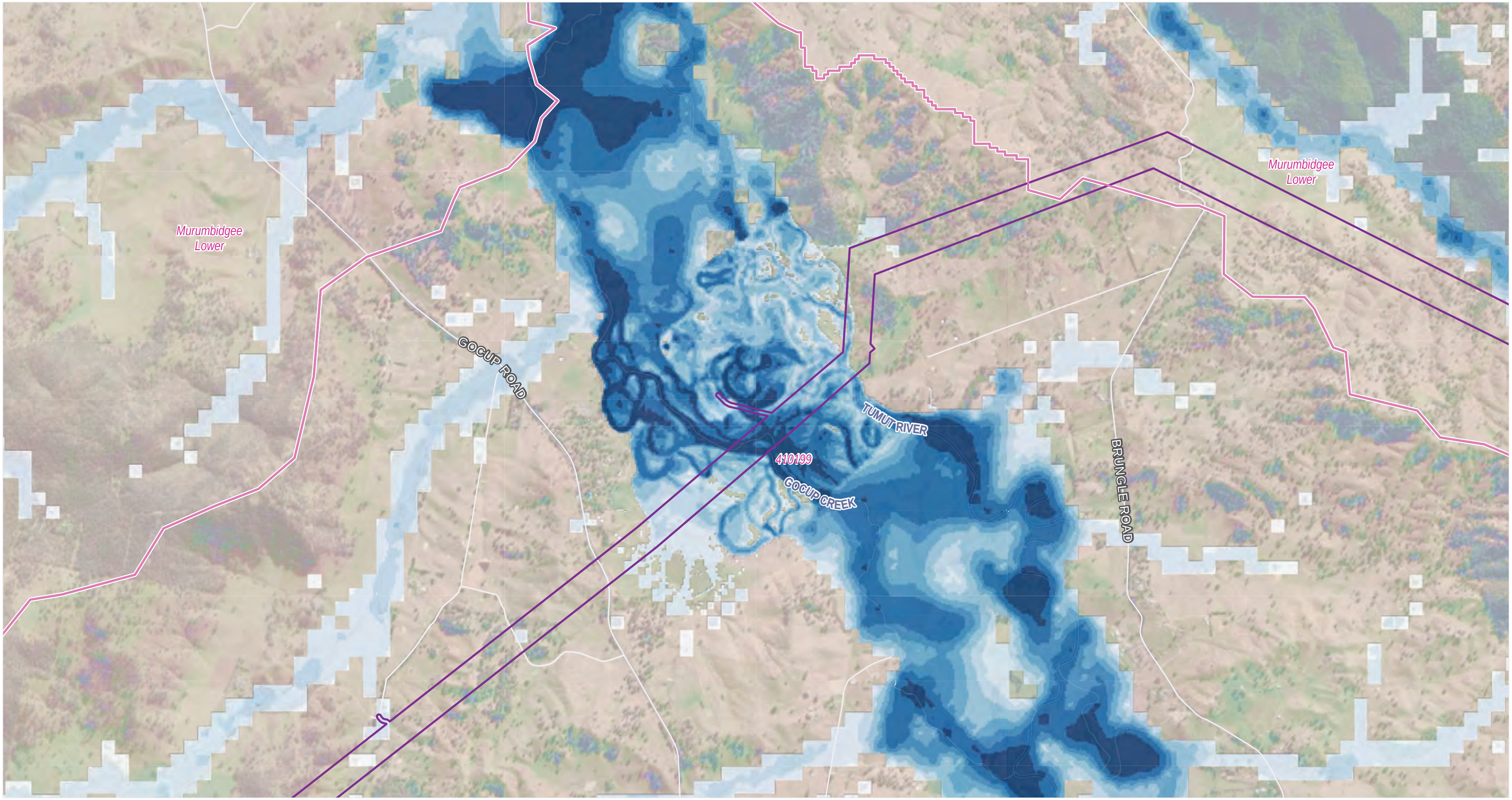
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 64b: ARR 2019 Flood Hazard Classification at Tarcutta Creek / Umbango Creek - Murumbidgee Catchment

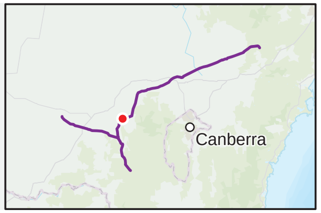
C:\Users\Virgil.Robinson\Aurecon Group\507179 - HumeLink Project Development Suppor - EIS\ArcPro\507179_HumeLink_Flooding.aprx\23-05-23\Virgil.Robinson



- ▭ Project footprint
- ▭ Murrumbidgee River Catchment

Flood Depth (m)

- ■ <=0.03
- ■ 0.03 - 0.1
- ■ 0.10 - 0.25
- ■ 0.25 - 0.5
- ■ 0.50 - 0.75
- ■ 0.75 - 1
- ■ 1.00 - 1.5
- ■ >1.5



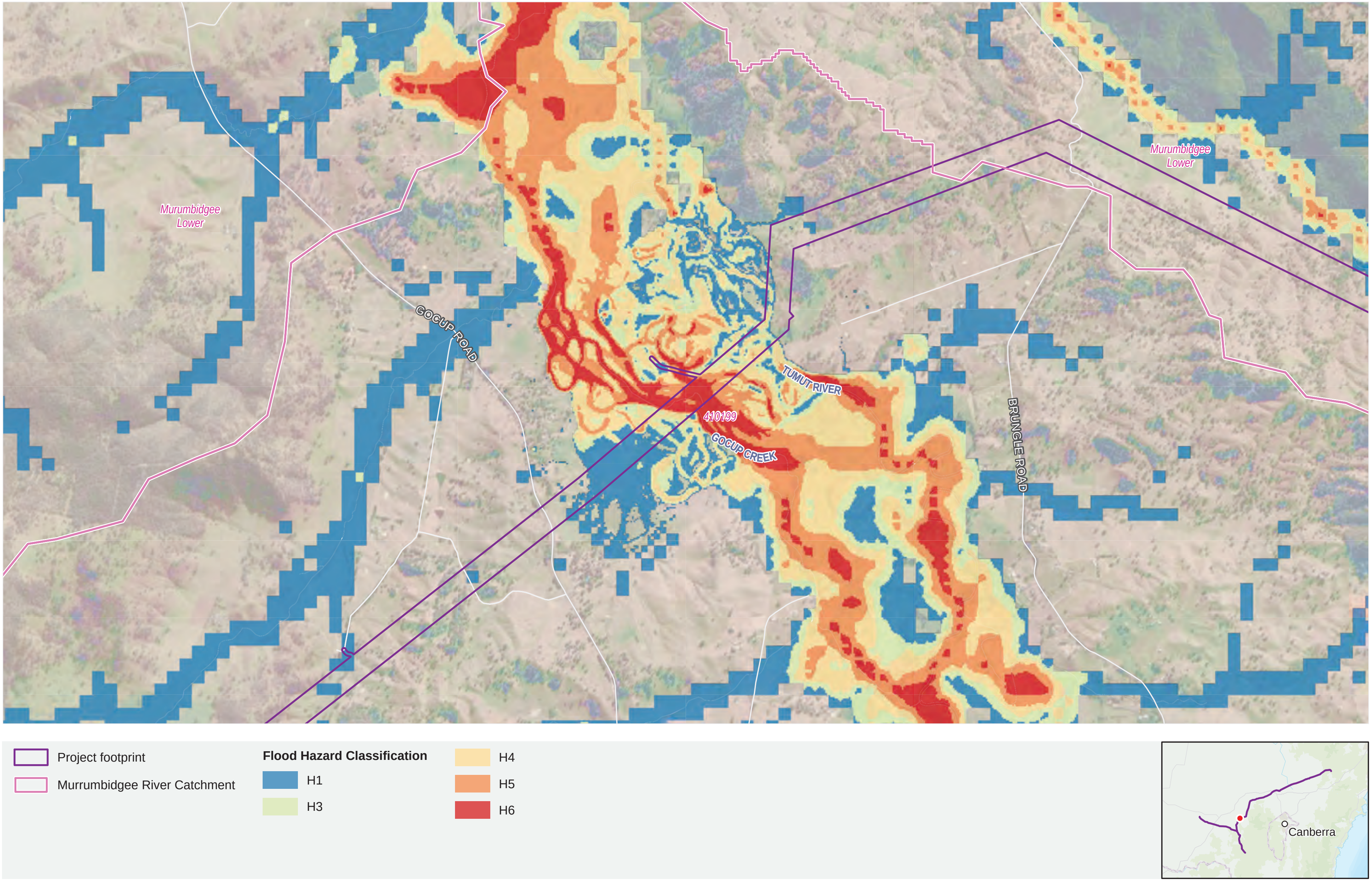
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:28,500
0 0.7 1.3 km

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 65a: 1% AEP flood depth (m) at Tumut River / Gocup Creek - Murumbidgee Catchment



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Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

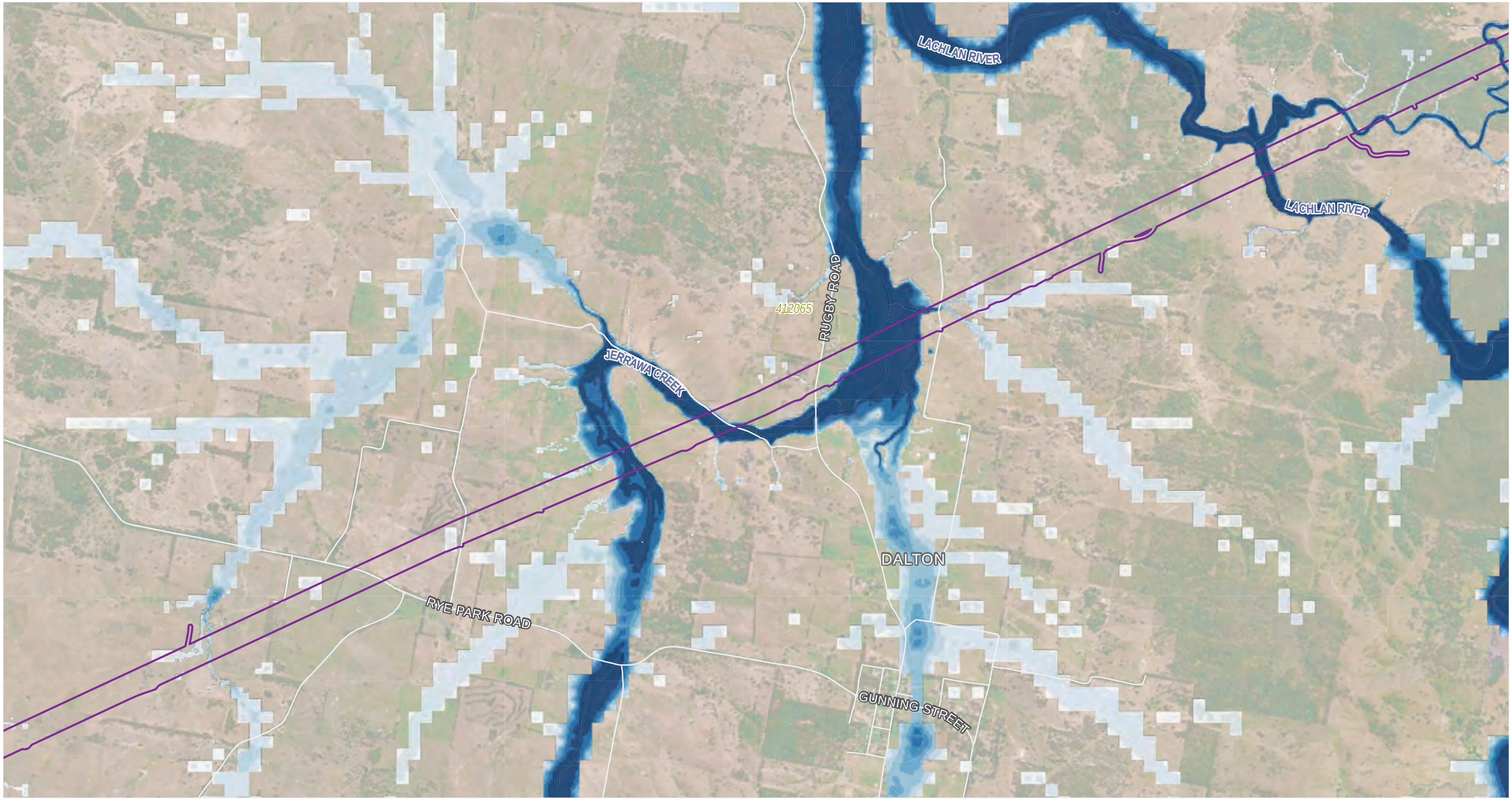
1:28,500

0 0.7 1.3 km

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

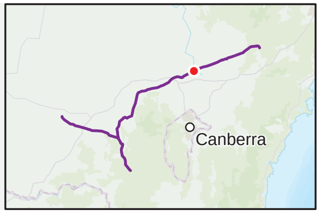
Map 65b: ARR 2019 Flood Hazard Classification at Tumut River / Gocup Creek - Murumbidgee Catchment



▭ Project footprint
▭ Lachlan River Catchment

Flood Depth (m)

■	<=0.03
■	0.03 - 0.1
■	0.10 - 0.25
■	0.25 - 0.5
■	0.50 - 0.75
■	0.75 - 1
■	1.00 - 1.5
■	>1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

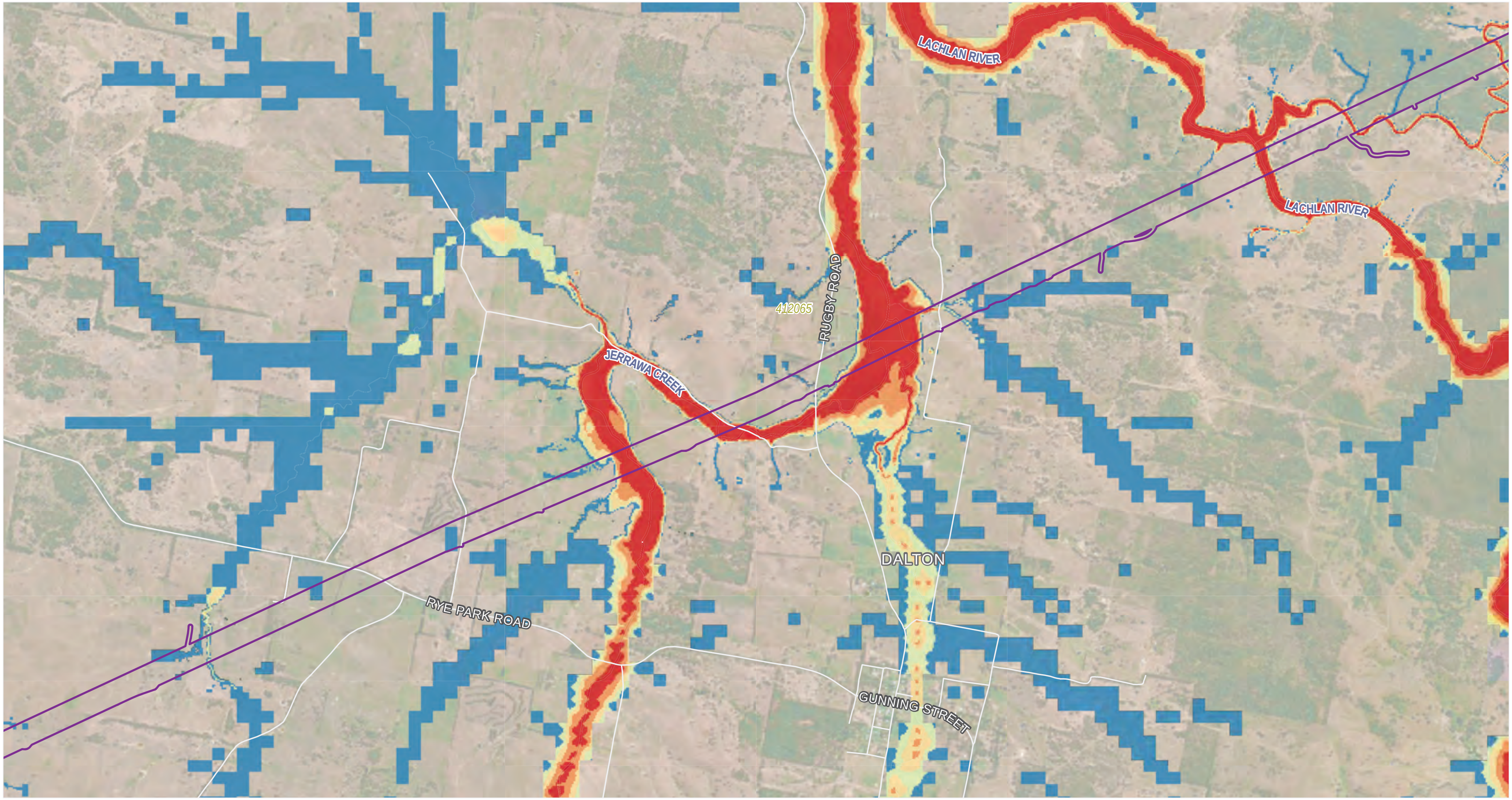
1:32,000
0 0.7 1.4km

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 66a: 1% AEP flood depth (m) at Jerrawa Creek - Lachlan Catchment

C:\Users\Virgil.Robinson\Aurecon Group\507179 - HumeLink Project Development Suppor - EIS\ArcPro\507179_HumeLink_Flooding.aprx\23-05-23\Virgil.Robinson



▭ Project footprint

▭ Lachlan River Catchment

Flood Hazard Classification

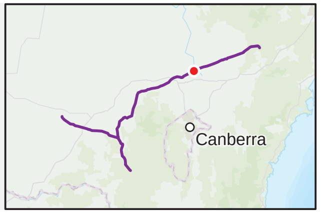
🟦 H1

🟩 H3

🟨 H4

🟧 H5

🟥 H6



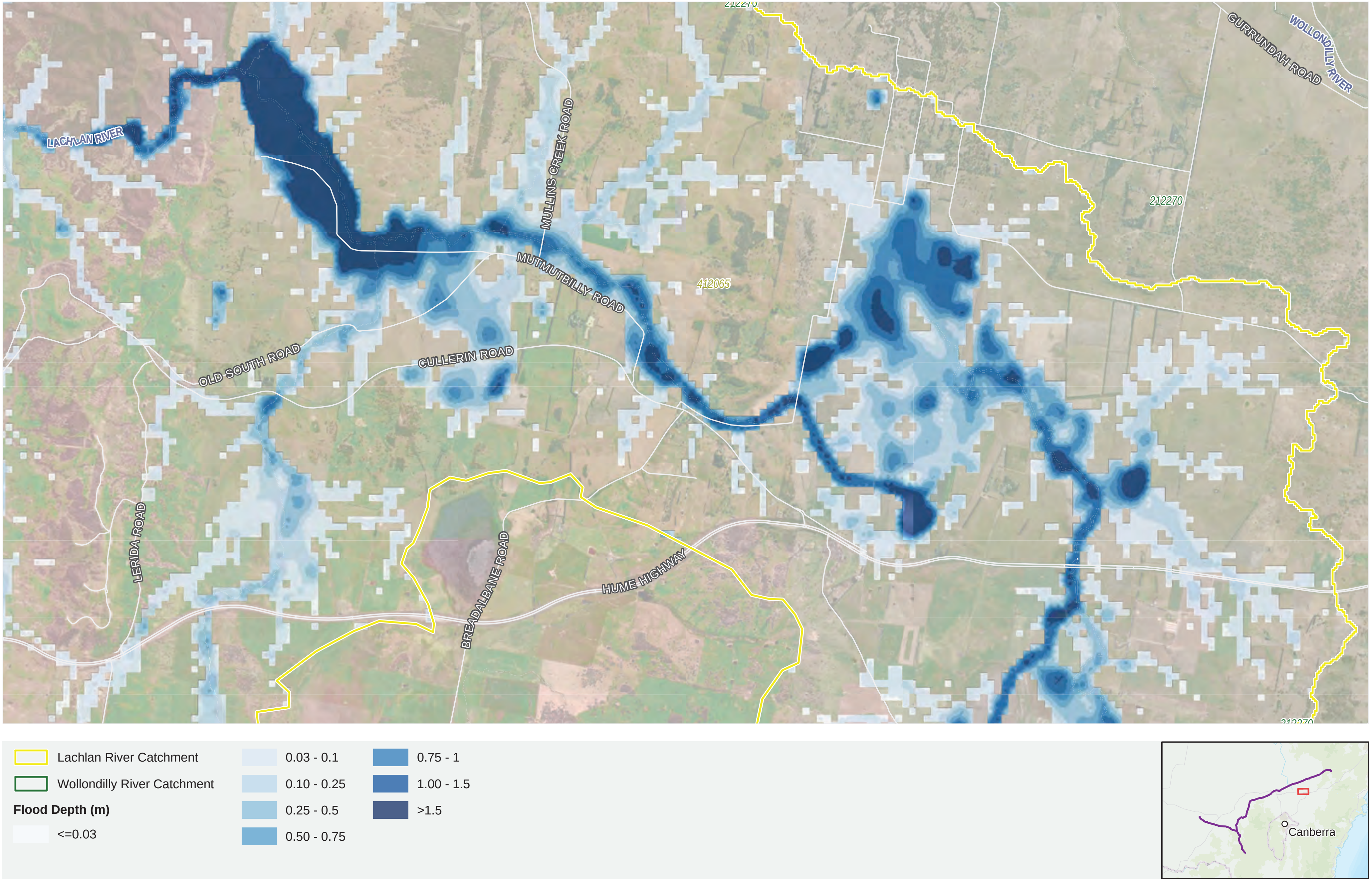
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:32,000

0 0.7 1.4km

Projection: GDA 1994 MGA Zone 55

Map 66b: ARR 2019 Flood Hazard Classification at Jerrawa Creek - Lachlan Catchment



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:50,000
0 1 2km

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 67a: 1% AEP flood depth (m) at Bredalbane locality - Lachlan Catchment

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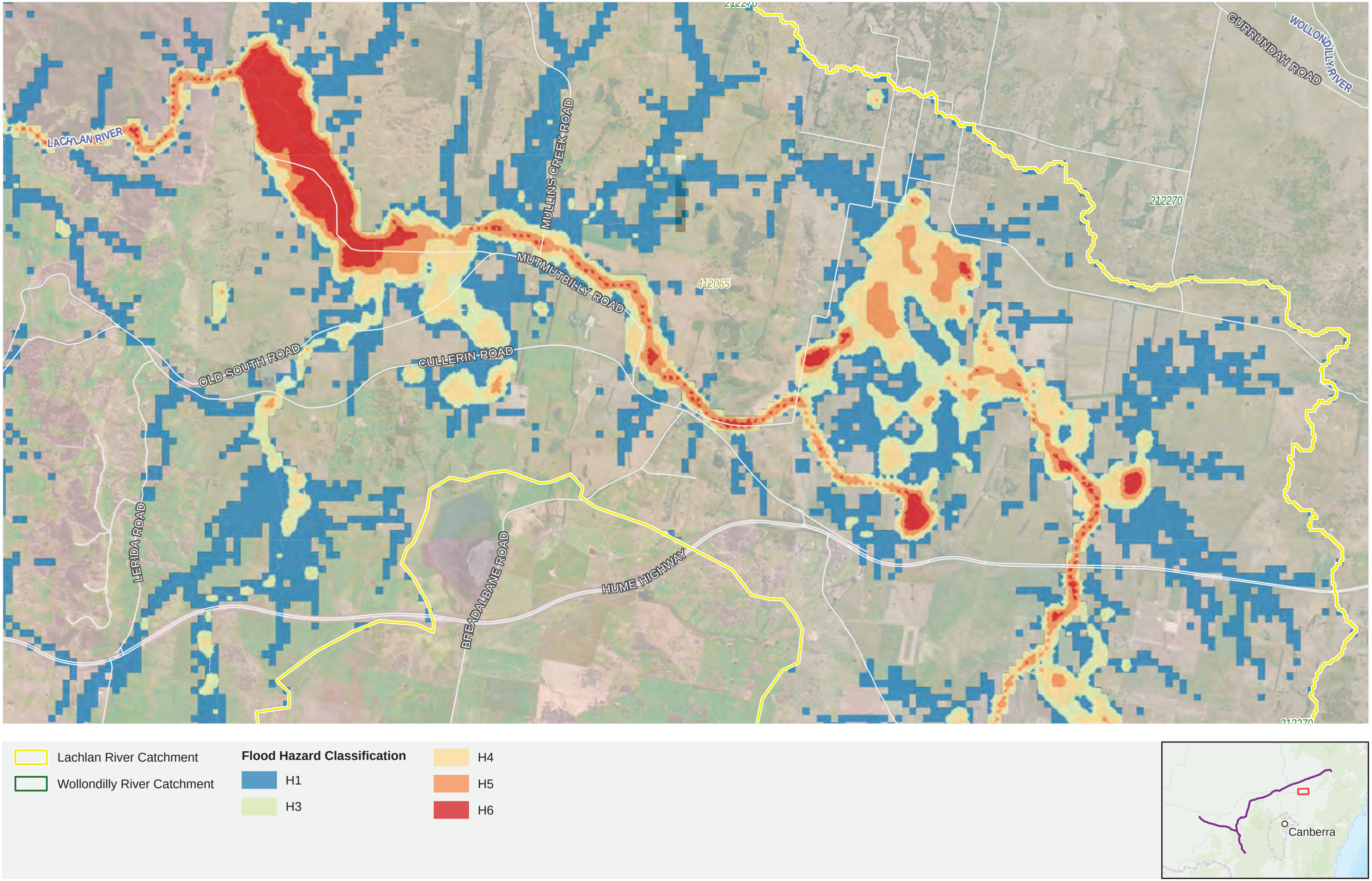

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:50,000
0 1 2km

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 67b: ARR 2019 Flood Hazard Classification at Bredalbane locality - Lachlan Catchment

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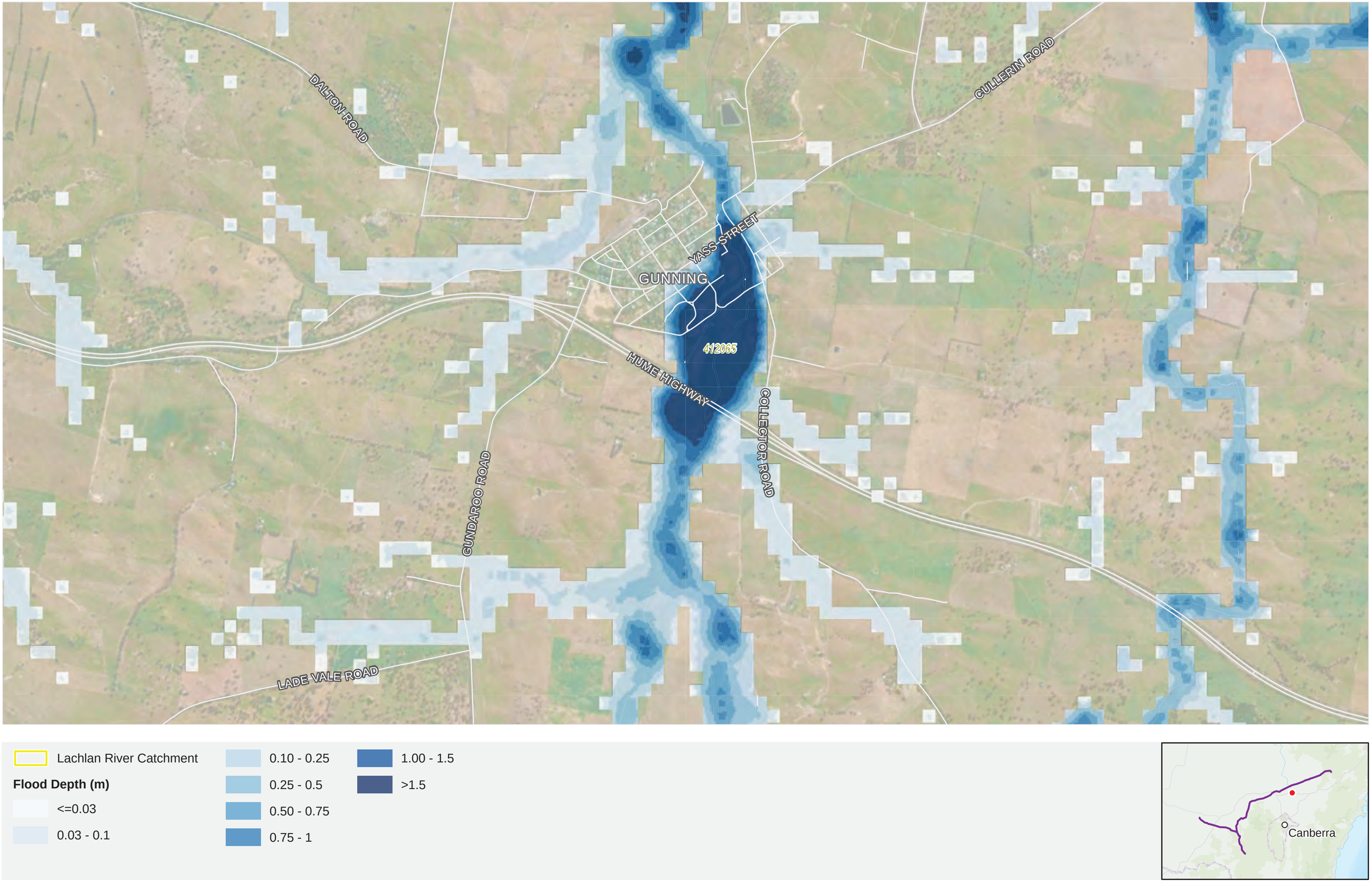

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:27,500

0 0.6 1.2km

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 68a: 1% AEP flood depth (m) at Gunning locality - Lachlan Catchment

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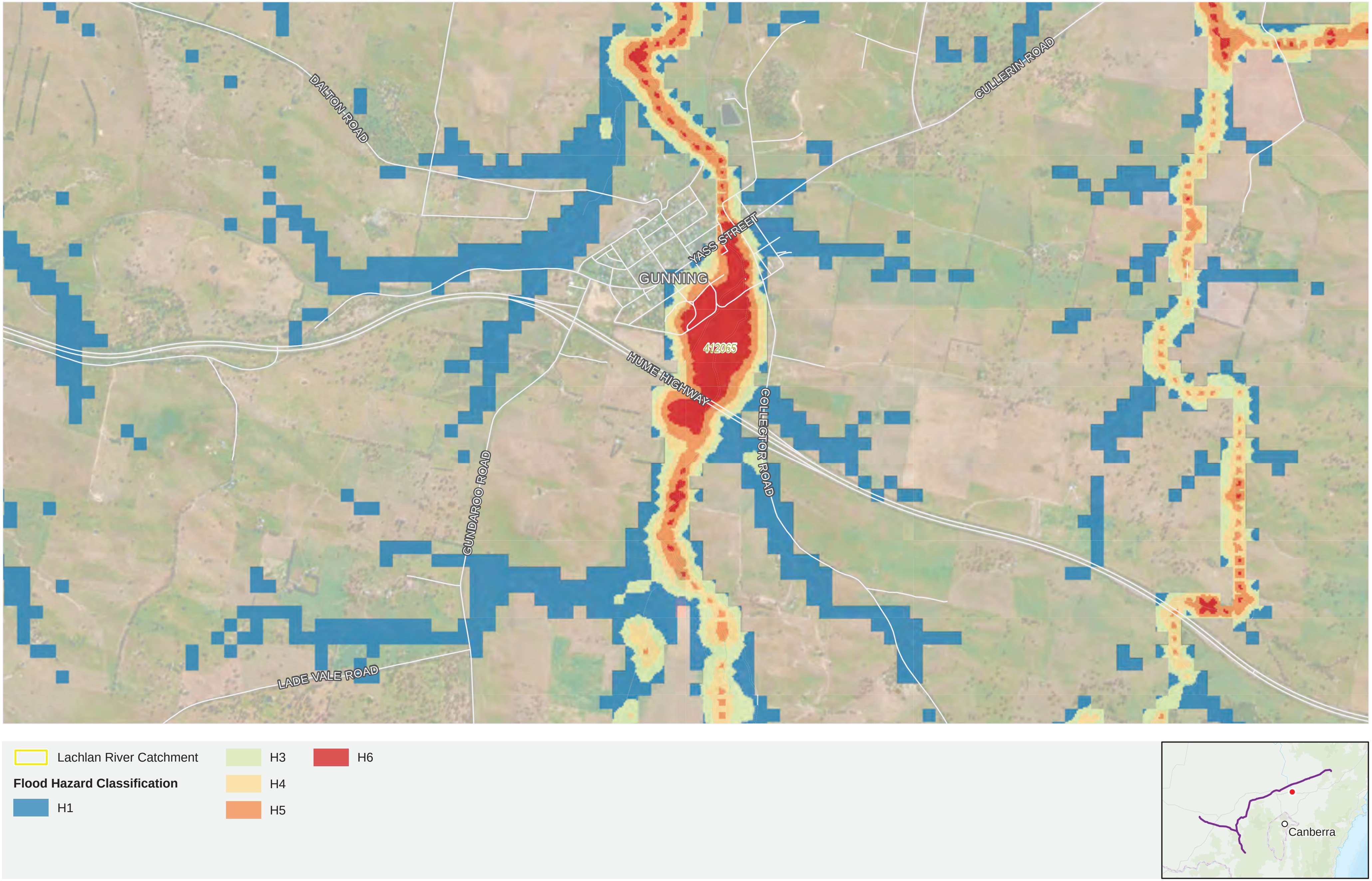


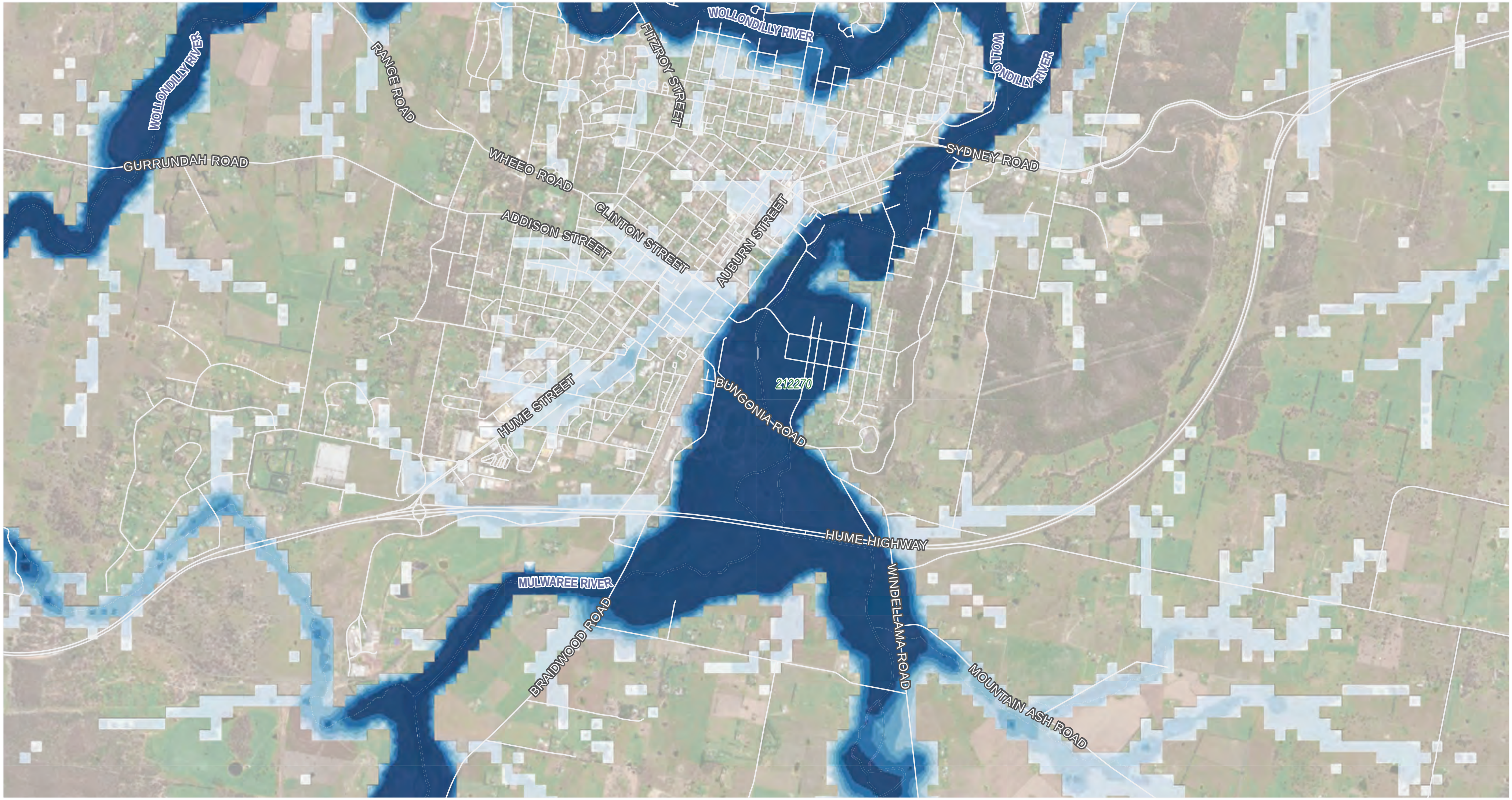
Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:27,500
0 0.6 1.2km

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

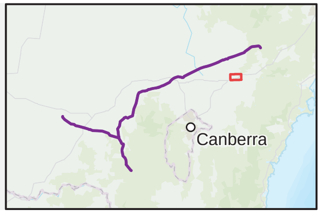
Map 68b: ARR 2019 Flood Hazard Classification at Gunning locality - Lachlan Catchment



▭ Wollondilly River Catchment

Flood Depth (m)

■ <=0.03
■ 0.03 - 0.1
■ 0.10 - 0.25
■ 0.25 - 0.5
■ 0.50 - 0.75
■ 0.75 - 1
■ 1.00 - 1.5
■ >1.5



Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:35,000
0 0.8 1.6 km

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 69a: 1% AEP flood depth (m) at Goulburn locality - Wollondilly Catchment

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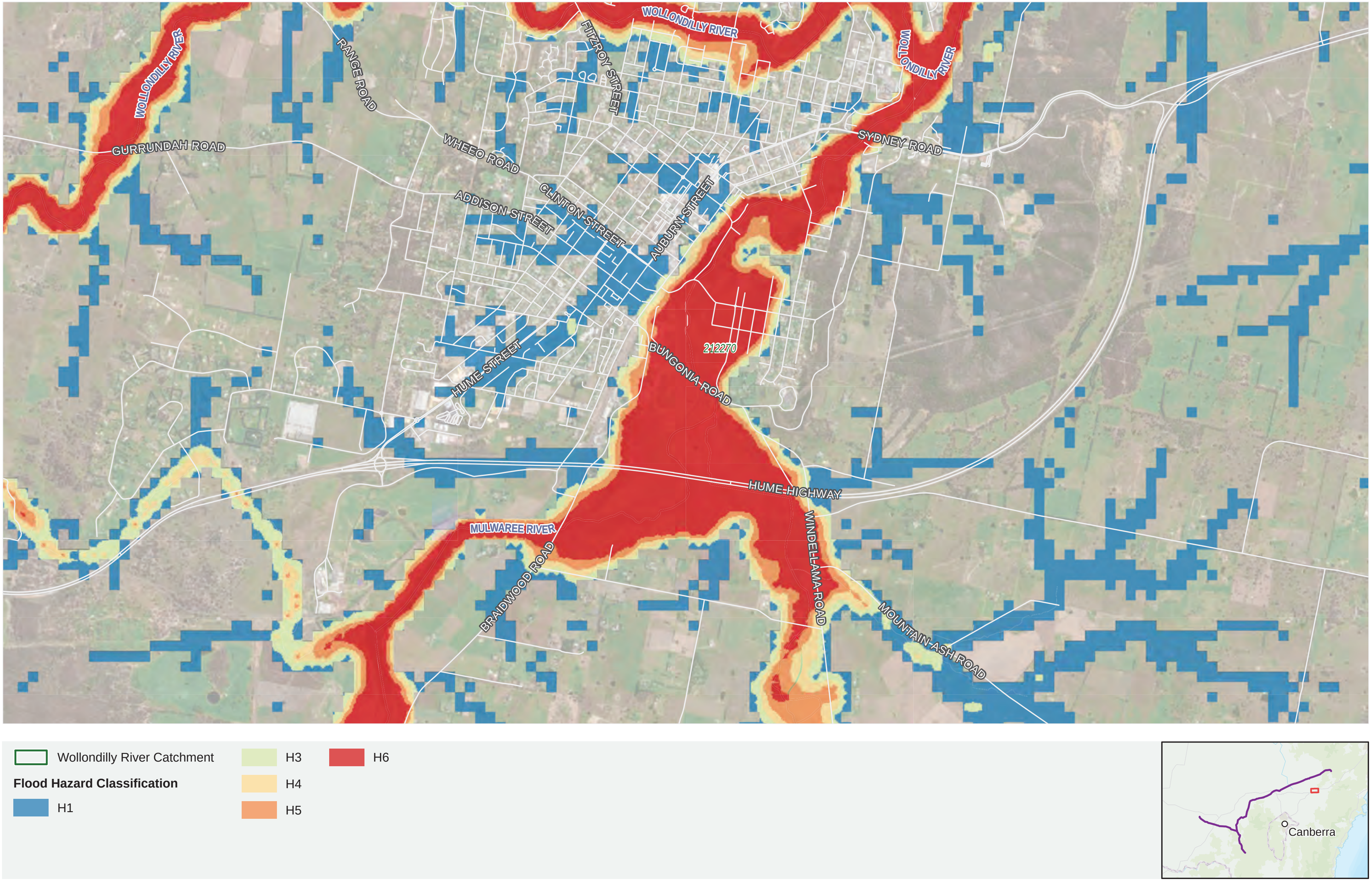

Source: *Aurecon, Transgrid, Spatial Services (DCS), ESRI Basemap*

1:35,000

0 0.8 1.6 km

Projection: GDA 1994 MGA Zone 55

HumeLink **Hydrology and Flooding**

Map 69b: ARR 2019 Flood Hazard Classification at Goulburn locality - Wollondilly Catchment

Attachment D

Lyall & Associates Gugaa 500 kV Substation Flooding Investigation

Lyall & Associates

stormwater & flood risk management
engineering design & documentation
hydrologic & hydraulic modelling
expert advice & peer review
river engineering

Transgrid
180 Thomas Street
SYDNEY NSW 2000

Job No. FP524.001

6 October 2022

Re: Gugaa 500 kV Substation Flooding Investigation

The letter sets out the findings of an investigation that has been undertaken to define the nature of flooding in the vicinity of a 500 kilovolt (kV) substation that Transgrid proposes to construct as part of the HumeLink project.

1. Background

The Australian energy landscape is transitioning to a greater mix of low-emission renewable energy sources, such as wind and solar. To support this transition, meet our future energy demands and connect Australian communities and businesses to these lower cost energy sources, the national electricity grid needs to evolve.

Transgrid proposes to increase the energy network capacity in southern New South Wales (NSW) through the development of around 360 kilometres of new 500 kV high-voltage transmission lines and associated infrastructure between Wagga Wagga, Bannaby and Maragle. This project is collectively referred to as HumeLink. The project would be located across five Local Government Areas including Wagga Wagga, Snowy Valleys, Cootamundra-Gundagai, Upper Lachlan and Yass Valley.

HumeLink would involve the construction of a new 500/300 kV substation at Gregadoo (Gugaa 500 kV substation) approximately 11 kilometres south-east of the existing Wagga 330/132 kV substation (Wagga 330 kV substation).

Transgrid has identified a preferred site for the Gugaa 500 kV substation at Lot A in DP 376288 and Lot 56 in DP 757261 (1.4 kilometres south of the intersection of Gregadoo East Road and Livingston Gully Road) on Livingston Gully Road, Gregadoo (**Gugaa 500 kV substation preferred location site**). The Gugaa 500 kV substation preferred location site is located to the west of O'Briens Creek which discharges to Kyeamba Creek approximately two kilometres to the north of Gregadoo East Road.

While our firm undertook a detailed flooding investigation for a short reach of Kyeamba Creek on behalf of City of Wagga Wagga Council in 2014 (*Tarcutta, Ladysmith and Uranquinty Flood Study* (Lyall & Associates, 2014)), its focus was on the definition of flood behaviour in the immediate vicinity of Ladysmith which is located about eight kilometres downstream of the Gugaa 500 kV substation preferred location site.

While the hydrologic model that was developed of the Kyeamba Creek catchment and tuned to the historic floods that occurred in October 2010 and March 2012 (**Kyeamba Creek Hydrologic Model**) was suitable, the extent of the hydraulic model was limited to the village of Ladysmith and therefore not suitable for use as part of the present study. It is also noted that the procedures that were adopted for defining design flood behaviour at Ladysmith as part of Lyall & Associates, 2014 were based on the now superseded edition of *Australian Rainfall and Runoff* (The Institution of Engineers Australia, 1987).

The following sections of this letter set out the methodology that was adopted for defining the nature of flooding in the vicinity of the Gugaa 500 kV substation preferred location site.

2. Analysis of historic flood data

2.1 Recorded rainfall and stream flow data

Figure 1 shows the location of two WaterNSW operated stream gauges that are located in the Kyeamba Creek catchment in the vicinity of the Gugaa 500 kV substation preferred location site. The *Kyeamba Creek at Book Book* stream gauge (Book Book stream gauge) is located about 15 kilometres to the south of the confluence of Kyeamba Creek and O'Briens Creek, while the *Kyeamba Creek at Ladysmith* stream gauge (Ladysmith stream gauge) is located about 10 kilometres to the north of this location. Figure 1 also shows the network of rain gauges that are located in the vicinity of the Gugaa 500 kV substation preferred location site.

Figure 2 shows the cumulative depth of rainfall that was recorded at the four pluviographic rainfall stations that are located in the vicinity of the Gugaa 500 kV substation preferred location site, as well as the instantaneous discharge that are recorded by the Book Book and Ladysmith stream gauges. Figure 3 (2 sheets) shows the design intensity-frequency-duration curves relative to the recorded rainfall for the October 2010 and March 2012 flood events. Figure 4 is an isohyetal map showing the estimated total depth of rain which fell over the Kyeamba Creek catchment on the rain days of 15-16 October 2010, while Figure 5 shows similar information for the rain days of 4-5 March 2012.[1]

The total rainfall depths shown on Figures 4 and 5 were applied to the various sub-catchments comprising the hydrologic model, while the temporal variability of the rainfall was assumed to be the same as that recoded by the *Humula (RMS)* rain gauge and the *Wagga Wagga (AWS)* (GS 72150) rain gauge in the case of the October 2010 and March 2012 floods, respectively.

A review was also undertaken of the rating curve associated with the Book Book stream gauge as part of the present investigation. This involved the development of a cross sectional based HEC-RAS hydraulic model (Book Book HEC-RAS Model), the layout of which is shown on Figure 6. Natural surface levels used to derive the various cross sections comprising the Book Book HEC-RAS Model were based on available WaterNSW survey data and photogrammetry.

The Book Book HEC-RAS model was run for a range of peak flows, with the resulting stage versus discharge relationship (denoted herein as the "L&A Derived Rating Curve") compared to WaterNSW's current rating curve for the Book Book stream gauge. By inspection of the two rating curves shown on Figure 7, the present investigation found that the current rating curve underestimates the flow in Kyeamba Creek for gauge heights higher than about 3.75 metres.

2.2 Flood frequency analysis

The L&A Derived Rating Curve was used to adjust the ordinates of the discharge hydrographs that were recorded for the October 2010 and March 2012 flood events (refer Figure 2), as well as the annual maximum peak flows that were recorded by the Book Book stream gauge for the period 1985-2020. Annexure A of this letter lists the annual maximum peak flows that have been recorded by the Book Book stream gauge for the 36 year period of record.

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[1] Note that in order to achieve a better match with the flow which was recorded by the Book Book stream gauge it was necessary to adjust the isohyetal contours shown on Figures 4 and 5 (ie they differ slightly from those presented in Lyall & Associates, 2014).

A Log Pearson Type III (LP3) distribution was fitted to the adjusted annual series of flood peaks for the 36 year period of record using the TUFLOW Flike software. The resulting frequency curves, along with 5% and 95% confidence limits are shown on the left-hand side of Figure 8. Column B in Table 1 gives the peak flow estimates for a range of AEPs as derived by the above analysis.

TABLE 1
FLOOD FREQUENCY DERIVED DESIGN PEAK FLOWS
BOOK BOOK STREAM GAUGE
(m^3/s)

Design Flood Event (% AEP) [A]	1985 – 2020 Full Period of Record [B]	1985 – 2020 Censored Data [C]	Refined Kyeamba Creek Hydrologic Model[(1)] [D]
20	48	46	48 [6.2 mm/hr, 3hr_S1]
10	90	85	88 [5.0 mm/hr, 3hr_S4]
5	145	138	142 [3.7 mm/hr, 9hr_S8]
2	250	230	246 [1.8 mm/hr, 6hr_S7]
1	350	330	339 [0.8 mm/hr, 6hr_S9]
0.5	490	455	390 [0.8 mm/hr, 6h_S8]

1. Values in [ ] are the adopted continuing loss in mm/hr, the critical storm duration in hours and the temporal pattern which is critical for deriving the median peak flow in Kyeamba Creek at the location of the Book Book stream gauge.

Values at the low end of the observed range of flood peaks can distort the fitted probability distribution and affect the estimates of large floods. Deletion of these low values may improve the fit to the remaining data. The right-hand side of Figure 8 shows that the censoring of the flow data based on the Multiple Grubbs Beck Test, while Column C in Table 1 gives the design peak flow estimates based on the censored data.

Given the similarity between the two sets of peak flows, it was determined that the values listed in Column B of Table 1 should be used for design flood estimation purposes.

3. Hydrologic model calibration

In order to define flow in the various minor drainage lines that are present in the vicinity of the Gugaa 500 kV substation preferred location site it was necessary to refine the sub-catchment definition within the Kyeamba Creek Hydrologic Model (Refined Kyeamba Creek Hydrologic Model). Figure 9 (2 sheets) shows the layout of the sub-catchments comprising the Refined Kyeamba Creek Hydrologic Model.

As Lyall & Associates, 2014 focussed on the definition of flood behaviour along the reach of Kyeamba Creek at Ladysmith, it was necessary to check the calibration of the Refined Kyeamba Creek Hydrologic Model to ensure that it reproduced recorded flows further upstream at the location of the Book Book stream gauge.

As per the approach adopted in Lyall & Associates, 2014, the Refined Kyeamba Creek Hydrologic Model was recalibrated to floods that occurred in October 2010 and March 2012, noting that the earlier flood was equivalent in peak flow terms to a design flood with an annual exceedance probability (AEP) of about 1% at the location of the Book Book stream gauge.

Table 2 provides a comparison of the hydrologic model parameters that were found to provide a good match with the recorded discharge hydrographs, while Figure 2 shows a comparison between the recorded and modelled discharge hydrographs for the October 2010 and March 2012 flood events at the location of the Book Book stream gauge. By inspection of the values set out in Table 2, only minor adjustments were required to be made to the previously adopted hydrologic model parameters in order to achieve a good match with the peak flow that was recorded by the Book Book stream gauge during the October 2010 flood.

TABLE 2
ADOPTED HYDROLOGIC MODEL PARAMETERS

Historic Flood Event	Parameter	Lyall & Associates, 2014	Present Investigation
October 2010	Initial Loss (mm)	43	40
	Continuing Loss (mm/hr)	2.5	2.0
	BX	0.9	0.9
	Velocity (m/s)	1.5	1.5
March 2012	Initial Loss (mm)	44	44
	Continuing Loss (mm/hr)	0.9	0.9
	BX	0.9	0.9
	Velocity (m/s)	1.5	1.5

4. Design flood estimation

4.1 Rainfall intensity

The procedures used to obtain temporally and spatially accurate and consistent intensity-frequency--duration (IFD) design rainfall curves for the assessment of flooding at the location of the Gugaa 500 kV substation preferred location site are presented in 2019 edition of *Australian Rainfall and Runoff* (Editors, 2019) (ARR 2019). Design storms for frequencies of 20%, 10%, 5%, 2%, 1% and 0.5% were derived for storm durations ranging between 30 minutes and 12 hours.

4.2 Temporal patterns

The design rainfalls were converted into rainfall hyetographs using the temporal patterns presented in ARR 2019 for the range of design storm events. ARR 2019 requires the analysis of ten temporal patterns for each storm duration and the selection of the pattern that produces a peak flow estimate that is closest to the mean.

4.3 Areal reduction factors

Areal reduction factors (ARFs) of between 0.77 and 0.93 were derived using the procedures set out in ARR 2019 in order to achieve a match between the design peak flow estimates derived from the flood frequency analysis at the Book Book stream gauge where the total catchment area is 144 square kilometres.

In order to derive design discharge hydrographs in the vicinity of the Gugaa 500 kV substation preferred location site, ARFs of between 0.74 and 0.92 were applied to the Kyeamba Creek sub-catchments upstream of the watercourse's confluence with Tooles Creek (where the total catchment area is 221 square kilometres) and the O'Briens Creek sub-catchments upstream of Gregadoo East Road (where the total catchment area is 190 square kilometres).

4.4 Probable maximum precipitation

Estimates of probable maximum precipitation (PMP) were made using the generalised short duration method (GSDM) as described in *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method* (Bureau of Meteorology (BoM), 2003). This method is appropriate for estimating extreme rainfall depths for catchments up to 1000 square kilometres in area and storm durations up to three hours.

The steps involved in assessing PMP for the study catchments are briefly as follows:

- Calculate PMP for a given duration and catchment area using depth-duration-area envelope curves derived from the highest recorded US and Australian rainfalls.
- Adjust the PMP estimate according to the percentages of the catchment which are meteorologically rough and smooth, and also according to elevation adjustment and moisture adjustment factors.
- Assess the design spatial distribution of rainfall using the distribution for convective storms based on US and world data but modified in the light of Australian experience.
- Derive storm hyetographs using the temporal distribution contained in BoM, 2003, which is based on pluviographic traces recorded in major Australian storms.

Figure 9 shows the location and orientation of the PMP ellipses which were used to derive the rainfall estimates for the present study. Note that two orientations of the PMP ellipses were adopted for the O'Briens Creek and Kyeamba Creek catchments in order to accurately derive the upper limit of flooding.

4.5 Design rainfall losses

The rainfall loss parameters for ARR 2019 design storms were obtained from the ARR Data Hub and applied using the procedures set out in *Incorporating 2016 Australian Rainfall and Runoff in studies* (Office of Environment and Heritage, 2019). A copy of the data extracted from the ARR Data Hub for the Refined Kyeamba Creek Hydrologic Model is contained in Annexure B of this letter.

Based on the NSW jurisdictional advice contained on the ARR Data Hub, the raw continuing loss (CL) value of 4.4 millimetres per hour was multiplied by a factor of 0.4, resulting in a CL of 1.76 millimetres per hour which was applied to the Refined Kyeamba Creek Hydrologic Model. Initial runs of the Refined Kyeamba Creek Hydrologic Model identified that the adoption of a single CL value did not provide a good match to the shape of the flood frequency relationship for the Book Book stream gauge. Based on this finding, a variable CL approach was adopted for design flood estimation purposes.

4.6 Design peak flows

Column D in Table 1 gives the design peak flows that were generated by the Refined Kyeamba Creek Hydrologic Model at the location of the Book Book stream gauge for floods ranging between 20 and 0.5% AEP. Also given in Table 1 are the adopted CL values, the storm duration which is critical for maximising flow in Kyeamba Creek and the temporal pattern which generates the median flow in the watercourse at the location of the Book Book stream gauge.

Table 3 gives the design peak flows on the main arms of O'Briens Creek and Big Spring Creek, as well as in three minor drainage lines that are located in the vicinity of the Gugaa 500 kV substation preferred location site (denoted herein as Minor Drainage Lines MDL_01, MDL_02 and MDL_03), noting that these have been extracted from the output files of the hydraulic model.

TABLE 3
DESIGN PEAK FLOWS IN THE VICINITY OF GUGAA 500 kV SUBSTATION PREFERRED LOCATION SITE
(m^3/s)

Design Flood Event (% AEP)	Main Arm of O'Briens Creek	Main Arm of Big Spring Creek	Minor Drainage Line MDL_01⁽¹⁾	Minor Drainage Line MDL_02⁽¹⁾	Minor Drainage Line MDL_03⁽¹⁾
20	71	15.5	1.4	0.7	2.1
10	142	26.5	2.0	1.0	3.6
5	231	37.9	3.1	1.6	5.5
2	414	57.6	4.1	2.0.	8.0
1	550	73.8	5.1	2.5	10.3
0.5	621	88.0	5.9	2.8	12.0
PMF	5,200	422	46.7	18.4	787⁽²⁾

1. The total catchment area contributing to flow in Minor Drainage Lines MDL_01, MDL_02 and MDL_03 at the northern boundary of the Gugaa 500 kV substation preferred location site is 0.72 km^2, 0.33 km^2 and 1.37 km^2, respectively.
2. Includes the total flow in Minor Drainage Line MDL_03 and Big Spring Creek.

5. Definition of flood behaviour in vicinity of the Gugaa 500 kV substation preferred location site

5.1 Background to TUFLOW model development

5.1.1 General

In order to accurately define flood behaviour in the vicinity of the Gugaa 500 kV substation preferred location site a two-dimensional (in plan) hydraulic model was developed using the TUFLOW software, the layout of which is shown on Figure 10 (Kyeamba Creek TUFLOW Model).

TUFLOW is a true two-dimensional hydraulic model which does not rely on a prior knowledge of the pattern of flood flows in order to set up the various fluvial and weir type linkages which describe the passage of a flood wave through the system. The basic equations of TUFLOW involve all of the terms of the St Venant equations of unsteady flow. Consequently, the model is "fully dynamic" and once tuned will provide an accurate representation of the passage of the floodwave through the drainage system (both surface and piped) in terms of depth, velocity and distribution of flow.

5.1.2 Two-dimensional model domain

An important consideration of two-dimensional modelling is how best to represent the features of the floodplain which influence the passage of flow over the natural surface. Two-dimensional modelling is very computationally intensive and it is not practicable to use a mesh of very fine elements without excessive times to complete the simulation, particularly for long duration flood events. The requirement for a reasonable simulation time therefore influences the way in which these features are represented in the model.

A grid spacing of three metres was found to provide an appropriate balance between the need to define features on the floodplain versus model run times, and was adopted for the present investigation. This grid spacing also allowed for the waterway area of O'Briens Creek and Kyeamba Creek (which are about 20 metres wide where they flow adjacent to the Gugaa 500 kV substation preferred location site) to be modelled within the two-dimensional (in plan) model domain.

Ground surface elevations for model grid points were assigned using LiDAR survey data which was provided by Transgrid for the purpose of undertaking the present investigation.

A default Manning's n roughness of 0.045 was applied to the Kyeamba Creek TUFLOW Model, while the following Manning's n roughness values were applied to the remaining primary land types:

- Roads = 0.02
- Macrophytes = 0.06
- Mildly Dense Vegetation = 0.1
- Buildings = 10

5.1.3 Boundary conditions

The locations where discharge hydrographs derived by the Refined Kyeamba Creek Hydrologic Model were applied to the Kyeamba Creek TUFLOW Model are shown on Figure 10. These comprise both point-source inflows at selected locations around the perimeter of the two-dimensional model domain and as distributed inflows via "Rain Boundaries".

The Rain Boundaries act to "inject" flow into the two-dimensional domain of the Kyeamba Creek TUFLOW Model, firstly at a point which has the lowest elevation, and then progressively over the extent of the Rain Boundary as the grid in the two-dimensional model domain becomes wet as a result of overland flow.

The downstream boundary of the Kyeamba Creek TUFLOW Model comprised a "free discharge" outlet, where a TUFLOW derived normal depth calculation was used to define hydraulic conditions.

5.2 Historic flooding patterns

The discharge hydrographs that were generated by the Refined Kyeamba Creek Hydrologic Model for the October 2010 and March 2012 floods were input to the Kyeamba Creek TUFLOW Model and the results compared to a number of in confidence historic photos taken on 15 October 2010 which were provided by Transgrid.

Figures 11 and 12 show the indicative extent and depth of inundation generated by the Kyeamba Creek TUFLOW Model for the October 2010 and March 2012 floods.

A comparison of the information shown on Figure 11 with the in confidence historic photos taken on 15 October 2010 confirmed that the extent and depth of inundation derived from running the Refined Kyeamba Creek Hydrologic Model in combination with the Kyeamba Creek TUFLOW Model provides a reasonable match to the flood behaviour that was observed during the October 2010 flood, noting this event approximated a flood with an AEP of 1% at the location of the Book Book stream gauge.

5.3 Design flooding patterns – present day conditions

The design discharge hydrographs that were generated by the Refined Kyeamba Creek Hydrologic Model were input to the Kyeamba Creek TUFLOW Model which was then run for floods with AEPs of 20%, 10%, 5%, 2%, 1% and 0.5%, as well as the Probable Maximum Flood (PMF).

Figure 13 (2 sheets) shows the indicative extent and depth of inundation in the vicinity of the Gugaa 500 kV substation preferred location site for a 20% AEP flood event. Also shown on sheet 2 of Figure 13 are design water surface elevation contours and scalar flow direction arrows. Figure 14 (2 sheets) shows maximum flow velocities in the vicinity of the Gugaa 500 kV substation preferred location site in combination with the scalar flow direction arrows. Similar information is shown on Figures 15 to 26 for floods with AEPs of 10%, 5%, 2%, 1% and 0.5%, as well as the PMF.

The key findings of the present investigation as they relate to flood behaviour in the vicinity of the Gugaa 500 kV substation preferred location site are as follows:

- While floodwater surcharges O'Briens Creek and inundates parts of the floodplain in flood events as frequent as 10% AEP, the section of Livingston Gully Road that runs between the Gugaa 500 kV substation preferred location site and Gregadoo East Road is located outside the extent of a 0.5% AEP flood event. It is also noted that Livingston Gully Road is elevated about 0.5 metres above the peak 0.5% AEP flood level in O'Briens Creek at this location.
- Floodwater surcharges the left bank of O'Briens Creek in a PMF event and inundates the eastern portion of the Gugaa 500 kV substation preferred location site to a maximum depth of about 1.5 metres.
- The eastern portion of the Gugaa 500 kV substation preferred location site is subject to relatively shallow overland flow which is generated by the catchments which drain to Minor Drainage Lines MDL_01 and MDL_02. For example, the depth of inundation along the alignment of Minor Drainage Lines MDL_01 and MDL_02 within the Gugaa 500 kV substation preferred location site generally does not exceed 0.2 metres in a 1% AEP flood event.
- Flow velocities are relatively mild and generally do not exceed one metre per second in a 1% AEP flood event along the alignment of Minor Drainage Lines MDL_01 and MDL_02 within the Gugaa 500 kV substation preferred location site.
- The depth of inundation along the alignment of Minor Drainage Lines MDL_01 and MDL_02 within the Gugaa 500 kV substation preferred location site generally does not exceed 0.6 metres in a PMF event, while flow velocities generally do not exceed two metres per second in an event of this magnitude.
- Runoff generated by the catchments which drain to Minor Drainage Lines MDL_01 and MDL02 commences to overtop Livingston Gully Road in a 20% AEP storm event.
- Livingston Gully Road would be inundated by runoff that is generated by the catchments which drain to Minor Drainage Lines MDL_01 and MDL02 to a maximum depth of 0.2 metres in a 0.5% AEP storm event.
- Minor Drainage Line MDL_03 runs in a north-easterly direction through the western portion of the Gugaa 500 kV substation preferred location site. Floodwater is generally contained within the banks of Minor Drainage Line MDL_03 in storm events up to 0.5% AEP in magnitude.
- Floodwater surcharges the right bank of Big Spring Creek and contributes to flow in Minor Drainage Line MDL_03 in a PMF event. Floodwater does not surcharge the right bank of Minor Drainage Line MDL_03 where it runs through the Gugaa 500 kV substation preferred location site in a PMF event

Access to the Gugaa 500 kV substation preferred location site would be restricted by floodwater that overtops Gregadoo East Road in the vicinity of the Gregadoo Creek, Big Springs Creek, O'Briens Creek and Kyeamba Creek crossings, while Livingston Gully Road which would also be subject to shallow inundation from runoff that is generated by the catchments which drain to Minor Drainage Lines MDL_01, MDL_02 and MDL_03. Table 4 sets out the maximum depth and approximate duration of inundation that would be experienced along Gregadoo East Road and Livingston Gully Road in the vicinity of the Gugaa 500 kV substation preferred location site for the range of assessed design flood events.

It is noted that Gregadoo East Road west of the study area may also be impacted by floodwater. However, the exact location where this may occur has not been assessed as part of the present investigation.

TABLE 4
DEPTH AND DURATION OF INUNDATION ALONG ROADS IN THE VICINITY OF THE GUGAA 500 kV SUBSTATION PREFERRED LOCATION SITE

Design Flood Event (% AEP)	Gregadoo East Road								Livingstone Gully Road	
	Gregadoo Creek		Big Spring Creek		O'Briens Creek		Kyeamba Creek		Major Overland Flow	
	Maximum Depth of Inundation (m)	Approximate Duration of Inundation (hours)	Maximum Depth of Inundation (m)	Approximate Duration of Inundation (hours)	Maximum Depth of Inundation (m)	Approximate Duration of Inundation (hours)	Maximum Depth of Inundation (m)	Approximate Duration of Inundation (hours)	Maximum Depth of Inundation (m)	Approximate Duration of Inundation (hours)
20	-	-	-	-	-	-	-	-	0.1	3
10	<0.1	1	<0.1	<1	0.2	3	-	-	0.1	4
5	0.1	3	0.1	1	0.4	8	<0.1	>6	0.2	4
2	0.1	5	0.2	3	0.8	9	0.1	>7	0.2	4
1	0.2	6	0.2	5	1.0	11	0.2	> 9	0.2	5
0.5	0.2	7	0.3	6	1.1	12	0.3	> 10	0.2	5
PMF	0.5	5	1.0	5	3.4	8	2.1	>10	1.8	6

5.4 Design flooding patterns – post-substation conditions

Figure 27 shows the plan layout of the key features that would be associated with the construction of a substation at the Gugaa 500 kV substation preferred location site.

The structure of the Kyeamba Creek TUFLOW Model was updated to incorporate the following key features that would be associated with the construction of the substation:

- the construction of a large sloping bench, the elevation of which would be set above the peak 0.5% AEP flood level at the site;
- the construction of a trapezoidal shaped channel which is required to intercept and convey flow around the southern and eastern sides of the sloping bench, noting that Figure 27 shows the approximate required channel dimensions;
- the construction of an access road between Livingston Gully Road and the sloping bench, noting that Figure 27 shows that a section of the road would need to raised when compared with the indicative concept design;
- the installation of four off 1800 millimetre wide by 1200 millimetre high box culverts beneath the access road where is crosses the aforementioned trapezoidal shaped channel;
- the installation of an 1800 millimetre wide by 1200 millimetre box culvert which is required to drain surface runoff beneath the access road at a location approximately 80 metres to the west of the trapezoidal shaped channel; and
- the installation of a 450 millimetre diameter pipe beneath the access road at its intersection with Livingstone Gully Road.

Note that the proposed dimensions of the drainage elements that are presented in this letter are preliminary in nature and will need to be refined as part of the detailed design.

Figure 28 shows the indicative extent and depth of inundation in the vicinity of the Gugaa 500 kV substation preferred location site under post-substation conditions, while Figure 29 shows the impact that the proposed works would have on the flood behaviour for a 20% AEP flood event. Figure 30 shows maximum flow velocities in the vicinity of the Gugaa 500 kV substation preferred location site under post-substation conditions, while Figure 31 shows the impact that the construction of the proposed works would have on maximum flow velocities for a 20% AEP flood event. Similar information is shown on Figures 32 to 55 for floods with AEPs of 10%, 5%, 1% and 0.5%, as well as the PMF. Table 5 over sets out the design flood levels at key locations along the southern and eastern sides of the sloping benches that are associated with the Gugaa 500 kV substation preferred, while Table 6 sets out the design peak flows in the trapezoidal shaped channel.

The key findings of the present investigation as they relate to the Gugaa 500 kV substation preferred location site are as follows:

- The construction of the proposed substation would increase peak flow velocities by up to 0.1 metres per second between the site boundary and Livingston Gully Road in storm events up to 0.5% AEP in magnitude, and by up to 0.5 metres per second in a PMF event.
- The construction of the proposed substation would increase peak flood levels by between 20 and 50 millimetres between the site boundary and Livingston Gully Road in storm events up to 0.5% AEP in magnitude, and by up to 200 millimetres in a PMF event.
- Construction of the access road increases peak flood levels and flow velocities on the eastern side of Livingston Gully Road by up to 20 millimetres and 0.1 metres per second, respectively full the range of assessed flood events.

TABLE 5
DESIGN PEAK FLOOD LEVELS BORDERING SUBSTATION BENCH[(1)]
(m AHD)

Design Flood Event (% AEP)	Peak Flood Level Identifier			
	A	B	C	D
20	232.92	229.92	226.38	225.45
10	232.94	229.98	226.44	225.58
5	232.96	230.06	226.54	225.73
2	232.98	230.13	226.61	225.81
1	233.00	230.20	226.68	225.91
0.5	233.02	230.25	226.73	225.97
PMF	233.82	231.56	227.67	227.67

1. Note that the quoted peak flood levels are dependent on the adopted channel dimensions and would need to be confirmed during detailed design.
2. Refer sheet 2 of Figures 28, 32, 36, 40, 44, 48 and 52 for location of Peak Flood Level Identifiers.

TABLE 6
DESIGN PEAK FLOWS IN TRAPEZOIDAL CHANNEL[(1,2)]
(m^3/s)

Design Flood Event (% AEP)	Q01	Q02
20	1.7	2.3
10	2.5	3.3
5	3.7	5.1
2	4.8	6.6
1	6.0	8.1
0.5	6.9	9.3
PMF	53.0	70.8[(3)]

1. Note that the quoted peak flood levels are dependent on the adopted channel dimensions and would need to be confirmed during detailed design.
2. Refer sheet 2 of Figures 28, 32, 36, 40, 44, 48 and 52 for location of Peak Flood Level Identifiers.
3. Includes flow on the right overbank area of trapezoidal channel.

6. Concluding remarks

While the construction of a substation on the Gugaa 500 kV substation preferred location site is shown to result in increases in peak flood levels and flow velocities, further refinement of the drainage works should be undertaken as part of the detailed design phase of the project in order to reduce the impacts that it would otherwise have on flood behaviour external to the site. Further consideration will also need to be given to the alignment and elevation of the access road associated with the Gugaa 500 kV substation to minimise the impact that it has on flood behaviour on the eastern side of Livingston Gully Road.

While outside the scope of the present investigation, it is noted that there is the potential for the construction of the proposed substation to increase the rate and volume of flow discharging from the Gugaa 500 kV substation, thereby increasing the frequency and duration of inundation that is experienced in the receiving drainage lines. The increase in flow also has the potential to increase the scour potential within the receiving drainage lines. It is therefore recommended that during detailed design an assessment be undertaken to determine whether additional mitigation measures need to be incorporated into the design of the proposed substation.

7. References

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We trust that the findings of the present investigation will assist Transgrid in progressing its assessment of the flood immunity and drainage requirements for the proposed substation. However, please do not hesitate to contact me should you have any queries or wish to discuss any aspect of our submission.

Yours faithfully
Lyall & Associates Consulting Water Engineers

Scott Button
Principal

ANNEXURE A
ANNUAL RECORDED PEAK FLOW DATA
BOOK BOOK STREAM GAUGE

TABLE A1
ANNUAL RECORDED PEAK FLOW DATA IN DATE ORDER

Year	Discharge (m^3/s)	Rank
1985	8.4	22
1986	29.8	10
1987	17.8	18
1988	18.4	17
1989	21.9	13
1990	30.9	9
1991	19	16
1992	59.3	5
1993	40	8
1994	8.1	23
1995	47.7	6
1996	21.7	14
1997	11	20
1998	26.1	11
1999	19.4	15
2000	45.4	7
2001	1.1	32
2002	2.5	29
2003	9.5	21
2004	6.1	26
2005	79.8	3
2006	0	35
2007	3.7	28
2008	0.7	33
2009	4	27
2010	335.8	1
2011	14.2	19
2012	118	2
2013	7.5	24
2014	1.2	31
2015	7.1	25
2016	65.3	4
2017	2.3	30
2018	0.1	34
2019	0	35
2020	25.1	12

TABLE A2
ANNUAL RECORDED PEAK FLOW DATA IN ORDER OF MAGNITUDE

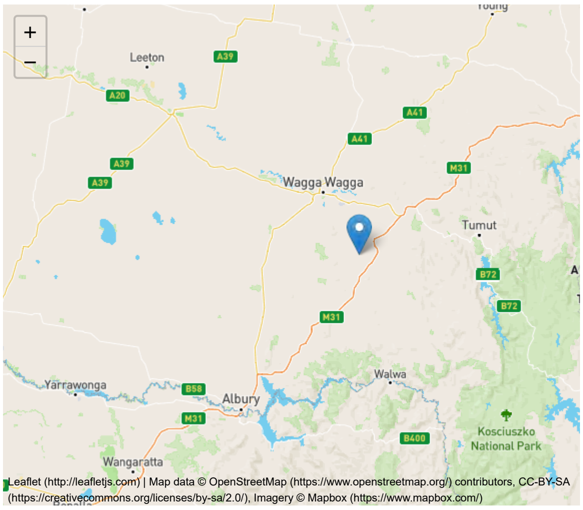
Year	Discharge (m^3/s)	Rank
2010	335.8	1
2012	118	2
2005	79.8	3
2016	65.3	4
1992	59.3	5
1995	47.7	6
2000	45.4	7
1993	40	8
1990	30.9	9
1986	29.8	10
1998	26.1	11
2020	25.1	12
1989	21.9	13
1996	21.7	14
1999	19.4	15
1991	19	16
1988	18.4	17
1987	17.8	18
2011	14.2	19
1997	11	20
2003	9.5	21
1985	8.4	22
1994	8.1	23
2013	7.5	24
2015	7.1	25
2004	6.1	26
2009	4	27
2007	3.7	28
2002	2.5	29
2017	2.3	30
2014	1.2	31
2001	1.1	32
2008	0.7	33
2018	0.1	34
2006	0	35
2019	0	35

ANNEXURE B
DESIGN INPUT DATA FROM ARR DATA HUB

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	147.561
Latitude	-35.394
Selected Regions (clear)	
River Region	show
ARF Parameters	show
Storm Losses	show
Temporal Patterns	show
Areal Temporal Patterns	show
BOM IFDs	show
Median Preburst Depths and Ratios	show
10% Preburst Depths	show
25% Preburst Depths	show
75% Preburst Depths	show
90% Preburst Depths	show
Interim Climate Change Factors	show
Probability Neutral Burst Initial Loss (./nsw_specific)	show



Leaflet (http://leafletjs.com) | Map data © OpenStreetMap (https://www.openstreetmap.org/) contributors, CC-BY-SA (https://creativecommons.org/licenses/by-sa/2.0/), Imagery © Mapbox (https://www.mapbox.com/)

Data

River Region

Division	Murray-Darling Basin
River Number	12
River Name	Murrumbidgee River

Layer Info

Time Accessed	19 February 2021 03:42PM
Version	2016_v1

ARF Parameters

$$ARF = Min\left\{1, \left[1 - a\left(Area^b - c\log_{10}Duration\right)Duration^{-d} + eArea^f Duration^g\left(0.3 + \log_{10}AEP\right) + h10^{iArea\frac{Duration}{1440}}\left(0.3 + \log_{10}AEP\right)\right]\right\}$$

Zone	a	b	c	d	e	f	g	h	i
Southern Temperate	0.158	0.276	0.372	0.315	0.000141	0.41	0.15	0.01	-0.0027

Layer Info

Time Accessed	19 February 2021 03:42PM
Version	2016_v1

Short Duration ARF

$$ARF = Min\left[1, 1 - 0.287\left(Area^{0.265} - 0.439\log_{10}(Duration)\right).Duration^{-0.36} + 2.26 \text{ x } 10^{-3} \text{ x } Area^{0.226}.Duration^{0.125}\left(0.3 + \log_{10}(AEP)\right) + 0.0141 \text{ x } Area^{0.213} \text{ x } 10^{-0.021\frac{(Duration-180)^2}{1440}}\left(0.3 + \log_{10}(AEP)\right)\right]$$

Storm Losses

Note: Burst Loss = Storm Loss - Preburst

Note: These losses are only for rural use and are **NOT FOR DIRECT USE** in urban areas

Note: As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub (./nsw_specific) is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. The continuing storm loss information from the ARR Datahub provided below should only be used where relevant under the loss hierarchy (level 5) and where used is to be multiplied by the factor of 0.4.

ID	25549.0
Storm Initial Losses (mm)	28.0
Storm Continuing Losses (mm/h)	4.4

Layer Info

Time Accessed	19 February 2021 03:42PM
Version	2016_v1

Temporal Patterns | Download (.zip) (static/temporal_patterns/TP/MB.zip)

code	MB
Label	Murray Basin

Layer Info

Time Accessed	19 February 2021 03:42PM
Version	2016_v2

Areal Temporal Patterns | Download (.zip) (./static/temporal_patterns/Areal/Areal_MB.zip)

code	MB
arealabel	Murray Basin

Layer Info

Time Accessed	19 February 2021 03:42PM
Version	2016_v2

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-35.39428&longitude=147.560855&sdmin=true to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	19 February 2021 03:42PM

Median Preburst Depths and Ratios

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	1.7 (0.088)	1.3 (0.047)	1.0 (0.030)	0.7 (0.018)	0.6 (0.013)	0.5 (0.010)
90 (1.5)	1.5 (0.067)	1.4 (0.045)	1.3 (0.035)	1.2 (0.029)	0.8 (0.015)	0.4 (0.007)
120 (2.0)	3.6 (0.143)	2.9 (0.088)	2.5 (0.064)	2.2 (0.047)	1.0 (0.018)	0.1 (0.001)
180 (3.0)	3.1 (0.112)	3.7 (0.098)	4.1 (0.091)	4.4 (0.086)	2.3 (0.038)	0.7 (0.010)
360 (6.0)	3.4 (0.098)	2.0 (0.042)	1.0 (0.019)	0.1 (0.002)	2.6 (0.035)	4.5 (0.054)
720 (12.0)	0.2 (0.004)	1.5 (0.027)	2.4 (0.036)	3.3 (0.042)	6.7 (0.073)	9.2 (0.090)
1080 (18.0)	0.0 (0.000)	0.4 (0.007)	0.7 (0.010)	1.0 (0.012)	4.0 (0.039)	6.2 (0.055)
1440 (24.0)	0.0 (0.000)	0.3 (0.004)	0.5 (0.006)	0.7 (0.007)	1.0 (0.009)	1.3 (0.010)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	19 February 2021 03:42PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

10% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
90 (1.5)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
120 (2.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
180 (3.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
360 (6.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
720 (12.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1080 (18.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	19 February 2021 03:42PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

25% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
90 (1.5)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
120 (2.0)	0.0 (0.001)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
180 (3.0)	0.1 (0.004)	0.1 (0.002)	0.0 (0.001)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
360 (6.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
720 (12.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1080 (18.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	19 February 2021 03:42PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

75% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	13.7 (0.691)	12.8 (0.476)	12.3 (0.384)	11.7 (0.317)	12.2 (0.278)	12.6 (0.255)
90 (1.5)	12.6 (0.558)	13.8 (0.449)	14.5 (0.400)	15.2 (0.363)	12.8 (0.258)	11.1 (0.198)
120 (2.0)	15.7 (0.632)	16.1 (0.480)	16.4 (0.413)	16.6 (0.363)	12.6 (0.231)	9.5 (0.156)
180 (3.0)	12.4 (0.440)	16.4 (0.433)	19.1 (0.427)	21.7 (0.420)	20.3 (0.332)	19.3 (0.281)
360 (6.0)	15.2 (0.436)	14.2 (0.303)	13.5 (0.245)	12.8 (0.202)	19.5 (0.260)	24.4 (0.291)
720 (12.0)	6.2 (0.144)	9.8 (0.170)	12.2 (0.180)	14.5 (0.186)	20.6 (0.225)	25.2 (0.247)
1080 (18.0)	2.2 (0.045)	5.6 (0.086)	7.8 (0.103)	10.0 (0.114)	15.1 (0.148)	18.9 (0.166)
1440 (24.0)	0.7 (0.013)	3.8 (0.054)	5.8 (0.071)	7.8 (0.083)	10.0 (0.091)	11.7 (0.096)
2160 (36.0)	0.0 (0.000)	1.9 (0.025)	3.2 (0.036)	4.4 (0.043)	4.4 (0.037)	4.4 (0.033)
2880 (48.0)	0.0 (0.000)	0.4 (0.004)	0.6 (0.006)	0.8 (0.008)	2.1 (0.016)	3.0 (0.021)
4320 (72.0)	0.0 (0.000)	0.1 (0.001)	0.1 (0.001)	0.2 (0.001)	0.2 (0.001)	0.2 (0.001)

Layer Info

Time Accessed	19 February 2021 03:42PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

90% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	26.5 (1.337)	24.8 (0.921)	23.7 (0.742)	22.6 (0.612)	23.3 (0.531)	23.8 (0.482)
90 (1.5)	30.4 (1.343)	32.0 (1.044)	33.1 (0.911)	34.1 (0.812)	31.4 (0.630)	29.3 (0.523)
120 (2.0)	37.8 (1.525)	36.5 (1.090)	35.7 (0.901)	34.9 (0.762)	36.5 (0.673)	37.7 (0.618)
180 (3.0)	29.0 (1.032)	31.6 (0.832)	33.2 (0.741)	34.8 (0.673)	39.3 (0.642)	42.6 (0.621)
360 (6.0)	33.9 (0.969)	32.7 (0.697)	31.9 (0.577)	31.1 (0.490)	45.2 (0.603)	55.8 (0.664)
720 (12.0)	18.4 (0.427)	26.7 (0.463)	32.1 (0.474)	37.4 (0.480)	43.2 (0.472)	47.5 (0.465)
1080 (18.0)	14.9 (0.307)	19.1 (0.296)	21.9 (0.289)	24.6 (0.283)	33.1 (0.324)	39.5 (0.346)
1440 (24.0)	10.1 (0.193)	15.0 (0.215)	18.2 (0.223)	21.3 (0.227)	23.8 (0.216)	25.7 (0.210)
2160 (36.0)	4.1 (0.071)	10.1 (0.132)	14.1 (0.156)	17.9 (0.173)	18.0 (0.149)	18.1 (0.135)
2880 (48.0)	1.6 (0.026)	5.8 (0.071)	8.6 (0.089)	11.2 (0.102)	19.4 (0.152)	25.6 (0.180)
4320 (72.0)	2.0 (0.030)	5.9 (0.066)	8.4 (0.081)	10.9 (0.092)	14.7 (0.107)	17.5 (0.115)

Layer Info

Time Accessed	19 February 2021 03:42PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

Interim Climate Change Factors

	RCP 4.5	RCP6	**RCP 8.5**
2030	**0.816 (4.1%)**	0.726 (3.6%)	**0.934 (4.7%)**
2040	**1.046 (5.2%)**	1.015 (5.1%)	**1.305 (6.6%)**
2050	**1.260 (6.3%)**	1.277 (6.4%)	**1.737 (8.8%)**
2060	**1.450 (7.3%)**	1.520 (7.7%)	**2.214 (11.4%)**
2070	**1.609 (8.2%)**	1.753 (8.9%)	**2.722 (14.2%)**
2080	**1.728 (8.8%)**	1.985 (10.2%)	**3.246 (17.2%)**
2090	**1.798 (9.2%)**	2.226 (11.5%)	**3.772 (20.2%)**

Layer Info

Time Accessed	19 February 2021 03:42PM
Version	2019_v1
Note	ARR recommends the use of RCP4.5 and RCP 8.5 values. These have been updated to the values that can be found on the climate change in Australia website.

Probability Neutral Burst Initial Loss

min (h)\AEP(%)	50.0	20.0	10.0	5.0	2.0	1.0
60 (1.0)	19.8	11.7	10.9	11.7	11.7	11.2
90 (1.5)	20.4	11.6	10.9	11.3	11.6	10.3
120 (2.0)	18.9	11.4	10.5	11.2	10.9	10.0
180 (3.0)	19.5	12.5	11.0	11.4	10.3	8.4
360 (6.0)	19.0	13.6	13.0	14.2	12.3	7.9
720 (12.0)	22.8	16.9	15.3	15.2	12.2	7.4
1080 (18.0)	24.3	19.0	18.4	18.4	14.6	9.4
1440 (24.0)	25.7	20.4	20.0	20.0	17.8	12.5
2160 (36.0)	27.1	22.3	22.2	22.5	20.4	17.0
2880 (48.0)	28.0	23.4	23.6	24.4	21.5	16.5
4320 (72.0)	28.3	23.7	24.2	25.1	22.9	18.1

Layer Info

Time Accessed	19 February 2021 03:42PM
Version	2018_v1
Note	As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub (./nsw_specific) is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. Probability neutral burst initial loss values for NSW are to be used in place of the standard initial loss and pre-burst as per the losses hierarchy.

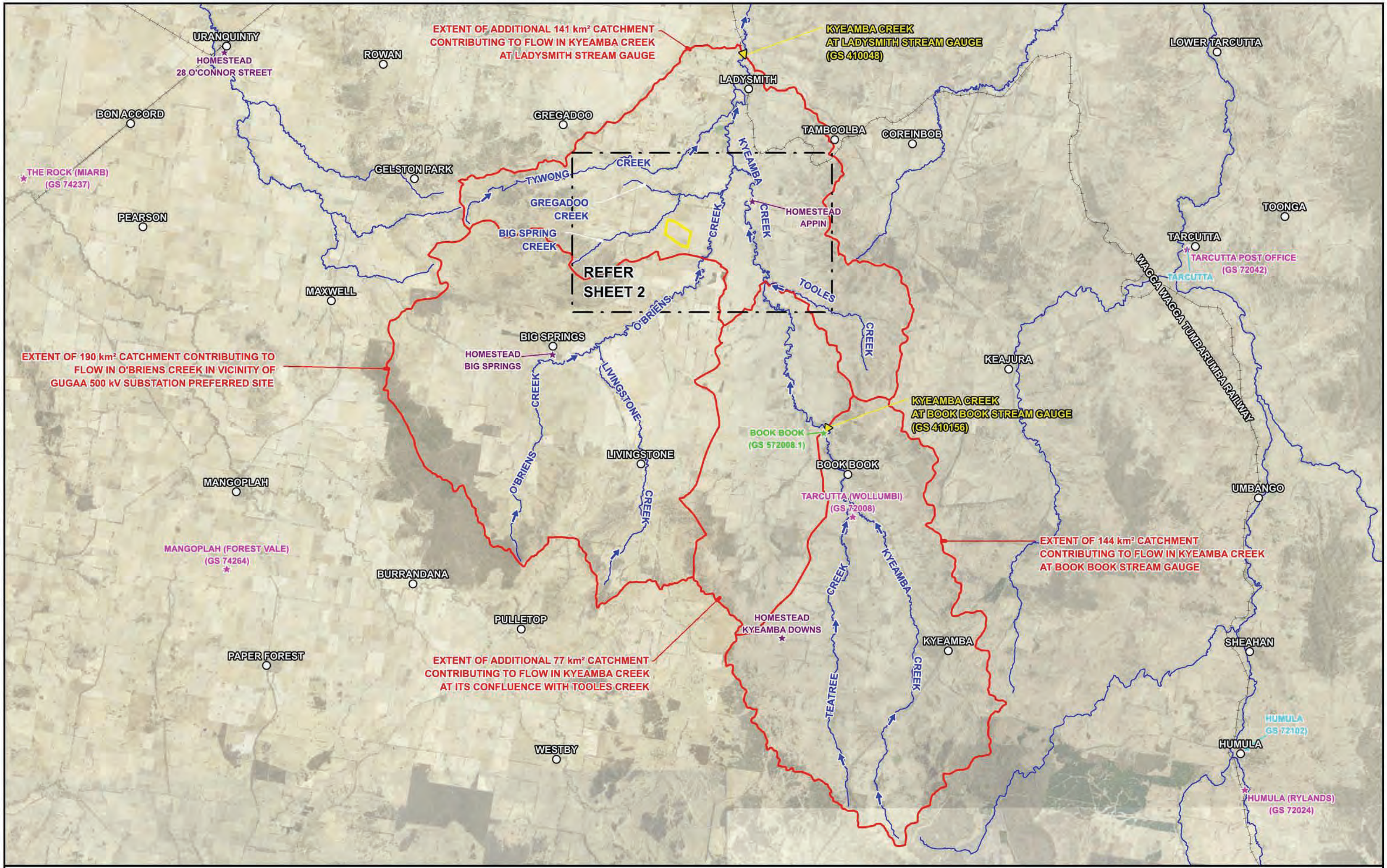
Download TXT (downloads/17c538fb-1095-4ff9-9e17-89e69f6fade6.txt)

Download JSON (downloads/d28c62ca-396d-4536-9389-71a931b3e365.json)

Generating PDF... (downloads/b9d96754-90b3-4600-866b-652b909fbb98.pdf)

FIGURES

LIST OF FIGURES



N

1.6 0 1.6 3.2 4.8 km

Scale: 1:160,000

LEGEND

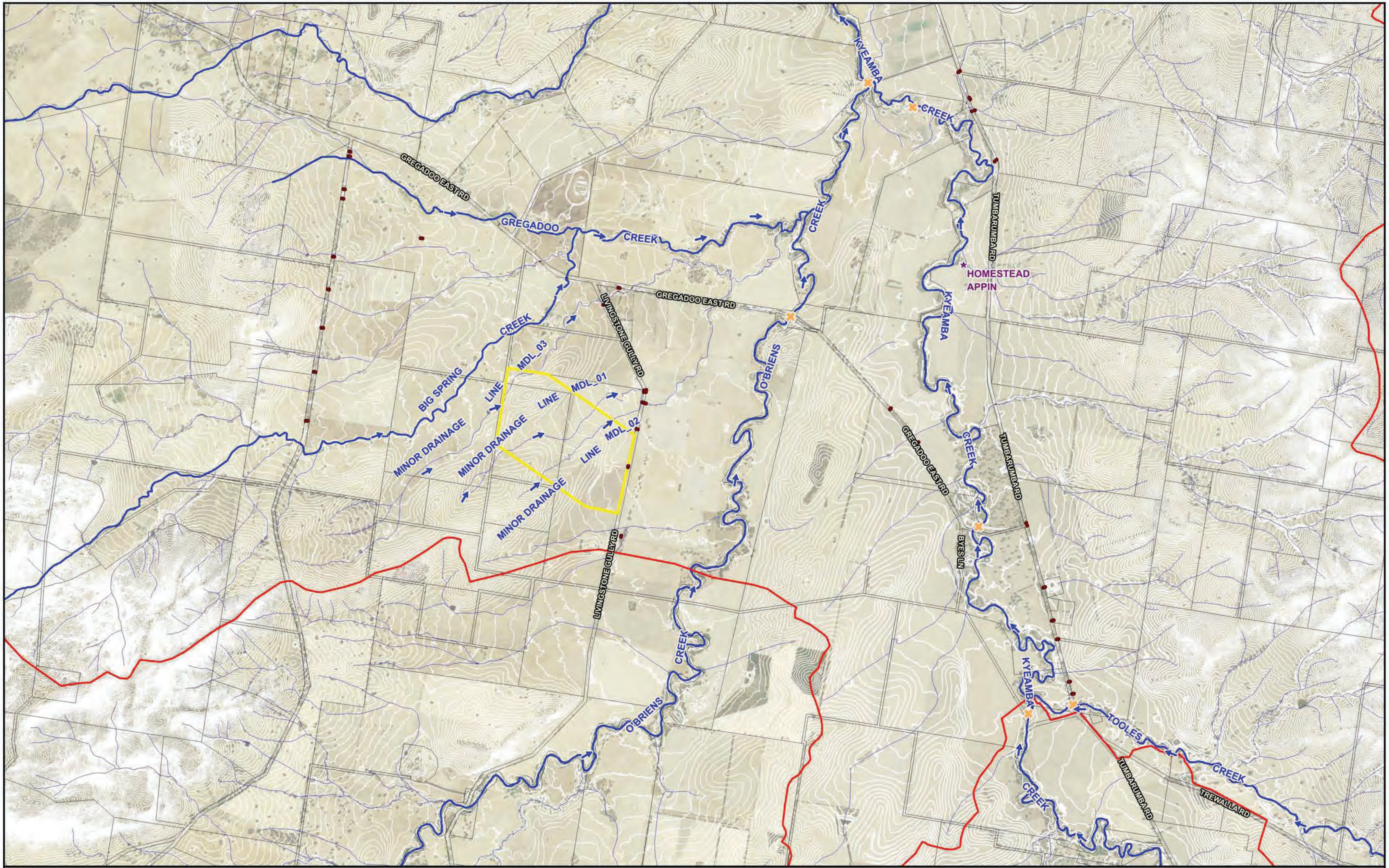
★ BoM Daily Rainfall Station	Catchment Boundary
★ BoM Flood Warning Station	▽ Stream Gauge
★ BoM Pluviograph	Site Boundary
★ SES FIR Location	

Lyall & Associates

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 1
(Sheet 1 of 2)

LOCATION AND CATCHMENT PLAN



N

300 0 300 600 900 m

Scale: 1:30,000

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LEGEND

★ SES FIR Location

✖ Bridge

●—● Existing Piped Drainage System

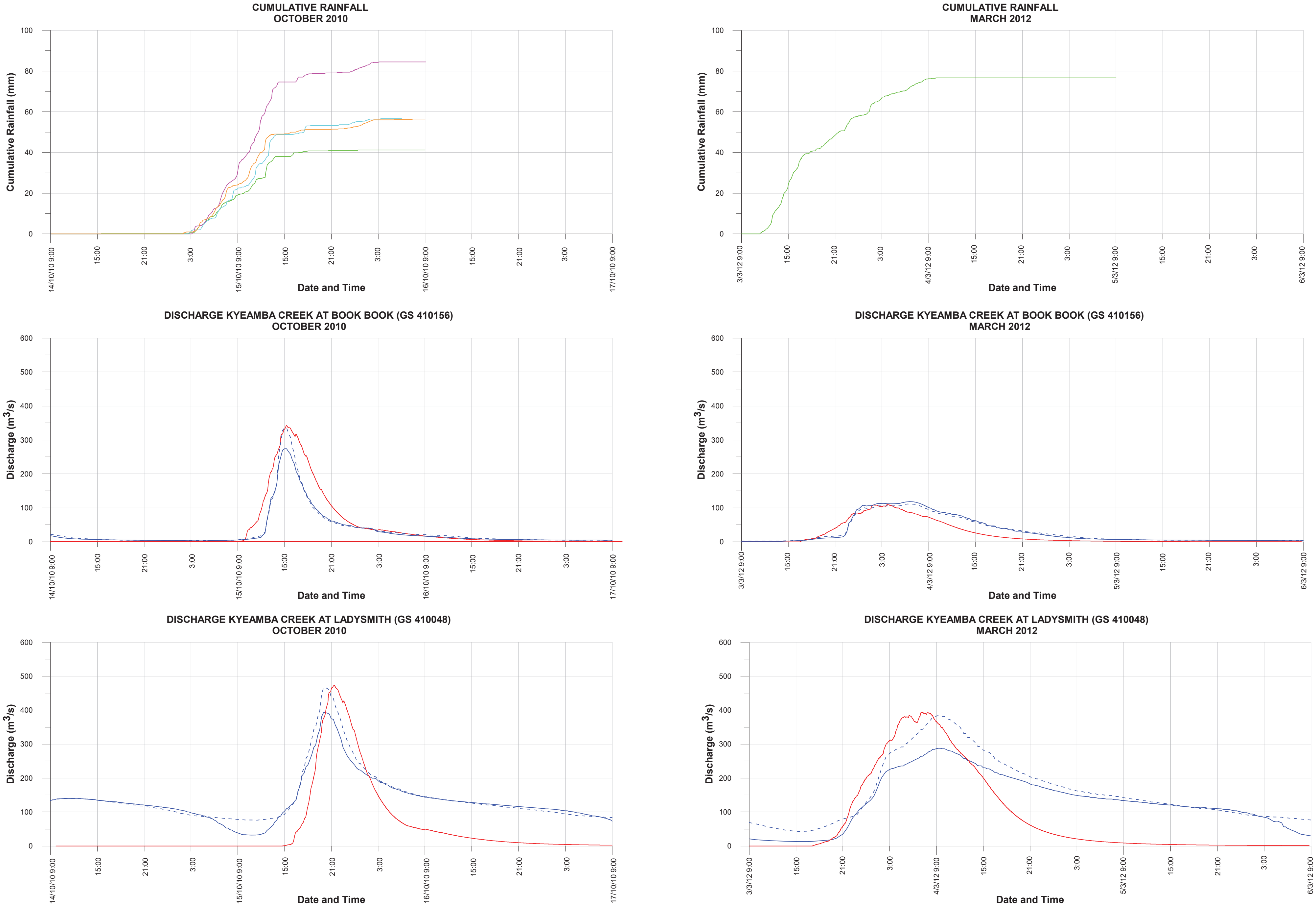
— Catchment Boundary

▬ Site Boundary

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 1
(Sheet 2 of 2)

LOCATION AND CATCHMENT PLAN



RAIN GAUGE DATA

Wagga Wagga AWS (GS 72150)

Humula (RMS)

Tarcutta (RMS)

Adelong (Ethan Park) (GS72159)

STREAM GAUGE DATA

Modelled

Recorded (LA Derived Rating Curve)

Recorded (WaterNSW Derived Rating Curve)

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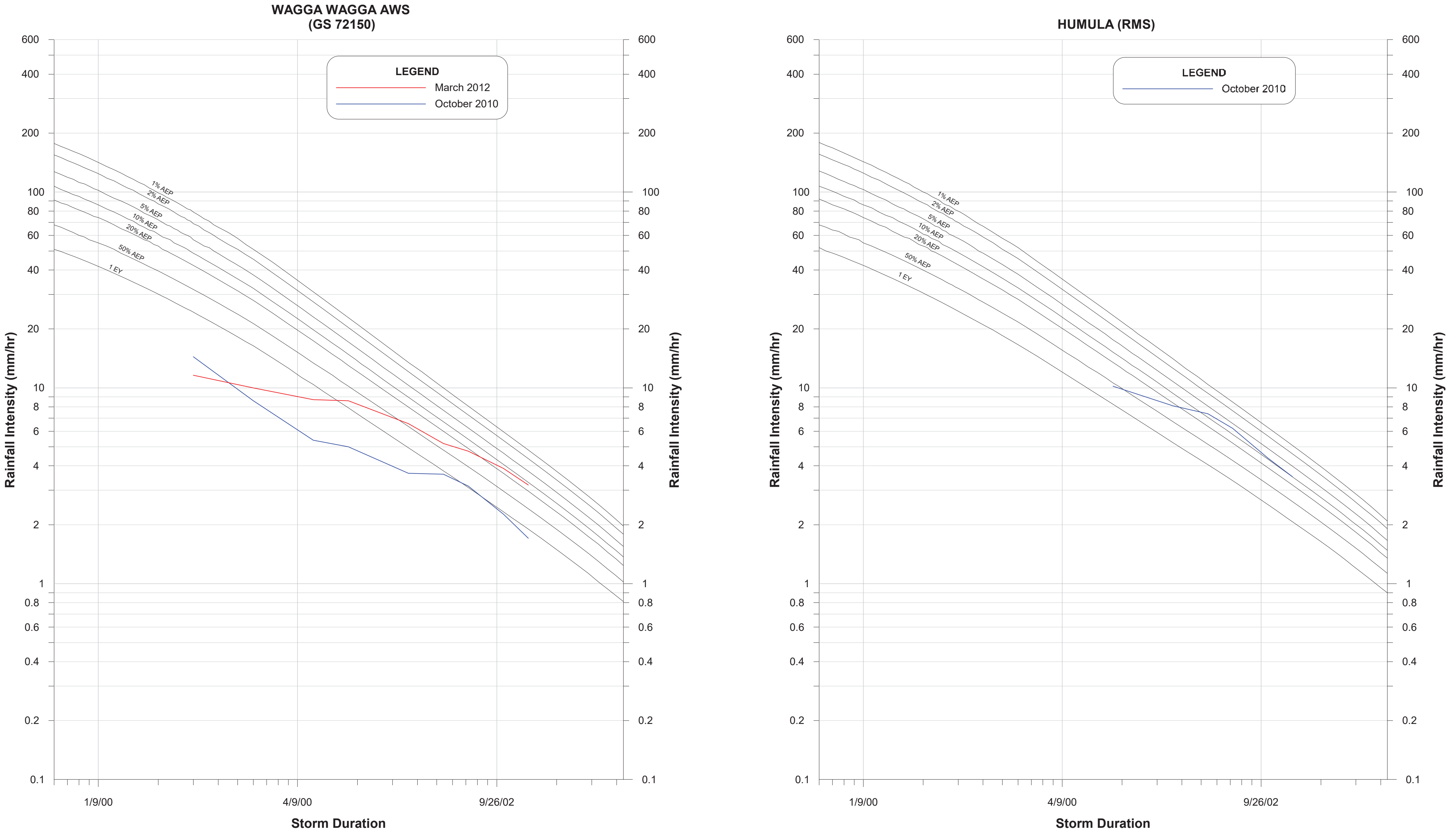
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 2

CUMULATIVE RAINFALL AND DISCHARGE HYDROGRAPHS FOR HISTORIC STORM EVENTS



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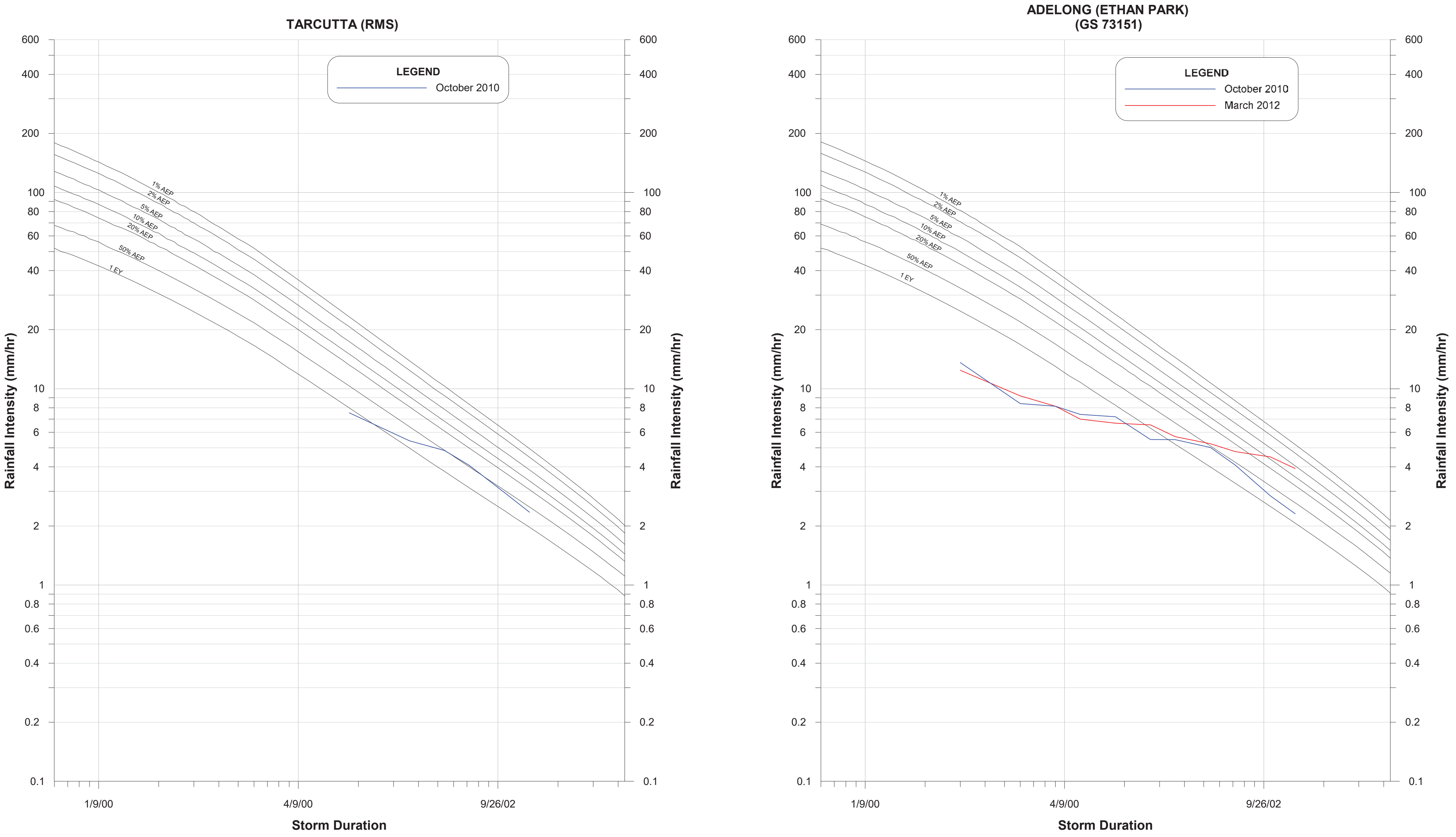
GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 3
(Sheet 1 of 2)

INTENSITY-FREQUENCY-DURATION CURVES
AND HISTORIC STORM EVENTS



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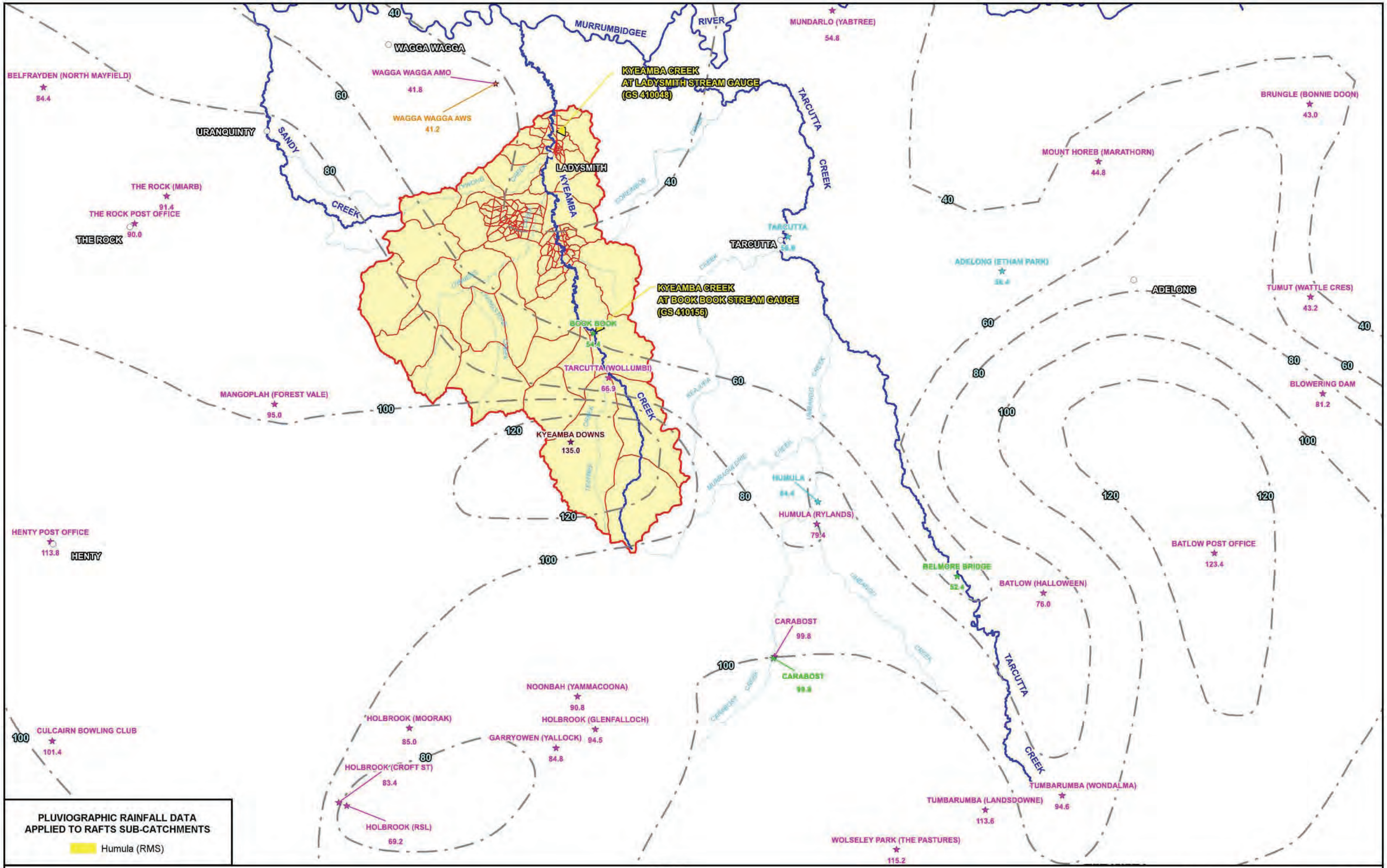
GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 3
(Sheet 2 of 2)

INTENSITY-FREQUENCY-DURATION CURVES
AND HISTORIC STORM EVENTS



PLUVIOGRAPHIC RAINFALL DATA APPLIED TO RAFTS SUB-CATCHMENTS

🟨 Humula (RMS)

N

3 0 3 6 9 km

Scale: 1:300,000

LEGEND

- ★ BoM Daily Rainfall Station and Recorded Depth (mm)
- ★ BoM All Weather Station (AWS) and Recorded Depth (mm)
- ★ BoM Pluviograph and Recorded Depth (mm)
- ★ BoM Flood Warning Station and Recorded Depth (mm)
- ★ SES FIR Location and Recorded Depth (mm)
- 120 48 Hour Depth of Rainfall (mm)
- Study Catchment
- Sub-Catchment Boundary
- ▼ Stream Gauge

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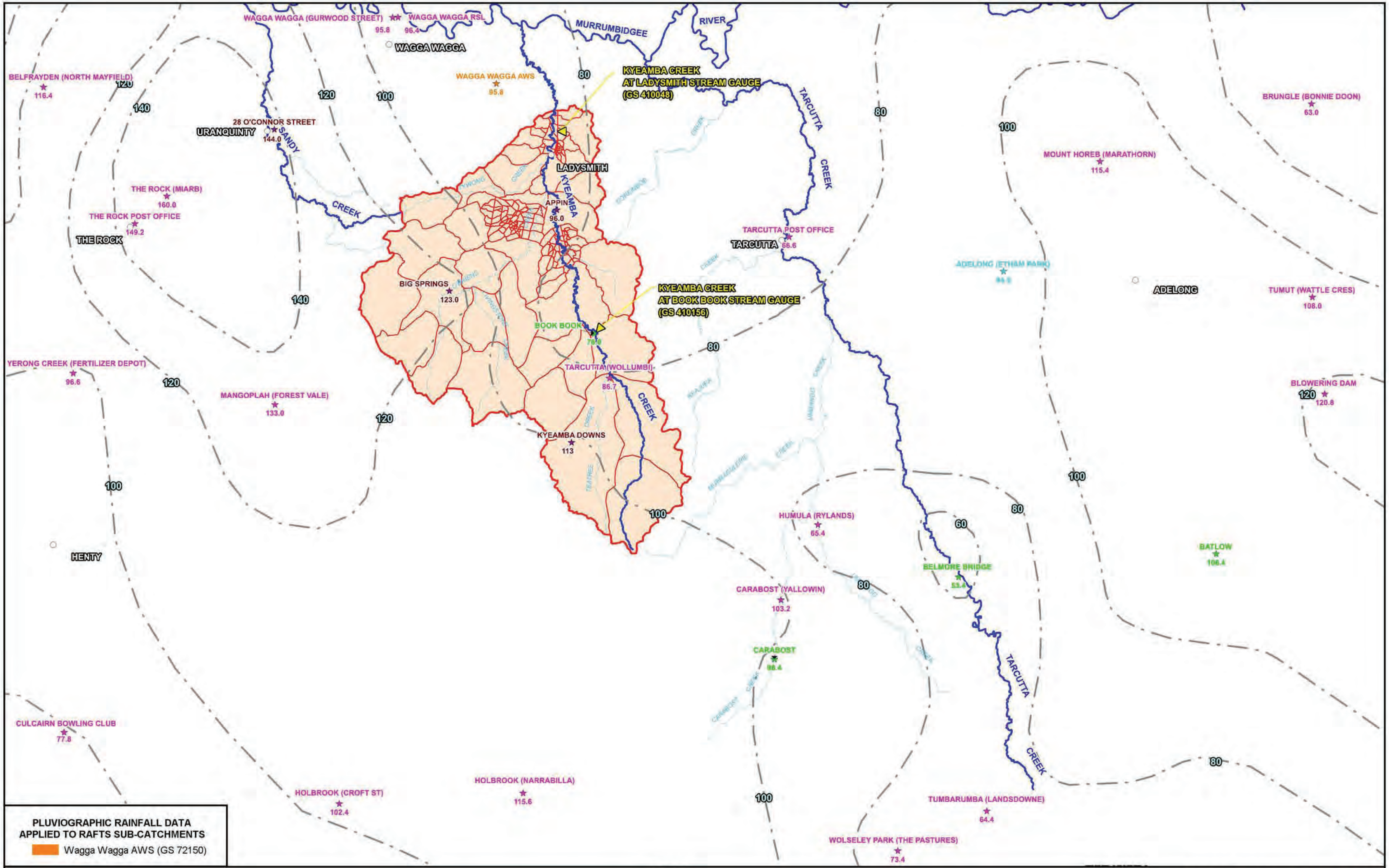
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 4

ISOHYETAL MAP
RAIN DAYS OF 15-16 OCTOBER 2010



PLUVIOGRAPHIC RAINFALL DATA APPLIED TO RAFTS SUB-CATCHMENTS

🟧 Wagga Wagga AWS (GS 72150)

N 3 0 3 6 9 km

Scale: 1:300,000

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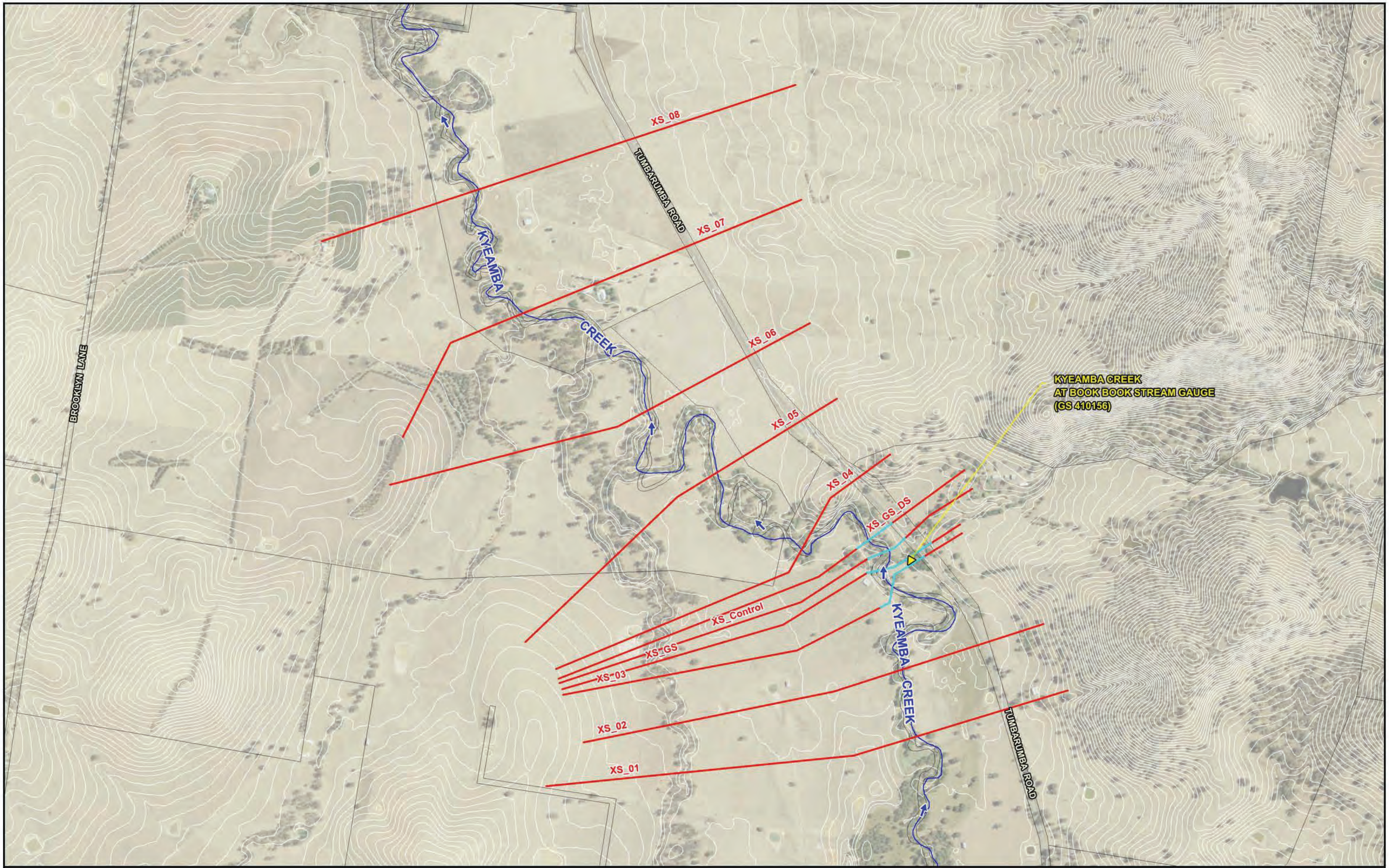
LEGEND

★	BoM Daily Rainfall Station and Recorded Depth (mm)
★	BoM All Weather Station (AWS) and Recorded Depth (mm)
★	BoM Pluviograph and Recorded Depth (mm)
★	BoM Flood Warning Station and Recorded Depth (mm)
★	SES FIR Location of Reported Depth (mm)
—120—	48 Hour Depth of Rainfall (mm)
—	Study Catchment
—	Sub-Catchment Boundary
▼	Stream Gauge

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 5

ISOHYETAL MAP
RAIN DAYS OF 4-5 MARCH 2012



LEGEND

🟥	Photogrammetry Derived Cross-Section
🟦	WaterNSW Derived Portion of Cross-Section Modelled
XS_01	HECRAS Cross-Section Identifier

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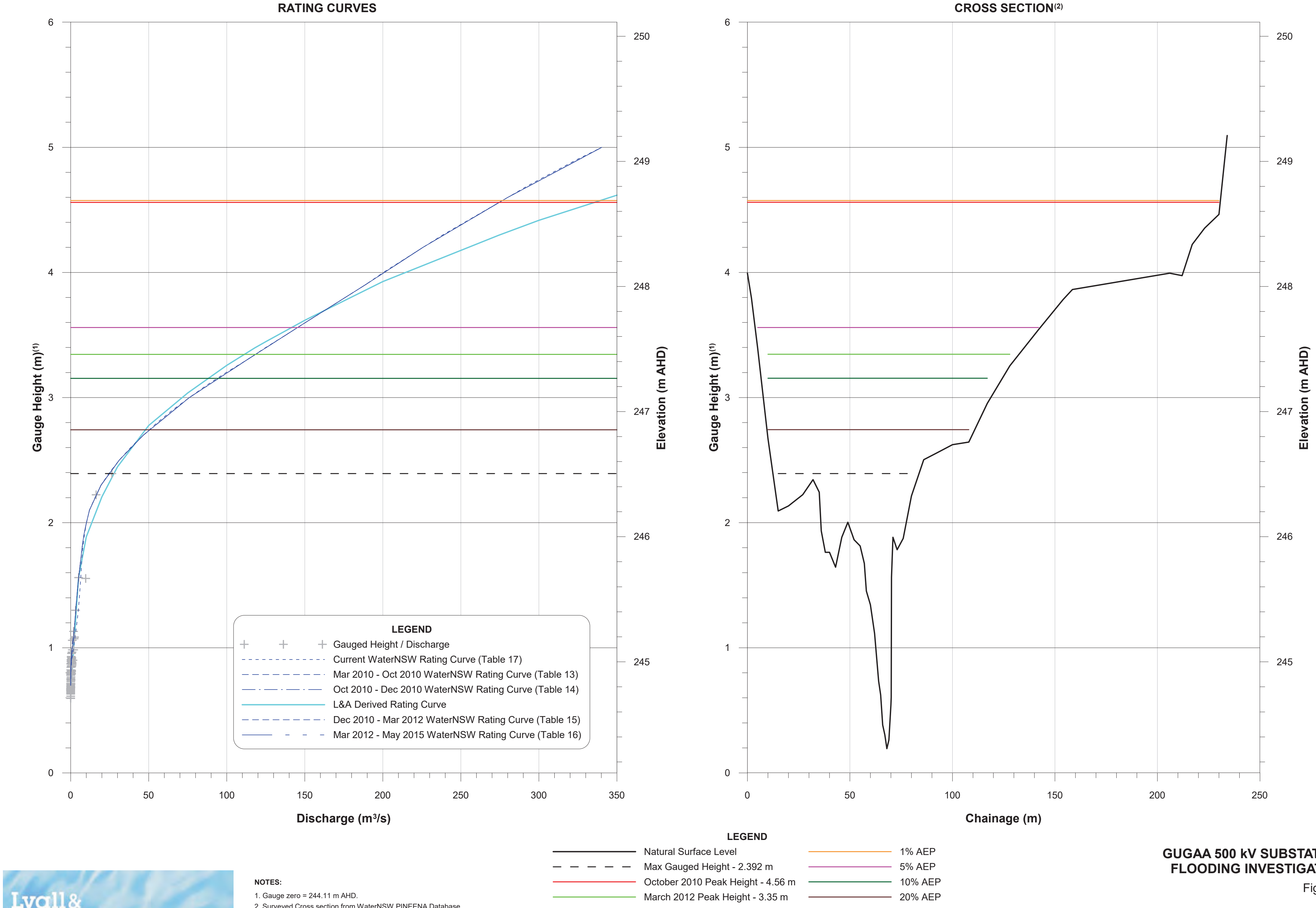
GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 6

BOOK BOOK HEC-RAS MODEL LAYOUT



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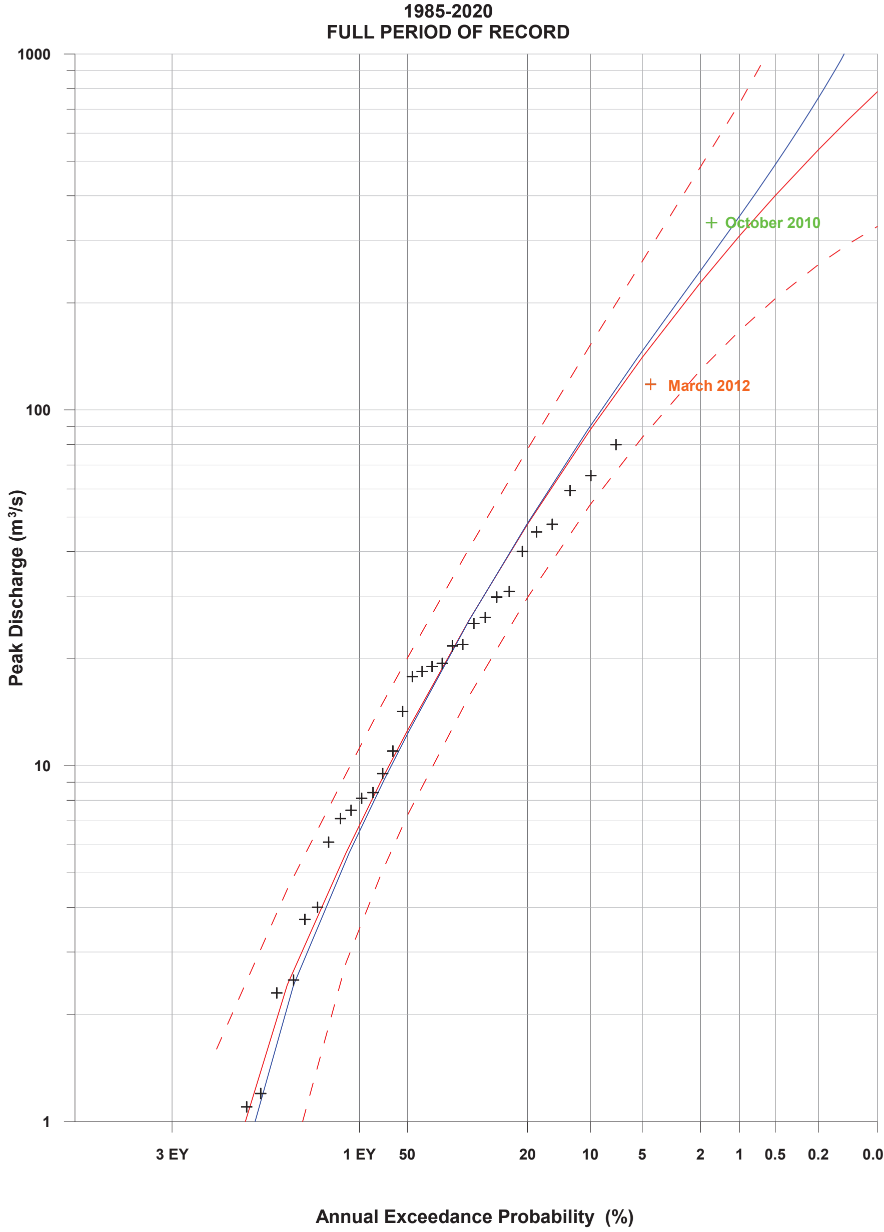
NOTES:

1. Gauge zero = 244.11 m AHD.
2. Surveyed Cross section from WaterNSW PINEENA Database.
3. Design Flood Levels derived from L&A Derived Rating Curve

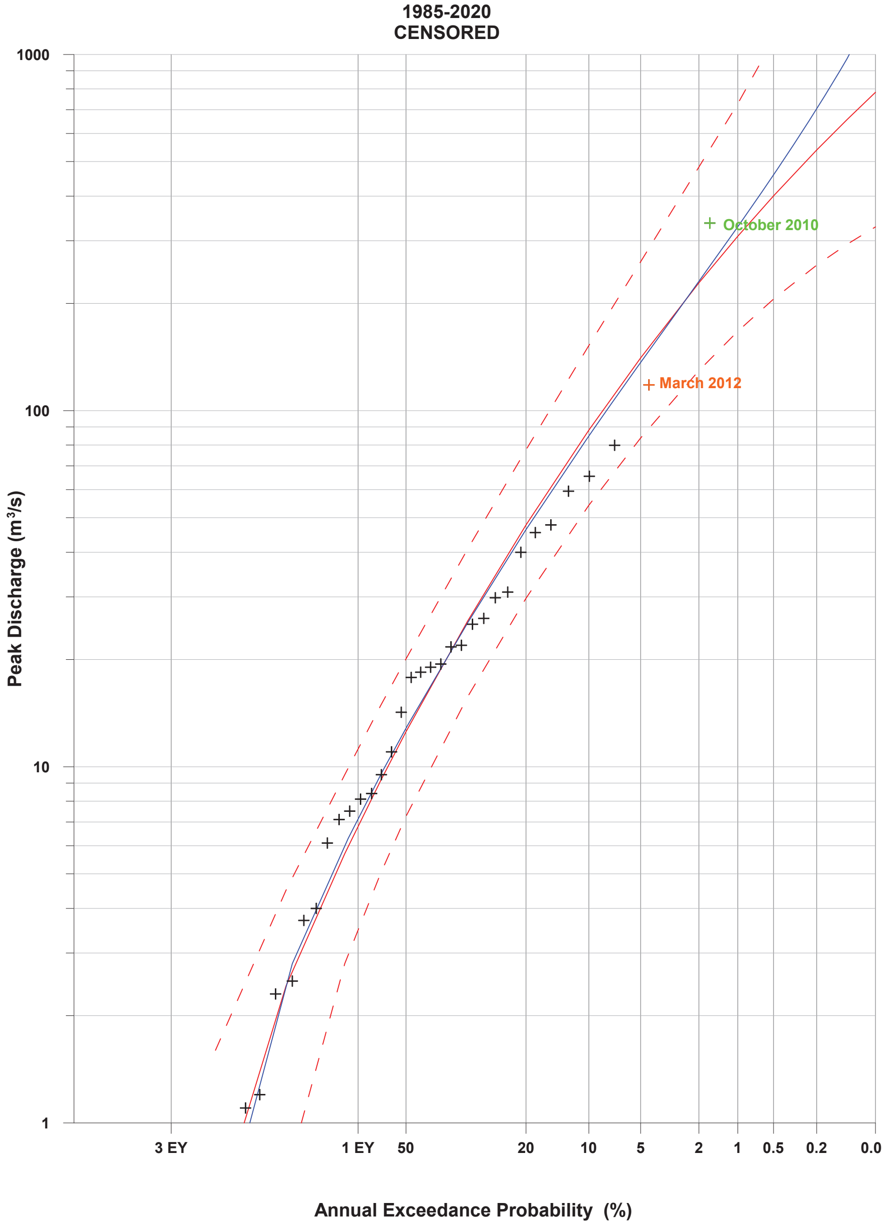
GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 7

RATING CURVES AND CROSS SECTION
KYEAMBA CREEK AT BOOK BOOK STREAM GAUGE (GS 410156)



1985-2020
FULL PERIOD OF RECORD



1985-2020
CENSORED

LEGEND

Expected Probability Adjustment	───
Recorded Annual Maximum Discharge	+
Log-Pearson III 95% Confidence Limits	— — —
Log-Pearson III Fit	───
Log-Pearson III 5% Confidence Limits	— — —

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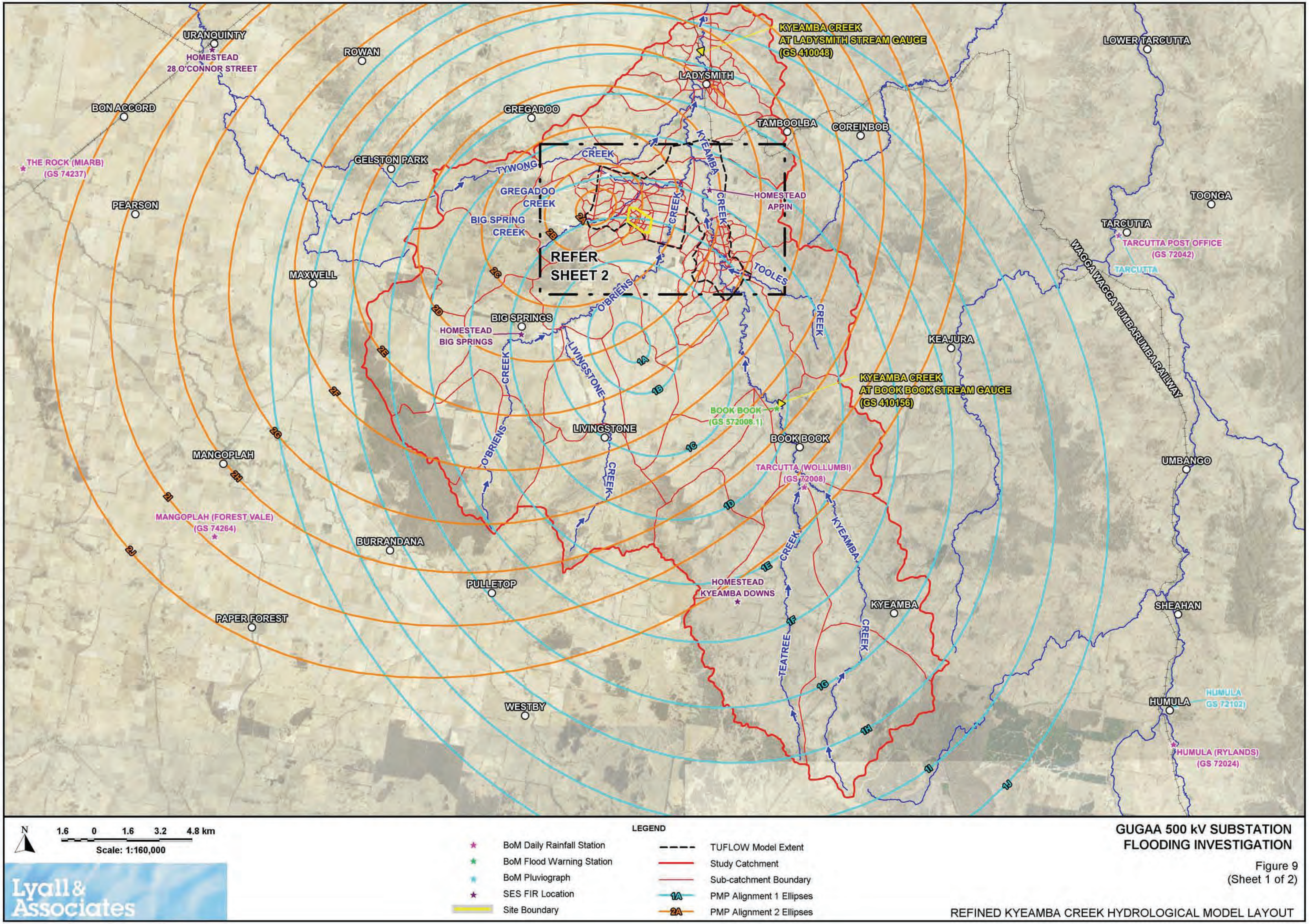
GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 8

FLOOD FREQUENCY RELATIONSHIP
LOG-PEARSON 3 ANNUAL SERIES 1985-2020
KYEAMBA CREEK AT BOOK BOOK STREAM GAUGE (GS 410156)



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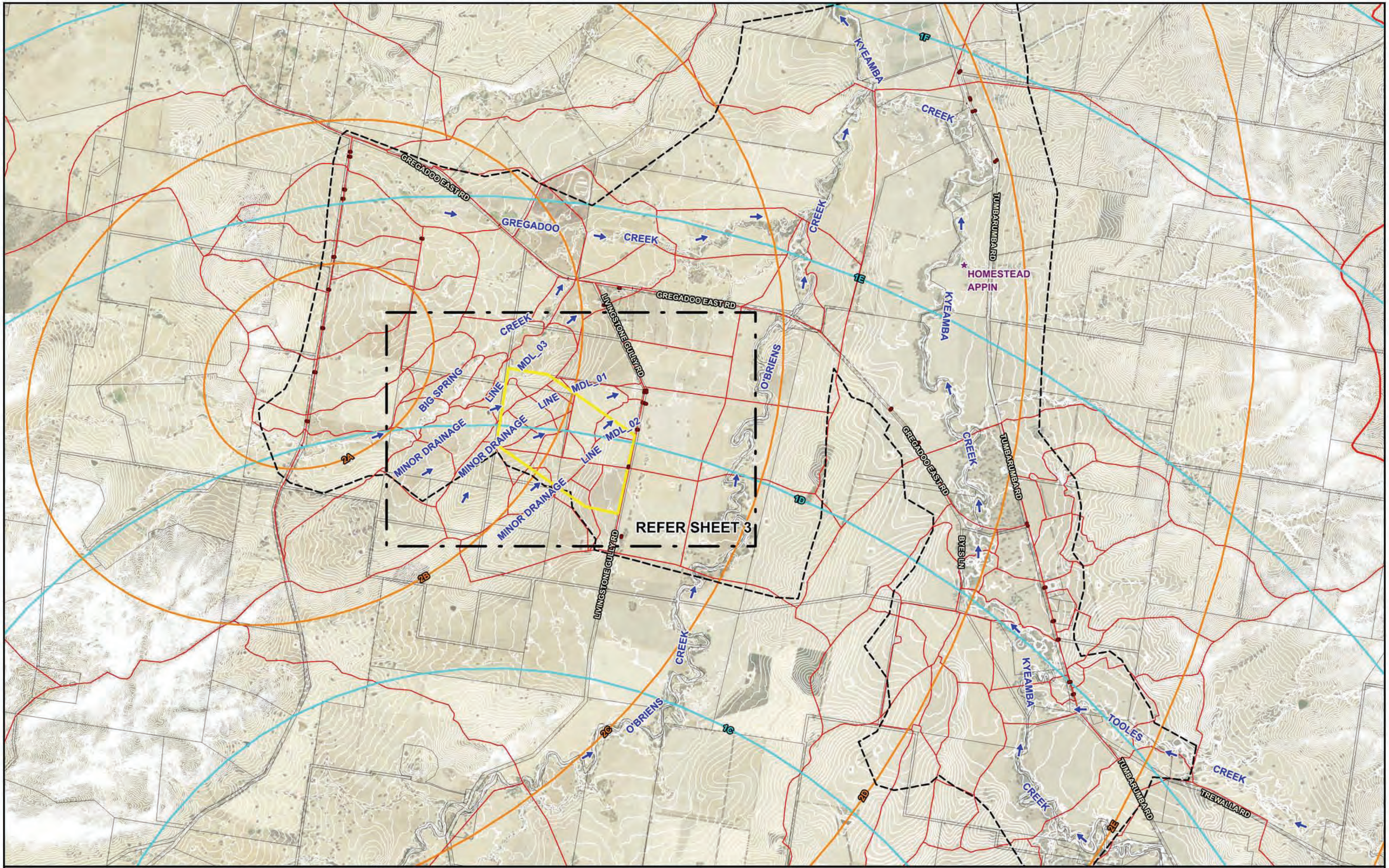
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 9
(Sheet 1 of 2)

REFINED KYEAMBA CREEK HYDROLOGICAL MODEL LAYOUT



N

300 0 300 600 900 m

Scale: 1:30,000

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LEGEND

★ SES FIR Location

Site Boundary

1A PMP Alignment 1 Ellipses

2A PMP Alignment 2 Ellipses

TUFLOW Model Extent

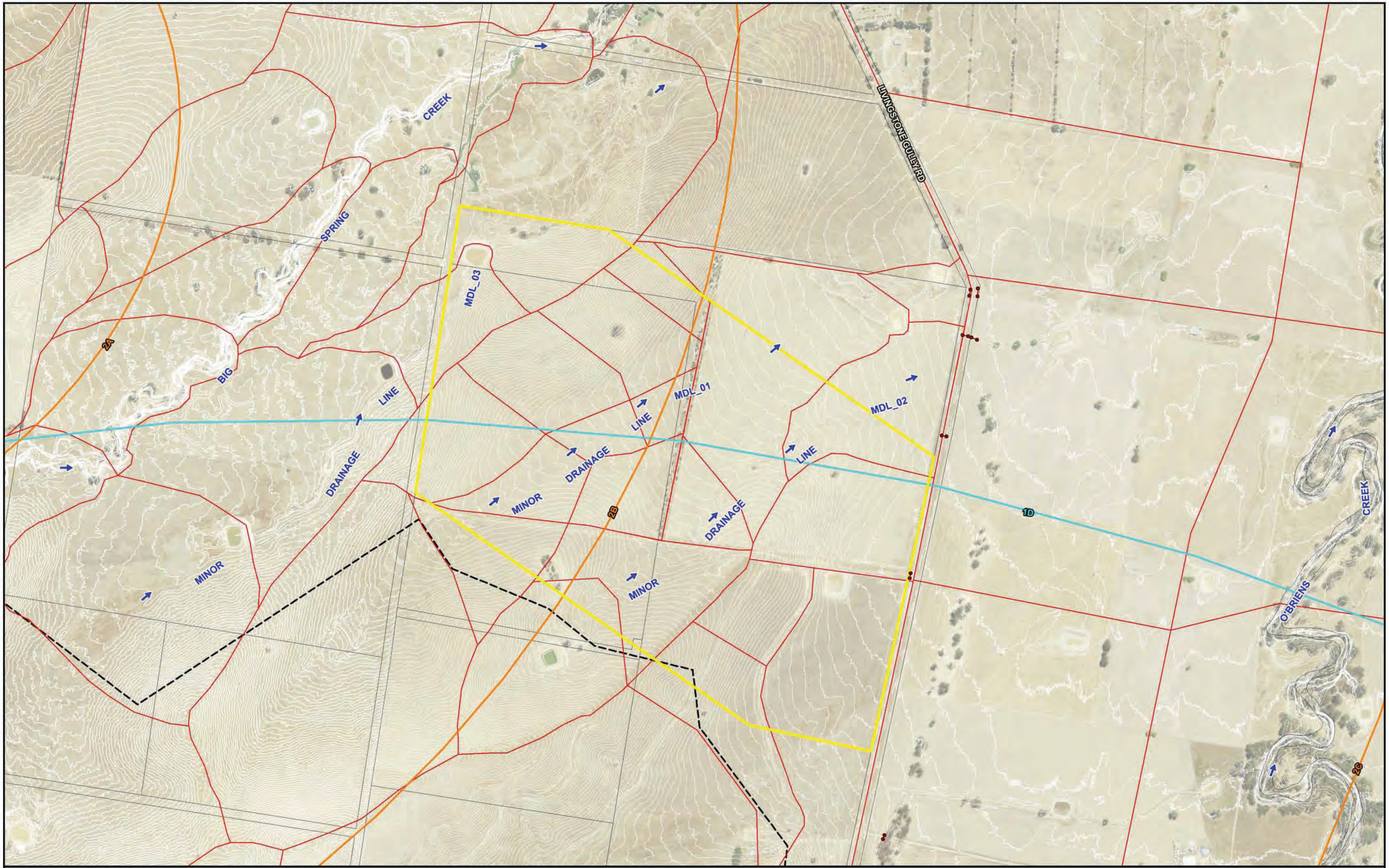
Study Catchment

Sub-catchment Boundary

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 9
(Sheet 2 of 3)

REFINED KYEAMBA CREEK HYDROLOGICAL MODEL LAYOUT



N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

- Sub-catchment Boundary
- Site Boundary
- 1A PMP Alignment 1 Ellipses
- 2A PMP Alignment 2 Ellipses
- Existing Piped Drainage System
- TUFLOW Model Extent

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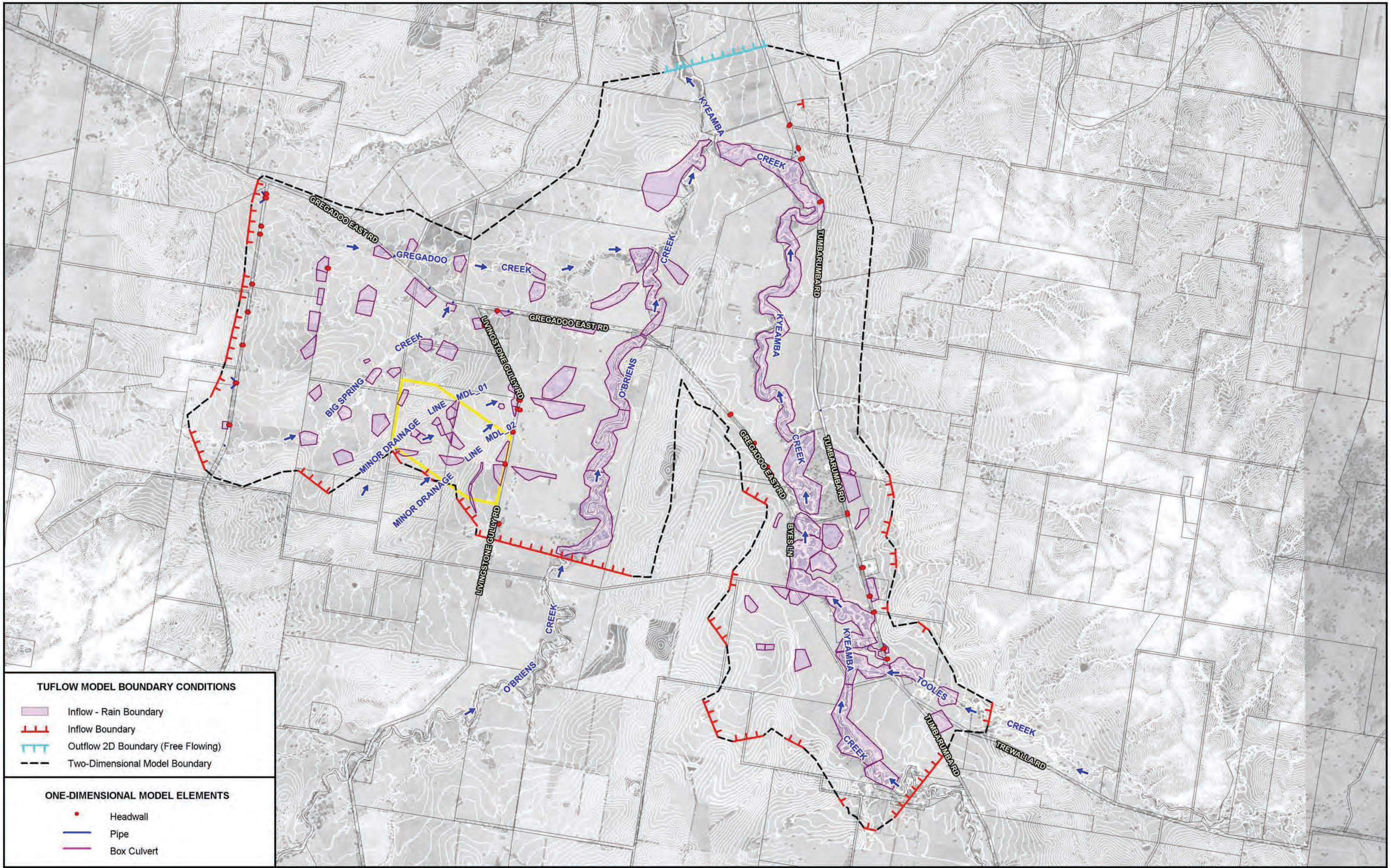
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 9
(Sheet 3 of 3)

REFINED KYEAMBA CREEK HYDROLOGICAL MODEL LAYOUT



Scale: 1:35,000

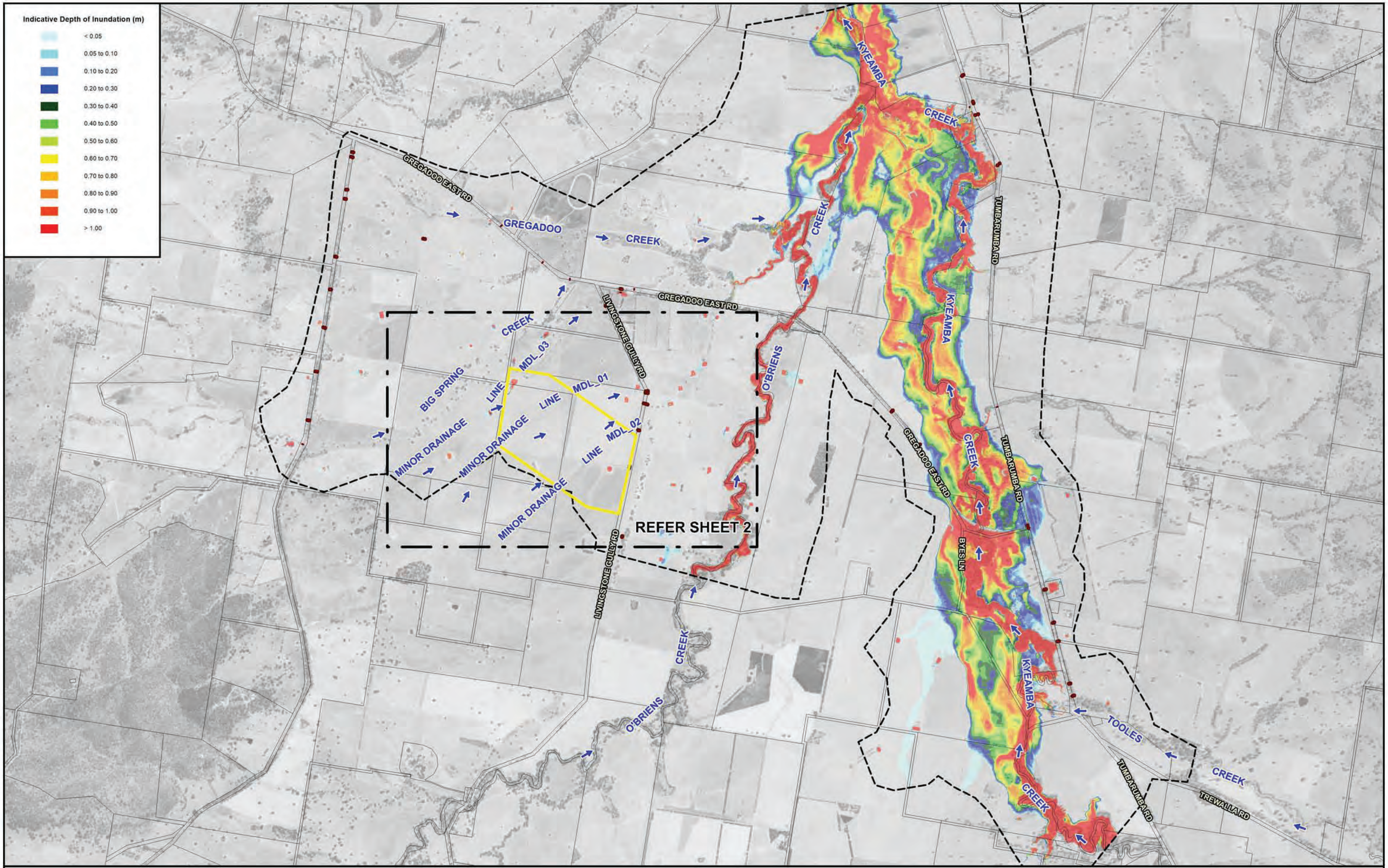
LEGEND

🟨 Site Boundary

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 10

KYEAMBA CREEK TUFLOW MODEL LAYOUT



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

Modelled Stormwater Drainage Network

TUFLOW Model Extent

Site Boundary

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GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 11
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
OCTOBER 2010 FLOOD EVENT

N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent
🟨	Site Boundary
219	Water Surface Elevation Contours (m AHD)

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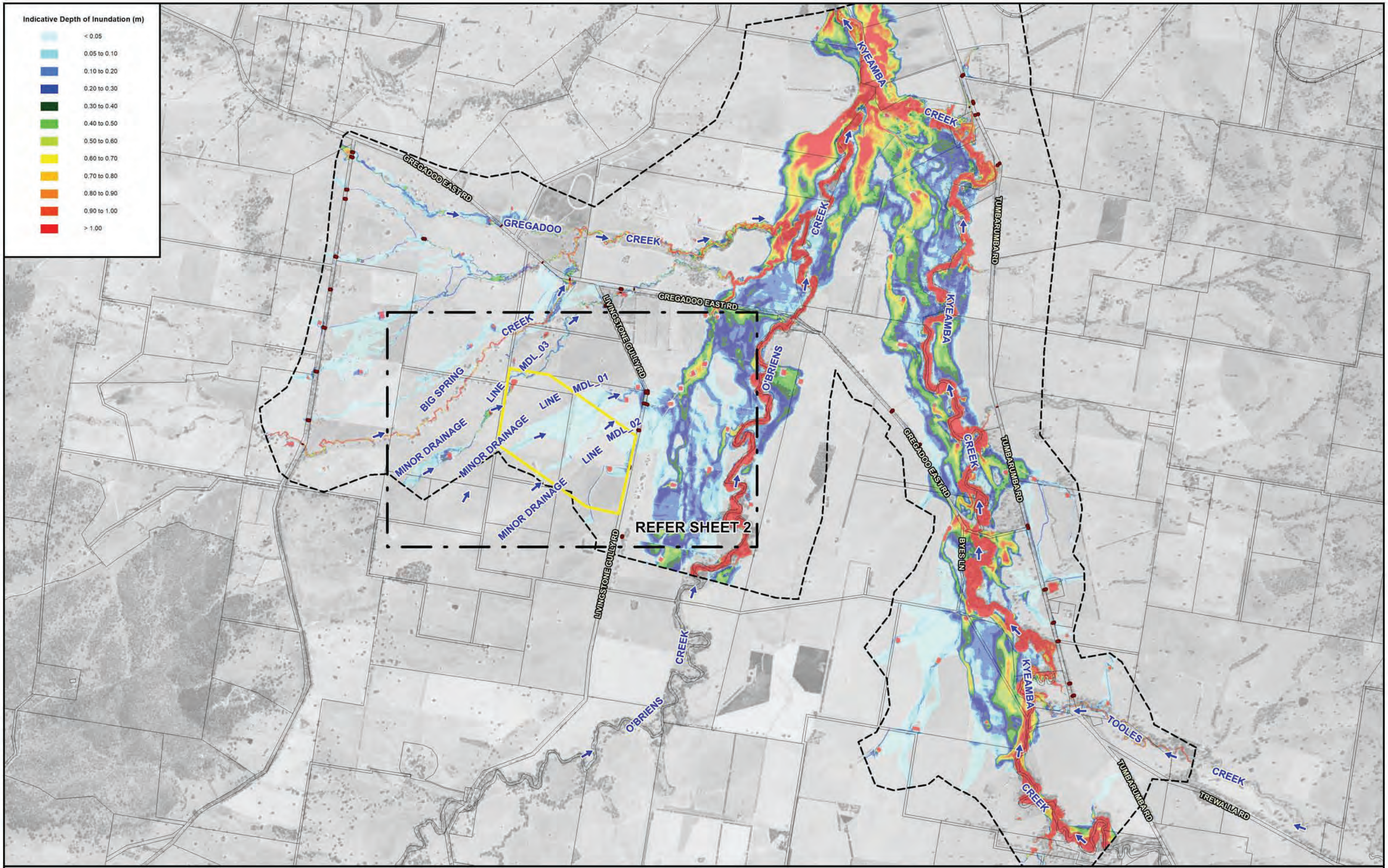
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 11
(Sheet 2 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
OCTOBER 2010 FLOOD EVENT



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

Modelled Stormwater Drainage Network

TUFLOW Model Extent

Site Boundary

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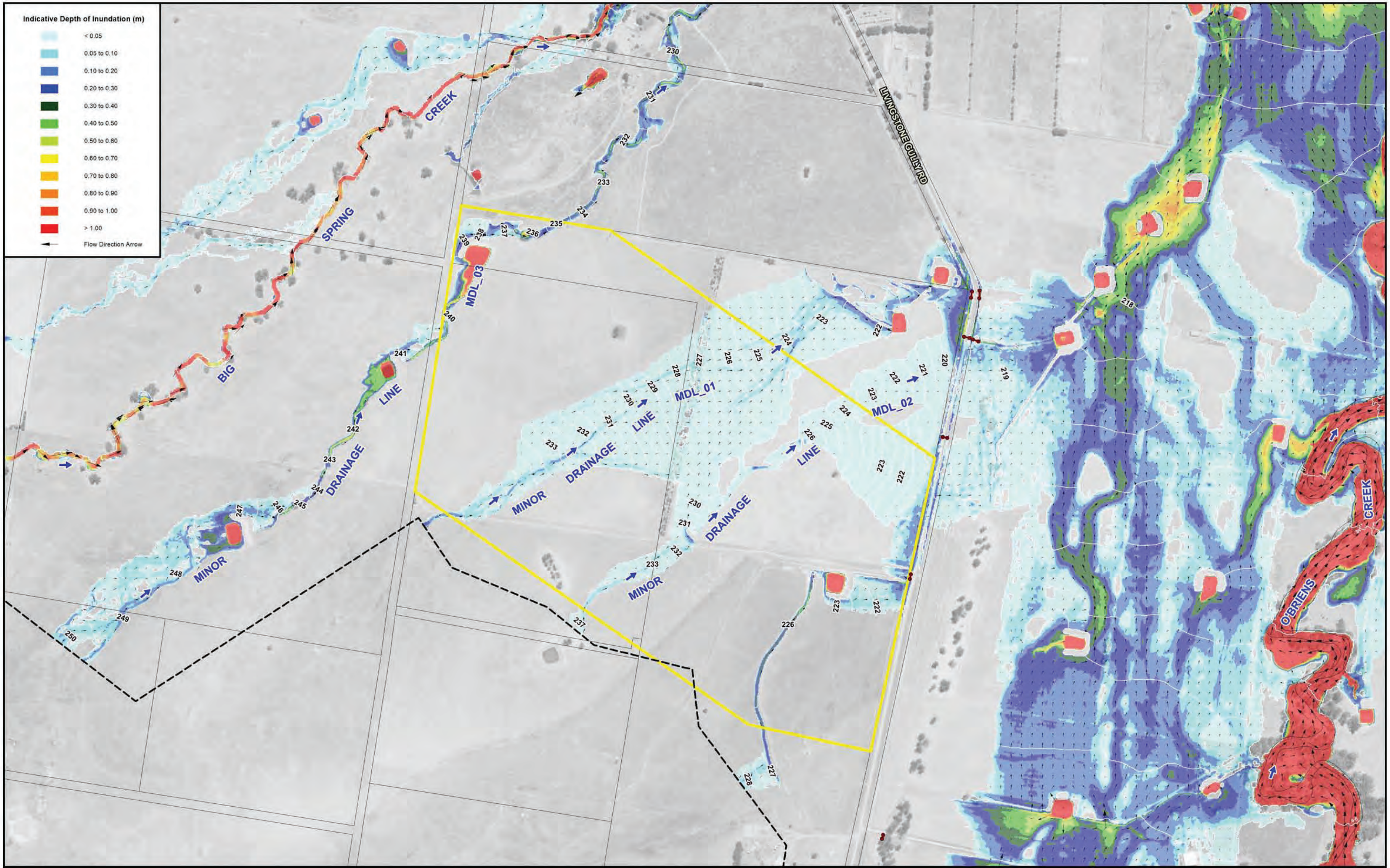
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 12
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
MARCH 2012 FLOOD EVENT



N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent
🟨	Site Boundary
217	Water Surface Elevation Contours (m AHD)

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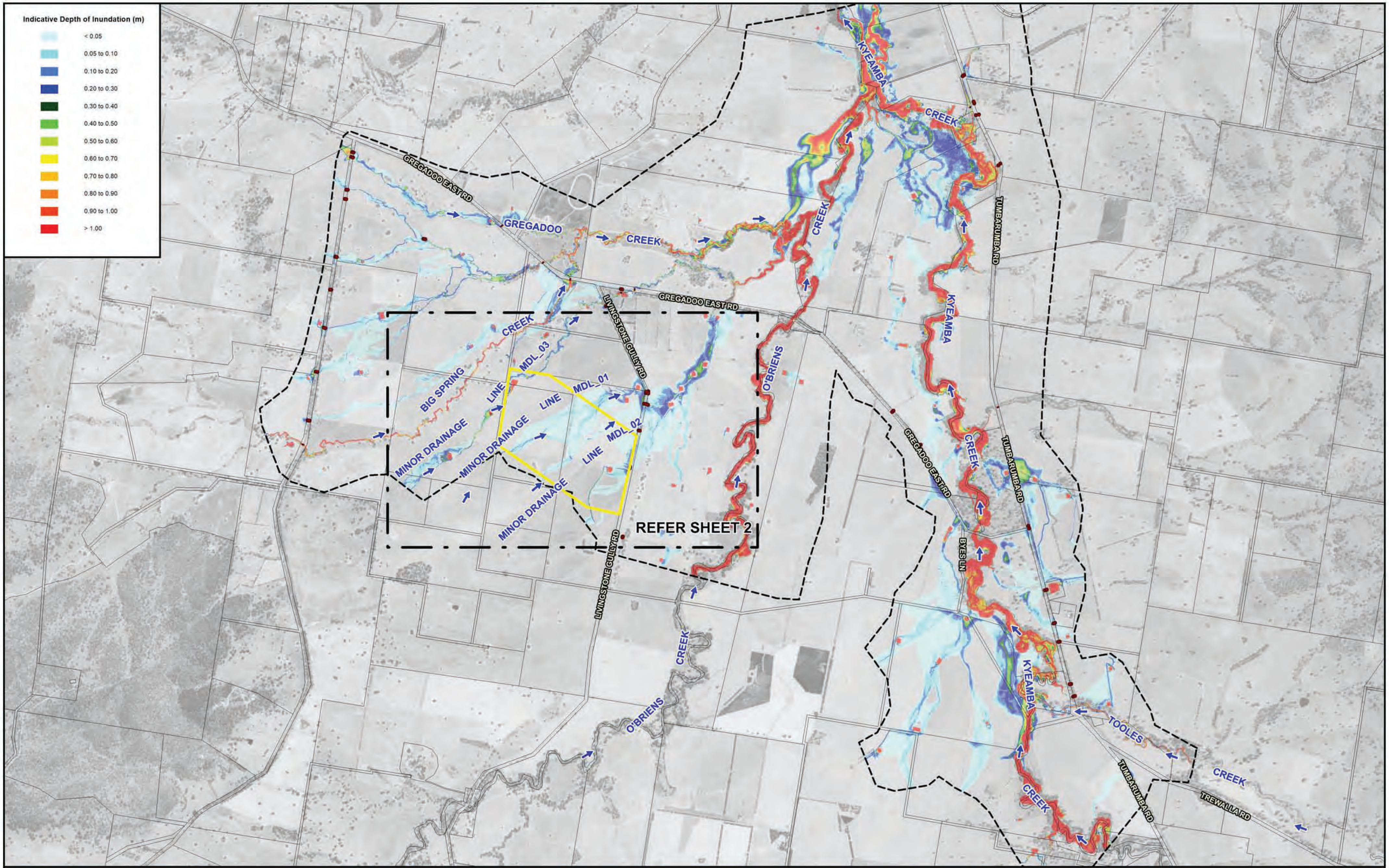
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 12
(Sheet 2 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
MARCH 2012 FLOOD EVENT



Scale: 1:30,000

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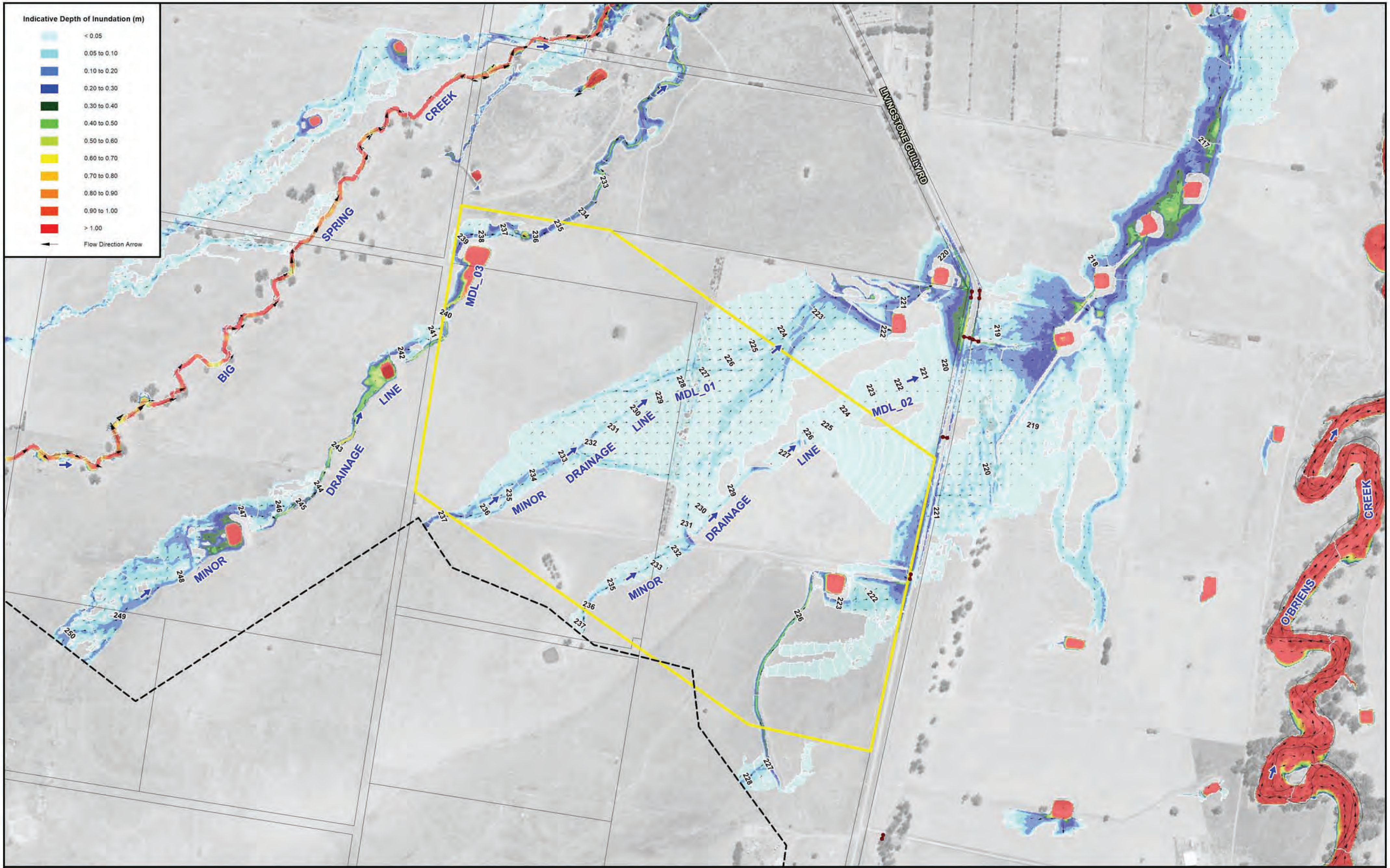
LEGEND

- Modelled Stormwater Drainage Network
- TUFLOW Model Extent
- Site Boundary

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 13
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
PRESENT DAY CONDITIONS - 20% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

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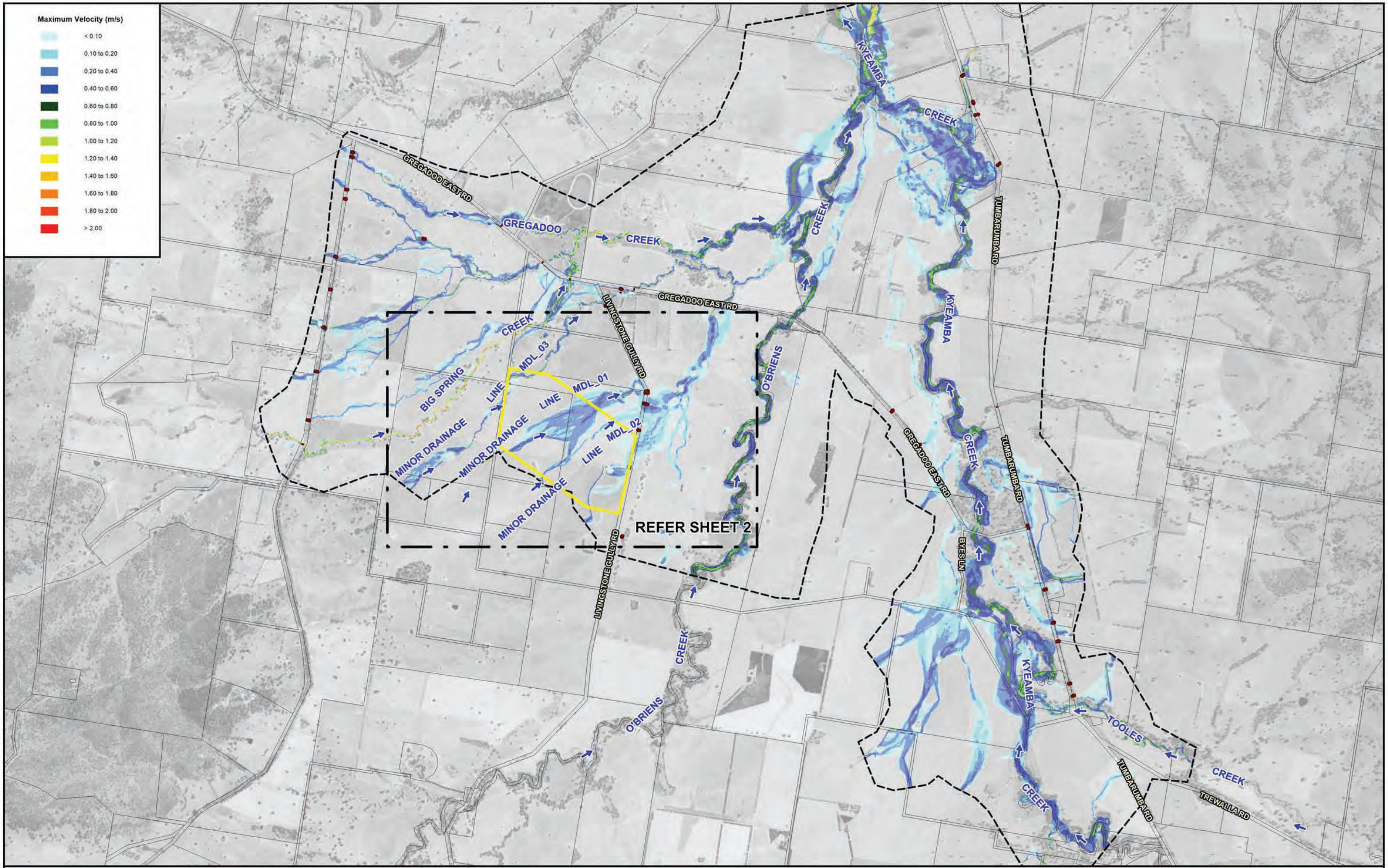
LEGEND

●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent
🟨	Site Boundary
217	Water Surface Elevation Contours (m AHD)

GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 13
(Sheet 2 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
PRESENT DAY CONDITIONS - 20% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent
🟨	Site Boundary

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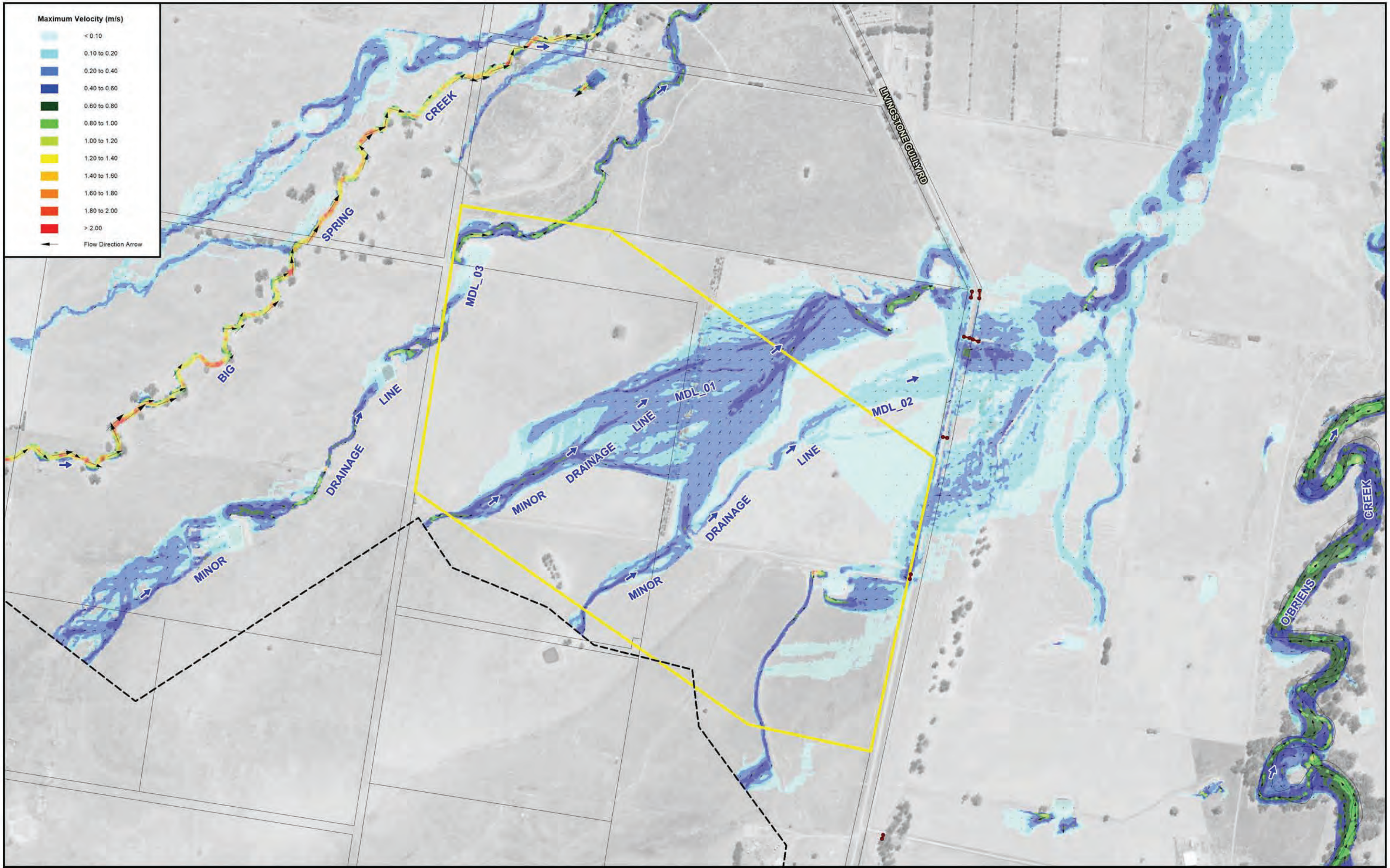
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 14
(Sheet 1 of 2)

MAXIMUM FLOW VELOCITIES
PRESENT DAY CONDITIONS - 20% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

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LEGEND

Modelled Stormwater Drainage Network

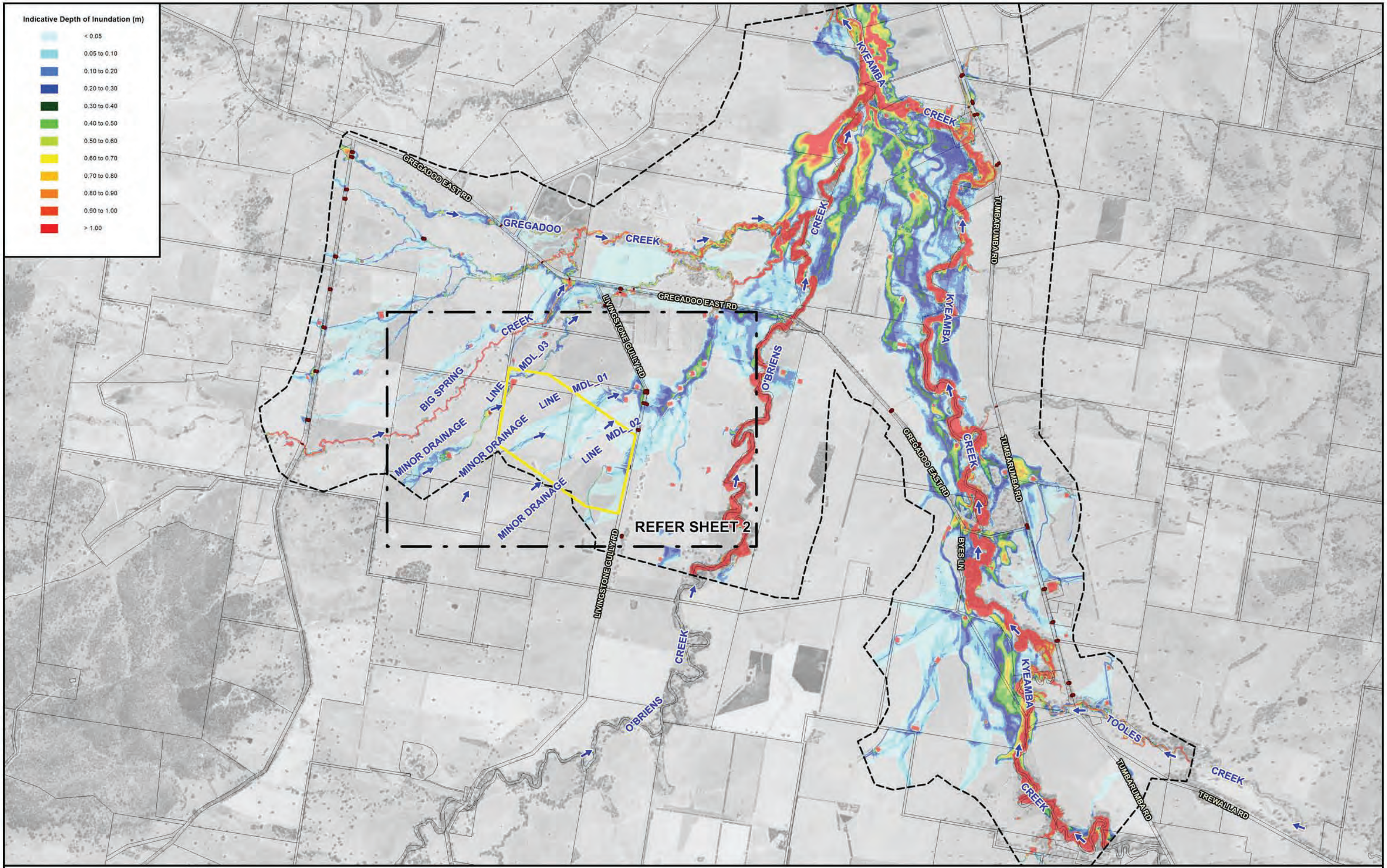
TUFLOW Model Extent

Site Boundary

GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 14
(Sheet 2 of 2)

MAXIMUM FLOW VELOCITIES
PRESENT DAY CONDITIONS - 20% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

- Modelled Stormwater Drainage Network
- TUFLOW Model Extent
- Site Boundary

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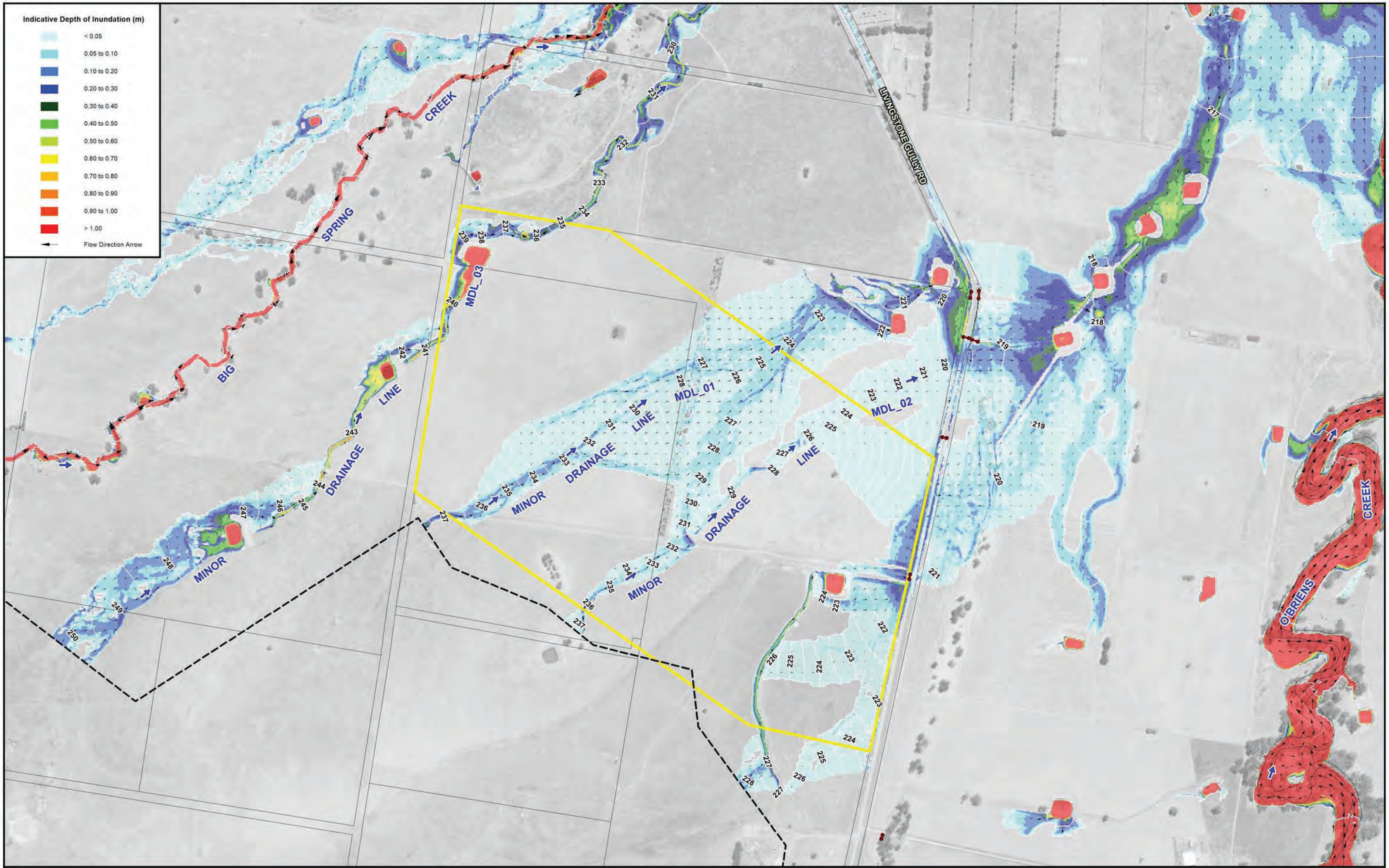
GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 15
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
PRESENT DAY CONDITIONS - 10% AEP



LEGEND

Modelled Stormwater Drainage Network

TUFLOW Model Extent

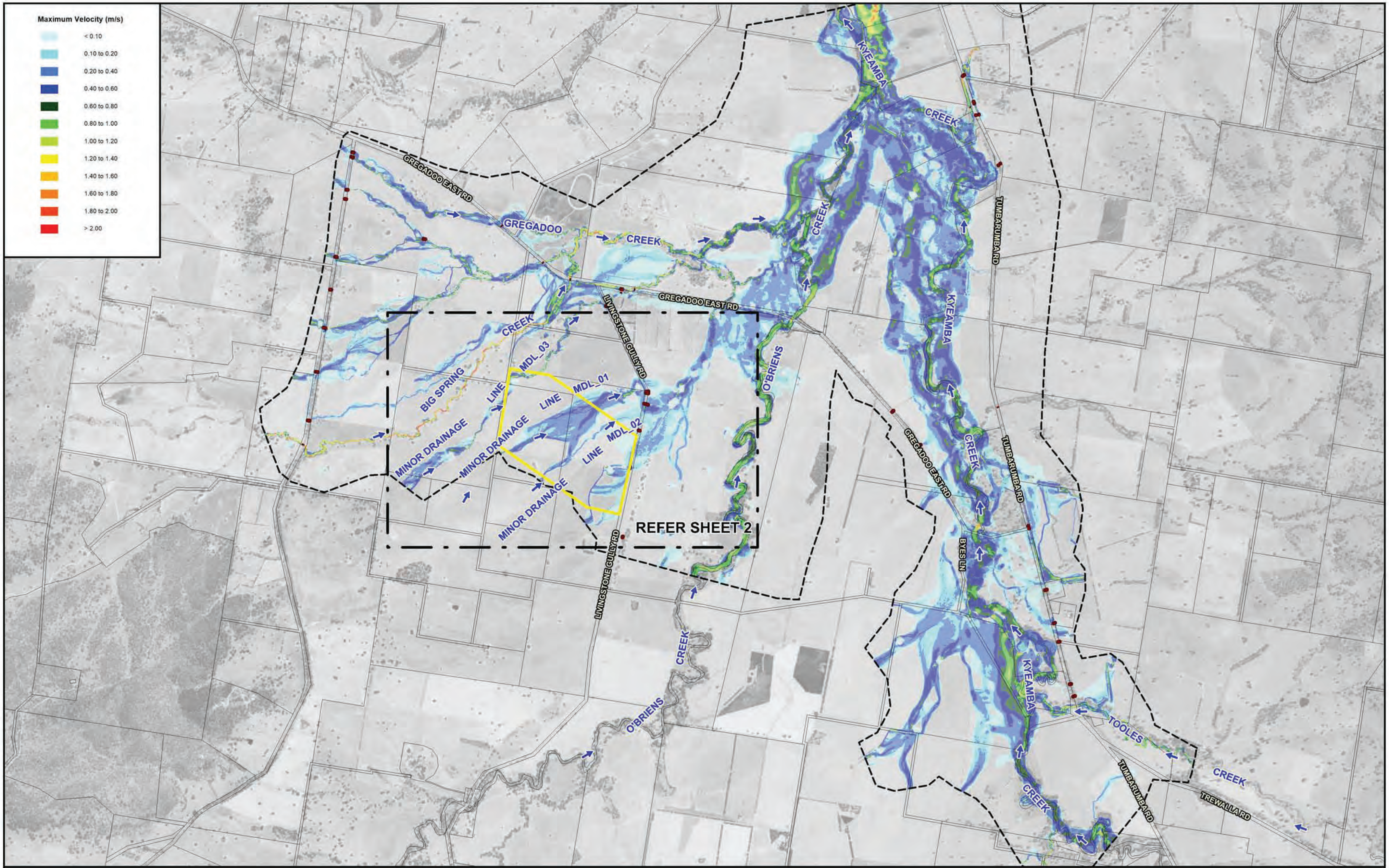
Site Boundary

Water Surface Elevation Contours (m AHD)

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 15
(Sheet 2 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
PRESENT DAY CONDITIONS - 10% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

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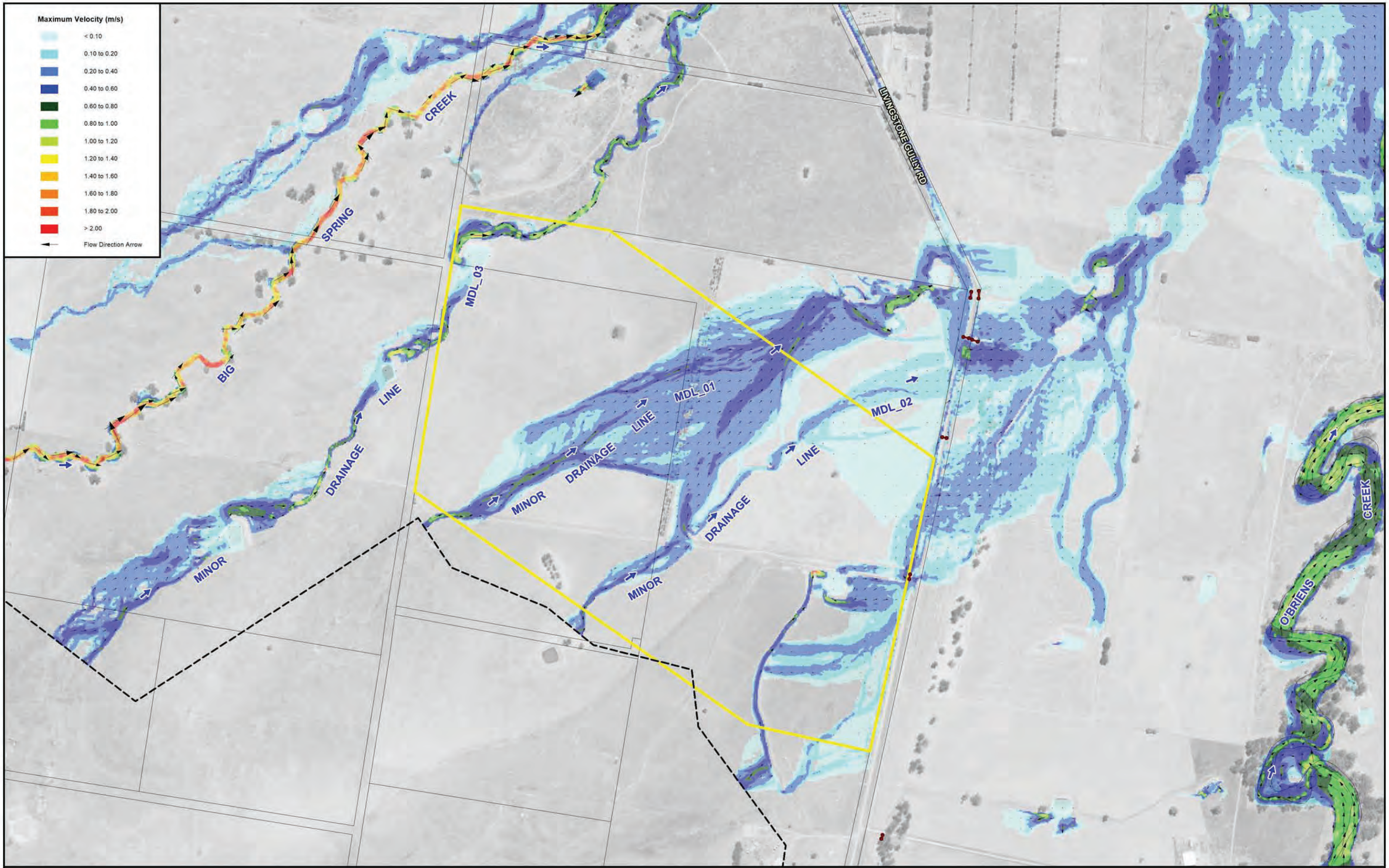
LEGEND

- Modelled Stormwater Drainage Network
- TUFLOW Model Extent
- Site Boundary

GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 16
(Sheet 1 of 2)

MAXIMUM FLOW VELOCITIES
PRESENT DAY CONDITIONS - 10% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

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LEGEND

Modelled Stormwater Drainage Network

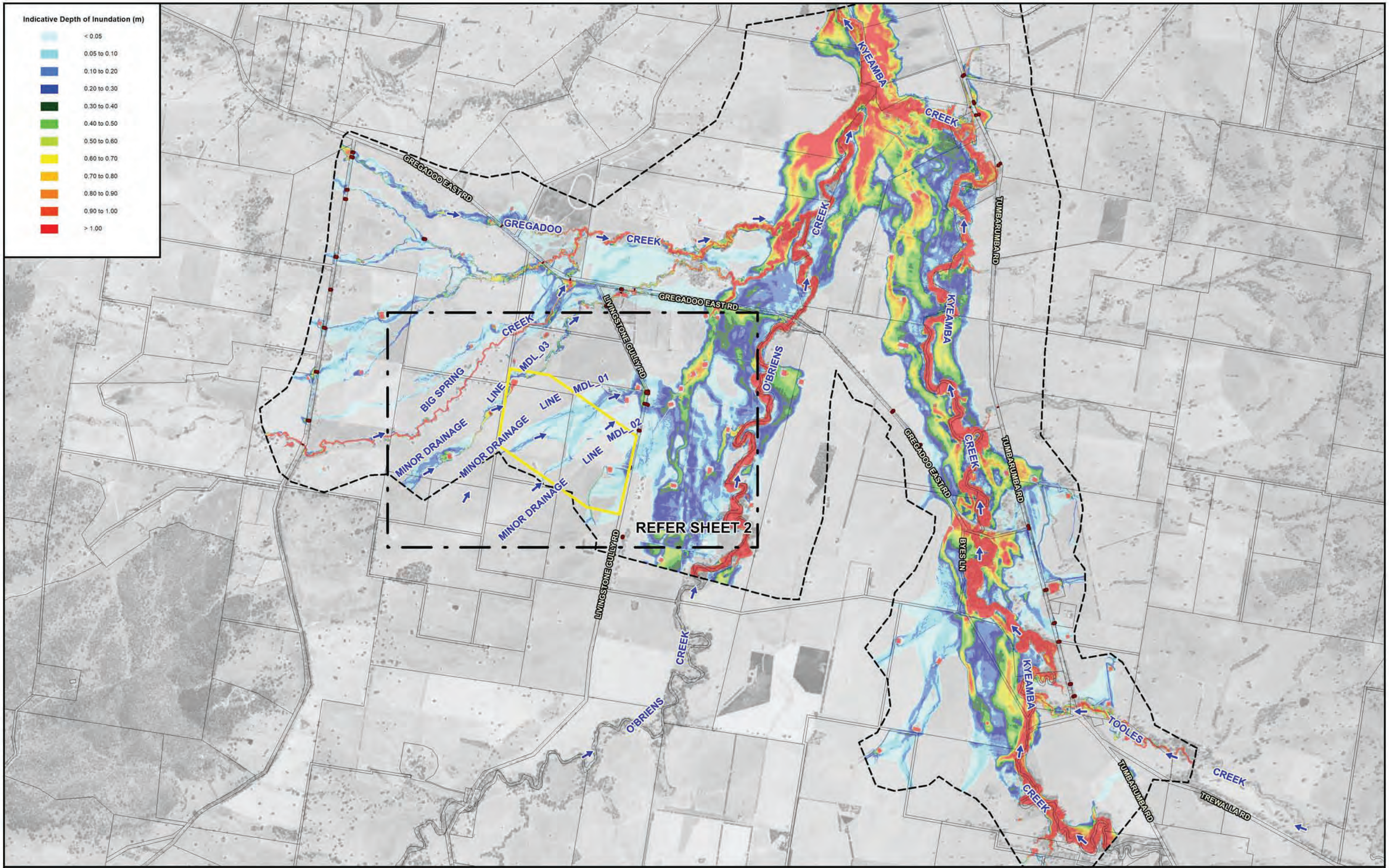
TUFLOW Model Extent

Site Boundary

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 16
(Sheet 2 of 2)

MAXIMUM FLOW VELOCITIES
PRESENT DAY CONDITIONS - 10% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

Modelled Stormwater Drainage Network

TUFLOW Model Extent

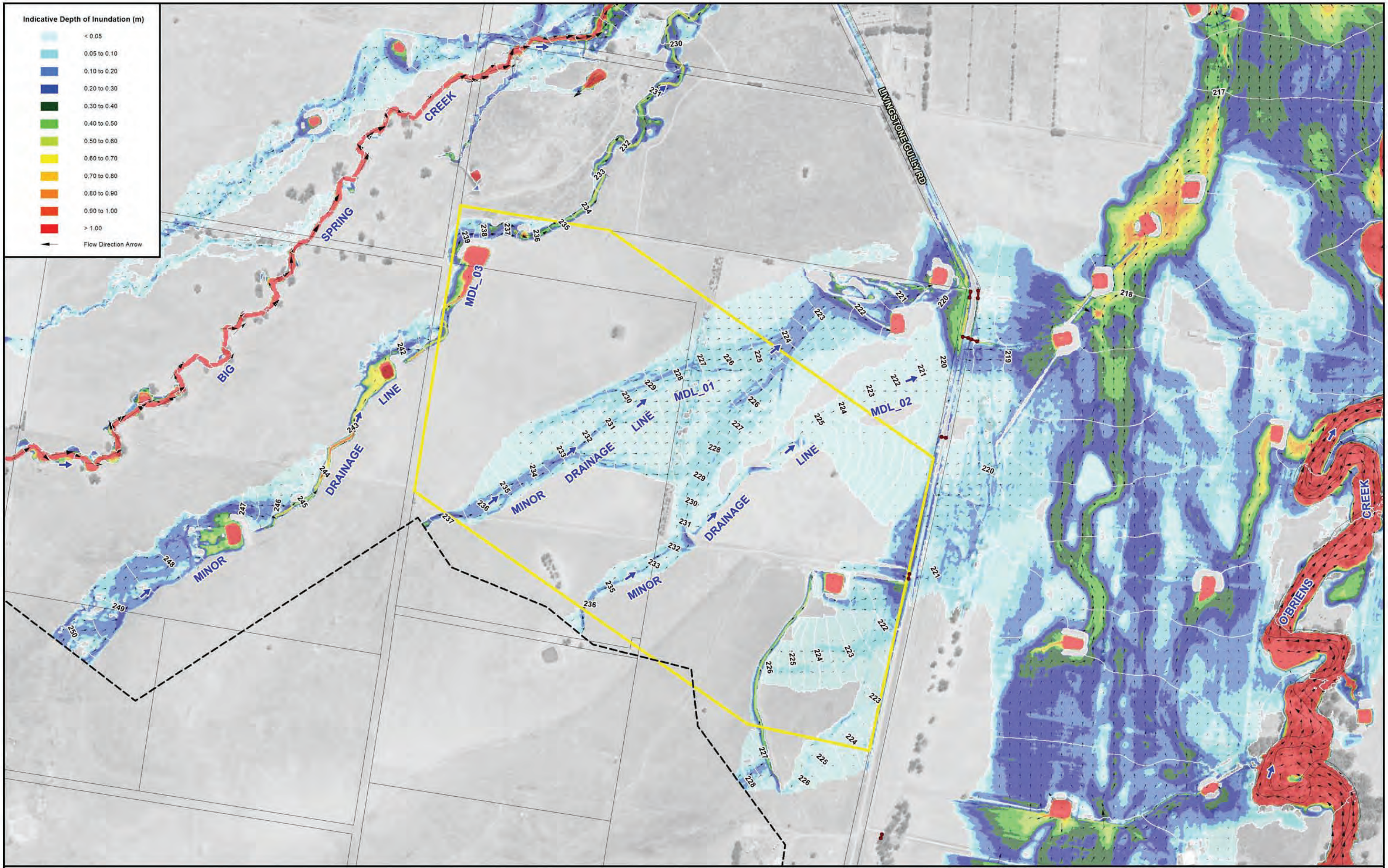
Site Boundary

Lyall & Associates

GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 17
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
PRESENT DAY CONDITIONS - 5% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

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LEGEND

Modelled Stormwater Drainage Network

TUFLOW Model Extent

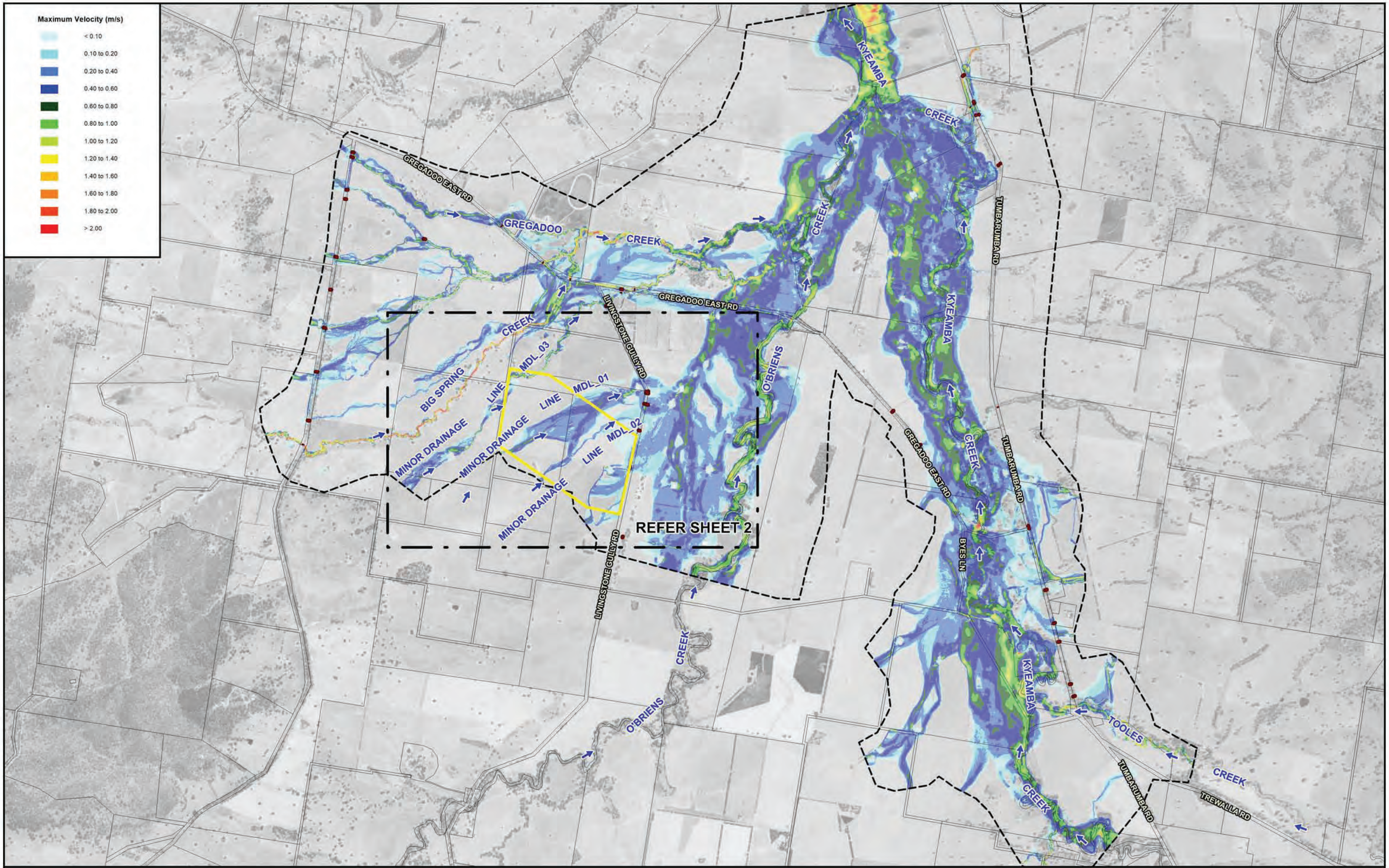
Site Boundary

217 Water Surface Elevation Contours (m AHD)

GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 17
(Sheet 2 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
PRESENT DAY CONDITIONS - 5% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

Lyall & Associates

LEGEND

Modelled Stormwater Drainage Network

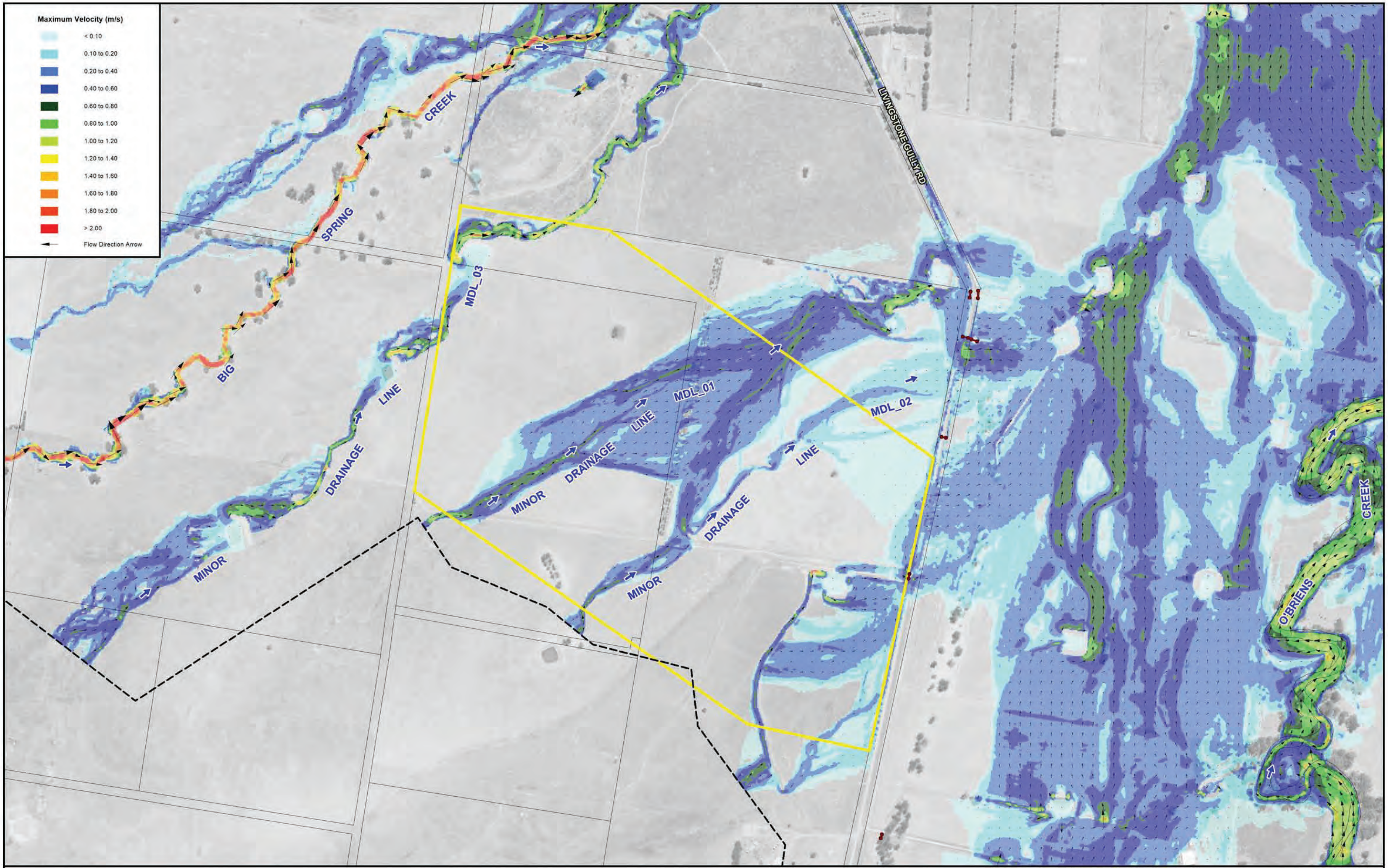
TUFLOW Model Extent

Site Boundary

GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 18
(Sheet 1 of 2)

MAXIMUM FLOW VELOCITIES
PRESENT DAY CONDITIONS - 5% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

Lyall & Associates

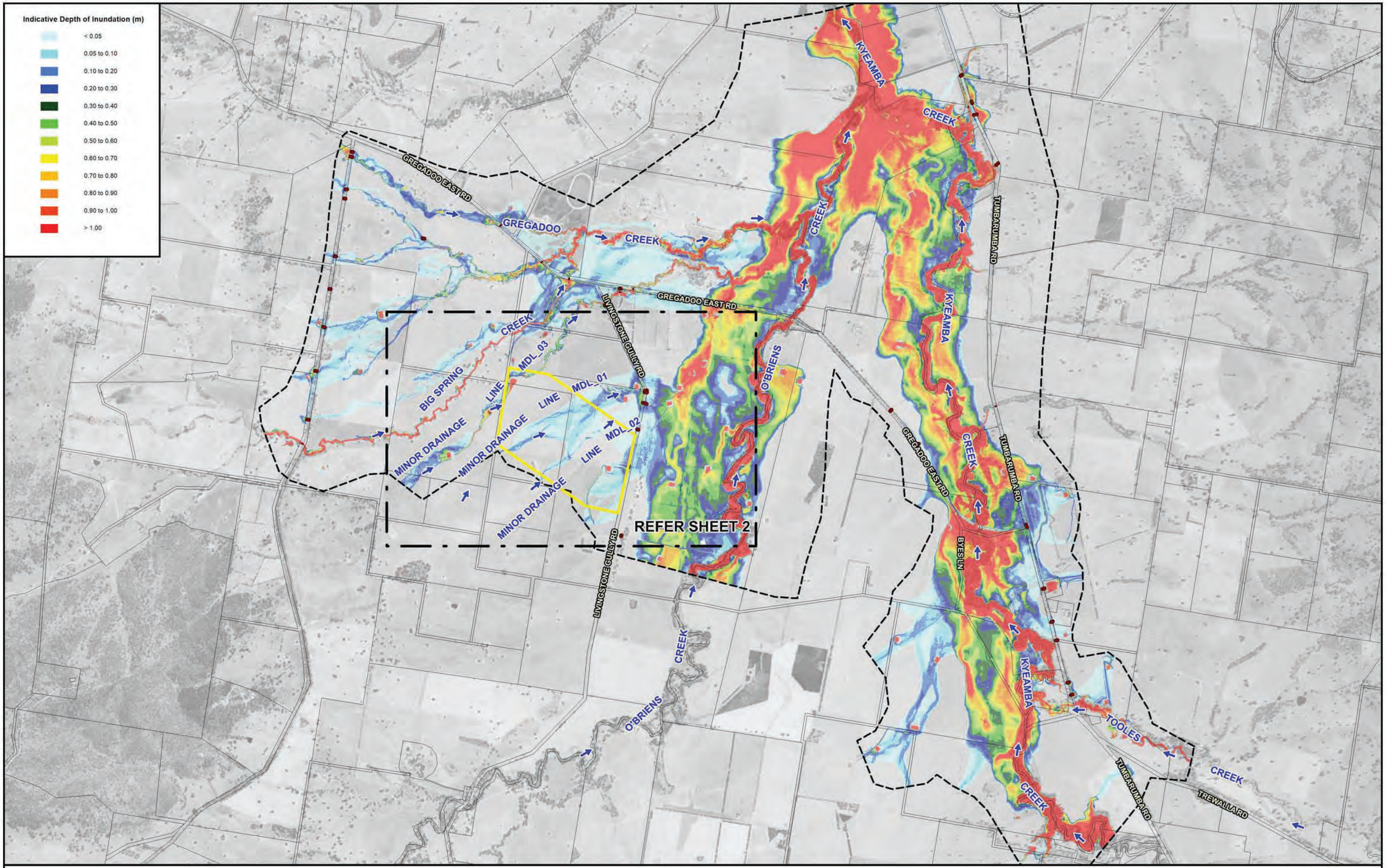
LEGEND

—●—	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent
▬	Site Boundary

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 18
(Sheet 2 of 2)

MAXIMUM FLOW VELOCITIES
PRESENT DAY CONDITIONS - 5% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

Lyall & Associates

LEGEND

Modelled Stormwater Drainage Network

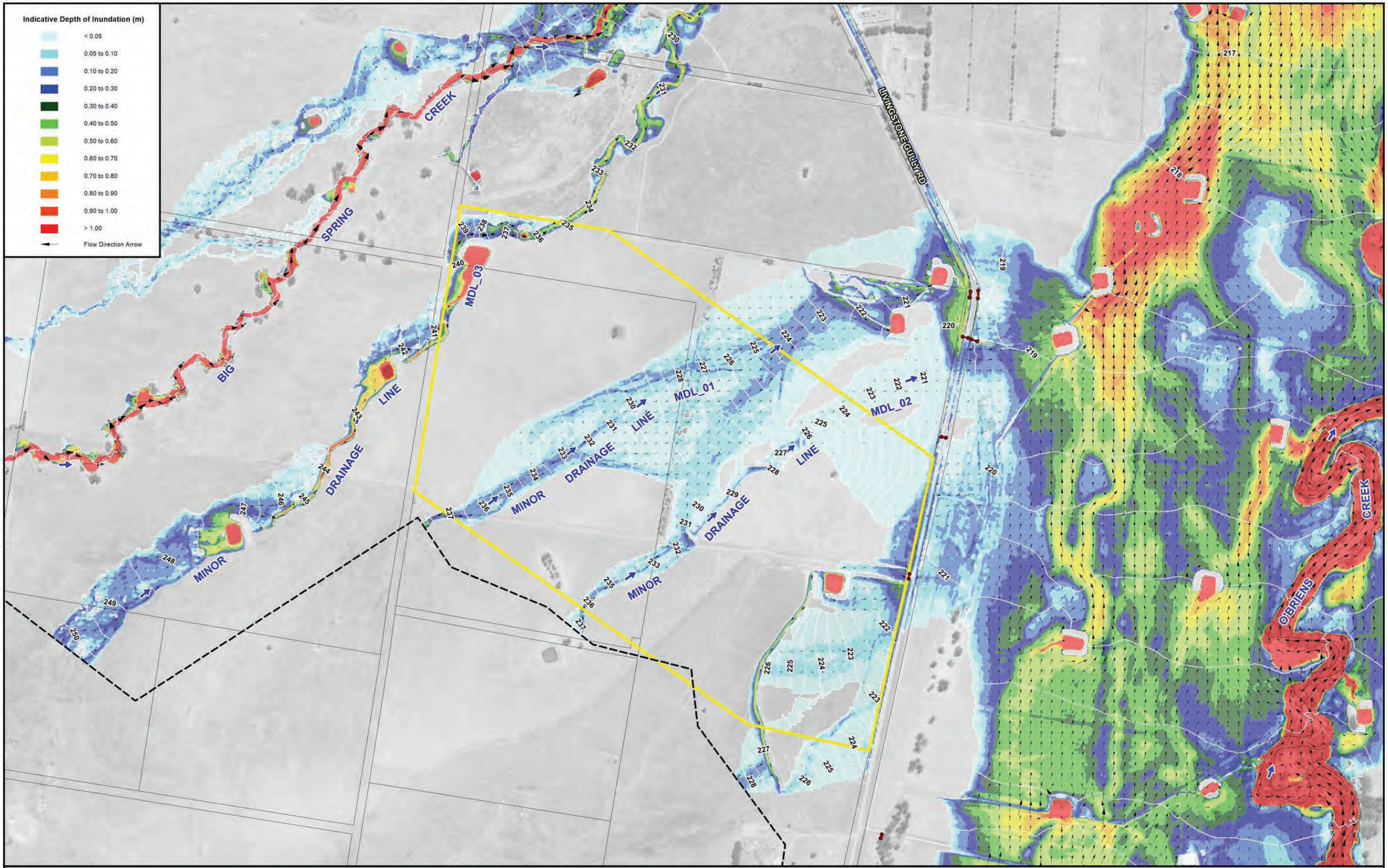
TUFLOW Model Extent

Site Boundary

GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 19
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
PRESENT DAY CONDITIONS - 2% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

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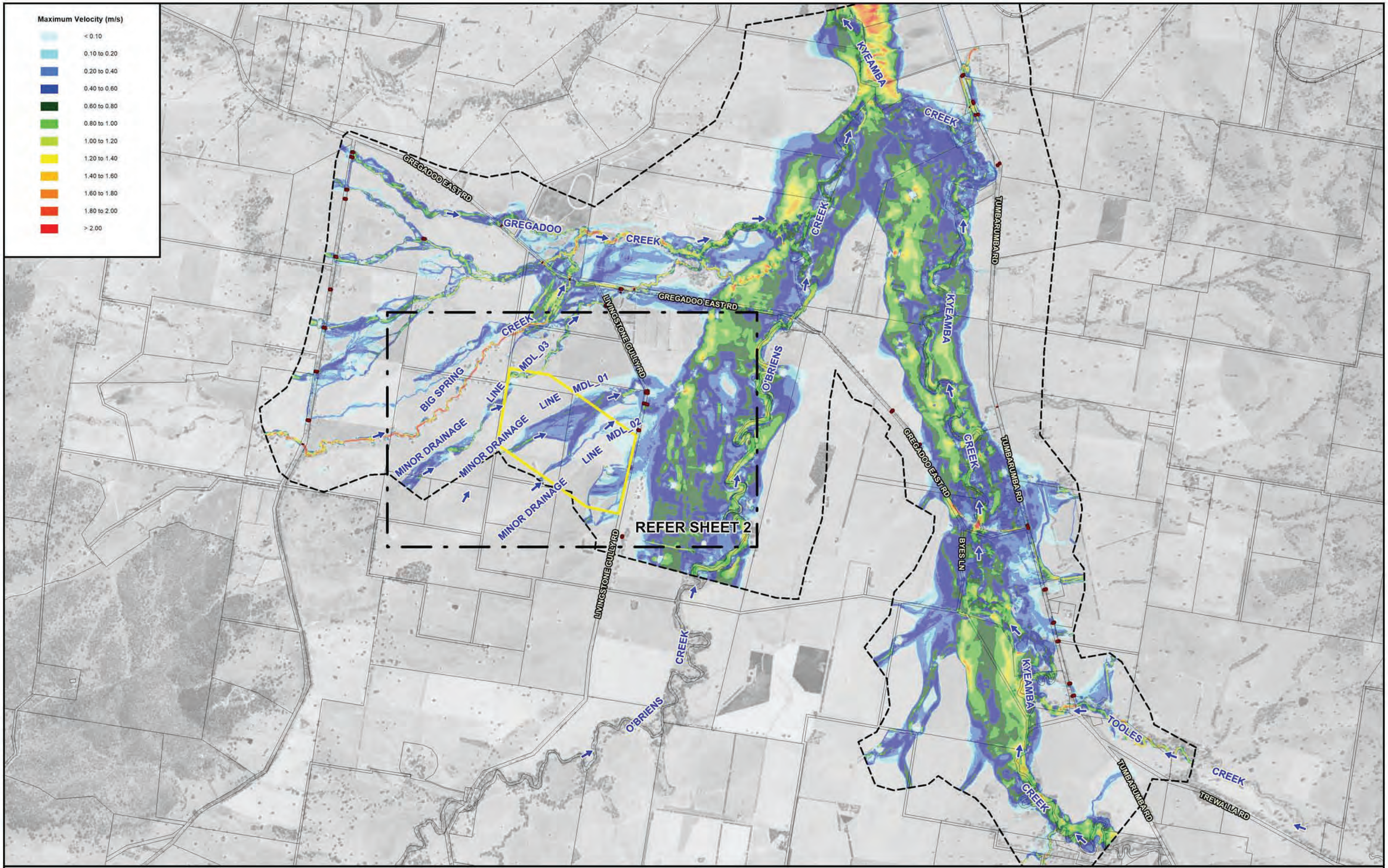
LEGEND

- Modelled Stormwater Drainage Network
- TUFLOW Model Extent
- Site Boundary
- 217 Water Surface Elevation Contours (m AHD)

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 19
(Sheet 2 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
PRESENT DAY CONDITIONS - 2% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

Modelled Stormwater Drainage Network

TUFLOW Model Extent

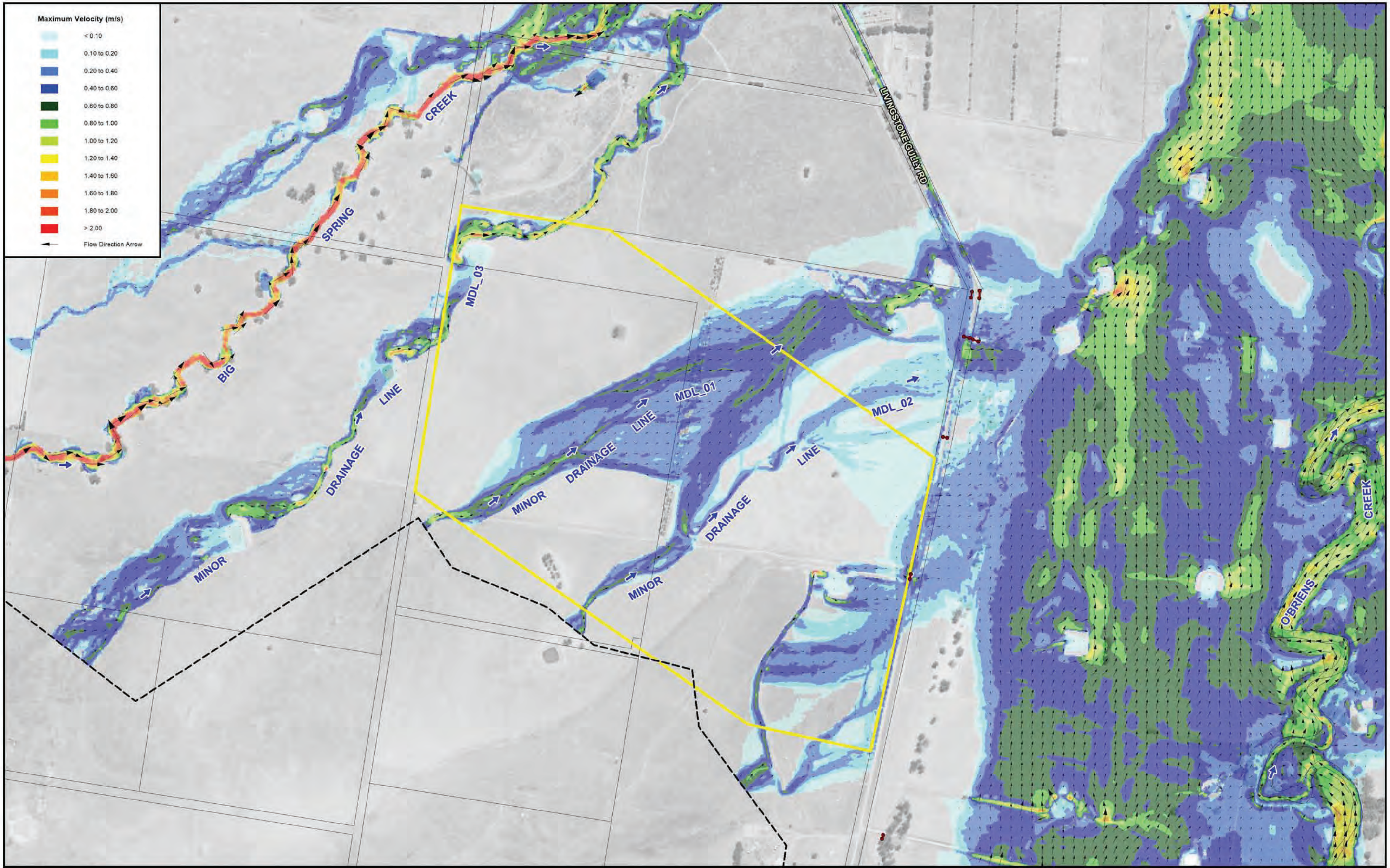
Site Boundary

Lyall & Associates

GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 20
(Sheet 1 of 2)

MAXIMUM FLOW VELOCITIES
PRESENT DAY CONDITIONS - 2% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

Modelled Stormwater Drainage Network

TUFLOW Model Extent

Site Boundary

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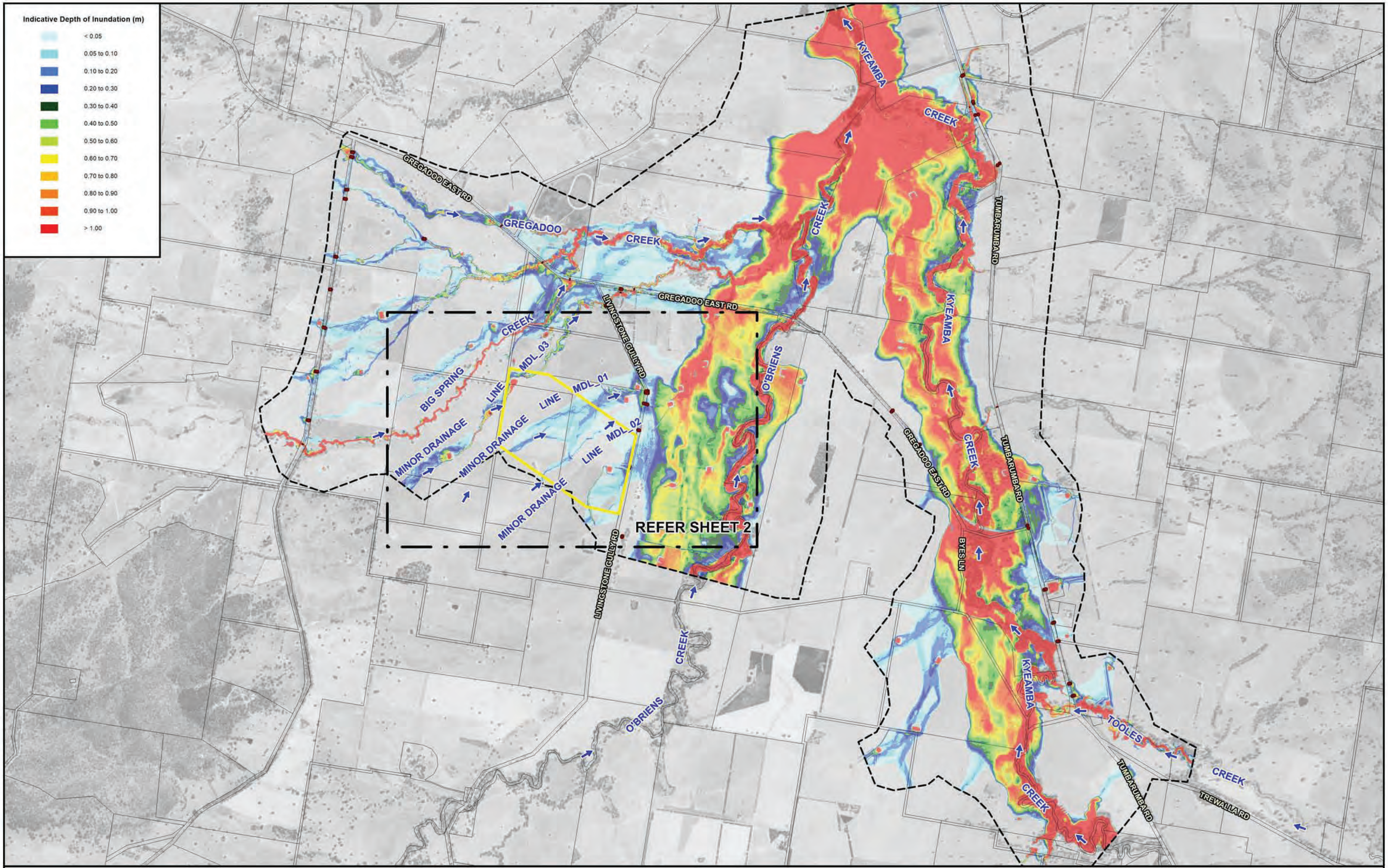
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 20
(Sheet 2 of 2)

MAXIMUM FLOW VELOCITIES
PRESENT DAY CONDITIONS - 2% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

Lyall & Associates

LEGEND

Modelled Stormwater Drainage Network

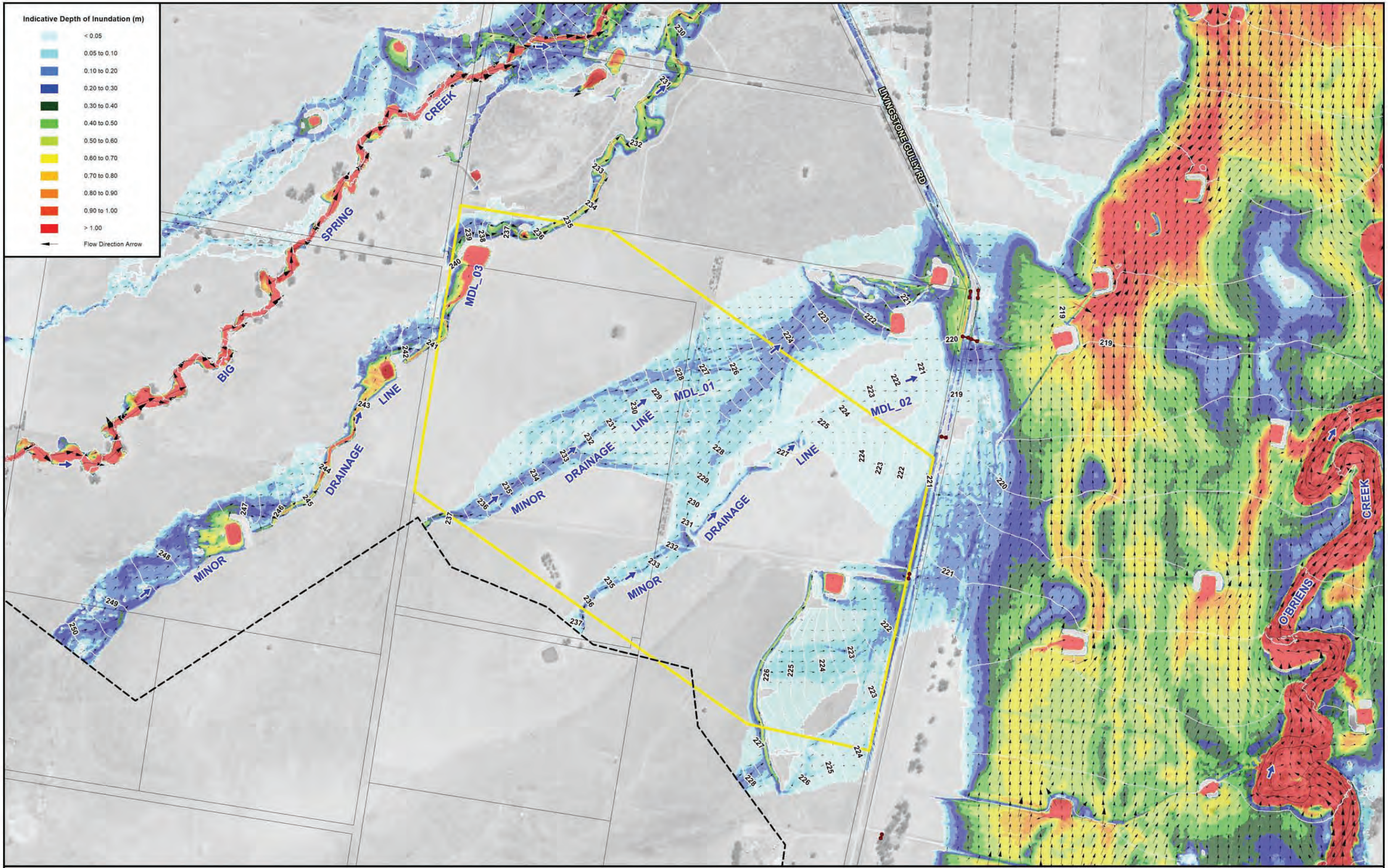
TUFLOW Model Extent

Site Boundary

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 21
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
PRESENT DAY CONDITIONS - 1% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

- Modelled Stormwater Drainage Network
- TUFLOW Model Extent
- Site Boundary
- 217 Water Surface Elevation Contours (m AHD)

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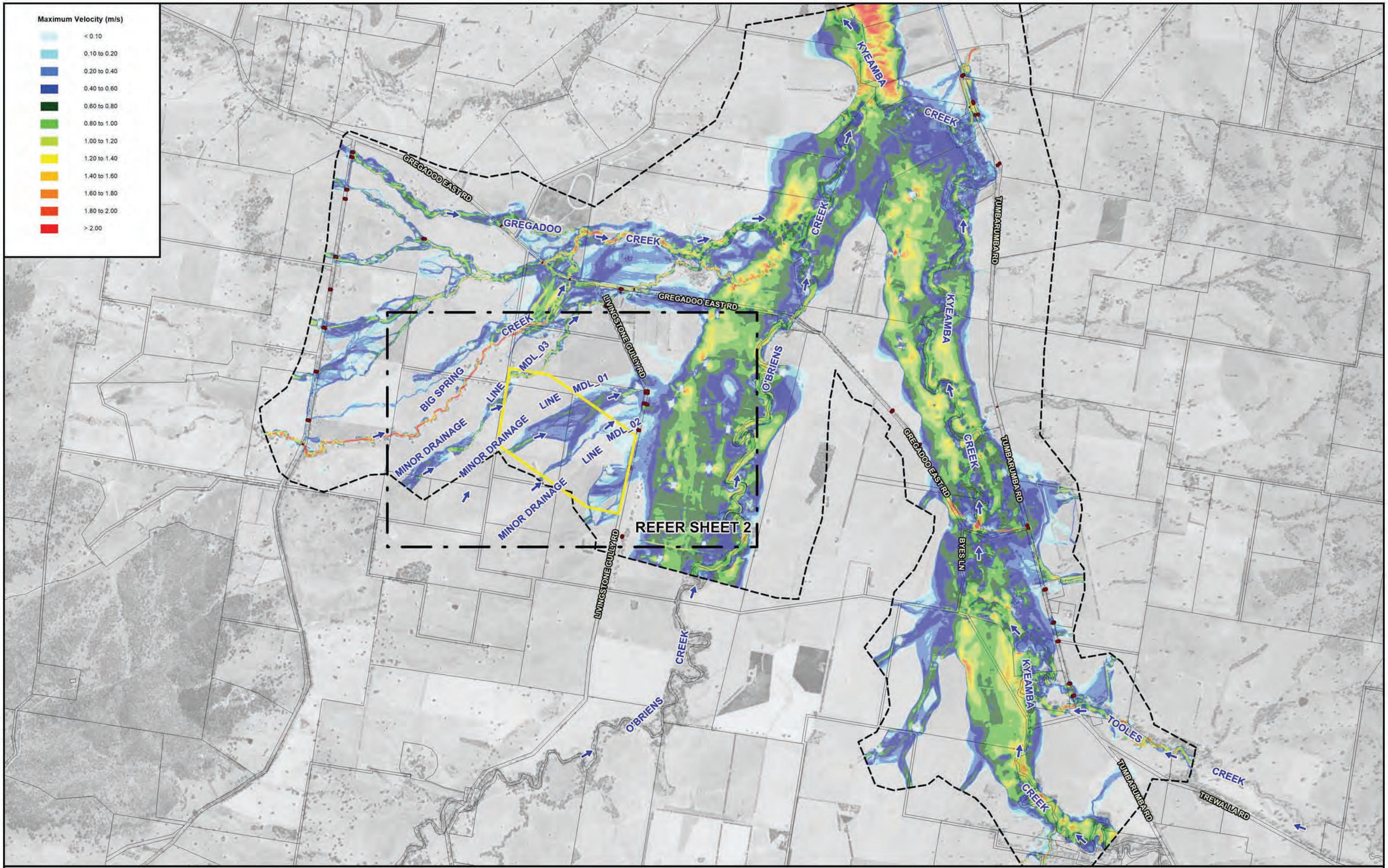
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 21
(Sheet 2 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
PRESENT DAY CONDITIONS - 1% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

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LEGEND

Modelled Stormwater Drainage Network

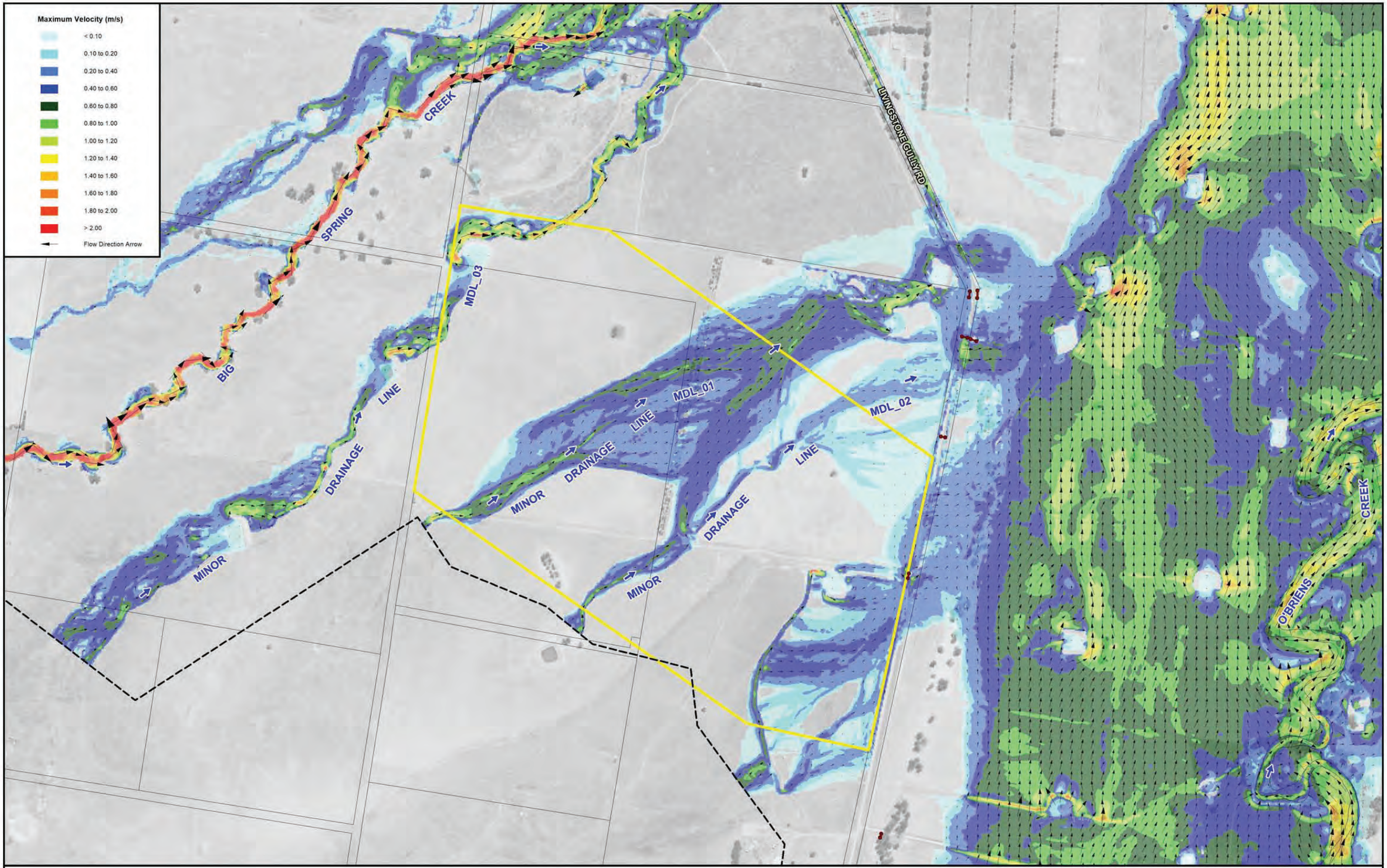
TUFLOW Model Extent

Site Boundary

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 22
(Sheet 1 of 2)

MAXIMUM FLOW VELOCITIES
PRESENT DAY CONDITIONS - 1% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

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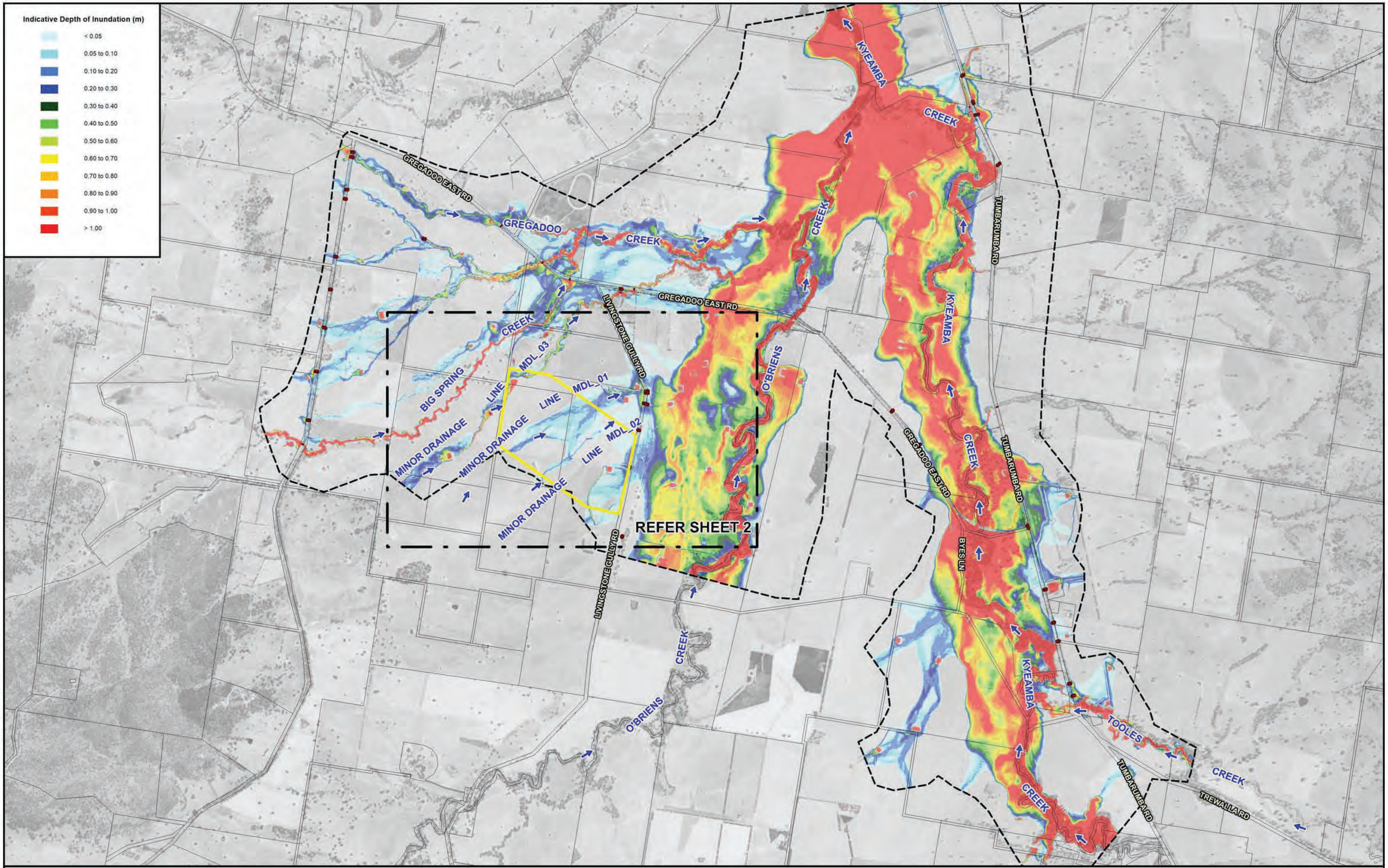
LEGEND

●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent
🟨	Site Boundary

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 22
(Sheet 2 of 2)

MAXIMUM FLOW VELOCITIES
PRESENT DAY CONDITIONS - 1% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

Modelled Stormwater Drainage Network

TUFLOW Model Extent

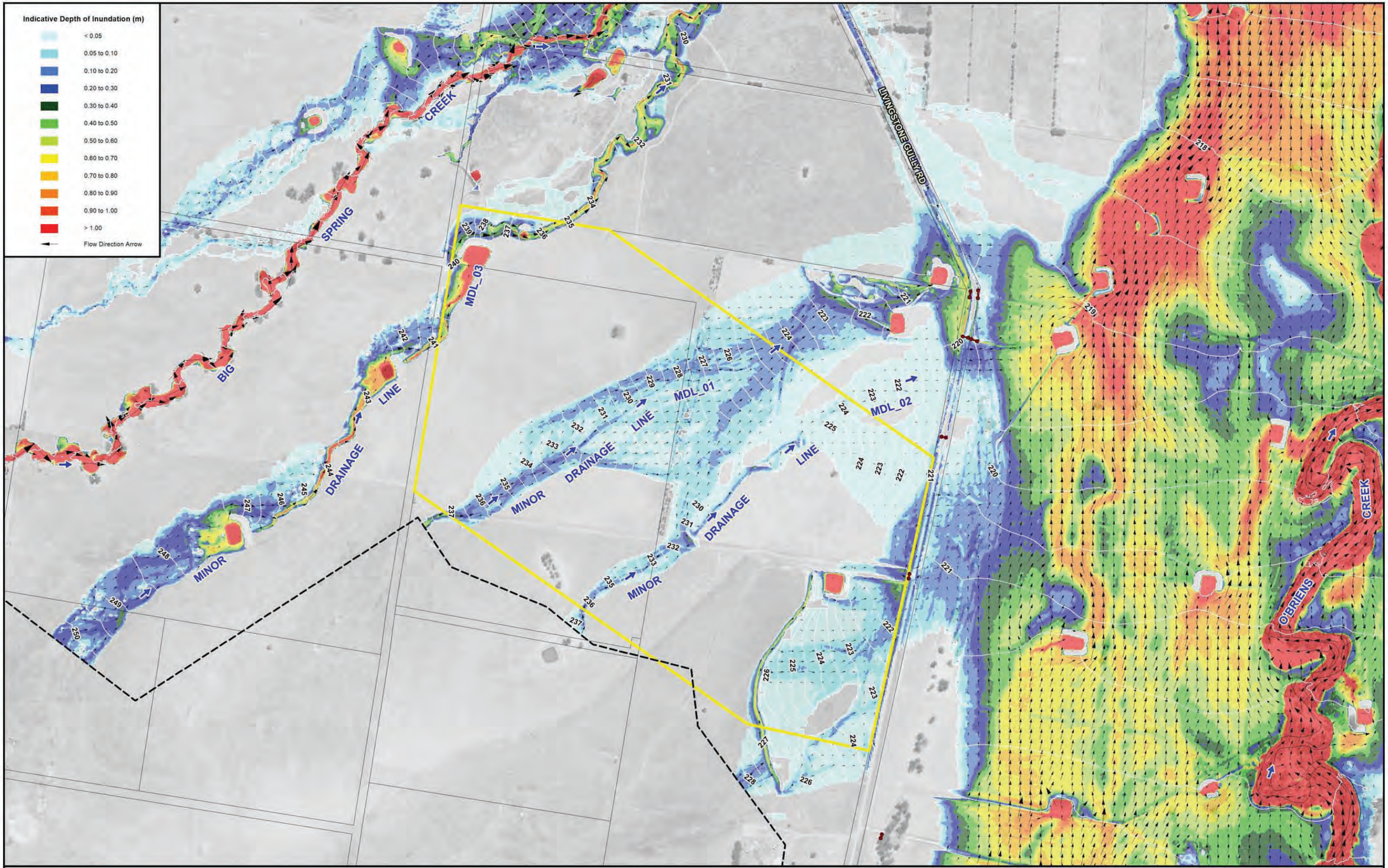
Site Boundary

Lyall & Associates

GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 23
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
PRESENT DAY CONDITIONS - 0.5% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

- Modelled Stormwater Drainage Network
- TUFLOW Model Extent
- Site Boundary
- 217 Water Surface Elevation Contours (m AHD)

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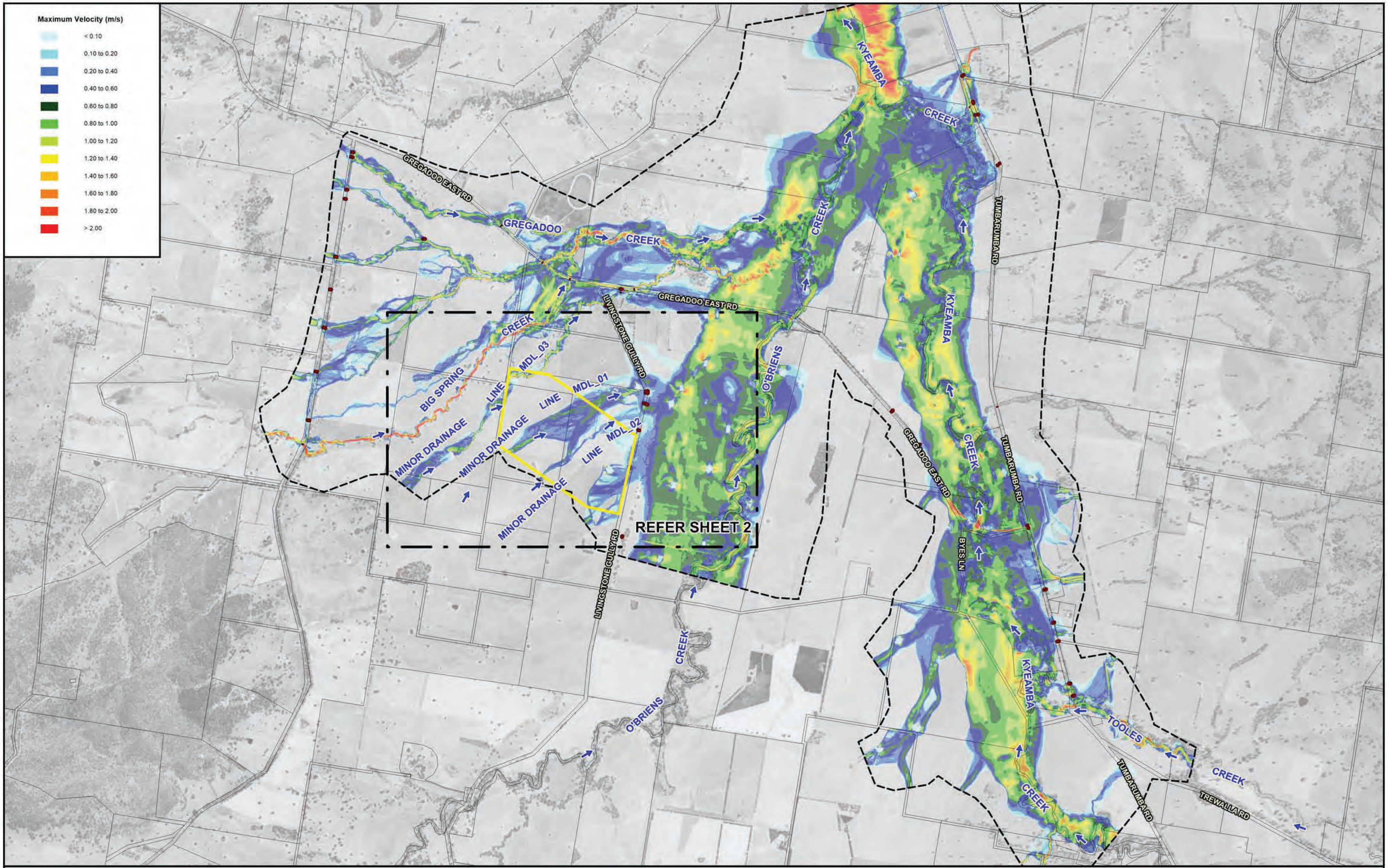
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 23
(Sheet 2 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
PRESENT DAY CONDITIONS - 0.5% AEP



LEGEND

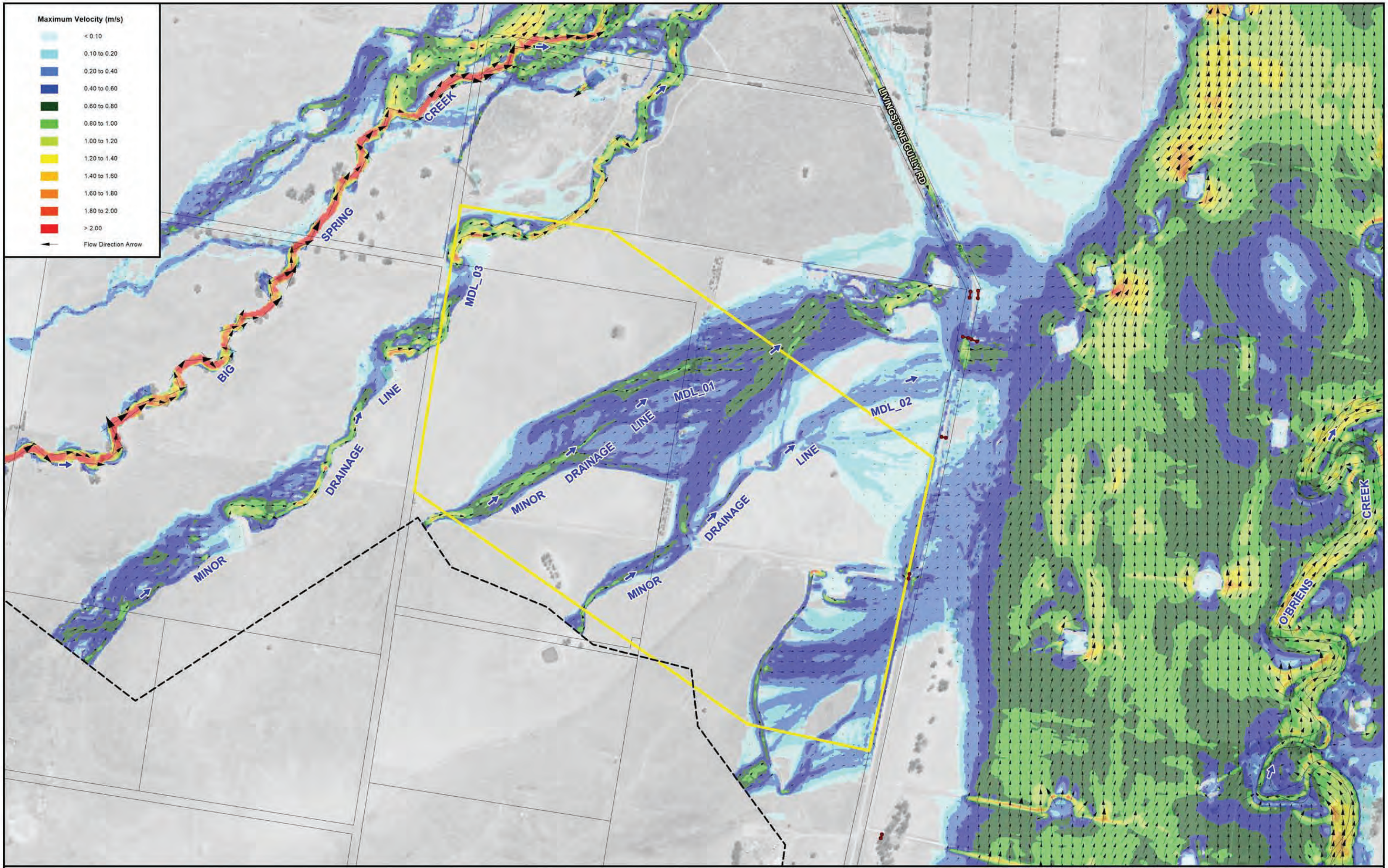
Modelled Stormwater Drainage Network
TUFLOW Model Extent
Site Boundary

Lyall & Associates

**GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION**

Figure 24
(Sheet 1 of 2)

MAXIMUM FLOW VELOCITIES
PRESENT DAY CONDITIONS - 0.5% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

Modelled Stormwater Drainage Network

TUFLOW Model Extent

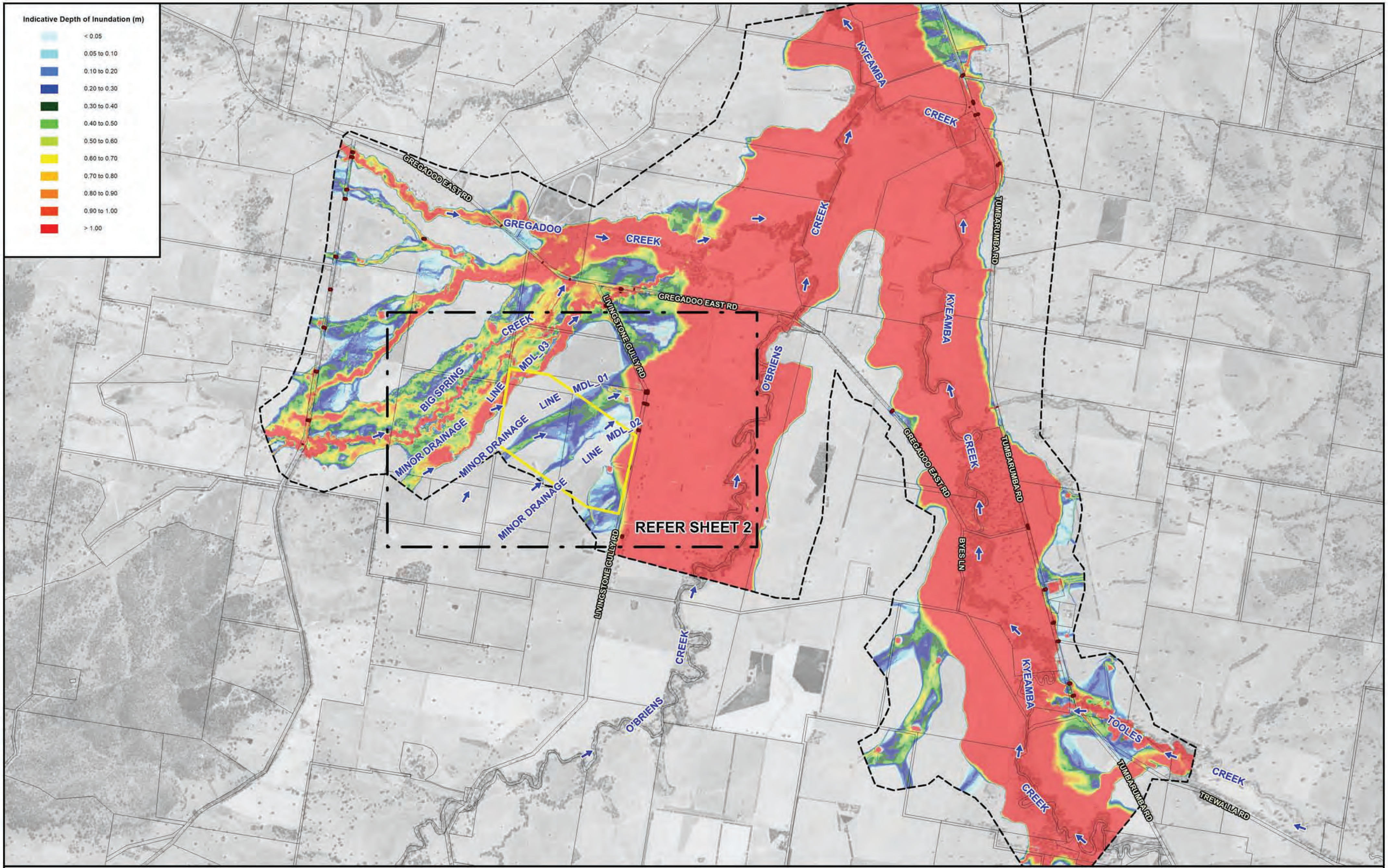
Site Boundary

Lyall & Associates

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 24
(Sheet 2 of 2)

MAXIMUM FLOW VELOCITIES
PRESENT DAY CONDITIONS - 0.5% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

Modelled Stormwater Drainage Network

TUFLOW Model Extent

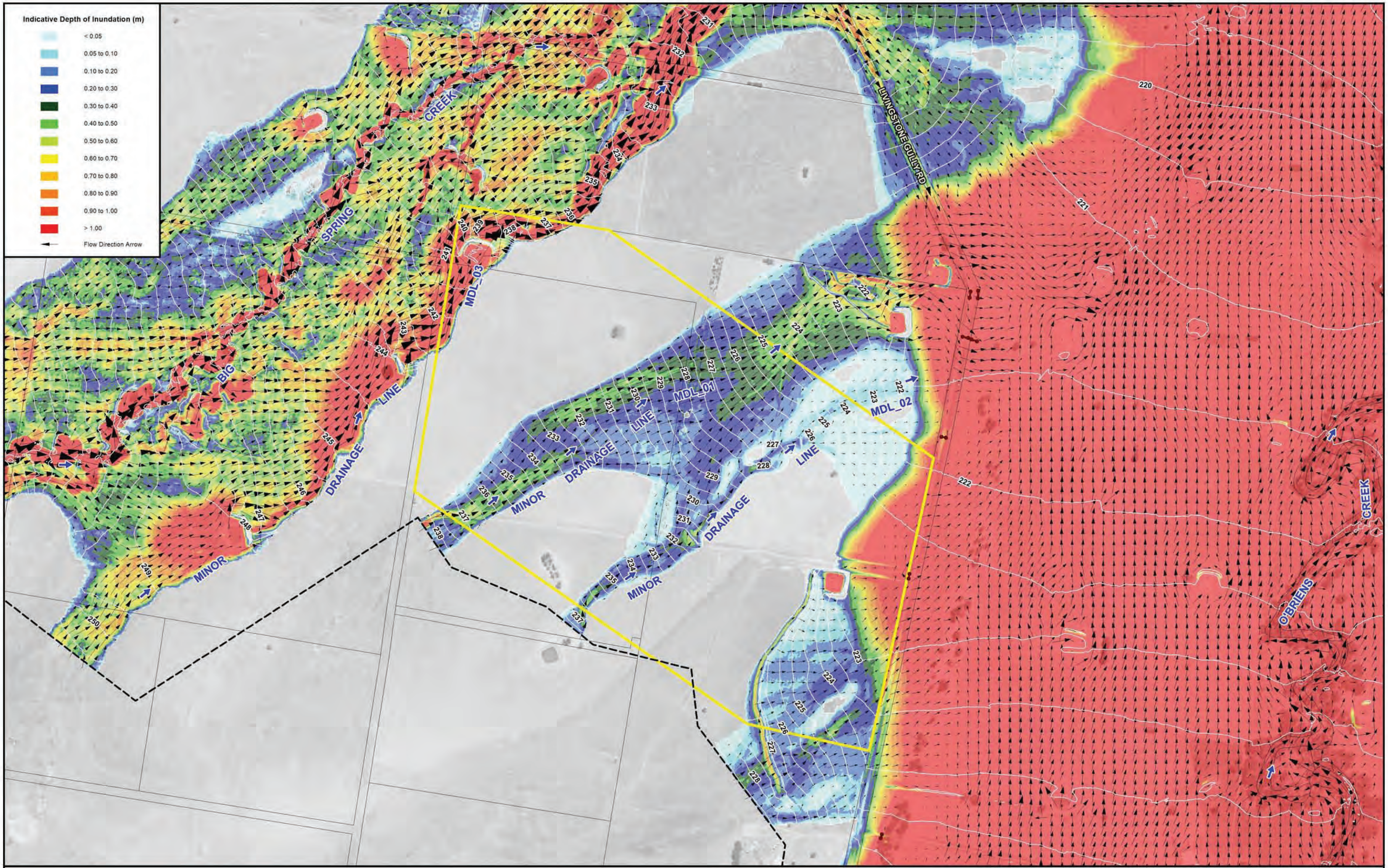
Site Boundary

Lyall & Associates

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 25
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
PRESENT DAY CONDITIONS - PMF



N

80 0 80 160 240 m

Scale: 1:8,000

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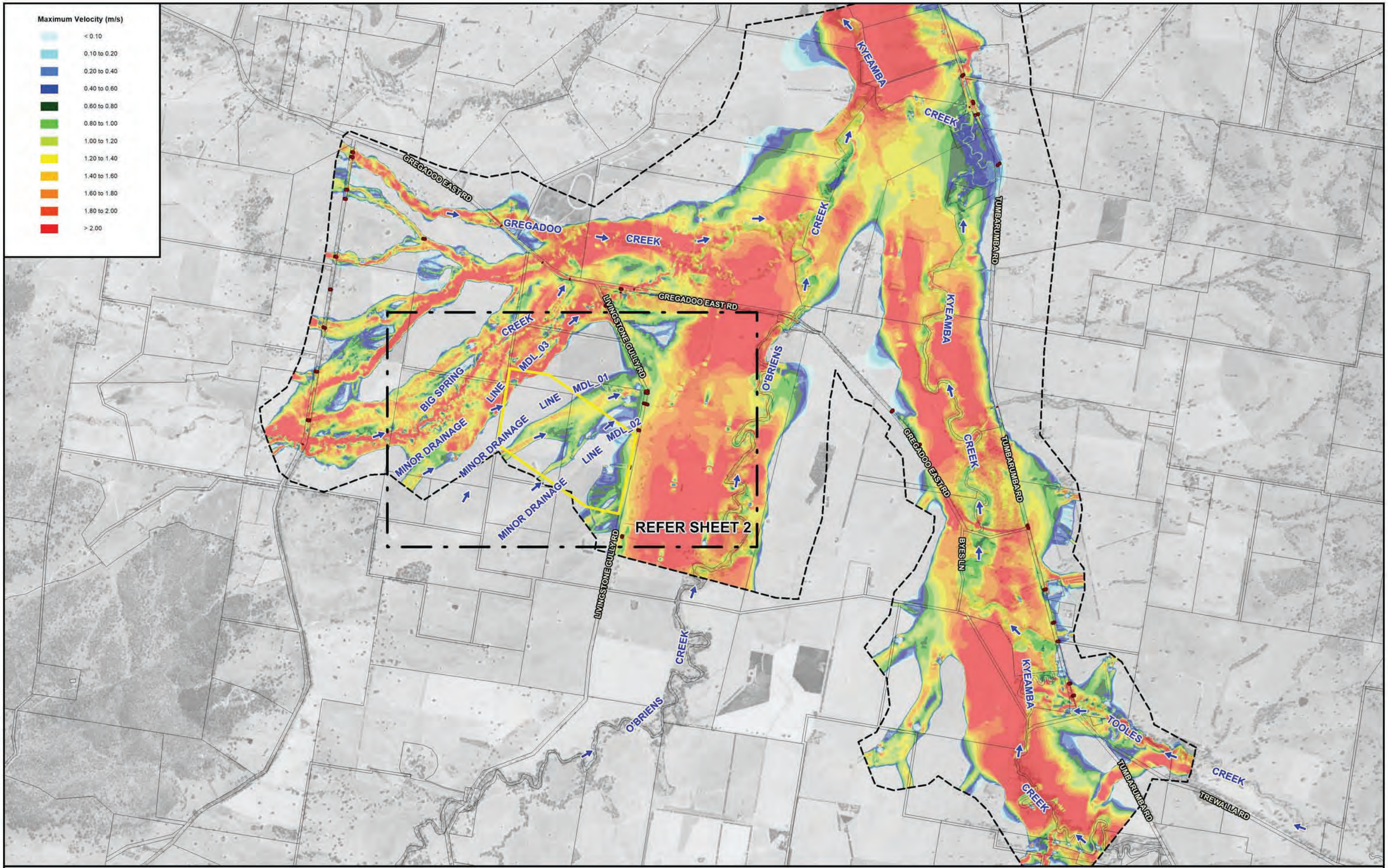
LEGEND

- Modelled Stormwater Drainage Network
- TUFLOW Model Extent
- Site Boundary
- 219 Water Surface Elevation Contours (m AHD)

GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 25
(Sheet 2 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
PRESENT DAY CONDITIONS - PMF



N

300 0 300 600 900 m

Scale: 1:30,000

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LEGEND

Modelled Stormwater Drainage Network

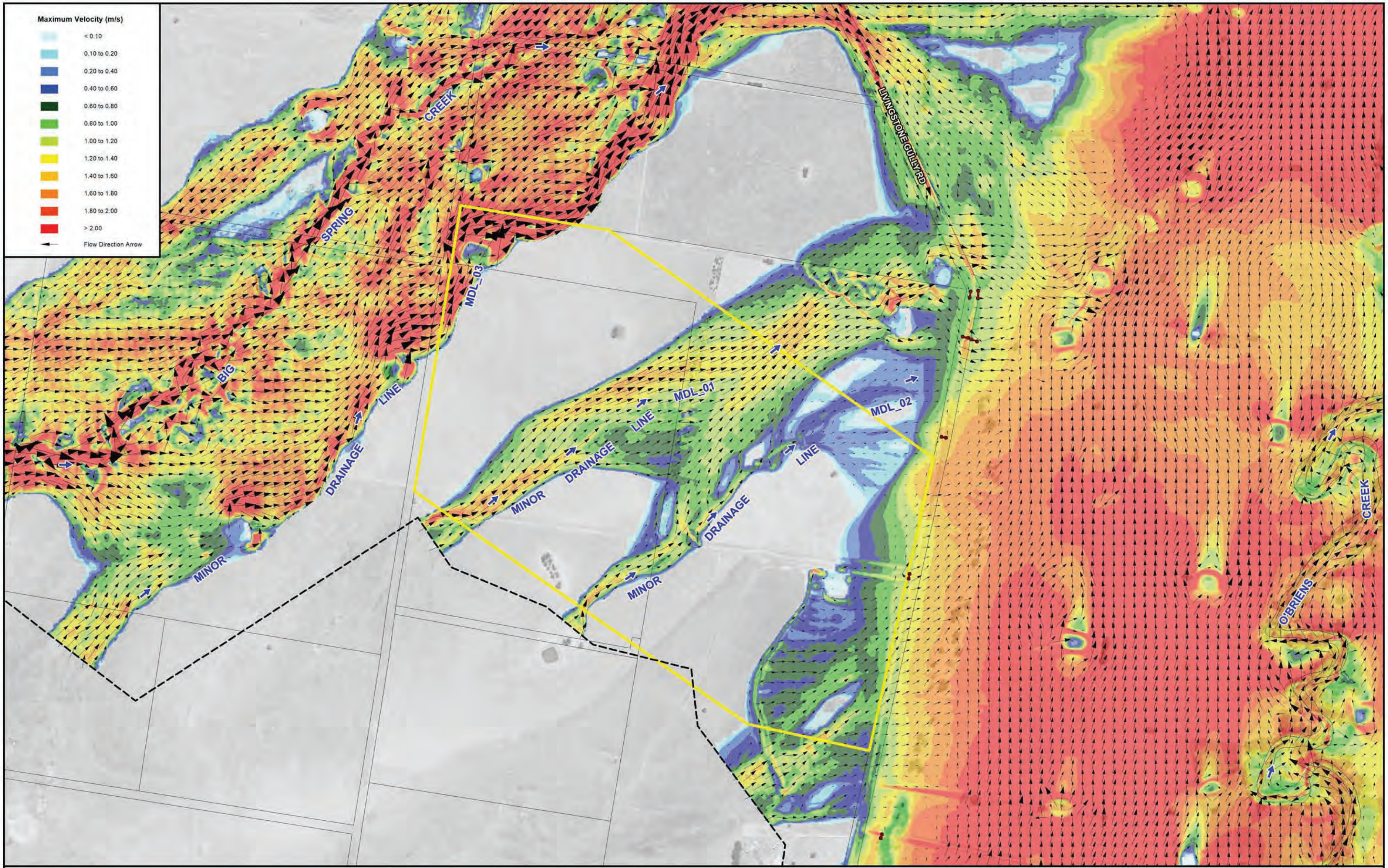
TUFLOW Model Extent

Site Boundary

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 26
(Sheet 1 of 2)

MAXIMUM FLOW VELOCITIES
PRESENT DAY CONDITIONS - PMF



N

80 0 80 160 240 m

Scale: 1:8,000

Lyall & Associates

LEGEND

Modelled Stormwater Drainage Network

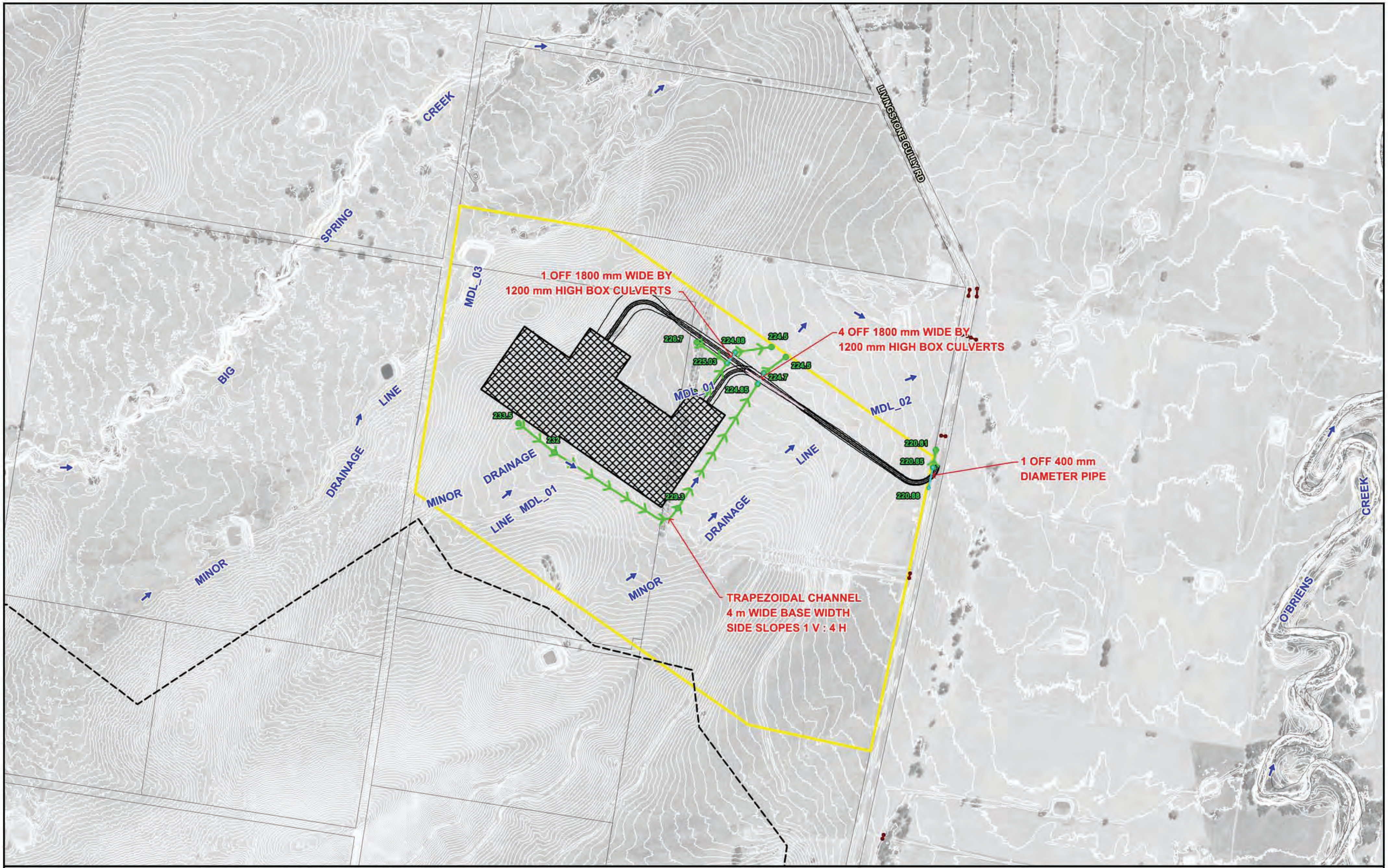
TUFLOW Model Extent

Site Boundary

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 26
(Sheet 2 of 2)

MAXIMUM FLOW VELOCITIES
PRESENT DAY CONDITIONS - PMF



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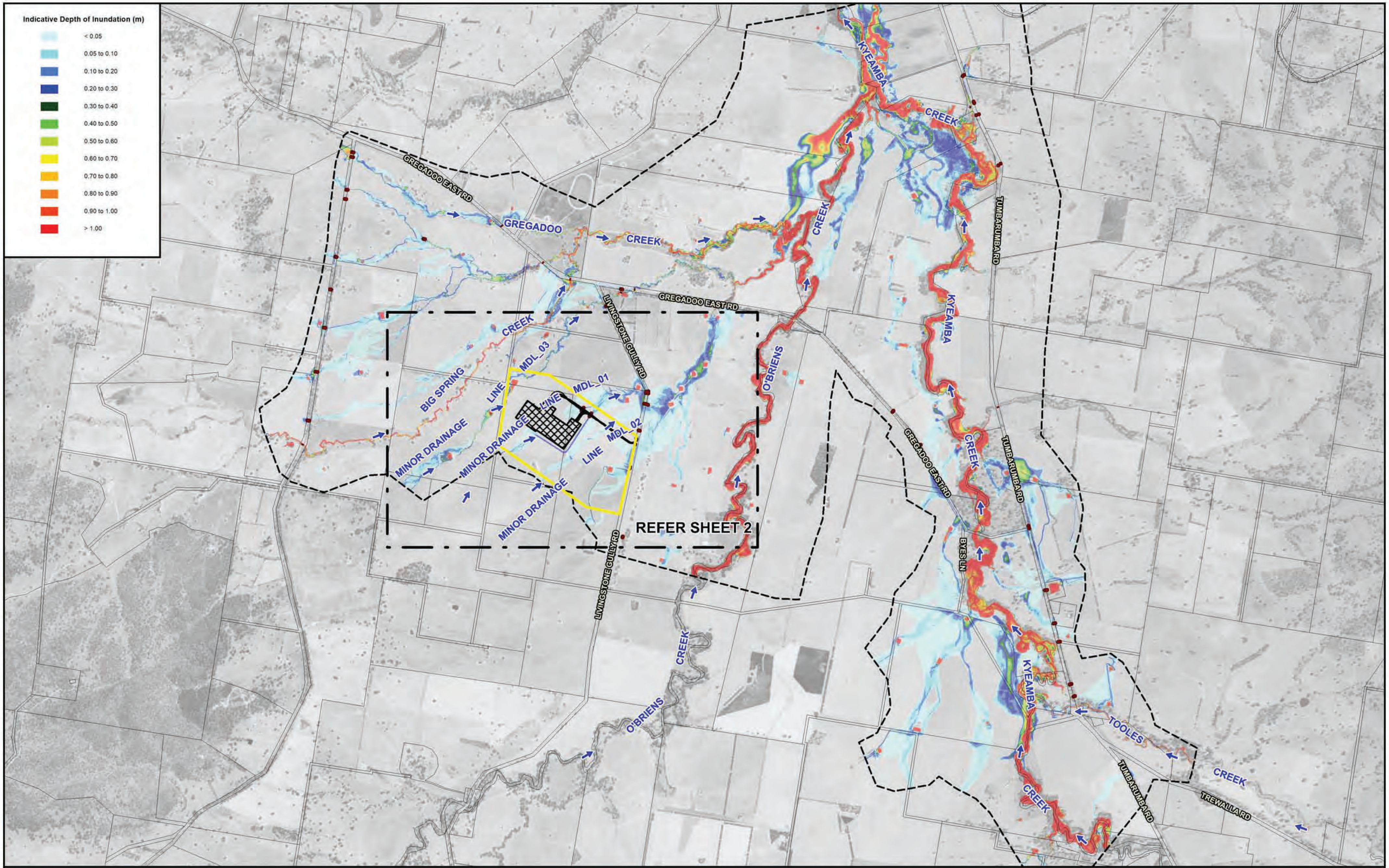
GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 27

LAYOUT OF PROPOSED SUBSTATION BENCH AND CHANNEL WORKS



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨ Extent of Substation Bench (Indicative)	Modelled Stormwater Drainage Network
Site Access Road (Indicative)	TUFLOW Model Extent
Site Boundary	

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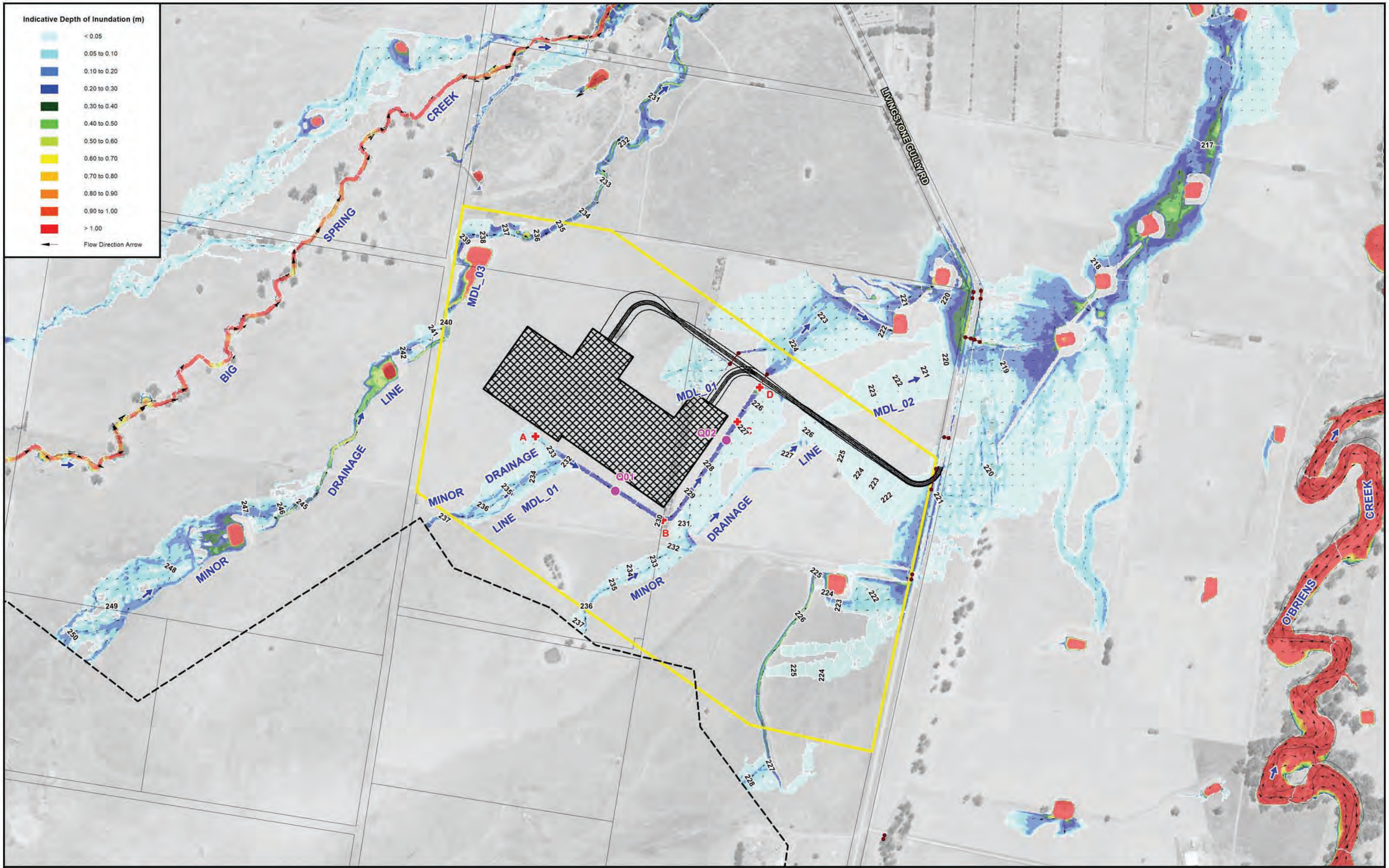
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 28
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 20% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

Lyall & Associates

LEGEND

A ✚ Peak Flood Level Identifier (Refer Table 5 in Report)

Q01 ● Peak Flow Identifier (Refer Table 6 in Report)

▩ Extent of Substation Bench (Indicative)

— Site Access Road (Indicative)

🟨 Site Boundary

●—● Modelled Stormwater Drainage Network

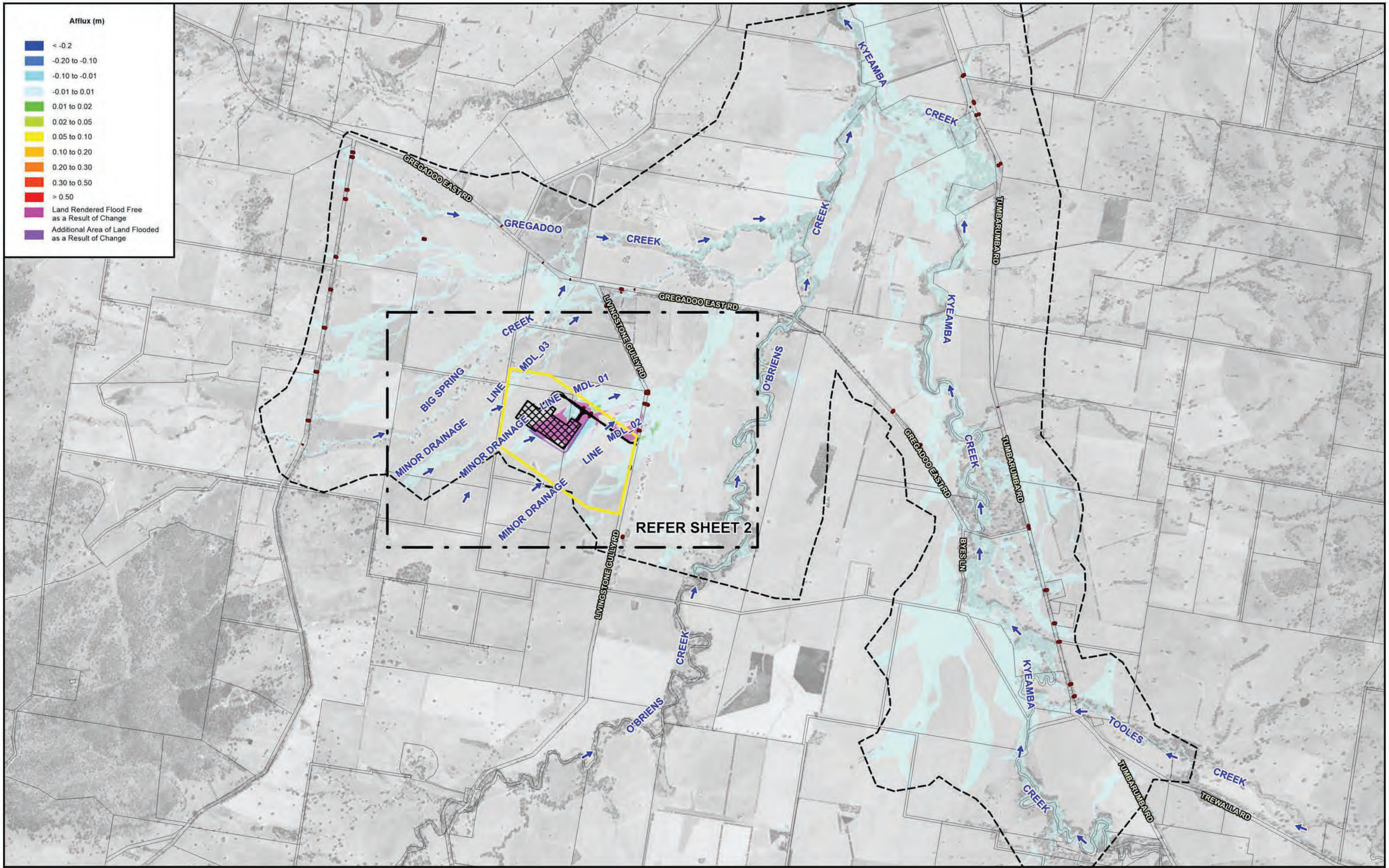
- - - TUFLOW Model Extent

217 Water Surface Elevation Contours (m AHD)

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 28
(Sheet 2 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 20% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨	Extent of Substation Bench (Indicative)
—	Site Access Road (Indicative)
🟨	Site Boundary
●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent

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GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 29
(Sheet 1 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON FLOOD BEHAVIOUR
20% AEP

N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

▨	Extent of Substation Bench (Indicative)
—	Site Access Road (Indicative)
—	Site Boundary
●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent

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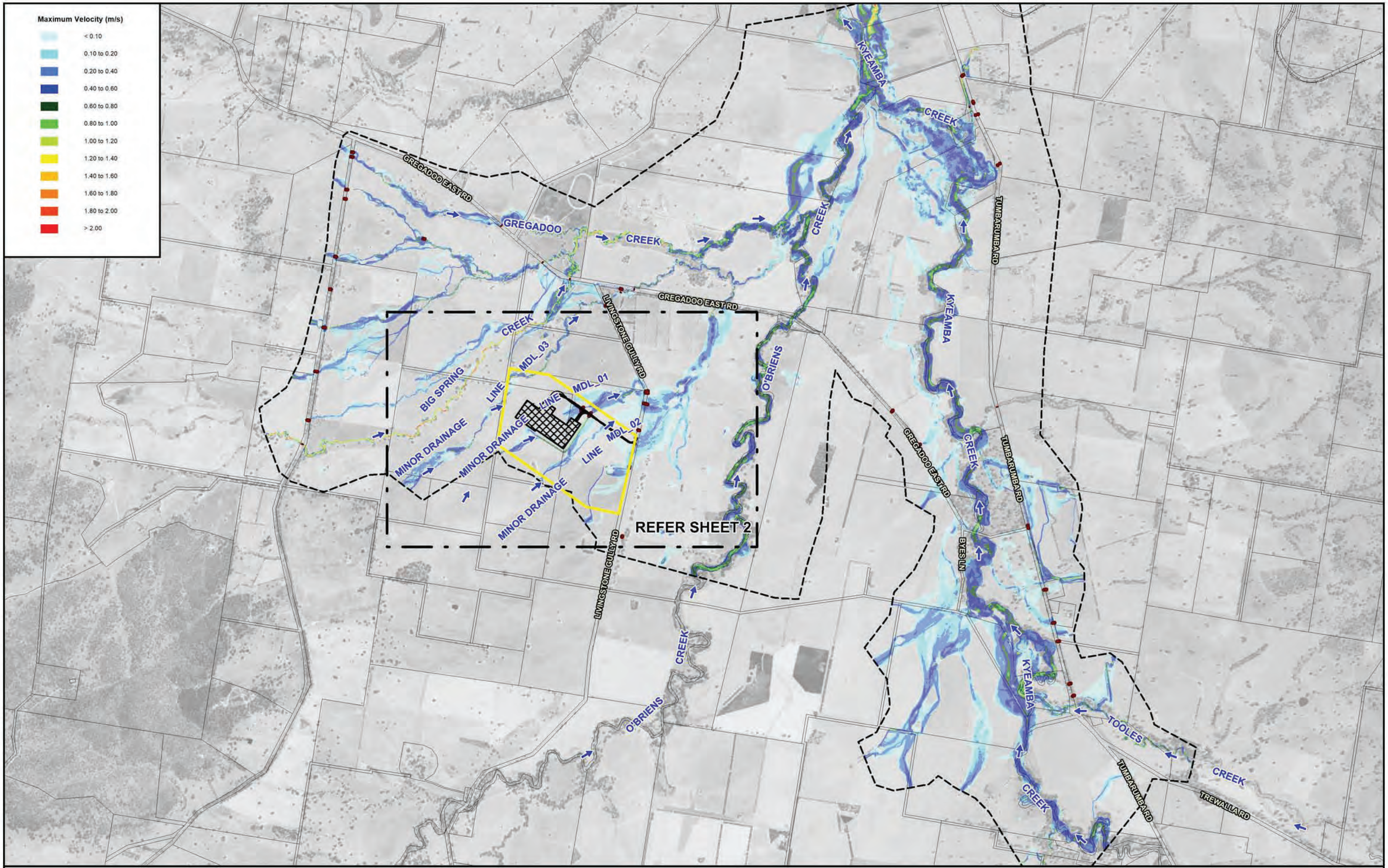
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 29
(Sheet 2 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON FLOOD BEHAVIOUR
20% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

Lyall & Associates

LEGEND

▨ Extent of Substation Bench (Indicative)

— Site Access Road (Indicative)

▭ Site Boundary

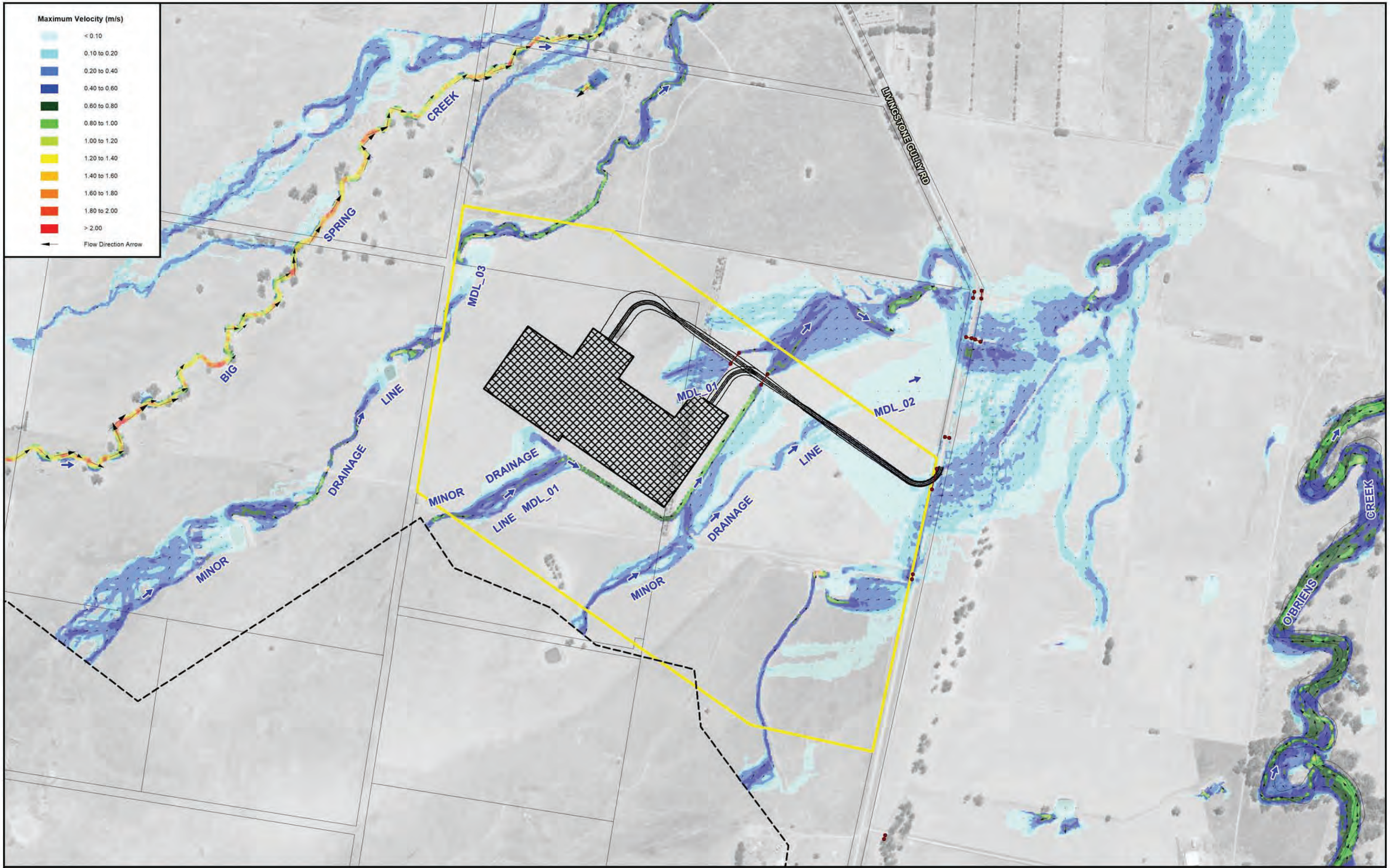
●—● Modelled Stormwater Drainage Network

- - - TUFLOW Model Extent

GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 30
(Sheet 1 of 2)

MAXIMUM FLOW VELOCITIES
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 20% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

▨	Extent of Substation Bench (Indicative)	—●—	Modelled Stormwater Drainage Network
—	Site Access Road (Indicative)	- - -	TUFLOW Model Extent
🟨	Site Boundary		

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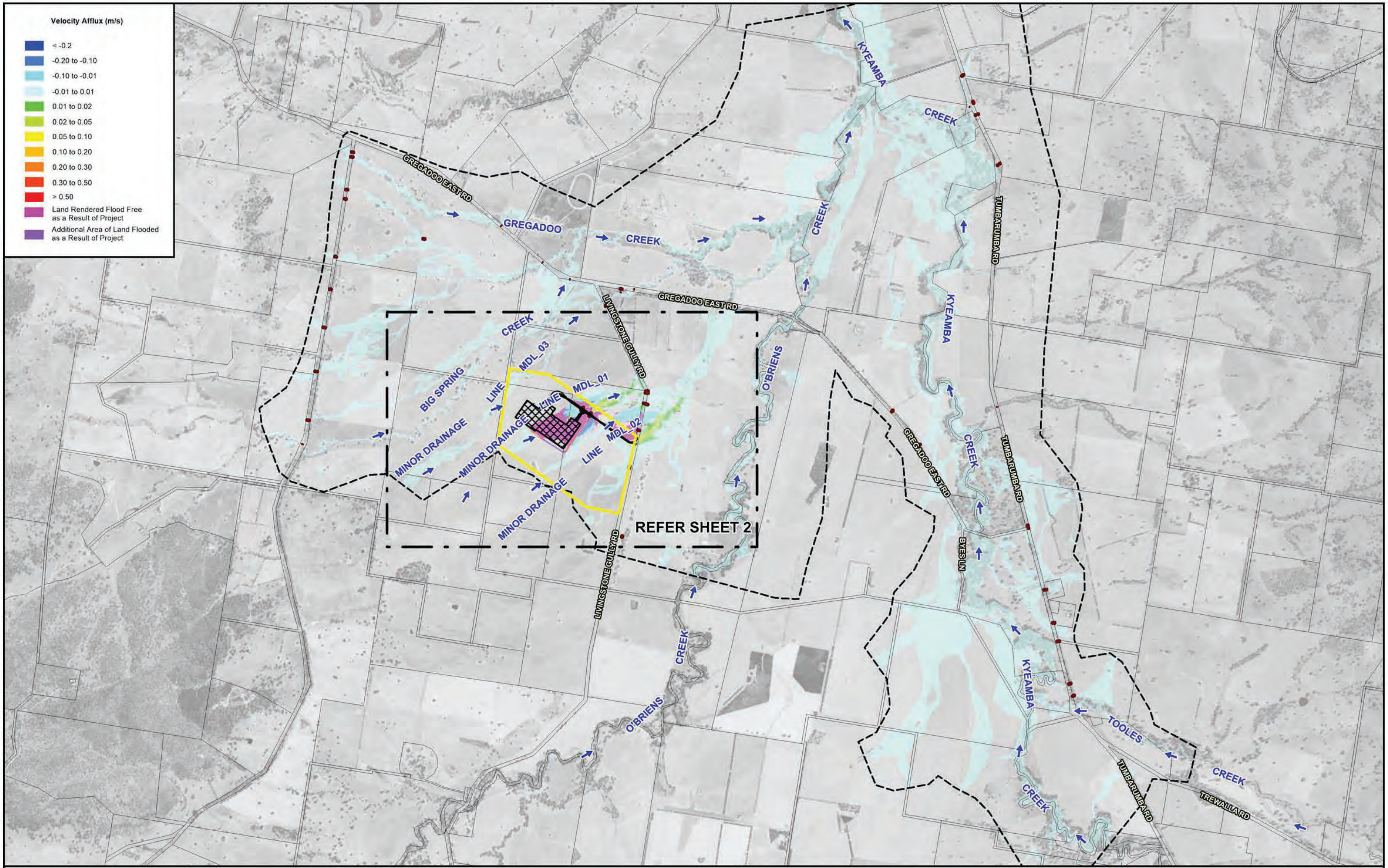
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 30
(Sheet 2 of 2)

MAXIMUM FLOW VELOCITIES
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 20% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

- Extent of Substation Bench (Indicative)
- Site Access Road (Indicative)
- Site Boundary
- Modelled Stormwater Drainage Network
- TUFLOW Model Extent

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GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 31
(Sheet 1 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON MAXIMUM FLOW VELOCITIES
20% AEP

N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

▨	Extent of Substation Bench (Indicative)
—	Site Access Road (Indicative)
—	Site Boundary
•—•	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent

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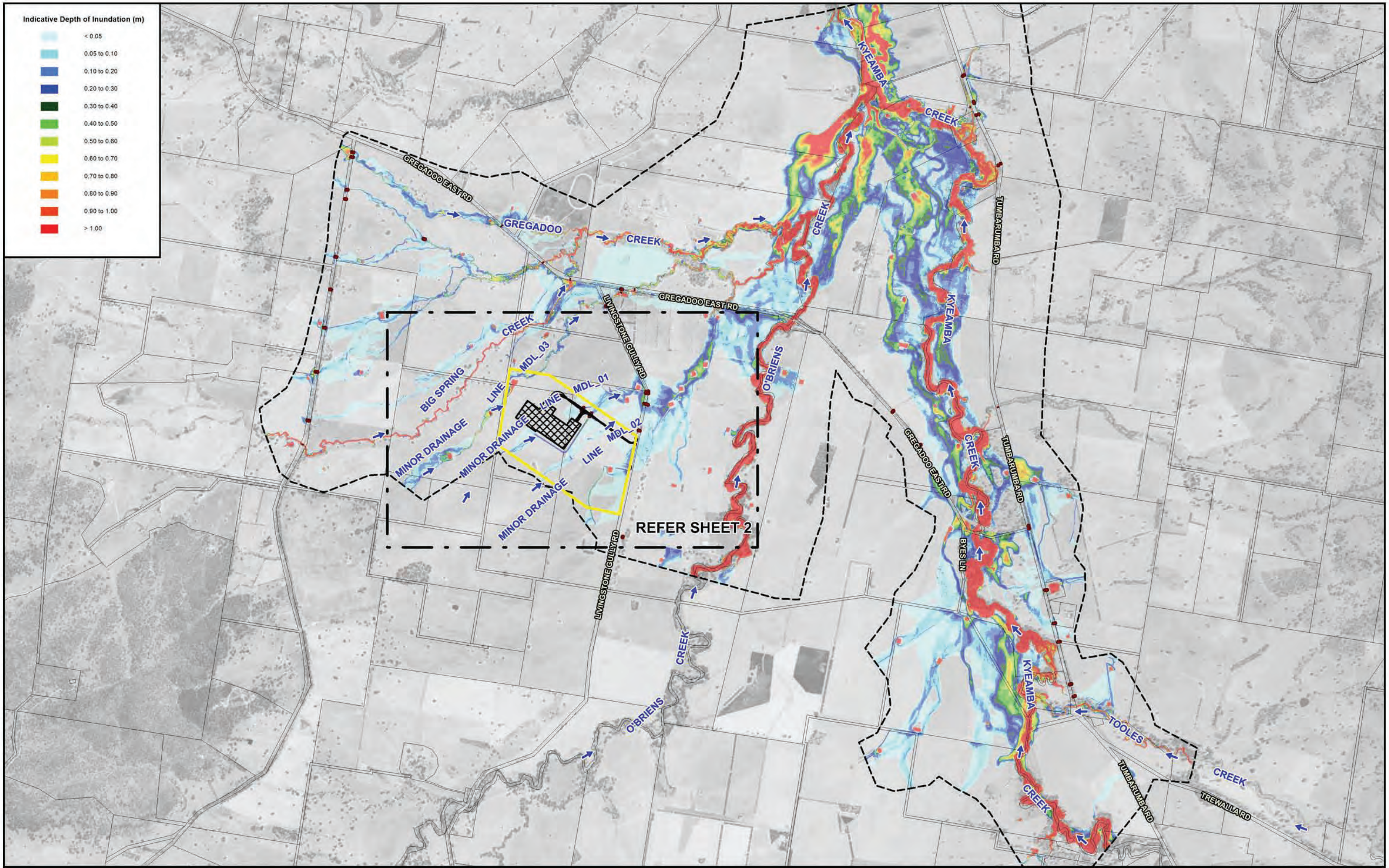
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 31
(Sheet 2 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON MAXIMUM FLOW VELOCITIES
20% AEP



LEGEND

▨ Extent of Substation Bench (Indicative)

— Site Access Road (Indicative)

— Site Boundary

—●— Modelled Stormwater Drainage Network

- - - TUFLOW Model Extent

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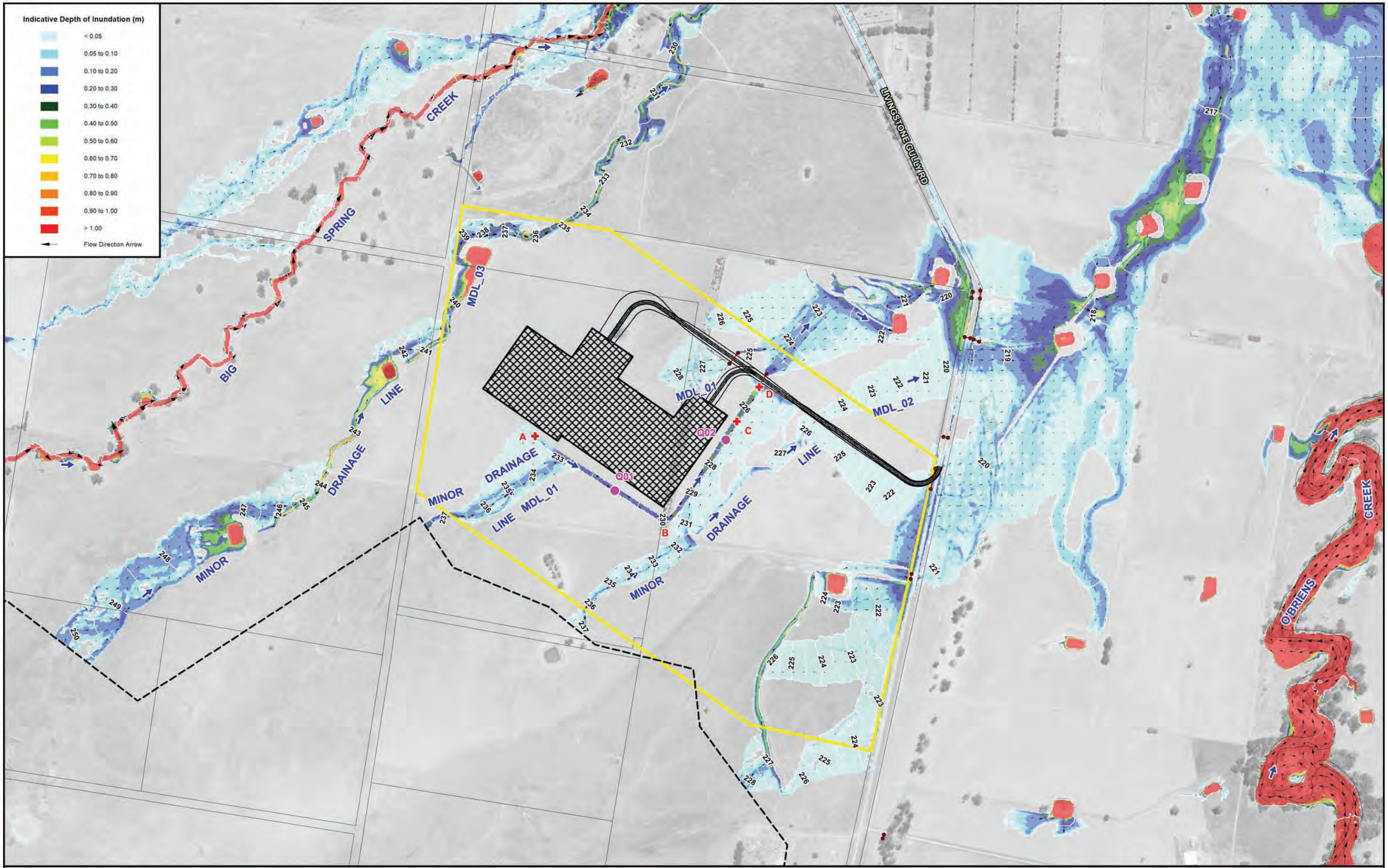
GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 32
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 10% AEP



80 0 80 160 240 m
Scale: 1:8,000

LEGEND

A ✚	Peak Flood Level Identifier (Refer Table 5 in Report)	▨	Extent of Substation Bench (Indicative)	●—●	Modelled Stormwater Drainage Network
Q01 ●	Peak Flow Identifier (Refer Table 6 in Report)	—	Site Access Road (Indicative)	- - -	TUFLOW Model Extent
		▬	Site Boundary	217	Water Surface Elevation Contours (m AHD)

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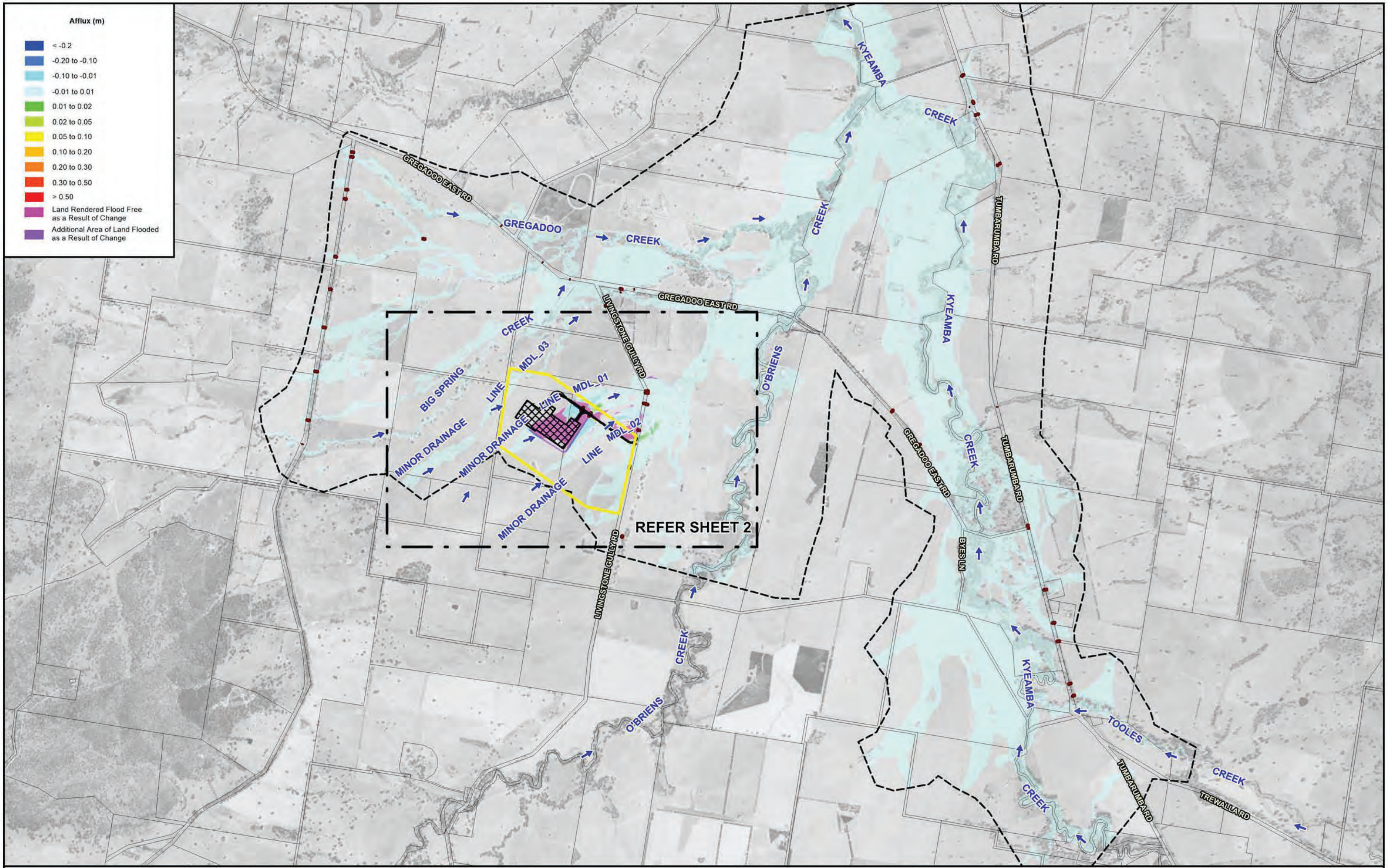
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 32
(Sheet 2 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 10% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨	Extent of Substation Bench (Indicative)
—	Site Access Road (Indicative)
🟨	Site Boundary
●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent

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GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 33
(Sheet 1 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON FLOOD BEHAVIOUR
10% AEP

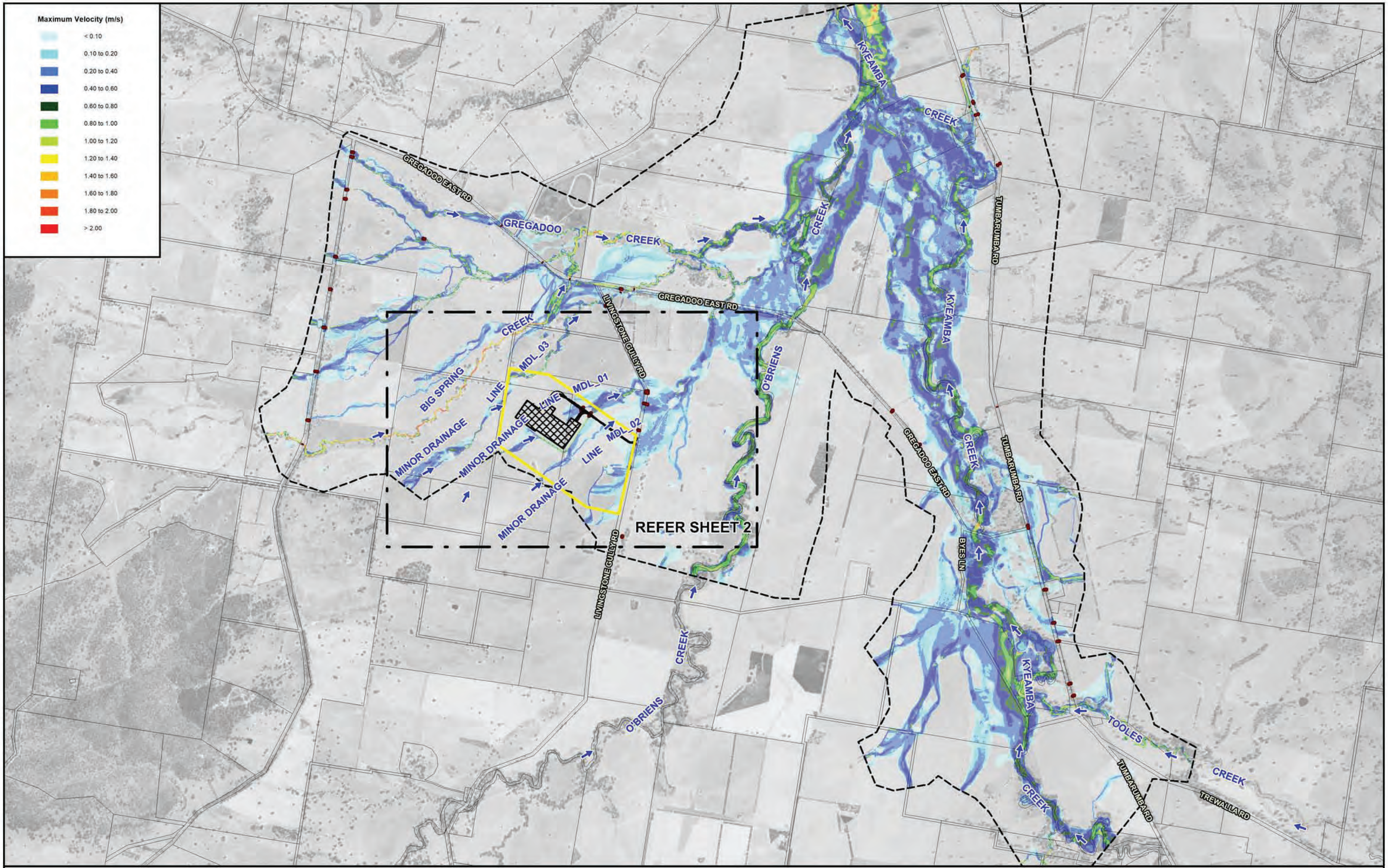
LEGEND

▨ Extent of Substation Bench (Indicative)	Modelled Stormwater Drainage Network
Site Access Road (Indicative)	TUFLOW Model Extent
Site Boundary	

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 33
(Sheet 2 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON FLOOD BEHAVIOUR
10% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨ Extent of Substation Bench (Indicative)

— Site Access Road (Indicative)

— Site Boundary

●—● Modelled Stormwater Drainage Network

- - - TUFLOW Model Extent

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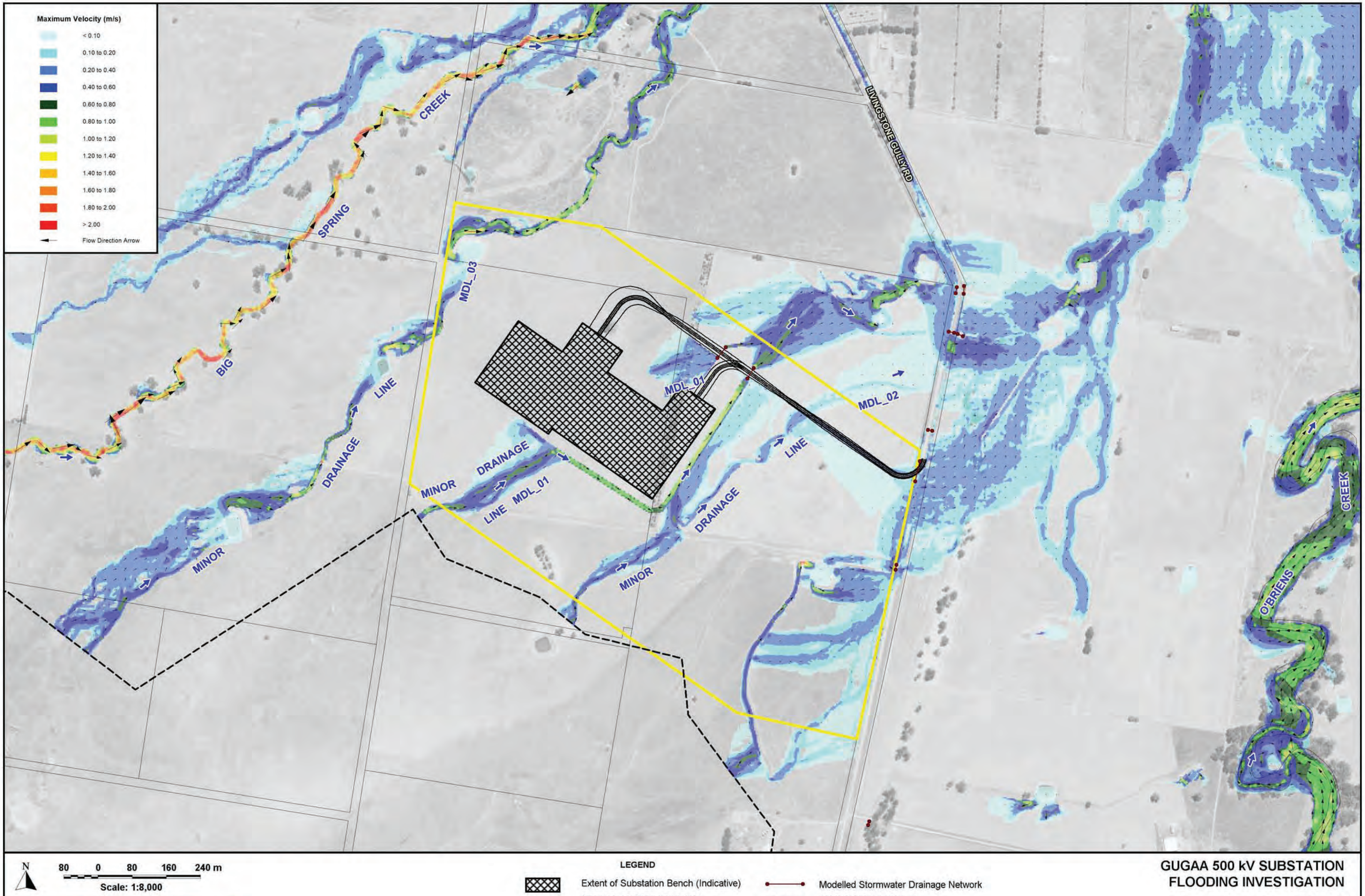
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 34
(Sheet 1 of 2)

MAXIMUM FLOW VELOCITIES
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 10% AEP



LEGEND

▨	Extent of Substation Bench (Indicative)
—	Site Access Road (Indicative)
🟨	Site Boundary
●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent

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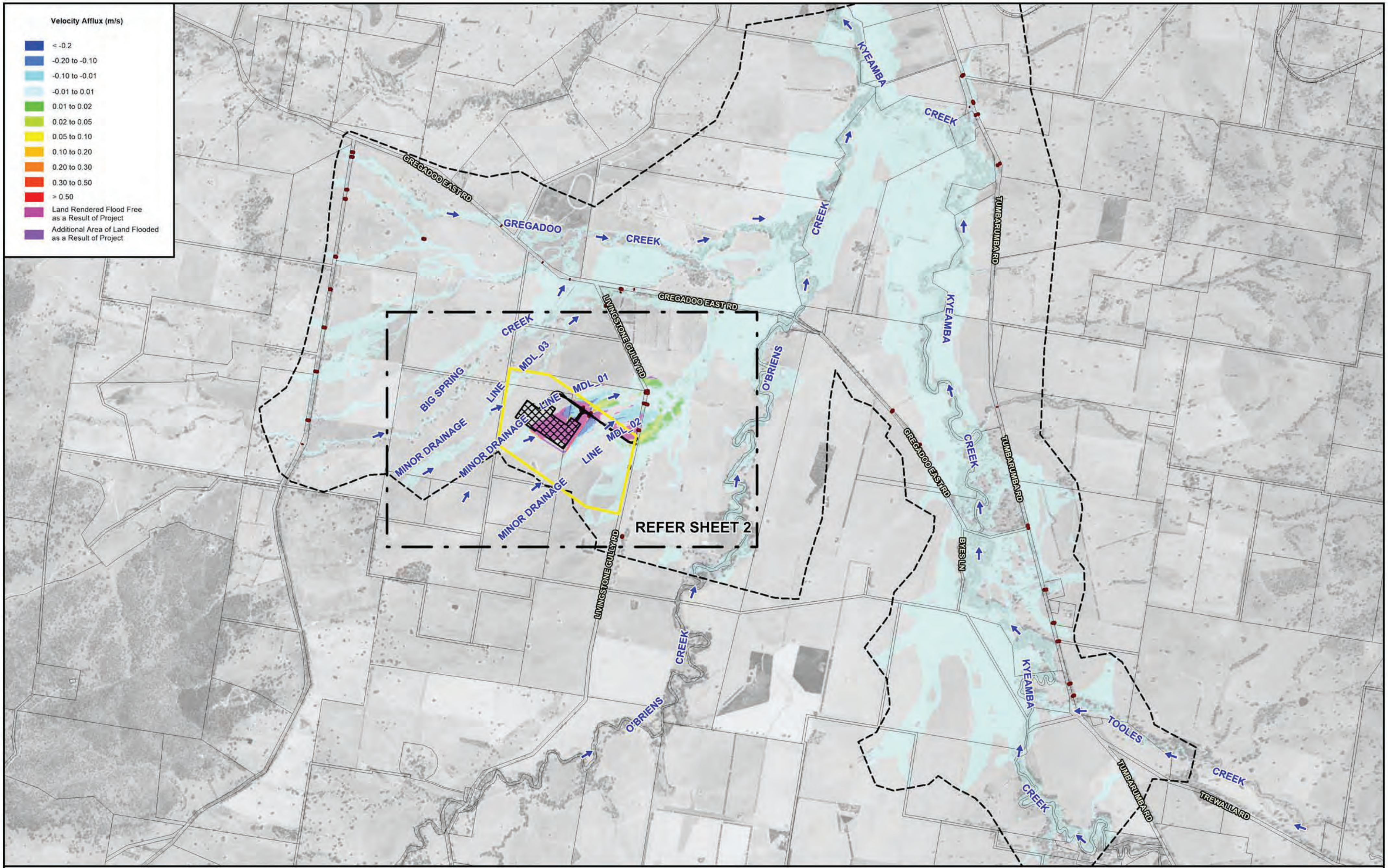
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 34
(Sheet 2 of 2)

MAXIMUM FLOW VELOCITIES
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 10% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨	Extent of Substation Bench (Indicative)
—	Site Access Road (Indicative)
🟨	Site Boundary
●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent

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GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 35
(Sheet 1 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON MAXIMUM FLOW VELOCITIES
10% AEP

LEGEND

▨ Extent of Substation Bench (Indicative)	Modelled Stormwater Drainage Network
Site Access Road (Indicative)	TUFLOW Model Extent
Site Boundary	

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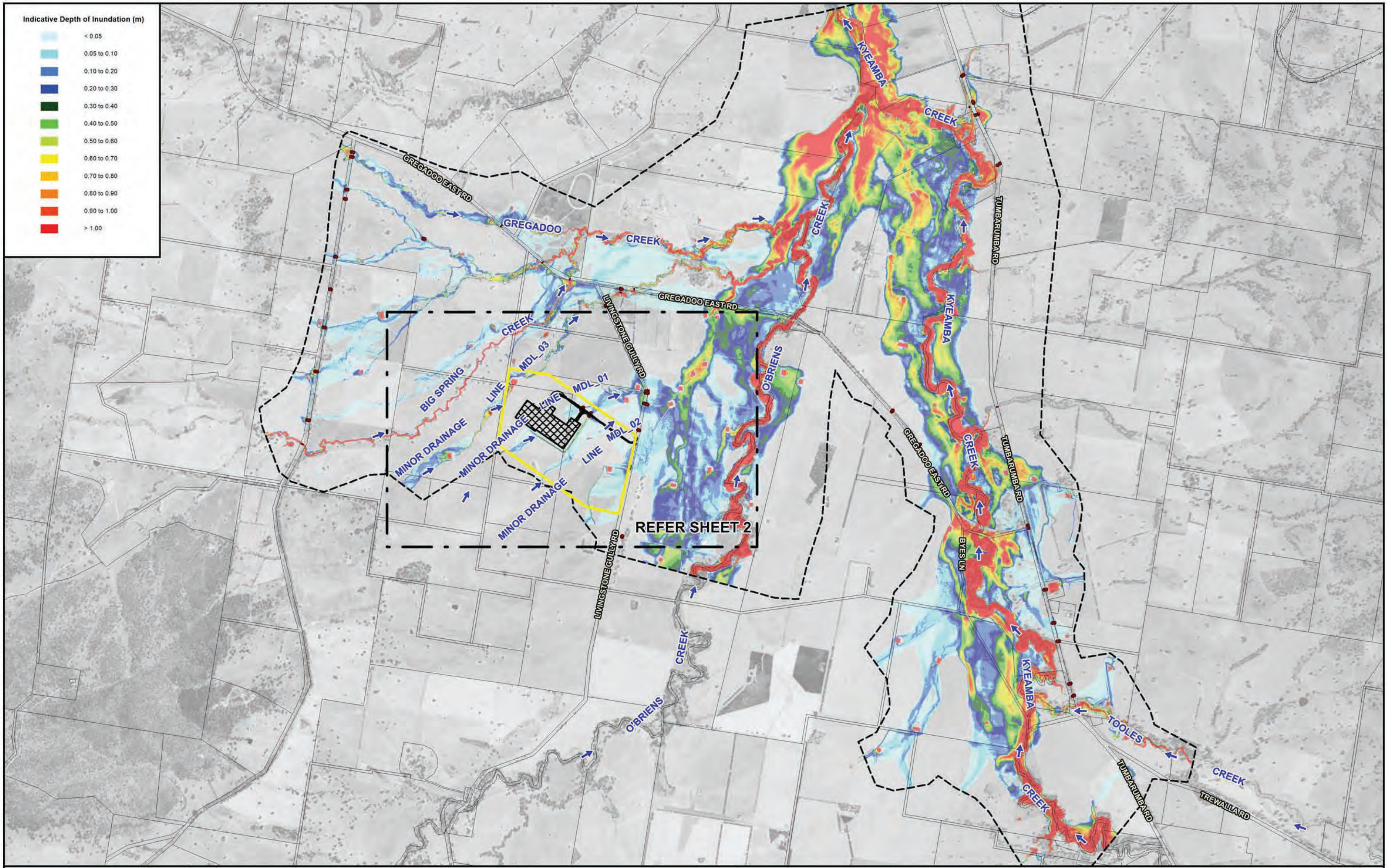
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 35
(Sheet 2 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON MAXIMUM FLOW VELOCITIES
10% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨ Extent of Substation Bench (Indicative)

— Site Access Road (Indicative)

▭ Site Boundary

—●— Modelled Stormwater Drainage Network

- - - TUFLOW Model Extent

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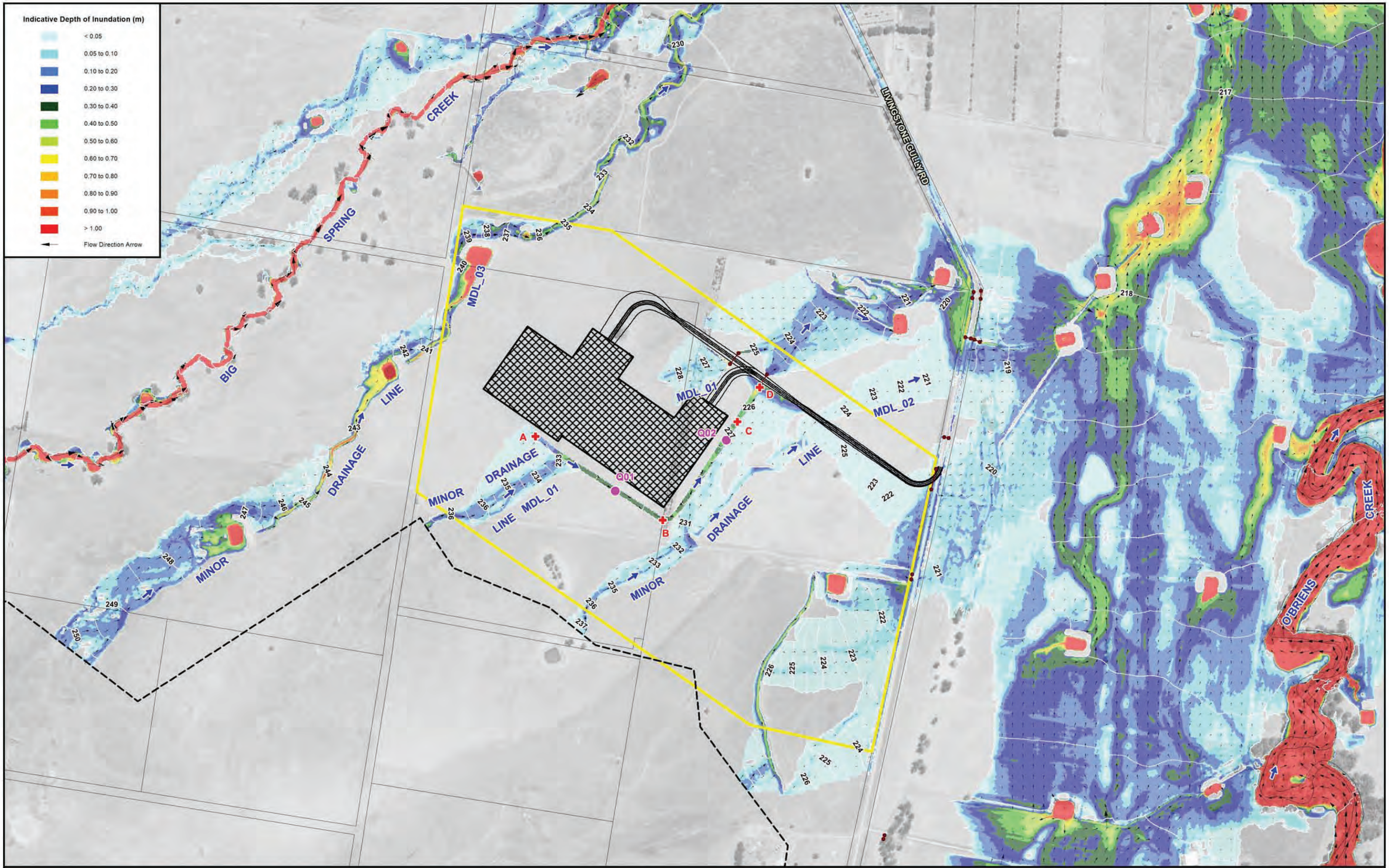
GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 36
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 5% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

A ✚	Peak Flood Level Identifier (Refer Table 5 in Report)
Q01 ●	Peak Flow Identifier (Refer Table 6 in Report)
▨	Extent of Substation Bench (Indicative)
──	Site Access Road (Indicative)
▬	Site Boundary
●─●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent
217	Water Surface Elevation Contours (m AHD)

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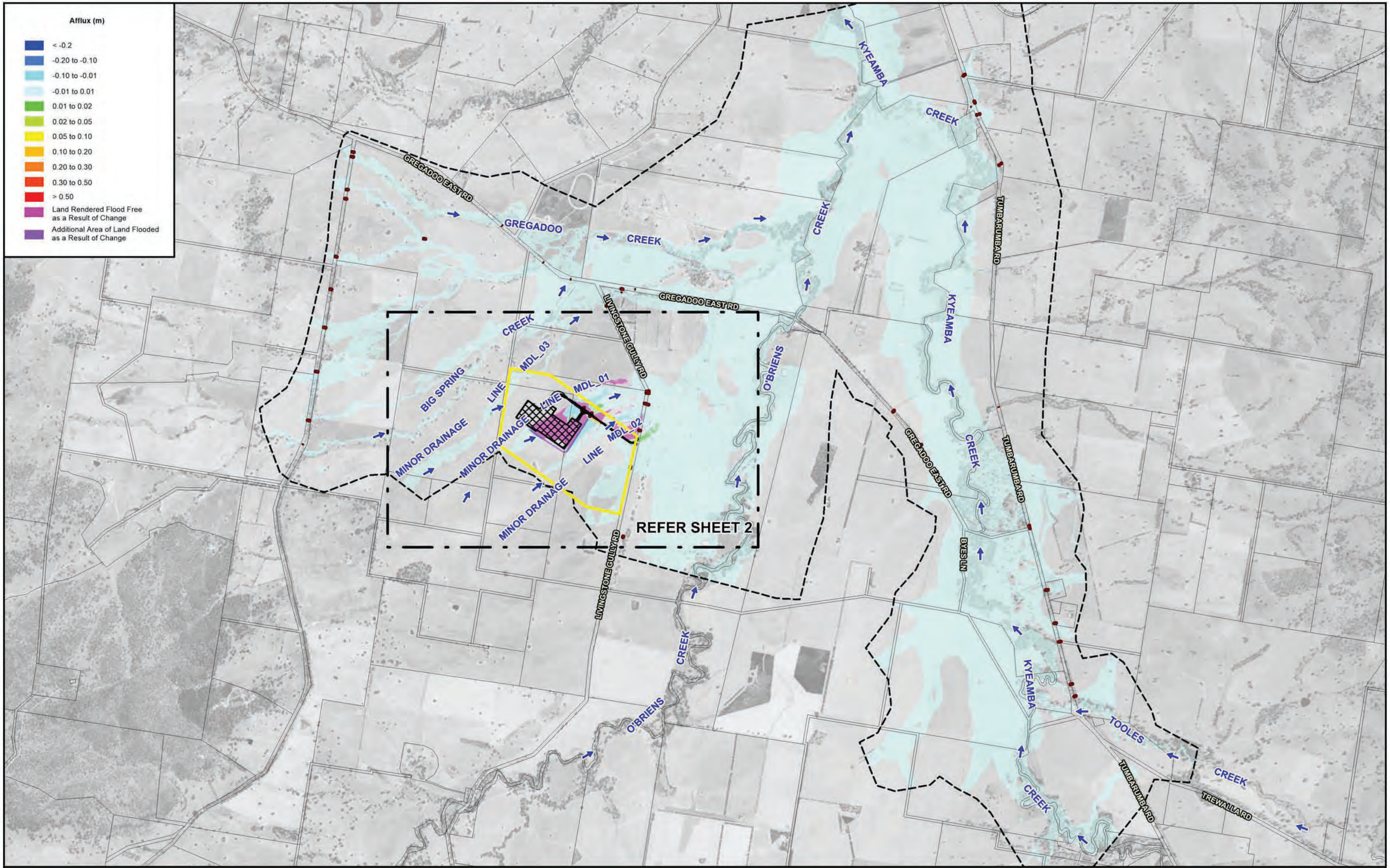
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 36
(Sheet 2 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 5% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨ Extent of Substation Bench (Indicative)

Site Access Road (Indicative)

Site Boundary

Modelled Stormwater Drainage Network

TUFLOW Model Extent

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GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 37
(Sheet 1 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON FLOOD BEHAVIOUR
5% AEP

LEGEND

▨ Extent of Substation Bench (Indicative)

Site Access Road (Indicative)

Site Boundary

Modelled Stormwater Drainage Network

TUFLOW Model Extent

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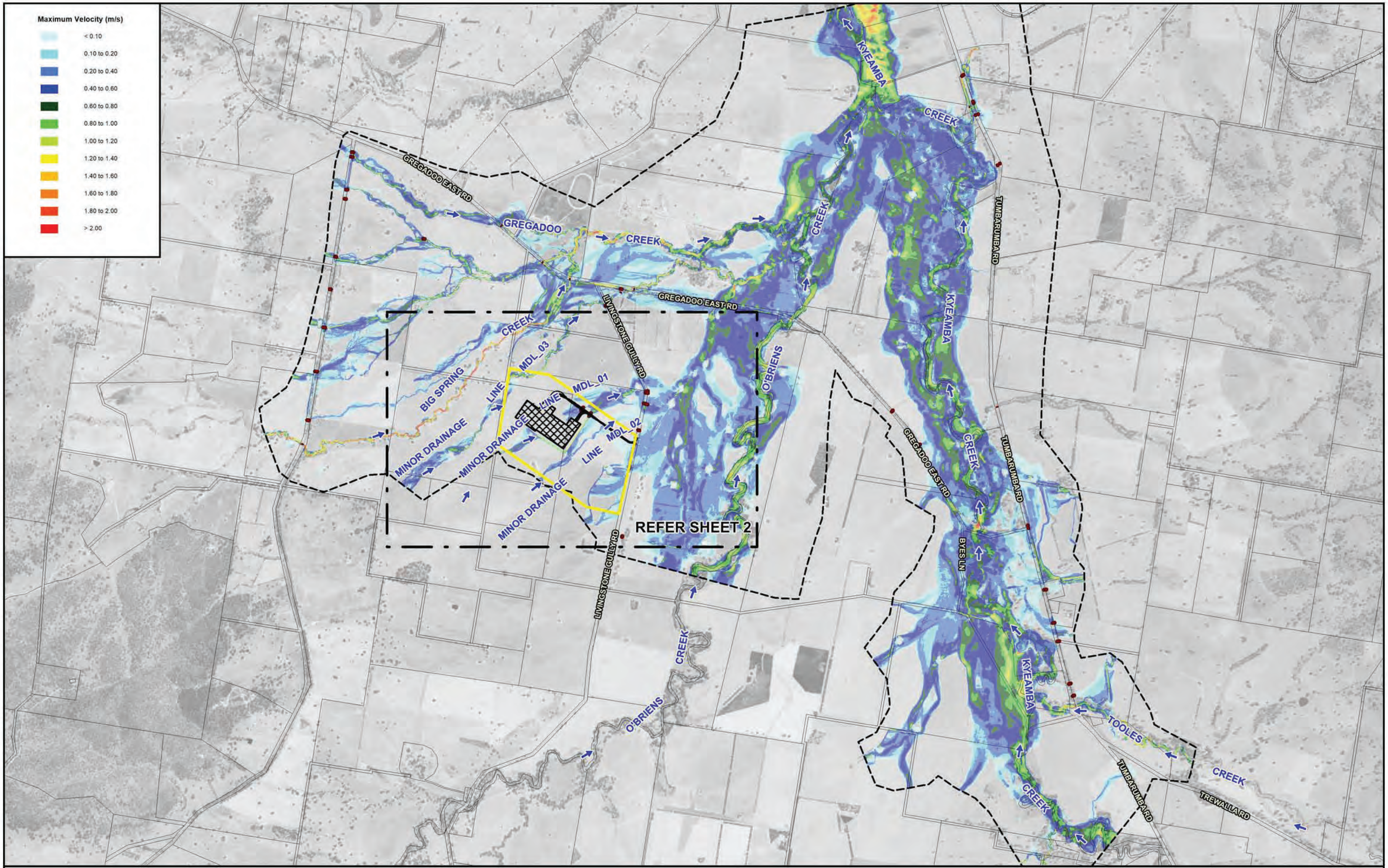
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 37
(Sheet 2 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON FLOOD BEHAVIOUR
5% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨ Extent of Substation Bench (Indicative)	Modelled Stormwater Drainage Network
Site Access Road (Indicative)	TUFLOW Model Extent
Site Boundary	

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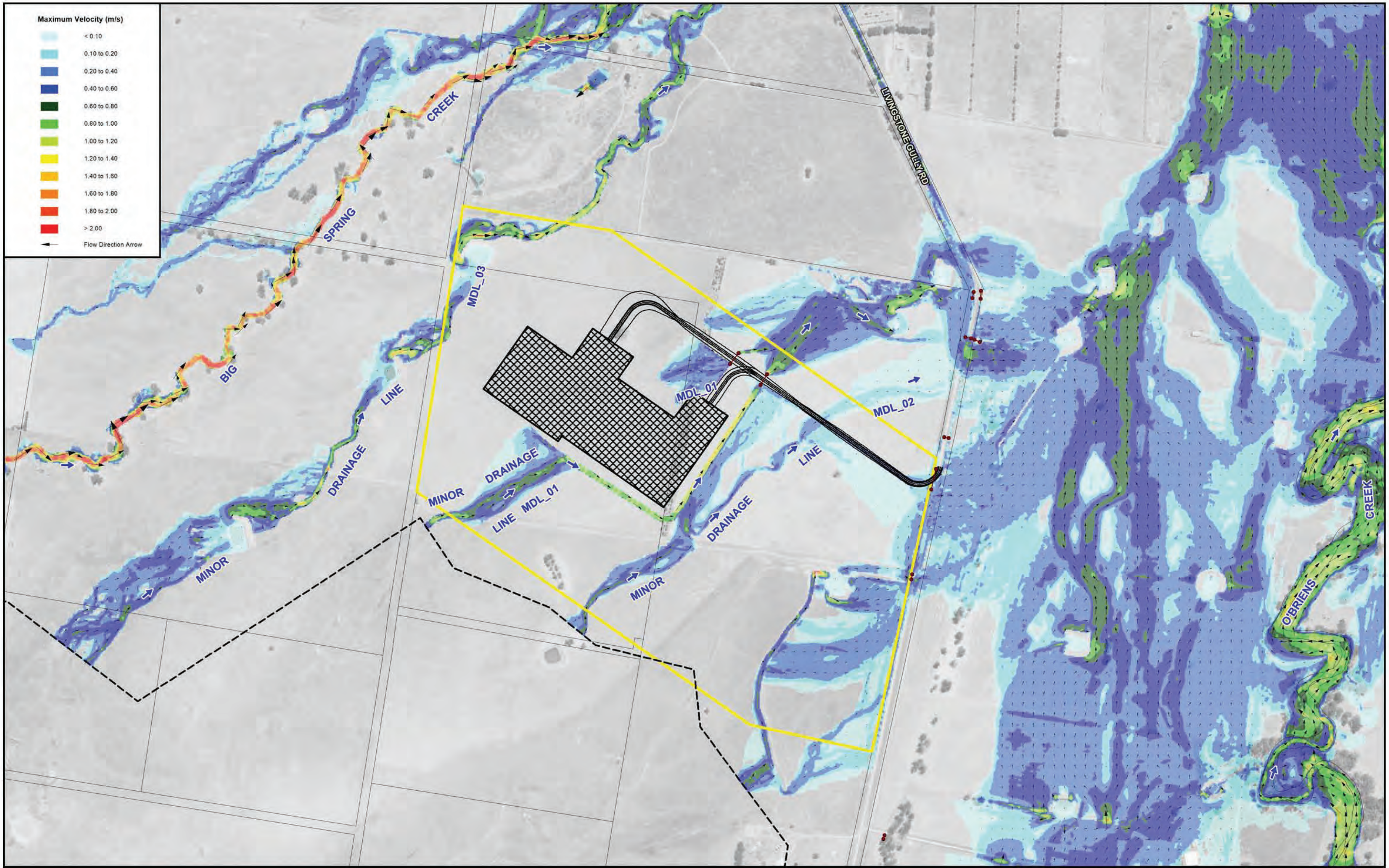
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 38
(Sheet 1 of 2)

MAXIMUM FLOW VELOCITIES
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 5% AEP



LEGEND

- ▨ Extent of Substation Bench (Indicative)
- — Site Access Road (Indicative)
- 🟨 Site Boundary
- ●—● Modelled Stormwater Drainage Network
- - - - TUFLOW Model Extent

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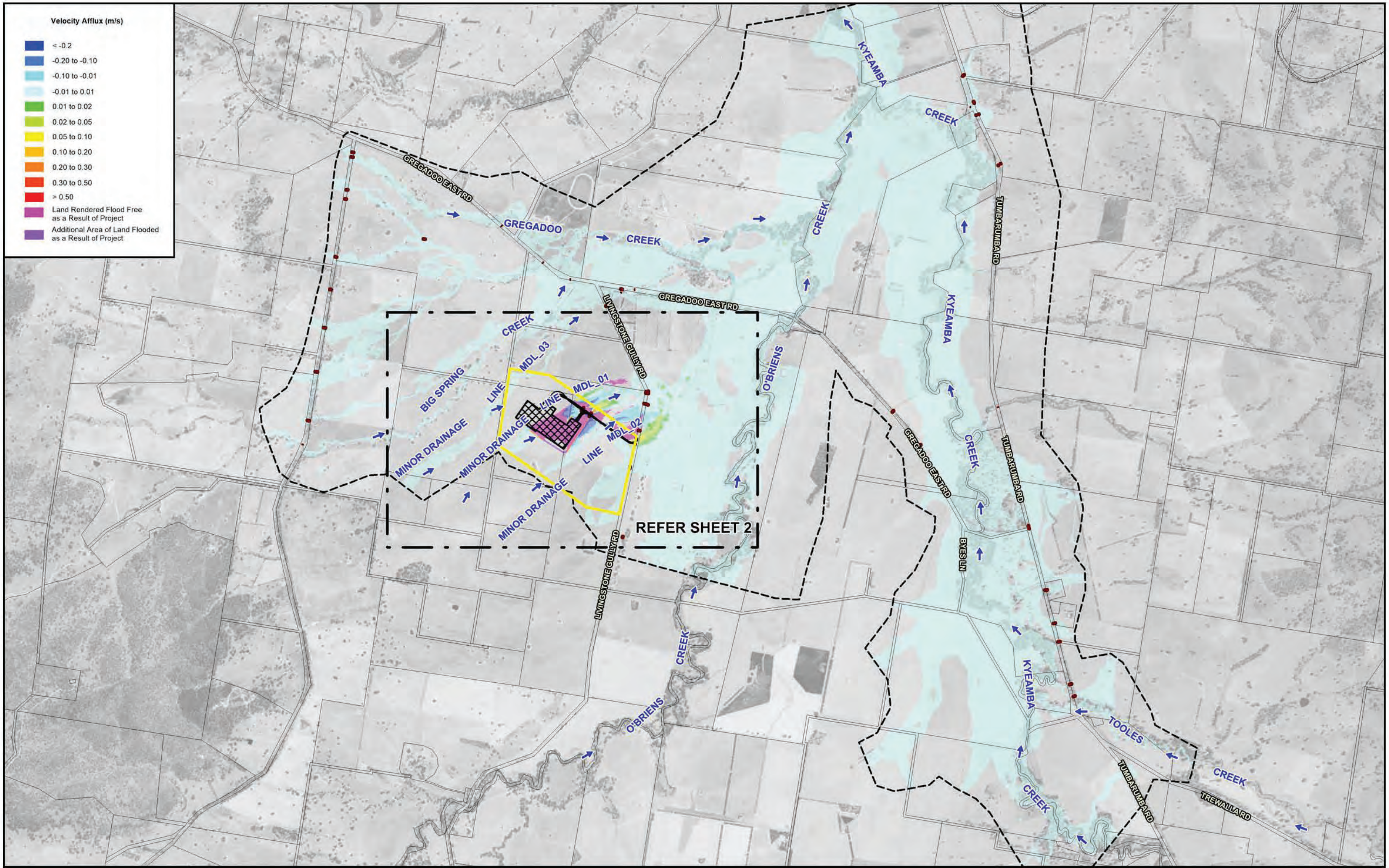
GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 38
(Sheet 2 of 2)

MAXIMUM FLOW VELOCITIES
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 5% AEP



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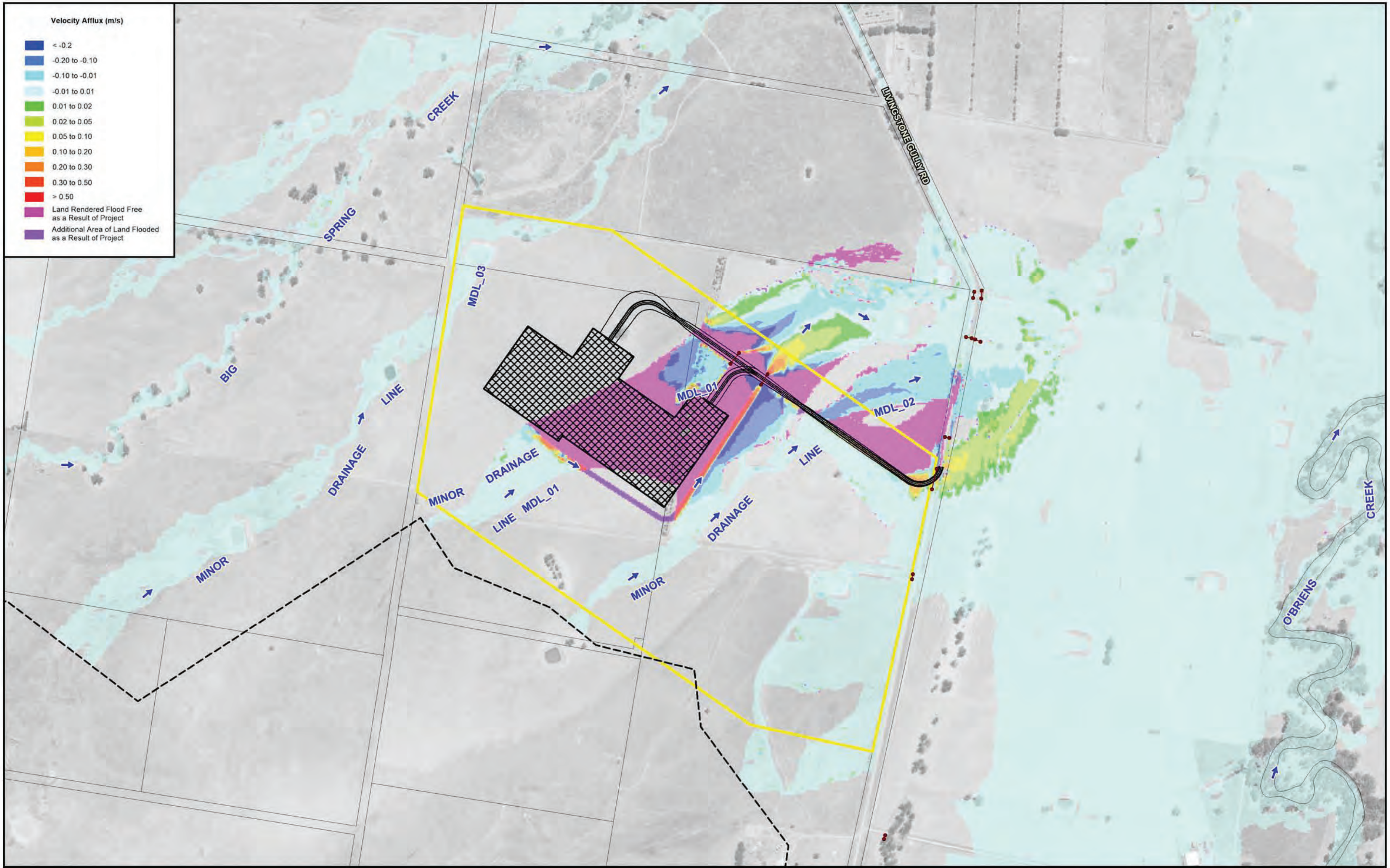
GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 39
(Sheet 1 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON MAXIMUM FLOW VELOCITIES
5% AEP



Scale: 1:8,000

LEGEND

▨ Extent of Substation Bench (Indicative)

Site Access Road (Indicative)

Site Boundary

Modelled Stormwater Drainage Network

TUFLOW Model Extent

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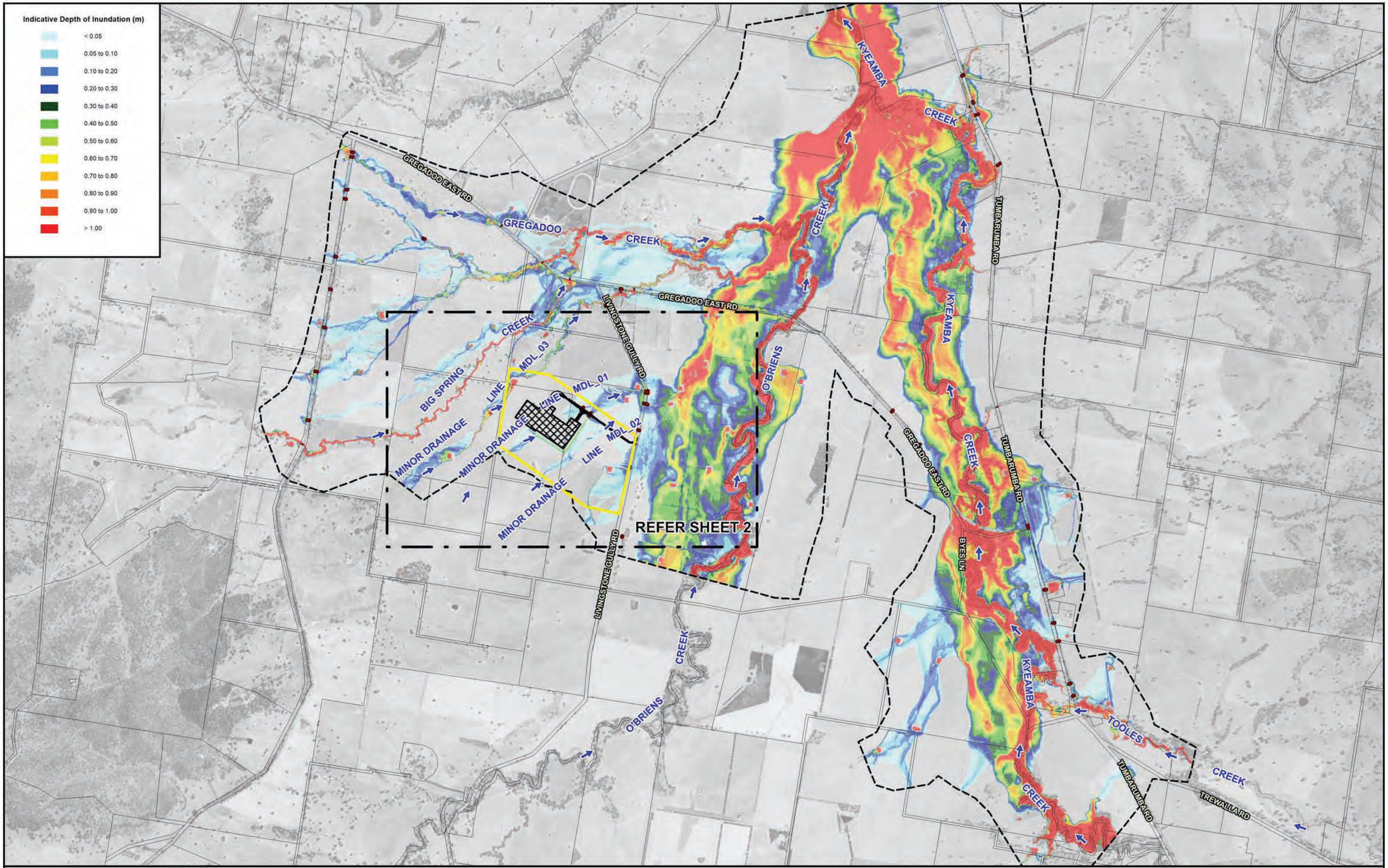
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 39
(Sheet 2 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON MAXIMUM FLOW VELOCITIES
5% AEP



N
300 0 300 600 900 m
Scale: 1:30,000

LEGEND

▨ Extent of Substation Bench (Indicative)
— Site Access Road (Indicative)
🟨 Site Boundary
●—● Modelled Stormwater Drainage Network
- - - TUFLOW Model Extent

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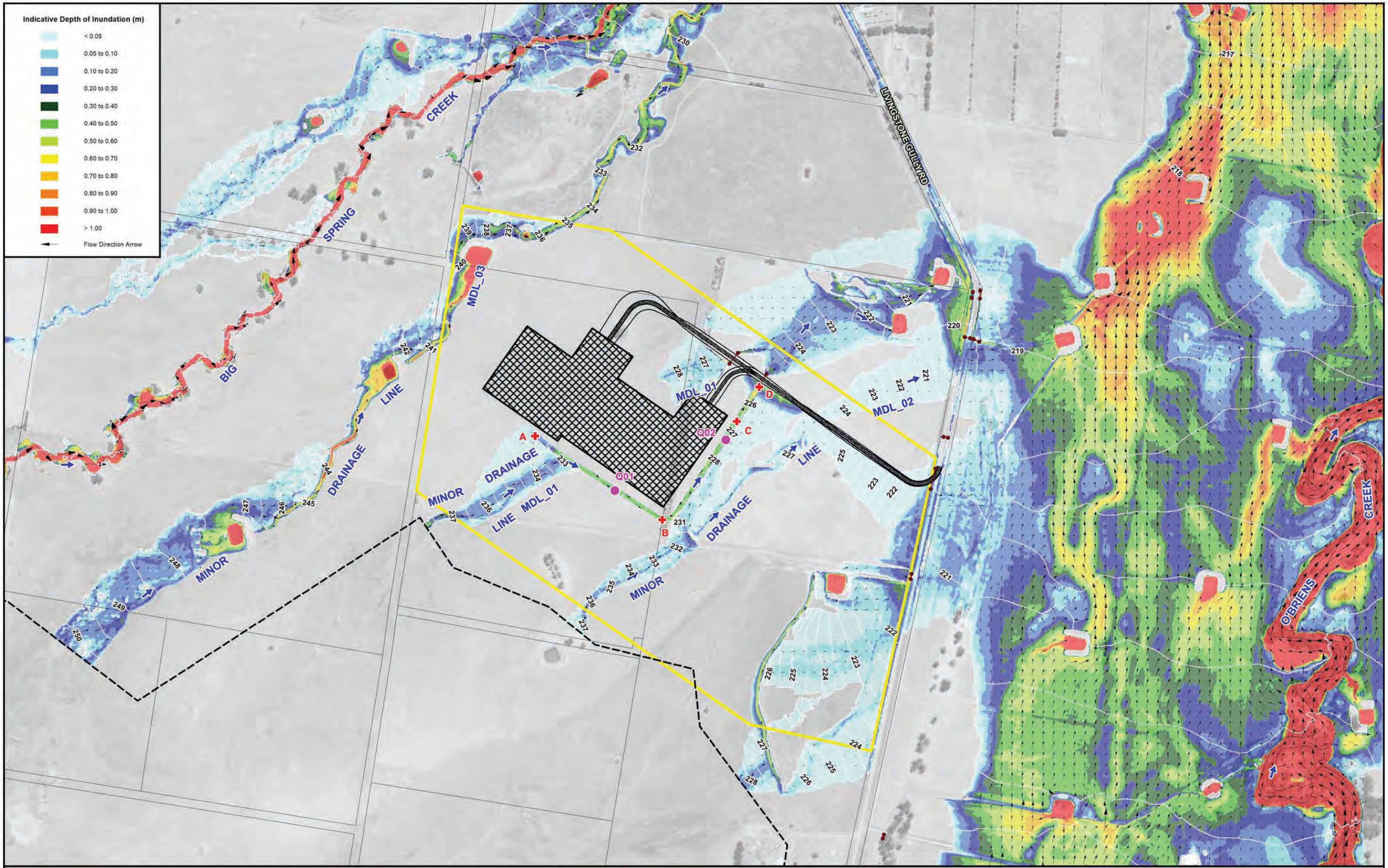
GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 40
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 2% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

A ✚	Peak Flood Level Identifier (Refer Table 5 in Report)
Q01 ●	Peak Flow Identifier (Refer Table 6 in Report)
▩	Extent of Substation Bench (Indicative)
—	Site Access Road (Indicative)
🟨	Site Boundary
●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent
217	Water Surface Elevation Contours (m AHD)

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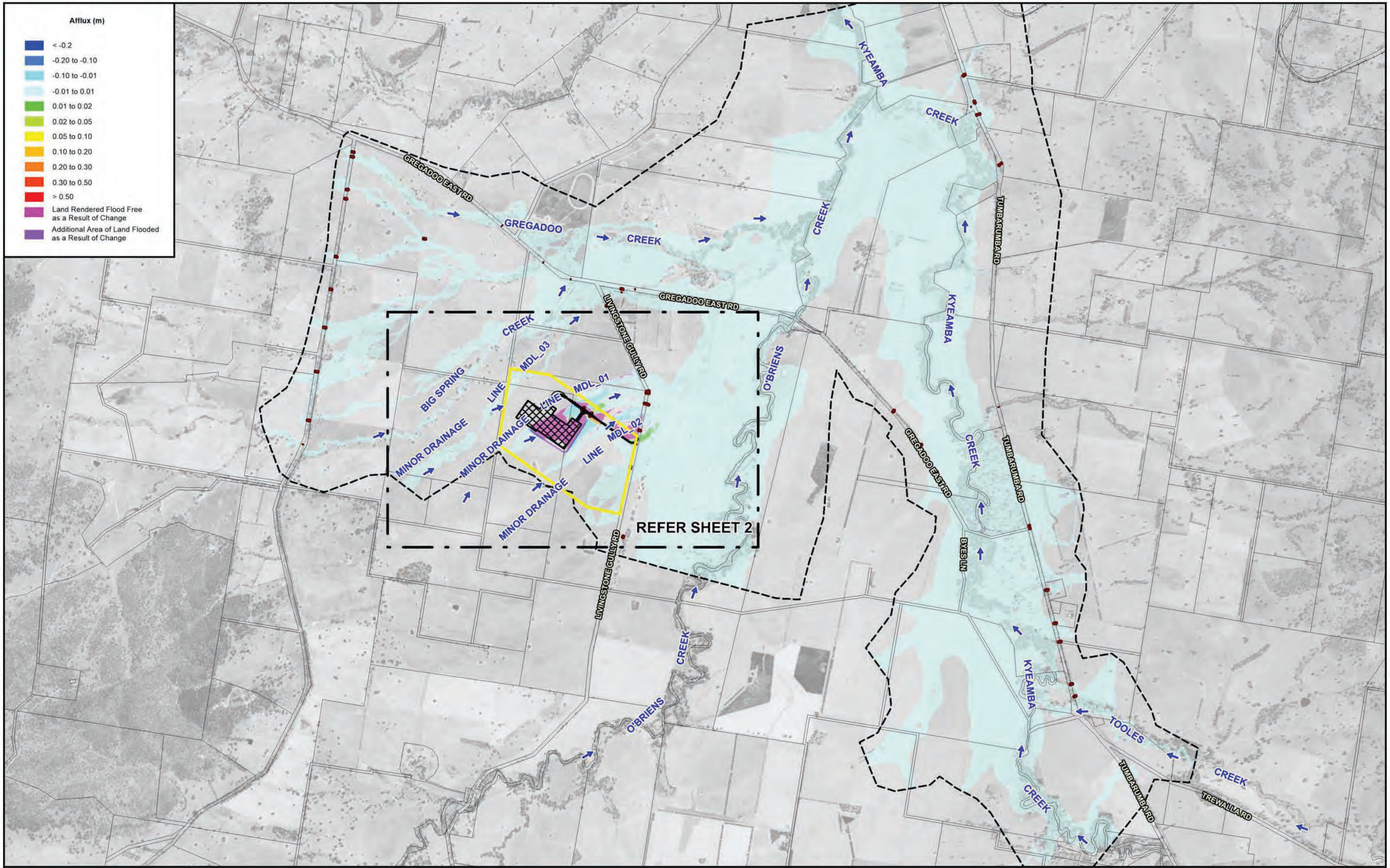
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 40
(Sheet 2 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 2% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

- ▨ Extent of Substation Bench (Indicative)
- Site Access Road (Indicative)
- Site Boundary
- Modelled Stormwater Drainage Network
- TUFLOW Model Extent

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GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 41
(Sheet 1 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON FLOOD BEHAVIOUR
2% AEP

N

80 0 80 160 240 m

Scale: 1:8,000

Lyall & Associates

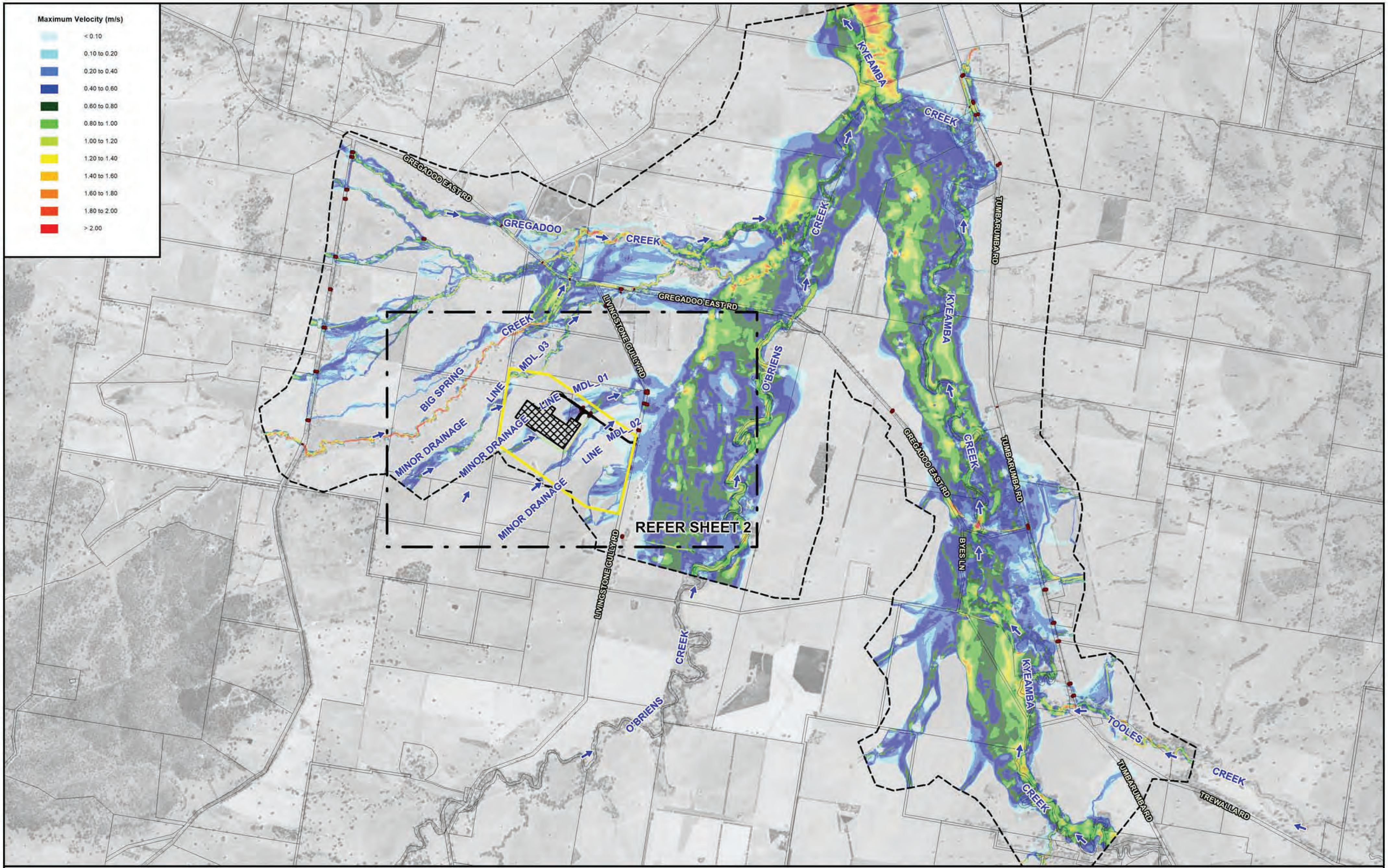
LEGEND

▨	Extent of Substation Bench (Indicative)
—	Site Access Road (Indicative)
🟨	Site Boundary
●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent

GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 41
(Sheet 2 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON FLOOD BEHAVIOUR
2% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨ Extent of Substation Bench (Indicative)

— Site Access Road (Indicative)

— Site Boundary

●—● Modelled Stormwater Drainage Network

- - - TUFLOW Model Extent

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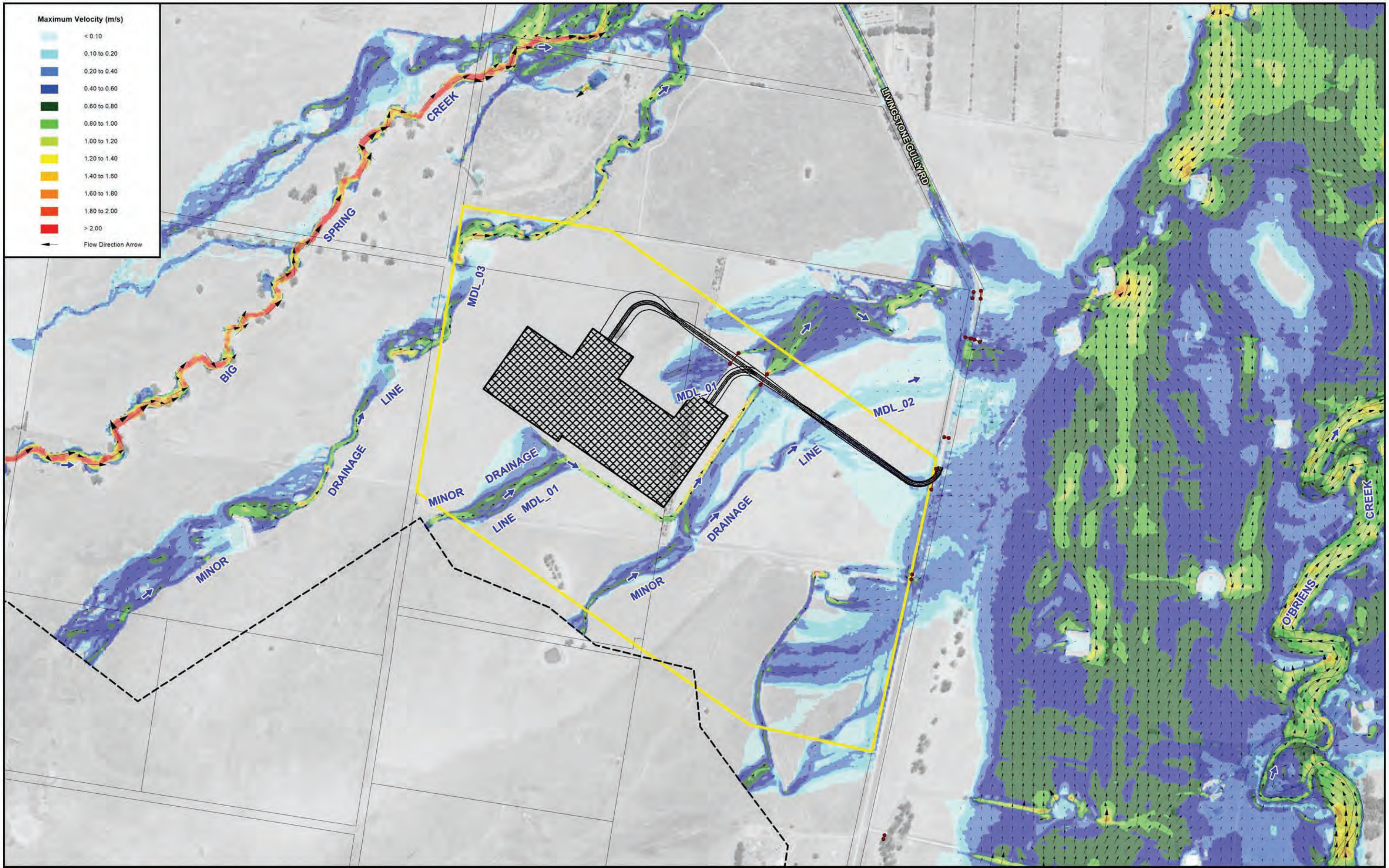
**GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION**

Figure 42
(Sheet 1 of 2)

MAXIMUM FLOW VELOCITIES
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 2% AEP



LEGEND

▨	Extent of Substation Bench (Indicative)	●—●	Modelled Stormwater Drainage Network
—	Site Access Road (Indicative)	- - -	TUFLOW Model Extent
🟨	Site Boundary		

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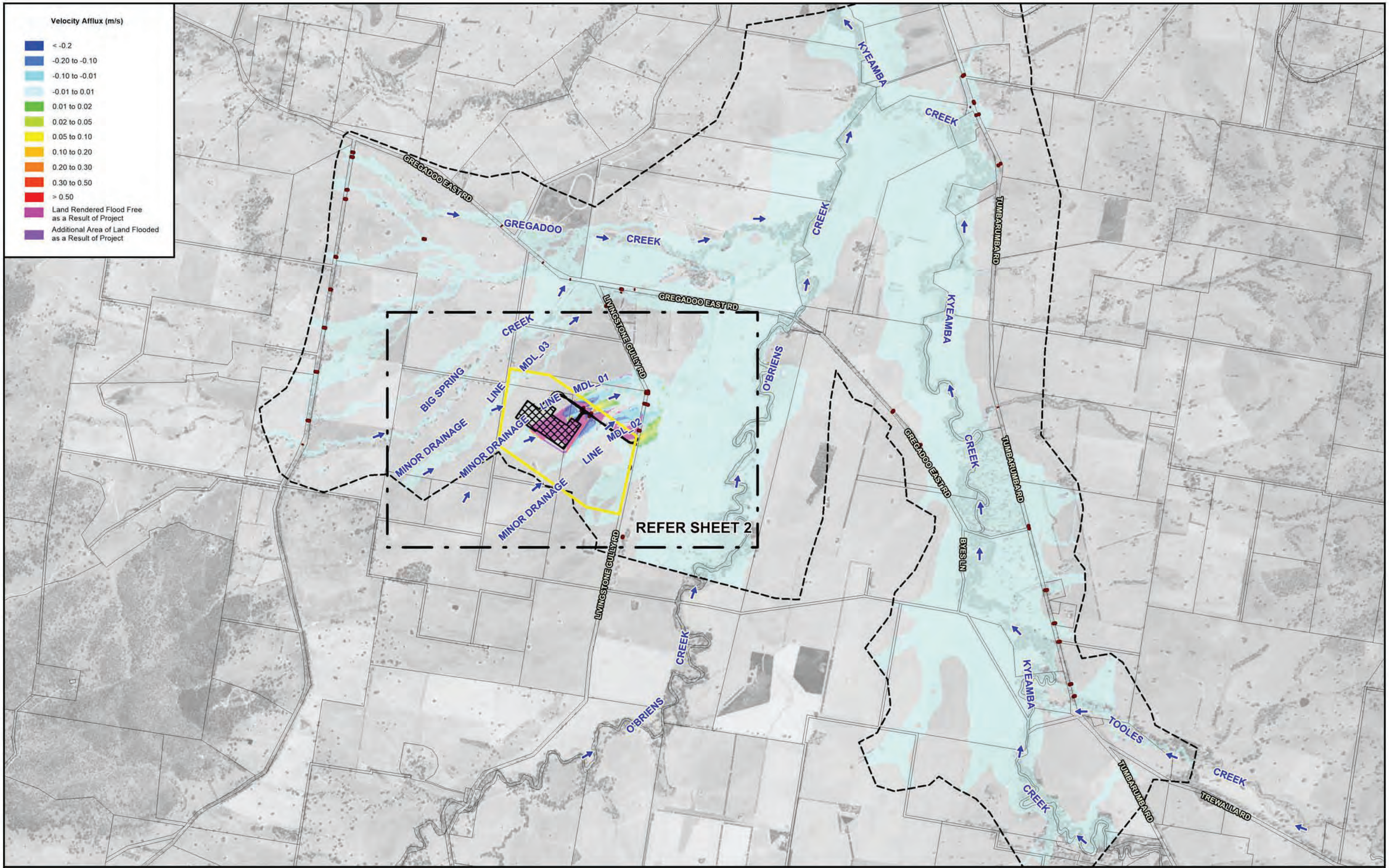
GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 42
(Sheet 2 of 2)

MAXIMUM FLOW VELOCITIES
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 2% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨ Extent of Substation Bench (Indicative)

Site Access Road (Indicative)

Site Boundary

Modelled Stormwater Drainage Network

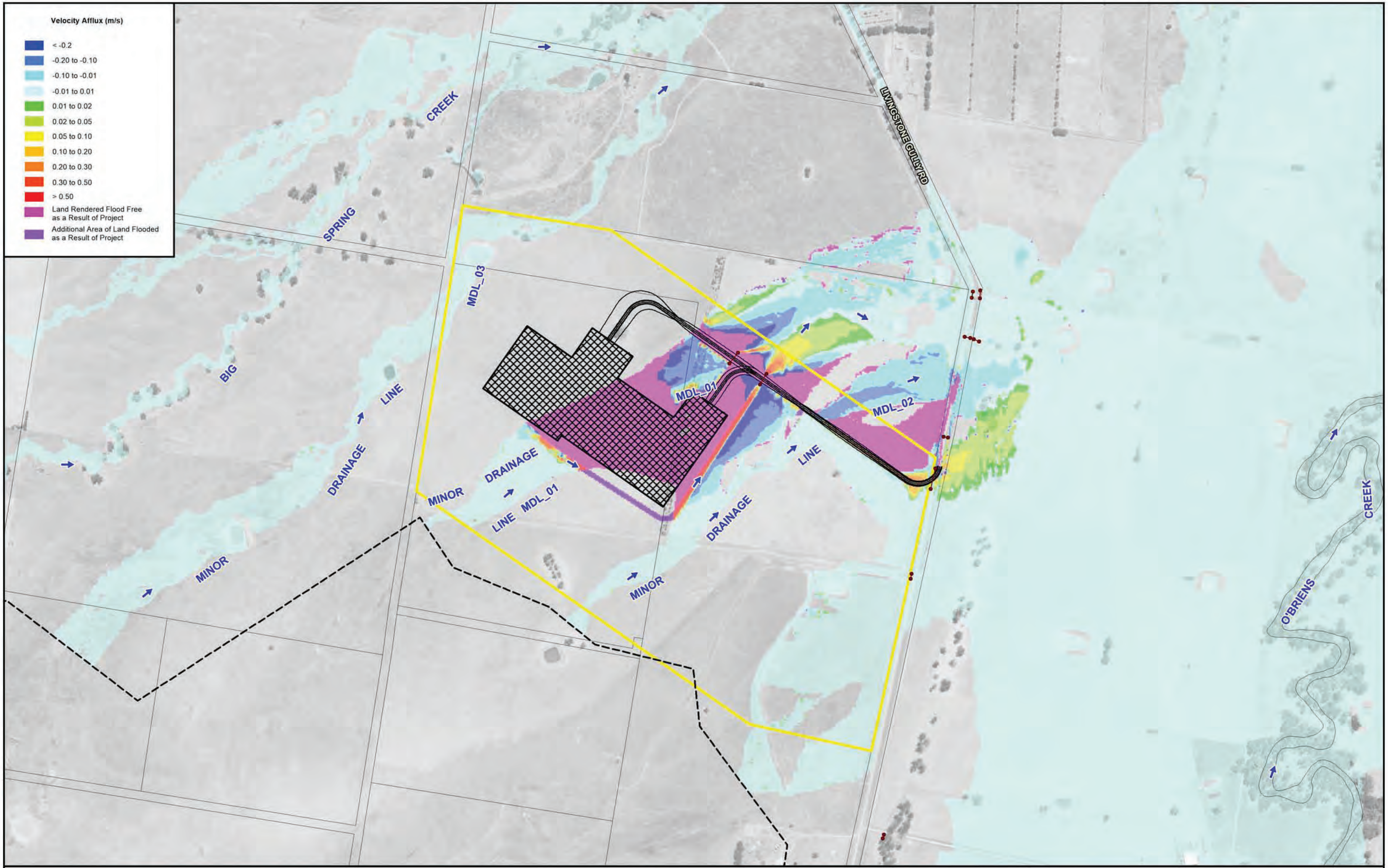
TUFLOW Model Extent

Lyall & Associates

GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 43
(Sheet 1 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON MAXIMUM FLOW VELOCITIES
2% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

▨ Extent of Substation Bench (Indicative)

Site Access Road (Indicative)

Site Boundary

Modelled Stormwater Drainage Network

TUFLOW Model Extent

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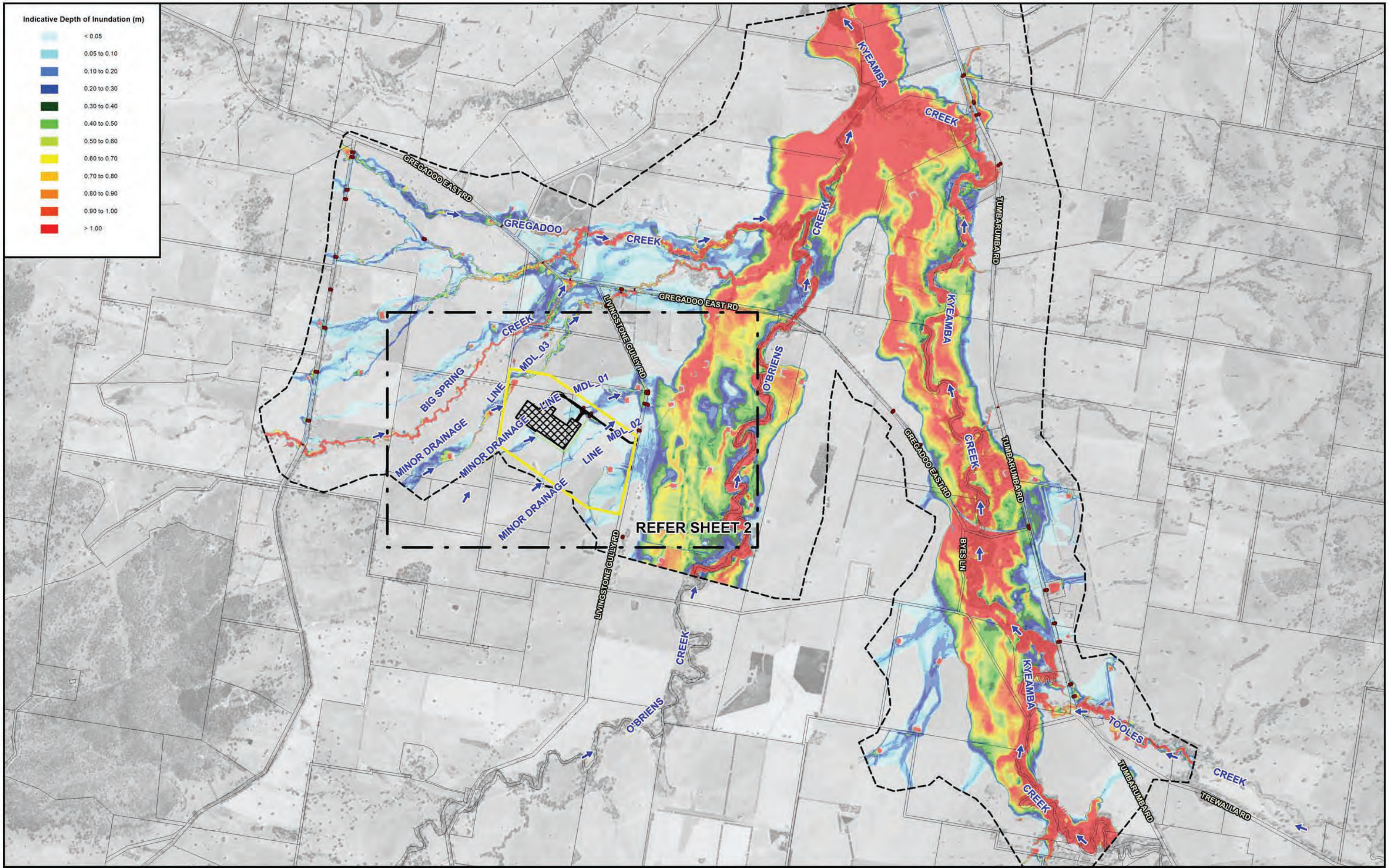
GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 43
(Sheet 2 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON MAXIMUM FLOW VELOCITIES
2% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨	Extent of Substation Bench (Indicative)
—	Site Access Road (Indicative)
🟨	Site Boundary
●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent

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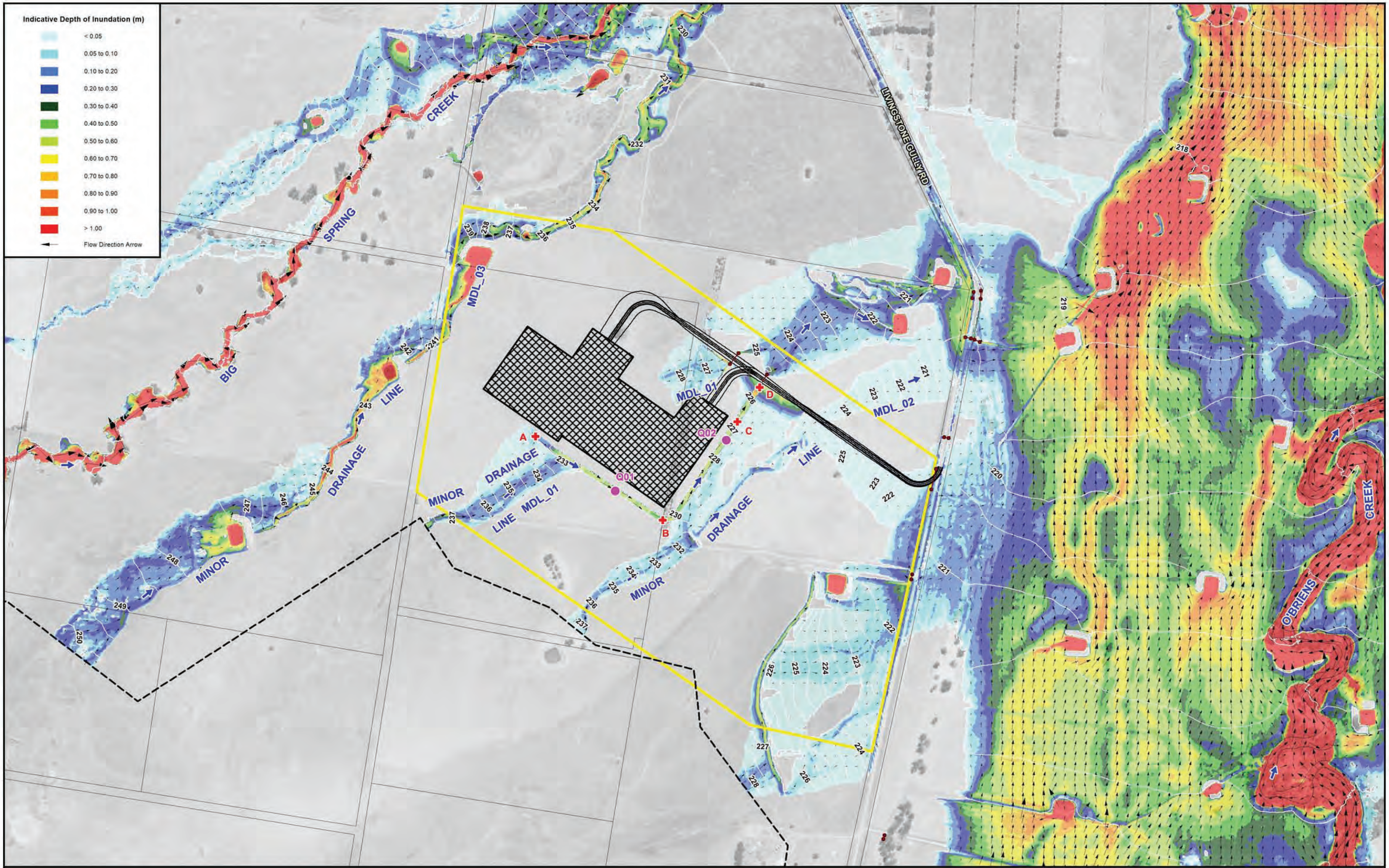
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 44
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 1% AEP



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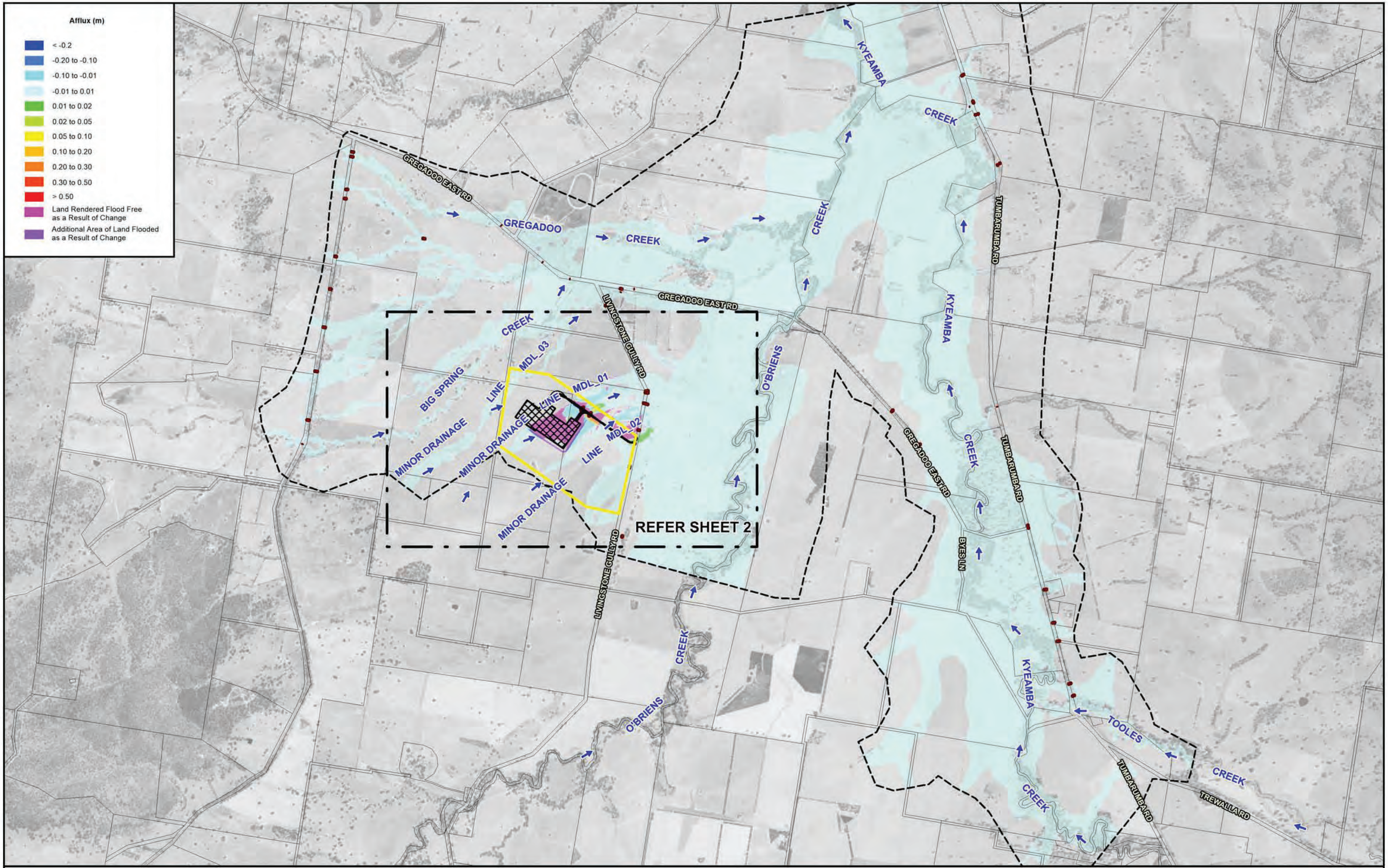
LEGEND

A ✚	Peak Flood Level Identifier (Refer Table 5 in Report)
Q01 ●	Peak Flow Identifier (Refer Table 6 in Report)
▨	Extent of Substation Bench (Indicative)
―	Site Access Road (Indicative)
▬	Site Boundary
●―●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent
217	Water Surface Elevation Contours (m AHD)

GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 44
(Sheet 2 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 1% AEP



LEGEND

▨ Extent of Substation Bench (Indicative)
— Site Access Road (Indicative)
▭ Site Boundary
●—● Modelled Stormwater Drainage Network
- - - TUFLOW Model Extent

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GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 45
(Sheet 1 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON FLOOD BEHAVIOUR
1% AEP

N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

▨ Extent of Substation Bench (Indicative)	Modelled Stormwater Drainage Network
Site Access Road (Indicative)	TUFLOW Model Extent
Site Boundary	

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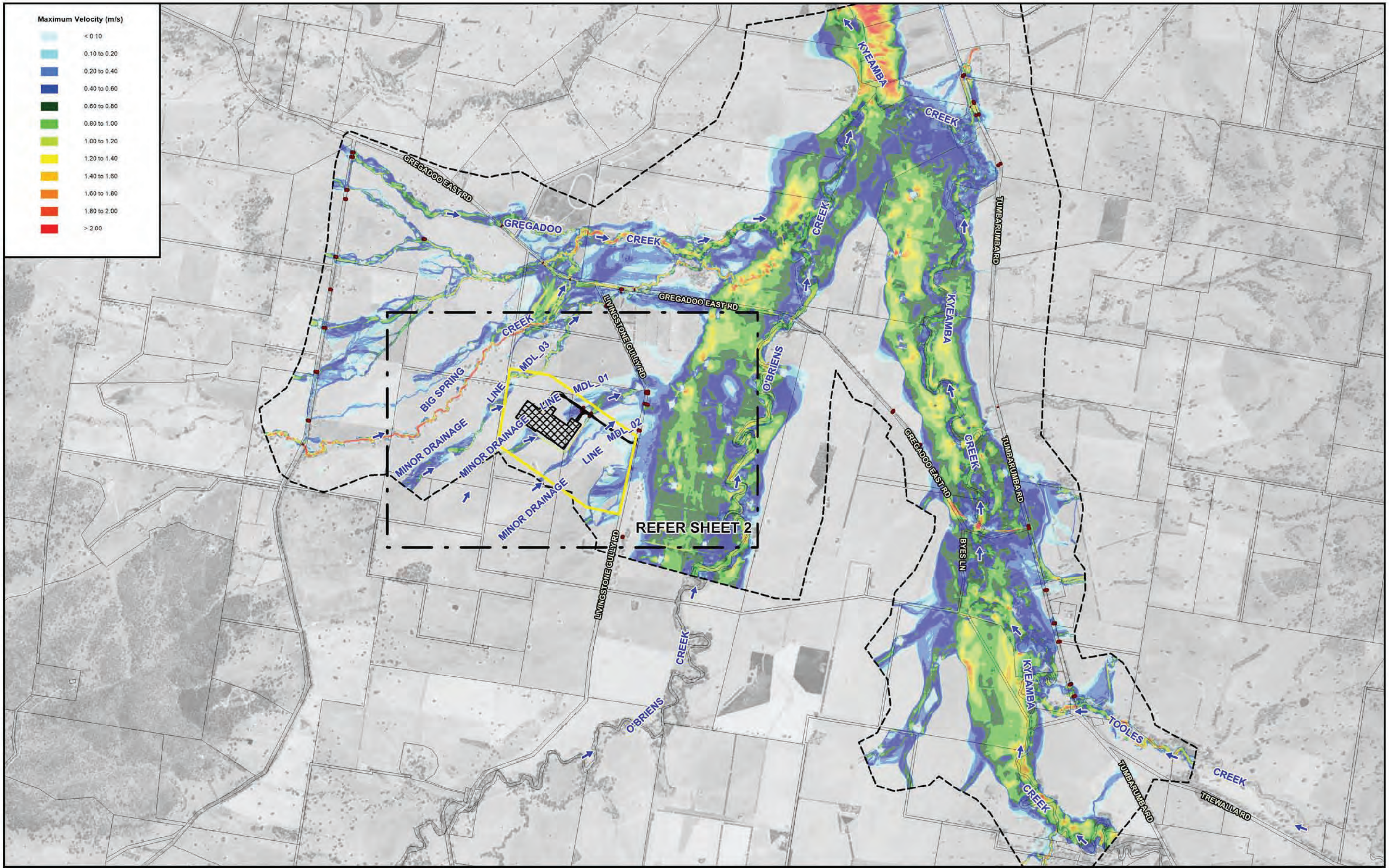
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 45
(Sheet 2 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON FLOOD BEHAVIOUR
1% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

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LEGEND

▨ Extent of Substation Bench (Indicative)

Site Access Road (Indicative)

Site Boundary

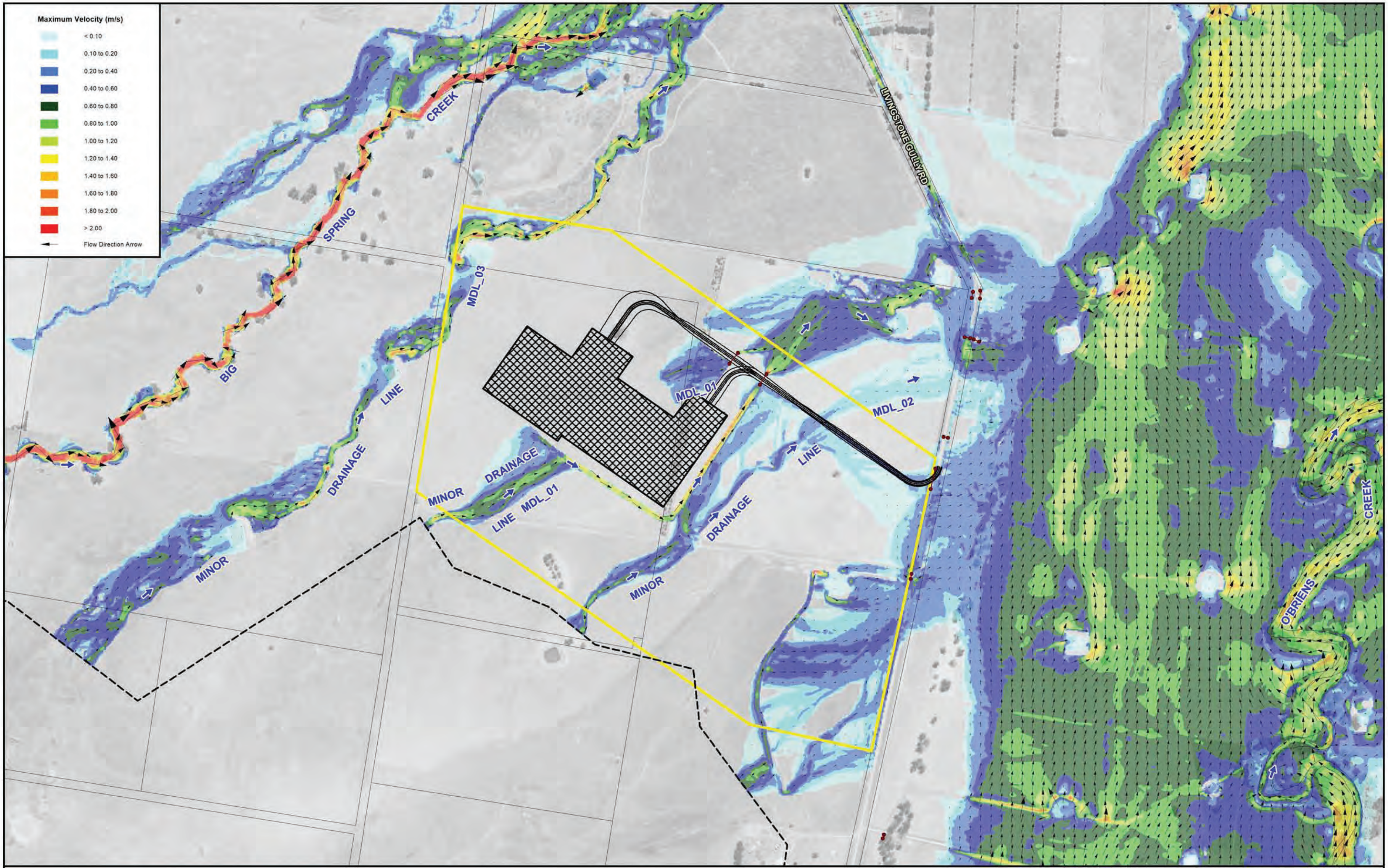
Modelled Stormwater Drainage Network

TUFLOW Model Extent

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 46
(Sheet 1 of 2)

MAXIMUM FLOW VELOCITIES
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 1% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

- ▨ Extent of Substation Bench (Indicative)
- Site Access Road (Indicative)
- Site Boundary
- Modelled Stormwater Drainage Network
- TUFLOW Model Extent

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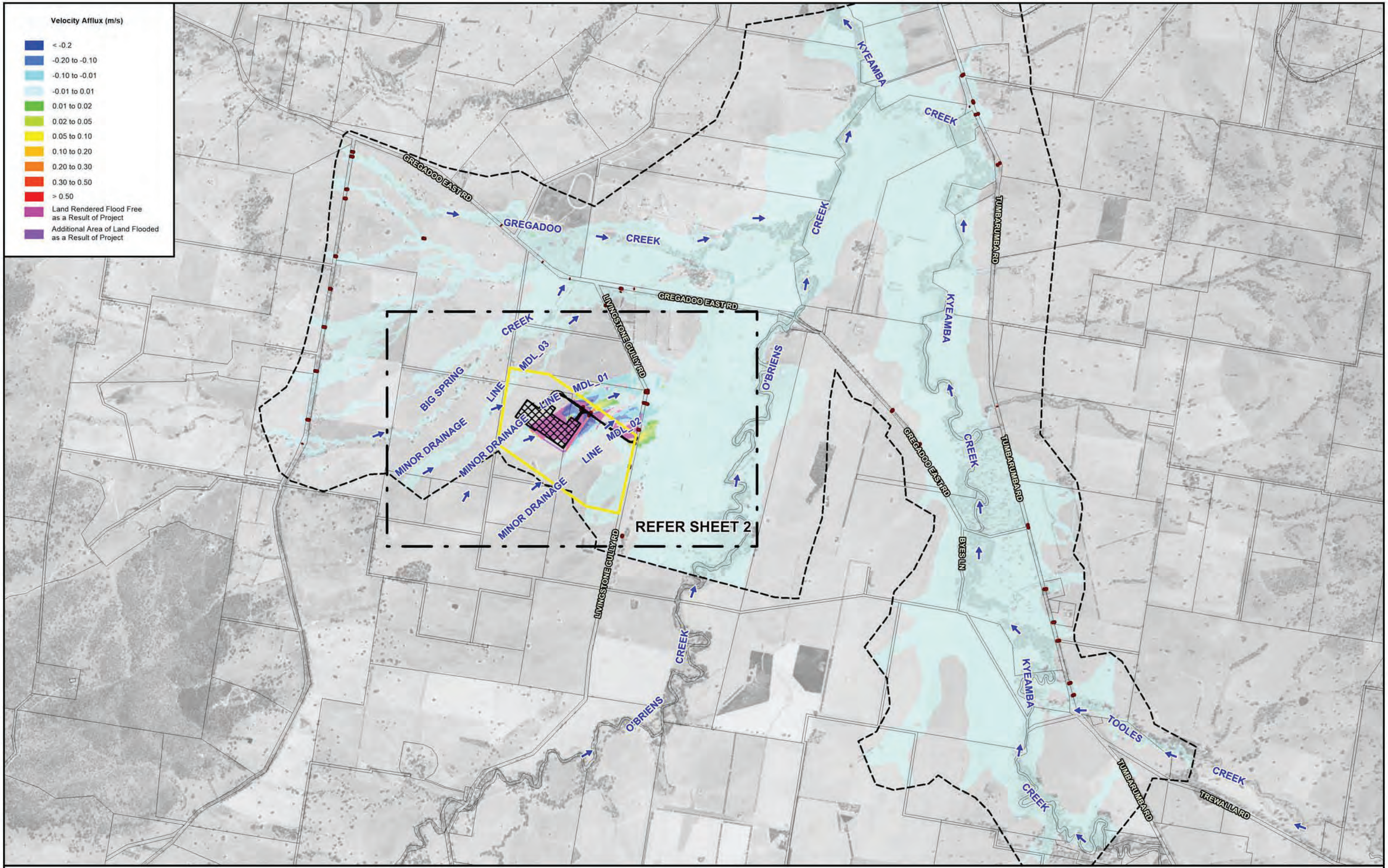
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 46
(Sheet 2 of 2)

MAXIMUM FLOW VELOCITIES
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 1% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨ Extent of Substation Bench (Indicative)	Modelled Stormwater Drainage Network
Site Access Road (Indicative)	TUFLOW Model Extent
Site Boundary	

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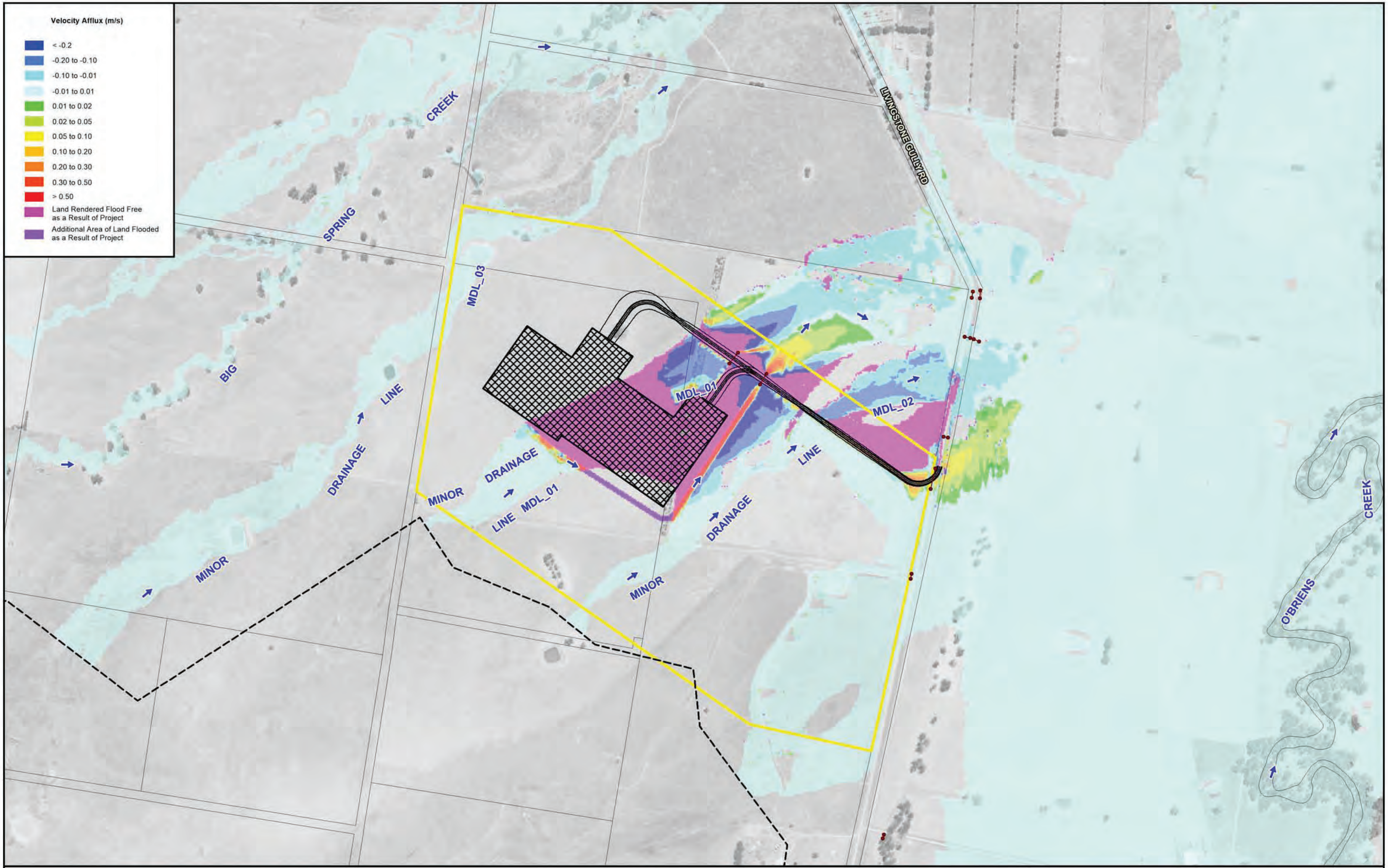
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 47
(Sheet 1 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON MAXIMUM FLOW VELOCITIES
1% AEP



LEGEND

▨	Extent of Substation Bench (Indicative)
—	Site Access Road (Indicative)
🟨	Site Boundary
●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent

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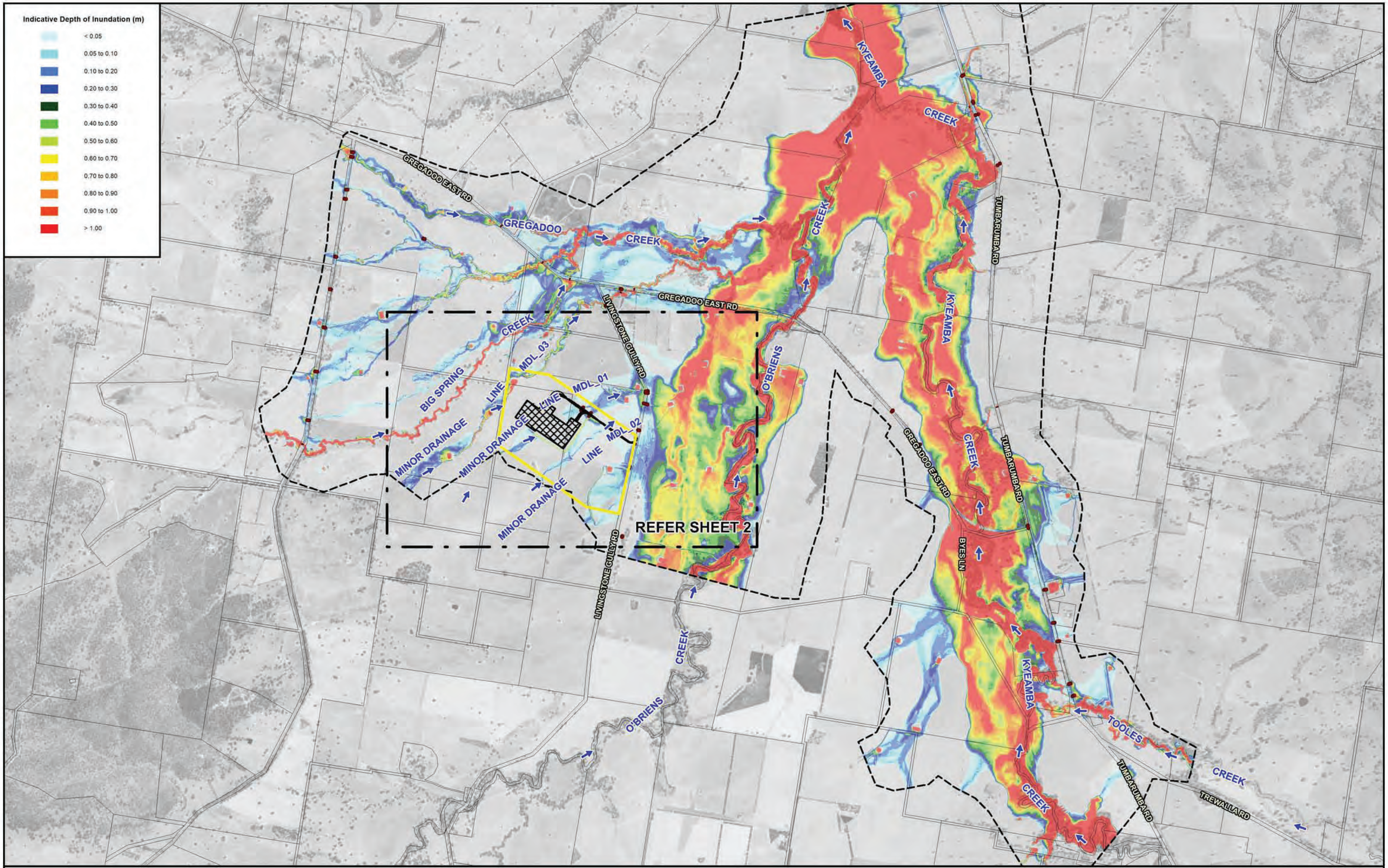
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 47
(Sheet 2 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON MAXIMUM FLOW VELOCITIES
1% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨ Extent of Substation Bench (Indicative)

— Site Access Road (Indicative)

🟨 Site Boundary

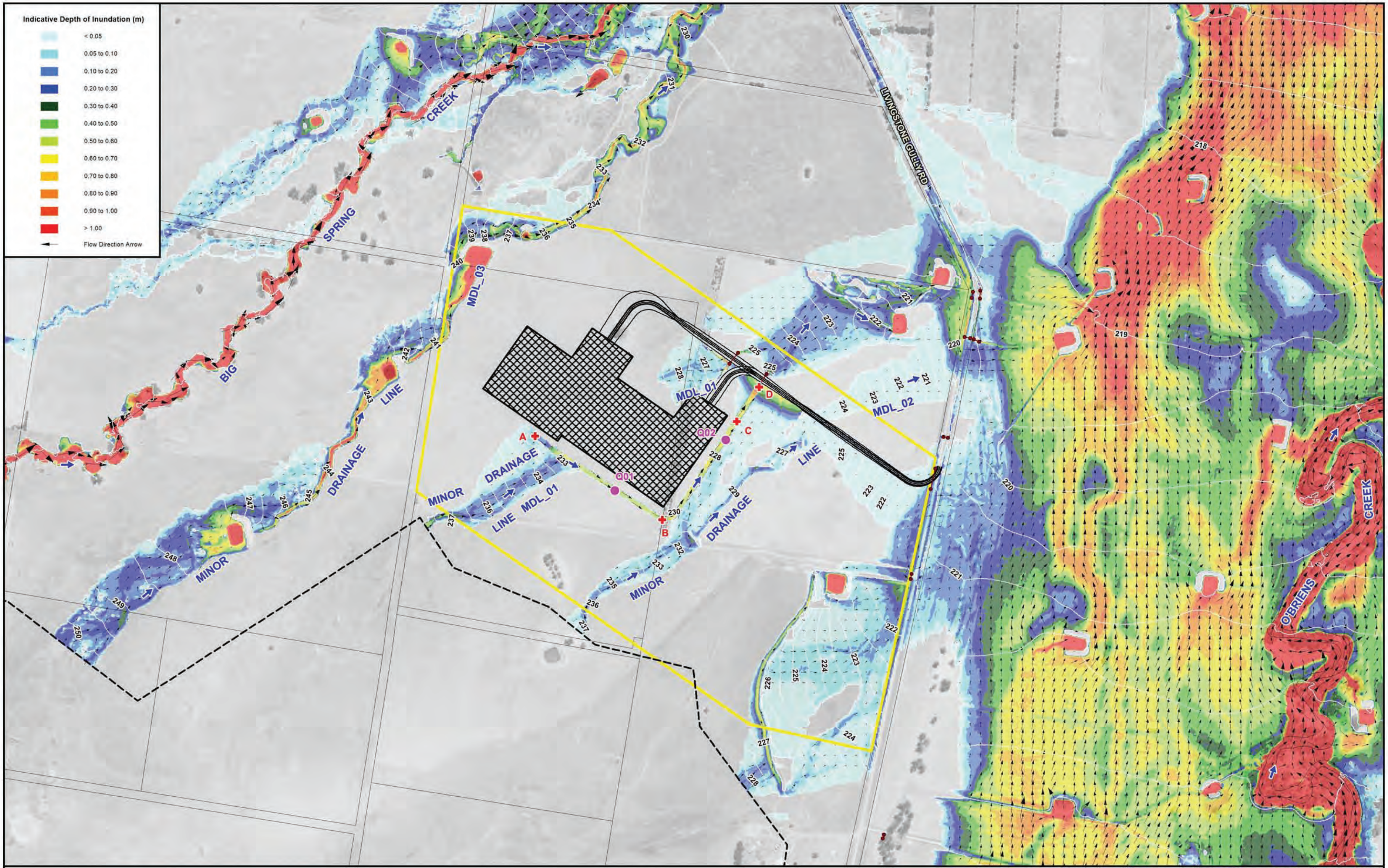
●—● Modelled Stormwater Drainage Network

- - - TUFLOW Model Extent

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 48
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 0.5% AEP



N

80 0 80 160 240 m

Scale: 1:8,000

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LEGEND

A ✚ Peak Flood Level Identifier (Refer Table 5 in Report)

Q01 ● Peak Flow Identifier (Refer Table 6 in Report)

▨ Extent of Substation Bench (Indicative)

Site Access Road (Indicative)

Site Boundary

Modelled Stormwater Drainage Network

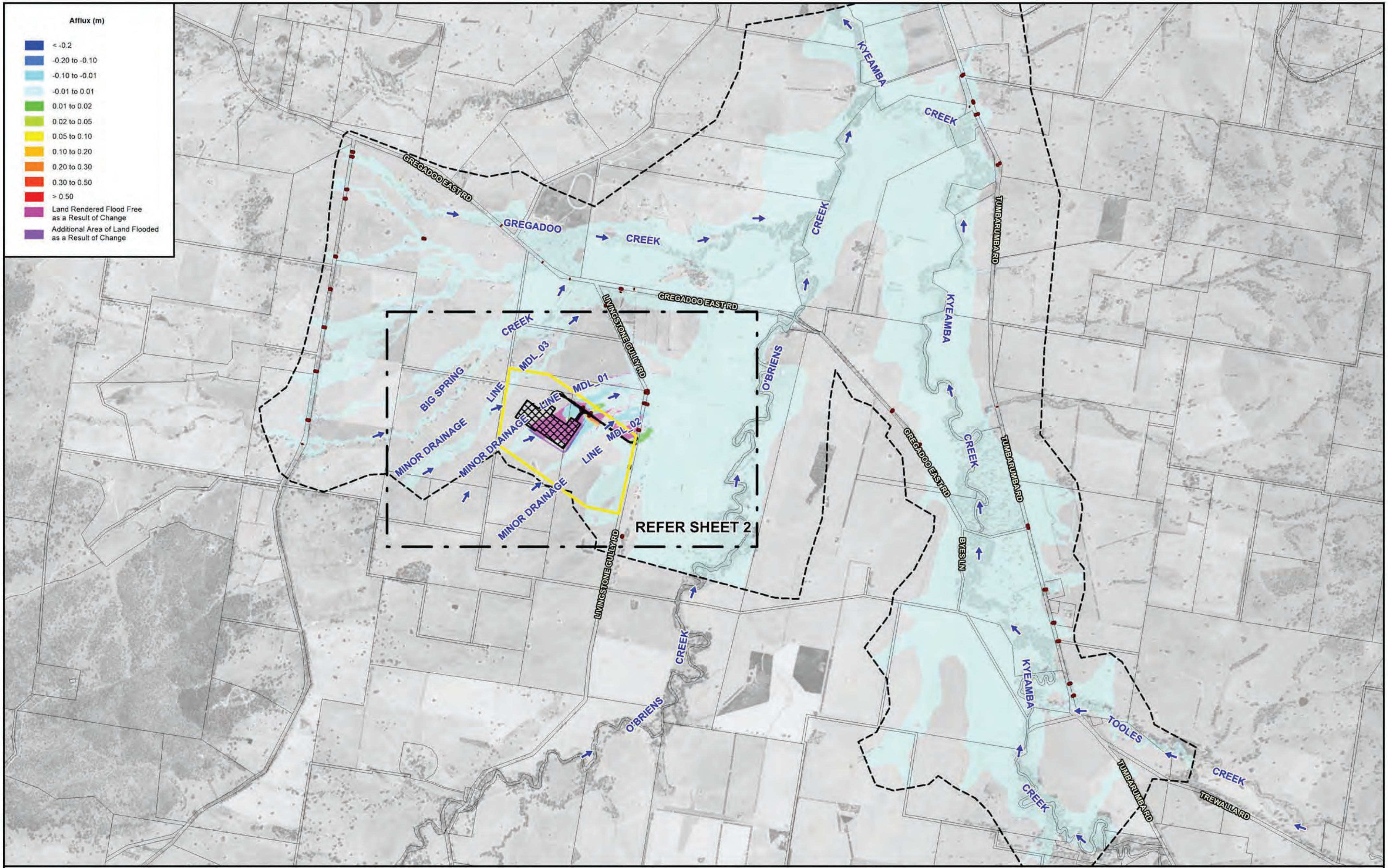
TUFLOW Model Extent

217 Water Surface Elevation Contours (m AHD)

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 48
(Sheet 2 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 0.5% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨ Extent of Substation Bench (Indicative)	Modelled Stormwater Drainage Network
Site Access Road (Indicative)	TUFLOW Model Extent
Site Boundary	

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 49
(Sheet 1 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON FLOOD BEHAVIOUR
0.5% AEP

N

80 0 80 160 240 m

Scale: 1:8,000

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LEGEND

▨ Extent of Substation Bench (Indicative)

— Site Access Road (Indicative)

▬ Site Boundary

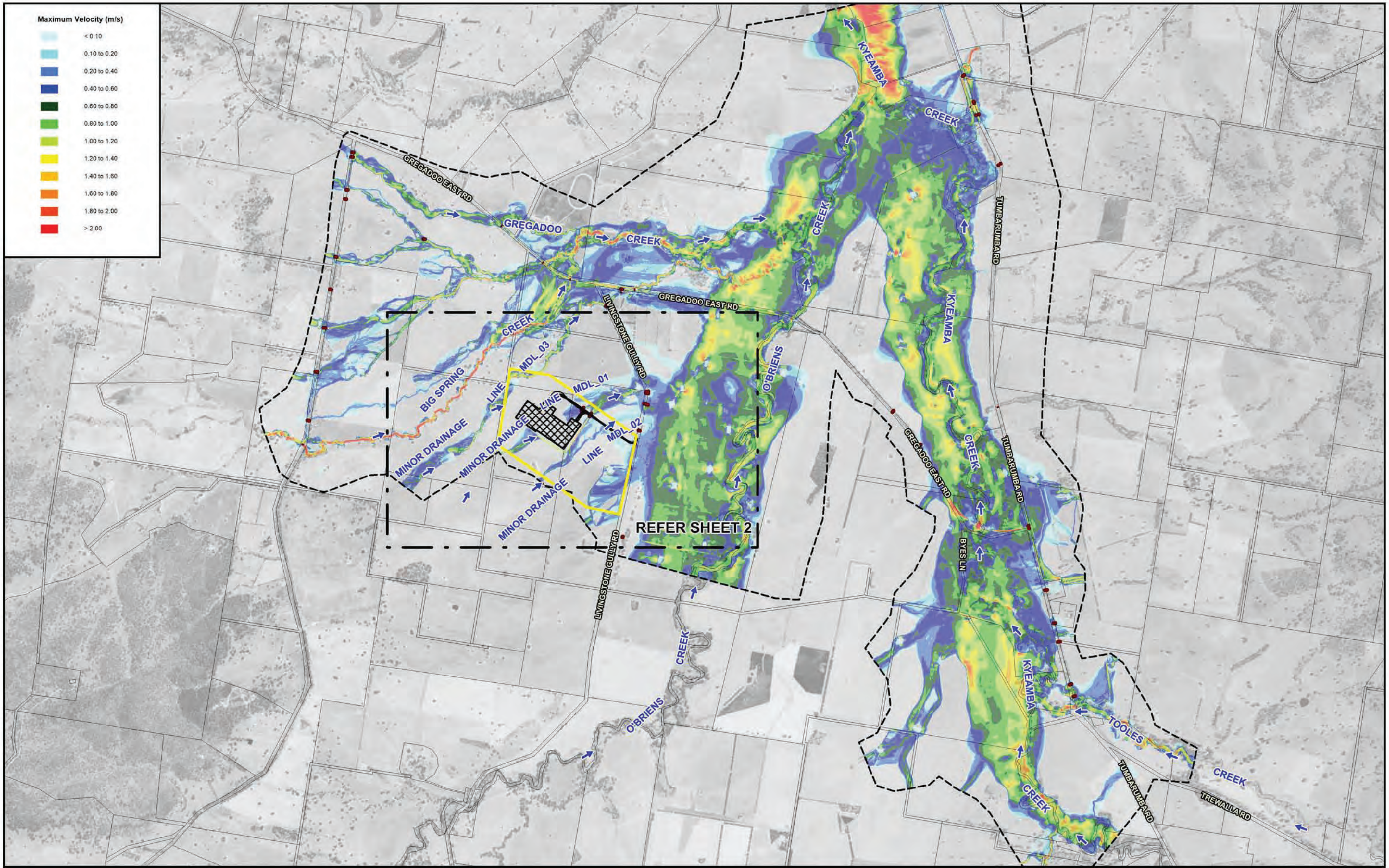
●—● Modelled Stormwater Drainage Network

- - - TUFLOW Model Extent

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 49
(Sheet 2 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON FLOOD BEHAVIOUR
0.5% AEP



LEGEND

▨ Extent of Substation Bench (Indicative)	Modelled Stormwater Drainage Network
Site Access Road (Indicative)	TUFLOW Model Extent
Site Boundary	

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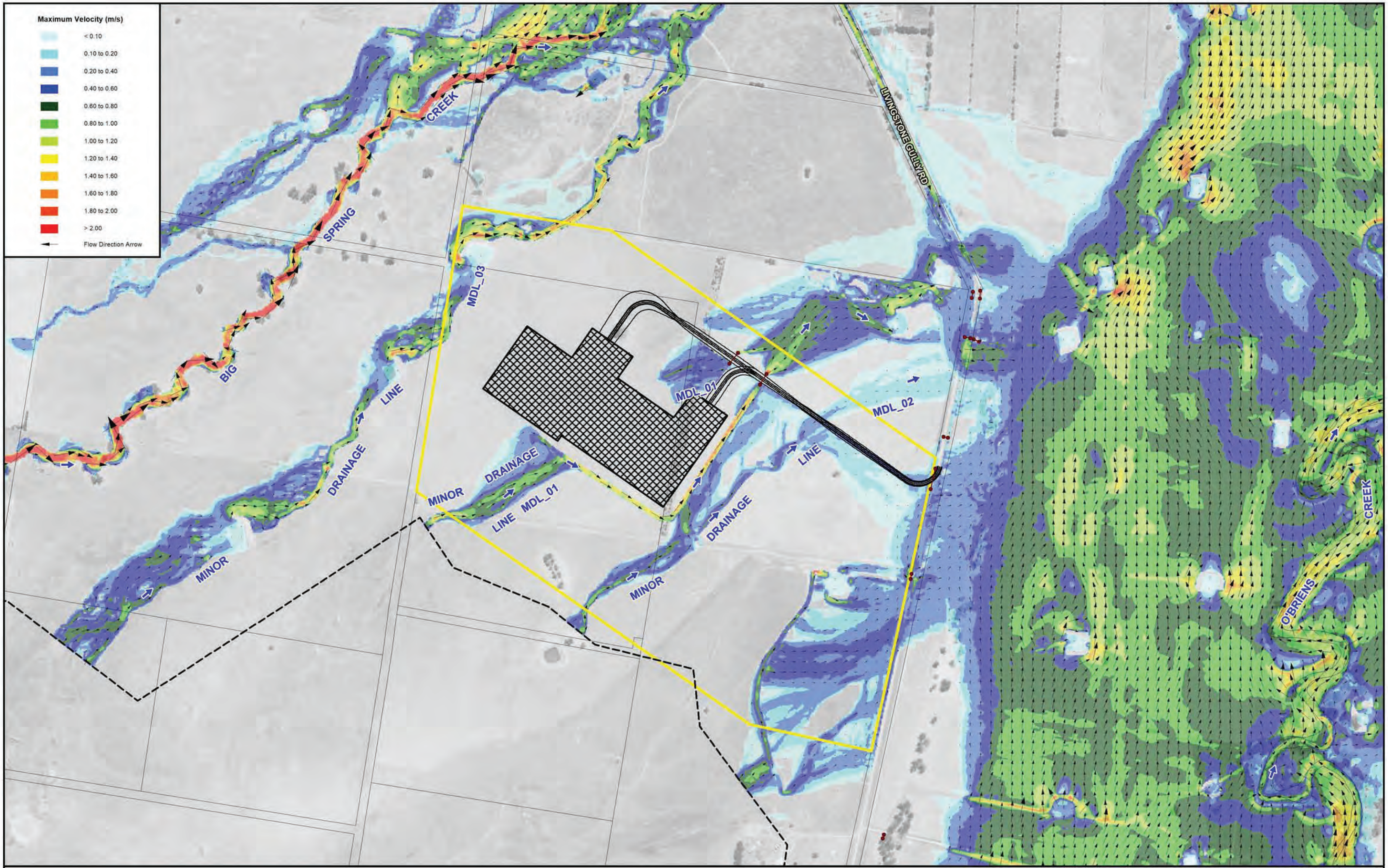
GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 50
(Sheet 1 of 2)

MAXIMUM FLOW VELOCITIES
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 0.5% AEP



LEGEND

▨	Extent of Substation Bench (Indicative)
—	Site Access Road (Indicative)
🟨	Site Boundary
●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent

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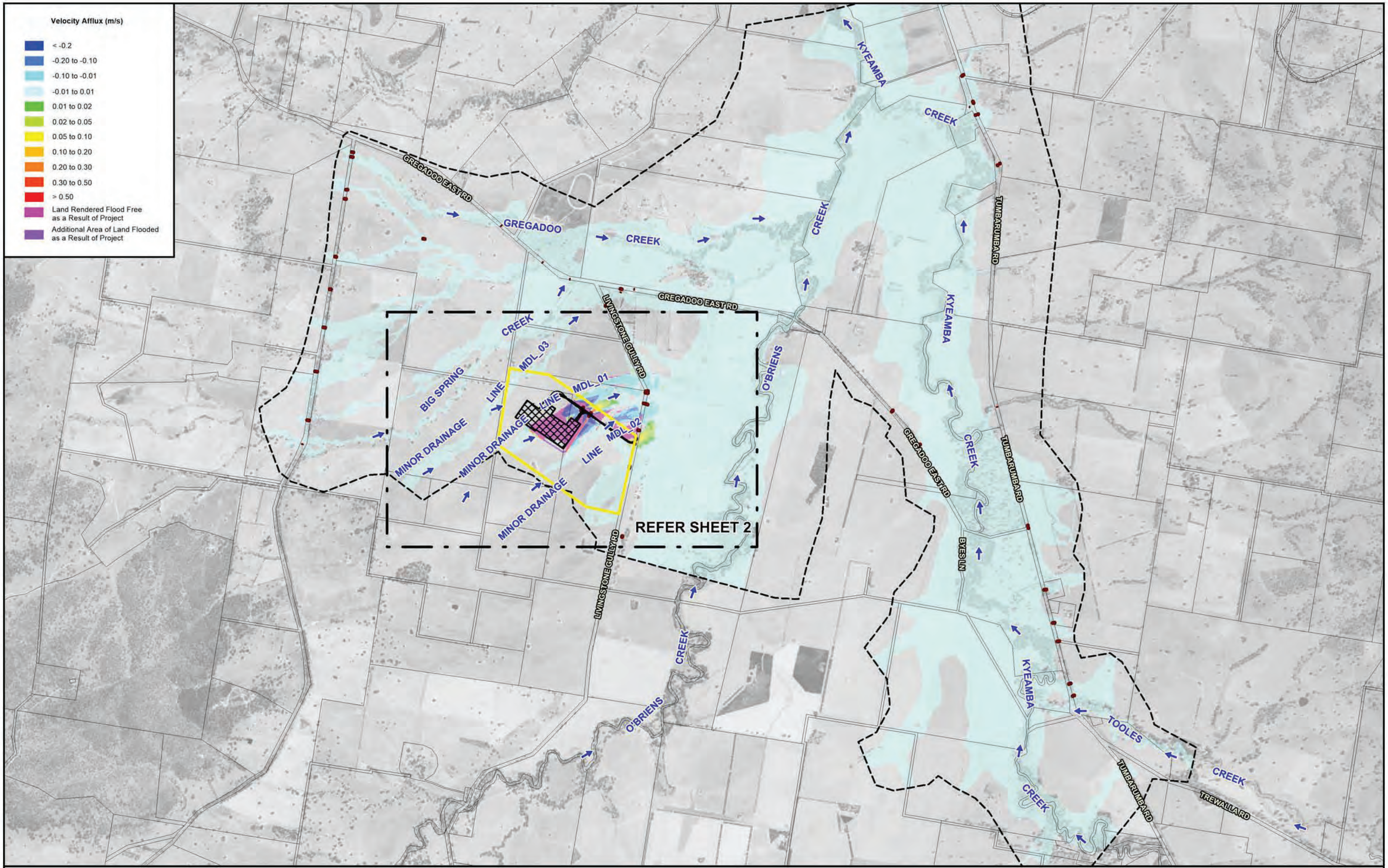
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 50
(Sheet 2 of 2)

MAXIMUM FLOW VELOCITIES
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - 0.5% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨	Extent of Substation Bench (Indicative)
—	Site Access Road (Indicative)
▬	Site Boundary
●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent

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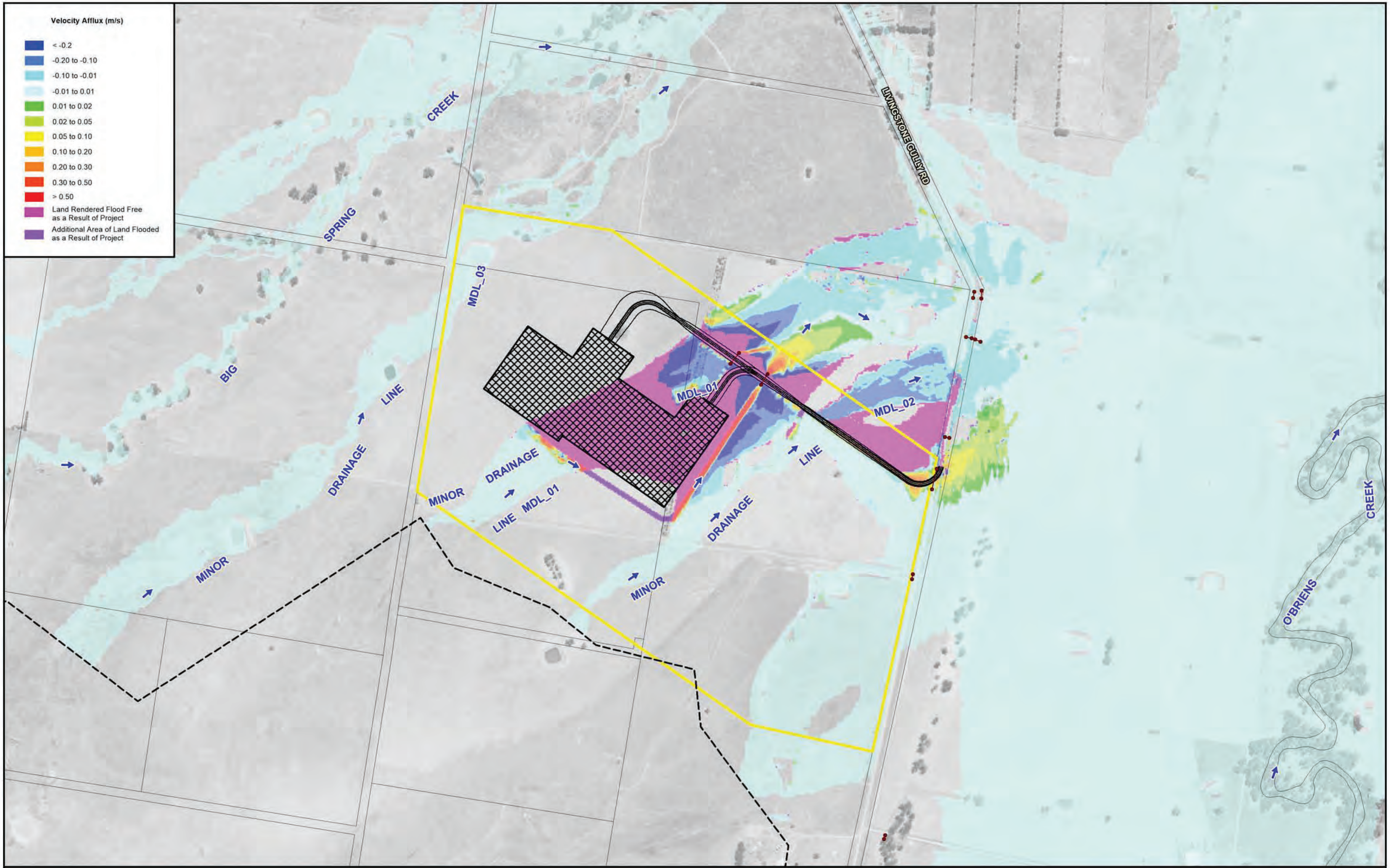
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 51
(Sheet 1 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON MAXIMUM FLOW VELOCITIES
0.5% AEP



LEGEND

▨ Extent of Substation Bench (Indicative)

Site Access Road (Indicative)

Site Boundary

Modelled Stormwater Drainage Network

TUFLOW Model Extent

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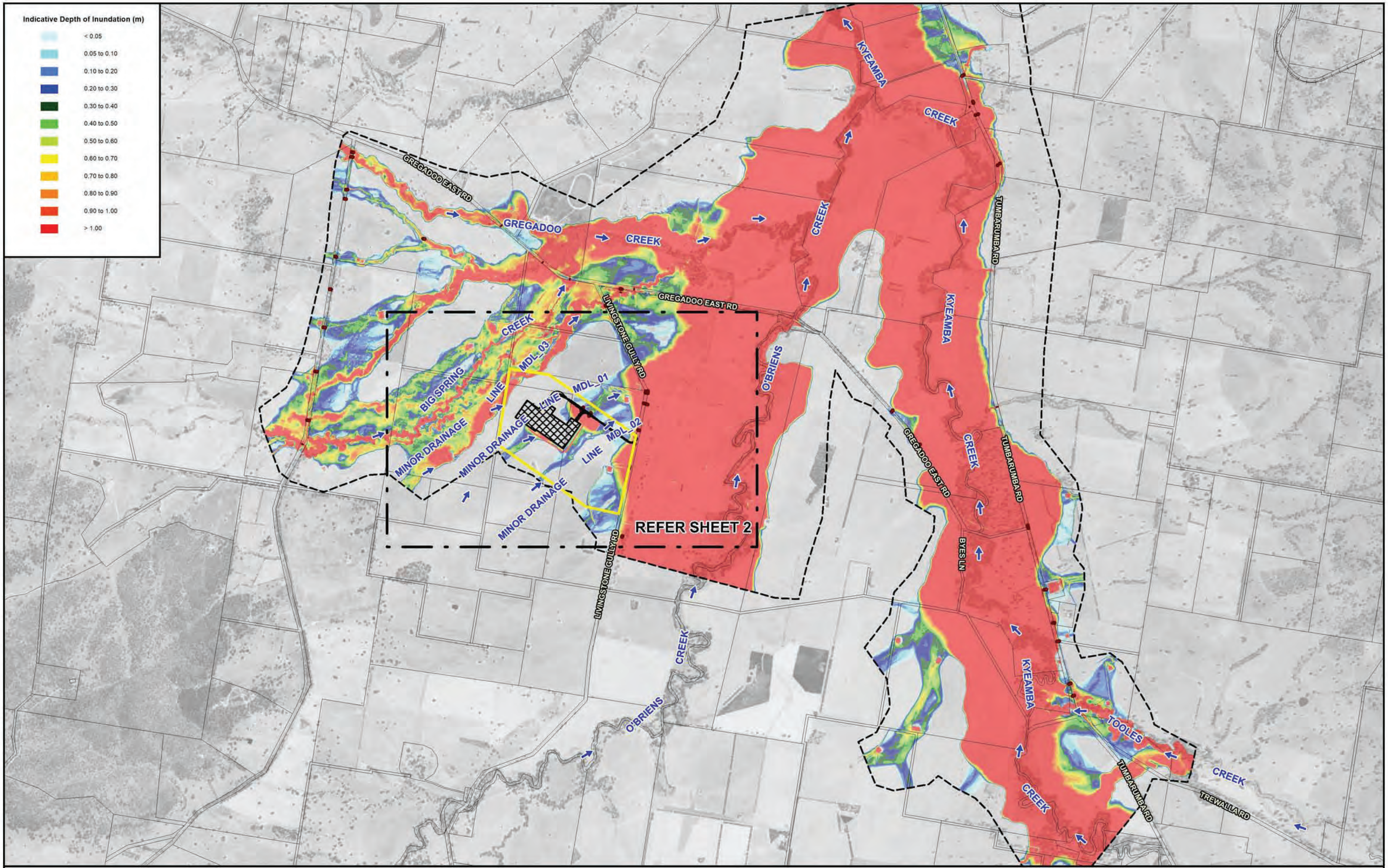
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 51
(Sheet 2 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON MAXIMUM FLOW VELOCITIES
0.5% AEP



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨	Extent of Substation Bench (Indicative)	●—●	Modelled Stormwater Drainage Network
—	Site Access Road (Indicative)	- - -	TUFLOW Model Extent
🟨	Site Boundary		

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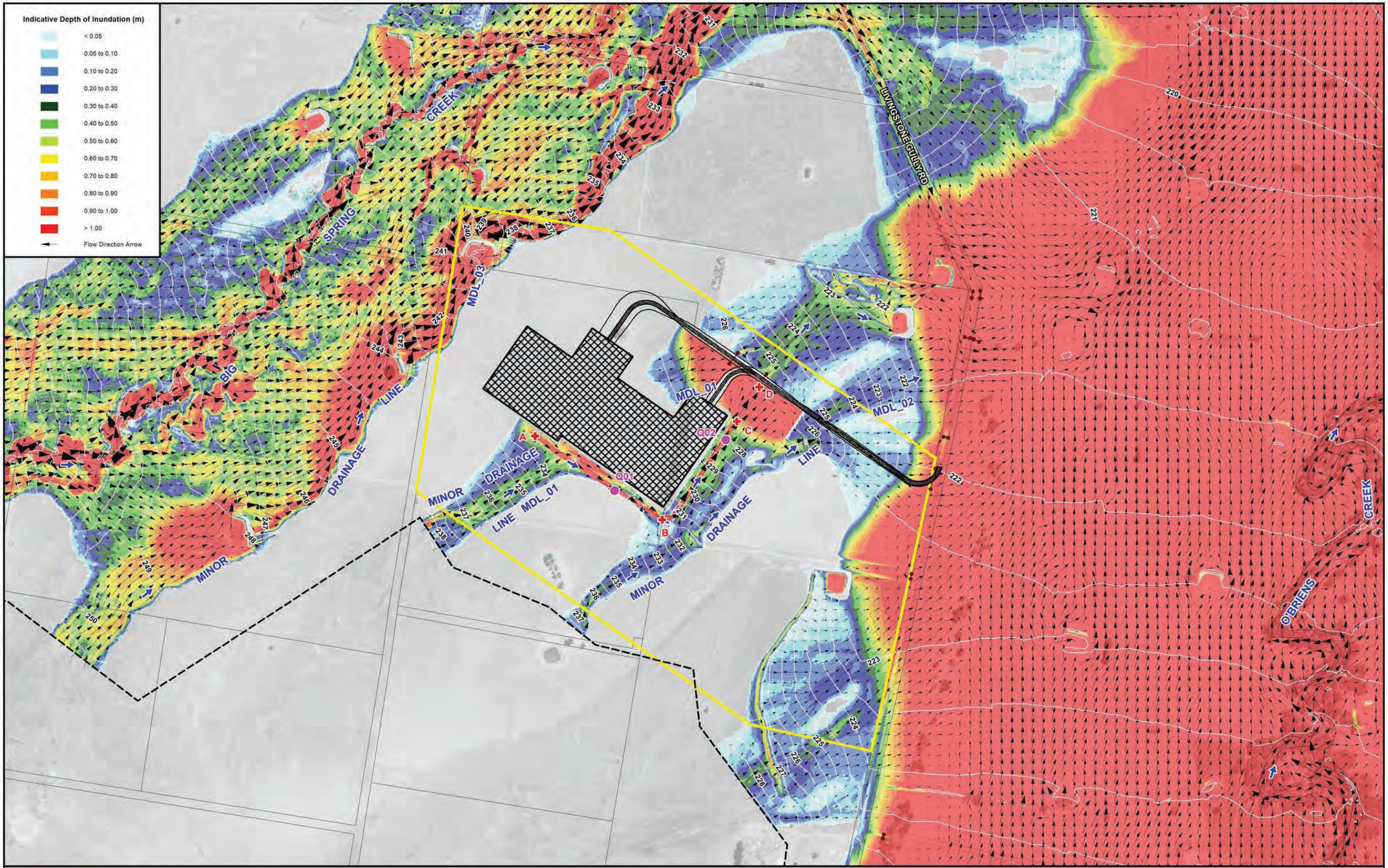
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 52
(Sheet 1 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - PMF



N

80 0 80 160 240 m

Scale: 1:8,000

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LEGEND

A ✚ Peak Flood Level Identifier (Refer Table 5 in Report)

Q01 ● Peak Flow Identifier (Refer Table 6 in Report)

▨ Extent of Substation Bench (Indicative)

— Site Access Road (Indicative)

▬ Site Boundary

•—• Modelled Stormwater Drainage Network

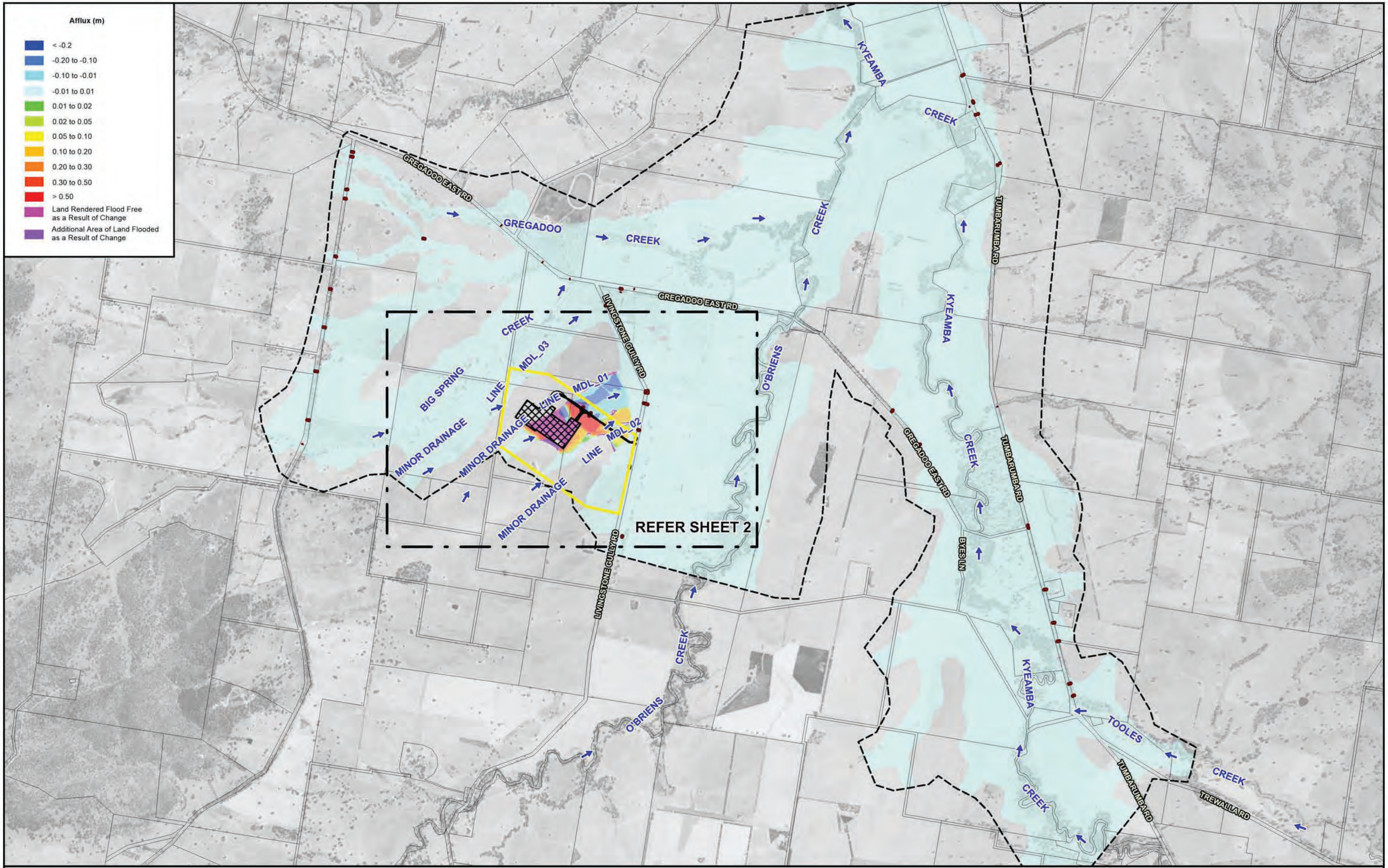
- - - TUFLOW Model Extent

219 Water Surface Elevation Contours (m AHD)

GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 52
(Sheet 2 of 2)

INDICATIVE EXTENT AND DEPTH OF INUNDATION
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - PMF



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▨	Extent of Substation Bench (Indicative)
—	Site Access Road (Indicative)
🟨	Site Boundary
●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent

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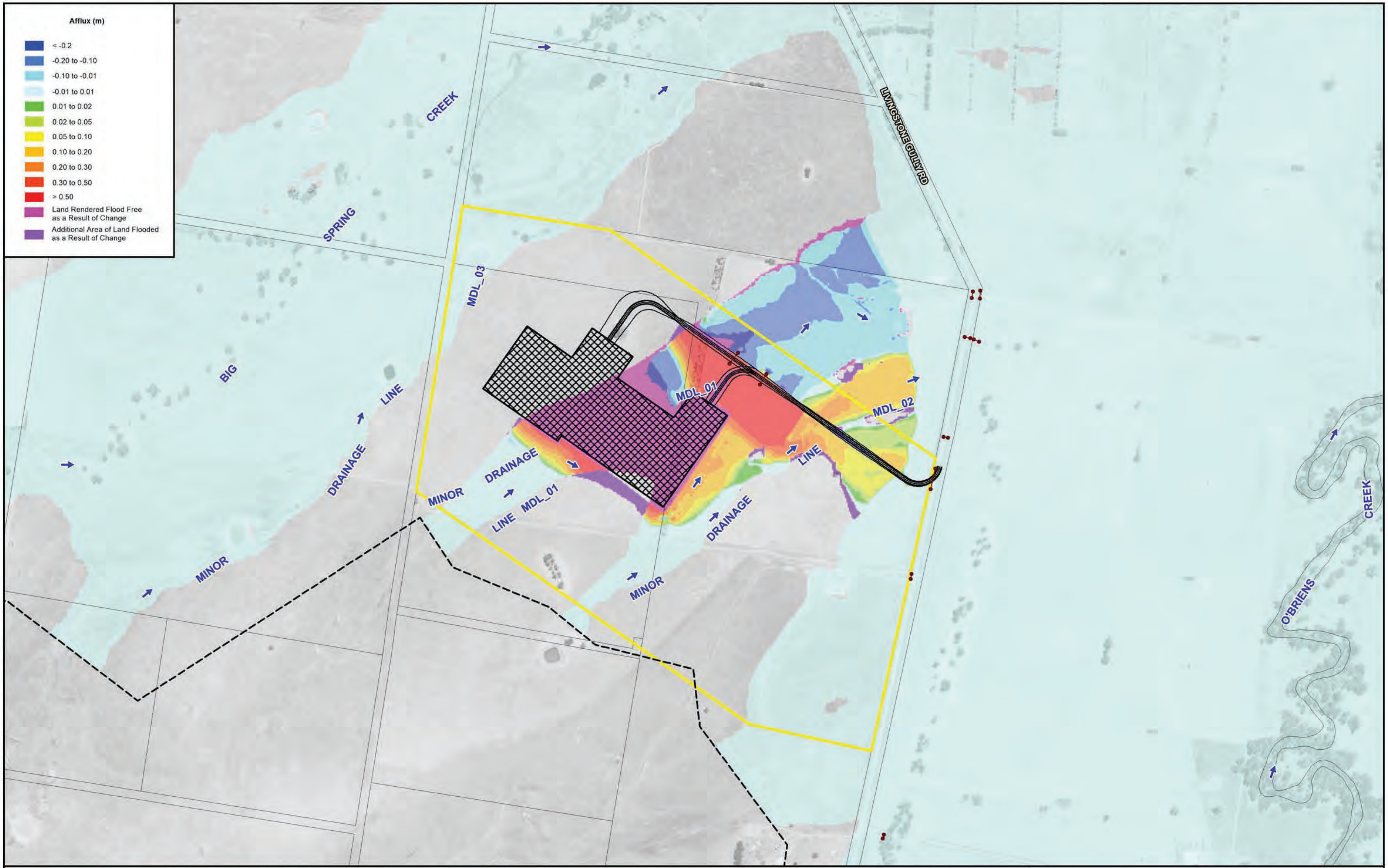
GUGAA 500 kV SUBSTATION
FLOODING INVESTIGATION

Figure 53
(Sheet 1 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON FLOOD BEHAVIOUR
PMF



N

80 0 80 160 240 m

Scale: 1:8,000

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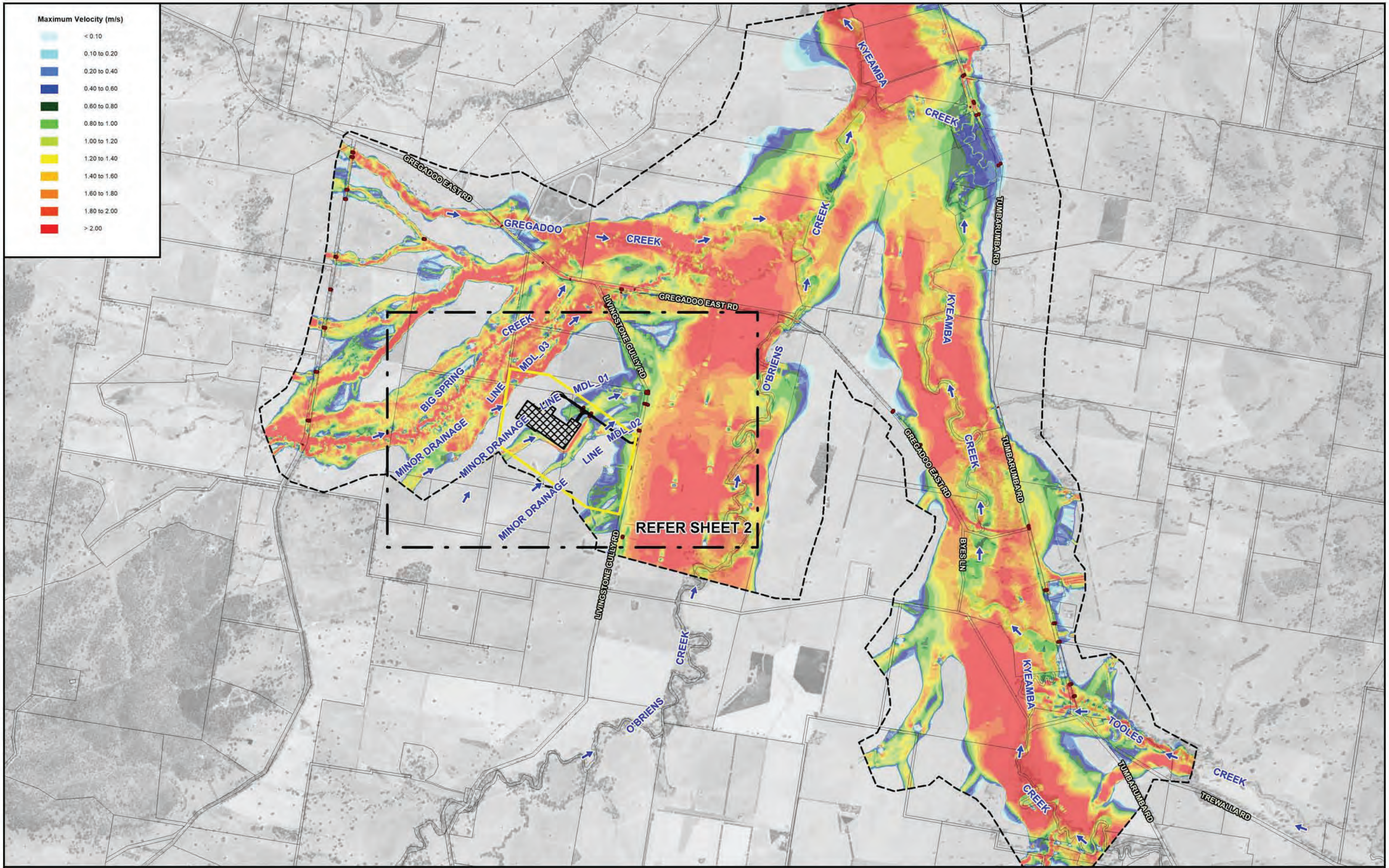
LEGEND

▨	Extent of Substation Bench (Indicative)
—	Site Access Road (Indicative)
🟨	Site Boundary
•—•	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent

GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 53
(Sheet 2 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON FLOOD BEHAVIOUR
PMF



N

300 0 300 600 900 m

Scale: 1:30,000

LEGEND

▩ Extent of Substation Bench (Indicative)

— Site Access Road (Indicative)

🟨 Site Boundary

●—● Modelled Stormwater Drainage Network

- - - TUFLOW Model Extent

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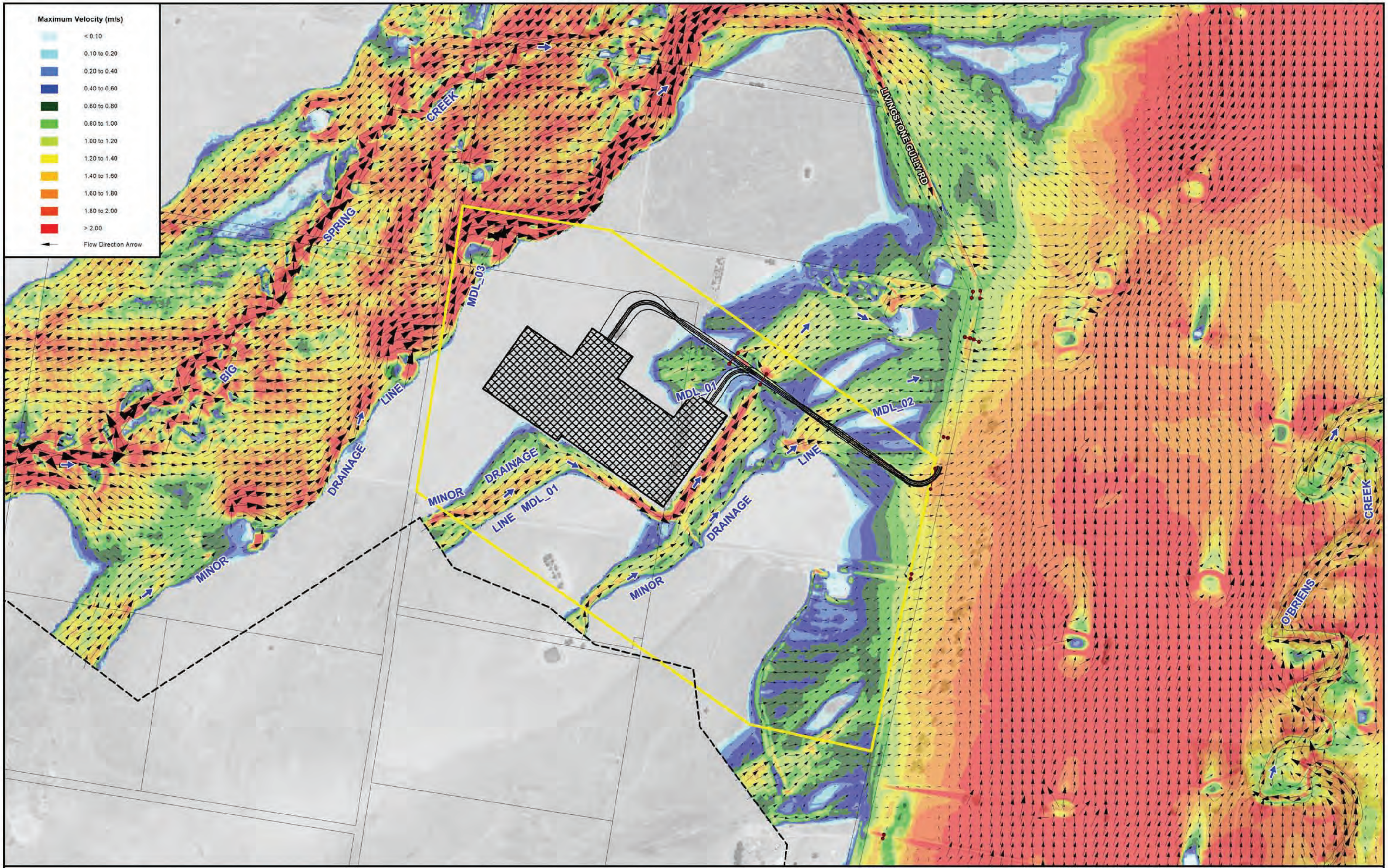
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 54
(Sheet 1 of 2)

MAXIMUM FLOW VELOCITIES
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - PMF



N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

▨ Extent of Substation Bench (Indicative)

— Site Access Road (Indicative)

▬ Site Boundary

•—• Modelled Stormwater Drainage Network

- - - TUFLOW Model Extent

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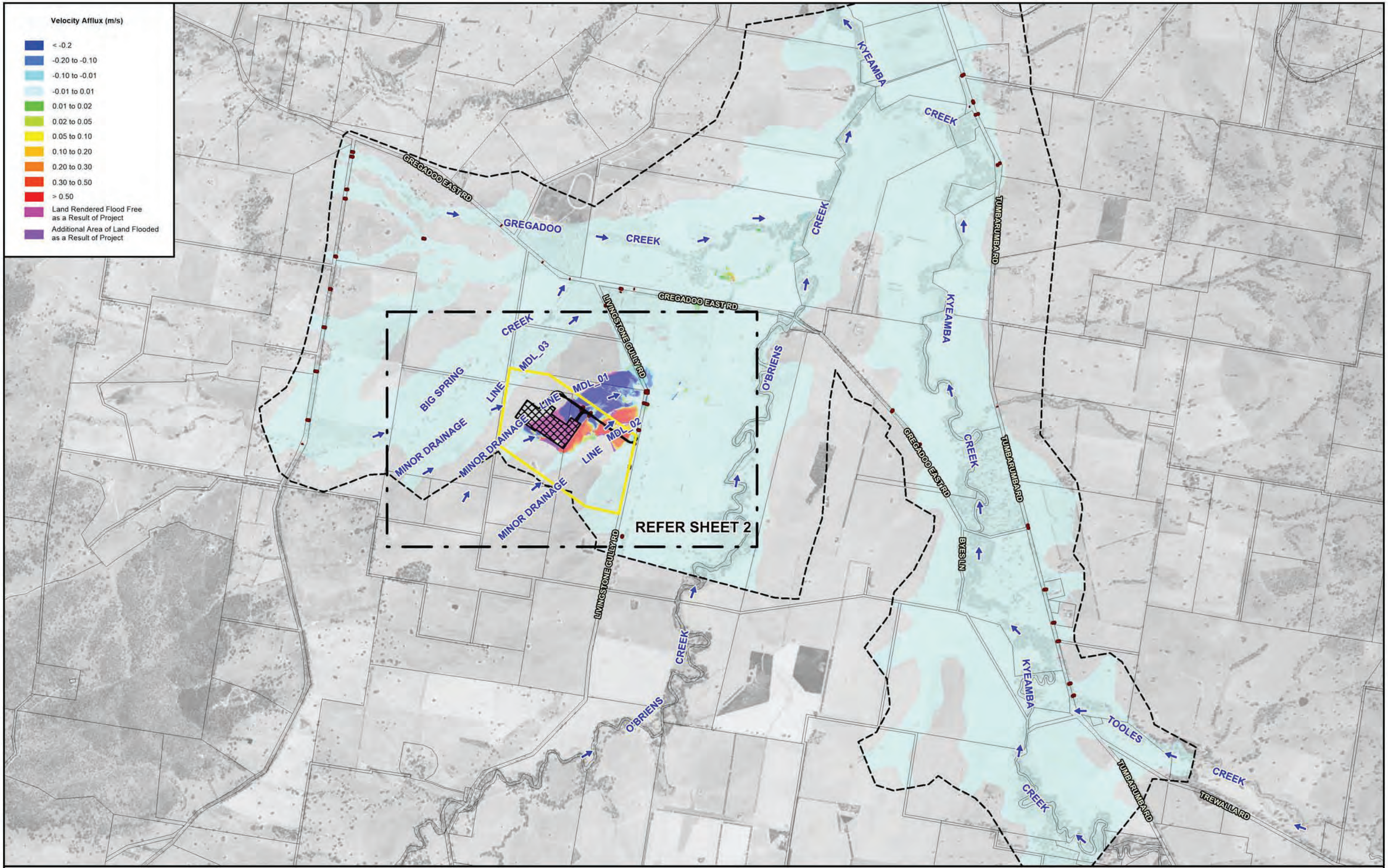
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 54
(Sheet 2 of 2)

MAXIMUM FLOW VELOCITIES
POST-SUBSTATION AND CHANNEL WORKS CONDITIONS - PMF



LEGEND

▨	Extent of Substation Bench (Indicative)
—	Site Access Road (Indicative)
🟨	Site Boundary
●—●	Modelled Stormwater Drainage Network
- - -	TUFLOW Model Extent

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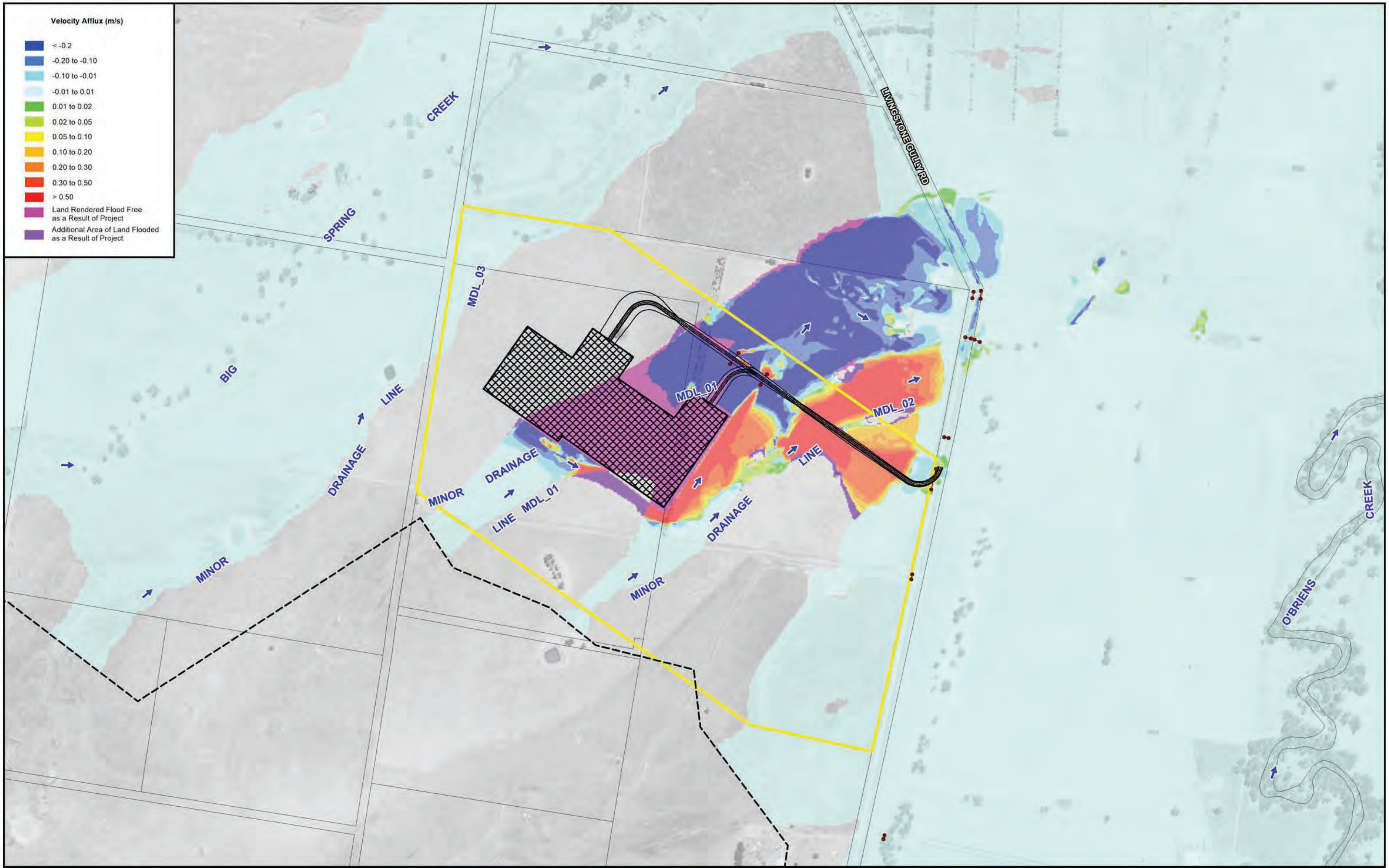
GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 55
(Sheet 1 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON MAXIMUM FLOW VELOCITIES
PMF



N

80 0 80 160 240 m

Scale: 1:8,000

LEGEND

▨ Extent of Substation Bench (Indicative)

— Site Access Road (Indicative)

▬ Site Boundary

●—● Modelled Stormwater Drainage Network

- - - TUFLOW Model Extent

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GUGAA 500 kV SUBSTATION FLOODING INVESTIGATION

Figure 55
(Sheet 2 of 2)

IMPACT OF PROPOSED SUBSTATION AND CHANNEL WORKS ON MAXIMUM FLOW VELOCITIES
PMF

Attachment E

Flood immunity

This section provides the approximate fill depth required based on flood depth from the local catchment scale assessment. The flood immunity to the site can be achieved by filling the site extents as per the depths presented in Table E-1 to achieve immunity. It should be noted that these values are approximate and subject to further investigation through modelling of the proposed works at detailed design stage.

Table E-1 Fill depth to achieve flood immunity

Local models	Immunity requirement	Approximate minimum fill depth to achieve immunity to the site
Wagga 330 kV substation compound (C01)	5% AEP	0.25m
Snowy Mountains Highway compound (C02)	5% AEP	1.4m
Snubba Road compound (C03)	N/A	N/A
Maragle 500 kV substation compound (C05)	5% AEP	1.5m
Gregadoo Road compound (C06)	5% AEP	0.2m
Honeysuckle Road compound (C07)	N/A	N/A
Red Hill Road compound (C08)	N/A	N/A
Adjungbilly Road compound (C09)	N/A	N/A
Yass substation compound (C10)	5% AEP	0.1m
Woodhouselee Road compound (C11)	5% AEP	No flood impact. No filling required
Bannaby 500 kV substation compound (C12)	5% AEP	0.5m
Memorial Avenue compound (C14)	5% AEP	0.5m
Bowmans Lane Compound (C15)	5% AEP	0.7m
Snubba Road compound (C16)	5% AEP	0.25m
Telecommunications Hut	1% AEP	No flood impact. No filling required
Bannaby 500 kV substation modification	1% AEP	0.75m
Wagga 330 kV substation modification	1% AEP	0.25m
Proposed Gugaa 500 kV substation	1% AEP	0.1m
Tumbarumba Accommodation Facility (AC1)	2% AEP	1m

No specific level of flood immunity was specified for access tracks. The contractor’s safety processes plan, procedures and documentation would need to allow safe travelling through access tracks during flood events. Similarly, the proposed access roads would be constructed at a surface level similar to the existing condition, which would not significantly impact the regional flooding.

Document prepared by

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