Ordinary Meeting of Council

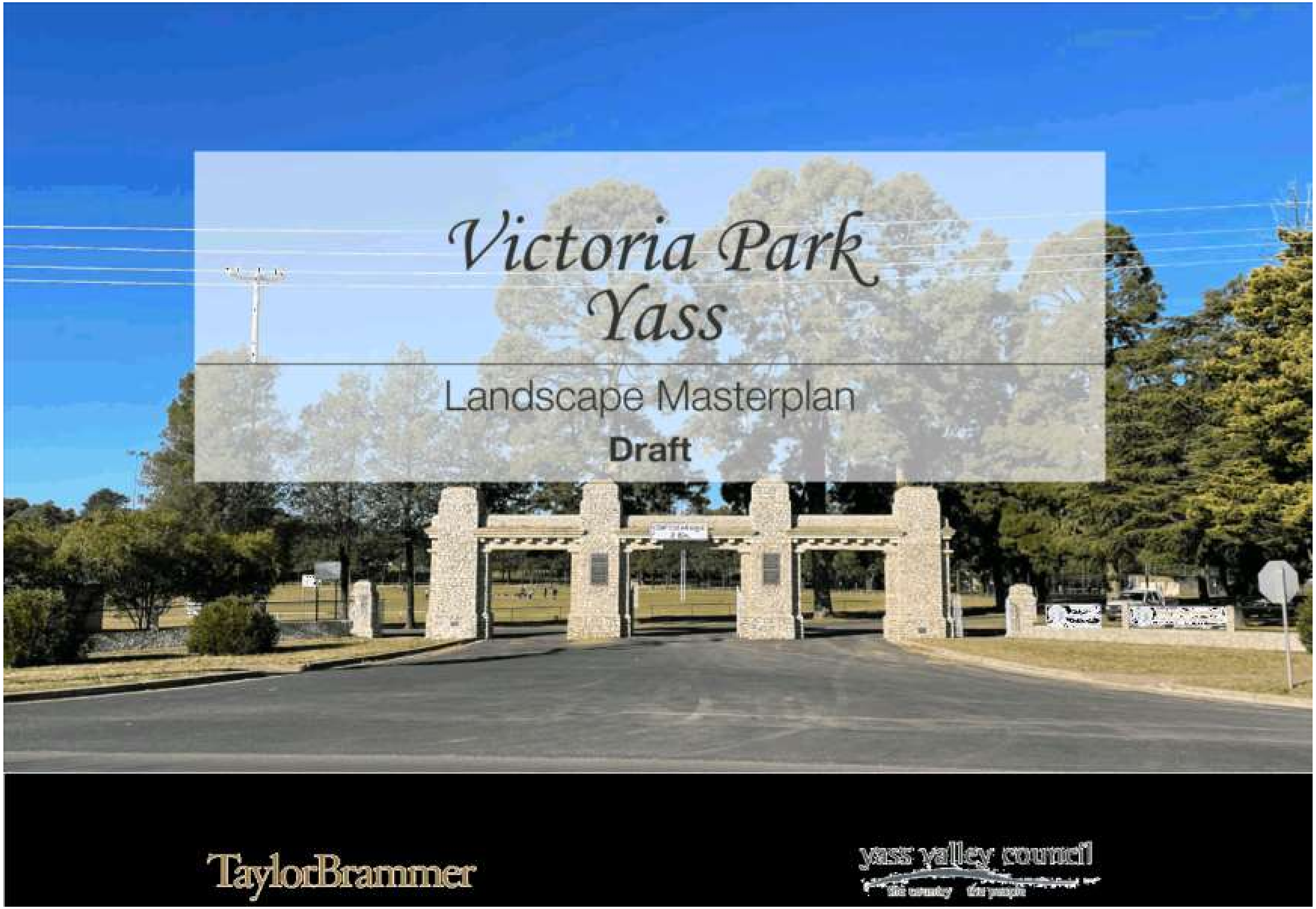
Wednesday 28 July 2021
4.00pm
Council Chambers
209 Comur Street, Yass

ATTACHMENTS TO REPORTS
ITEMS UNDER SEPARATE COVER

Ordinary Meeting of Council

Attachments to Reports
Items Under Separate Cover

Page No.


Victoria Park
Yass
Landscape Masterplan
Draft
TaylorBrammer
yass valley council
the country the people

Contents

'In the spirit of reconciliation we acknowledge the Ngunnawal People, as the Traditional Custodians whose country where Victoria Park is located and their connections to land, river and community. We pay our respect to their elders past and present and extend that respect to all Aboriginal and Torres Strait Islander peoples today.'

Prepared for Yass Valley Council

Amendment register

DOCUMENT TITLE	REVISION	DATE	STATUS	PREPARED	CHECKED
DRAFT FOR DISCUSSION	P1	[illegible]	[illegible]	SH	[illegible]
DRAFT	P2	[illegible]	[illegible]	SH	[illegible]


01 | Overview

Overview

Introduction

Victoria Park is a district sporting park located to the north of the Yass River and Yass town centre. The site is located on crown land with Yass High School nestled harmoniously within the precinct. The park covers an area spanning approximately 10 ha.

Victoria Park caters to a range of local sporting clubs including rugby, cricket, tennis, little athletics and swimming. Competitions including gala days, athletics and swimming carnivals and junior development tennis tournaments are held at the park.

The park also offers community facilities including an off leash dog park, skate park, walking trails and caravan park.

A Masterplan has been developed which provides a long term vision for the park to ensure that any future development will be appropriate to the site and the recreational, cultural and environmental values of the park will be realised.

This Masterplan has been developed incorporating ideas and feedback from the community and key user groups. It provides a future direction for the park which will provide greater recreational opportunities, enhance existing uses and improve the general amenity, functionality and capacity of the site. It envisions a quality facility that meets contemporary standards.

Existing heritage park gates.
Image by [illegible] 2021

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[illegible]

Overview

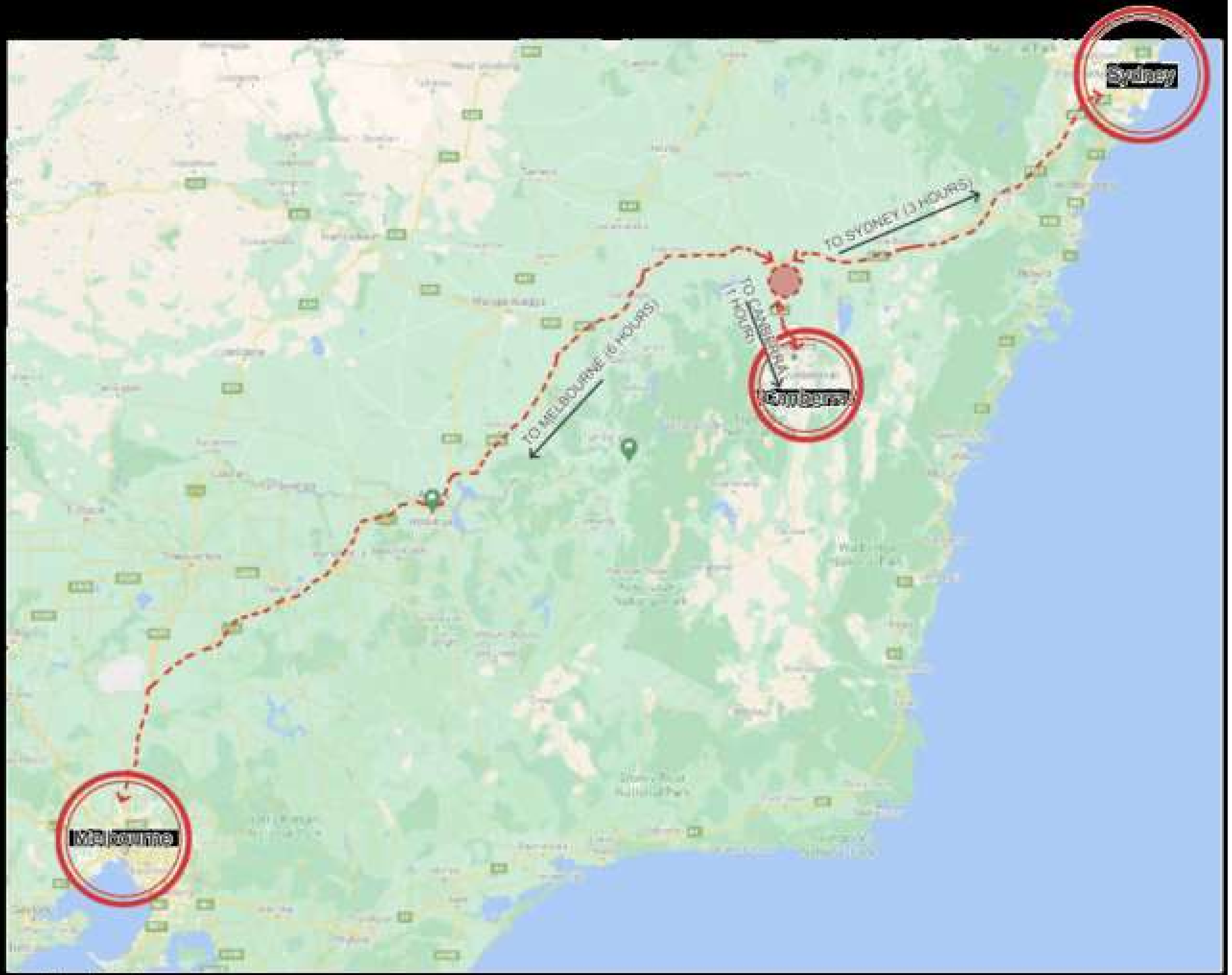
Regional Connections

Victoria Park is located within the regional town of Yass [illegible] south of Sydney and [illegible] north of Canberra in Ngunnawal Country. A town of [illegible] residents, Yass is situated within [illegible] of the Hume Hwy, the main vehicular passageway connecting Sydney to Melbourne.

Yass is often visited as a transitional stop on a greater journey with travellers often stopping for a night or two or a meal when travelling through.

The proximity to Canberra results in [illegible] of residents commuting from Yass to Canberra for school or work.

The Yass River which meanders through the Yass valley is part of the eastern extent of the Murray Darling catchment, holding great significance to the Ngunnawal People.



Google Maps [illegible]

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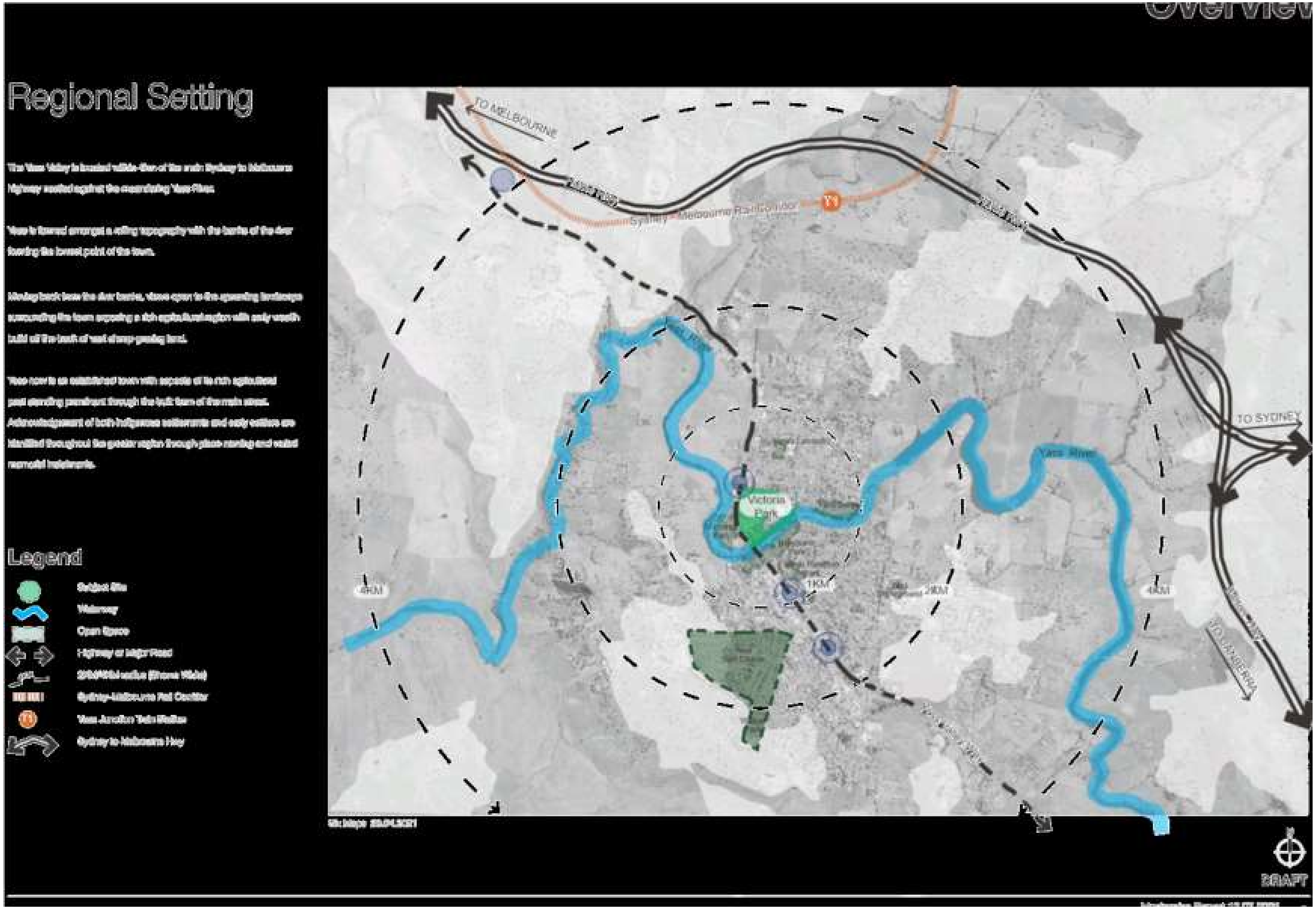
Regional Setting
Legend
TO MELBOURNE
Sydney - Melbourne Rail Corridor
TO SYDNEY
Victoria Park
Yass River
1KM
2KM
4KM
4KM
DRAFT

Overview

Connection to Country

Centralised in the town of Yass, Victoria Park presents an opportunity to build on strong Indigenous links which are present throughout the regional township.

Currently Yass holds a strong connection to country with Indigenous mapping and acknowledgement scattered throughout the town in the form of memorials, signage, walking trails and art installations.

[illegible] provides links to Yass Gorge, located east of Victoria Park, part of which is noted as a significant Aboriginal camping ground. This is signified through walking trails with signage and storytelling highlighting the area's history.

Two river tree memorials at Oak Hill remember the people of the Ngunnawal Country and their history of resettlement resulting from white settlement.

The Yass River which divides the town, is home to areas of great significance to the Ngunnawal People, including the renowned campgrounds surrounding the Yass Gorge, examples of Indigenous art murals are applied to the built form are used to highlight the First Nation's history.

'In the spirit of reconciliation we acknowledge the Ngunnawal People, as the Traditional Custodians whose country where Victoria Park is located and their connections to land, river and community. We pay our respect to their elders past and present and extend that respect to all Aboriginal and Torres Strait Islander peoples today.'

Aboriginal Language Map of NSW, published by www.ourlanguages.org.au

Key Plan, sourced Google Maps, July 2021.

Indigenous art mural applied to the foundations of the Hume Bridge. Image by TELA 2021

Yass Gorge, significant place to First Nations people. Image by TELA 2021

Oak Hill, significant First Nations site with preserved scar tree memorial. Image by TELA 2021

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Overview

Layered History

[illegible]

Hamilton Hume
Australian Explorer
(1797–1873)

- Led the first Europeans to the Yass plains in 1821
- Occupied the land grant of Yass in 1828.

Banjo Paterson
Australian Bush Poet, journalist & author
(1864–1941)

-Moved to Illalong near Yass aged 7
- Poetry inspired by his rural boyhood

Uncle Eric Bell
Ngunnawal elder,
(1940-2015)

-Spent childhood in 'Hollywood 'mission
-Identified champion for Yass' Indigenous community
-Recognised with the Yass Citizen of the Year Award in 2011.

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Regional Character
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Local Context

Legend

Six Maps 29.04.2021

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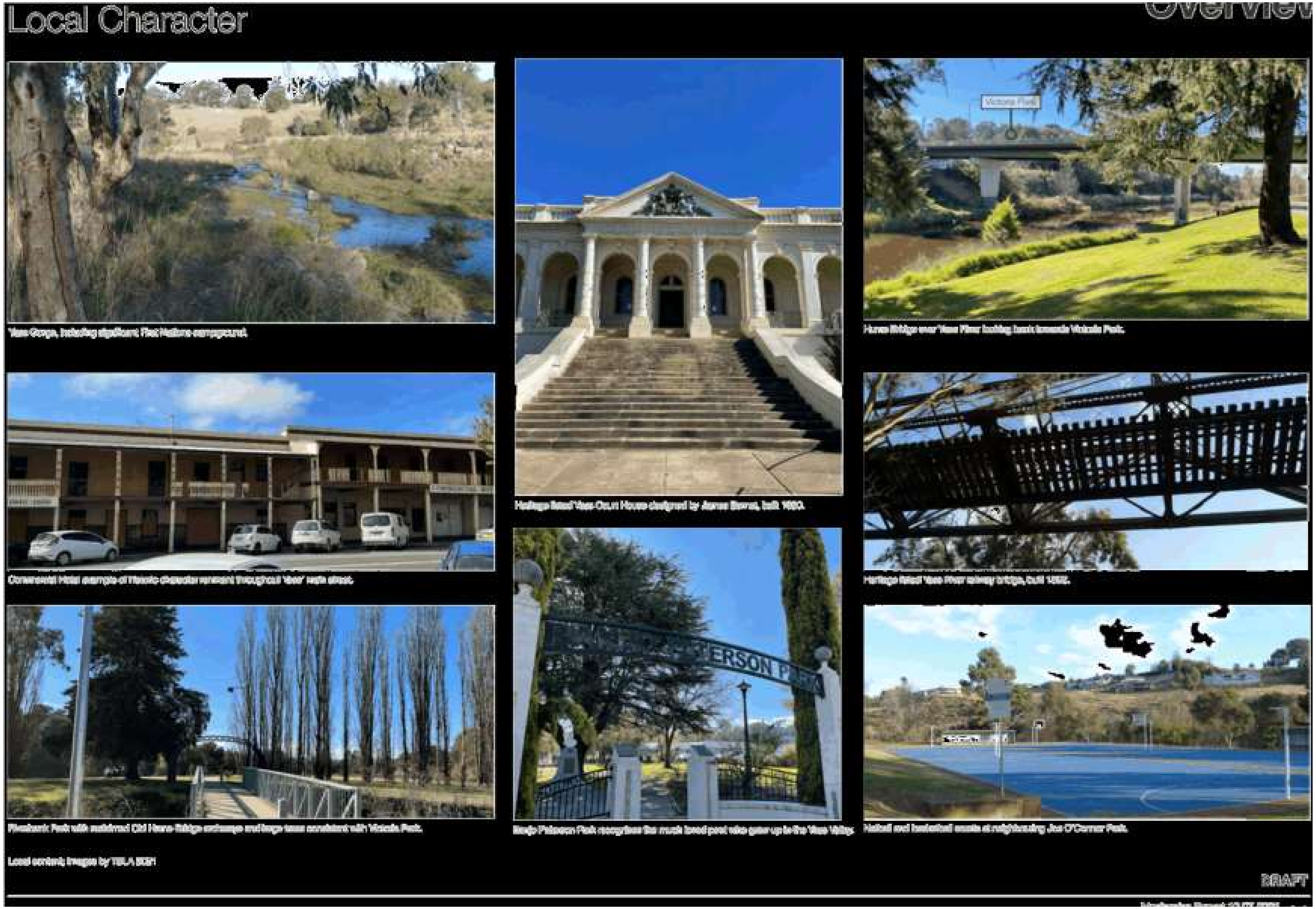
Local Character
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Overview

The Site

Victoria Park is home to a diverse selection of established community sporting groups.

Been a sporting hub within the local community, Victoria Park plays an integral role as home to the Yass Rams Rugby Club, Yass District Cricket Association and Home Tennis Club. In addition, Yass Little Athletics Club, while not currently utilising the facility, also has a connection to the park.

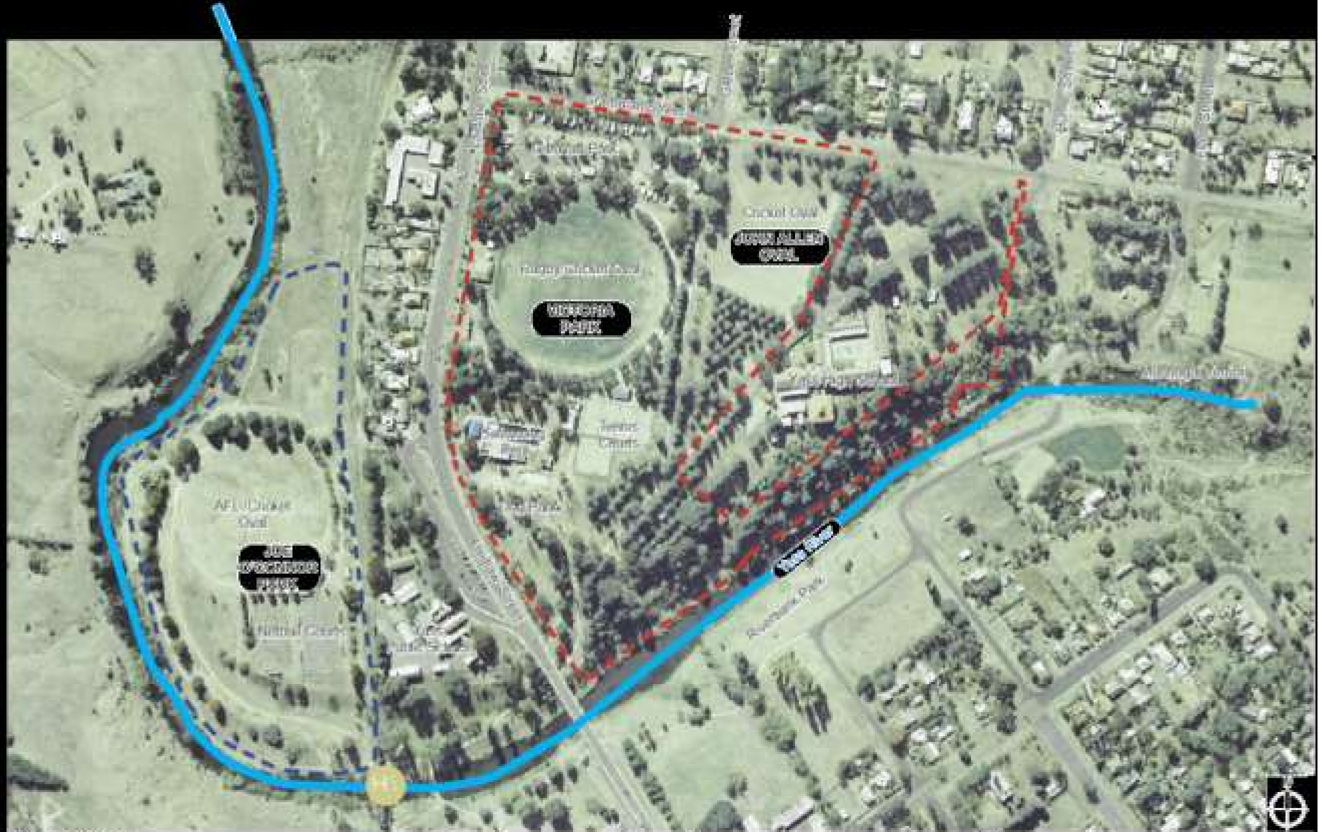
The Yass Memorial Olympic Swimming Pool is also a key element within the site. The pool is used by the community, school groups and swim club.

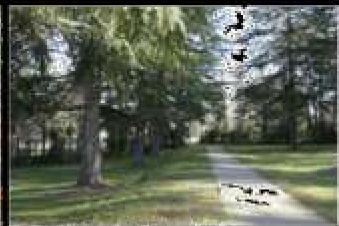
Local schools rely on Victoria Park for structured recreation, utilising park facilities for athletics carnivals and grade sport and other structured sporting events.

There is also a skate park and dog park which are open to community use.

Legend

- Subject Site Boundary
- Yass River
- Yass Town rail bridge over Yass River
- Joe O'Connor Park





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Existing Site Character
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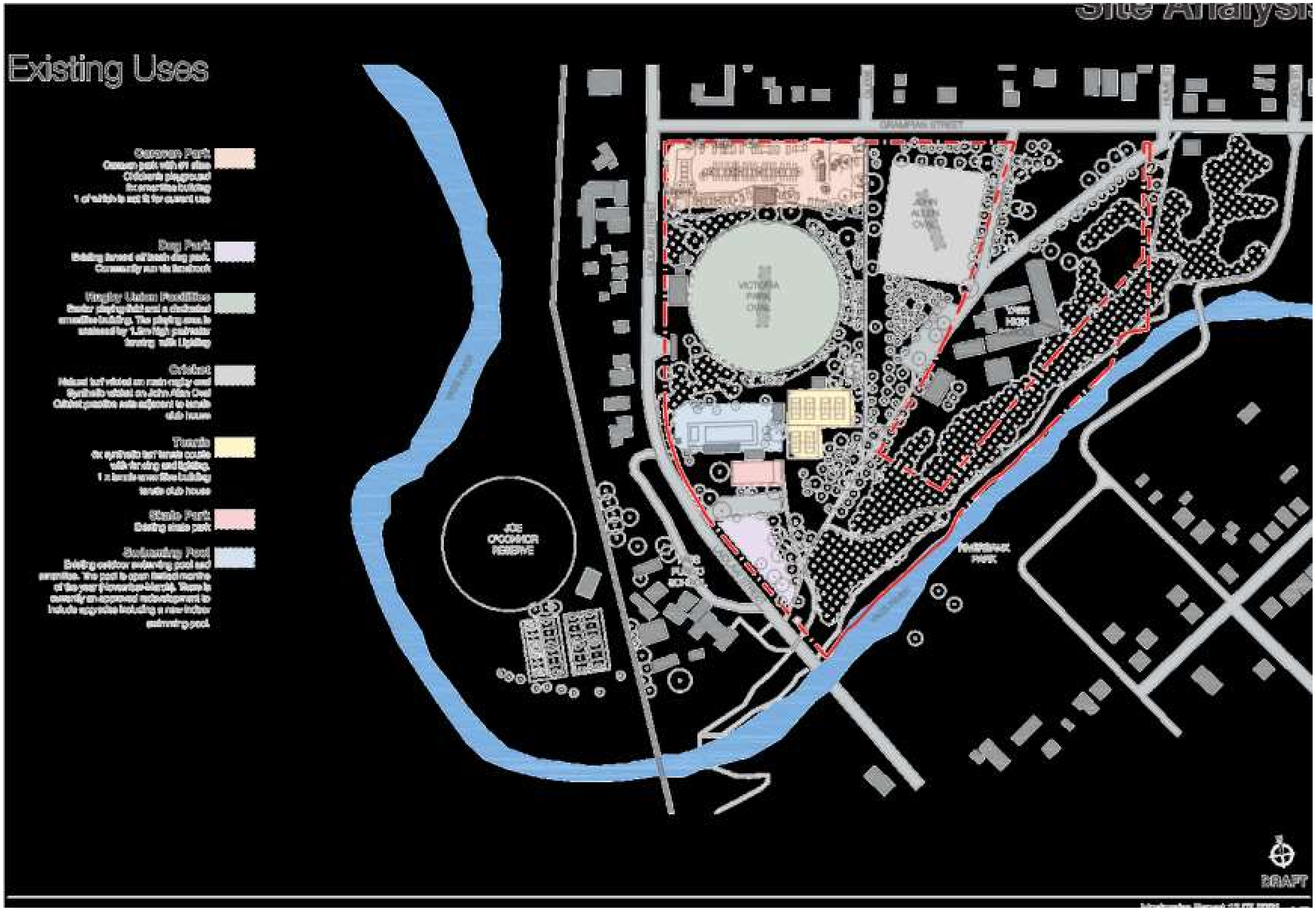
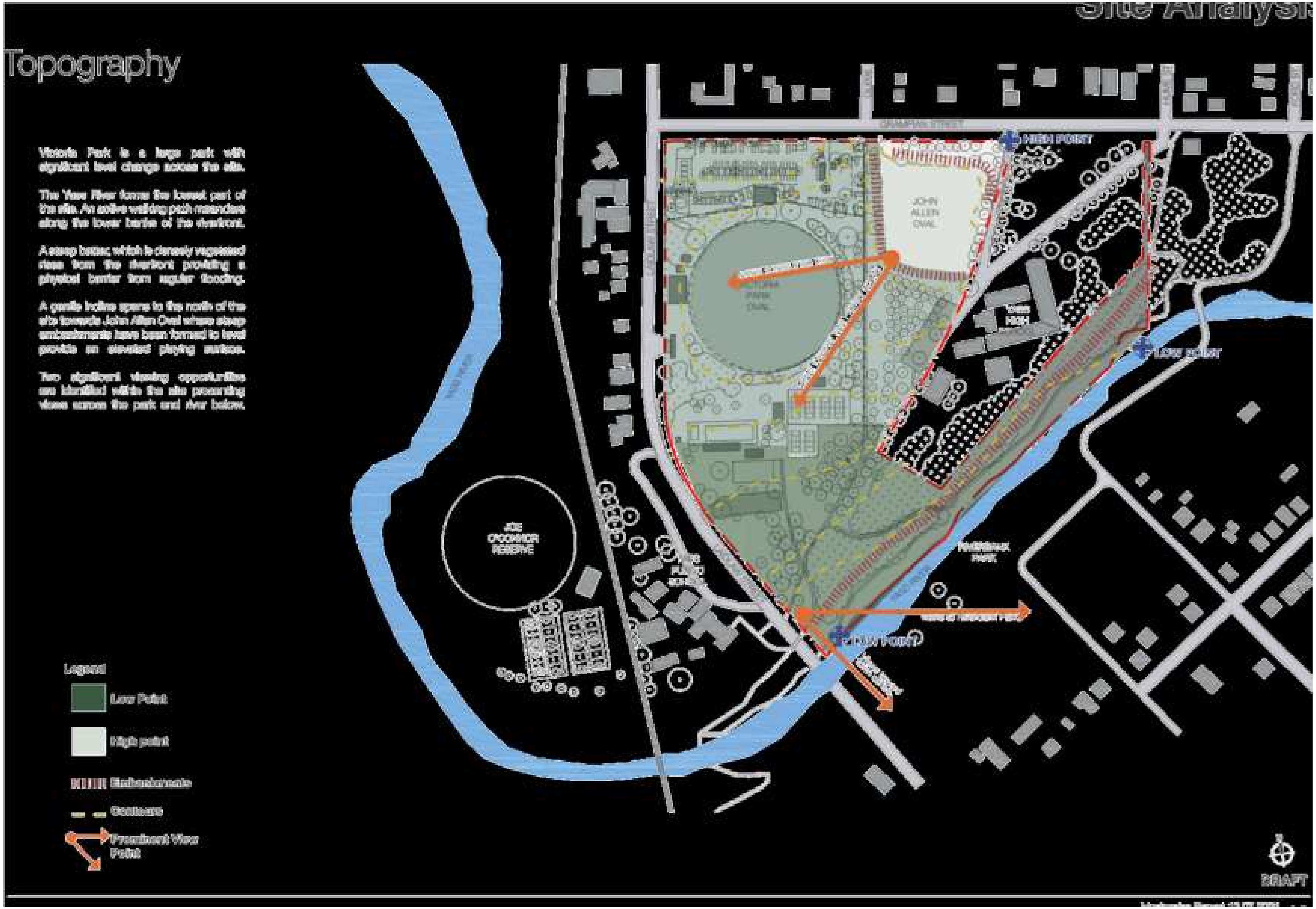
02 | Site Analysis


Existing Uses
Caravan Park
Dog Park
Rugby Union Facilities
Cricket
Tennis
Skate Park
Swimming Pool
VICTORIA PARK OVAL
JOE O'CONNOR RESERVE
DRAFT


Access
School Carpark
Service Vehicles
Southern Carpark
Main Oval Carpark
VICTORIA PARK OVAL
DRAFT


Parking
DRAFT

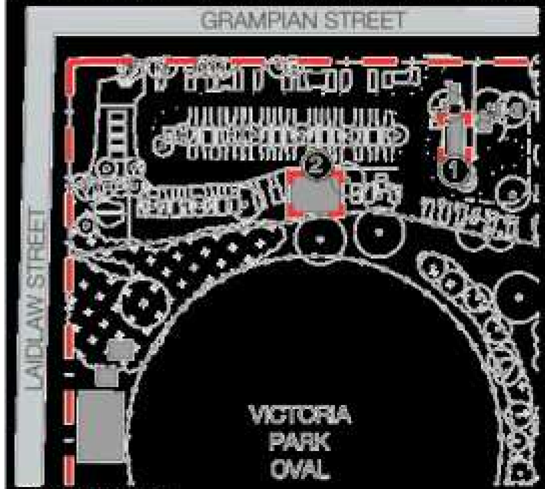

Safety and Accessibility
Lighting
VICTORIA PARK OVAL
JOE O'CONNOR RESERVE
DRAFT


Site Analysis
Topography
Victoria Park is a large park with significant level change across the site.
The Yass River forms the lowest part of the site. An active walking path meanders along the lower banks of the riverfront.
A steep batter, which is densely vegetated rises from the riverfront providing a physical barrier from regular flooding.
A gentle incline spans to the north of the site towards John Allen Oval where steep embankments have been formed to level provide an elevated playing surface.
Two significant viewing opportunities are identified within the site presenting views across the park and river below.
HIGH POINT
JOHN ALLEN OVAL
LOW POINT
JOE O'CONNOR RESERVE
Legend
Low Point
High point
Embankments
Contours
Prominent View Point
DRAFT


Existing Amenities/Storage
3. Temporary Storage
4. Storage Shed
7. Swimming Pool Amenities
8. Dog Park
Legend
Shipping Container
Storage Shed
Amenities Building
VICTORIA PARK OVAL
DRAFT

Site Analysis

Existing Amenities - Caravan Park



Plan of existing facilities

Uses
Caravan Park

Sizes
Amenities block 1 - Approximately 180m²
Amenities block 2 - Approximately 120m²

Conditions
Amenities block 1 - Bathrooms non compliant with current building code and no longer in use. Laundry is currently in use.
Amenities block 2 - Current patron amenities building, more recent than amenities block 1, deemed fit for purpose.

Aspects
Amenities block 1 - Western
Amenities block 2 - Northern

General Assessments
Amenities block 1 - Due to ongoing safety concerns and a poor internal layout the existing building is deemed unsuitable for continued use. It is understood that a grant for internal refurbishments is underway.
Amenities block 2 - Currently meets the needs of patrons.

Key Plan

Amenities block 1 - bathrooms not currently in use due to building condition

Amenities block 1 - laundry still active

Amenities block 2 - amenities building currently active

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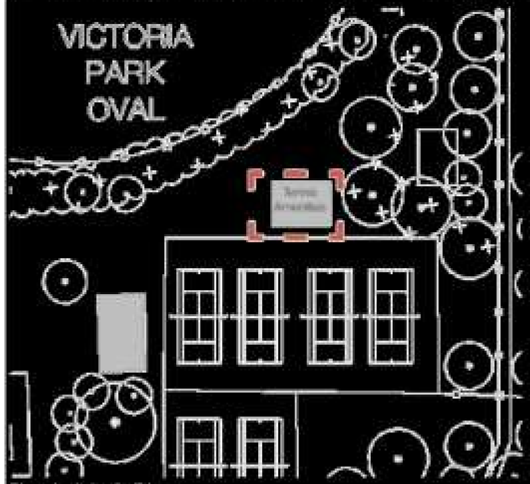
Site Analysi

Existing Amenities - Tennis



Plan of existing facilities

Uses
Tennis club

Size
Approximately 180m²

Conditions
External building is structurally sound however the hallway in the clubhouse has started dropping.

Aspect
Southern

General Assessment
The clubhouse venue is hired out 10-20 times per year to private groups. Lacks adequate storage for tennis club requirements.

Key Plan

Existing tennis facilities building In close proximity to vehicle access way

Image from Hume Tennis Club facebook. 2021

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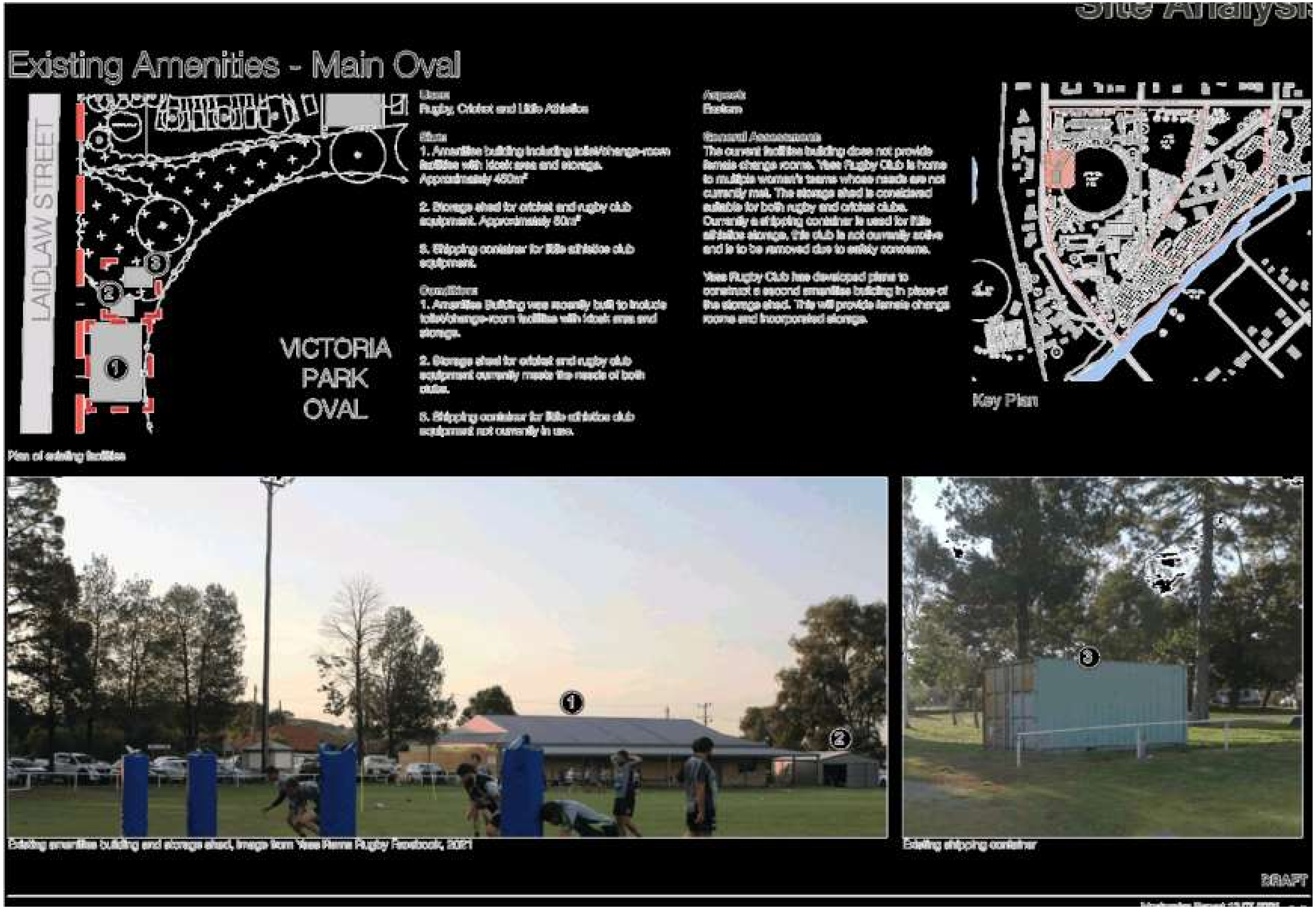
Site Analysis
Existing Amenities - Main Oval
LAIDLAW STREET
VICTORIA PARK OVAL
Users
Rugby, Cricket and Little Athletics
Sizes
1. Amenities building including toilet/change-room facilities with kiosk area and storage. Approximately 450m²
2. Storage shed for cricket and rugby club equipment. Approximately 60m²
3. Shipping container for little athletics club equipment.
Conditions
1. Amenities Building was recently built to include toilet/change-room facilities with kiosk area and storage.
2. Storage shed for cricket and rugby club equipment currently meets the needs of both clubs.
3. Shipping container for little athletics club equipment not currently in use.
General Assessment
The current facilities building does not provide female change rooms. Yass Rugby Club is home to multiple women's teams whose needs are not currently met. The storage shed is considered suitable for both rugby and cricket clubs. Currently a shipping container is used for little athletics storage, this club is not currently active and is to be removed due to safety concerns.
Yass Rugby Club has developed plans to construct a second amenities building in place of the storage shed. This will provide female change rooms and incorporated storage.
Key Plan
Plan of existing facilities
Existing amenities building and storage shed, image from Yass Rams Rugby Facebook, 2021
Existing shipping container
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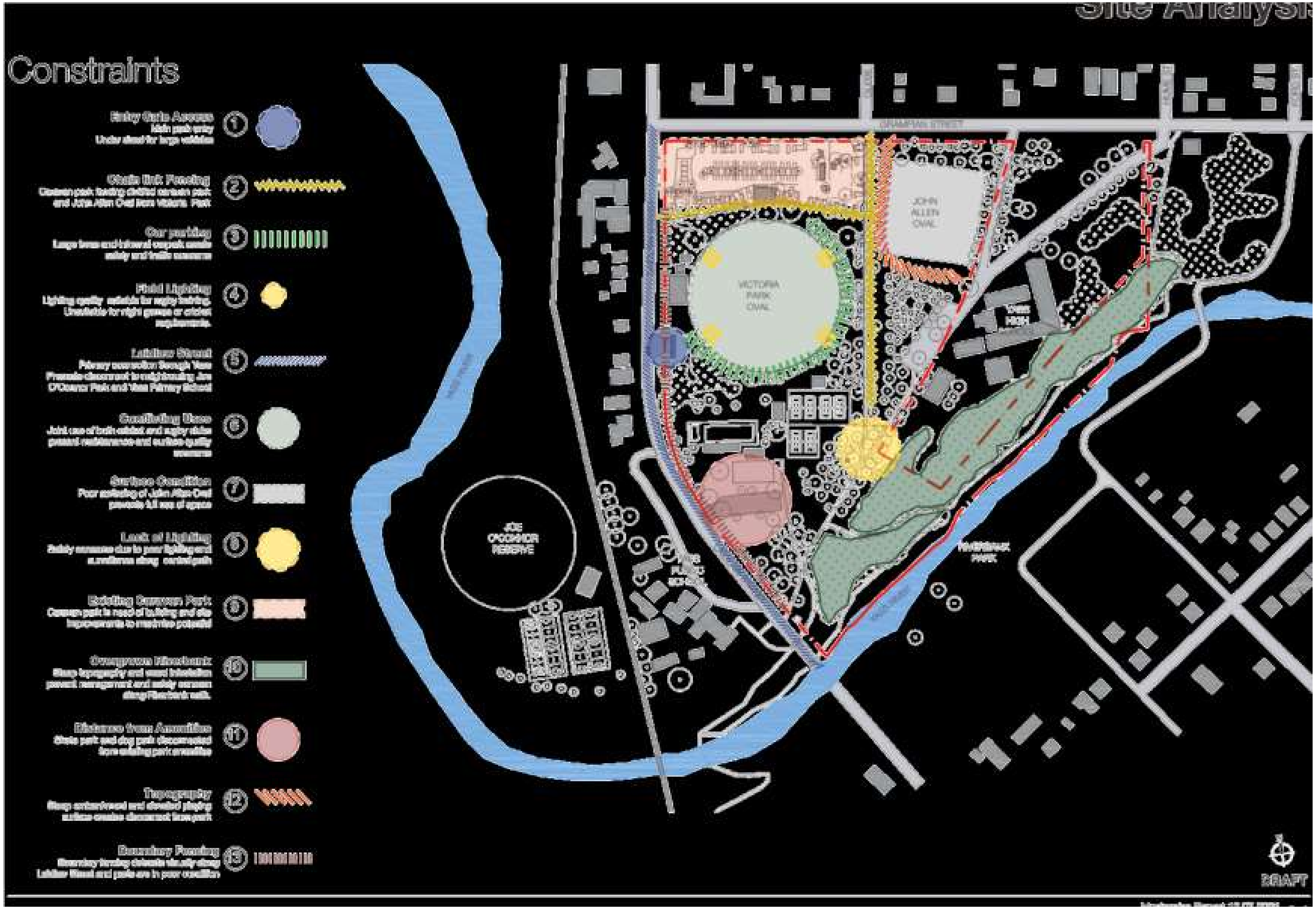
Constraints
VICTORIA PARK OVAL
JOHN ALLEN OVAL
JOE O'CONNOR RESERVE
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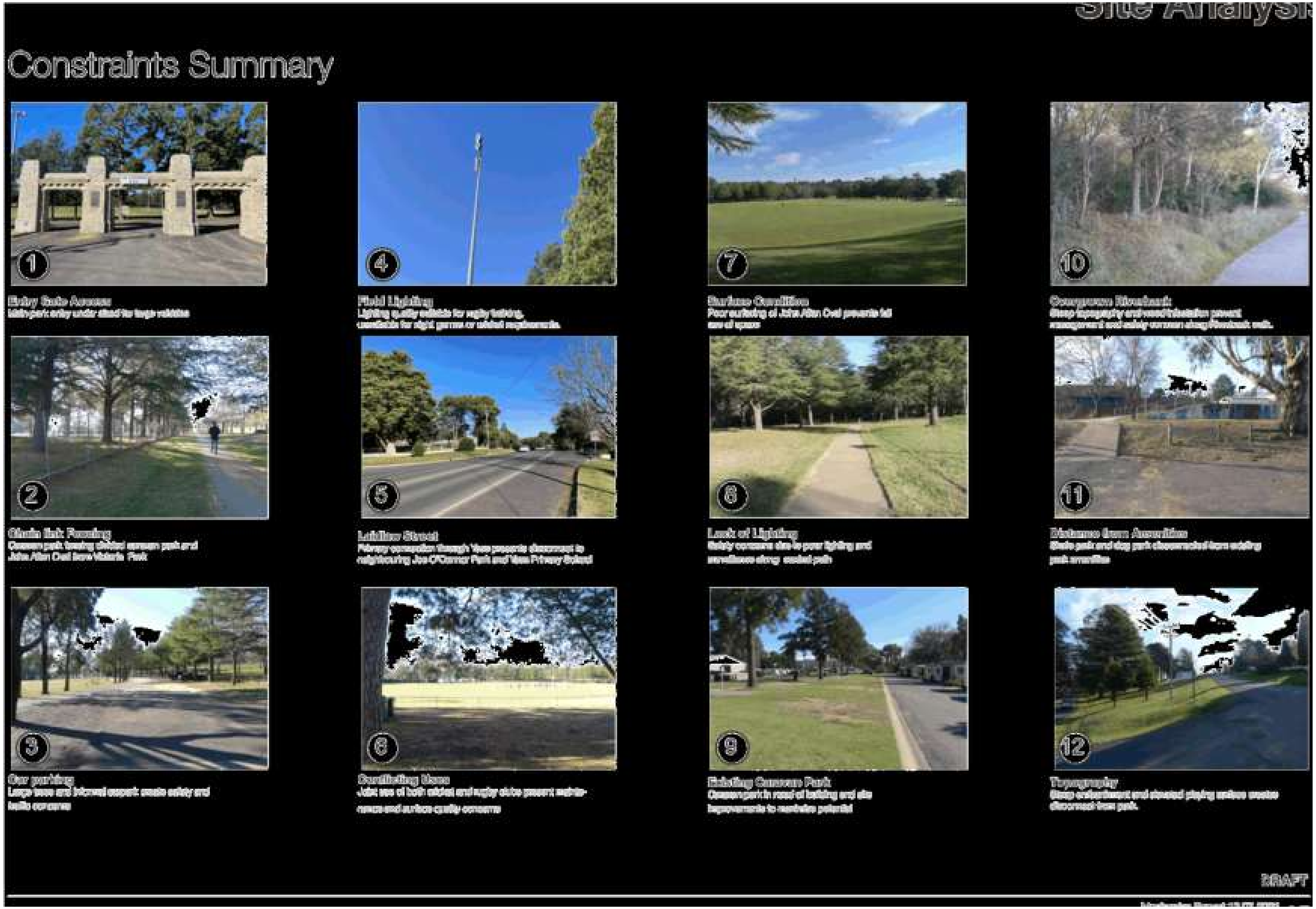
Constraints Summary
1
4
7
10
Field Lighting
2
5
8
11
Laidlaw Street
Lack of Lighting
3
6
9
12
Car parking
Existing Caravan Park
Topography
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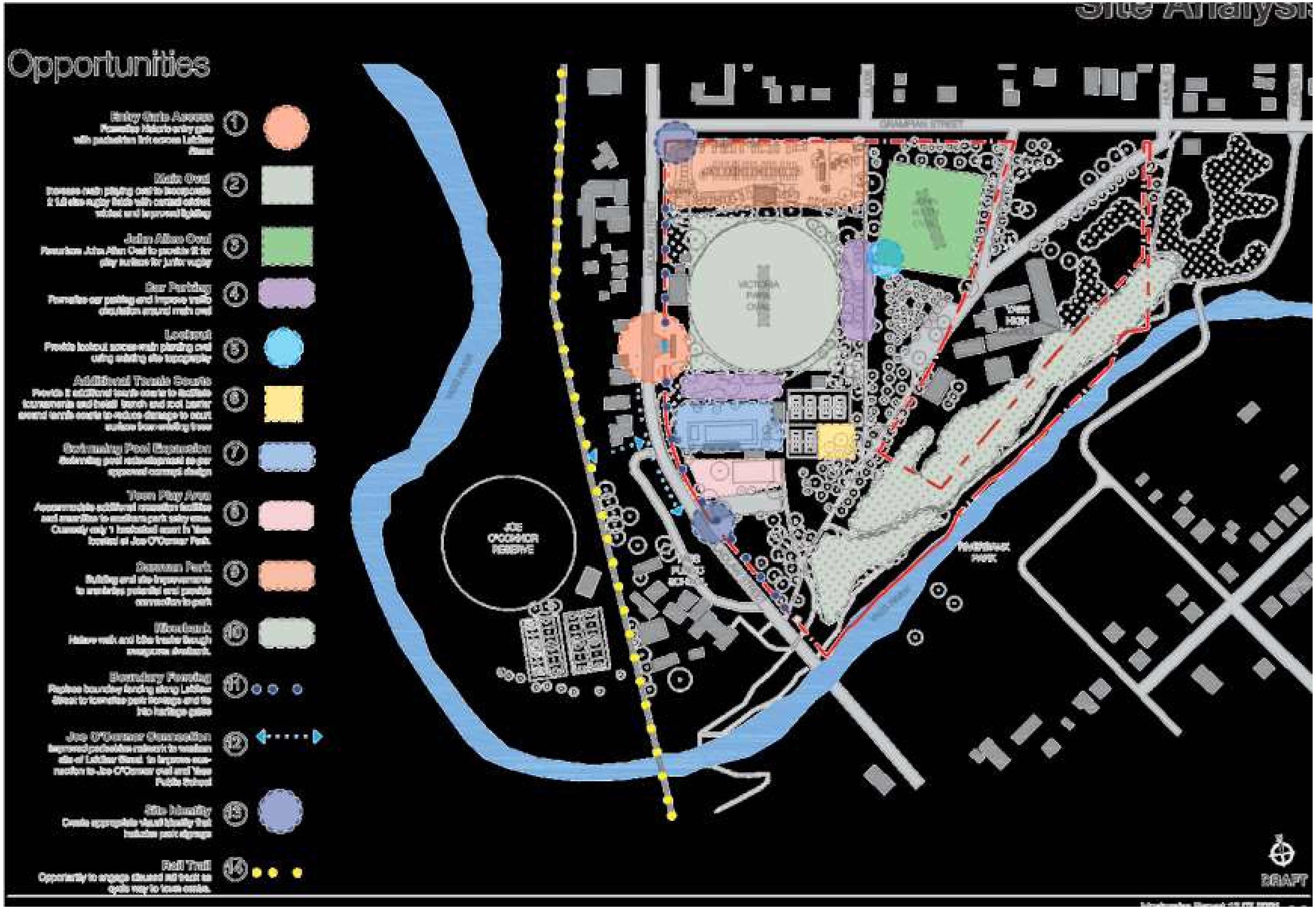
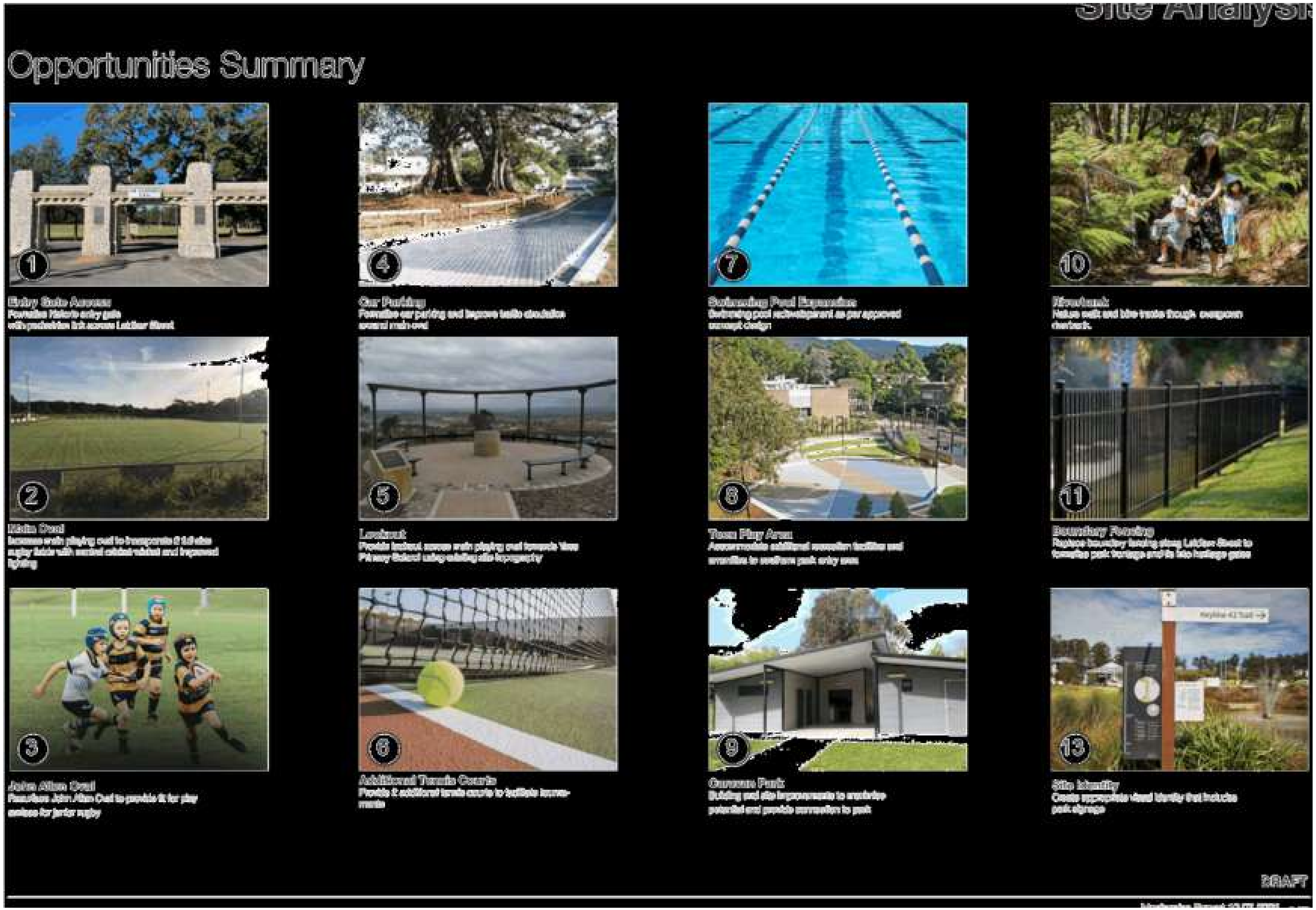

Site Analysis
Opportunities
Entry Gate Access
Main Oval
Car Parking
Lookout
Additional Tennis Courts
Swimming Pool Expansion
Teen Play Area
Caravan Park
Riverbank
Boundary Fencing
Joe O'Connor Connection
Site Identity
Rail Trail
VICTORIA PARK OVAL
JOE O'CONNOR RESERVE
DRAFT


Site Analysis
Opportunities Summary
1
Car Parking
4
Swimming Pool Expansion
7
10
2
Main Oval
5
Lookout
8
Town Play Area
11
Boundary Fencing
3
6
Additional Tennis Courts
9
Caravan Park
13
Site Identity
DRAFT


04 | Masterplan


Masterplan
ACTIONS
Main Oval
Car Parking
Lookout
Additional Tennis Courts
Swimming Pool Expansion
Play Hub
Caravan Park
Riverbank
Site Identity
Boundary Fence
GRAMPIAN STREET
LAIDLAW STREET
YASS HIGH SCHOOL
YASS PUBLIC SCHOOL
RIVERBANK PARK
DRAFT


Masterplan
Playing Field Upgrades
ACTIONS
LAIDLAW STREET
KEY PLAN
DRAFT


Play Hub
ACTIONS
Basketball Courts 1
Graffiti Wall 2
Picnic Shelter 3
Dog Off Leash Area 4
Car Parking 5
Additional Tennis Courts 6
Playground 7
Car Parking 8
Swimming Pool Expansion 9
KEY PLAN
YASS
PUBLIC
SCHOOL
LAIDLAW ST
DRAFT


Caravan Park Actions
GLEBE ST
GRAMPIAN STREET
35000
50000
70000
10M
DRAFT


Proposed Character
Site Identity
Entry Gate Access
Improve Main Oval
Lookout
Additional Tennis Courts
Riverbank Walking Trails
Engage John Allen Oval
Caravan Park Improvements
Teen Play Area
Swimming Pool Expansion
GRAMPIAN STREET
LAIDLAW STREET
YASS HIGH SCHOOL
YASS PUBLIC SCHOOL
RIVERBANK PARK
DRAFT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22 April 2021

P1546 CPC Barton Highway services Yass TIA

Catalyze Property Consulting Pty Ltd
PO Box 44
Islington NSW 2296

Attn: Craig McGaffin

Dear Craig,

Planning Proposal in relation to Lot 12 DP 1158637

Proposed Highway Service Station, Barton Highway adjacent to Longrail Gully Road, south of Yass, NSW

Further to your request we have now completed our review of the documentation for the proposed Highway Service Centre development located to the immediate north of Longrail Gully Road on the Barton Highway, south of Yass. We have also discussed the project with Transport for NSW (TfNSW) and completed our site observations to determine the current traffic demands in this location as well as review the layout of the intersection of the Barton Highway and Longrail Gully Road. The findings our of project work are provided below.

Background

Seca Solution was commissioned by Catalyze Property Consulting Pty Ltd on behalf of The Trustee for the Barton Highway Trust (Client) to undertake a review of traffic and access issues for the site on the Barton Highway, Murrumbateman, NSW (Lot 12 DP1158637) located in the Yass Valley Council LGA.

The applicant has been previously lodged seeking to amend Schedule 1 Additional Permitted Uses to permit a 'highway service centre' on Lot 12 DP1158637 zoned RU1 Primary Production Zone located north of Murrumbateman and fronting the Barton Highway. Prior to any approval for this rezoning application, a detailed traffic assessment is required to be undertaken to the satisfaction of TfNSW prior to public consultation.

The subject land is bounded by the Barton Highway along the eastern boundary and the old road corridor along its western boundary, with Longrail Gully Road slitting the sterilised land in half. The project site for the proposed service station is located to the immediate north of Longrail Gully Road.

Quality Traffic Advice

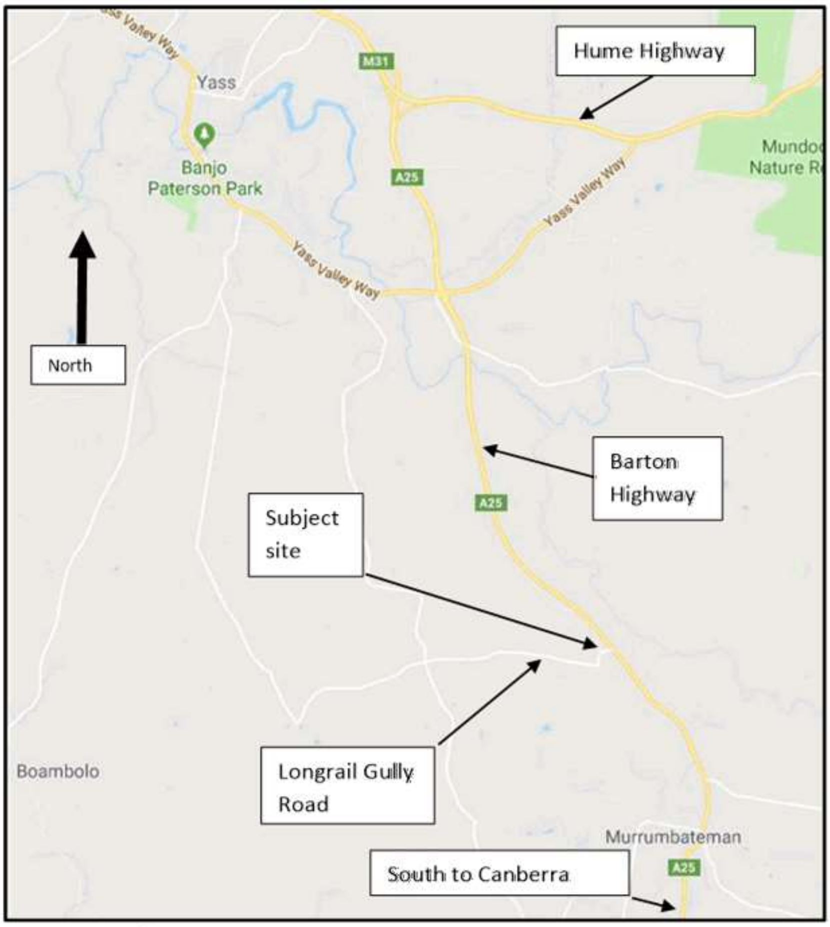

Figure 1 – Site location

Current situation

The Barton Highway in this location provides an important link in the road network, providing a direct route between Canberra and Yass for connection to the Hume Highway. In the vicinity of the subject site is provides a single lane of travel in each direction with a sealed shoulder. It operates under the posted speed limit of 100 km/h and carries a mixture of local and regional traffic. As part of the project work, Seca Solution collected traffic data at the intersection of the Barton Highway and Longrail Gully Road to determine the morning peak hour flow along the Barton Highway (Thursday 1st August 2019). Between 8.00 and 9.00 AM the 2-way traffic movement was 710 vehicles, with 400 vehicles southbound (56%). Heavy vehicles represented 4.2% of the total traffic flows. A single vehicle turned right out of Longrail Gully Road and a single heavy vehicle turned right into Longrail Gully Road from the Barton Highway.

The TfNSW web page shows that in Murrumbateman the daily traffic flow in 2012 was 9,283 vehicles per day. The Barton Highway Duplication Economic Evaluation Report (dated November 2013 prepared by SKM) shows that the daily traffic flows in 2013 were 10,884 and allowed for 2-3% growth in traffic. This would indicate that current daily traffic flows on the Barton Highway could be in the order of 12,800 vehicles per day.

The intersection of the Barton Highway and Longrail Gully Road allows for all turning movements with a sheltered right turn lane for southbound traffic turning right into Longrail Gully Road and a left turn deceleration lane on the Barton Highway for traffic turning into Longrail Gully Road. The right turn lane is 175 metres long including the taper whilst the left turn slip is 145 metres long. The Barton Highway in this location provides a straight horizontal alignment and a relatively flat vertical alignment, ensuring good visibility is available for drivers turning in and out of Longrail Gully Road.

For the posted speed limit of 100 km/h, the sight distance required from Austroads Guidelines is 248 metres and for a limit of 110 km/h the sight distance requirement is 300 metres. The sight distance available at this intersection has been measured on site and exceeds 500 metres in both directions.

Photo 1 – View to right for driver exiting Longrail Gully Road

Photo 2 – View to left for driver exiting Longrail Gully Road

Photo 3 – Existing deceleration lane for vehicles turning left into Longrail Gully Road

Photo 4 – Existing right turn lane for vehicles entering Longrail Gully Road

Consultation with RMS

As part of the project work, Seca Solution has discussed the proposal with Maurice Morgan from the TfNSW Wagga Wagga office and the following points were made:

- TfNSW are continuing to review the performance of the Barton Highway and the intention is to duplicate the full length of the Barton Highway between the ACT and Yass, to improve traffic conditions between Canberra and the Hume Highway;
- The current intersection controls at the intersection of the Barton Highway and Longrail Gully Road are considered adequate for the current traffic demands. A proposal for a service station at this location will require a detailed traffic assessment to the satisfaction of Council as the road authority and this will also be reviewed by TfNSW prior to them providing any concurrence. The assessment will need to take into account the future plans for the road upgrades in this location, in consultation with TfNSW;
- TfNSW stated that all vehicle access will be via Longrail Gully Road only and no direct vehicle access to the Barton Highway will be permitted in accordance with Clause 101 from the SEPP (Infrastructure) 2007;
- TfNSW further stated that the plans for the upgrade of the Barton Highway have not yet been fully developed and the existing controls and movements at this intersection will be reviewed as part of the upgrades at this location. The future upgrades could provide restrictions on the turns at this location especially the right turn out of Longrail Gully Road onto the Barton Highway. The upgrade may also only allow for future left in and left out turns for Longrail Gully Road;
- As part of the upgrade of the Barton Highway, TfNSW will review the various intersections along this section of the road to reduce the number of conflicts for right turns, which would then be catered for at U-turn facilities.

A review of the TfNSW webpage shows that the planning for the upgrade of the Barton Highway is on-going and there are no detailed plans nor timeframes provided for the full upgrade of the road. The September 2020 community update provides the following advice:

" Transport for NSW has formed an alliance with Seymour Whyte and SMEC to design and construct the initial length of Barton Highway duplication from the ACT border towards Murrumbateman. Qualified contractors were invited to tender in October last year to build the $100 million first stage of duplication, and Seymour Whyte and SMEC were selected as the successful candidates after a competitive tender process and participating in a series of technical workshops.

A partnership with the private sector will enable Transport for NSW to be more agile, and leverage expertise for a speedier delivery and better value for money.

It is anticipated duplication of the Barton Highway from the ACT border towards Murrumbateman will start on site later this year and be completed in 2023.

Meanwhile, a submissions report has been produced, summarising all feedback to the Review of Environmental Factors (REF) for the Barton Highway duplication project.

Thanks to the responses received during the submission period, a key design improvement has been made by adding a dedicated right turn from the highway to Kaveneys Road to improve safety."

This community update indicates that the section of the highway north of Murrumbateman that covers the area in the vicinity of the subject site is still being assessed and determined in terns of upgrade requirements etc.

The Proposal

The proposal will allow for a highway service centre to be provided on the site, providing a fuel outlet, together with food / retail outlet and parking for light and heavy vehicles. All vehicle access will be provided on Longrail Gully Road only and the footprint of the site will allow all vehicles to be able to enter and exit the site in a forward direction.

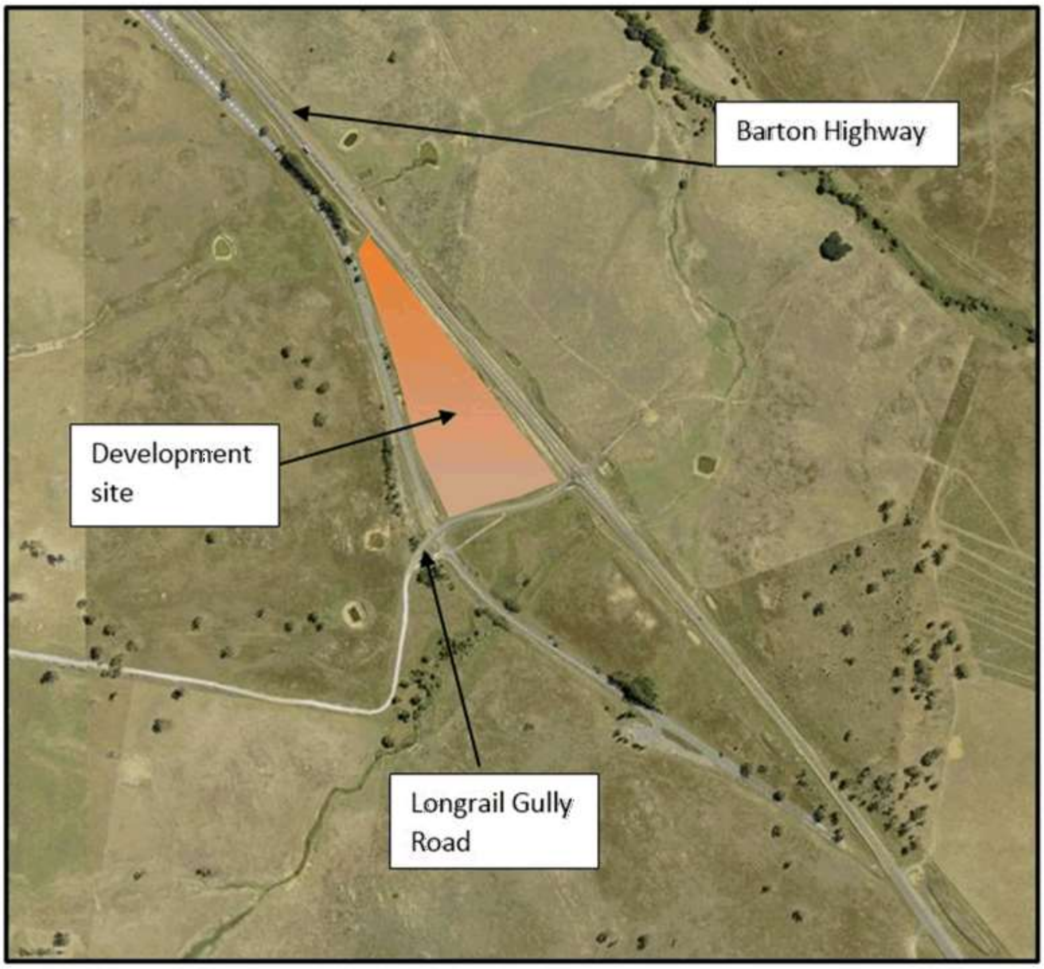

Figure 2 - Site location relative to intersection of Barton Highway and Longrail Gully Road

A concept plan for the project has been developed and allows for the following to be provided on site:

- Fuel retail shop
- Quick service restaurant
- Quick service restaurant with drive-thru facility
- Fuel canopy with 4 pumps for light vehicles
- Fuel canopy with 3 pumps for trucks
- 30 car parking spaces
- 5 car with caravan parking spaces
- 1 waiting bay associated with the drive-thru facility
- 6 truck parking bays to accommodate B-doubles

When determining the traffic impacts of the project it is important to note that the vast majority of the traffic will be passing trade and as such the project will not generate any significant additional traffic movements. The site is relatively remote and will predominantly service the needs of passing motorists on the Barton Highway. While the majority of the movements will be left in and left out, the traffic southbound on the Barton Highway will require right turn movements in and out. As discussed with TfNSW, the future upgrade of the Barton Highway in this location may restrict the movements at this location to left in and left out only. If this restriction is imposed, then the development will typically only service the northbound traffic movements along the highway, depending on where U-turn facilities are provided.

The design of the highway service centre will be completed in accordance with the road authority requirements and AS2890. The design will allow for all vehicles to enter and exit the site off Longrail Gully Road only in a forward direction and allow for safe and appropriate circulation around the site.

It is noted that Longrail Gully Road currently does not permit the use of B-doubles. A separate application for B-double access shall be submitted to Council to allow for B-double access between the Barton Highway and the site access. Any associated road or pavement upgrades will be agreed with Council (as the road authority) and will form part of any future DA consent for the project.

The design of the service station is at a preliminary stage only at this point. Based on comments from TfNSW, the design allows for the entry into the site to be furthest away from the Barton Highway, to reduce any risk of the right turn queue into the site extending back into the highway. The entry to the site is approximately 80 metres form the intersection of Longrail Gully Road and the Barton Highway, which would be sufficient for a B-double and / or a semi trailer to be propped waiting to turn into the and 5 or more cars to be behind this truck and still not queue back to the Barton Highway. The internal layout of the site allows vehicles to enter the site and move away from the entry point, with no parking or queues expected in the site to block the site entry off Longrail Gully Road. Given the negligible traffic flows on Longrail Gully Road it is considered that there will not be any queues forming on Longrail Gully Road for vehicles entering the site. The exit is nearest the Barton Highway and the traffic will generally all be left turning out of the site on to Longrail Gully Road which avoids any cross over of movements.

Traffic Impacts

The RMS Guide to Traffic Generating Developments provides advice on the potential traffic movements associated with the project with the following rates provide for the project site:

- McDonalds Drive-thru restaurant a rate of 180 vehicles per hour
- KFC restaurant a rate of 100 vehicles per hour
- Service station rate of 0.04 x site area plus 0.3 x area of the convenience store or a rate of 0.66 times the area of the convenience store.

It is considered that applying the rate for a KFC type facility is appropriate in this location and the 2 outlets could therefore generate 200 vehicle movements per hour, with 100 inbound and 100 outbound. For the service station, there is no separation between the service station and the balance of the site but applying the whole of the site footprint to determine the extent of traffic is not considered appropriate. The convenience store provides an area of 244m^2 and applying the rate of 0.66 x floor area would give 161 trips, split 80 inbound and 80 outbound.

Thus, for the overall site, the total flows could be 180 vehicles inbound and 180 vehicles outbound (360trips). This is considered a worst-case scenario, as it is proposed that there would be significant overlap in use, with drivers fuelling their vehicles and also choosing to have a break for food etc. It can also be seen that 180 inbound vehicles represents 25% of the existing traffic flows on the Barton Highway i.e. using this rate, 1 in 4 drivers would look to access this site, which is considered to be excessive.

It can be seen that the traffic impacts for the project will need to take into account the current intersection layout as well as the future layout / controls. The current at-grade intersection allows for all turning movements, with a sheltered right turn lane. Allowing for this current layout, it has been assumed that 60% of the traffic would be left in and left out of Longrail Gully Road i.e. northbound and the Barton Highway and 40% would turn right in and right out of Longrail Gully Road to access the site i.e. southbound.

The impact of the above traffic demands at this location have been assessed with Sidra and the results are presented below. The morning traffic flows, including the heavy vehicle percentage observed as part of these surveys surveyed by Seca Solution in August 2019 have been used, with the PM flows assumed to be the same as the AM peak with the directional split reversed.

*Table 1 – **2020** traffic flows plus development flows with existing intersection controls*

Approach	Level of service	Delay (seconds)	Queue (metres)
Barton Highway northbound	A / A	5.6 / 5.6 (left turn)	0.0 / 0.0
Barton Highway southbound	A / A	7.7 / 8.4 (right turn)	2.4 / 2.7 (right turn)
Longrail Gully Road	A / A (left turn) B / B (right turn)	8.9 / 9.8 (left turn) 21.1 / 21.3 (right turn)	13.8 / 14.3

Note: results for the AM / PM peak.

The above results show that with the projected traffic flows of 180 vehicles inbound and outbound the existing intersection controls at the intersection of the Barton Highway and Longrail Gully Road will allow for minimal delays for road users.

The traffic modelling completed for the upgrade of the Barton Highway project shows that traffic is projected to increase along the Barton Highway at an annual rate of 3.5% (Barton Highway Duplication Business case dated October 2019). For the future design year of 2030 this would indicate that the traffic volumes will increase by 38.5% over those surveyed by Seca Solution in 2018.

The impact of the above traffic demands at this location have been assessed with Sidra for the future design year of 2030 and the results are presented below. This assessment below assumes that the existing intersection controls remain in place and all turning movements are permitted.

*Table 2 - **2030** traffic flows plus development flows with existing intersection controls*

Approach	Level of service	Delay (seconds)	Queue (metres)
Barton Highway northbound	A / A	5.6 / 5.6 (left turn)	0.0 / 0.0
Barton Highway southbound	A / A	8.7 / 10.1 (right turn)	2.8 / 3.3 (right turn)
Longrail Gully Road	B / B (left turn) C / C (right turn)	16.5.9 / 18.7 (left turn) 41.3 / 42.1 (right turn)	25.6 / 26.4

Note: results for the AM / PM peak.

The future scenario for the design year of 2030 has also been assessed with Sidra allowing for the duplication of the Barton Highway in this location. It has been assumed that the upgrade will allow for the right turn in to Longrail Gully Road, but the right turn out will be banned and drivers would proceed north to then complete a U-turn to the north of the location. The distribution of trips northbound and southbound has remained as per the above assessment. The operation of this intersection has been assessed with Sidra for the future design year of 2030, with background traffic growth along the Barton Highway applied in accordance with the modelling prepared for the upgrade of the Barton Highway.

*Table 3 - **2030** traffic flows plus development flows with upgraded intersection controls*

Approach	Level of service	Delay (seconds)	Queue (metres)
Barton Highway northbound	A / A	5.6 / 5.6 (left turn)	0.0 / 0.0
Barton Highway southbound	A / A	10.4 / 12.4 (right turn)	3.7 / 4.5 (right turn)
Longrail Gully Road	A / A (left turn)	6.7 / 7.0 (left turn)	5.2 / 3.2

Note: results for the AM / PM peak.

The above Sidra modelling demonstrates that the future upgrade, allowing for the 2 through lanes in each direction on the Barton Highway and no right turn out of Longrail Gully Road will provide good access for all traffic using Longrail Gully Road. The delays and queues are very low and well within acceptable limits.

With the removal of the right turn out, all traffic exiting Longrail Gully Road will need to turn left. Traffic then wishing to head south will need to use the U-turn facility to the north of this location. The report prepared for the upgrade of the Barton Highway identifies that the upgrade will generally reduce the right turn opportunities for traffic, to improve road safety. Right turn movements would then be catered for at U-turn facilities. These turn facilities will be designed in accordance with Austroads Guidelines, which allow for deceleration lane and acceleration lanes as required.

As part of the project work, the left turn out acceleration lane from Longrail Gully Road will need to be reviewed to allow for the increased left turn movement out of the side road. The existing left turn acceleration lane is not adequate for increased demands and will need to be lengthened in accordance with Austroads Guidelines. This road upgrade to allow for this left turn acceleration lane will be completed under a WAD process requiring review and concurrence with TfNSW.

With TfNSW still assessing the upgrade requirements along the length of the Barton Highway, the turning movements or restrictions at the intersection with Longrail Gully Road have not been determined. If the right turn continues to be permitted, then the project site may require the provision of a right turn acceleration lane to cater for the heavy vehicles in particular exiting the side road. This will be assessed and determined as part of any future DA for the project and the intersection controls and requirements will be agreed with TfNSW, as at that stage of the project the plans for the upgrade of the Barton Highway in this location may have been finalised by TfNSW.

Right Turn from Longrail Gully Road

We understand that there has been feedback from the residents who live along Longrail Gully Road that they are concerned the development will cause the removal of the righthand turn to the Highway from Longrail Gully Road.

Our analysis, in the event that the Highway Service Centre was developed and Barton Highway was not upgraded, the intersection will operate at a satisfactory level and there is no reason to remove the right hand turn out of Longrail Gully Road to the Highway due to this development.

We do note that the stated intention of TfNSW is to upgrade the Barton Highway, however at this point there are no detailed plans nor timeframes for this work.

If this upgrade does proceed, we would expect the number of right turn movements onto the Highway to be limited due to safety reasons. However, the development of a Highway Service Centre on the proposed site will not influence TfNSW decision to include or remove a right hand turn from Longrail Gully Road to the Highway. That is, there is no basis to the concern that the development of a Highway Service Centre at this location will be the reason for removal of the right hand turn from Longrail Gully Road to the Highway.

Conclusion

From our study work it is concluded that the proposed highway service centre could be approved by the road authority, with the no issues associated with the capacity of the road network to accommodate the turning movements associated with the project site. The operation of the intersection of the Barton Highway and Longrail Gully Road has been assessed with Sidra, for the current 2020 flows and the future 2030 flows and demonstrates that the intersection will operate well with minor delays and queues. The modelling has been completed for the current layout and the future layout, allowing for the duplication of the Barton Highway and the removal of the right turn out of Longrail Gully Road.

The site can be designed to accommodate the swept path movements of the appropriate design vehicles with adequate space to provide suitable parking for the service centre, including for car / caravan combinations and B-doubles. For B-double access a separate application for B-double access shall be submitted to Council as part of any future DA for the project.

Overall, it is considered that the proposal can be provided to the satisfaction of the road authority with traffic, access and parking being able to be provided in a safe and acceptable manner.

Please feel free to contact me on (02) 40327979 should you have any further queries.

Yours sincerely,

Sean Morgan
Director

Quality Traffic Advice

SECA solution

Sidra output

MOVEMENT SUMMARY

Site: 101 [2020 AM base+dev]

Barton Hwy and Longrail Gully Road
2020 AM plus dev existing layout
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Barton Hwy												
1	L2	105	4.2	0.058	5.6	LOS A	0.0	0.0	0.00	0.58	0.00	50.8
2	T1	326	4.2	0.172	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		432	4.2	0.172	1.4	NA	0.0	0.0	0.00	0.14	0.00	58.0
North: Barton Hwy												
8	T1	421	4.2	0.223	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
9	R2	76	4.2	0.086	7.7	LOS A	0.3	2.4	0.47	0.70	0.47	48.1
Approach		497	4.2	0.223	1.2	NA	0.3	2.4	0.07	0.11	0.07	58.3
West: Longrail Gully Road												
10	L2	114	4.2	0.389	8.9	LOS A	1.9	13.8	0.61	0.86	0.82	44.0
12	R2	76	4.2	0.389	21.1	LOS B	1.9	13.8	0.61	0.86	0.82	43.7
Approach		189	4.2	0.389	13.8	LOS A	1.9	13.8	0.61	0.86	0.82	43.9
All Vehicles		1118	4.2	0.389	3.4	NA	1.9	13.8	0.14	0.25	0.17	55.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Organisation: SECA SOLUTION | Processed: Friday, 31 July 2020 11:20:58 AM
Project: C:\Sidra folders\P1546 Barton Hwy servces.sip8

Quality Traffic Advice

MOVEMENT SUMMARY

Site: 101 [2020 PM base+dev]

Barton Hwy and Longrail Gully Road
2020 PM plus dev existing layout
2-way floweversed from AM surveys
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Barton Hwy												
1	L2	105	4.2	0.058	5.6	LOS A	0.0	0.0	0.00	0.58	0.00	50.8
2	T1	421	4.2	0.222	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		526	4.2	0.222	1.1	NA	0.0	0.0	0.00	0.12	0.00	58.4
North: Barton Hwy												
8	T1	326	4.2	0.174	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
9	R2	76	4.2	0.097	8.4	LOS A	0.4	2.7	0.53	0.75	0.53	47.4
Approach		402	4.2	0.174	1.6	NA	0.4	2.7	0.10	0.14	0.10	57.8
West: Longrail Gully Road												
10	L2	114	4.2	0.404	9.8	LOS A	2.0	14.3	0.65	0.93	0.91	43.5
12	R2	76	4.2	0.404	21.3	LOS B	2.0	14.3	0.65	0.93	0.91	43.3
Approach		189	4.2	0.404	14.4	LOS A	2.0	14.3	0.65	0.93	0.91	43.4
All Vehicles		1118	4.2	0.404	3.6	NA	2.0	14.3	0.15	0.26	0.19	55.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Organisation: SECA SOLUTION | Processed: Friday, 31 July 2020 11:22:45 AM
Project: C:\Sidra folders\P1546 Barton Hwy servces.sip8

Quality Traffic Advice

MOVEMENT SUMMARY

Site: 101 [2030 AM base+dev]

Barton Hwy and Longrail Gully Road
2030 AM plus dev existing layout
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Barton Hwy												
1	L2	105	4.2	0.058	5.6	LOS A	0.0	0.0	0.00	0.58	0.00	50.8
2	T1	452	4.2	0.238	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
Approach		557	4.2	0.238	1.1	NA	0.0	0.0	0.00	0.11	0.00	58.5
North: Barton Hwy												
8	T1	583	4.2	0.309	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
9	R2	76	4.2	0.102	8.7	LOS A	0.4	2.8	0.54	0.76	0.54	47.2
Approach		659	4.2	0.309	1.0	NA	0.4	2.8	0.06	0.09	0.06	58.6
West: Longrail Gully Road												
10	L2	114	4.2	0.623	16.5	LOS B	3.5	25.6	0.79	1.14	1.50	36.1
12	R2	76	4.2	0.623	41.3	LOS C	3.5	25.6	0.79	1.14	1.50	36.0
Approach		189	4.2	0.623	26.5	LOS B	3.5	25.6	0.79	1.14	1.50	36.1
All Vehicles		1405	4.2	0.623	4.5	NA	3.5	25.6	0.14	0.24	0.23	55.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Organisation: SECA SOLUTION | Processed: Friday, 31 July 2020 11:31:25 AM
Project: C:\Sidra folders\P1546 Barton Hwy servces.sip8

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MOVEMENT SUMMARY

Site: 101 [2030 PM base+dev]

Barton Hwy and Longrail Gully Road
2030 PM plus dev existing layout
2-way floweversed from AM surveys
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total	Demand Flows HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed
		veh/h	%	v/c	sec		veh	m				km/h
South: Barton Hwy												
1	L2	105	4.2	0.058	5.6	LOS A	0.0	0.0	0.00	0.58	0.00	50.8
2	T1	583	4.2	0.307	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
Approach		688	4.2	0.307	0.9	NA	0.0	0.0	0.00	0.09	0.00	58.7
North: Barton Hwy												
8	T1	452	4.2	0.239	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
9	R2	76	4.2	0.124	10.1	LOS A	0.5	3.3	0.60	0.84	0.60	46.0
Approach		527	4.2	0.239	1.5	NA	0.5	3.3	0.09	0.12	0.09	58.1
West: Longrail Gully Road												
10	L2	114	4.2	0.654	18.7	LOS B	3.6	26.4	0.85	1.17	1.63	35.3
12	R2	76	4.2	0.654	42.1	LOS C	3.6	26.4	0.85	1.17	1.63	35.2
Approach		189	4.2	0.654	28.0	LOS B	3.6	26.4	0.85	1.17	1.63	35.3
All Vehicles		1405	4.2	0.654	4.8	NA	3.6	26.4	0.15	0.25	0.25	54.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Organisation: SECA SOLUTION | Processed: Friday, 31 July 2020 11:34:12 AM
Project: C:\Sidra folders\P1546 Barton Hwy servces.sip8

Quality Traffic Advice

SECA solution

MOVEMENT SUMMARY

Site: 101 [2030 AM base+dev with intersection upgrade]

Barton Hwy and Longrail Gully Road
2030 AM plus dev upgraded layout
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Barton Hwy												
1	L2	105	4.2	0.058	5.6	LOS A	0.0	0.0	0.00	0.58	0.00	50.8
2	T1	452	4.2	0.119	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		557	4.2	0.119	1.1	NA	0.0	0.0	0.00	0.11	0.00	58.5
North: Barton Hwy												
8	T1	583	4.2	0.155	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
9	R2	76	4.2	0.151	10.4	LOS A	0.5	3.7	0.54	0.81	0.54	46.1
Approach		659	4.2	0.155	1.2	NA	0.5	3.7	0.06	0.09	0.06	58.5
West: Longrail Gully Road												
10	L2	189	4.2	0.182	6.7	LOS A	0.7	5.2	0.35	0.62	0.35	49.7
Approach		189	4.2	0.182	6.7	LOS A	0.7	5.2	0.35	0.62	0.35	49.7
All Vehicles		1405	4.2	0.182	1.9	NA	0.7	5.2	0.08	0.17	0.08	57.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Organisation: SECA SOLUTION | Processed: Friday, 31 July 2020 11:39:19 AM
Project: C:\Sidra folders\P1546 Barton Hwy servces.sip8

Quality Traffic Advice

MOVEMENT SUMMARY

Site: 101 [2030 PM base+dev with intersection upgrade]

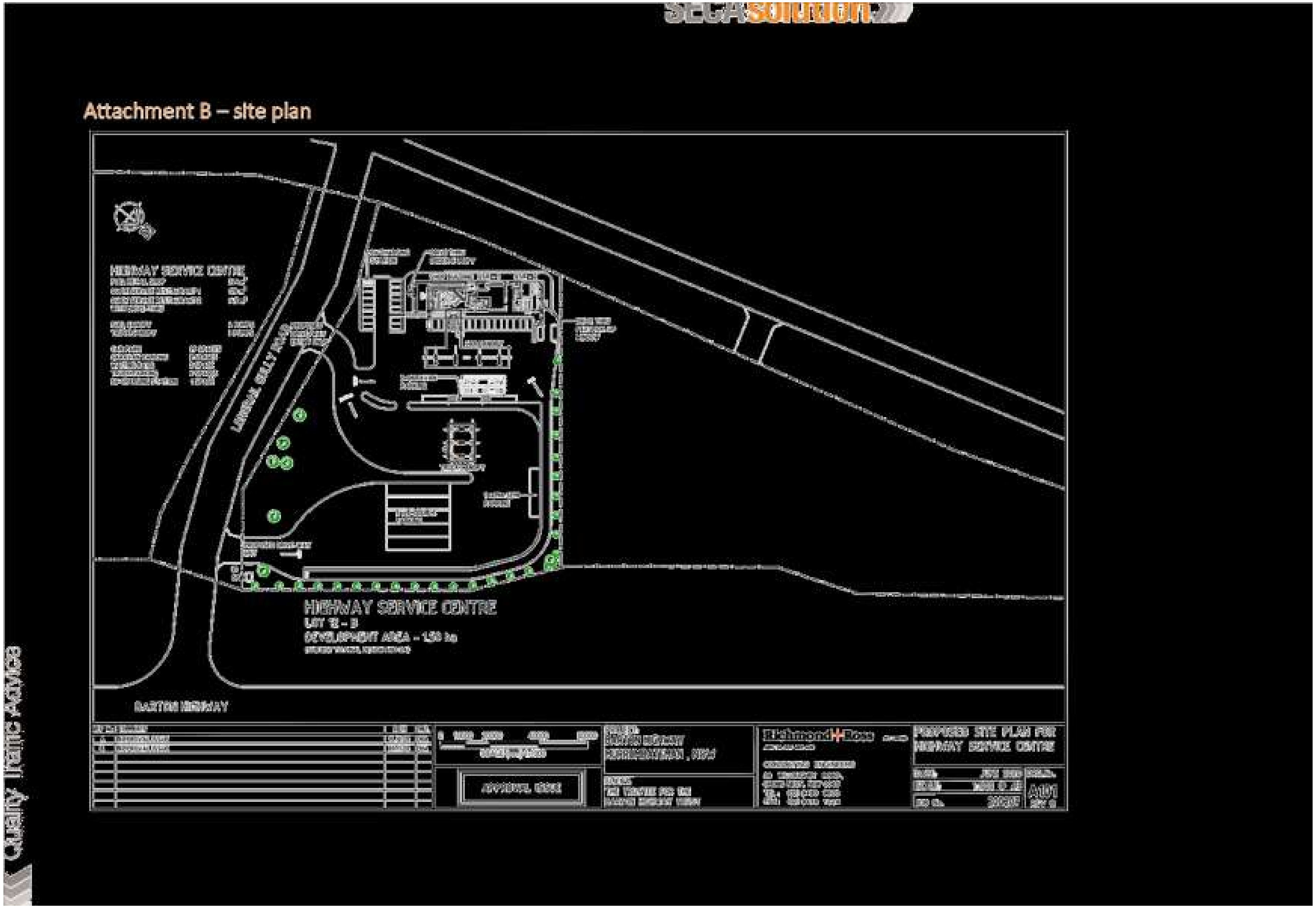
Barton Hwy and Longrail Gully Road
2030 PM plus dev upgraded layout
2-way floweversed from AM surveys
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Barton Hwy												
1	L2	105	4.2	0.058	5.6	LOS A	0.0	0.0	0.00	0.58	0.00	50.8
2	T1	583	4.2	0.154	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		688	4.2	0.154	0.9	NA	0.0	0.0	0.00	0.09	0.00	58.8
North: Barton Hwy												
8	T1	452	4.2	0.120	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
9	R2	76	4.2	0.183	12.4	LOS A	0.6	4.5	0.64	0.85	0.64	44.6
Approach		527	4.2	0.183	1.8	NA	0.6	4.5	0.09	0.12	0.09	57.9
West: Longrail Gully Road												
10	L2	114	4.2	0.117	7.0	LOS A	0.4	3.2	0.38	0.64	0.38	49.6
Approach		114	4.2	0.117	7.0	LOS A	0.4	3.2	0.38	0.64	0.38	49.6
All Vehicles		1329	4.2	0.183	1.8	NA	0.6	4.5	0.07	0.15	0.07	57.7

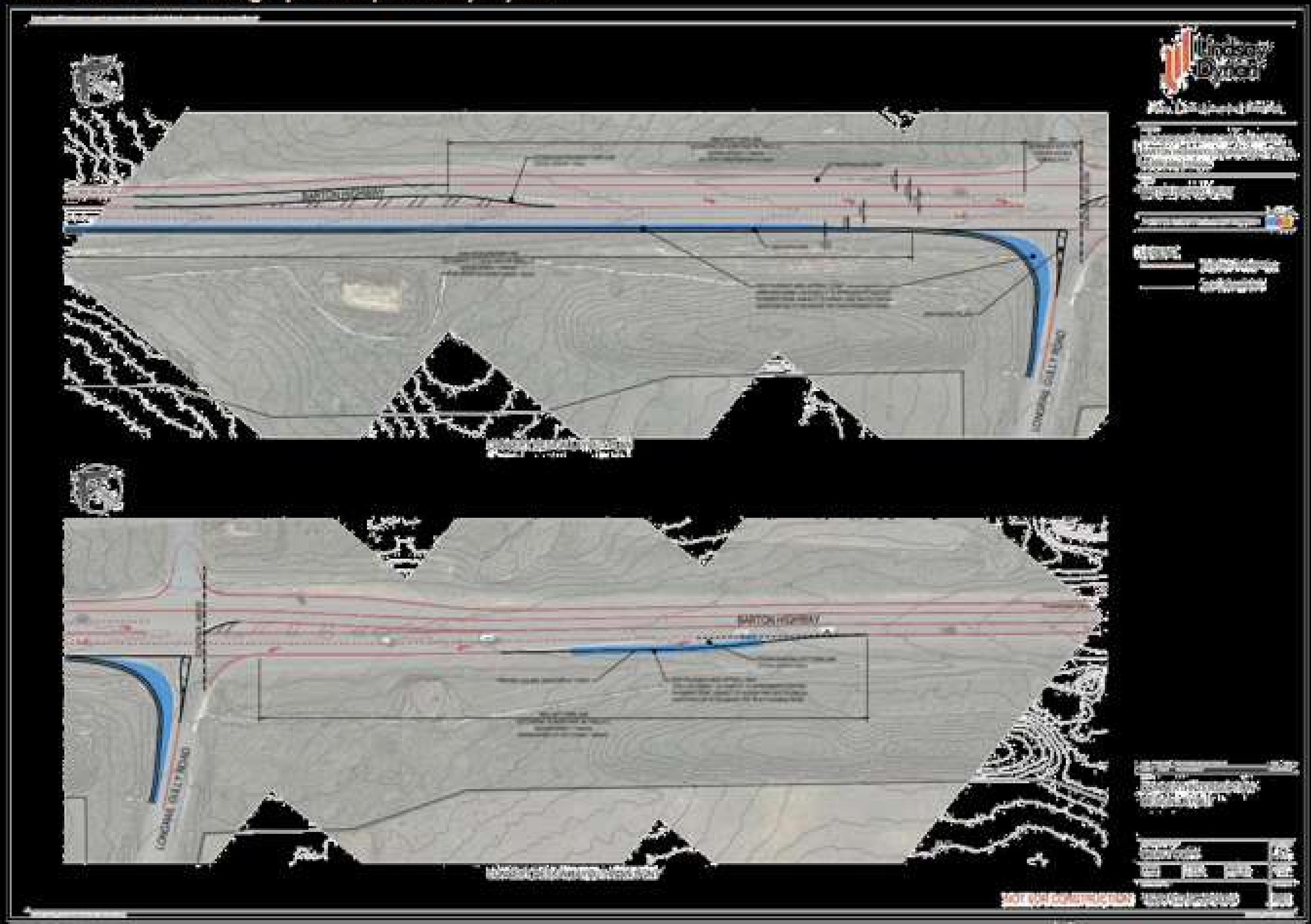
Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

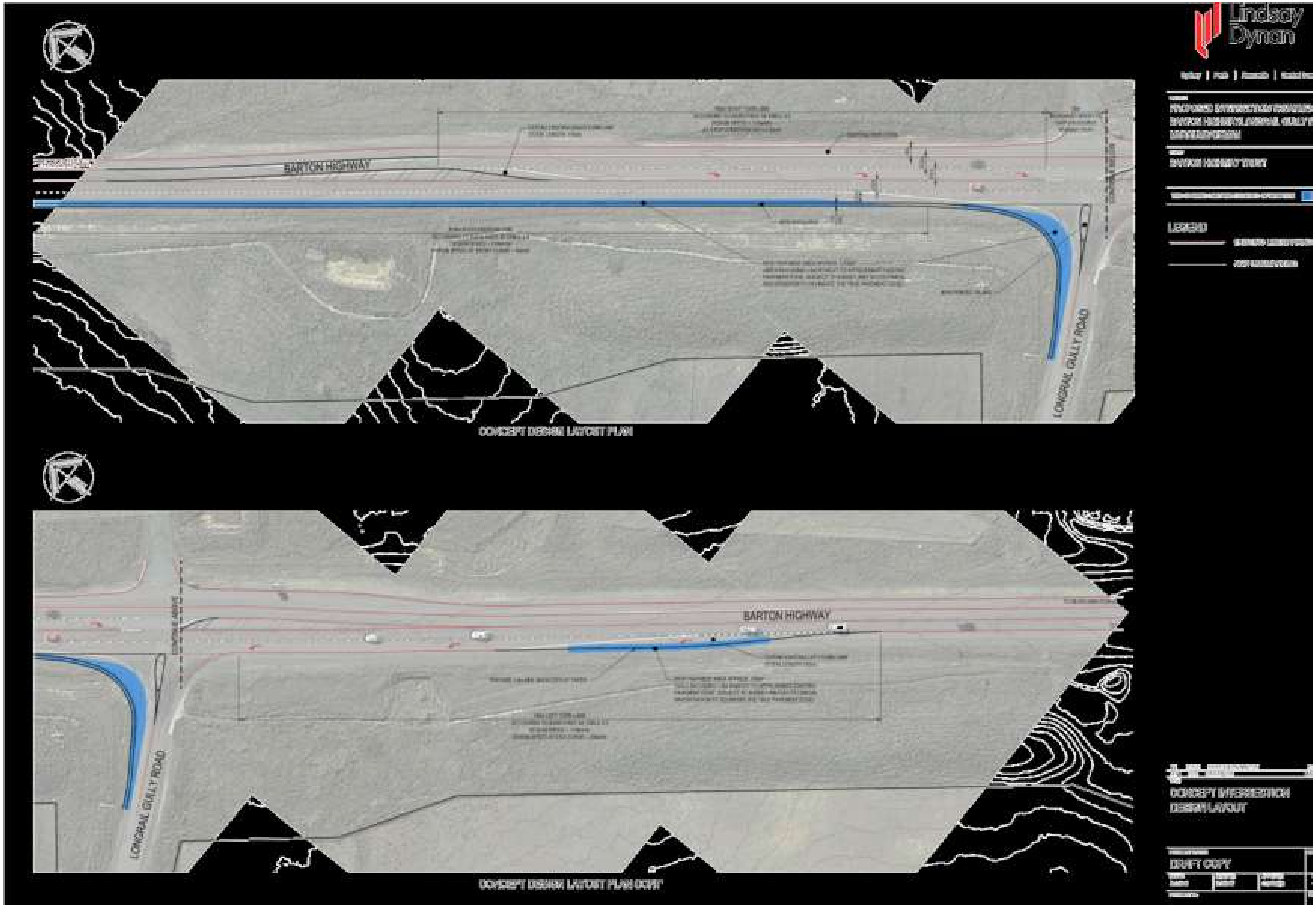
Organisation: SECA SOLUTION | Processed: Friday, 31 July 2020 11:41:51 AM
Project: C:\Sidra folders\P1546 Barton Hwy servces.sip8

Quality Traffic Advice


Attachment B – site plan
HIGHWAY SERVICE CENTRE
LOT 12 - B
DEVELOPMENT AREA - 1.50 ha
BARTON HIGHWAY
APPROVAL ISSUE
PROPOSED SITE PLAN FOR
HIGHWAY SERVICE CENTRE
A101
Quality Traffic Advice

Attachment C – design plans by Lindsay Dynan




Lindsay Dynan
BARTON HIGHWAY
LONGRAIL GULLY ROAD
CONCEPT DESIGN LAYOUT PLAN
BARTON HIGHWAY
LONGRAIL GULLY ROAD
CONCEPT INTERSECTION DESIGN LAYOUT
DRAFT COPY


Lindsay Dynan
BARTON HIGHWAY
LONGRAIL GULLY ROAD
BARTON HIGHWAY
LONGRAIL GULLY ROAD
BARTON HIGHWAY
LONGRAIL GULLY ROAD
BARTON HIGHWAY
LONGRAIL GULLY ROAD

---------- Forwarded message ---------
From: [redacted]
Date: Wed, May 13, 2020 at 5:48 PM
Subject: Highway Service Centre Proposal.
To: [redacted]

Fellow residents

At the Yass Valley Council meeting held on the 22nd of April, a proposal was submitted to develop a Highway Service Centre at the intersection of the Long Rail Gully Road and the Barton Highway.

In the Traffic Impact Statement as part of the attachments presented to council, it stated that right hand turns from Long Rail Gully Road onto the Barton Highway will not be permitted. It refers to the (mythical) Barton Highway duplication saying that as part of that process the RMS will investigate the POSSIBLE development of a U turn facility further along the Barton Highway.

My reading of the attachments is that access to the service centre will be from Long Rail Gully Road one way in and one way out, both north bound, along the old Barton Highway alignment. Local residents (mainly those living on the Dog Trap, Long Rail Gully Roads and the Gums Lane) will not be able to turn right from Long Rail Gully Road onto the Barton Highway.

That means that anyone who currently uses the Long Rail Gully Road to access the Barton Highway will need to do so via Yass Valley Way, McIntosh Circuit or Kaveneys Road which could easily add 20-25 minutes to the journey. This will impact anyone going to Canberra for work, school (including meeting the school bus), medical appointments, shopping, entertainment, or transport (including the airport) as well as those going to the coast.

The Traffic Impact Assessment (Appendix 6 of the attachments) was prepared by SECA SOLUTION from Newcastle.

Their report is dated 8th of April 2020 and says that they conducted a survey of traffic movements on the Barton Highway and the Long Rail Gully Road between 8.00am and 9.00am to measure "peak hour" traffic. It reported that only one vehicle exited Long Rail Gully Road onto the Barton Highway during that time. A 1-hour survey at that time of day and during the Covid 19 lockdown says a lot about the credibility of this report.

Unfortunately, the relevant council agenda and the proposal attachments are too large to include here but can be accessed via the links below. (I suggest that if you download them, save them as a document to avoid a repeat download). As I have mentioned, Appendix 6 Traffic Impact Assessment, is of most interest to residents in respect to access to the Barton Highway.

The minutes of the council meeting say that the proposal will be adopted ***"if no significant objections are received after the public exhibition of the planning proposal…."***

In my humble opinion 'public exhibition' is code for *"this is what we are going to do whether you like it or not"* so objections by residents and others affected should commence <u>now</u>.

My concern is not with the merits or otherwise of the proposed service centre but only with the proposed changes to the traffic conditions, specifically the removal of the right turn option to the Barton Highway.

The motion voted by council was;

> ***Planning Proposal PP.2020.01 be adopted if no significant objections are received after the pu exhibition of the planning proposal pursuant to the conditions of Gateway determination in accorda with s3.34(2)(c) Environmental Planning & Assessment Act 1979.***
>
> ***(Jones/Burgess***

FOR: Councillors R Abbey, C Burgess, G Frost and M Reid
AGAINST: Councillors N Furry, J Jones and K Turner
ABSENT: Councillor McManus
At 4:30 pm Councillor Harker returned to the Chambers.

If, after reviewing the proposal and in particular the Traffic Impact Assessment, you feel that right-turn access to the Barton Highway from the Long Rail Gully Road is not important, then happy days'; simply delete this email and have a nice day.

If, on the other hand, you feel that removing the right turn access to the Barton Highway is a significant issue then it is time to make your views known.

I have included a list of councillors and their email addresses. More council contact details, including the executive management team, can be found on the council web site.
https://www.yassvalley.nsw.gov.au/our-council/about-council/management/

(Note: Councillor Allision Harker has not been included due to a possible conflict of interest).

I would welcome any feedback from fellow residents in regard to the proposed traffic changes.

Kind regards,

[redacted]

Arif Yasin Chohan

From:	[redacted]
Sent:	Monday, 7 June 2021 11:16 AM
To:	YVC Customer Service Team
Subject:	Planning Proposal (PP.2020.01) - Highway Service Centre, Murrumbateman - Submission
Attachments:	Service Centre Council Letter.docx

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

This email is to draw to your attention to my concerns regarding
a) the implications to the traffic conditions and
b) the water supply for the proposed site.

On the 10th June 2020 I hand delivered the attached letter to the council offices which outlines my concerns from an emergency management perspective. I have reviewed the up-dated Traffic Impact Assessment Report and my concerns have not changed. The removal of right hand turns into and out of Long Rail Gully Road will could have significant impact on the response time of emergency services and potentially put the safety of residents at risk.

As a resident, I am amazed that the council could base and decisions on the Traffic Impact Assessment attached to this proposal. The report states " *As part of the project work, Seca Solution collected traffic data at the intersection of the Barton Highway and Longrail Gully Road to determine the morning peak hour flow along the Barton Highway (Thursday 1 st August 2019). Between 8.00 and 9.00 AM the 2-way traffic movement was 710 vehicles, with 400 vehicles southbound (56%). Heavy vehicles represented 4.2% of the total traffic flows. A single vehicle turned right out of Longrail Gully Road and a single heavy vehicle turned right into Longrail Gully Road from the Barton Highway*."

Anyone with any local knowledge, and I would hope council would be included, or someone undertaking even basic research would realise that conducting a 1 hour visual survey of the traffic flows between 8.00 – 9.00am would produce a very erroneous report. A more realistic survey should be done between 6.00-9.00am which is when that intersection has its busiest morning traffic flow.

Further, the report appears to use old traffic flow data. The proposal to remove any right turn out of Long Rail Gully Road onto the Barton Highway would remove the only access to the Barton Highway from the west between Yass and Murrumbateman and have a server impact on residents and ratepayers.
The Traffic Impact Assessment report by Seca Solution should be rejected and a further study should be undertaken to produce a more realistic assessment of the traffic flows and implications prior to any decision to change the traffic flow at the intersection.

My other concern is the use of ground water for this proposal. There has already been a significant decline in the flow of ground water locally and the amount of water used in a service centre would have an unacceptable impact on current water usage for agricultural purposes.

I can be contacted at any time to expand on these comments.

Regards,

Greg Minahan
[redacted]

JEIR MARCHMONT VOLUNTEER BUSHFIRE BRIGADE

PO Box 480 YASS 2582

Mr Chris Berry
General Manager
Yass Valley Council

Cc Ms Liz Makin
Acting Director Planning and Environment
Cc Ms Rowena Abbey
Mayor
Cc Superintendent Peter Ally, Zone Manager, NSW Rural Fire Service.

Planning Proposal PP.2020.01 – Highway Service Centre Murrumbateman

Dear Mr Berry,
I am writing in my capacity as the Captain of Jeir Volunteer Bushfire Brigade in relation to the Planning Proposal to establish a Highway Service Centre at the junction of Longrail Gully Road and the Barton Highway.

I am not offering any comment on the relative merits or otherwise of the proposal but I do need to draw your attention to my concerns with aspects of the Traffic Impact Assessment, (Appendix 6 of the associated proposal attachments) and the potentially serious consequences for emergency services responses that could result from any changes to the current traffic conditions associated with the Longrail Gully Road and Barton Highway intersection.

Our brigade covers the area from Yass Valley Way in the north to Boundary Road and the Murrumbidgee River in the south, which includes the majority of the Barton Highway. The brigade has a fire station on the corner of Long Rail Gully Road and Dog Trap Road. From there we can be responded either North or South, not only as primary responders, but also to support other brigades including Manton, Yass River, Murrumbateman, Springfield and Wallaroo. We also support other emergency services including NSW Fire and Rescue, ambulance and police.

Longrail Gully Road is the only access road to the Barton Highway from the western side of the Barton Highway between Yass and Murrumbateman and as such is our most direct access to the Barton Highway.

Postal Address: PO Box 480 Yass 2582

The Traffic Impact Assessment prepared by SECO Solution and dated the 8th of April 2020, under the heading 'Consultation with RMS' says that "*The current intersection controls at the intersection of the Barton Highway and Longrail Gully Road are considered adequate for the current traffic demands. A proposal for a service centre at this location will require a detailed traffic assessment to the satisfaction of Council as the road authority....*"

It goes on to say that in future upgrades of the Highway, right turns out of, and into Longrail Gully Road may not be permitted. It is this aspect of the proposal that is of concern due to the potential impact on the operational capability of our brigade and other emergency services.

In emergencies minutes count and any changes to the current traffic controls at the intersection of the Longrail Gully Road and the Barton Highway could adversely affect our response times, potentially placing lives and property at greater risk.

Further, if right hand turns into Longrail Gully Road are removed, this could impact emergency services including NSW Fire & Rescue, ambulance and police coming from Yass in response to any incidents at the proposed service centre or properties and residents in parts of our brigade area.

For the safety and well being of many Yass Valley residents I would strongly urge the council that, when considering the traffic assessment associated with a proposal for the service centre, that they ensure that the current access to and from the Barton Highway and Longrail Guly Road is maintained now and into the future.

I can be contacted on mobile [redacted] if you require any additional information.

Could you please table this letter at the next meeting of council.

Yours faithfully,

[redacted]

Greg Minahan
Captain
Jeir Bushfire Brigade

Email: [redacted]

10th June 2020

Postal Address: PO Box 480 Yass 2582

Submission 3

On 18 Jun 2020, at 7:52 pm, [redacted] wrote:

Good Evening Councillor Abbey,

We are writing to you to express our concerns with the proposed Barton Highway Service Centre identified for development on the corner of Long Rail Gully Rd and the Barton Highway.

While we are aware this proposal is yet to go to public consultation we wanted to raise our concerns regarding the proposal with you prior to submitting a formal submission.

While we understand progress and development must continue we have a number of specific concerns related to the proposed development site including:

- The suggestion that a dedicated rest, refuel and revive area is required between the ACT border and Yass, particularly if it is limited to northbound traffic who are likely to have only just commenced their journey from Canberra.
- The assertion that the proposed development is in a suitable location to address both current and future needs and that Barton highway duplication, which has not yet been approved for this section of highway, will lie to the east of the proposed service centre.
- The assertion that no significant impact would be felt by local businesses, tourism and residents located to the west of the proposed development, in particular those located on Long Rail Gully Rd, Dog Trap Road, Gums Lane and Hearnes Road, should the only **right of access** point (Long Rail Gully Road) between Yass Valley Way and Murrumbateman be redeveloped to support north bound exiting traffic only.

Of most significance to us is the suggested removal of the southbound right of access (right hand turn) from Long Rail Gully Road onto the Barton Highway. Our concerns regarding the removal of this right of access are as follows:

1. Long Rail Gully Rd, a classified rural road, is the **only** access road to the west of the Barton Highway between Murrumbateman and Yass. The road services the community not only located on Long Rail Gully Road but also Dog Trap Road, Gums Lane and Hearnes Rd. If the no-right hand turn was implemented this would have the following significant impacts on the growing community located to the west of the proposed site:
    a) Lengthy detours to access the Barton Highway for southbound traffic adding an additional 20-25 minutes via either Yass Valley Way, McIntosh Circuit or Kaveney's Rd or alternatively heading left on the Barton Highway and completing a 18km round trip to complete a U-turn at the Yass Valley Way/ Barton Highway overpass.
    b) Inability to access Canberra school buses at the corner of Long Rail Gully Rd and the Barton Highway or within the township of Murrumbateman.
    c) Reduction in tourism and numbers of visitors to businesses west of the proposed service centre due to an inability to easily access the Barton Highway southbound towards the ACT.
    d) Inability for emergency services vehicles in particular the local RFS (located on Long Rail Gully Road approximately 4kms from the proposed site) and NSW Ambulance Service to quickly access the Barton Highway from the local area if required to head south or in the direction of Canberra.
    e) Inability to easily access medical, dental and other services/businesses in Murrumbateman.
    f) Inability to easily access sporting and recreation groups/ facilities in Murrumbateman.
    g) Significant drop in land prices and decline in tourism and development to the west of the proposed development due to lack of south bound access to the Barton Highway.

2. The Traffic Impact Assessment dated 8 April 2020 and completed by SECA Solution states that an assessment of the intersection was completed over the period of one hour, on one day, during 'peak hour' 8-9am reporting that just one vehicle used the right hand turn from Long Rail Gully Road onto the Barton Highway during that time. The fact that the survey is based on a one hour period and that the peak hour reported for this intersection was incorrect, does not give much credibility to the report. Peak hour for this intersection which is used by businesses and residents accessing school buses and traveling south to work in Murrumbateman, Canberra and surrounds is actually much earlier and between the hours of 6.30-8am in the morning and 4-6pm in the evening. During the morning peak it is not unusual for at least 35-45 vehicles to turn right onto the Barton Highway at this intersection.
3. The Traffic Impact Assessment does not take into account the multiple times a day that businesses and residents use the intersection and assumes instead that local traffic only accesses the intersection once a day.
4. The proposal makes mention of the Barton Highway Duplication and suggests that a U-turn be created at a suitable location to the north of the current intersection for those wishing to head south. Duplication of the highway between Murrumbateman and the current dual expressway 6kms to the north of the proposed development site, is not yet approved and may be decades away. Therefore, if a northbound, left in left out, entry/exit for the service centre is approved as part of this development there is no guarantee that a U-turn will be created for traffic wanting to head south once the service centre has been completed, nor is there currently a safe place for a U-turn to be developed in close proximity to the current intersection. This will impact not only businesses and locals located to the west of the development but also any future employees of the service centre who will have to complete either a U-turn in Murrumbateman if heading to work from Yass (additional 8kms) or a U-turn at the Yass Valley Way overpass for those returning home to Murrumbateman (additional 18kms).
5. The requirement to travel additional distances under these circumstances will increase the likelihood of motorists attempting U-turns on the single carriage section of the highway in order to reduce travel times and distances incurred by the new traffic controls. As poor driving practices have already been identified as a main cause of accidents on the Barton Highway, traffic accidents are likely to increase in the area due to these practices.

We both commute to Canberra daily and as of next year, 2021, our eldest child will be accessing school buses at the Long Rail Gully intersection to attend Secondary school in Canberra.

In addition to this, we use the intersection at least four afternoons/evenings a week and multiple times on weekends for our children to participate in sport and recreation in Murrumbateman as well as access other local services including the dentist, doctor, chemist, café and other eateries. A detour via Yass or the Barton Highway north bound to the Yass Valley Way intersection will add an additional 18kms to our trip multiple times a day. A detour via Dog Trap Road would add an additional 6kms to our trip if traveling onto Canberra and 10kms to our trip for the bus and sport and recreation in Murrumbateman. This option would also add considerable traffic to the already badly deteriorated unsealed section of Dog Trap Road, which at times is almost impassable.

The intersection at the proposed development site (Long Rail Gully Road) would become extremely dangerous in terms of a pickup/dropoff point for school buses in the morning and afternoon, if they were able to continue to use the intersection for this purpose.

If a decision was made to move the Canberra/Yass school bus pickup drop off points from Long Rail Gully Road to Murrumbateman, without the ability to turn right and head south along the Barton Highway to Murrumbateman we would be unable to make the arrival times of the Canberra buses in the afternoons, due to a need to also meet the bus of our younger children at the RFS shed on the corner of Dog Trap Road and Long Rail Gully Road just 10-15 mins prior to the arrival of the Canberra buses at Murrumbateman.

Completing the additional detour kms, multiple times a day will not only be time consuming and add unneeded anxiety and frustration to our lives but also be financially unviable.

We thank you for taking the time to consider our concerns which have created a great deal of anxiety for ourselves and the broader community located to the west of the proposed site.

Regards
[redacted]
Gums Lane
Marchmont

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted]com>
Sent:	Tuesday, 11 May 2021 8:05 AM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#253]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] MURRUMBATEMAN - NSW, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Planning Proposal (PP.2020.01) – Highway Service Centre, Murrumbateman

Submission *

With a Service Centre in Yass (approx 20 mins away), and multiple service stations in Nicholls (20 mins away), I can't see the point of a service centre in Murrumbateman. If a pit stop is required, I would rather see the local pub, cafe, IGA get the travelling business and stay afloat, than a corporate entity that doesn't have their roots in the local community.

Most people coming down the Barton would be headed south, and their journey most likely would originate in or near Canberra, noting that travellers from Sydney to Melbourne would use the Federal. So the vast majority of people using the Barton as a highway south (as opposed to a commute home) would have only just started their journey, and having a service centre there is less useful than the one already at Yass (approx 40mins from Canberra)

Putting a service centre at Long Rail Gully Road not only saturates such a short stretch of highway unnecessarily with service centre options, but will also take business away from the local community.

I can't in good conscience support such a proposal.

Arif Yasin Chohan

From: Yass Valley Council <no-reply@[redacted]com>
Sent: Monday, 10 May 2021 10:45 PM
To: YVC Customer Service Team
Subject: Public Consultation online submission [#252]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] JEIR, NSW 2582 Australia
Email *	[redacted]
Phone Number *	
What item are you making a submission on? *	Planning Proposal (PP.2020.01) – Highway Service Centre, Murrumbateman
Submission *	We already have 3 service stations in yass town. Plus one on the Hume. Plus one in Murrumbateman already. Canberra less than 30 mins away. This is not necessary or appropriate given the other needs of our community.

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted].com>
Sent:	Monday, 10 May 2021 10:30 PM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#251]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Murrumbateman, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Planning Proposal (PP.2020.01) – Highway Service Centre, Murrumbateman

Submission *

Simply, No. I would prefer this development not to happen. I purchased my home in Murrumbateman late last year to move away from major cities and get away from development, how quickly the landscape is changing.

I watched as the Barton expands massive trees being bulldozed over, the machinery effects local wildlife and disrupts surrounding habitats. Meanwhile us locals have extended travel times as 80 zones (on the side of the road the roadworks aren't) continue to cause congestion where there shouldn't be any.

Being aware it's all about growing business and money, this development pays no respect to local business.

Murrumbateman already has a service station, also on the same side of the road as the proposed development. The main road at Hercules St is already difficult and the last thing we need is another traffics point up the road.

In short, I'm dealing with enough disruption and development and would vote this development does not proceed, I would ask the council to not support developers or assist in lining pockets in the name of a redundant service station that will provide no direct value to our community.

I hope the community concerns are heard, actioned and taken seriously with the ability for locals to protest this or feedback provided as to define what benefit this development will have. Between Yass, Murrumbateman to Gold Creek/Gunghalin & Spence there is really no value to another service station being constructed.

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted].com>
Sent:	Monday, 10 May 2021 8:27 PM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#250]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Murrumbateman , Nsw 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Pp.2020.01 highway service centre murrumbateman
Submission *	I oppose this planning proposal. It seems that the grounds for the proposal are mainly based on the needs of the specific land owners as opposed to the needs of the community. There is rarely a need for a service centre in murrumbateman currently. It's proximity to Yass and Canberra negates the need. Planning proposals that can have positive impacts on the residents of the yass valley council area should be given preference over this kind of proposal.

Arif Yasin Chohan

From: Yass Valley Council <no-reply@[redacted].com>
Sent: Monday, 10 May 2021 8:20 PM
To: YVC Customer Service Team
Subject: Public Consultation online submission [#249]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Yass, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	PP.2020.01

Submission *

To Council:

This is a frankly ridiculous proposal.

The section of the Barton Highway where this will be located was recently straightened because it was a significantly dangerous road. This proposal would totally negate any safety gains made on the Highway. Apart from the ludicrously complex new lanes in this proposal, you would have drivers turning onto the Barton from it while eating fast food.

It is totally unnecessary. Yass has plenty of service stations, and Murrumbateman also has one. All these local businesses depend on trade, and it takes less than 15 minutes to get from one town to the other.

Finally, this would develop a site of natural beauty in the area. That stretch of the Barton is a quintessential view of the Yass Valley region.

This proposal should not go ahead – it has no merit. It is such a bad idea that I wondered if it was a late April fool's joke.

Submission 9

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted].com>
Sent:	Monday, 10 May 2021 7:34 PM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#248]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] BOAMBOLO, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	(PP.2020.01) – Highway Service Centre, Murrumbateman

Submission *

I live on Long Rail Gully Road, like many others. I access the Barton Highway everyday, at least once, turning right from Long Rail Gully Road onto the Barton Hwy, along with the other 3 drivers in my family. All the residents of LRG, Gums Lane, and Dog Trap Road, utilise this right turning option regularly. Visitors to the award winning LRG Winery turn right to head back to the ACT. The resident who runs an earth moving and construction company on LRG runs many, many semis on LRG everyday, turning right from the Hwy junction. And the Rapley business which has significant volume of traffic utilising that junction and LRG itself.

The reality is that if you allow the closure of the right hand turning option out of Long Rail Gully Road, which is clearly a serious consideration for you based on this proposal, you will have a significant volume of traffic doing u-turns further up the hwy (which is incredibly dangerous), as well as accessing Dog Trap, just to head to Murrumbateman or Canberra. Dog Trap road is constantly in a hell of a state. If all that traffic is pushed down Dog Trap, there will be so many more accidents... it is already dangerous. Go take a drive!

In regard to u-turns, I see that the proposal suggests that if the intersection is 'upgraded' (an offensive term for someone who you are about to massively inconvenience) u-turn facilities may be put in place. How about we focus on the fact that the study showed there was no need to close off the right turning, and let us all continue to use the junction as we currently do.

At a bare minimum, Council must seriously consider the tarmacking of Dog Trap road, to support the current, rate paying residents that live here and ensure that all measures have been taken to keep residents and visitors safe. Perhaps the developer could contribute to the community by considering upgrading LRG itself, rather than only facilitating their own business' needs.

This developmental move is clearly a step toward increasing residences between Yass and Murrumbateman, along the highway in some capacity moving forward. Will they too be stopped from turning right? Accessing the Barton from Hercules, West St, and Fairley, is diabolical most mornings. You need to seriously evaluate this decision. Are we not trying to make the Barton safer??

Whilst we can all see the financial benefit for Council and for the developer, more must be done to care for the residents of this community, their children, their businesses, and their safety. Numerous suggestions have been made here in this consultation feedback.

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted].com>
Sent:	Monday, 10 May 2021 7:20 PM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#247]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Jeir, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Proposed highway service centre

Submission *

Manor service centres are already available at Nicholls (ACT) and Yass (NSW), in addition to the petroleum service station facilities already in the Murrumbateman township. This proposed development is totally unnecessary I, will degrade the visual and rural environment, and will significantly reduce amenity for the residents of the Murrumbateman region. It is not clear to me that there is any significant demand for fast food outlets amongst ratepayers and residents. Given this is the case, whose interests does the proposed development serve? Certainly not those of the local community who have chosen to live in Murrumbateman to escape the urbanised sprawl of Canberra and its environs.

Any decision to proceed will be viewed by ratepayers as little more tha a duplicitous effort by councillors to put a few dollars into councils back pocket at the expense of the residents you ostensibly servez

Reject this unnecessary and obnoxious proposal.

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted].com>
Sent:	Monday, 10 May 2021 7:11 PM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#246]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Yass River, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Highway entrance and exit layout.

Submission *

The idea for a service centre on the highway is a good idea as there is currently no other service facility beyond Murrumbateman until the other side of Yass at the southern service centre.

My concern is the entrance and exit off the highway, as was evident with the Macintosh Circuit entrance as a prime example that this type of entrance is not suitable for vehicles entering or exiting the highway prior to its upgrade which has reduced the number of incidents considerably.

Having a dedicated run on lane when crossing into the southbound traffic has allowed vehicles to gain speed close to the carriageway speed of 100km/h prior to merging. Especially if it is predicted that B-doubles will be using the service centre.

For your consideration.

Regards

[redacted]

Submission 12

Arif Yasin Chohan

From: Yass Valley Council <no-reply@[redacted].com>
Sent: Tuesday, 11 May 2021 10:48 AM
To: YVC Customer Service Team
Subject: Public Consultation online submission [#255]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Murrumbateman , NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Service Station Barton and Long Gully Road
Submission *	With 4 petrol stations in Yass and one in Murrumbateman this new proposed service station is not required and will take away money and livlihood from the existing service station. It does not need competition as prices are usually reasonable. I therefore vote it is not allowed.

Submission 1[illegible]

Arif Yasin Chohan

From: Yass Valley Council <no-reply@[redacted].com>
Sent: Tuesday, 11 May 2021 7:31 PM
To: YVC Customer Service Team
Subject: Public Consultation online submission [#256]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Murrumbateman, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Planning Proposal (PP.2020.01) – Highway Service Centre, Murrumbateman

Submission *

The submission of the Highway Service Centre at Long Rail Gully and Barton Hwy adds no value to the community. There is a service station in the village, plus the service centre on the Hume at Yass and only a short drive to the next one in Canberra.

I see major potential of this causing traffic issues greater than already experienced on the Barton.

Also a development of this nature takes away the country appeal of the area for why so many people move to the area.

I strongly suggest this does not proceed any further as there are many more developments that would benefit the local community before this.

Submission 11

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted].com>
Sent:	Monday, 24 May 2021 6:25 PM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#260]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Queanbeyan, New South Wales 2620 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	The planned second service station at murrambateman
Submission *	Do not go ahead with such a fool hardy plan it would ruin the local town economy and ruin the town in itself. If people need a rest stop there they already have one if they need fuel there is petrol there or if it is closed there are about 20 minutes in either way from another one...another multi million expenditure just to rip up and replace or duplicate and out compete the town it NOT needed.

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted].com>
Sent:	Monday, 24 May 2021 8:28 PM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#261]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Murrumbateman , NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Proposed Service Area at Long Rail Gully Road

Submission *

I am writing to express my opposition to the proposed development of a service area on the Barton Highway at Long Rail Gully Road. Given the distance to both Yass and Canberra there is no requirement for a furher service area that will draw business from the established service stations in Murrumbateman and Yass. The proposal will force vehicles to turn across the highway in an area that was straightened to make it safer for traffic. This would be dangerous and result in conflict of through and crossing traffic. There is no logical requirement for this area to be developed as a service station even if the Barton Highway realignment at Murrumbateman goes ahead as it will draw even more business from the established local business.

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted].com>
Sent:	Tuesday, 25 May 2021 10:55 AM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#262]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Murrumbateman, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Yass Valley Council is currently assessing the planning proposal which seeks to amend the Yass Valley Local Environmental Plan 2013 to facilitate a highway service centre on land zoned RU1 Primary Production.

Submission *

The petrol station in Murrumbateman already suffers loss of business due to the surrounding towns multiple and excessive petrol stations. There is no reason to build another larger petrol station, it would be more efficient and make more sense to upgrade the existing one to cater to a larger customer base as it is a poor design due to the entry and exit ways. It isn't as convenient to stop at.

There is no reason to take away business from the already small town of Murrumbateman. This is a way to make this town become obsolete, it will detract from the wineries business as well as people will see less signs if not travelling and stopping at the town.

We already have no marketing for the community, we have at best the Murrumbateman Markets which are so small and honestly pathetic due to the little foot traffic Murrumbateman gets in general.

Encouraging people to give money to another corporation away from the town is negative. It takes away the travelling experience in general for Tourism as it creates a sense of journey having to go through a little town to fill up.

There are many reasons why this is not a good idea. And at the end of the day, the government does what it wants and I feel as though none of us have a real say. I hope someone listens to this one.

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted].com>
Sent:	Tuesday, 25 May 2021 7:06 PM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#266]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Murrumbateman, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Proposed service station development at Longrail Gully Road
Submission *	The proposed new service station would inevitably work to reduce patronage of the established service station and supermarket in Murrumbateman township. The supermarket in particular is the only relatively convenient source of groceries for residents of the township and surrounds, and its loss would constitute significant damage to the community.

Arif Yasin Chohan

From: Yass Valley Council <no-reply@[redacted].com>
Sent: Tuesday, 25 May 2021 6:50 PM
To: YVC Customer Service Team
Subject: Public Consultation online submission [#265]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name * [redacted]

Address *

[redacted]

YASS, NSW 2582

Australia

Email * [redacted]

Phone Number * [redacted]

What item are you making a submission on? * Proposed plan for additional service station in Murrumbateman

Submission *

I wish to lodge my dismay at this proposal. The existing fuel station and grocery store is more than sufficient for local residents and those travelling through Murrumbateman. Why would our local council support taking away business from a local trader?? It totally defies logic and undermines community spirit. No doubt the proposal is from a large fuel company who would be better placed opening up on the Barton Highway in between Murrumbateman and Hall. I travel into Canberra from Yass everyday and make a point of re-fueling in Murrumbateman to ensure that I'm making a valid contribution to our community.

Submission 19

Arif Yasin Chohan

From: Yass Valley Council <no-reply@[redacted].com>
Sent: Tuesday, 25 May 2021 5:03 PM
To: YVC Customer Service Team
Subject: Public Consultation online submission [#263]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] MURRUMBATEMAN, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Planned amendment to the Yass Valley Local Environmental Plan 2013 to facilitate a highway service centre on land zoned RU1 Primary Production

Submission *

I am writing in opposition to this proposal.

The main reason for opposition is that a highway service centre will compete with and inevitably damage the business of the existing service station and convenience store. This small business is an important service and hub for the Murrumbateman community, and competition with a large highway centre will threaten its continued viability. As well as the impact to the local owners, this in turn will reduce the amenities available for the community.

While I am not opposed in principle to development of the land, there are many more options or services that could be developed that would benefit both the community and those travelling through the region.

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted].com>
Sent:	Thursday, 27 May 2021 2:56 PM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#269]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] MURRUMBATEMAN, New South Wales 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Planning Proposal (PP.2020.01) Highway Service Centre, Long Rail Gully

Submission *

I am writing to oppose the Planning Proposal (PP.2020.01) - Highway Service Centre, seeking an amendment to the Yass Valley Local Environmental Plan 2013 (YVLEP) to permit a highway service centre at the intersection of Barton Highway and Long Rail Gully Road.

I have four main objections to the proposal

1. The development is not needed. The drive from Yass to Canberra is approximately 60 minute long. The drive from Yass to Murrumbateman is 20 minutes. There is a service station at Murrumbateman. Why do we need another service centre 5 minutes from Murrumbateman. There is no need for additional rest stops on such a short journey.
2. The proposal is inconsistent with the The Yass Valley Settlement Strategy (YVSS) which calls for developments to complement the hierarchy of settlements and assists in maximising infrastructure and service efficiencies. This proposal is in direct conflict with this requirement. It will dilute the hierarchy of settlements and in the construction of more roads, parking, provision of water and other infrastructure does not maximise efficiencies.

3. The development will impact negatively on local businesses. The Murrumbateman Community is well served by the existing BP petrol station and small supermarket and butcher. This business provides the only such service available locally and is a major hub of the community and employs local people. This business relies on petrol sales to make a profit. This proposal is likely to negatively impact on that business and its loss would be devastating for the community.

4. Impact on the rural landscape along the Barton Highway. Most residents of Yass and Murrumbateman strongly value living in a natural and rural landscape. A major highway service centre would significantly impact on this landscape negatively. It would introduce large buildings, parking areas, advertising and directional signs disrupting the enjoyment of the rolling hills and valleys of the site.

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted].com>
Sent:	Thursday, 3 June 2021 4:34 PM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#278]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Yass, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Planning Proposal (PPz.2020.01) – Highway Service Centre, Murrumbateman

Submission *

With respect to the proposed plan of the site, it looks as though all traffic into the centre will enter via the Long Rail Gully Road. This will create significant risks for those who use long Rail Gully road regularly. I and my family will need considerably more information about this and will need to be consulted considerably more closely than we have so far. I have not been consulted at all on these arrangements as at 3rd June 2021. With trucks, vehicles, motorbikes etc all appearing to turn into Long Rail Gully Rd from travelling on both directions on the Barton Highway, before then turning into the service centre this has the potential to create considerable confusion and risks if not managed correctly. I would appreciate a site visit with the proponents of the development, Council and RMS to better understand the proposed arrangements and ascertain the level of risk created. Regards, [redacted]

Arif Yasin Chohan

From:	[redacted]
Sent:	Thursday, 3 June 2021 5:39 PM
To:	YVC Customer Service Team
Subject:	Planning Proposal (PP.2020.01) - Highway Service Centre, Murrumbateman

Dear Sir, Madam,
I have sent in an online submission with respect to this proposal outlining the further information that I require regarding traffic etc.
I also wish to request that I be informed of the various processes as they progress through the application phases. I am formally requesting that I receive email and/or text messages with this information.
That is, I wish to be informed in a timely manner when this proposal is going before Council so that I can review the council papers and be given an opportunity to present to Council. I also wish to be informed of other relevant matters pertaining to this project proposal as they become relevant. This does not mean after the event, it means beforehand in a timeframe that allows me to give considered response and have the opportunity to have meaningful input.
I and my family often use this road to get to work in Canberra, trucks use it to move stock to and from my property. I am in the Fire Brigade that often gets asked to attend incidents and/or divert traffic at this intersection.
I am formally requesting a meeting on site with the Proponents, Council staff and RMS management to better understand the risks that are created and how they impact my life.
Regards,

[redacted]

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted].com>
Sent:	Sunday, 6 June 2021 9:38 PM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#288]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Marchmont, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	PP.2020.01, Murrumbateman Service Centre

Submission *

We are writing to you to express our concerns with the proposed Barton Highway Service Centre identified for development on the corner of Long Rail Gully Rd and the Barton Highway.

While we understand progress and development must continue we have a number of specific concerns related to the proposed development site including:

· The suggestion that a dedicated rest, refuell and revive area is required between the ACT border and Yass, particularly if it is limited to northbound traffic who are likely to have only just commenced their journey from Canberra.

· The assertion that the proposed development is in a suitable location to address both current and future needs and that Barton highway duplication, which has not yet been approved for this section of highway, will lie to the east of the proposed service centre.

· The assertion that no significant impact would be felt by local businesses, tourism and residents located to the west of the proposed development, in particular those located on Long Rail Gully Rd, Dog Trap Road, Gums Lane and Hearnes Road, should the only right of access point (Long Rail Gully Road) between Yass Valley Way and Murrumbateman be redeveloped to support north bound exiting traffic only onto the Barton Highway.

Of most significance to us is the suggested removal of the southbound right of access (right hand turn) from Long Rail Gully Road onto the Barton Highway. Our concerns regarding the removal of this right of access are as follows:

1. Long Rail Gully Rd, a classified rural road, is the only access road to the west of the Barton Highway between Murrumbateman and Yass. The road services the community not only located on Long Rail Gully Road but also Dog Trap Road, Gums Lane and Hearnes Rd. If the no-right hand turn was implemented this would have the following significant impacts on us as local residents and the growing community located to the west of the proposed site:
a) Lengthy detours to access the Barton Highway for southbound traffic adding an additional 20-25 minutes via either Yass Valley Way, or via long sections of unsealed road to access McIntosh Circuit or Kaveney's Rd or alternatively heading left on the Barton Highway and completing an 18km round trip to complete a U-turn at the Yass Valley Way/ Barton Highway overpass.
b) Inability to safely and easily access Canberra school buses at the Long Rail Gully Rd and Barton Highway intersection or within the township of Murrumbateman.
c) Reduction in tourism and numbers of visitors to businesses west of the proposed service centre due to an inability to easily access the Barton Highway southbound towards the ACT.
d) Inability for emergency services vehicles in particular the local RFS (located on Long Rail Gully Road approximately 4kms from the proposed site) and NSW Ambulance Service to quickly access the Barton Highway from the local area if required to head south or in the direction of Canberra.
e) Inability to easily access medical, dental and other services/businesses in Murrumbateman.
f) Inability to easily access sporting and recreation groups/ facilities in Murrumbateman.
g) Significant drop in land prices and decline in tourism and development to the west of the proposed development due to lack of south bound access to the Barton Highway.
2. The Traffic Impact Assessment dated 22 April 2021 and completed by SECA Solution is misleading and incorrect and completely fails to represent the traffic movements in the location, particularly the number of local vehicles that use the intersection and the timings of use. It states that an assessment of the intersection was completed over the period of one hour, on one day, during 'peak hour' 8-9am reporting that just one vehicle used the right hand turn from Long Rail Gully Road onto the Barton Highway during that time. The fact that the survey is based on a one hour assessment and that the peak hour reported for this intersection was incorrect, does not give much credibility to the report. Peak hour for this intersection, which is used by businesses and residents accessing school buses and traveling south to work in Murrumbateman, Canberra and surrounds, is actually much earlier between the hours of 6.30-8am in the morning and 4-6pm in the evening. This is supported by the traffic assessment included as Appendix A in the Barton Highway Duplication Business Case of October 2019 and supports the fact that the local traffic exiting south bound at the intersection would have already passed through before the assessment

commenced at 8am. During the correct morning peak of 6:30-8am it is not unusual for at least 35-45 vehicles to turn right, southbound onto the Barton Highway at this intersection.

3. The Traffic Impact Assessment continues to be misleading making no mention of the fact that the intersection is used by local school buses as a pick up and drop off point for students that live to the west of the intersection and travel to Canberra for school. Presumably because this occurred outside the one hour timeslot in which the assessment was conducted

4. The Traffic Impact Assessment does not take into account the multiple times a day that businesses and residents use the intersection and assumes instead that local traffic only accesses the intersection once a day.

5. The proposal makes mention of the Barton Highway Duplication and suggests that a U-turn be created at a suitable location to the north of the current intersection for those wishing to head south. Duplication of the highway between Murrumbateman and the current dual expressway, 6kms to the north of the proposed development site, is not yet approved and may be decades away. Therefore, if a northbound, left in left out, entry/exit for the service centre is approved as part of this development there is no guarantee that a U-turn will be created for traffic wanting to head south once the service centre has been completed, nor is there currently a safe place for a U-turn to be developed in close proximity to the current intersection. This will impact not only businesses and residents located to the west of the development but also any future employees of the service centre who will have to complete either a U-turn in Murrumbateman if heading to work from Yass (additional 8kms) or a U-turn at the Yass Valley Way overpass for those returning home to Murrumbateman (additional 18kms).

6. The requirement to travel additional distances under these circumstances will increase the likelihood of motorists attempting U-turns on the single carriage section of the highway in order to reduce travel times and distances incurred by the new traffic controls. As poor driving practices have already been identified as a main cause of accidents on the Barton Highway, traffic accidents are likely to increase in the area due to these practices.

We both commute to Canberra daily and our eldest child accesses the south bound Canberra school buses at the Long Rail Gully intersection to attend Secondary school in Canberra.

In addition to this, we use the intersection at least four afternoons/evenings a week and multiple times on weekends for our children to participate in sport and recreation in Murrumbateman as well as access other local services including the dentist, doctor, chemist, café and other eateries. A detour via Yass or the Barton Highway north bound to the Yass Valley Way intersection will add an additional 18kms to our trip multiple times a day. A detour via Dog Trap Road would add an additional 6kms to our trip if traveling onto Canberra and 10kms to our trip for the bus and sport and recreation in Murrumbateman. This option would also add considerable traffic to the already badly deteriorated unsealed section of Dog Trap Road, which at times is almost impassable.

The intersection at the proposed development site (Long Rail Gully Road) would become extremely dangerous in terms of a pickup/dropoff point for school buses in the morning and afternoon, particularly if our children were required to cross the road on foot, if indeed the buses were able to continue to use the intersection as a designated bus stop.

If a decision were made to move the Canberra/Yass school bus pickup/ drop off points from Long Rail Gully Road to Murrumbateman, without the ability to turn right and head south along the Barton Highway to Murrumbateman, this would add an additional 15-20 minutes to our children's school trip in the morning and we would be unable to make the arrival times of the Canberra buses in the afternoons in Murrumbateman, due to a need to also meet the bus of our younger children at the RFS shed on the corner of Dog Trap Road and Long Rail Gully Road just 10-15 mins prior to the arrival of the Canberra buses at Murrumbateman.

Completing the additional kms for the detour, multiple times a day will not only be time consuming and add unneeded anxiety and frustration to our lives and that of our children but also be financially unviable.

With the area to the west experiencing rapid growth, due to its proximity to Canberra and Murrumbateman, it is essential that the residents of the area have fair access and right of way to head south from this intersection. As such it is recommended that the proposal only be supported if the right of access southbound, at the intersection of LongRail Gully be supported and that the proposal for a U-Turn to be created to the north, on one of the most dangerous roads in NSW and Australia, be denied.

Every service centre within a 300km radius, along the Hume Highway from Sydney to Albury and the Federal highway into Canberra, offers the opportunity to exit both southbound and northbound. Why therefore, should this proposed service centre, on a busy highway in the vicinity of so many other service centres, only offer access in one direction, northbound, and in the opposite direction that is currently used by the local residents to access their local services?

We thank you for taking the time to consider our concerns which have created a great deal of anxiety for ourselves and the broader community located to the west of the proposed site.

Regards

[redacted]

Arif Yasin Chohan

From: Yass Valley Council <no-reply@[redacted]com>
Sent: Sunday, 6 June 2021 1:56 PM
To: YVC Customer Service Team
Subject: Public Consultation online submission [#287]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Murrumbateman, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Murrumbateman Highway Service Centre

Submission *

1. The Proposal is not consistent with the Government and Council strategic planning frameworks in that the proposed Service Centre only contributes marginally through casual employment to economic growth in the Region.
2. The Service Centre will only provide services to through tourists and transports (as the name implies 3.B.2). It would not enhance travel to and from the ACT through provision of an additional bus, truck and motorist rest stop. These currently exist along the Barton Highway.
3. The Proposal could have an adverse effect on the social environment through visual pollution. It would demean the visual rural vista with extractive (bore) infrastructure, by promoting the use of inappropriate fuel distribution outlets, and with waste and rubbish outlets. The proposal suggests the site is not identified as important agricultural land. On the contrary, it is part of the rural vista and the proposal promotes "conflict and fragmentation" of agricultural land (Regional Plan, Goal1 8.2).
4. Importantly, the Proposal ignores the implications for climate change in that alternative investments such as silviculture and agriculture in the Proposal area and surrounds are neither mentioned nor considered, and therefore the Proposal does not align with 3.B.2, Yass Valley Settlement Strategy ;

5. The Proposal ignores the potential negative impacts for Murrumbateman Village and the current and emerging businesses that relate to the Service Centre's proposed businesses. The Centre would contribute only marginally to employment and tourism support, as argued in the Proposal, and hence contribute only marginally, if at all, to a Yass Valley Settlement Strategy (3.B.2);

6. The Ecological Assessment Report does not address the issues of potential pollution and climate change effects (Section C). Already there is a service centre on the Hume Highway at Yass some 30 kms north of Murrumbateman causing an unnecessary duplication with associated pollution and negative impact on climate change. Irrespective the Service Centre Proposal would create negative visual pollution, transforming the environment from serene rural landscape to one of light service industry and associated infrastructure. Pollution would also occur through waste management, garbage disposal, and roadside littering.

7. An alternative exists to the Proposal and that is investment in agriculture or silviculture that would not involve the negative effects of the Proposal. Importantly the alternative would contribute positive benefits of climate change, such as CO2 consuming trees, and positive environmental sustainability. Both contribute to employment and would use less of scarce groundwater, another contribution to environment sustainability.

8. Proposals of this nature need to address the financial conflict between individual and social benefits, and to contributions for sustainable economic development. Unfortunately the Proposal illustrates minimal social/financial benefits with only casual employment, yet coupled with visual and actual environmental damage. There would be a considerable individual financial benefit to the proponent, that would far outweigh the potential social benefits to the community. Of concern are the potential negative environmental benefits which would amount to a considerable social cost. These are not compensated by the financial gainer. Already the proposer has been a financial beneficiary of past and future changes to the Barton Highway location (3.C.2).

9. The Proposal has made no attempt to forecast the impact of the introduction of electric transport and its effects on a proposed fossil fuel based Service Centre, apart from including one electric charging station in the complex;

10. The Proposal concludes that it will utilise a suitable site to provide services to the local community and motorists, heavy vehicles and one electric charging facility. It suggest no amenity impacts and that it would be self contained in terms of water and sewer provision. These benefits are currently accommodated by the Yass Service Centre, and Murrumbateman businesses. It is inconsistent with the SEPP in that it would not contribute to positive social and economic impact but would contribute to individual financial gain.

In brief:

i. It is visually polluting.

ii. It fragments the rural landscape.

iii. It sets the precedent for further fragmentation of the rural landscape.

iv. It is environmentally unfriendly.

v. It provides minimal employment opportunities.

vi It draws service away from existing Murrumbateman businesses.

vii the services it offers currently exist in Murrumbateman, Yass and Yass Service Centre, a 30 kilometre rural thoroughfare.

viii the social costs far outweigh the social benefits with the financial gainer being the Trustee for Barton Highway Trust.

Arif Yasin Chohan

From: Yass Valley Council <no-reply@[redacted].com>
Sent: Saturday, 5 June 2021 8:18 PM
To: YVC Customer Service Team
Subject: Public Consultation online submission [#286]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Murrumbateman , NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Barton Highway Service Centre
Submission *	Why do we need another service centre we have the one at Yass which services people coming onto the highway and also 15 mins from the proposed sight you have two stations and major food outlets also Murrumbateman's petrol station has serviced the locals and travellers for several years. In times that are hard we should be trying to support already struggling businesses rather than building unnecessary ones possibly causing closures of others for the sake of profit in someone's pocket.

Arif Yasin Chohan

From: Yass Valley Council <no-reply@[redacted].com>
Sent: Saturday, 5 June 2021 11:14 AM
To: YVC Customer Service Team
Subject: Public Consultation online submission [#284]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Murrumbateman , NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	PP.2020.01 – Highway Service Centre, Murrumbateman

Submission *

I would like to express my support for the development of the service centre on the Barton Highway, Murrumbateman for the following reasons:

* Murrumbateman is a Growth area for residential development which the current infrastructure struggles to support. The present service station in Murrumbateman village is often unable to cope with the existing demand from local residents, tourists and passing trade.

* Council is undertaking the construction of bike paths in the area to support the winery region by attracting tourism. The existing service station currently struggles to cope on weekends and holidays and, therefore, an additional service centre would make the area more accommodating for tourists as well as Yass Valley residents.

* The proposed service centre would provide opportunity for employment, in particular, younger residents seeking casual work.

* The proposal would encourage passing travellers to pause in the area and this could potentially increase the opportunity for more tourism. It is suggested that this could be a valuable opportunity for the provision of tourist information.

* The proposal has been designed with a specific view to ensuring traffic safety and, as such, should not contribute to increasing traffic hazards.

* The service centre would support commercial development in the region.

* The design of the service centre allows access for large vehicles such as semi-trailer trucks which currently often travel through the Yass town centre to access the service centre near the Hume Highway, thereby increasing traffic hazards for the town.

* Tourists and local residents with horse trailers and caravans would be able to easily access the services offered by the proposed development.

I sincerely hope that the Council will make a favourable decision in support of the proposed development.

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted].com>
Sent:	Saturday, 5 June 2021 11:32 AM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#285]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Murrumbateman , NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	PP.2020.01 Highway Service Centre, Murrumbateman.

Submission *

Dear Sir/Madam.

I wish to make a submission supporting the proposed Highway Service Centre, Barton Highway, Murrumbateman.

My reasons for the support arise from the growing population in Murrumbateman. I'm aware, from reading council documents, that there is approximately 150 new homes, either approved or proposed, for the Murrumbateman area. ('The Fields' next to Shaws, 'The Meadows' in the village, Jiparu, and 9 lots along Murrumbateman Road. Then there is the future development of approximately 1800 homes on the Council owned Hawthorn. Woodside is also another strong possibility for development in the near future.

It's difficult to get into the existing service station in the village on some occasions. I've sometimes had to go back at another time. Traffic backs out onto the Barton Highway if there aren't any pumps available.

The new proposed Service Centre would be good for long vehicles or vehicles with trailers. I believe the new Service

Centre will have a cafe. If this happens to be a fast food business, such as McDonald's, Burger King or similar, it will be a great opportunity for young people in the village to seek part time employment which is very limited for them at the moment in this area.

Regards

[redacted]

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted]com>
Sent:	Saturday, 5 June 2021 9:57 AM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#283]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Murrumbateman , Nsw 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	New service station Murrumbateman

Submission *

I feel thete is no need for another service station on this district.

Trucks and those likely to be travelling long distances on the proposed new highway are adequately for in Hall and Yass.

In addition to the it will not be diffucult to make a short detour from the highway into the village for travellers "caught short" between the larger existing serice stations.

Residents in and around the village are well provided for by the existing servo/shop and we value the service it provides.

The owners are there for us 7 long days a week and deserve support and considerationfrom residents in return.

The vast majority of residents share my view.

Yours faithfully

[redacted]

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted].com>
Sent:	Friday, 4 June 2021 3:17 PM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#280]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Murrumbateman, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	PP2020.01 Murrumbateman Service Centre

Submission *

I would like to register my dissent and objection to PP2020.01 for the following reasons

TRAFFIC/ ROAD SAFETY.

The location of the proposed service centre is on a single lane section of the Barton Highway with turning lanes providing access Long Rail Gully Rd.

I note that a 1 hour traffic study was completed between 0800 and 0900 on 1 August 2019 which noted that approximately 12000 trips per day were undertaken along that stretch of road.

The proposed access and exit from the service centre is via Long Rail Gully Rd, and I accept and acknowledge that there are suitable turning lanes to provide access into Long Rail Gully Rd, however there is no provision of facility for safe exit back onto the Barton Highway. As a service centre, the target market is likely to be travellers and trucks, including long-haul B Double semi trailers.

The lack of slip lanes for outbound traffic from Long Rail Gully Rd is, an almost inevitable accident waiting to happen. Trucks, caravans and vehicles towing car trailers etc, simply cannot accelerate to 100kph in time to not interfere with traffic flow. This is particularly an issue in winter with heavy fog being common throughout the day and certainly in the morning peak hour.

Whilst the Barton Highway duplication is occurring, there is no timeframe for the continuation of the dual carriageway through this area and as such, there is a possibility that the service centre access will not be conducive with the future highway design.

COMMUNITY VALUES

The Service Centre appears to be in conflict with the Yass Valley Council's previous statements of keeping Murrumbateman as a rural village. The simple fact is that there is no need for people to stop at a service centre when there is one only 20km away in Yass and Canberra is only 35km away. This does not take into account that there is an existing service station in the Village that provides fuel and food for travellers who have misjudged their fuel levels or need to have a rest stop.

The service centre will not be able to offer anything that is not currently provided in the Village and any additional employment would be offset if additional retail space becomes available in the current Village area (as had been previously proposed).

There is also the huge question of supporting local business and keeping business local. Service Centres of this type are not owned by local families but by international corporations who will not contribute to the area but have the potential to destroy small family businesses by drawing travellers in to the service centre, rather than encouraging them into the Village.

COMPLIANCE

There must be some questions asked and answers provided as to why this proposal sat for so long that an extension needed to be granted to Council. What was the delay? Why was this not put out to public consultation within the agree timeframe?

The simple fact is, this development is both unwanted and unneeded, it will have an adverse affect on local business and provides the potential for additional traffic hazards on what is recognised as one of the worst and most dangerous roads in NSW.

Arif Yasin Chohan

From: Yass Valley Council <no-reply@[redacted].com>
Sent: Friday, 4 June 2021 5:35 PM
To: YVC Customer Service Team
Subject: Public Consultation online submission [#281]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] MARCHMONT, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Proposed service station
Submission *	I'd like it to go ahead. As a small business owner I work in both Yass and Murrumbateman. I've always got trailers on and can't fill up at Murrumbateman as it to difficult due to being so small. Regards, [redacted]

Submission [illegible]

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted]com>
Sent:	Saturday, 5 June 2021 9:27 AM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#282]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Murrumbateman, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Planning Proposal (PP.2020.01) – Highway Service Centre, Murrumbateman

Submission *

I don't have a problem with the idea of a service centre, but the current plan seems like a huge waste of time and money given the location. Wouldn't it make a lot more sense for it to be between Murrumbateman and Canberra? Thousands of people drive back and forth to Canberra every day. There's already a large service centre just outside Yass.

What's really very needed urgently is a proper shopping area for Murrumbateman and the surrounding rural area. Murrumbateman is seeing rapid development, and people are not going to want to buy these homes if the only services on offer are one tiny IGA, bakery and take away that already struggle to meet demand. The bakery is only open for a couple of hours a day.

When discussing Murrumbateman online (e.g. when people ask for advice on whether to move here) many people advise against moving here due to the lack of services. Murrumbateman is desperate for an actual supermarket.

There is also a severe lack of retail space – right now businesses like food trucks are trying to open up, and can't because of a lack of room. There is a huge demand here for a cafe, better take away options etc.

Nearby towns like Bungendore, which is essentially the same size (or will be after the large new developments in Murrumbateman), have far more businesses – a supermarket, take away stores, cafes, a gallery etc. Personally I can't see how, when I'm elderly, I'll be able to stay in the town with such a ridiculously low level of basic services, and I've heard of many older residents having to move back to Canberra. Yass and Canberra are too far to travel for many, and there is also a lack of bus services.

Another consideration is tourism. Murrumbateman attracts a lot of visitors but I've heard colleagues and friends complain that there's no playground or place to get lunch, which dissuades them from coming out for the day to visit wineries. I felt the same before moving to Murrumbateman – there's nothing nearby and the pub has very little to offer kids (no play area etc) so it's difficult especially for families. I would have come out to the wineries much more often if there were cafes or a supermarket to buy lunch or a recreation area.

This service centre idea seems to summarise the council's approach to Murrumbateman – to provide services and developments that are poorly thought out and are useless to residents. This highway service centre will have no benefit for me and discussions I've seen online suggest it'll have little benefit for other Murrumbateman residents.

Please look into building a shopping centre. The lack of services in this town is absolutely ridiculous.

Submission 31

Submission re Yass Valley Council Planning Proposal (PP.2020.01) – Highway Service Centre, Murrumbateman

Details of person making submission :

[redacted]

I would like to make some comments regarding the proposed service centre at the Long Rail Gully/ Barton Highway junction (Lot 12 DP 1158637).

In the planning proposal document Section C – Environmental, Social and Economic Impact - Land Use Compatibility pg 14 the following is stated :

"Given the separation of the Site from its neighbours, there will be no amenity impacts or land use compatibility issues resulting from the Proposal."

This statement is incorrect.

There are a number of houses, particularly those on Gounyan road, which will be severely impacted by this proposal.

- there will be considerable visual impacts for any house which has line-of-sight contact with the service centre. Most houses are orientated to take advantage of the views towards the Brindabella Ranges.
- this will be exacerbated at night, particularly if the service centre is brightly lit. Additionally, the proposal for a truck stop will have lights coming and going at all hours.
- even houses several kilometres away will be impacted, if they have a direct line of sight. This may include my house, depending on the exact location and height of structures etc.
- not only will those closer to the service centre be adversely affected by the visual impact, they will also have the noise disturbance associated with a truck stop. I expect to be impacted by the noise of the truck stop.
- the combined effects of visual and noise disturbances are also likely to decrease the value of the impacted properties.

The false statement that there will be no impacts on the amenity of neighbouring properties is repeated throughout the document. 3.A.1, , 3.C.2, Part 7-Conclusion.

The proponents of this proposal should be asked to state how they intend to mitigate these impacts.

Suggestions in relation to this include :

- some kind of screening at the site to lessen the impact

- planting a thick bank of rapidly growing tall trees (immediately after the proposal is approved, if approved) on the opposite side of the highway. It is assumed that this land is still in the same ownership as the land described in this application. If not, the proponents should be asked to aquire land on the opposite side of the highway as a condition of approval.

- ensuring lights are covered and/or point inwards towards the service centre, to minimise the outward impact.

- the design of the truck/ resting stop should ensure that lights are not directed in a northerly direction at any time

For those people likely to be affected, this is not an insignificant issue, and Yass Valley Council is asked to seriously consider this impact in approving this proposal or setting conditions around the approval.

Regards

[redacted]

Submission 32

Arif Yasin Chohan

From:	Yass Valley Council <no-reply@[redacted].com>
Sent:	Monday, 7 June 2021 3:13 PM
To:	YVC Customer Service Team
Subject:	Public Consultation online submission [#289]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] MURRUMBATEMAN, NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	PP.2020 01 Highway Service Centre.

Submission *

I am a resident of Murrumbateman and hold land at 634 Long Rail Gully Road.

I do not support Rezoning of Lot 12 DP 1158637 to include Additional Uses.

I believe the proposed rezoning of Lot 12 DP 1158637 to include Additional Permitted Uses will cause unnecessary fragmentation of our precious rural landscape and would set precedence for further fragmentation.

The proposed Service Centre, I believe is an unnecessary supply, as the proposed services are already well provided at Murrumbateman Village, Yass Town, Yass Service Centre and Canberra.

I also have great concerns about Road Safety, mainly in respect to traffic crossing northbound traffic in heavy fog.

Thank you for your consideration.

[redacted]

Submission 33

[redacted]
Murrumbateman
NSW 2582.

7/06/2021

We oppose the Planning Proposal PP.2020.01 on several grounds.
These include:

1. It is visually polluting.

2. It fragments the rural landscape.

3. It sets the precedent for further fragmentation of the rural landscape.

4. It is environmentally unfriendly.

5. It provides minimal employment opportunities.

6. It draws service away from existing Murrumbateman businesses.

7. The services it offers currently exist in Murrumbateman, Yass and Yass Service Centre

Further, the traffic assessment grossly understates the movements on Long Rail Gully Rd and the Barton Highway. The assessment was done in the middle of Covid restrictions when people were working from home and kids were not going to school. The traffic load was substantially less on both roads at that time. It was also over period of time when peak traffic was not occurring. Additionally, Long Rail Gully Road does not only service Long Rail Gully Rd residents, but there is also considerable through traffic from Dog Trap and surrounds. Therefore, this assessment is flawed and at the least needs to be done for an extended period and at appropriate times.
The additional traffic, particularly large trucks, that would exit Long Rail Gully due to the development would make an already dangerous right-hand turn onto the Barton highway even more dangerous. The time taken for a B-double to enter the highway from a standing start would be considerable and even with good line of sight it would increase the risks associated with the

intersection. At busy times it can take some time to get enough room to make the turn in a car let alone a fully laden B-double. Particularly if there were several trucks waiting to turn across the Barton Highway traffic at one time. The danger would be exponentially increased on foggy or wet mornings. At the very least an intersection would need to be constructed similarly to McIntosh Circuit and Kavenys Road. Both with a protected right-hand turn and extended right hand turn off the highway.

The increased risk to travellers on the Barton Highway and local residents, I think is too high a price to pay for the Proposed development to proceed.

Kind regards,

[redacted]

Arif Yasin Chohan

From: Yass Valley Council <no-reply@[redacted].com>
Sent: Monday, 7 June 2021 6:22 PM
To: YVC Customer Service Team
Subject: Public Consultation online submission [#290]

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Name *	[redacted]
Address *	[redacted] Murrumbateman , NSW 2582 Australia
Email *	[redacted]
Phone Number *	[redacted]
What item are you making a submission on? *	Planning proposal for a highway service centre Murrumbateman

Submission *

Delayed in submitting because your server was down as confirmed by Amanda in your office at 4.31 today.

Hello

I am writing to submit against the proposal for a highway service station at Long Rail Gully Road, Murrumbateman.

There are a number of factors against this proposal

1 Having discussed with a number of truck companies who frequent the Barton Highway, most trucks are heading to Victoria and therefore use the Yass Highway Services.

2 Trucks heading south on the Hume highway from Goulburn know to fill up at Yass if need be.

3 Trucks heading out of Canberra to Murrumbateman have fuelled up in Canberra and therefore there is no requirement to refuel in Murrumbateman knowing that there is availability to do so at Yass.

4 Huge costs have been expended to straighten the Barton Highway at the Long Rain Gully location, by putting in a fuel station there, this will negate taxpayers money spent by creating junctions and exits for HGVs

5 Due to the location it would also create dangerous situations at the junction which was the whole point of straightening it.

6 Murrumbateman BP provides a village community service.
By building another fuel station 10 minutes up the road will deprive that current business of a livelihood.

7 There is no need for another fuel station to be built in such close proximity to 3 others - Nichols, Murrumbateman, Yass and Gunning.

8 We do not require fast food outlets

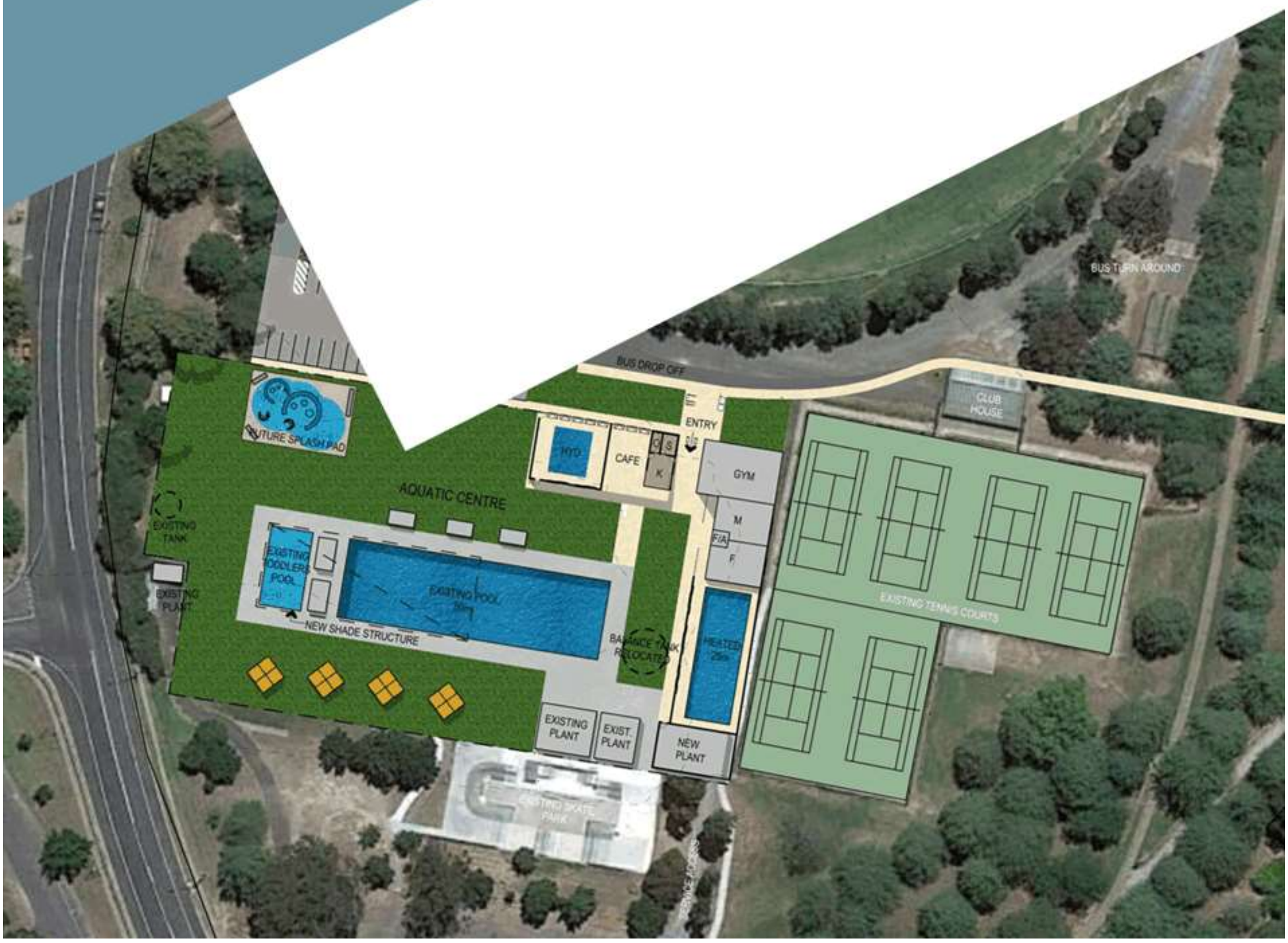
9 We do not want the light pollution which is already a problem in the area.

COMPLETE

yass valley council
the country the people

CONCEPT DESIGN AND COSTINGS FOR AN INDOOR HEATED SWIMMING POOL AND SPORTS FACILITY

CLIENT | YASS VALLEY COUNCIL
REVISION | C
DATE | 15/04/2019
PREPARED BY | COMPLETE URBAN

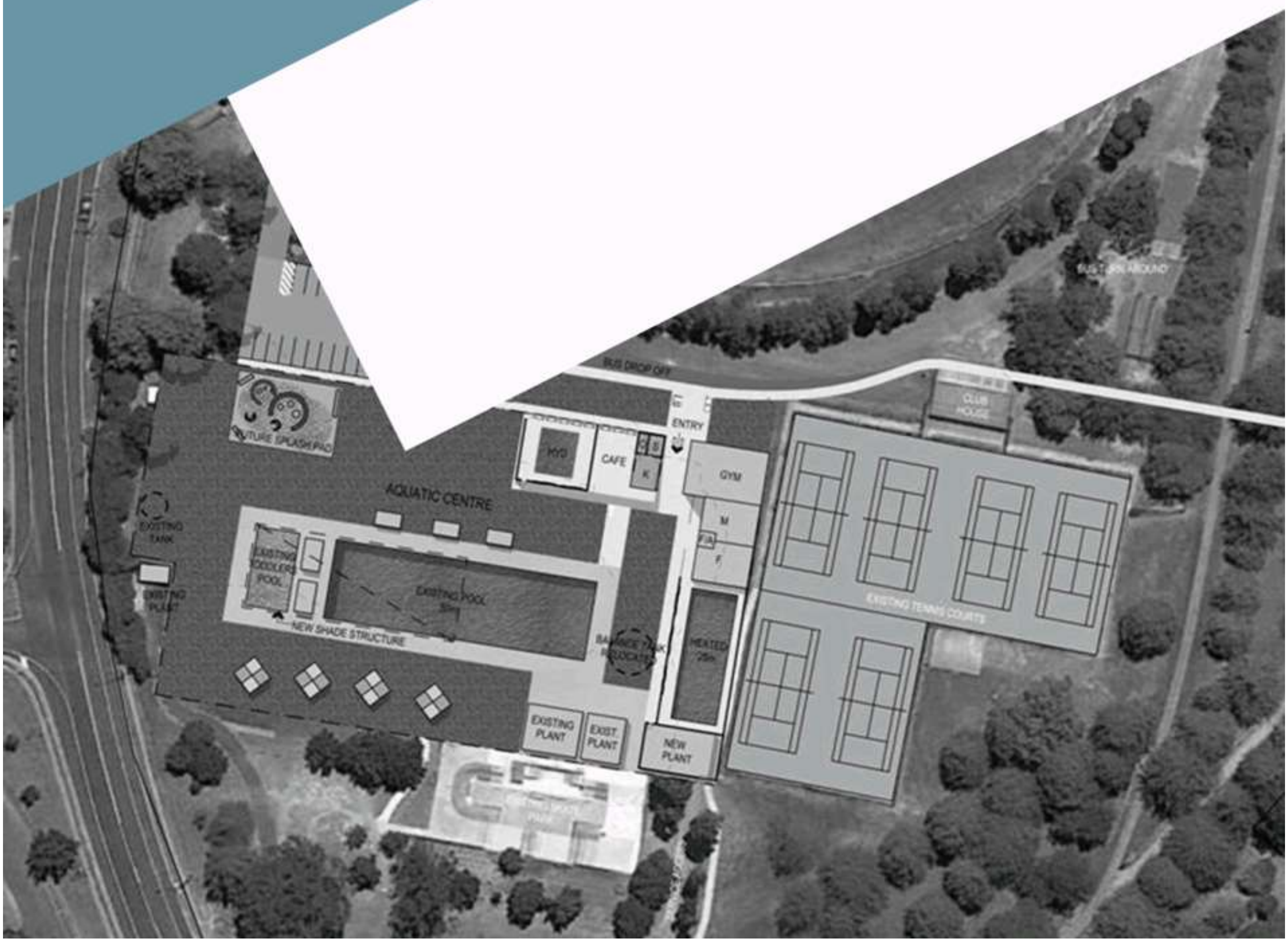


REVISION	DATE	APPROVED BY
A	29/03/2019	
B	11/04/2019	
C	15/04/2019	

Contents

List of Figures

1. PROJECT OVERVIEW



1.1 Background

Complete Urban have been engaged by Yass Valley Council to undertake a Concept Design and Costings for an indoor heated swimming pool and sports facility at the Victoria Park pool precinct in Yass. The project is to include the following:

- 25m – 4 lane heated pool
- New amenities/change rooms, kiosk and office space
- Indoor hydrotherapy pool
- Outdoor splash pad
- Gym
- Indoor sports hall of size to cater for 2 basketball courts
- Car parking

1.2 Documents supplied by Council

- Request for quotation document TVC/B5/04.2018

2. EXISTING SITE

2.1 General

It is proposed to extend the existing Yass Memorial Swimming Pool by the addition of the following:

- 25m – 4 lane heated pool
- Hydrotherapy pool
- New amenities and kiosk
- Outdoor splash pad – (future provision)
- Gymnasium

It is anticipated that a new facility will be built on the north or northeast side of the current pool and that new carparking associated with a new entry will be required.

The proposed 2 courtyard basketball facility including associated change rooms is proposed to be located on Council owned land further east between the existing school and the pool in a joint venture with the school so it can become a shared facility. The pool is part of a larger multipurpose sports facility including an oval immediately to the north. There is a current ring road around the oval providing informal parking.

2.2 Existing Yass Memorial Swimming Pool

The existing Yass Memorial Swimming Pool comprises a 50m outdoor pool, toddler pool, kiosk, change rooms and plant.

Figure 1: Existing Aerial Image

The Yass Memorial Swimming Pool was built in 1964. Whilst a PWD facility has been added recently it appears to have but undergone limited upgrading since completion. It is served by a carpark south of the site. This is approximately 3m lower than the pool complex and is accessed by a ramp and stairs. There are also general parking areas at grade to the north of the pool serving the adjacent playing field. The pools is fenced to the north so there is no direct connection to these.

Figure 2: View to pool complex from northwest

Figure 3: View to toddler's pool looking south

Figure 4: View to toddler's pool and main pool looking south

Figure 5: Main plant areas looking east

The existing facility has been inspected during the site visit on the 30th January 2019. The facility provides basic accommodation to service the current 50m pool and toddler pool. However, the accommodation is outdated and does not provide a modern level of amenity and would not support the expanded offering proposed without significant rebuilding and upgrading.

The key issues with the existing facility are as follows:

- Old, outdated staff accommodation and public change rooms
- No universal access to facility from southern carpark
- Lack of shade over main pool
- No connection to Civic Park to the north
- No indoor all-weather facility
- Limited leisure based offering with pool not open for 6 months of the year

3. CONCEPT OPTIONS

3.1 Overview

In accordance with the project brief, two high level concept options were prepared and submitted to Council staff for feedback. Both options have been prepared in response to the brief and to the findings of the site inspection undertaken 30th January 2019. Both options proposed a new facility to replace the existing facility and provided the areas as briefed and as follows:

- 25m – 4 lane heated pool indoor pool
- Hydrotherapy pool
- New amenities and kiosk
- Outdoor splash pad – (future provision)

In addition, a new 2 court basketball facility was proposed closer to the existing school. The proposed building plan for this facility is the same for both options, although in different locations.

3.2 Option 1

Option 1 proposes a new pool building as a linear building form north of the current 50m pool. The facility would be entered from the north with new carparking provided north of the new building and accessed off Laidlaw St. A future splash pad has been located to the north east corner of the pool site.

A new 2 court basketball facility on the possible joint venture site west of the school with new carparking west of the facility and accessed off the existing road network around the oval is also proposed.

Figure 6: Option 1 Concept

Key Features

- New aquatic centre north of existing pool with splash pad between aquatic centre and existing tennis courts.
- The proposed 2 court basketball hall is located close to the school and is accessible from either carpark. This location would most likely suit the school better.
- Split road layout with access to the aquatic centre and basketball hall from the west and the separate existing access to the basketball hall from the existing road in front of the school.
- Bus drop off - As access is from Laidlaw St. only and given the bus has to drop off on the correct side (south side) of the road, the bus must turn around within the site.
- Swimming pool has a larger mustering area at the deep end of the main pool for events etc
- Greater potential for the indoor lap pool and hydrotherapy pool to be used independently of the outdoor pool – this could be useful in the off season.

3.3 Option 2

Option 2 proposes a new L-shaped pool complex to the north and east of the current pool with parking to the north. A splash pad is proposed to be located on the north west corner of the pool complex.

New 2 court basketball facility on the possible joint venture site west of the school. This has a new carpark north of the facility which is accessed both from the existing ring road around the oval and from the entry road west of the school.

Figure 7: Option 2 Concept

Key Features

- New aquatic centre as an L-shaped building to the north and east of the existing pool. This will require the relocation/replacement of the existing main pool balance tank.
- Basketball hall closer to the tennis courts – it is possible that the existing tennis clubhouse could be incorporated in the new basketball hall building (allowing the existing clubhouse to be removed in the future)
- Road network east west through the site is connected which provides flexibility in parking options. However, could encourage unwanted through traffic.
- Bus drop off – The bus would not need to turn around within the site. Given bus can potentially enter the precinct via the road to the east adjacent the school, the bus can drop off on the correct side of the road north of the pool and then exit the site using Laidlaw St.

3.4 Issues and considerations common to both options

- The existing carpark south of the existing pool would remain and be used mainly for the skate bowl. New carparking for the pool and basketball hall is provided close to and at grade with each facility.
- The existing carpark also provides service access to the pool plant area.
- There is a loss of open space north/east of the existing pool in both options but this would be offset by new open space where the existing building is removed.
- There may be an opportunity for future shade on south side of the pool as it is facing the northern sun.
- The splash pad could be external or internal to the pool area in either option. Council may need to address any issues of perceived risks associated with safety/hygiene and assumed surveillance etc. with a totally accessible splash pad.
- The road networks are interchangeable between each option
- The aquatic centre gym is able to be accessed outside from of the pool enclosure to allow after hours assess
- Good visual surveillance of all water bodies in both options (although better in option 1)
- Option 1 bus drop off would require a turnaround within the site so it is on the correct side of the road for drop off.

In addition, to the 2 options proposed, there was also a brief investigation of a new building to the west of the current toddler pool. However, further development of this was not pursued as is insufficient space to the west of the pool for a new aquatic centre. The slope of the land in this area would also be a major consideration.

3.5 Description of proposed buildings

It is anticipated that the aquatic centre will be constructed as follows:

- Concrete slab on ground
- Concrete masonry walls to exterior and interior
- Aluminium glazing and doors
- Flat roof cladding with steel structure
- 'tilt up' polycarbonate glazed panels to hydro pool and outdoor dining area
- Insitu concrete pools fully tiled
- Epoxy flooring to change rooms with tiled walls
- Epoxy flooring to change rooms with tiled walls with natural ventilation

- Solar pool heating – available roof area is approx. 1000m2
- External Concrete paving

It is anticipated that the basketball facility will be constructed as follows

- Concrete slab on ground
- Concrete masonry walls to exterior and interior walls to 3m above floor level and lightweight Colorbond cladding above to provide minimum 6.1m clearance inside (recreational court height)
- Aluminium glazing and doors
- Epoxy flooring to change rooms with tiled walls
- Epoxy flooring to change rooms with tiled walls with natural ventilation
- Flat roof cladding with steel structure
- External Concrete paving

3.6 Council Feedback

Following feedback on Option 1 and Option 2, Council staff identified Option 2 as the preferred option and chose this option to be developed further and to incorporate the following feedback.

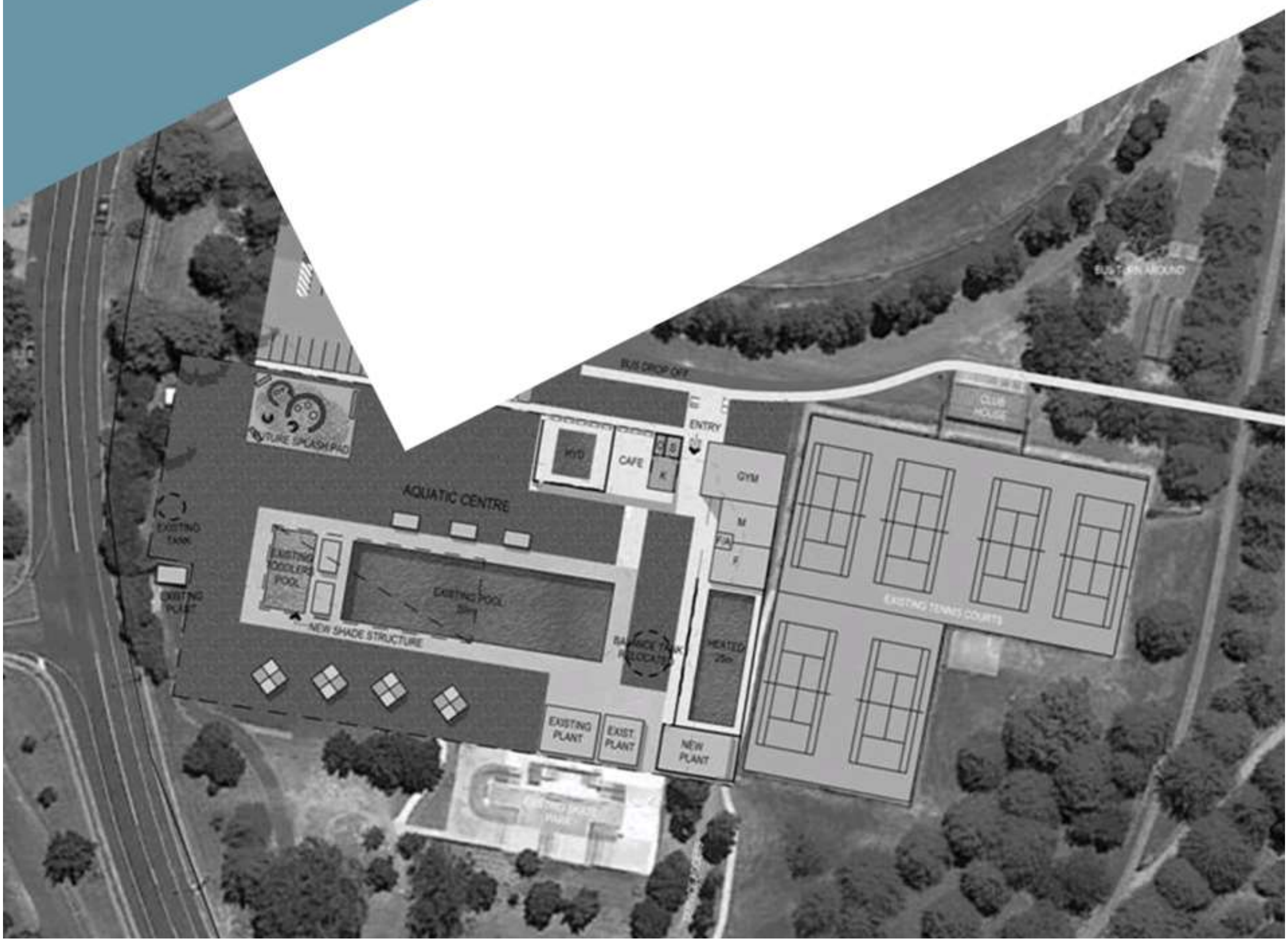
- Prefer the indoor pool located near the tennis courts.
- Prefer the Male & Female change rooms to be indoor near the 25m indoor pool with access that can be locked/separated from the outdoor pool when it is closed.
- Need to be able to separate the 25m pool and hydrotherapy pool so that a gym can operate in conjunction with the 25m indoor pool when the centre is closed.
- Hydrotherapy users will have internal access to the male and female change room inside the building.
- Basketball gymnasium moved to high school carpark.

Prior to the commencement of the final version of Option 2, the following revised blocking plan of the aquatic centre was issued to Yass Valley Council staff for comment.

Figure 8: Revised Aquatic Centre Blocking Plan

The above layout was endorsed by Council staff by return email on 8/3/19 and from this the final option was developed.

4. DEVELOPED CONCEPT DESIGN

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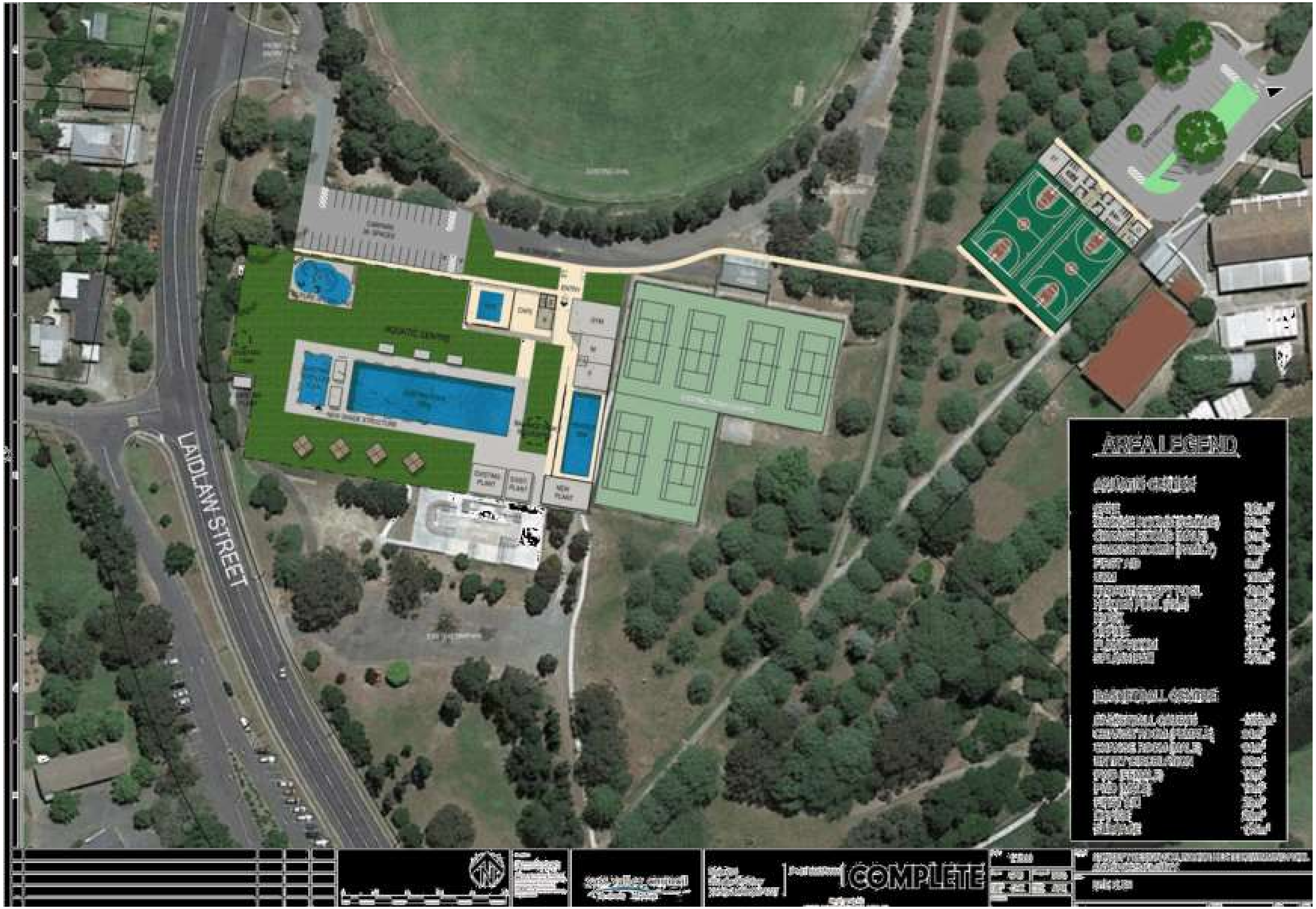

LAIDLAW STREET
AREA LEGEND
COMPLETE


AFTER HOURS ACCESS POSSIBLE TO THIS AREA
GYM
MALE CHANGE ROOM
FEMALE CHANGE ROOM
FAMILY CHANGE/ PWD
FIRST AID
HEATED POOL 25m
NEW PLANT
BUS DROP OFF
AFTER HOURS ACCESS
FOYER
STORE ROOM
DRINKING FOUNTAINS
NOTICE BOARDS
ENTRY
BIKE RACKS
BALANCE TANK RELOCATED
OFFICE
KITCHEN
SERVICE AREA
STORAGE
EXISTING PLANT
EXISTING CONCOURSE
CAFE
EXISTING PLANT
OUTDOOR SHOWER
EXISTING POOL 50m
COMPLETE


EQUIPMENT STORE
FEMALE CHANGE ROOM
PWD
ENTRY
PWD
MALE CHANGE ROOM
OFFICE
FIRST AID
HALL 1
HALL 2
COMPLETE

Staging

It is proposed to complete project in 4 stages.

Stage 1a

- Build new changerooms, gymnasium, entry, kiosk, office, plant room
- Construct new bitumen carpark, aquatic centre entry paving and bus drop off
- Construct connecting path between aquatic centre and basketball hall

Stage 1b

- Build new 25m pool and new plant room

Stage 1c

- Build new 2 court basketball court and associated change rooms and support spaces

Stage 2

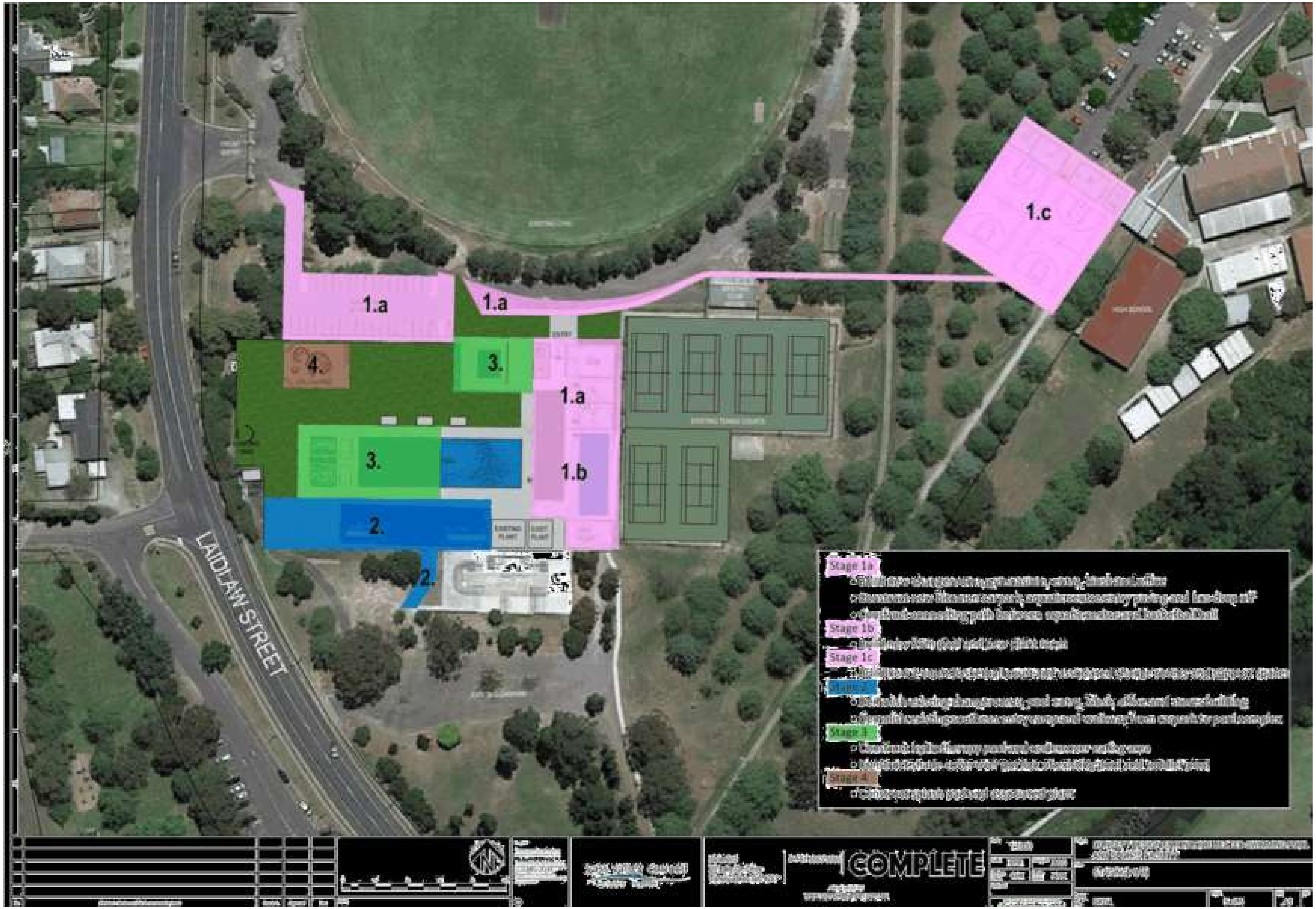
- Demolish existing changerooms, pool entry, kiosk, office and stores building
- Demolish existing southern entry ramp and walkway from carpark to pool complex

Stage 3

- Construct hydrotherapy pool and undercover eating area
- Construct shade cover over portion of existing pool and toddler pool

Stage 4

- Construct splash pad and associated plant


1.a
1.a
1.a
1.b
1.c
2.
2.
3.
3.
4.
LAIDLAW STREET
Stage 1a
Stage 1b
Stage 1c
Stage 3
COMPLETE

5. COSTING


BUS DROP OFF
FUTURE SPLASH PAD
ENTRY
CAFE
GYM
AQUATIC CENTRE
EXISTING POOL
NEW SHADE STRUCTURE
EXISTING PLANT
EXIST. PLANT
NEW PLANT
EXISTING TENNIS COURTS
CLUB HOUSE

5.1 Cost Estimate

Yass Valley Council

QS Concept Design Budget - Summary

Project Description:
Yass Indoor Heated Pool & Sports Facility

yass valley council
the country the people

COMPLETE

proactive quantitysurveying

12th April 2019

No.	Category Description	Totals
1	**DRAWINGS**	
2	**STAGE 1**	$5,771,000
3	**STAGE 2**	$120,000
4	**STAGE 3**	$1,950,000
5	**STAGE 4**	$750,000
6	**PROFESSIONAL FEES**	$1,030,920
7	**REGIONAL INDEX (Yass) - 8%**	$769,754
	Sub Total :	**$10,391,674**
8	**CONTINGENCY - 15%**	$1,558,751
	Total :	**$11,950,425**

Yass Valley Council

QS Concept Design Budget - Detail

Project Description:
Yass Indoor Heated Pool & Sports Facility

yass valley council
the country the people

COMPLETE proactive quantitysurveying

12th April 2019

Item No.	Item Description	Quantity	Unit	Rate	Amount
	DRAWINGS				
1	This Concept Design Estimate has been prepared based on on the following Word Document Report done by Complete - 2911 Yass Aquatic Design Report Rev B.pdf which also includes the following Drawings: SK00 - EXISTING SITE, SK01 - SITE PLAN, SK02 - AQUATIC CENTRE FLOOR PLAN, SK03 - BASKETBALL HALL, SK04 - STAGING PLAN	1.00	item		$ -
				DRAWINGS - Total:	**$ -**
	STAGE 1				
	Stage 1a				
1	New Changerooms, Gymnasium, Entry, Kiosk & Office	1.00	item	$944,000.00	$ 944,000.00
	New Bitumen Carpark, Aquatic Centre Entry Paving and Bus Drop off	1.00	item	$495,000.00	$ 495,000.00
	Connecting path between Aquatic Centre and Basketball Hall	1.00	item	$50,000.00	$ 50,000.00
				Sub-Total - Stage 1a	***$ 1,489,000.00***
	Stage 1b				
	New 25m Indoor Pool & New Plant Room	1.00	item	$1,532,000.00	$ 1,532,000.00
				Sub-Total - Stage 1b	***$ 1,532,000.00***
	Stage 1c				
5	New Building for 2 Basketball Courts with associated Changerooms and Support Spaces	1.00	item	$2,750,000.00	$ 2,750,000.00
				Sub-Total - Stage 1c	***$ 2,750,000.00***
				STAGE 1 - Total:	**$ 5,771,000.00**
	STAGE 2				
1	Demolish existing Changerooms, Pool Entry, Kiosk, Office and Stores Building	1.00	item	$70,000.00	$ 70,000.00
2	Demolish existing Southern Entry Ramp and Walkway from Carpark to Pool Complex	1.00	item	$50,000.00	$ 50,000.00
				STAGE 2 - Total:	**$ 120,000.00**
	STAGE 3				
1	Hydrotherapy Pool and undercover Eating Area	1.00	item	$1,700,000.00	$ 1,700,000.00
2	Shade Cover over portion of existing Pool and Toddler Pool	1.00	item	$250,000.00	$ 250,000.00
				STAGE 3 - Total:	**$ 1,950,000.00**
	STAGE 4				
1	Construct Splashpad and associated Plant	1.00	item	$750,000.00	$ 750,000.00
				STAGE 4 - Total:	**$ 750,000.00**

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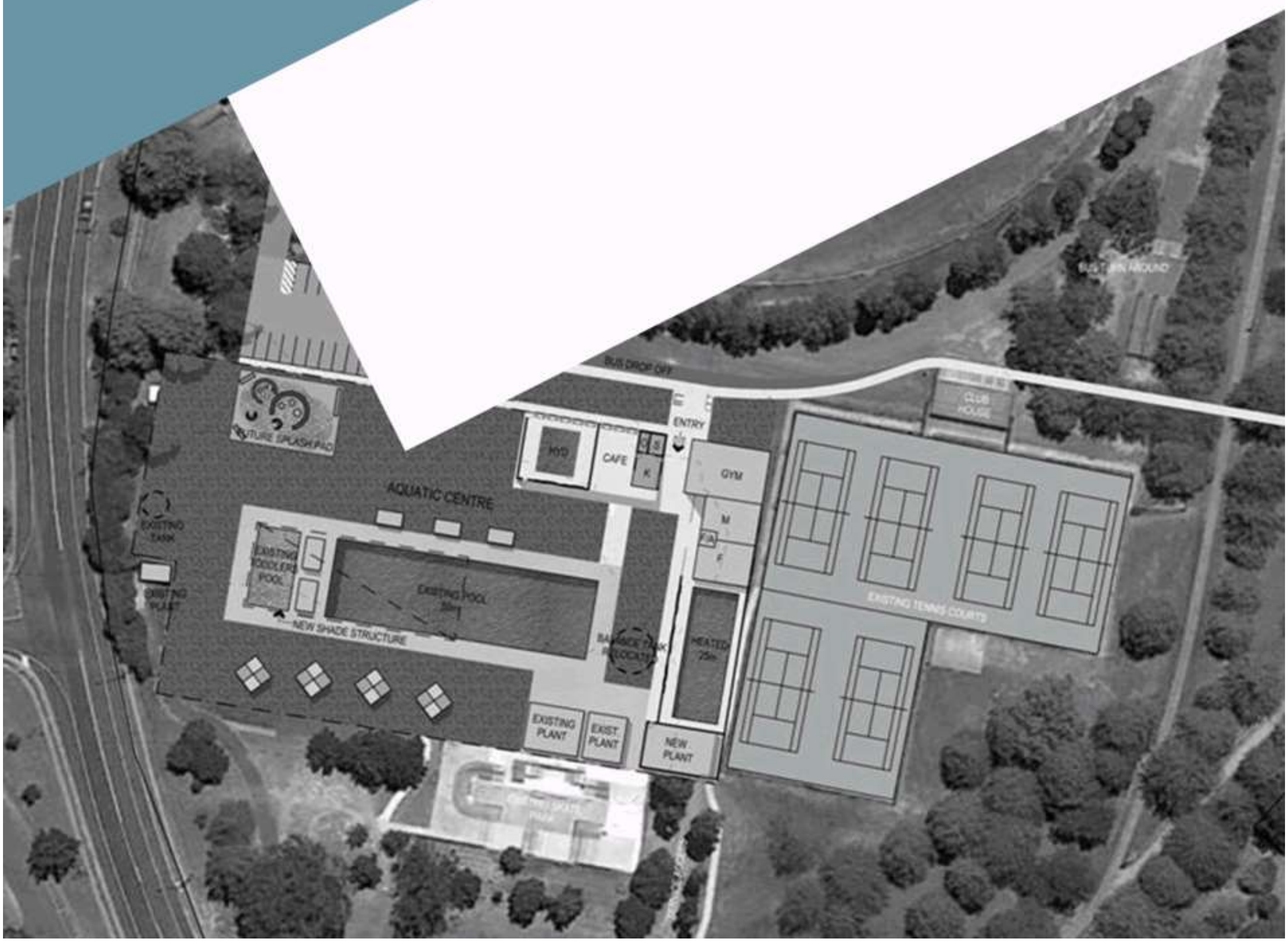
QS Concept Design Budget - Detail

Project Description:
Yass Indoor Heated Pool & Sports Facility

12th April 2019

Item No.	Item Description	Quantity	Unit	Rate	Amount
	PROFESSIONAL FEES				
1	Consultancy Fees - 12%	0.12	Item	$8,591,000.00	$ 1,030,920.00
				PROFESSIONAL FEES - Total:	**$ 1,030,920.00**
	REGIONAL INDEX (Yass) - 8%				
1	Regional Cost Allowance - 8%	0.08	%	$9,621,920.00	$ 769,753.60
				REGIONAL INDEX (Yass) - 8% - Total:	**$ 769,753.60**
	CONTINGENCY - 15%				
1	Contingency - 15%	0.15	%	$10,391,673.60	$ 1,558,751.04
				CONTINGENCY - Total:	**$ 1,558,751.04**

APPENDIX 1 - DBYD



Appendix 1 - DBYD

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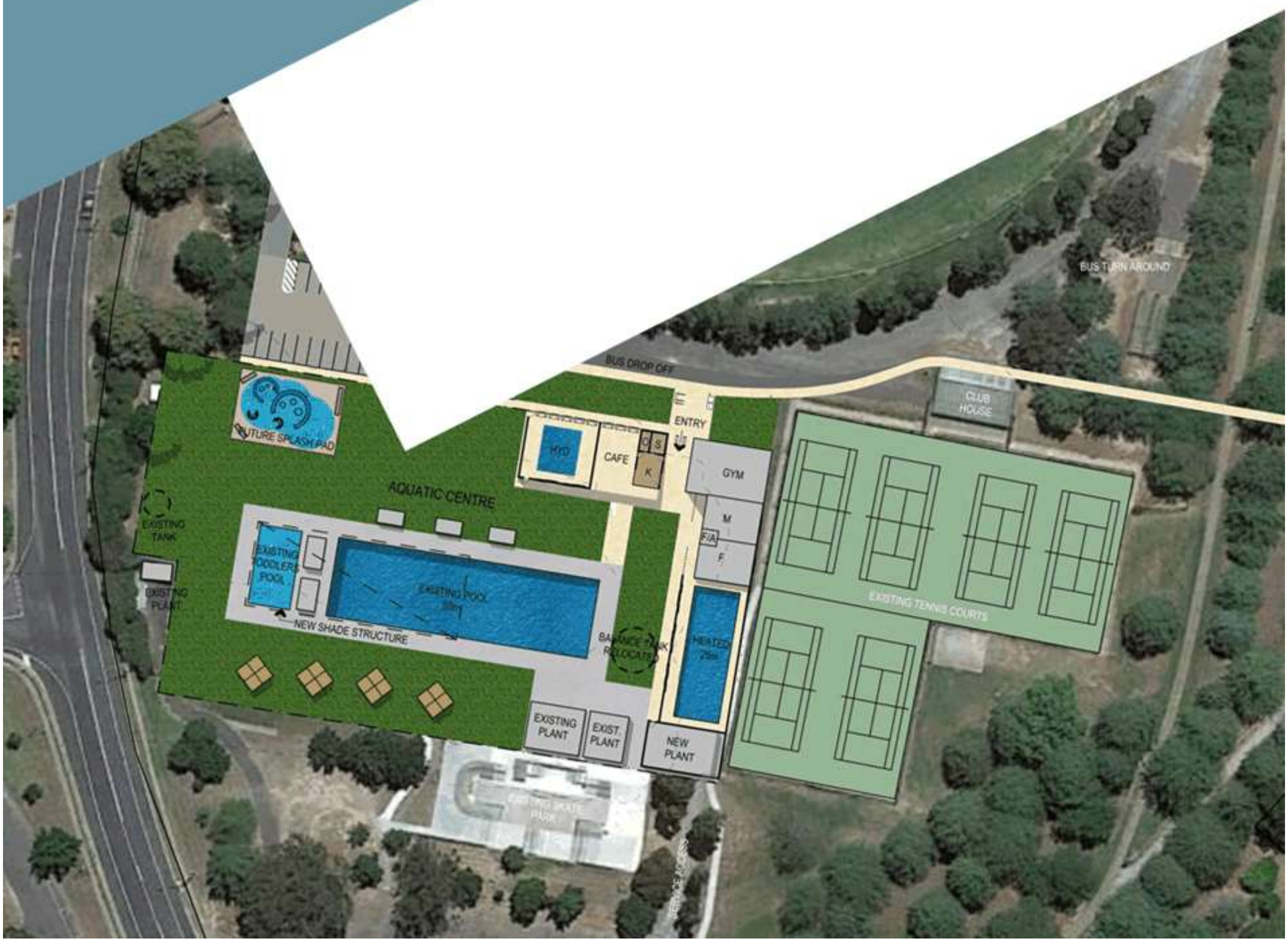

ATTACHMENT B

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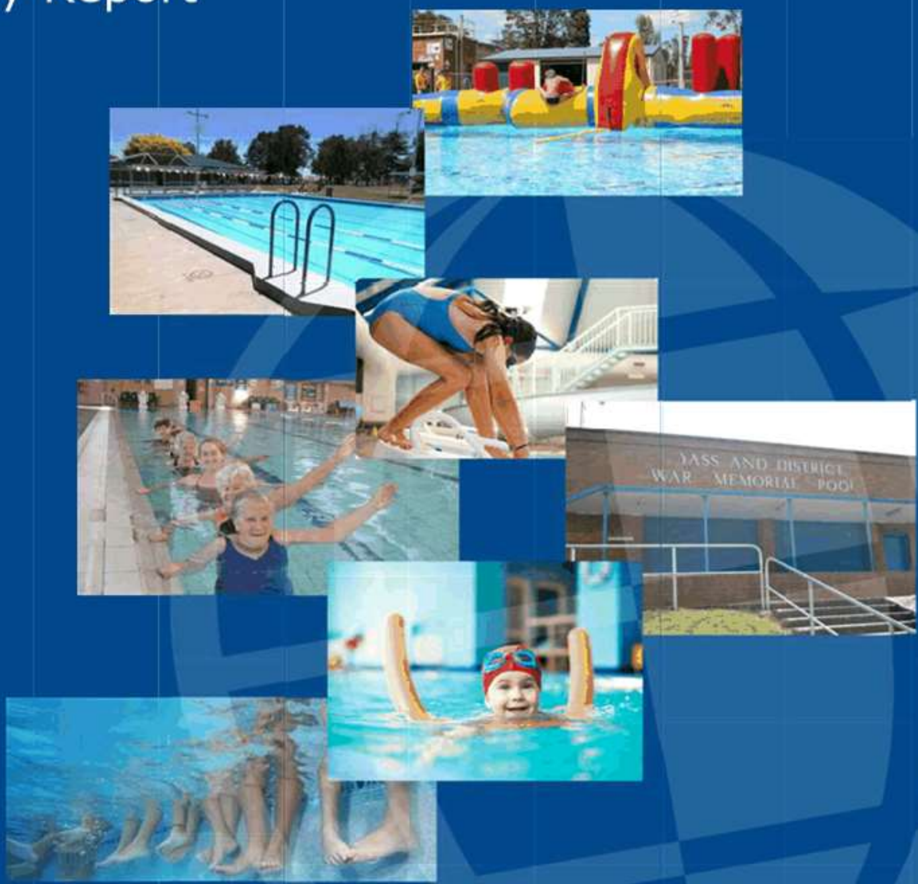
Yass Indoor Heated Swimming Pool

Feasibility Report



Prepared by SGL Consulting Group in association with Geoff Ninnes Fong & Partners, DKJ projects.architecture and Rider Levett Bucknall

sgl www.sglgroup.net

TABLE OF CONTENTS

1 INTRODUCTION

This chapter summarises the background to the study, its aims and objectives and the methodology used.

1.1 Background

Yass Memorial Swimming Pool was built in 1965 and incorporates a 50 metre Olympic pool and children's pool, plus associated office, change rooms and kiosk.

Council is considering ways to minimise the subsidy payable in the operation of the pool, acknowledging also that structural elements of the pool are reaching the end of their useful life and will require significant investment in years to come to bring up to standard. The pool already suffers modest water losses due to leakage.

The local community has expressed a desire to investigate the feasibility of Council providing a 25 metre indoor heated swimming pool on the site. The pool would incorporate features for lap swimming, water aerobics and hydrotherapy. In order to assist Council in developing the feasibility study a Community Committee comprising 15 residents was formed to provide input into this process.

1.2 Aims and Objectives

The aim of the study is to review the Yass Memorial Pool, prepare a feasibility study for a heated pool in the Yass Valley LGA and a strategic report to provide direction for the future management of the asset(s).

The objectives are:

Yass Memorial Pool

1 Review of demographic profile of the Yass Valley LGA and undertake a review of current usage and future usage from a strategic perspective;

2 Undertake a usage review of the current Yass Memorial Pool to consider season times, operating times, staffing, current swim programs and any opportunities to improve the pool's income and ways in which to reduce outgoings;

3 Undertake a review of work previously undertaken that identified an asset renewal plan which responds to ageing of the pool and pool leakage. Review the current filtration plant and dosing equipment to identify any possible savings which may come about through changing technologies or improved operating practices.

4 Prepare a 10 year business and financial plan based on these investigations.

Yass Valley Indoor Heated Swimming Pool Feasibility Study

1 Consult with the Community Committee (3 sessions) to understand the needs of the community with respect to providing an indoor heated swimming pool;

2 Based on the feedback from the Community Committee prepare a summary of recommendations and submit to Council for consideration. Council will determine

which proposal best meets its future needs.

3 Prepare suitable options which will allow for the development of a heated indoor swimming pool in the Yass Valley. The options plan is to incorporate concept designs and also include a 10 year business plan for;
- ✓ Ongoing additional operating costs;
- ✓ Debt servicing requirements assuming the pool is fully funded from loans.

Strategic Report

Provide a strategic directions report on the future management of the current pool centre and a second report with the inclusion of an indoor heated pool.

1.3 Methodology

The study was undertaken in four phases involving the following tasks:

Phase 1: Project Inception
Project Inception Meeting
Community Committee Meeting #1
Phase 2: Operational Review
Document Review
Operational Audit
Data Analysis
Review Filtration Plant and Dosing Equipment
Population/Participation Analysis
Business Plan
Phase 3: Indoor Pool Feasibility Study
Community Committee Meeting #2
E survey
Stakeholder Interviews
Written Design Brief
Operating Cost
Draft Feasibility Report
Community Committee Meeting #3
Feasibility Report
Phase 4: Strategic Report
Draft Strategic Report
Final Report

2 DEMAND

This chapter estimates demand for swimming facilities in Yass, by reviewing the responses to the on-line questionnaire and analysing population projections and swimming participation data.

2.1 Market Research

2.1.1 E-Survey

A web based and paper based questionnaire was prepared and made available to the Yass Valley Community for self-completion. A comprehensive reporting of the results are included in Appendix A. Findings related to demand and use of indoor swimming facilities are summarised below.

Existing Participation in Swimming

- 67% of respondents had visited a swimming pool. Almost half of the respondents (46%) had visited the Yass Memorial Swimming Pool within the last 12 months, 10% had visited the Binalong Swimming Pool and 29% had travelled to an indoor pool in Canberra.
- Of those respondents who had visited a swimming pool:
  - ✓ 87% had used Yass Memorial Swimming Pool.
  - ✓ 11% had only used an indoor pool.
- 33% of people who had visited Yass Memorial Swimming Pool and 8% of people who had visited Binalong Swimming Pool, had also visited an indoor pool.
- A significant majority of respondents use a pool mainly in summer. 37% had been to a pool more than three times a week during the summer, compared with 6% who visited a pool more than three times a week all year round.
- The most popular activities were recreational swimming with family (37%), lap swimming (25%) and learn to swim lessons (15%).

Upgrade Options

- The top two upgrade options were add an indoor swimming pool to the existing Yass Memorial Swimming Pool and upgrade the existing outdoor pools.
- The "Do Nothing" option was the least favoured, by a substantial score.
- The priority development options if an indoor pool is constructed in Yass were for a lap and teaching pool with hydrotherapy water.

Future Use

- The results indicate demand for year round swimming, for example 30% said they would use the facility more than 3 times a week all year round and 18% would use it once a week all year round.
- Reasonably high levels of support were given to:
  - ✓ Adult entry price of $6
  - ✓ Development cost up to $5M
  - ✓ Annual rate increase to cover capital and operating costs of $25

2.1.2 Hydrotherapy Market

To understand the market for a hydrotherapy pool, Council officers recommended contact was made with two physiotherapy practices and a retirement village.

- Linton RSL Retirement Village
  - ✓ 49 Village Units for independent living with both individuals and couples.
  - ✓ Some residents would use a hydrotherapy pool on a regular basis.
  - ✓ 82 residents (non-independent) would not use as this would be logistically impossible.
  - ✓ Prices seem affordable
- Yass Wellness Centre
  - ✓ 20 – 30 patients would use a hydrotherapy pool on a weekly basis
  - ✓ Prices seem reasonable
  - ✓ 30 – 40 people per week would use the hydrotherapy pool independently
  - ✓ An indoor facility would be used a lot for their own personal fitness, exercise and for rehabilitation post injury and surgery.
- Yass Physiotherapy did not provide a response.

Based on these responses, a hydrotherapy pool would be used by up to 100 people per week. However, given the likelihood that these projections are inflated, it is prudent to assume a maximum of 75 hydrotherapy users weekly, and more likely use of the hydrotherapy will be between 25 – 50 per week.

No data is available on "industry standards" regarding use of hydrotherapy pools. The key determinants of demand are price, accessibility, populations size and age profile in the primary catchment. This projected attendance can be used to estimate potential income. Attendance projections, however used in the financial modelling of this report does not separate out users of the hydrotherapy pool.

2.1.3 School Swimming Programs

Five primary schools and Yass High School were contacted to understand their use of swimming pools for their swim program.

- Binalong Public School use the Binalong Pool, paying $1.20 per child per lesson. The school does not envisage using an indoor facility at Yass.
- Berinba Public School
  - ✓ Uses Yass Pool
  - ✓ 230 students in swim program per year
  - ✓ Pay $50 for 20 lessons ($2.50 per lesson), including transport
  - ✓ Would use an indoor pool at Yass
  - ✓ Beneficial if swim program was not in Term 4
  - ✓ If the cost rose it would greatly impact on the families as there are many that come from low socio-economic backgrounds
  - ✓ 50% could not afford more than $1.20 entry fee
- Bowning School
  - ✓ Uses Yass Pool
  - ✓ 29 students in swim program per year
  - ✓ Pay $1.20 per lesson
  - ✓ Would use an indoor pool at Yass
  - ✓ If the cost rose it would greatly impact on the families as there are many that come from low socio-economic backgrounds
  - ✓ Most could not afford more than $1.20 entry fee
- Mount Carmel School

  - ✓ Uses Yass Pool
  - ✓ 120 students in swim program per year
  - ✓ Pay $60 for 5 lessons
  - ✓ Would use an indoor pool at Yass
  - ✓ Beneficial if swim program was not in Term 4
  - ✓ Would not use Yass Pool if entry increased to $3 or more

- Yass Public School
  - ✓ Uses Yass Pool
  - ✓ 150 students in 12 week program and 90 in intensive two week program per year
  - ✓ Pay $1.20 per lesson
  - ✓ Would use an indoor pool at Yass
  - ✓ If the cost rose above $3, some families may not be able to afford the cost
  - ✓ If an indoor pool is constructed a winter swim program may be included in the out of school sports program.

- Yass High School
  - ✓ Uses Yass Pool
  - ✓ Did not provide any additional information

These responses indicate that school swimming programs are highly price sensitive. Thus while a price rise may be justified, it is unlikely to be accepted by schools if more than, say $2.

2.2 Community Profile

The Yass Valley Council local government area estimated resident population in 2016 was 16,144. At the 2016 ABS census, the age profile, by service age groups was:

Service age group (years)	Number	%
Babies and pre-schoolers (0 to 4)	1,010	6.3%
Primary schoolers (5 to 11)	1,584	9.8%
Secondary schoolers (12 to 17)	1,425	8.8%
Tertiary education and independence (18 to 24)	1,143	7.1%
Young workforce (25 to 34)	1,457	9.0%
Parents and homebuilders (35 to 49)	3,529	21.9%
Older workers and pre-retirees (50 to 59)	2,336	14.5%
Empty nesters and retirees (60 to 69)	1,979	12.3%
Seniors (70 to 84)	1,385	8.6%
Elderly aged (85 and over)	296	1.8%
Total population	**16,144**	**100.0**

From an aquatic recreation perspective, the points to note are the number and percentage of the population of primary school age, and adults over 50 years. These two age groups primarily require a teaching pool and a hydrotherapy facility.

Projections of population growth to 2021 prepared by NSW Department Planning & Environment indicates Yass Valley Council area will increase to 18,800. It is projected that the major percentage growth will occur in the 65+ age group

2.3 Swimming Participation

The Australian Bureau of Statistics produce two statistical reports relating to participation in sport.

- Participation in Sport and Physical Recreation, Australia, 2011-12 addresses participation at least once in the previous 12 months by people living in NSW, aged over 15 years, and

- Children's Participation in Sport and Leisure Time Activities, 2003 to 2012 addresses national participation at least once outside of school hours, in the previous 12 months by people aged 5 to 14 years.

In relation to swimming the reports have found:

Percentage of population that swims at least once in 12 month period:

Participation Rate	15–17	18–24	25–34	35–44	45–54	55–64	65 +	Total
Swimming/Diving	8.6%	5.3%	11.5%	10.8%	8.6%	9.0%	5.6%	8.6%

Of these people who swim:

Annual Participation	1–12 times	13–26 times	27–52 times	53–104 times	105+ times
Swimming/Diving	15.9%	22.7%	31.4%	14.8%	15.2%

Type of Participation	Organised only	Non-organised only	Both organised and non-organised
Swimming/Diving	5.7%	90.4%	3.9%

Percentage of child swimmers, who swim at least once in a 12 month period:

Children's Participation	2012
5 – 8 Years	24.5%
9 – 11 Year	18.1%
11 – 14 Years	8.0%

This data shows the popularity of swimming for young children, and for non organised participation. It is also likely that a high proportion of young children participate in swimming lessons.

2.4 Potential Projections

Swimming Participation in NSW

Based on participation rates for swimming in NSW identified in section 2.3,, the total number of swims per annum (if year round swimming was available) by Yass Valley residents aged over 15 years is projected to be:

1 Based on 2016 Census population - between 55,061 and 89,875.

2 Based on 2021 population projections - between 61,268 and 100,008.

On-line Survey Data

The results of the on-line survey were used to estimate demand by cross tabulating the proportion of swimmers who visited a swimming pool and their reported frequency of visits. The result (240,728) is an estimate of total swimming attendances by Yass Valley residents. This is clearly a grossly inflated figure, which reflects the respondents inflated view of how often they swim. However, it suggests that there may be substantial latent demand for all year swimming facilities.

It is also noted that the on line survey found that 29% of respondents who had visited a pool, had used an indoor pool in Canberra or the local region.

CERM PI Operational Management Benchmarks

Based at the University of South Australia Business School, CERM (Centre for Environmental and Recreation Management) PI is a leader in customer service quality research, and operational management indicators in the sport and leisure, tourism and hospitality, and event industries.

The 2013 CERM PI Operational Management Benchmarks for Australian Public Sport, Leisure & Aquatic Centres found that the average number of visits per annum by people living within a 5km catchment was 5.5. This finding was based on a survey of 90 indoor and outdoor pools throughout Australia.

Based on:

- CERM data, which are indicative industry estimates of swimming pool use, and
- Population of Yass Valley of 16,144 in 2016 and 18,800 projected in 2021, and
- Population within a 5km radius of Yass township is approximately 8,000

the annual number of swims, will be approximately 44,000 from within the primary catchment and 88,792 and 103,400 from a broader catchment. [Note: this broader catchment projection includes residents who live outside the 5km catchment of the Yass pool, and who may use other pools that are closer to where they live.]

Projection

There is some leakage of Yass Valley Council area residents to pools outside the Council area. Whilst, some may be attracted to an indoor pool in Yass, it is probable that a significant percentage will continue to use these other pools.

It is not possible to accurately predict attendances at an indoor swimming pool in a location where such a facility has not operated in the past. This data suggests that attendances at Yass Memorial Swimming Pool will increase if an indoor swimming pool, catering for year round swimming is constructed. The projected number of annual swims is estimated to be at least 45,000 and up to 67,500.

A conservative estimate of demand is a prudent approach. For the purposes of analysis in this report, 45,000 shall be used as the projected number of annual swims at Yass Memorial Swimming Pool if an indoor pool facility is constructed.

3 DEVELOPMENT CONCEPTS

This chapter reviews existing facilities in Yass, including condition, potential aquatic markets, strategic options and a preliminary design brief for a new or upgraded facility in Yass.

3.1 Existing Facilities

Yass Memorial Swimming Pool comprises two pools:

Main pool

50.4m length,15.24m width, depth varying uniformly from 1.1m at shallow end to 1.8m at the 38m length, then falls to 3.5m over the next 4.6m, the 3.5 m being maintained for the rest of the pool. The pool has a wet deck gutter system and its own filtration, water treatment and dosing system.

Children's pool

15.24m length, 7.0m width, depth 0.3m along one long side, increasing to 0.6m across the pool. The pool has a wet deck gutter system and its own filtration, water treatment and dosing system.

These pools are serviced by an amenities building with male and female open air change rooms and toilets, reception and kiosk which are serviceable, but do not meet contemporary standards for a modern aquatic centre.

3.2 Asset Condition

A report on the Yass Memorial Swimming Pool prepared by structural and civil engineers in 2011 concluded that "the most economical solution is to address the maintenance issues on an as needed basis and to budget to replace the pool in ten years".

A review of the current filtration plant and dosing equipment in 2017 compared the performance of the centre's existing plant with the current compliant base level requirements of the NSW Health's "Public Swimming Pool and Spa Pool Advisory Document", (April 2013). It was found that:

- The filtration system for the Main Pool is inadequate. It needs a new filtration system to achieve the compliant turnover rate (4 times per hour compared with existing turnover rate of 6.5 per hour). The new pump recently installed can provide adequate capacity to achieve the required turnover rate. It is doubtful that the reticulation system pipes could return a compliant flow to the pool, and similarly, the floor based filtered water return system may also be inadequate. These elements need further investigation prior to providing a positive answer on particular performance.
- The filtration and reticulation system for the Toddlers Pool was adequate on the basis that both existing pumps are running at full capacity.

3.3 Aquatic Markets

The aquatics market comprises at least six distinct segments, each requiring a specific marketing mix to maximise market share and hence attendances:

1 Lap swimming – tend to swim early in the morning or after work, supplemented by some who swim during their lunch time. Require lane space (at least 25 metre pool size), with speed indicators for each lane (ie slow, medium, fast). Tend to swim on a regular basis, and often more than once per week. Water temperature is preferably between 26ºC and 28ºC. Most lap swimmers prefer to swim year round.

2 Swim coaching/squads – usually children and young people up to about 16 years, supplemented by adult squads comprising mainly masters swim squads and triathlon swim squads. Main squad training times are early morning (from 5.30am) and early evening (5.30pm – 7.30pm). Require reserved lane space, for between three and 10 times per week. Water temperature is preferably between 260C and 280C. As with lap swimmers, squads swim year round.

3 Learn to swim lessons (private, group and school) – lessons are offered to all ages, from "mothers and babies" to adult lessons. Most lessons are conducted after school (4pm to 6pm) and on Saturday and Sunday mornings. Adult lessons tend to be offered later in the evening and "mothers and babies" classes are usually on weekday morning between 9am and noon. Most classes are offered once a week, often for a ten week term or block. Water temperature is preferably between 290C and 310C. In indoor pools, the number of people in swim lessons declines in winter, although many children participate in lessons year round.

4 Recreational aquatic play – all humans play and socially interact. In an aquatic environment, play is often defined by the age of participants (ie pre-schoolers, junior primary school age, senior primary school age, young teenagers, young people and adults). Play equipment is larger and more adventurous the older the participant.

Play experiences are enhanced by either moving water (eg water cannons and rapid rivers) or moving the participant (eg water slides and climbing structures). Most recreational play is conducted after school/work time (eg weekday evenings and weekends). It can also involve relaxation (eg sunbathing, and "hanging about") and supervising young children. Water temperature is preferably between 28ºC and 31ºC.

5 Aquatic fitness programs – in addition to lap swimming, aquatic fitness programs include aqua aerobics (group exercise to music in water), water walking (using a floatation vest), and other similar gentle exercise activities. These activities tend to attract older adults, particularly women. Classes are held at times to suit the participants (eg older women on weekday mornings). Water temperature is preferably between 28ºC and 31ºC.

6 Therapeutic and rehabilitation programs – tend to be supervised by a physiotherapist. In some instances an individual will perform prescribed exercises for warm water exercise without supervision. The main requirement is warm water (approximately 34ºC) of about 1.5m in depth.

3.4 Strategic Options

Catering for the needs of the six major aquatic markets and to provide aquatic facilities for the residents of Yass Valley Council area, the following options should be considered. It should be noted the options are not mutually exclusive and that both the Yass and Binalong pools should be considered together. However, these options only relate to the Yass Memorial Swimming Pool.

1 Do Nothing

Under this option the pools, along with many other pools in rural NSW, will continue to function without meeting NSW Health Advisory Document turnover rates, although providing water quality which meets recommended standards and meets public expectations. It is not a practical long term option and does not protect community health.

2 Upgrade Yass Memorial Swimming Pool

Under this option the existing outdoor swimming pools would be upgraded to meet standards. Whilst it will meet NSW Health regulations, it will not meet the expectations of all the community, and is not the best solution for a growing and ageing population.

3 Construct an indoor 25m pool at Yass Memorial Swimming Pool

New four lane pool (similar to Cootamundra) to complement an upgraded 50m outdoor pool

4 Construct an indoor 25m pool at Yass Memorial Swimming Pool

New six to eight lane pool to replace the main outdoor pool.

The existing amenities building at Yass Memorial swimming Pool is not adequate to service a new indoor swimming pool. It can be upgraded, but it is not likely to be cost effective when compared with constructing new amenities as part of a major redevelopment.

3.5 Design Brief

The "Cootamundra Option" of demolishing the existing amenities building and replacing with a four lane indoor pool, change rooms, entry and kiosk is not a realistic option. A detailed site survey has not been completed. However there is not adequate land to construct an indoor pool with four lanes (1.8m) and an access ramp (1m) plus concourse between the concourse around the outdoor main pool and the steep slope outside the front of the western existing entry, as it is less than 12m.

Principal options to establish an indoor pool at Yass Memorial Swimming Pool are:

1 Retain the two existing outdoor pools and construct a four lane indoor pool, change rooms, entry and kiosk on either the northern or western side of the existing main pool.

2 Demolish the main pool and construct a six to eight lane indoor swimming pool, possibly incorporating and enclosing the outdoor toddlers pool. This option will enable a complete redesign of the swimming complex, including new change rooms, entry and kiosk.

Following a recommendation from the Indoor Heated Pool Committee, Council at its meeting on 26 April 2017 resolved to:

1 *Note the minutes of the Indoor Heated Swimming Pool Committee meeting held 16 March 2017.*

2 *Receive and note the draft Yass Indoor Heated Swimming Pool Draft Feasibility Report.*

3 *Endorse a Design Brief and detailed costing to be undertaken by the consultant to demolish the current facility and build an indoor 25m x 6 to 8 lane indoor heated pool, which would incorporate a separate hydrotherapy pool and toddler's pool within the facility.*

4 *That the final feasibility report include a basic analysis and costing of incorporation of a splash pad, consultants room and gym into a new facility.*

Overview of Design Brief

- The existing facility will be decommissioned and all structures demolished.
- New buildings and pools will be constructed and be fully accessible.
- Two entry points to be considered:
  - ✓ Existing entry from the southern car park
  - ✓ From Victoria Park to the north

Specifications

- Main pool comprising 25m x 6-8 lanes (6 x 2.5m = 15m), depth ranging from approximately 1.1m to between 1.6m and 1.8m, freefom shape, beach entry area on one long side of the main pool at the shallow end, approximately 100m², ranging from zero depth to 1.1m.
  [The freeform option ensures compliance with disability access, consequently, no need for ramp or hoist. Alternatively a separate toddlers pool of 100m² will require a lane for disabled access in the main pool and disability access into the toddlers pool.]
- Hydrotherapy pool (5m x 6m) incorporating access for people with disabilities to accommodate up to five patients - minimum space required for each patient is 2.5m x 2.25m. A smaller hydrotherapy pool can be constructed to accommodate fewer patients.
- Outdoor splash pad (75m²) (possibly could be smaller ,but can be considered at a later date) with a small number of water play features of varying types eg overhead and ground sprays, tipping buckets, water cannons and fountains. The final size and number of water play features will be dependent upon available capital funding. There are also options for this pad to be indoors or outdoors.
- Concourse area of at least 3m around the pools and between the pools
- Pool to incorporate a wet deck and plant room with separate plant for the main pool and hydrotherapy pool given they will have different water temperatures.
- Concourse are will have some fixed seating along walls around pools.
- Mechanical heating will be required to maintain water temperature to at least 26°C. [Note: Cootamundra uses an evacuated heated solar tube system to heat the water and the floor of the indoor complex.]
- An air handling system to minimise condensation
- The building to be fully insulated to minimise heat loss in winter.
- Amenities building incorporating accessibility provisions and comprising:
  - ✓ Entry and reception including kiosk (20m²), office (10m²), kiosk store (10m²).
  - ✓ Change rooms and toilets approximately 2 x 100m².
  - ✓ First aid room of approximately 8m², with easy access by ambulance.
  - ✓ Social area of approximately 100m² for tables and chairs off main concourse close to kiosk and overlooking pools.
  - ✓ Storage areas for aquatic accessories eg kick boards, floats and noodles (20m²).
  - ✓ Storage space for cleaning and maintenance equipment (10m²).
- Plant room and storage area for pool chemicals, approximately 120m², with external access for delivery of chemicals and supplies.
- Grass area around the aquatic components for spectators and families of approximately 500m².
- 2 x shade shelters to be provided on grass area – either permanent or with retractable sails.
- Car parking and bicycle parking (which may be developed in stages).

Spatial Relationships

- Entrance to the pool should be as close as possible to the car park.
- Reception, kiosk and office in a single location, capable of being staffed by one person. It must be located so that observation of the indoor pools from reception is possible.
- Kiosk to overlook the indoor pools to provide extra supervision, in addition to the duty

lifeguard.

- Shallow end of pool and beach entry (toddlers pool) to be close to the entry and change rooms.
- Health and fitness studio to have both direct external access (24/7 gym) and access through reception.
- Health and fitness studio to have access to toilets and change rooms on 24/7 basis.
- Café style seating area near reception/kiosk and overlooking the pool.
- An outdoor grassed area accessible to the indoor pool.

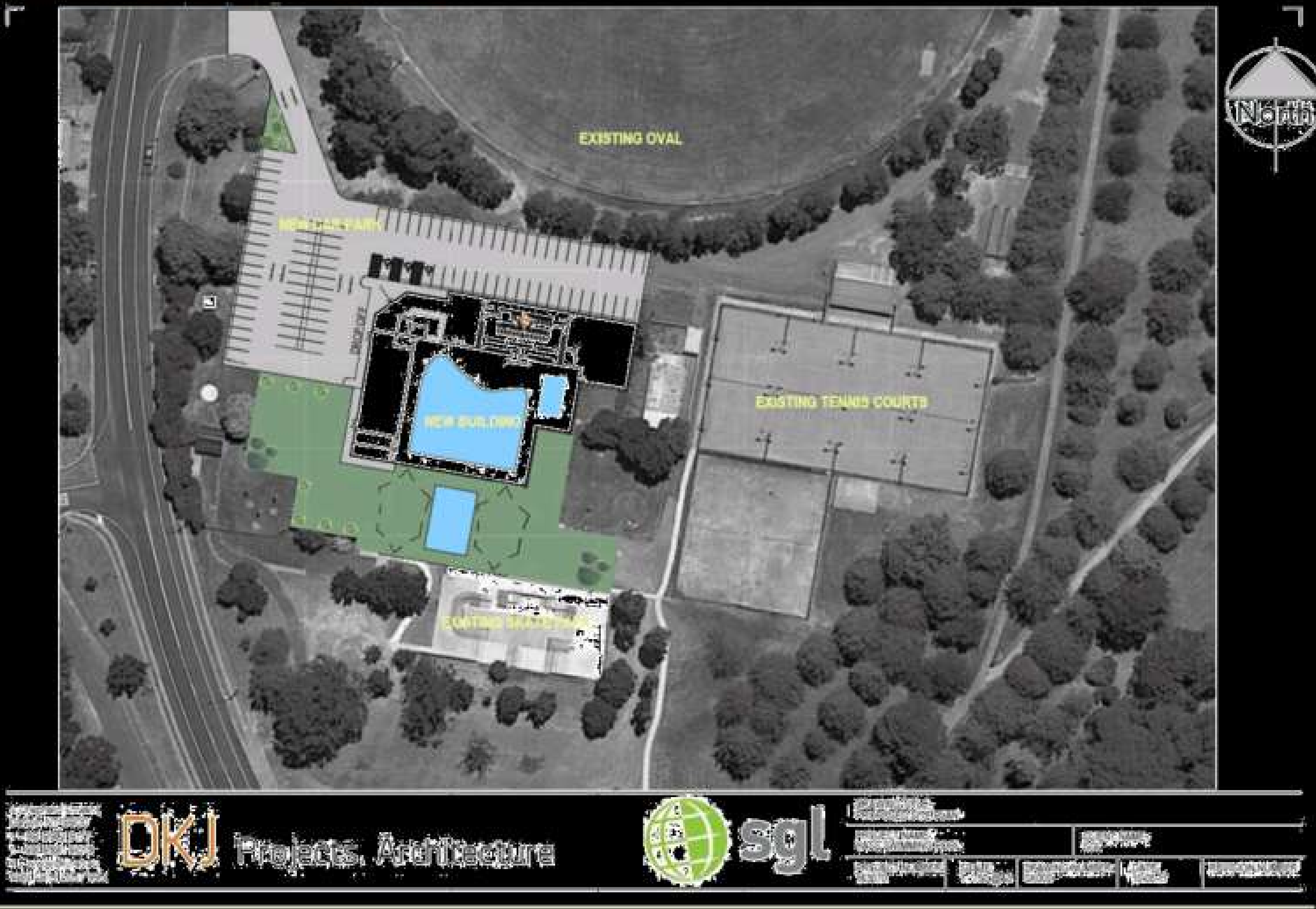
Health and Fitness Studio

- Designed so that it may be constructed as a later stage.
- Gym of approximately 200m² suitable to operate on a 24/7 basis, with direct external access and internal access to toilets, shower and change rooms.
- Consultant room (10m²) – close to both health and fitness studio and hydrotherapy pool.
- Allow room to expand the health and fitness studio (150m²), if membership increases.

3.6 Design Concept

Based on the design brief above a concept plan was prepared (refer to Plan 3.1 and 3.2). This concept plan shows an indicative layout. For example the main pool may be designed with a physical divider between the shallow toddlers pool and the main lap pool, or as separate pools.

Plan 3.1: Proposed Yass Aquatic Centre Site Plan



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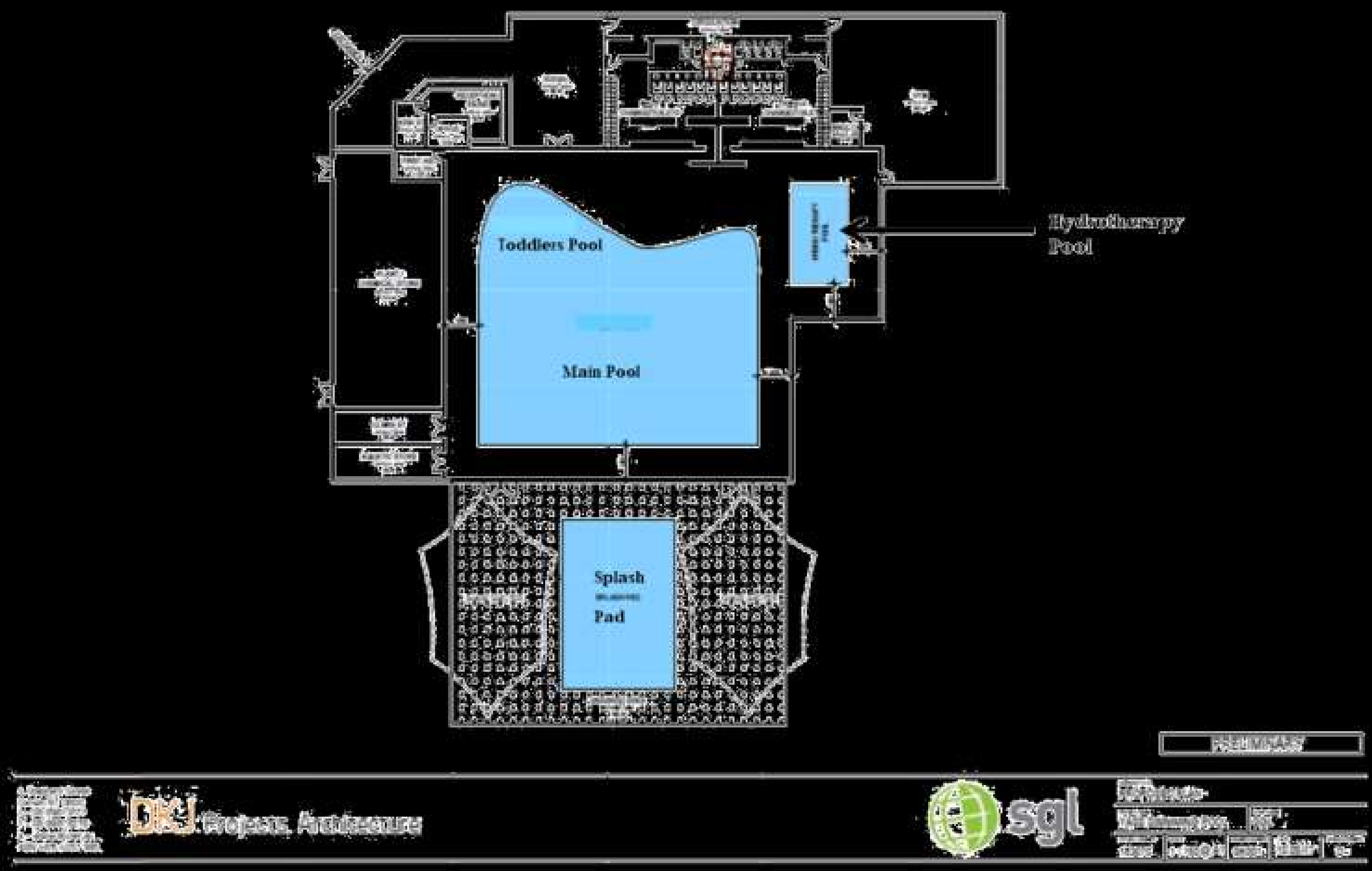
Plan 3.2: Proposed Yass Aquatic Centre Concept Plan



4 FINANCIAL PROJECTIONS

This chapter addresses the capital cost of development, and an operating budget based on detailed income and expenditure assumptions.

4.1 Capital Cost Estimates

4.1.1 Retain and Upgrade Existing Pool

Indicative and preliminary cost estimates are available for some of the proposed works including:

- Upgrading of existing main pool filtration and water treatment plant $540,000 including chemical systems and retaining new main pump
- Reticulation system, including upgrading of floor filtered $150,000 (floor return system)
- Water return system and possible upgrading of wet deck $300,000 (wet deck gutter system)

Total cost is estimated to be in the order of $990,000.

4.1.2 Cootamundra Style Pool to Complement Existing Pool

Construction of an indoor four lane pool (based on Cootamundra costs) are likely to be about $2.6m - $2.8m subject to building cost escalation since 2014.

- Stage 1 – demolish existing buildings and replace with new entry, kiosk, change rooms and first aid room - $1.1m
- Stage 2 – construct indoor 25m x 4 lane pool with access ramp - $1.3m
- Architects fees - $60,000
- Project managed in-house by Council
- Pool built under a design and construct approach
- Design features include wet deck, concrete pool, evacuated heated solar tubes for water and floor heating, steel frame building with sandwich panels, colour bond on end walls

Based on these cost estimates, the cost to construct a "Cootamundra style" indoor pool and retain the upgraded outdoor pools is in the order of at least $3.8m based on 2014 costs. Based on the Rider Levett Bucknall Tender Price Index for Canberra, costs have escalated by 4.6% between 2014 and 2016. Hence the 2017 cost of a Cootamundra Style pool will be at least $4.0m.

4.1.3 New Indoor Facility (as per Council Resolution)

Quantity surveyor capital cost estimates were prepared for the development concept to meet Council's resolution and described in section 3.5 and 3.6. Table 4.1 summarises the order of cost estimates for the separate components of the redevelopment and detailed cost estimates and specifications are included in Appendix B. The estimates include a series of allowances:

Builder's Preliminaries and Supervision	10%
Builder's Margin and Overheads	5%
Locality Loading	10%
Design Development Contingency	5%
Construction Contingency	5%
Professional Fees	9%
Allowance for Statutory Fees and Charges	0.5%

Items excluded from the cost estimates are:

- Stand-by power generator
- Termite protection
- Stormwater storage tanks
- Work outside site boundaries
- Loose, soft and hard furnishings
- Vertical blinds, curtains or other window treatments
- Tenant fitout
- Relocation and upgrade of existing services
- Contaminated ground removal and reinstatement
- Asbestos and hazardous materials removal
- Rock excavation
- De-watering
- Staging / phasing costs
- Land costs
- Legal fees
- Goods and Services Taxation

The total estimated cost of the total redevelopment of Yass Memorial Swimming Pool based on the Design Brief in section 3.5 and the concept plans shown in Plans 3.1 and 3.2 is $11.40M.

Important points to note are:

- Included within the Design Brief Specification cost estimates, are substantial on costs for various allowances, totalling $4,252,288.
- The total cost of demolition works and the indoor pool alone, excluding allowances is $6,132,190.
- Some elements may be staged, such as the car parking, health and fitness studio, splash pad and hydrotherapy pool. When these capital development costs are excluded, the total cost reduces to $10,187,499.

Table 4.1: Capital Cost Estimates

Works	Design Brief Specification	Indoor Pool Facility Only
Demolition Works	$296,480	$296,480
Indoor Pool Hall	$9,236,812	$9,236,812
Gym And Consulting Room	$180,713	Not included
Hydrotherapy Pool	$690,492	Not included
Outdoor Splash Pad	$345,246	Not included
Carparking & Paths	$442,265	$442,265
Landscaping & Improvements	$211,942	$211,942
Estimated Net Cost	**$11,403,949**	**$10,187,499**

4.2 Grants and Subsidies

Potential grants from State and Federal Governments were investigated. It was found that because of the uncertainty as to when a redevelopment of the Yass pool will occur it is not possible to give a definitive estimate of potential grant funds. Grants from both levels of government are subject to change due to changes in government and budgetary considerations. Consequently, policy changes seem to occur regularly. Summarised below are grant programs which have finished but give an indication of future grant programs.

National Stronger Regions Fund

National Stronger Regions Fund (NSRF) provided funds of up to 20% - 30% of the costs of major infrastructure such as aquatic wellness facilities. This program has now finished.

Building Better Regions Fund

This program provides funding for infrastructure and community investment projects that will create jobs, drive economic growth and build stronger regional communities into the future. The Infrastructure Projects Stream closed on 28 February 2017.

The Infrastructure Projects Stream supported projects which involved the construction of new infrastructure, or the upgrade or extension of existing infrastructure that provide economic and social benefits to regional and remote areas.

The minimum grant amount is $20,000 and the maximum grant amount is $10 million. The project must be completed by 31 December 2019.

Stronger Country Communities Grant

The Stronger Country Communities Fund is investing in infrastructure projects in regional NSW communities to improve the lives of residents and enhance the attractiveness of these areas as vibrant places to live and work.

The NSW Government has committed $200 million over the next two years for applications to support local infrastructure projects that will improve amenity and help sustain the social bonds at the heart of strong regional communities such as:

- building new community facilities (such as parks, playgrounds, walking and cycle pathways)
- refurbishing existing local facilities (such as community centres and libraries)
- enhancing local parks and the supporting facilities (such as kitchens and toilet blocks).

Each rural and regional local government area will receive a base allocation with additional funding calculated in accordance with population size and a loading that accounts for variation in costs of construction across NSW.

The Stronger Country Communities Fund is seeking projects of at least $100,000, but typically in the range of $250,000 to $1 million. Where there is a significant financial co-contribution, larger projects (above $1 million) will be considered.

NSW Sport and Recreation Grants

An range of grants are available from NSW Sport and Recreation. In addition, one-off grant schemes are available from time to time.

4.3 Operating Costs

A projected operating budget for the indoor aquatic centre as described in the Design Brief in section 3.5 has been developed. This option has been compared with retention of the existing outdoor pool and construction of a new indoor 25m pool. The projected operating costs do not include income or expenditure related to the health and fitness studio.

4.3.1 Assumptions

A series of assumptions have been used to project an operating budget.

Income Assumptions

Income has been projected using a series of assumptions:

1 Entry prices are increased by 150% on the 2016/17 prices:

Casual Entry	
Adults	$6.00
Children	$4.50
Aged Pensioners	$4.50
Pre School children	$1.00
Spectators	$1.00
School groups per student	$2.00
Season Tickets	
Extra card holder	$0.00
Family	$300.00
Adults	$195.00
Children	$150.00
Aged Pensioners	$150.00
Pensioner Family	$225.00

2 Total annual attendances of 45,000, based on minimum demand estimate and including 2,000 school swims, based on current use.

3 Membership attendances are 47% of non program entries (ie excluding swim lessons, school swimming and aqua) and casual attendances are 53% of non program entries.

4 Membership income and attendances are based on:

Average price of memberships	$242.55
2015/16 swims per membership	44
Increase in swims per membership (1)	150%
Swims per membership	65
Memberships(2)	292

(1) Based on year round facilities being available
(2) Based on 19,060 membership attendances and 65 swims per membership

5 Casual attendances percentages are based on 2015/16 actual attendances adjusted to reflect trends in use of indoor swimming pools.

Adult	35%
Child	35%
Pensioner	10%
Preschool children	10%
Spectators	10%

6 School swimming attendances are based on information provided by schools:

Number of schools	4
Children per school	100

Lessons per annum	5

7 Swim school attendances are based on:

Number of children per annum(3)	450
Price per block of 5 lessons	$70.00
Lessons per child	5

(3) Based on a 100% increase on current swim school participation

8 Attendances and revenues from aqua classes are based on:

Number of participants per class	10
Lessons per week	2
Weeks per annum	40
Price (excluding entry)	$3.00

9 Kiosk revenue and cost of goods sold is based on 2015/16 sales per admission ($1.28) and profit on cost of goods sold (20%).

Expenditure Assumptions

Expenditure has been projected using a series of assumptions:

1 Indoor pool is open 52 weeks per annum and outdoor pool is open 21 weeks per annum (same as 2015/16)

2 Opening hours are:

Indoor Pool	**Open**	**Close**
Monday - Friday	6.00	19.00
Saturday	9.00	17.00
Sunday	9.00	17.00

Outdoor Pool	**Open**	**Close**
Monday - Friday	11.00	19.00
Saturday	12.30	17.00
Sunday	12.30	17.00

3 Staffing costs are based on:

Manager employed full time on salary of $60,000 and required to work 25 hours per week on pool deck or reception.

Lifeguard on duty at all hours the pools are open – one in the indoor pool and one in the outdoor pool (if retained). During the summer months an extra lifeguard is employed for 3 hours on 20 days when attendances increase due to hot weather.

A customer service officer, with lifeguard qualifications, is employed at all hours the swimming centre is open.

All lifeguards and customer service officers are employed on a casual basis at $26.00 per hour with penalties of 1.5x and 2.0x paid on Saturday and Sunday.

Staffing on costs are charged at 20%

4 Swimming lesson costs are based on instructor pay rate of $26.00 per hour, and one hour lessons

5 Aqua staffing costs are based on $26.00 per hour and one hour classes

6 The 2015/16 costs have been applied to the outdoor pools in Year 1 of a redeveloped

complex (with some rounding of amounts)

7 Expenditure costs for the indoor pool are based on similar facilities except that Maintenance and Utilities costs use the CERM averages for this size complex on a m^2 basis - $45.00 and $81.14, respectively.

8 The size of the 4 lane pool is 700m^2 and an 8 lane pool is 1400m^2.

9 No allowance is made for depreciation, management supervision and payroll and accounting which are actual costs associated with managing the facility.

4.3.2 Budget Projections

Table 4.2 summarises the projected operating budget based on the assumptions above, compared with 2015/16 costs. The three columns summarise:

- Actual operating costs for the Yass Memorial Swimming Pool in the 2015/16 season.
- Projected operating budget if a four lane indoor pool is constructed and the existing outdoor pools are retained.
- Demolition of the existing facilities and construction of a new indoor 6 – 8 lane pool with free form toddlers area.

Based on the assumptions above, the operating loss is projected to increase to $394,905 if an indoor 4 lane pool is constructed in addition to the existing facilities and to $392,577 if the existing facilities are replaced with a 6 – 8 lane indoor pool.

No allowance has been made for the operating income and expenditure of a health and fitness studio and consulting room. These spaces can be leased to a commercial tenant at market rates. It is anticipated that a splash pad will generate additional revenues through increased attendances by families with young children. The additional operating costs will be minimal and no extra supervision costs will be needed.

Table 4.2: Operating Budget for Year 1

	2015/16	Existing Pools + 4 lane 25m Pool	6-8 Lane x 25 m Pool
Income			
Casual swimmers	$44,108		
Adult		$40,770	$40,770
Adult concession		$8,736	$8,736
Child		$30,578	$30,578
Preschool children		$1,941	$1,941
Spectators		$1,941	$1,941
Memberships	$39,940	$69,065	$69,065
Sub Total	**$84,048**	**$153,032**	**$153,032**
Lane hire	$1,064		
Swim school		$31,500	$31,500
Aqua		$2,400	$2,400
School swim		$3,636	$3,636
Miscellaneous	$1,462		
Sub Total	**$2,526**	**$37,536**	**$37,536**
Kiosk sales	$29,601	$57,657	$57,657
COGS	$23,647	$46,060	$46,060
Kiosk gross profit	**$5,954**	**$11,597**	**$11,597**
TOTAL INCOME	**$92,528**	**$202,165**	**$202,165**

	2015/16	Existing Pools + 4 lane 25m Pool	6-8 Lane x 25 m Pool
Expenditure			
Staffing			
Manager		$60,000	$60,000
CSO/Kiosk		$117,624	$117,624
Lifeguard - pool	$111,028	$113,891	$84,994
Learn to Swim Instructors	$9,950	$14,625	$14,625
Cleaning			
Staffing sub total		$307,310	$278,413
Staffing on costs		$61,462	$55,683
Total staffing costs	**$120,978**	$368,772	$334,096
General Expenses			
Maintenance	$30,245	$61,750	$63,000
Pool chemicals	$12,070	$37,100	$43,750
Security		$1,500	$1,500
Utilities	$18,133	$74,948	$99,397
Tele communications	$801	$1,000	$1,000
Insurance	$2,078	$5,000	$5,000
Advertising		$5,000	$5,000
Legal and accounting		$2,500	$2,500
General administration	$33	$10,000	$10,000
Bank charges		$5,000	$5,000
Program Expenses		$2,500	$2,500
Travel costs		$0	$0
Training		$5,000	$5,000
Staff Uniforms		$2,000	$2,000
Depreciation		$0	$0
Management supervision		$0	$0
Payroll and accounting		$0	$0
Miscellaneous	-$4,056	$15,000	$15,000
Total general costs	**$59,304**	$228,298	$260,647
TOTAL EXPENDITURE	**$180,281**	$597,070	$577,192
PROFIT/LOSS	**-$87,753**	**-$394,905**	**-$392,577**

4.4 Scenario Analysis

To test how robust the operating budget is, and the impact of different operating conditions a scenario analysis was conducted.

4.4.1 Increasing Attendances

The impact of increasing attendances on the operating loss is:

Attendance	2015/16	Existing Pools + 4 lane 25m Pool	6-8 Lane x 25 m Pool
23,100	-$87,753		
45,000		-$394,905	-$392,577
49,500		-$376,508	-$374,180
54,000		-$358,111	-$355,783
67,500		-$302,919	-$300,591

If attendances increase to 67,500 per annum, the operating loss will decrease to $302,919 if a four lane indoor pool is constructed and the existing outdoor pools are retained and $300,591 for a new 6-8 lane indoor pool and demolition of the existing pools.

4.4.2 Reduced Operating Hours

An option is to reduce the operating hours during winter and summer. The scenario modelled is based on the following opening hours for the proposed indoor pool and demolition of the outdoor facilities:

Summer (31 weeks)	Open	Close
Monday – Friday	6.00	7.30
Monday – Friday	12.00	14.00
Monday – Friday	16.00	19.00
Saturday	10.00	17.00
Sunday	10.00	17.00
Winter (21 weeks)	**Open**	**Close**
Monday – Friday	11.00	19.00
Saturday	12.30	17.00
Sunday	12.30	17.00

Under this scenario the operating loss for the indoor swimming centre is $278,198.

4.4.3 Increased Entry Fees

If entry fees are increased the impact on the operating loss is:

Increase	Adult Entry	Existing Pools + 4 lane 25m Pool	6-8 Lane x 25 m Pool
Base	$6.00	-$394,905	-$392,577
5%	$6.30	-$390,525	-$388,197
10%	$6.60	-$386,145	-$383,817
20%	$7.20	-$377,385	-$375,057
25%	$7.50	-$373,004	-$370,676

This scenario indicates a small reduction in the operating loss if entry fees are increased. A 25% increase in fees across all entry categories will have a $21,901 positive impact, reducing the loss to $370,676 for the indoor pool option.

4.4.4 Combination of Scenarios

The financial impact of a combination of scenarios was tested. If total attendances increased to 67,500, entry fees increased by 25% ($7.50 for single adult entry), and opening hours reduced as above the projected operating loss will be reduced to:

Existing Pools + 4 lane 25m Pool Option	$160,959
6-8 Lane x 25 m Pool Option	$152,488

4.5 Summary

Key points to note based on the financial projections are:

1 The cost of a "Cootamundra style " 4 lane x 25m indoor pool will be at least $4m.

2 Estimated capital development cost of an indoor 6 - 8 lane, 25m indoor pool in accord with Council's resolution in April 2017 is $11.40m. These estimates include on-costs of approximately $4.25m.

3 The development would be staged over a number of years, such as the car parking,

health and fitness studio, splash pad and hydrotherapy pool. When these capital development costs are excluded, the total cost reduces to $10,187,499.

4 The operating loss is projected to be $394,905 if an indoor 4 lane pool is constructed in addition to the existing facilities and to $392,577 if the existing facilities are replaced with a 6 – 8 lane indoor pool.

5 A range of scenarios have been modelled. Based on a reduction in the operating hours combined with attendances of 67,500 and 25% increase of adult entry fees above the base model, will result in a loss of $152,488 for an indoor 6 – 8 lane, 25m pool.

APPENDIX A: E-SURVEY RESULTS

A web based and paper based questionnaire was prepared and made available to the Yass Valley Community for self-completion.

Respondent Sample

502 people completed the questionnaire. The demographic profile of respondents is summarised below. The sample is clearly gender biased, with over three quarters of the sample being female. 77% of the respondents were from Yass District.

Characteristic	%	Female	Male
Age			
< 17 years	2%	2%	2%
17 - 25 years	7%	6%	9%
26 – 30 years	7%	8%	7%
31 – 35 years	14%	14%	15%
36 – 40 years	18%	18%	17%
41 – 45 years	13%	14%	12%
46 – 50 years	9%	9%	9%
51 – 60 years	15%	14%	18%
61 + years	15%	16%	13%
	100%	**77%**	**23%**

Suburb	%
Yass district	77%
Murrumbateman district	11%
Bowning district	4%
Binalong district	2%
Elsewhere	2%
Gundaroo district	1%
Sutton district	1%
Wee Jasper district	1%
Bookham district	1%

Swimming Centres Visited

Respondents were asked if they had visited a swimming pool within the last 12 months and if so which pool had they used. It was found that:

- 67% of respondents had visited a swimming pool.
- Over half of the respondents (54%) had visited the Yass memorial Swimming Pool within the last 12 months and 10% had visited the Binalong pool.
- 31% had travelled to an indoor pool in Canberra.

Swimming Pool	%
Yass Memorial Swimming Pool	54%
Indoor pool in Canberra	31%
Binalong Memorial Swimming Pool	10%
Indoor pool in the local region	5%

The most commonly used pools in Canberra were:

- Gungahlin Leisure Centre
- Canberra International Sports and Aquatic Centre (CISAC) and
- Australian Institute of Sport (AIS).

Frequency of Visits

Respondents were asked how often they had visited a swimming pool during the last 12 months. Not surprisingly a significant majority of respondents use the pool mainly in summer. 37% had been more than three times a week during the summer compared with 6% who visited a pool more than three times a week all year round.

Frequency of visits	%
More than three times a week in summer	37%
Once a week in summer	19%
More than once a month, but less than once per week in summer	10%
Once a week all year	10%
More than once a month, but less than once per week all year	7%
Less than once a month all year	6%
More than three times a week all year	6%
Less than once a month in summer	3%
Once in summer	1%
Once all year	1%

Activities Undertaken

Respondents were then asked what activities they participated in on their last visit to a pool. The most popular activity was found to be recreational swimming with family and/or friends.

Activity	%
Recreational swimming with family	30%
Lap swimming	20%
Recreational swimming with friends	15%
Learn to swim lessons (as a parent/caregiver)	13%
Spectator	8%
Competition swimming	4%
Hydrotherapy or rehabilitation	4%
Aqua aerobics	3%
Aqua fitness activity (eg water walking)	3%
Learn to swim lessons (as a participant)	1%

'Other' activities included: -

- Movie Night
- Squad Swimming

- Children's Birthday Parties

When asked to nominate the main activity, the most popular three activities were recreational swimming with family (37%), lap swimming (25%) and learn to swim lessons (15%).

Main Activity	%
Recreational swimming with family	37%
Lap swimming	26%
Learn to swim lessons (as a parent/caregiver)	15%
Recreational swimming with friends	8%
Aqua fitness activity (eg water walking)	3%
Competition swimming	3%
Hydrotherapy or rehabilitation	3%
Spectator	3%
Aqua aerobics	2%
Learn to swim lessons (as a participant)	0%
Other (specify)	0%

Time of Visits

Respondents that had visited Yass Outdoor Swimming Pool within the last 12 months were asked when they mostly used the pool. Swimming during the afternoon and evening is the most popular time, compared with early morning swimming.

	6am - 7.30am	3pm - 4pm	4pm - 5pm	5pm - 6pm
Monday	17%	26%	25%	32%
Tuesday	11%	26%	25%	38%
Wednesday	17%	25%	27%	31%
Thursday	10%	24%	27%	39%
Friday	14%	24%	26%	35%
Saturday	1%	53%	28%	19%
Sunday	1%	54%	27%	18%
Total	**10%**	**34%**	**26%**	**29%**

The respondents were asked if an indoor pool was to be built in the Yass Valley area, when would they mainly use it. The results reinforced the popularity of the afternoon (2.30pm to 5pm)and evening(5.30pm to 7.30pm). Significantly, it also showed substantial demand for early (6am to 8am)and mid morning (8.30am to noon)swimming sessions. Only limited swimmers indicated they will swim during the early afternoon (12.30pm to 2pm) period.

	Early morning	Mid morning	Early afternoon	Mid afternoon	Evening
Monday	25%	25%	5%	19%	26%
Tuesday	20%	21%	6%	24%	28%
Wednesday	22%	25%	6%	20%	27%
Thursday	19%	20%	6%	25%	30%
Friday	21%	23%	6%	21%	28%
Saturday	10%	28%	15%	36%	12%
Sunday	10%	27%	15%	36%	12%
Total	**18%**	**24%**	**8%**	**26%**	**24%**

Satisfaction with Yass Pool

Respondents were asked to rate their satisfaction on a scale of 1 to 5 (5 = very satisfied and 1=very dissatisfied, 0 = Don't know) on a number of aspects at the Yass Memorial Swimming Pool. Overall, the pool received a reasonable satisfaction rating, with all features receiving a positive satisfaction rating (ie >2.5). Water quality and pricing received the highest satisfaction rating.

Feature	Satisfaction
Water quality	3.78
Cost of daily entry	3.40
Cost of season tickets	3.34
Kiosk	3.09
Aquatic programs	2.94
Water temperature	2.68
Change rooms and amenities	2.52

Upgrade Options

Respondents were offered a number of options that maybe available to upgrade swimming facilities in Yass. They were asked to place them in priority order (1 = highest priority and 6 = lowest priority). The top two upgrade options were:

- Add an indoor swimming pool to existing Yass Memorial Swimming Pool
- Upgrade existing outdoor pools at Yass Memorial Swimming Pool

The points score indicated these two options were clearly favoured more highly than the other options. Significantly, the "Do Nothing" option was the least favoured, by a substantial score.

Upgrade Options	Ranking	Score
Add an indoor swimming pool to existing Yass Memorial Swimming Pool	1	2,457
Upgrade existing outdoor pools at Yass Memorial Swimming Pool	2	2,049
Upgrade existing amenities at Yass Memorial Swimming Pool	3	1,866
Demolish existing Yass Memorial Swimming Pool and construct an indoor pool	4	1,660
Retain, and do nothing to existing Yass Memorial Swimming Pool and build an indoor pool elsewhere	5	1,595
Do nothing	6	915

Other commenta made by respondents as possible options for upgrade within the Yass Valley Community were: -

- Build a 50m indoor pool (possibly at Murrumbateman)
- Construct an indoor pool, with a gym, cafe and sports halls
- Have a dedicated Hydrotherapy pool within the Yass Valley area
- Heat the outdoor pool

Respondents were then asked if an indoor swimming pool was constructed in Yass what priority would they give to a number of options (1 = highest priority and 6 = lowest priority). The priority is clearly for a lap and teaching pool with hydrotherapy water.

Options	Ranking	Score
25m lap pool	1	2,313
Teaching pool	2	1,982
Hydrotherapy/rehabilitation pool	3	1,980
Leisure pool with aquatic play features	4	1,755
Toddlers pool	5	1,465
Splash pad with play features	6	1,047

The respondents were asked if their highest priority option was constructed, how often would they use it. The results indicate demand for year round swimming, for example 30% said they would use the facility more than 3 times a week all year round.

Frequency of use	%
More than three times a week all year	30%
Once a week all year	18%
Less than once a month all year	14%
More than once a month, but less than once per week all year	4%
More than three times a week in summer	24%
Once a week in summer	6%
More than once a month, but less than once per week in summer	4%
Less than once a month in summer	<1%

If the respondents highest priority option was constructed, they were asked how much would they be willing to pay for one visit, given the current entry price at Yass is $4 and at Gungahlin Leisure Centre is $6 for an adult, with discounts for children, concessions and multi pass. Respondents seemed to appreciate that an indoor pool will have an increased entry price, for example 35% were willing to pay up to $6 for one visit.

Admission costs	%
No more than $6	35%
No more than $5	25%
$4	20%
No more than $8	11%
No more than $7	9%

Respondents were then asked to indicate their level of support for developing their priority option using the following scale (5 = high level of support and 1 = do not support, 0 = Don't know). Reasonably high levels of support were given to:

- Adult entry price $6
- Development cost up to $5M
- Annual rate increase to cover capital and operating costs of $25

Option	Level of Support
Adult entry price $6	3.64
Adult entry price $8	2.45
Adult entry price more than $8	1.85
Development cost up to $5M	3.62
Development cost $5M to $10M	3.38
Annual rate increase to cover capital and operating costs of $25	3.20

Option	Level of Support
Annual rate increase to cover capital and operating costs of $50	2.63
Annual rate increase to cover capital and operating costs of $75	2.09
Annual rate increase to cover capital and operating costs of $100	1.81

General Comments

Respondents were offered the opportunity to make any comments regarding swimming facilities in Yass Valley (refer Appendix B for details of all comments). The most common comments were:

- No more rate increases
- Use the money to invest in the road network/infrastructure
- Keep the existing outdoor pool and make upgrades – change rooms/ bathrooms / additional shade / extend the opening hours
- Heated pool/hydrotherapy pool
- Build a sporting complex at Murrumbateman incorporating indoor pool, health and fitness suite and sports halls.

Additional Responses

Do you have any other upgrade options that you feel would benefit Yass Valley?
50m lap pool
50mtr pool
A heated indoor pool for year round use
Add a gym to the indoor swimming pool
An indoor pool, with a gym and a basketball volleyball court
better facilities at the pool for the younger swimmers and teenagers
Build a completely new sporting facility with pool, cafe, gym, b/ball stadium
Build an all year pool in Murrumbateman or Gundaroo, and upgrade existing Yass pool amenities
build an indoor pool in m'bateman
Build an indoor pool with health and fitness facility. Speak with sonic fitness owner about moving his gym into there, he would be happy to run his fitness facility along side or as a part of the council indoor pool.
Build it in Murrumbateman
Build the indoor pool in Murrumbateman.
Change rooms
Do the same as Junee pool
Fewer people would have to travel to Canberra for physical therapy
free zumba classes; free exercise classes; free bike riding around track with obstacles
Grade my dirt road more often would be a lot more useful
Half indoor half outdoor heated pool like wagga. Young heated their pool 2 or 3 seasons ago. Incredible. MAKE the hours open from 6am til 6 or 7pm & people will buy season tickets.
Heated pool that can be used 12 months of the year
Hydro therapy pool
Hydrotherapy
I live 45 from Yass there are closer options for me. Fix the roads around Sutton and Gundaroo as a priority.
I think an indoor pool would encourage swimming lessons for children all year round, especially if a swim school company was involved.
I work at Yass hospital and think a hydrotherapy pool would be of great benefit to the community
Improve other forms of infrastructure across the shire and provide all tax payers with better amenities - not just Yass
Incorporate it in a club instead of having the ratepayers fork out for it
Indoor sports centre
It would be great to see fun play equipment in the little pool, such a water fountains like Bathurst pool has.
Keep existing pool but make it heated
Keep outdoor pool
Keep the out door pools but add a few improvements and make them more activity focused - water slide/ water adventure equipment. Build an indoor pool inside the existing complex that can be used for hydrotherapy (hotter than normal temps) and winter lap swimming/ lessons. No need to double up staff requirements
Lights at Joe O'Connor oval
Make it a sporting complex with gym, squash courts and then one membership can access all
Not everybody lives in Yass, how about building it at Gundaroo??
Open the existing pool later so people can use it after work!
Please make the pool 50m long
Primary school in Murrumbateman
The roads, the mains street, & investing in attracting business.
The town needs services like a heated pool so people can provide their children with essential

Do you have any other upgrade options that you feel would benefit Yass Valley?
swimming lessons or undertake rehabilitation without driving to Canberra. Yass needs an upgraded service.
Think of people living out of YASS. There are villages you can provide facilities for. Think of equity council
Turn into an aquatic centre
Upgrade Binalong Pool
Upgrade existing amenities at Yass pool AND build an indoor pool
Water park
We need an indoor pool in addition to an out door pool but if this is not possible perhaps a dome for existing pool that closes in Winter so current pool can be used all year round.
Yass needs a hydrotherapy pool that includes being easy accessed for the countless Yass residents that are wheelchair bound or unable to access the pool now after surgery etc. My daughter will also benefit greatly from a heated pool to help stretch and strengthen her muscles after being diagnosed with cerebral palsy this earlier year!!
Yes, don't waste ratepayers money on stupid surveys
Spend the money on roads instead of a pool
Upgrade further amenities to include an indoor infrared spa /jacuzzi and indoor sauna
Heated pool for use during every other season other than summer.
Current pool requires flat deck upgrade.
Convert Binalong pool to heated pool and Yass residents travel to Binalong.
Heated pool
A splash park. More shade
Construct indoor heated pool in Murrumbateman
Sauna
Upgrading the kiosk and amenities at the Yass memorial pool, and built an indoor pool at Murrumbateman.
Slides and activities for kids
Spend some money on the roads!!!!!!!
12 month pool opening
Indoor pool in Murrumbateman
Build a new heated pool in Murrumbateman
add flat deck to current pool
Heat the pool we have now in winter only
Pneumatic Structure might be viable so you could cover in winter and take down in summer.
Don't do it, how about putting the money towards something else
Not all ratepayers are swimmers
Convert existing outdoor pool to an indoor one, much like the pool at Junee
Sell to private investor to manage as a business
Better street lighting, especially North Yass. It's not safe.
Build in Murrumbateman where there are no facilities for their ever growing population
Don't do it and save the ratepayers some money
Let them drive to Canberra like most Yass Valley residents do anyway
Improved outdoor area and tables and shaded areas around pool to encourage families
Build and indoor pool and a themed outdoor splash pad as an amenity for both residents and tourists thereby increasing the potential customers and income. Cafe could be included which has access for both sides (internal and external so it can cater for customers beyond the opening times of pool. Alternatively build a health complex with consulting rooms for associated medical businesses such as physiotherapist and gym. Once again sharing the retail footprint to receive income to help offset running costs. The pool should also for part of a renewable energy project with income/energy streams from wind farms we are forced to have and competitive solar initiatives as starting suggestions.

Do you have any other upgrade options that you feel would benefit Yass Valley?
Do something for the villages instead
Spend the money elsewhere, not everybody is a swimmer
Let private interests put up the money for it
Put a bus on to ferry people to Canberra pools. It would be much cheaper.
Stop wasting ratepayers money on stupid ideas
Library upgrade
Def heated for injury recovery
Library
Put solar heating to existing pool like Gundagai
Sun cover over playgrounds

Other comments
A profoundly low level priority in the bigger scheme of things the council should invest in - if it had the funds to do so without further revenue increases.
Again Yass Council looking after Yass, pathetic
An indoor pool should not be built. There are many other needs in the Yass valley that should be addressed and getting an indoor pool is not one of them. If you want to upgrade stuff, the change room and bathroom should be updated and made more comfortable. A shade cloth and various other undercover things should be put up around and over the outdoor pool.
An indoor pool would be a drain on public finances
Another rate increase on top of the 50% currently happening to fix the financial miss management of this council is out of the question. I don' even get my road graded for $12 K. NO NO NO. Yass town pays if they want not everyone.
Another thing that services the town of Yass and not the shire. The shire is so big little old Gundaroo has to settle for a few new street trees and a new path and very badly maintained roads in and out of the town. Pools are not our priority.
As someone with a disability I can only access hydrotherapy in Canberra. I need regular hydrotherapy access (3 times per week) and at the moment I can only access it in Canberra once a week which is not suitable for my level of physical disability.
As the mother of a baby an indoor heated pool would be such a wonderful thing for us. We wouldn't have to travel to Canberra to go swimming. I think it would be amazing to be able to support a local business and have more local jobs
Build it in Murrumbateman
Building an indoor or heated pool is a complete waste of money that would continue to be a drain on all YVC ratepayers for many years to come.
Canberra is way more expensive that Yass. But facilities are superior.
Children are able to learn to swim faster and more proficiently with access to year round swimming and swimming lessons. Swimming is also a great gentle exercise for the elderly, pregnant and people with injuries or asthma. Year round local access to this would be wonderful.
Children in Yass are very disadvantaged at present as they are unable to undergo year round swimming lessons or have access to a pool in order to practice skills learnt at lessons. I find my kids are having to re-learn the same skills each year due it being so long since they swam last at the beginning of summer.
Consider a natural swimming pool for a chlorine-free environment and much lower maintenance costs. Most public swimming pools in Germany are natural ponds that are artificially created and can be heated as well.
Desperately need somewhere for kids to learn to swim. Too high risk not too. Demand too high to get home private lessons
Do it properly. Will only get one chance. Should incorporate adjoining gym etc. Make sure change rooms are large like Gungahlin, the change rooms at new pool at Moss Vale are a disaster,
Don't put my rates up to pay fo a pool I don't want or need
Good survey, finally people who realise it's cost can get their view
Having an indoor facility may encourage more children to learn to swim, a very important life skill.

Other comments
Heated pool after a car accident would have been really good for my recovery as wasn't feasible going to Canberra with pain during travel.
How will you justify rate increase after raising it by 8% per year already.
I am looking forward to using the existing pool this year as we have just moved to Yass
I am moving to Yass. I have a hip condition, which doesn't go well in cold water. I would travel to Canberra several times a week to use a heated pool. If Yass had a heated pool, I would swim every morning as part of my long term physio treatment.
I believe a heated pool would vastly benefit the majority of the community. I think it would also be very important to include a hydrotherapy pool for those who need it. Both of these would benefit the community
I believe creating enough space for a fitness facility to attach to the indoor pool facility would assist in revenue for the pool in the form of rent. Creates your one stop health and fitness facility, encouraging an active and healthy community. Having the council and a health and fitness facility working together can only be a good thing for the community.
I cannot support an upgrade to this pool when it is too far away for us to use and the roads and public infrastructure where I live are falling apart and is ignored by Yass Council. Rates should NOT be increased to cover the costs as council does not even provide my district garbage collection or mobile phone coverage.
I cannot wait for a heated pool to allow for year round exercise and children's lesson. ; ; It will provide employment opportunities for instructors and keep money within the local area. ; ; Such huge benefits from rehab perspective as well. Bring it on!!
I can't afford any more increase to my rates. If an indoor pool means another increase I don't want it.
I do not believe that Yass community has the need for a huge facility to be built in Yass. Many people don't use the facility that we have at the moment. People may use the new facility at first but will loose interest after time. We are 30 mins from Canberra, spending millions of $ seems silly. Many people don't have the money for rates to go up. It seems to be that people in Yass want want want but never support the change once it has been implemented. I think something should be built at the current pool so that everything is contained in the one area. ; ; I think people need to understand that the pool cost does not just involve building it. It involves the running cost including chemicals. This cost will be ongoing and will place a huge debt on the town.
I don't believe that either heating the existing pool or constructing a new heated pool represents a wise use of ratepayers money, especially given a number of villages in the Yass Valley are generally within a commuting direction to Canberra, rather than Yass.
I feel this is an extremely important project heading into our towns future, and its growth keeping up with the needs and wants of next generations of all ages
I have Primary school aged children & strongly believe their ability to swim would increase so much if Yass had a heated pool. Being a family of four we would use a heated pool all year round frequently likely to be at least weekly for swim school, leisure as a family as well as adult swimming for health. ; The existing Yass pool is fantastic during summer & a social meeting point for friends. Given its history I'd like it to remain.
I hope our yearly rates won't go up if the indoor pool goes ahead, as the rates are too expensive now. I'm not for the indoor pool if our rates rise.
I just brought a house and don't want anymore rate rises. A heated pool would just be a drain on all ratepayers
I pay enough rates.
I pay roughly $20 per child each week at Kingswim. Cost is not the issue, the distance to Canberra is. I would happily pay a lot more money to council for a proper indoor year round facility.
I think a heated pool with options for hydrotherapy and swimming would be great for the community and save people driving to Canberra.
I think it would be a better idea to build the indoor pool in Murrumbateman rather than Yass. I think it would increase your market, and it would further the community outreach.
I would go more often to a heated pool if it was open later so that I could go after kids are in bed
I would love to be able to use a heated pool almost daily as I have significant musculoskeletal issues, which I know would benefit from regular use of a heated pool. given the demographics in

Other comments
Yass I am sure an indoor heated pool would be well used by the young, the older residents and people recovering from injuries. Young people who swim competitively are disadvantaged when they are unable to train during the winter months, an indoor pool open all year would be of great benefit to them.
I wouldn't mind paying a bit extra to get my daughter into a heated pool regularly to help with her pain management for her cerebral palsy. We really need this in Yass especially for the colder months!!!
I'd like to be able to buy a bunch of tickets at a discounted price, rather than a season ticket.; Also swimming lessons!! They were so disorganised and last year and you can't expect a toddler to learn to swim with a half hour lesson for 5 weeks. More lessons!!
If there was an indoor heated swimming pool that provided good quality swimming lessons we would move our two children from their current weekly swim lessons at Aquatots Gold Creek to Yass.
In the context of the current rate rises, and the councils responsibilities to appropriately plan to maintain and upgrade its facilities, I would note support additional financial burden on rate payers.
Indoor pool would be fantastic for rehabilitation programs, to keep the elderly active, and to help residents keep their fitness over winter (sporting teams would be able to use the pool as part of training when grounds are wet)
It's hardly used, hence, don't waste rate payers money.
just get on with it and get it done - Yass needs more facilities
More swim lessons would be better from the start of the season
My children already swim in Canberra, we spend 6.5 hours a week at the pool. I use Yass pool approx 2 times per year in summer, as often the water there is too cold & therefore commute to Canberra if the kids want to swim for fun. . Given that we travel to Canberra for work & school I would never consider doubling back to Yass to use the heated indoor pool. If the facility was built in Murrumbateman I definitely would use the facilities.
My children have always attended swimming lessons in Canberra as there was no local option.
My daughters love swimming and are very good at it and it is a big cost and commitment to have to travel to Canberra through the winter months to swim and compete.
My husband has mobility issues which would benefit by a heated pool if ventilated effectively. He has DVA support for payment
My kids have used the pool during summer and have had season passes. I do not support an indoor pool at all and object to the amount of money proposed being spent on something that will not be used by my family in any way. I also object to the proposed increase in rates required to pay for it.
My mother and sister are unable to swim in the Yass pool due to health issues. We could and will go as a family if there is a heated pool
No more rate hikes!!!!!!!!!!!!!!
Opening hours. I'd rather buy a season ticket in Young as its open from start oct- end April now that it's heated & I can go any time b/w 6am- 7pm. PLEASE look at how they've achieved this.
Our children need this, Yass needs to start moving ahead and improving.
Our family regularly use the Yass Pool in summer, but two members of our family need hydrotherapy, so we travel to Gungahlin once a week, as that is all we can afford. We normally take several other friends from Yass with us. There are almost always Yass people at Gungahlin pool when we are there. If we had a heated indoor pool in Yass, our family would use it three or more times a week.
People need to exercise AND have fun. Please build the pool.
Please can we get an indoor pool!!!! Would be happy to help fund raise!!
please open existing pool for longer hours; please consider very seriously providing an indoor heated pool
Please please i think it would be a great addition to the town.
Seriously, do you expect the rest of the shire to support this? How about looking after the villages for once?

Other comments
Some thought could be given to improving the existing pool - including its opening hours. Plenty of people work in Canberra and finish work at 5pm - closing the pool at 6-7pm is likely to exclude these people in summer. Given daylight saving it would be sensible to pilot or trial extended opening hours in summer and see what the response would be. Good luck.
The hours of opening are terrible and the pool manager should be told to open the pool earlier in the year and all day!
The option of children's pool parties for birthdays could be another business line
The swimming clubs take up too much of the pool
They need to improve, at the start of the swimming season the water is far too cold for children to do swimming lessons in. It is ridiculous that nowhere in Yass LGA do we have a heated pool of some sort.
This development needs to happen ASAP not only community will benefit but also the Yass tourism industry.
This survey really doesn't allow one to provide accurate responses. I would do a number of extra things on a number extra days (and more than once a day) if the option was available - for example I don't currently do aquatic classes but if there was an indoor pool I would attend aquatic classes as well as being my children after school. We sometimes attend the pool in summer in the morning on a weekend and sometimes in the afternoon... and during school holidays all during the day on most days (when it is warm enough) and this survey allows no indication of any of this.
Typical Yass Council thinking only of Yass
Unless there is a grant to build it, I don't support any rate hike to build it.
user pays
Waste of money building another pool
We are close enough to Canberra so why do we need to build an indoor pool??? It would just be a burden on all ratepayers in the Shire
What about Binalong 25m pool as an indoor pool option in the YVC
While I strongly support building a new pool in MB/Gundaroo area and upgrading/ retaining Yass pool, I do not support any option that only involves the Yass pool as its too far away & thus I would never use it, whereas I would regularly use a pool in the MB area.
Why could you not include the Wallaroo area in the list above. There are more pressing things for council to spend our money on than a new pool in Yass. This survey is very poorly constructed.
With 3 aged facilities & disability care, a hydrotherapy pool would be so beneficial to this community. I currently regularly attend a hydrotherapy pool in Canberra for rehab & chronic pain issues & it is of great benefit. I see carers bringing people with disabilities into the pool & the expressions of these people's faces once in the pool just says it all.
Worst way to spend my rates given all the work that is needed across the shire
Yass Council cannot afford this - just scraped through as fit for the future.
Yass for Yass, how about spending some money on the villages?
Yass has been waiting far too long for an indoor pool. The council need to consider what's best for the residence. We have an increasing population, with lots of young families. We need to stop giving them excuses to go to Canberra (I know lots of mums who head to the Gungahlin pool). We need this improve!
Yass is attracting retirees from a large and varied area and is a shire with an average growth rate of 2.5% + so a facility such as a Heated Indoor Pool would only help to attract residents. Aged care is a growth industry therefore the heated pool would be an asset to aged care.
Yass needs an upgrade of swimming facilities. There are smaller towns in other communities which have heated pools. It is a service that would be useful to many people in the town and keep business in town as opposed to people travelling to Canberra.
You could offer the gym space to an existing gym business in town to move into. We really need and indoor pool for teaching kids to swim and therapy. Eumundi Qld has a model worth looking at.
You won't please everyone but something does need to be done. And wide opening hour options need to be available to cater for commuting population to keep their business in town and not in Canberra or other regional centres.

Other comments
Roads not Pools!!!!
Yass is close to Canberra so if anybody wants to swim in an indoor pool, they can go there. As the pool doesn't make money now, it would become an even bigger financial drain on council if a new one was built
I have had to take my children to swimming lessons in Canberra which is very difficult as I live and work full time me in Yass. I do not like gyms or running and swimming or aqua aerobics is an exercise that i could fit into my Lucy time breaks. We need lessons and lap swimming facilities year round
My family and I have grown up in Yass and the local swimming pool has a place in all of our hearts as some of our best summertime memories, a few years back we had a fairly large pool built at our family home, but I still really enjoy visiting our local pool in summer to socialise and exercise as our pool at home unfortunately is not a lap pool, I have noticed over the last few years though that the number of people using the local swimming pool is dwindling, I would really love to see the next generation of local kids and families to have a place they'll be happy to hang out, have fun, get some exercise and build memories that same way myself and my family and friends were once able to, I think we need to keep up with the times and changes with what people want and expect of local swimming pool centres these days, otherwise our beautiful town will fall behind in providing the locals the up to date places for activities they need.
I think it is very important for Yass to have a indoor pool
the pool needs to be a priority and something needs to be done ASAP
it would be great to have a better pool in Yass then people would not have to travel to Canberra to train or lap swim - please build ASAP
Has Binalong or Murrumbateman areas been considered...let Yass residents travel...
I have two small children and I am keen to have a place they can have weekly swim lessons.
The current facility is a wonderful asset; an indoor pool would add to it. Should incorporate undercover parking so swimmers do not go out into the cold wind after swimming in a heated environment, particularly important for aged users.
I currently travel to Canberra to use an indoor facility for my children's swimming lessons as our pool not only does not operate year round, but is also ridiculously cold for young children. They swim year round and would be great to be able to use local facilities rather than those of Canberra, considering we live in yass
Please keep pool open until end of competitions
This is a very poor survey and I don't think it will get you the response you need.
I feel that a pool in Yass is a necessity for all ages
Heat the pool
Murrumbateman needs more facilities. We pay rates too and have the crapiest roads and no facilities or regular Maintenance done in the area. We are the forgotten town in the Yass valley.
When I lived in Canberra swimming was a major part of my life. Living in Yass does not give me that option all year.
If a Masters swimming club existed I would join it and train with them and swim more than once a week
i have to travel to Canberra for swimming lessons for my children as there is not enough facilities in Yass for winter and even in summer there isn't enough for everyone
Juzt do it please
Yass would at least need a 25m lap pool for everyday swimmers/trainer's so that all clubs can keep training there swimmers during the winter and summer and the general public too.
Be wonderful for elderly and rehabilitation residents
Would be awesome.
Murrumbateman would be a great place for a pool. Lots of morning and afternoon traffic and a way to attract a large proportion of the district.
Covered pool much needed
I live in Spring Range and can\t even drive on my road!!! And you want to build a new pool in Yass??? Rates roads and rubbish, get back to the basics Yass Shire
if funding is an issue, organise community support. eg check out the history of lightning Ridge pool!

Other comments
Consideration should be given to providing new infrastructure to Murrumbateman ahead of Yass who already has a pool.
You haven't provided enough options for what time you swim. I come at 10:00am on days when pool is not open for morning swimming and rarely swim late afternoons during the week as it is too crowded due to squad and club training. the pool needs consistent opening hours which encourage people to use the pool and not resort to pools in Canberra.
Wheel chair access by ramp would be great and not hoist
My understanding of commercial pools is that they don't cover their own costs by entry fees, but instead by the businesses attached (swimming lessons, cafes, health exercise activities etc.) This is where the council needs to put its costing analysis, not just fixed on the cost to construct and entry fees.
The learn to swim programs run in January are fantastic but most kids -- including ours -- need weekly swimming practice to maintain and develop skills. We make a special trip to Canberra every week to attend swimming lessons for two kids in Canberra and also use their free public swimming times on the weekend as well as CISAC pool. We'd love to be spending all that time and money in Yass rather than Canberra!
Money could be better spent elsewhere
What a joke, how about doing up the dirt roads instead
Yass Shire needs a real kick up the bum for wasting ratepayers money on these ridiculous surveys. I suppose there is thousands more spent on studies as well. Your priorities are all wrong.
Yass pool is always a pleasure to swim in during its operating season. My focus is lap swimming, which is hard to do during pool weekday opening hours due to 2 swim clubs operating and taking up space. This in itself is great, as many of these kids would surely use the pool during winter as well. I imagine there would be a high demand for swimming all year round, and I would much rather swim locally than at CISAC through the week.
I would like to see the resources allocated elsewhere such as our 700km of unsealed roads before Council makes a heated swimming pool a priority.
Please use the money for this upgrade to fund vital road works. Our road is dangerous and has been made worse by the this year's rain. Yet instead of addressing this you want to charge me higher rates for a project that I won't ever use.
Sell it to private sector, don't waste ratepayers money to run what should be commercial enterprises
It's important for our children to have access to swimming lessons all year round.
Would get great use from Boorowa residents.
Maybe we should have had this survey before we had the committee set up some time ago to look into the feasibility of a sporting complex that would contain a heated pool.
Waste of money
What a waste of money this whole exercise is
From Wallaroo, not even considered in this survey. Yass, you are pathetic.
I don't think comparison between Gungahlin and Yass should be compared. Yass will never build an indoor pool with the extensive facilities, including gym, that Gungahlin pool has. ; The community could utilise a pool throughout the year rather than for limited 3 months over the summer period. With Vic Govt linking being able to swim 50m with passing school, the region should prepare for this approach to occur in NSW next ...
With three children under the age yet to Elan to swim confidently I see this as a vital piece infrastructure for families in a rural, environment where dams and rivers and lakes are and where visits to the beach are not common and therefore carry extra risks for country kids. The aging pool is not an attractive facility for tourists and with no other way to cool off, not even a splash pad in the biggest park, Yass is crying out for an updated new facility.
I would not need the heated pool myself but think it is very important to provide one for those who do need it. Also I think the outdoor swimming pools with grass and shade trees are really important for children and families. I would not mind paying a bit extra in rates and if I used the pool paying more for it. I would expect to use it more after retiring.
Long overdue, sick of travelling to Canberra for an indoor heated pool

Other comments
Please do not lumber Yass residents with rates rise or very few people wanting a heated pool. Put money into current 50m pool to bring up to modern standard
Canberra facilities are preferred while working all week in Canberra
lack of patronage
[redacted].
The pool loses money now so why should all the ratepayers have to pay for a new one when the overwhelming majority will never ever use it!!! Typical bloody council.
Stick to clearing the Yass gorge [redacted], this is a total waste of money
No money for pools, more money for roads
Only swim when its hot so wouldn't use an indoor pool
Money would be better spent on other projects rather than slugging ratepayers for something that is continually going to lose money
would rather travel to Canberra out of swim season if I wanted to use a heated pool
would be happy to travel to Canberra to use indoor pool
Yass simply does not need an indoor pool with Canberra so close
How can you expect non swimming ratepayers to support a proposal like this. It will cost millions to build and thousands each year to run.
Upgrade existing pool but it would be a giant waste of money to build and indoor pool
I think council should be worrying about other issues rather than building an indoor pool that will just suck up the money over the forthcoming years. None ever even break even.
Waste of money to build a new one when most of Yass's population travels to Canberra anyway
We do not require an indoor pool in Yass and am offended that my rates is paying for this rubbish
Yass is not in need of an expensive indoor pool, there are other sporting options outside the swim season that are available and supported by community.
Travel to Canberra to indoor pool outside opening times, We don't need to waste ratepayers money when it is an easy 30 minute drive to use a facility.
We love the current outdoor pool and would be sorry to see it go in favour of an indoor pool. It would be great if both options could be available to allow for year round swimming.
Suggest an indoor pool should be though of a different. Probably best separate form main pool. Outdoor pool could be closed during winter indoor pool open mainly in the winter ie best suitable for hydrotherapy/ rehabilitation. Heated indoor swimming pool in different location with car parking.
Council will benefit in the long run with most residents taking advantage of the facility. Travelling to Canberra etc is not an option for lots of people. We need to start making Yass a place that people want to visit. I'm sure visitors staying at the caravan park would also use this facility is it was available.
Hydro pool top priority. 50m pool too.
Currently cannot use as access too hard with osteoarthritis - go to CISAC weekly instead.
User pays - not another rate payer funded increase. Already too high over the next 3 years
Currently travel to Gungahlin up to 3 times a week for hydro and always see Yass people there. A pool for rehabilitation not only allows people to get better quicker but groups form and this increases a feeling of community and connectiveness that is often lacking when experiencing long term rehab.
Very important we have a heated pool for teaching young children to swim and for rehabilitation and recovery from injuries and surgery.
Water too cold at Yass Pool
I'm a new mum, wanting to spend time swimming with my son, teaching him. Driving to Canberra is too much.
Yass pool too cold and season too short. We need a new hot pool asap.
Hydrotherapy pool please. Woefully inadequate. Need a hydrotherapy and indoor pool as a priority.
Please make any changes fully accessible.

Other comments
Please complete the feasibility study asap and start works. Need new 50m pool
Water temp not good.
We need a swimming school in Yass. If we had an enclosed pool, i would take up lap swimming again all year round at least x2 /week and have lessons there for my child. What would we get for \$5m compared to \$10m?
The current pool is a great local family venue.
Heated hydro pool for rehab
Current pool is great. Is it possible to add solar heating (to the roof of associated buildings) to lengthen the swimming season? Hopefully by several months. This may be lower cost and 1/2 way house.
Affordable pool facilities and lessons
It would be an extreme shame to lose the existing pool.
A growing town like Yass should have up to date swimming facilities, including a heated pool to use for hydrotherapy among other uses.
No more rate increases. Stop selling prime rural land. Stop building roads for people building homes on rural land. Excellent idea to upgrade pool.
Totally over rate increases in all circumstances. Where is our money going?? Every year a rate increase. We used to be able to afford lifestyle options without increases. Financing these options is councils job. You are paid to do this. It is not up to rate payers. Just get on with it, we all need pool facilities in Yass.
During summer i travel 20 each way to attend aqua exercise classes at Yass Pool - essential to maintain fitness at my age. These have to stop in February and only begin late Nov. 3 months in a year is inadequate. In winter, autumn and spring i have to travel to Gungahlin or do no swimming based exercise. Developing an indoor pool is essential for senior health
Ideally a small heated pool for Yass, any venue. I would like to see repairs done to the existing pool as i believe they are needed badly. This pool must remain for laps and learn to swim and school sports and carnivals.
I mostly want this for my children to have year round access to swimming lessons.
I would be prepared to run aqua aerobic classes for mums with young babies if an adequate facility was available. (heated and water cleanliness of high quality, uv filtration)

APPENDIX B: CAPITAL COST ESTIMATES

RLB | Rider Levett Bucknall

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9 June 2017

SGL Consulting
Group 2a Mellor
Street
West Beach SA 5024

Attention: Mr Phillip Gray

Dear Phillip,

YASS AQUATIC CENTRE ORDER OF COST ESTIMATE

As requested, we have prepared an Order of Cost estimate based on the report provided for the proposed Aquatic Centre at Yass, New South Wales. Our estimate can be summarised as follows:

Order of Cost Estimate Summary

▪ Demolition & Site Works	$296,480
▪ Indoor Pool Hall (1,789m2)	$9,236,812
▪ Gym and Consulting Room (210m2)	$180,713
▪ Hydrotherapy Pool	$920,492
▪ Outdoor Splash Pad	$345,246
▪ External Works - Car parking & Landscaping	$654,205
Total Order of Cost Estimate (Excl. GST)	**$11,403,949**

The estimate is based upon the report provided to which we have applied rates and conditions we currently believe applicable as at June 2017.

As discussed with our New South Wales office, Yass attracts a 10% locality loading when compared with Sydney pricing.

We refer you to the attached estimate report which provides a detailed breakdown of the scope included, basis of estimate and exclusions.

We trust this report is of assistance, however should you require any further information or clarification please do not hesitate to contact our office.

Yours faithfully,

Andrew Knowles

Director
Rider Levett Bucknall
Andrew.knowles@au.rlb.c
om

Encl:

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Yass Aquatic Centre
Order of Cost Estimate

Project Details

Laidlaw St, Yass NSW 2582

YASS AQUATIC CENTRE

Order of Cost Estimate

June 2017

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Yass Aquatic Centre
Order of Cost Estimate

Project Details

BASIS OF ESTIMATE

This estimate is based upon measured quantities to which we have applied rates and conditions we currently believe applicable as at ***JUNE 2017***. We assumed that the project will be competitively tendered under standard industry conditions and form of contract.

This cost estimate is based on the documentation listed under the "Documents" section and does not at this stage provide a direct comparison with tenders received for the work at any future date. To enable monitoring of costs this estimate should be updated regularly during the design and documentation phases of this project.

Scope of Works / Assumptions

In preparing this estimate we, in conjunction with the project team, have assumed the following scope of works;

- Demolition of Existing Facilities
- Indoor Pool Hall
- Gym and Consulting Room
- Hydro-therapy Pool
- Outdoor Splash Pad
- Car parking and Landscaping

ITEMS SPECIFICALLY INCLUDED

This estimate specifically includes the following:

Contingencies & Escalation

The estimate includes the following contingency allowances:

- Design Development Contingency which allows for issues that will arise during the design and documentation period as the design team develops the design through to 100% documentation
- Construction Contingency which allows for issues that will arise during the construction period including for latent conditions, design errors and omissions, design changes, client changes, extension of time costs and provisional sum adjustments.
- Locality Loading which allows for the differential in pricing between the base of Sydney and the actual project locality of ***YASS*** and allows for the additional labour, material, transport and associated costs of contraction in this location.

ITEMS SPECIFICALLY EXCLUDED

The estimate **specifically excludes** the following which should be considered in an overall project feasibility study:

Project Scope Exclusions

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Yass Aquatic Centre
Order of Cost Estimate

Project Details

- Stand-by power generator
- Termite protection
- Stormwater storage tanks
- Work outside site boundaries Scope

Exclusions for works by others

- Loose, soft and hard furnishings
- Vertical blinds, curtains or other window treatments
- Tenant fitout

Risk Exclusions

- Relocation and upgrade of existing services
- Contaminated ground Removal and Reinstatement
- Asbestos and Hazardous Materials Removal
- Rock excavation
- De-watering
- Staging / Phasing costs Other

Project Cost Exclusions

- Land costs
- Legal fees
- Goods and Services Taxation

DOCUMENTS

The following documents have been used in preparing this estimate:

ARCHITECTURAL Documents prepared *by DKJ Projects. Architecture*

	Date Received
•SK001 Proposed Plan	24/06/17
•SK002 Proposed Site Plan	24/06/17

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Yass Aquatic Centre
Order of Cost Estimate

Location Summary

Rates Current At June 2017

Location			Total Cost
A	DEMOLITION WORKS		296,480.68
B	INDOOR POOL HALL		9,236,812.43
C	GYM AND CONSULTING ROOM		180,713.70
D	HYDROTHERAPY POOL		690,492.56
E	OUTDOOR SPLASH PAD		345,246.42
F	EXTERNAL WORKS		
	F1 Carparking & Paths		442,260.63
	F2 Landscaping & Improvements		211,942.58
		F - EXTERNAL WORKS	*$654,208.21*
		ESTIMATED NET COST	$11,403,949.00

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Yass Aquatic Centre

Order of Cost Estimate

Location Elements Item

A DEMOLITION WORKS — Rates Current At June 2017

	Description	Unit	Qty	Rate	Total
AR	**Alterations and Renovations**				
1	from site	m²	540	65.00	35,100.00
2	Demolish existing storage Demolish existing brick amenities building (assumed 5.0m high) including removal of debris shed including removal of debris from site	m²	66	40.00	2,640.00
3	Demolish existing pool plant room including removal of debris from site	m²	89	120.00	10,680.00
4	Demolish existing lightweight shelter including removal of debris from site	m²	158	20.00	3,160.00
5	Demolish existing concrete pavement including removal of debris from site	m²	812	15.00	12,180.00
6	Demolish existing light tower including decommissioning, capping and terminating electrical services	No	6	850.00	5,100.00
7	Allowance to demolish existing 50 x 15m swimming pool including removal of debris from site (assumed 1.5m average depth) (1125m3)	m²	750	40.00	30,000.00
8	Allowance to demolish existing 16 x 9m toddlers pool including removal of debris from site (assumed 0.4m average depth) (58m3)	m²	144	40.00	5,760.00
115	Allowance to cut down existing medium sized tree including removal of debris from site	No	4	350.00	1,400.00
9	Allowance for removal of existing underground engineering services	Item			5,000.00
	Alterations and Renovations				***$111,020.00***
XP	**Site Preparation**				
10	Excavate topsoil including including stockpiling soil on site	m²	5,848	1.50	8,772.00
110	Imported fill to removed pool (arrange depth 1.7m)	m³	1,350	55.00	74,250.00
	Site Preparation				***$83,022.00***
PR	**Preliminaries**				
101	Builder's Preliminaries and Supervision (10%)	Item			19,000.00
	Preliminaries				***$19,000.00***
MA	**Builders Margin**				
102	Builder's Margin and Overheads (5%)	Item			11,000.00
	Builders Margin				***$11,000.00***
LL	**Locality Loading**				
103	Locality Loading (10%)	Item			22,000.00
	Locality Loading				***$22,000.00***
CT	**Contingency**				
104	Design Development Contingency (5%)	Item			12,000.00
105	Construction Contingency (5%)	Item			13,000.00
	Contingency				***$25,000.00***
ES	**Escalation**				
106	No Allowance for Escalation	Item			Excl.
	Escalation				***Excl.***

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Yass Aquatic Centre

Order of Cost Estimate

Location Elements Item

A DEMOLITION WORKS (continued) Rates Current At June 2017

PF	**Professional Fees**		
107	Professional Fees (9%)	Item	24,000.00
	PROFESSIONAL FEES		*$24,000.00*
1.1.1	**Statutory Charges**		
108	Allowance for Statutory Fees and Charges (0.5%)	Item	1,438.68
	***STATUTORY CHARGES* DEMOLITION WORKS**		***$1,438.68***
			$296,480.68

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Yass Aquatic Centre

Order of Cost Estimate

Location Elements Item

B INDOOR POOL HALL Rates Current At June 2017

	Description	Unit	Qty	Rate	Total
XP	**Site Preparation**				
11	Site preparation including minor cut/fill to achieve levels, leveling, compacting, etc.	m²	2,042	10.00	20,420.00
14	Detailed excavation to main pool including disposal of debris off site (average 1.35m deep)	m³	665	60.00	39,900.00
15	Detailed excavation to hydrotherapy pool including disposal of debris off site (0.55m deep)	m³	25	60.00	1,500.00
12	No allowance for contaminated soil remediation - RISK	Item			Excl.
	Site Preparation				***$61,820.00***
SB	**Substructure**				
13	150mm Thick reinforced concrete slab including excavation, footings, damp proof membrane, reinforcement, formwork, etc.	m²	1,505	185.00	278,425.00
	Substructure				***$278,425.00***
RF	**Roof**				
16	Steel framed roof structure including framing, covering, flashings, plumbing, insulation, etc.	m²	2,042	300.00	612,600.00
111	Roof walkway / safety system	Item			10,000.00
	Roof				***$622,600.00***
EW	**External Walls**				
17	200mm Thick pre-cast external wall including fixings, 92mm steel stud framing, insulation, water resistant plasterboard and paint finish internally (5.0m high)	m²	841	470.00	395,270.00
18	Anodised aluminium framed glazed partition (3.0m high)	m²	157	750.00	117,750.00
	External Walls				***$513,020.00***
ED	**External Doors**				
19	Pair of automatic aluminium framed glazed sliding doors including motor, frame and hardware	No	1	12,000.00	12,000.00
20	Pair of aluminium framed glazed swing doors including frame and hardware	No	2	3,500.00	7,000.00
21	Pair of solid core doors including frame, hardware and paint finish both sides	No	2	1,500.00	3,000.00
	External Doors				***$22,000.00***
NW	**Internal Walls**				
22	200mm Thick pre-cast internal wall including fixings, 92mm steel stud framing, insulation, water resistant plasterboard and paint finish both sides (5.0m high)	m²	213	470.00	100,110.00
23	120mm Thick pre-cast internal wall including fixings, 92mm steel stud framing, insulation, water resistant plasterboard and paint finish both sides (65.0m high)	m²	807	420.00	338,940.00
24	Anodised aluminium framed glazed partition (3.0m high)	m²	26	500.00	13,000.00
	Internal Walls				***$452,050.00***
NS	**Internal Screens and Borrowed Lights**				
28	Laminate shower partition including framing, door and hardware - no bench seat or storage documented	No	12	1,650.00	19,800.00

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Yass Aquatic Centre

Order of Cost Estimate

Location Elements Item

B INDOOR POOL HALL (continued)

Rates Current At June 2017

	Description	Unit	Qty	Rate	Total
29	Laminate toilet partition including framing, door and hardware	No	7	1,650.00	11,550.00
	Internal Screens and Borrowed Lights				***$31,350.00***
ND	**Internal Doors**				
25	Pair of solid core doors including frame, hardware and paint finish both sides	No	2	2,350.00	4,700.00
26	Single solid core door including frame, hardware and paint finish both sides	No	9	1,350.00	12,150.00
27	Pair of aluminium framed glazed swing doors including frame and hardware	No	1	3,500.00	3,500.00
	Internal Doors				***$20,350.00***
WF	**Wall Finishes**				
68	Ceramic wall tiling	m²	35	140.00	4,900.00
69	Allowance for feature wall finishes (reception, gym)	Item			2,500.00
	Wall Finishes				***$7,400.00***
FF	**Floor Finishes**				
30	Epoxy finish to plant/storage areas	m²	282	45.00	12,690.00
31	High traffic carpet including underlay	m²	268	70.00	18,760.00
32	Non-slip vinyl floor covering	m²	12	95.00	1,140.00
33	Tiled floor finish including leveling screed	m²	178	120.00	21,360.00
35	Tiled floor finish to pool concourse - assumed laid direct to sealed concrete	m²	488	180.00	87,840.00
70	Ceramic tiled skirting	m	172	30.00	5,160.00
71	Timber skirting	m	188	10.00	1,880.00
	Floor Finishes				***$148,830.00***
CF	**Ceiling Finishes**				
65	Suspended metal grid ceiling (Rondo or similar) including insulation	m²	522	90.00	46,980.00
66	Flushed plasterboard bulkhead including insulation and paint finish (2.0m high)	m	13	350.00	4,550.00
67	Perforated stainless steel metal lining to underside of roof including insulation	m²	1,025	80.00	82,000.00
	Ceiling Finishes				***$133,530.00***
FT	**Fitments**				
38	PC sum allowance for fixed seating along walls of pool concourse	Item			12,500.00
39	Reception desk	m	18	1,500.00	27,000.00
40	Steel storage lockers	No	28	850.00	23,800.00
41	Fixed timber seating to changerooms	m	25	140.00	3,500.00
42	Toilet roll holder	No	8	80.00	640.00
43	Soap dispenser	No	7	85.00	595.00
44	Paper towel dispenser	No	2	120.00	240.00
45	Hand dryer	No	3	800.00	2,400.00
54	Fold-away shower seat (DDA compliant)	No	1	900.00	900.00

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Yass Aquatic Centre

Order of Cost Estimate

Location Elements Item

B INDOOR POOL HALL (continued) Rates Current At June 2017

46	Laminate vanity unit including underbench storage cupboards	m	10	1,250.00	12,500.00
55	Mirror to amenities	m²	10	450.00	4,500.00
56	Allowance for sundry fitments (coat hooks, etc.)	Item			500.00
80	Allowance for statutory and wayfinding signage	Item			3,000.00
81	Allowance for external building signage	Item			5,000.00
84	No allowance for internal fitout of areas (shelving, joinery, etc.)	Item			Excl.
	Fitments				***$97,075.00***
SE	**Special Equipment**				
83	Allowance for security system to building (motion detectors, security system base unit)	Item			5,000.00
	Special Equipment				***$5,000.00***
PD	**Sanitary Plumbing**				
47	Stainless steel shower head and tapware including water and waste connections	No	12	1,000.00	12,000.00
48	Ceramic toilet suite including water and waste connection	No	7	3,450.00	24,150.00
49	Ceramic hand wash basin and stainless steel tapware (vanity mounted) including water and waste connection	No	8	3,000.00	24,000.00
50	Stainless steel floor mounted urinal (2.6m long) including water and waste connection	No	1	2,400.00	2,400.00
51	Ceramic wall mounted hand wash basin including water and waste connection (DDA WC)	No	1	3,250.00	3,250.00
52	Ceramic toilet suite (DDA compliant) including water and waste connection	No	1	3,850.00	3,850.00
53	Stainless steel shower head and tapware (DDA compliant) including water and waste connection	No	1	1,450.00	1,450.00
	Sanitary Plumbing				***$71,100.00***
PO	**Pools and Plant**				
36	25m x 15m Freeform Shape Main Pool (6-lanes) including 100m2 Toddler Pool · Budget allowance for Main Pool (1.1 - 1.6m deep), Equipment and tank structures · Budget allowance for Toddlers Pool, Disabled Ramp, Equipment and tank structures · Budget allowance for Solar Evacuated Tube Heating System - $200,000 INCLUDES · Excavation, waterproofing, in-situ reinforced concrete slabs and walls, tiling and backwash boxes · Filtration and water treatment UV system, variable speed pump, solar pool water heating, lanes ropes, safety lines, demountable starting blocks, disabled access ramp · Builders Works in Connection EXCLUDES · Lifeguard podiums, loose FFE & safety hooks	Item			2,100,000.00
	Pools and Plant				***$2,100,000.00***

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Yass Aquatic Centre

Order of Cost Estimate

Location Elements Item

B INDOOR POOL HALL (continued)

Rates Current At June 2017

Description		Unit	Qty	Rate	Total
VE	**Ventilation**				
59	Allowance for ventilation (swirl diffusers, vents, louvres, etc.)	Item			10,000.00
	Ventilation				***$10,000.00***
AC	**Air Conditioning**				
57	Allowance for mechanical services to pool/plant/changeroom area - minimise condensation	m²	1,479	550.00	813,450.00
58	Allowance for mechanical services to front of house - heating and cooling	m²	294	280.00	82,320.00
	Air Conditioning				***$895,770.00***
FP	**Fire Protection**				
60	Allowance for fire protection services (hose-reels, hand-held extinguishers, blankets, **no sprinkler system**)	m²	1,579	10.00	15,790.00
	Fire Protection				***$15,790.00***
LP	**Electric Light and Power**				
61	Allowance for electric, light and power services to pool area	m²	1,026	145.00	148,770.00
62	Allowance for electric, light and power services to front of house/plant/amenities	m²	747	145.00	108,315.00
	Electric Light and Power				***$257,085.00***
CM	**Communications**				
63	Allowance for communication services	m²	1,579	25.00	39,475.00
	Communications				***$39,475.00***
XB	**Outbuildings and Covered Ways**				
64	Allowance for attached canopys (entrance or alike) including framing, covering and plumbing	Item			20,000.00
	Outbuildings and Covered Ways				***$20,000.00***
XK	**External Stormwater Drainage**				
112	Allowance for stormwater infrastructure and connections	Item			50,000.00
	External Stormwater Drainage				***$50,000.00***
XD	**External Sewer Drainage**				
96	Allowance for upgrade works to existing sewer infrastructure (septic, etc.)	Item			50,000.00
	External Sewer Drainage				***$50,000.00***
XW	**External Water Supply**				
113	Allowance for external water supply infrastructure and connection	Item			20,000.00
	External Water Supply				***$20,000.00***
XG	**External Gas**				
114	Allowance for external gas supply infrastructure and connection	Item			20,000.00
	External Gas				***$20,000.00***
XF	**External Fire Protection**				
95	Allowance for upgrade works to existing fire protection infrastructure (hydrants, etc.)	Item			75,000.00
	External Fire Protection				***$75,000.00***

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Yass Aquatic Centre
Order of Cost Estimate
Location Elements Item

B INDOOR POOL HALL (continued)

Rates Current At June 2017

Description		Unit	Qty	Rate	Total
XE	**External Electric Light and Power**				
82	External lighting to building perimeter (wall mounted flood-lights)	Item			3,500.00
94	No allowance for upgrade works to existing electrical infrastructure (transformer, etc.)	Item			Excl.
	External Electric Light and Power				***$3,500.00***
PR	**Preliminaries**				
101	Builder's Preliminaries and Supervision (10%)	Item			602,000.00
	Preliminaries				***$602,000.00***
MA	**Builders Margin**				
102	Builder's Margin and Overheads (5%)	Item			331,000.00
	Builders Margin				***$331,000.00***
FE	**Furniture, Fittings & Equipment**				
85	No allowance for loose furniture fittings or equipment (tables, seats, bins, etc.)	Item			Excl.
	Furniture, Fittings & Equipment				***Excl.***
LL	**Locality Loading**				
103	Locality Loading (10%)	Item			695,000.00
	Locality Loading				***$695,000.00***
CT	**Contingency**				
104	Design Development Contingency (5%)	Item			382,000.00
105	Construction Contingency (5%)	Item			402,000.00
	Contingency				***$784,000.00***
ES	**Escalation**				
106	No Allowance for Escalation	Item			Excl.
	Escalation				***Excl.***
PF	**Professional Fees**				
107	Professional Fees (9%)	Item			759,000.00
	Professional Fees				***$759,000.00***
ST	**Statutory Charges**				
108	Allowance for Statutory Fees and Charges (0.5%)	Item			44,642.43
	Statutory Charges				***$44,642.43***
	INDOOR POOL HALL				***$9,236,812.43***

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Yass Aquatic Centre

Order of Cost Estimate

Location Elements Item

C GYM AND CONSULTING ROOM

Rates Current At June 2017

	Description	Unit	Qty	Rate	Total
FF	**Floor Finishes**				
31	High traffic carpet including underlay	m²	210	70.00	14,700.00
34	Extra over allowance for rubberised floor finish to gym (20% allowance)	m²	41	80.00	3,280.00
71	Timber skirting	m	69	10.00	690.00
	Floor Finishes				***$18,670.00***
CF	**Ceiling Finishes**				
65	Suspended metal grid ceiling (Rondo or similar) including insulation	m²	211	90.00	18,990.00
	Ceiling Finishes				***$18,990.00***
FT	**Fitments**				
72	No allowance for gym fitout (mirrors, fitments, etc.)	Item			Excl.
	Fitments				***Excl.***
AC	**Air Conditioning**				
73	Allowance for mechanical services to gym heating and cooling	m²	211	220.00	46,420.00
	Air Conditioning				***$46,420.00***
FP	**Fire Protection**				
60	Allowance for fire protection services (hose-reels, hand-held extinguishers, blankets, **no sprinkler system)**	m²	211	10.00	2,110.00
	Fire Protection				***$2,110.00***
LP	**Electric Light and Power**				
75	Allowance for electric, light and power services to gym	m²	211	125.00	26,375.00
	Electric Light and Power				***$26,375.00***
CM	**Communications**				
63	Allowance for communication services	m²	211	25.00	5,275.00
	Communications				***$5,275.00***
PR	**Preliminaries**				
101	Builder's Preliminaries and Supervision (10%)	Item			12,000.00
	Preliminaries				***$12,000.00***
MA	**Builders Margin**				
102	Builder's Margin and Overheads (5%)	Item			6,000.00
	Builders Margin				***$6,000.00***
LL	**Locality Loading**				
103	Locality Loading (10%)	Item			14,000.00
	Locality Loading				***$14,000.00***
CT	**Contingency**				
104	Design Development Contingency (5%)	Item			7,000.00
105	Construction Contingency (5%)	Item			8,000.00
	Contingency				***$15,000.00***

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Yass Aquatic Centre

Order of Cost Estimate

Location Elements Item

C GYM AND CONSULTING ROOM (continued)

Rates Current At June 2017

Description		Unit	Qty	Rate	Total
ES	**Escalation**				
106	No Allowance for Escalation	Item			Excl.
	Escalation				***Excl.***
PF	**Professional Fees**				
107	Professional Fees (9%)	Item			15,000.00
	Professional Fees				***$15,000.00***
ST	**Statutory Charges**				
108	Allowance for Statutory Fees and Charges (0.5%)	Item			873.70
	Statutory Charges				***$873.70***
	GYM AND CONSULTING ROOM				***$180,713.70***

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Yass Aquatic Centre

Order of Cost Estimate

Location Elements Item

D HYDROTHERAPY POOL

Rates Current At June 2017

	Description	Unit	Qty	Rate	Total
PO	**Pools and Plant**				
37	5m x 6m Warm Water Pool - Budget allowance for Pool, Equipment and tank structures INCLUDES - Excavation, waterproofing, in-situ reinforced concrete, slab & walls, tiling and backwash boxes - Filtration and water treatment UV system, variable speed pump, solar pool water heating, disabled access ramp - Builders Works in Connection EXCLUDES - Lifeguard podiums, loose FFE & safety hooks - Lane ropes, safety lines, starting blocks	Item			600,000.00
	Pools and Plant				***$448,820.00***
PR	**Preliminaries**				
101	Builder's Preliminaries and Supervision (10%)	Item			44,880.00
	Preliminaries				***$44,880.00***
MA	**Builders Margin**				
102	Builder's Margin and Overheads (5%)	Item			24,860.00
	Builders Margin				***$24,860.00***
LL	**Locality Loading**				
103	Locality Loading (10%)	Item			51,790.00
	Locality Loading				***$51,790.00***
CT	**Contingency**				
104	Design Development Contingency (5%)	Item			28,310.00
105	Construction Contingency (5%)	Item			29,600.00
	Contingency				***$57,910.00***
ES	**Escalation**				
106	No Allowance for Escalation	Item			Excl.
	Escalation				***Excl.***
PF	**Professional Fees**				
107	Professional Fees (9%)	Item			57310.00
	Professional Fees				***$57310.00***
ST	**Statutory Charges**				
108	Allowance for Statutory Fees and Charges (0.5%)	Item			4,832.00
	Statutory Charges				***$4,832.00***
	HYDROTHERAPY POOL				***$690,492.00***

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Yass Aquatic Centre

Order of Cost Estimate

Location Elements Item

Rates Current At June 2017

E OUTDOOR SPLASH PAD

	Description	Unit	Qty	Rate	Total
PO	**Pools and Plant**				
76	PC SUM allowance for Splash Pad · Budget allowance for Pad Area, Equipment and tank structures INCLUDES · Excavation, waterproofing, in-situ reinforced concrete, slab & walls, tiling and backwash boxes · Filtration and water treatment UV system, variable speed pump, solar pool water heating, disabled access ramp · Builders Works in Connection · 3-5 Water play features of varying types (overhead and ground sprays, tipping buckets, water cannons and fountains) EXCLUDES · Lifeguard podiums, loose FFE & safety hooks	Item			450,000.00
	Pools and Plant				***$224,410.00***
PR	**Preliminaries**				
101	Builder's Preliminaries and Supervision (10%)	Item			22,440.00
	Preliminaries				***$22,440.00***
MA	**Builders Margin**				
102	Builder's Margin and Overheads (5%)	Item			10,360.00
	Builders Margin				***$10,360.00***
LL	**Locality Loading**				
103	Locality Loading (10%)	Item			25,895.00
	Locality Loading				***$25,895.00***
CT	**Contingency**				
104	Design Development Contingency (5%)	Item			14,500.00
105	Construction Contingency (5%)	Item			14,850.00
	Contingency				***$59,000.00***
ES	**Escalation**				
106	No Allowance for Escalation	Item			Excl.
	Escalation				***Excl.***
PF	**Professional Fees**				
107	Professional Fees (9%)	Item			28,310.00
	Professional Fees				***$28,310.00***
ST	**Statutory Charges**				
108	Allowance for Statutory Fees and Charges (0.5%)	Item			4,486.00
	Statutory Charges				***$4,486.00***
	OUTDOOR SPLASH PAD				***$345,246.00***

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Yass Aquatic Centre

Order of Cost Estimate

Location Elements Item

F EXTERNAL WORKS

F1 Carparking and Paths

Rates Current At June 2017

Description		Unit	Qty	Rate	Total
XP	**Site Preparation**				
11	Site preparation including minor cut/fill to achieve levels, leveling, compacting, etc.	m²	2,967	10.00	29,670.00
	Site Preparation				***$29,670.00***
FT	**Fitments**				
90	Allowance for bollards and crash protection	Item			7,500.00
98	Concrete wheel stop	No	91	120.00	10,920.00
	Fitments				***$18,420.00***
XR	**Roads, Footpaths and Paved Areas**				
86	Bitumen car parking including quarry rubble sub-base, fine crushed rock base-course, compaction and seal	m²	2,798	55.00	153,890.00
87	Concrete kerb and gutter	m	349	65.00	22,685.00
88	Concrete footpath including leveling sand base, formwork, construction joints, etc.	m²	171	60.00	10,260.00
89	Allowance for line and symbol marking	m²	2,798	1.50	4,197.00
93	Allowance for minor work to crossover to Yass Valley Way (spoon drain, etc.)	Item			5,000.00
	Roads, Footpaths and Paved Areas				***$196,032.00***
XK	**External Stormwater Drainage**				
91	Allowance for stormwater drainage to car parking (Humeceptor, etc.)	Item			30,000.00
	External Stormwater Drainage				***$30,000.00***
XE	**External Electric Light and Power**				
92	Allowance for lighting to carparking	Item			15,000.00
	External Electric Light and Power				***$15,000.00***
PR	**Preliminaries**				
101	Builder's Preliminaries and Supervision (10%)	Item			29,000.00
	Preliminaries				***$29,000.00***
MA	**Builders Margin**				
102	Builder's Margin and Overheads (5%)	Item			16,000.00
	Builders Margin				***$16,000.00***
LL	**Locality Loading**				
103	Locality Loading (10%)	Item			33,000.00
	Locality Loading				***$33,000.00***
CT	**Contingency**				
104	Design Development Contingency (5%)	Item			18,000.00
105	Construction Contingency (5%)	Item			19,000.00
	Contingency				***$37,000.00***
ES	**Escalation**				
106	No Allowance for Escalation	Item			Excl.

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Yass Aquatic Centre

Order of Cost Estimate

Location Elements Item

F EXTERNAL WORKS

Rates Current At June 2017

F1 Carparking and Paths (Continued)

PF	**Professional Fees**			
107	Professional Fees (9%)		Item	36,000.00
1.1.2	**Statutory Charges**	***PROFESSIONAL FEES***		*$36,000.00*
108	Allowance for Statutory Fees and Charges (0.5%)		Item	2,143.63
		STATUTORY CHARGES		***$2,143.63***
		CARPARKING & PATHS		***$442,265.63***

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Yass Aquatic Centre

Order of Cost Estimate

Location Elements Item

F EXTERNAL WORKS
F2 Landscaping & Improvements

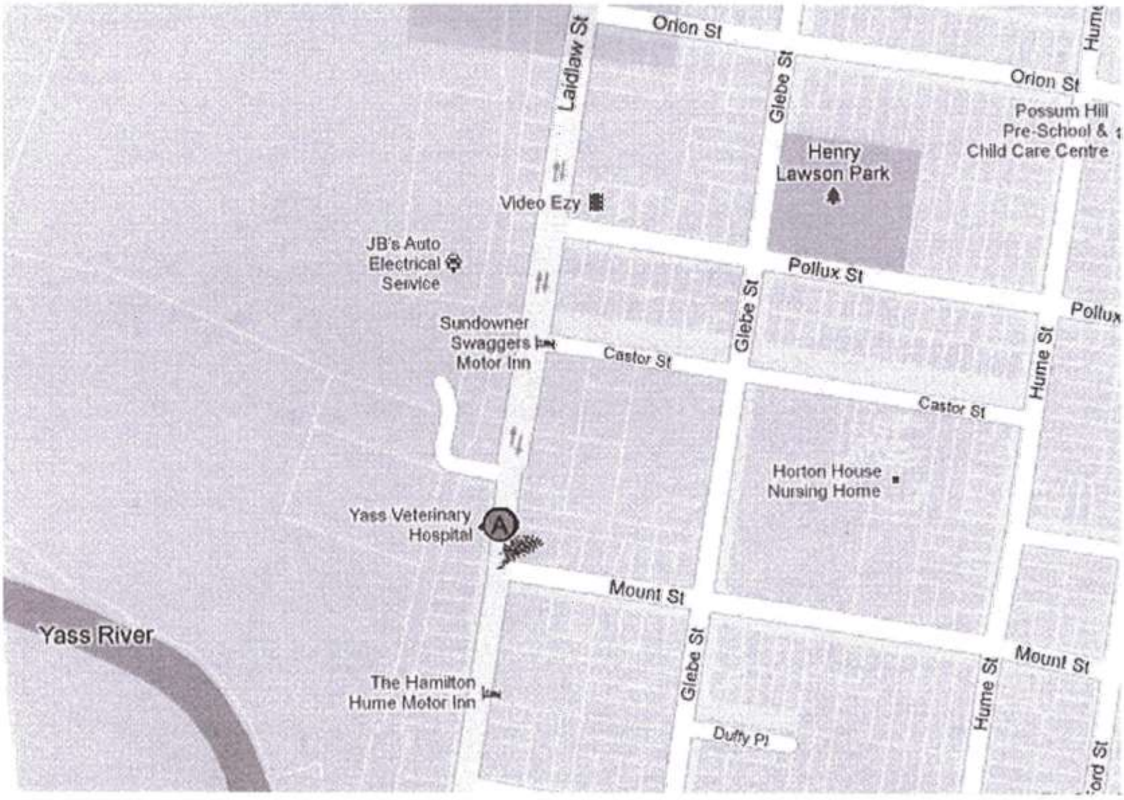
Rates Current At June 2017

	Description	Unit	Qty	Rate	Total
XB	**Outbuildings and Covered Ways**				
79	Steel framed shade shelter including framing and synthetic shade sail	m²	297	150.00	44,550.00
	Outbuildings and Covered Ways				***$44,550.00***
XL	**Landscaping and Improvements**				
77	Instant lawn including topsoil and automated irrigation system	m²	1,716	45.00	77,220.00
97	Blade entrance sign including foundation, lighting, power supply, etc.	Item			10,000.00
99	Allowance for medium sized tree including automated irrigation	No	11	450.00	4,950.00
100	Allowance for large sized tree including automated irrigation	No	2	600.00	1,200.00
	Landscaping and Improvements				***$93,370.00***
PR	**Preliminaries**				
101	Builder's Preliminaries and Supervision (10%)	Item			14,000.00
	Preliminaries				***$14,000.00***
MA	**Builders Margin**				
102	Builder's Margin and Overheads (5%)	Item			8,000.00
	Builders Margin				***$8,000.00***
LL	**Locality Loading**				
103	Locality Loading (10%)	Item			16,000.00
	Locality Loading				***$16,000.00***
CT	**Contingency**				
104	Design Development Contingency (5%)	Item			9,000.00
105	Construction Contingency (5%)	Item			9,000.00
	Contingency				***$18,000.00***
ES	**Escalation**				
106	No Allowance for Escalation	Item			Excl.
	Escalation				***Excl.***
PF	**Professional Fees**				
107	Professional Fees (9%)	Item			17,000.00
	Professional Fees				***$17,000.00***
		Item			1,022.58
					$1,022.58
	LANDSCAPING & IMPROVEMENTS				***$211,942.58***

John Skurr Consulting Engineers Pty Ltd
STRUCTURAL & CIVIL ENGINEERS
2/23 Bentham Street | Yarralumla ACT 2600 | Ph (02) 6282 4620

YASS POOL
STRUCTURAL ENGINEERING INSPECTION REPORT

1. As requested by Peter Harvey of Yass Valley Council, ph. 6226 9275, email peter.harvey@yass.nsw.gov.au, PO Box 6, Yass NSW 2582, I inspected with Robert & Belinda, the Yass pool on Friday the 17th of June 2011. It is located at flag A on the map below, north is up the page.



2. I met with Robert & Belinda firstly at the Yass Valley Council offices at 209 Comur Street, Yass, to view and obtain copies of the pool's original construction plans for information, to understand the issues involved and to better propose remediation options. My office scanned the supplied plans and they are on the

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attached disc to the hard copy of this report sent to Peter at the Council. The paper copies of the plans were already returned to Peter once they were scanned.

3. The pool complex consists of an 55m Olympic pool, a wading pool, an amenities building and a filter house, see attached plan. The main issues of concern to Robert & Belinda were:
    a. Joints spalling in the Olympic pool.
    b. Tile breakage and cracking in the Olympic pool.
    c. Spalling of concrete and concrete cancer rusting of the Olympic pool walls especially on the western wall of the Olympic pool.
    d. Bubbling of the paint lining in the Olympic pool.
    e. Rusting of the step rails on the Olympic pool.
    f. Rusting of the light poles.
    g. Leaking valves.
    h. Cracks in the filter house walls.
    i. Trip hazards on the joint between pool paving slabs.
    j. Blockages in the grated drains.
    k. Change room roof issues.
    l. Disabled access.

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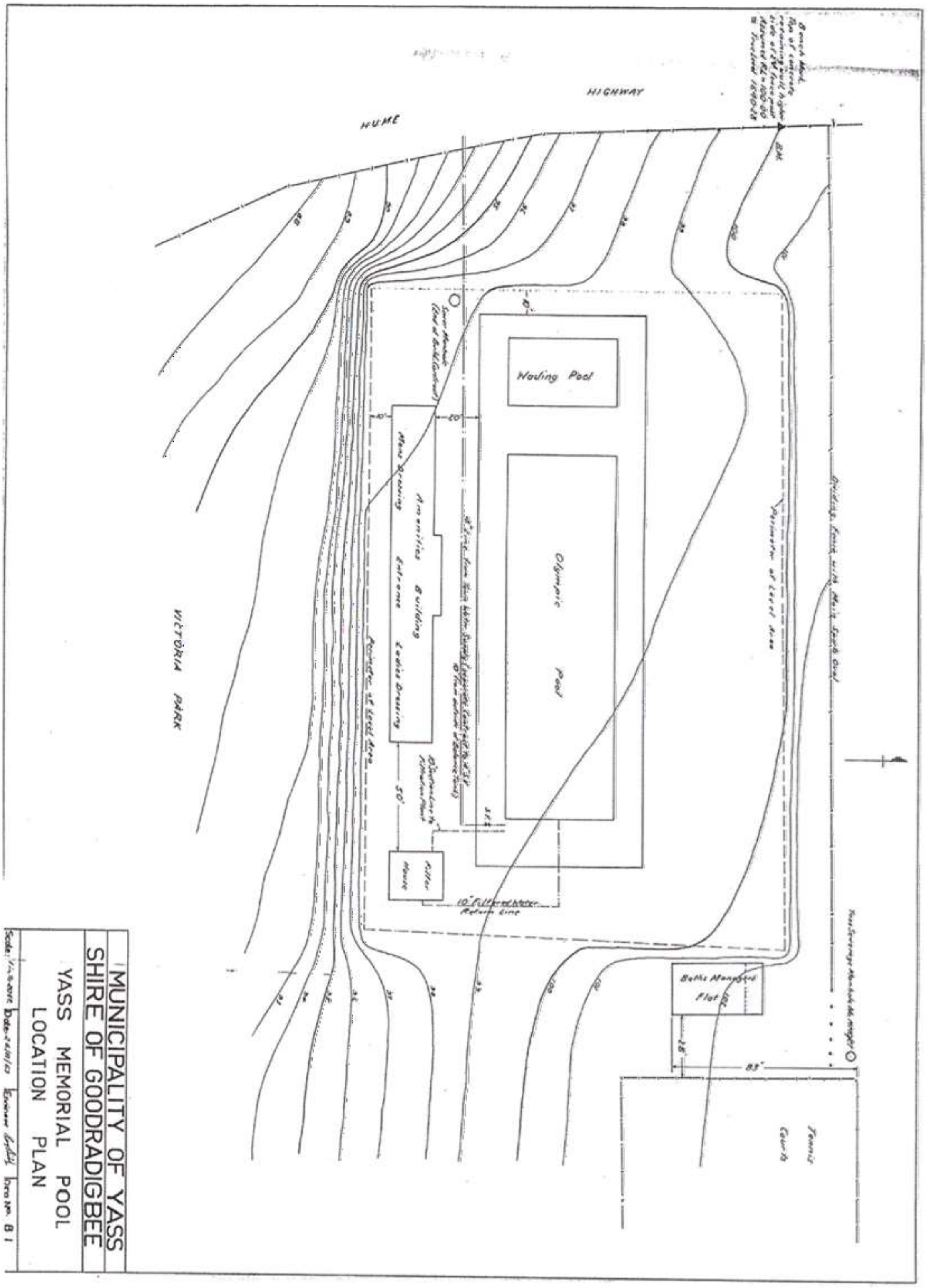
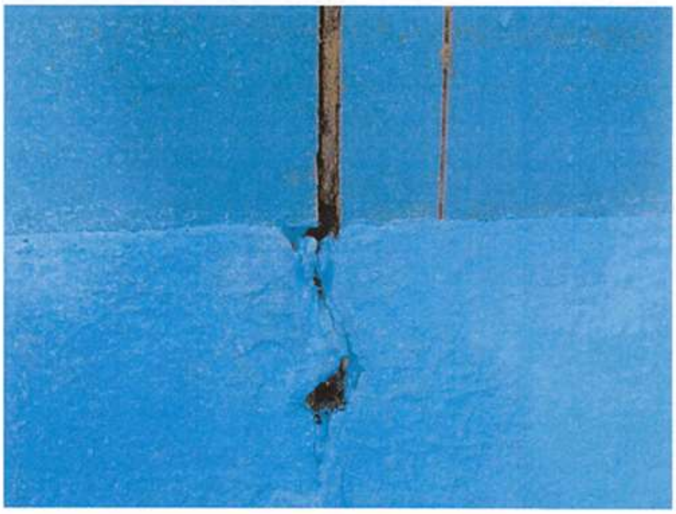

MUNICIPALITY OF YASS
SHIRE OF GOODRADIGBEE
YASS MEMORIAL POOL
LOCATION PLAN
HUME
HIGHWAY
VICTORIA PARK
Wading Pool
Olympic Pool
Amenities Building
Filter House
Tennis Courts

-3-

4. I conclude that the most economical solution is to address the maintenance issues on an as needed basis and to budget to replace the pool in ten years.

5. Each of the above issues is dealt with in turn:
   a. Joints spalling in the Olympic pool.



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These problems are caused by leaching of the cement in the original concrete and as a consequence rusting of the reinforcement which swells causing the concrete to crack and spall, this is called concrete cancer. I recommend the affected areas be chipped out, the resulting surface painted with 2 coats of AV600M, then M8 gal threaded rods epoxied in 100mm at approximate max 100mm c/c each way, gal chicken wire 5 thicknesses placed and the concrete volume restored using AV600M concrete mix maintaining 25mm cover to the chicken wire and M8 rods. AV600M is available from CE Industries, ph. 6280 6010. The joint itself should be maintained and filled with Kuniseal then a backing rod and min 15mm depth of polyurethane sealant Sikaflex Tank to manufacturer's specs including primer etc, again both of these are available from CE Industries.

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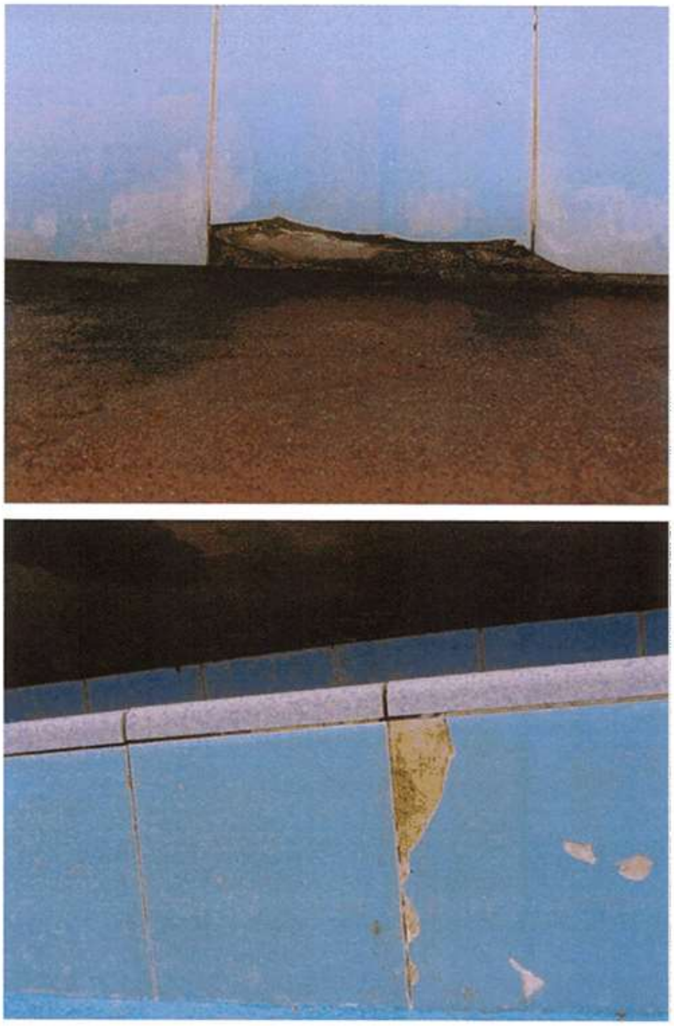
b. Tile breakage and tile cracking in the Olympic pool.



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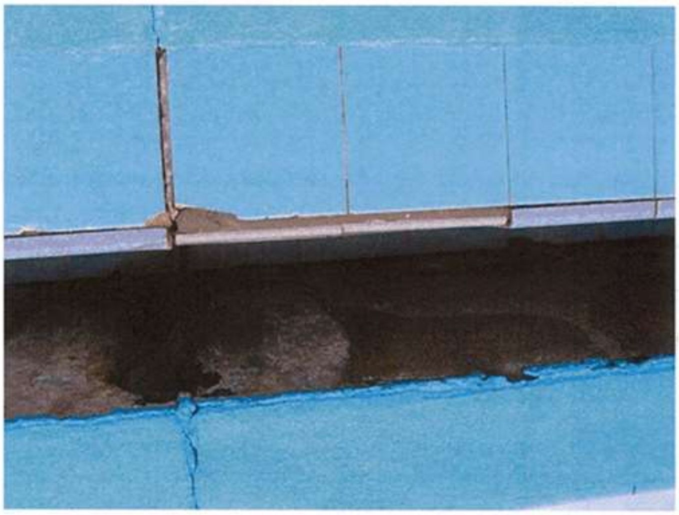

I conclude that this is caused by the frost in winter in combination with the seasonal movement of the pool at the expansion joints.

The affected tiles should be chipped off, the resulting surface painted with 2 coats of AV600M and matching replacement tiles installed. The tiles next to the expansion joint need to ensure that the joint can still move at least 6mm so the joint needs to be 12mm wide minimum and sealed with a minimum of 15mm deep polyurethane Sikaflex Tank.

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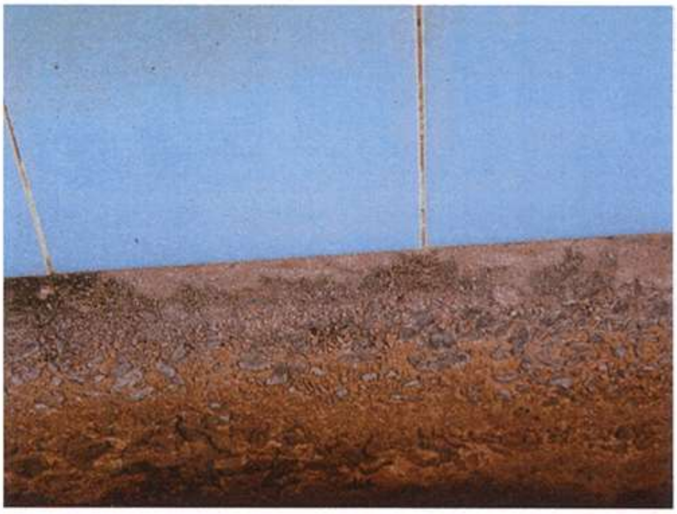
c. Spalling of concrete and concrete cancer rusting of the Olympic pool walls especially on the western wall of the Olympic pool.



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Again I conclude that this is caused by insufficiently impervious original concrete i.e. concrete of inadequate strength in combination with frost. The drawings call up 4000psi concrete i.e. 27MPa, however I assess the actual insitu strength is closer to 20MPa.

I recommend that the surfaces affected be painted with 2 coats of AV600M concentrate before repainting. I recommend an area be trialled first to ensure that the paint and AV600M are compatible.

d. Bubbling paint lining.

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I conclude that this is the same problem as (b.) above but to a lesser extent. I recommend that the bubbled areas be wire brushed, two coats of AV600M applied and the surface repainted. Again a trial area is recommended to check the compatibility of the AV600M and the paint.

e. Rusting of the stair rails at their bases.

This is a difficult issue to solve. The current regime of painting with epoxy paint and checking that the rails have not been rusted sufficiently so

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that they are structurally inadequate by pulling them hard is recommended to be maintained.

f. Rusting of the light poles.

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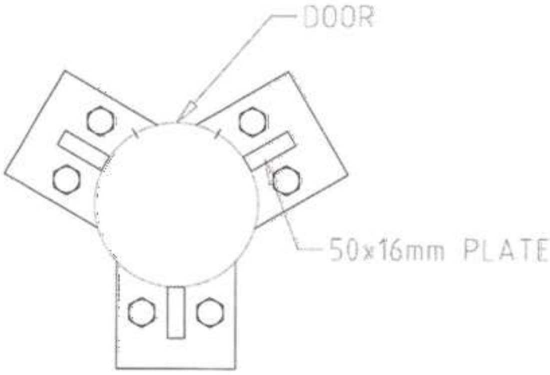
These poles are concluded as inadequate as they have rusted a good proportion of the way through. They should be reinforced with 3 off 50x16mm plates at 120° so the access doors can still be used, approx. 1.5m high, stitch welded to posts 3mm fillets weld 50mm leave 50mm from approx. 1m above the ground with 45° chamfer with 16mm baseplate & 2/M16 gal threaded rods epoxied 150mm into existing footing, see sketch below. The result should be painted



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g. Leaking valves.

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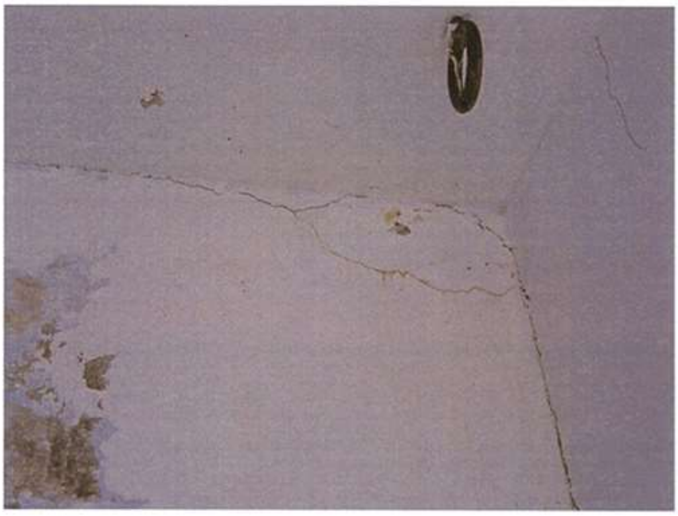
Robert advises that there are some leaking valves that require maintenance. I recommend that these be costed to determine if replacement is in fact cheaper than further maintenance over 10 years.

h. Cracks in the filter house walls.



These are caused by the roof slab shrinking after construction and possibly footing settlement. They are not a structural issue and should be ripped with a screw driver and filled with "no-more-gaps" and painted.

i. Trip hazards in the pool surround paving.

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These should be ground down at 10H:1V if they are more than 5mm high. This is because the Council is leaving itself open to an insurance claim if they are more than 5mm high as the paving then does not conform to AS1428.1 clause 5.1.2 last line, copy attached.

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4.15 Walkway

Any accessway with a gradient not steeper than 1 in 20.

5 WALKWAYS, RAMPS AND LANDINGS

5.1 General

5.1.1 *Circulation space*

Accessways, walkways, ramps and landing shall have—

(a) an unobstructed width of not less than 1000 mm; and

(b) an unobstructed vertical clearance of not less than 2000 mm, and

the gradients and crossfalls of the surface area within a landing or circulation space shall not exceed 1:40.

5.1.2 *Continuous path of travel*

There shall be a continuous path of travel to and within any building to provide access to all required facilities.

A landing or circulation space shall be provided at every doorway, gate, or the like, on an accessible path of travel.

Acceesways, walkways, ramps and landings shall be constructed with no lip or step at joints between abutting surfaces.

NOTE: A construction tolerance of up to 5 mm is acceptable using rounded or bevelled edges.

5.2 Walkways

The requirements for the design and construction of walkways are as follows:

(a) Walkways shall be provided with landings as specified in Clause 5.7, at intervals not exceeding the following:

(i) For walkway gradients of 1 in 33 .... 25 m.

(ii) For walkway gradients of 1 in 20 .... 15 m.

(iii) For walkway gradients between 1 in 33 and 1 in 20, at intervals which shall be obtained by linear interpolation.

NOTE: Landings are not required where walkway gradients are flatter than 1 in 33.

(b) The gradient of walkways between landings shall be constant.

(c) The intervals in Item (a) may be increased by 30% where at least one side of a walkway is bounded by—

(i) a kerb as specified in Clause 5.3(f) and a handrail as specified in Clause 5.3(e); or

(ii) a wall and a handrail as specified in Clause 5.3(e).

(d) If no kerb and handrail or wall and handrail are provided, the ground abutting the side of the walkway shall follow the grade of the walkway and extend horizontally for 600 mm.

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j. Blockages of the grated drains.

Grated drains are notorious for blocking this way. The inlets should be modified to side entry pits.

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k. Change room roof.

The change room roof needs maintenance work and perhaps the gutter removed to prevent blockages.

l. Disabled access.

The council may need to address the issue of disabled access.

6. The supplied plans are attached

John Skurr

BE CIVIL UNSW (HONS) MIE AUST. CPENG. DIP. ECO. NPER. 118674

8.9.11

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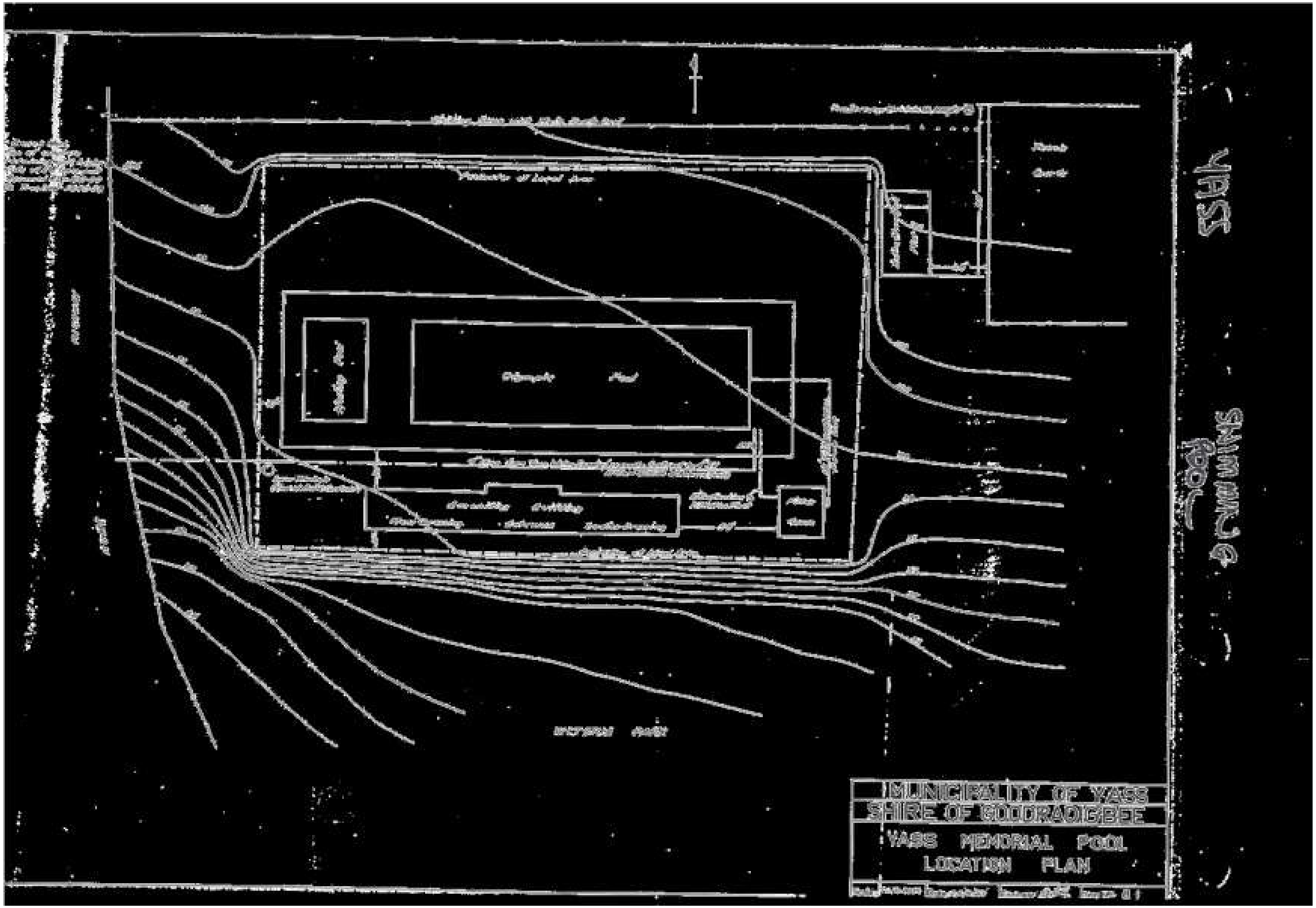
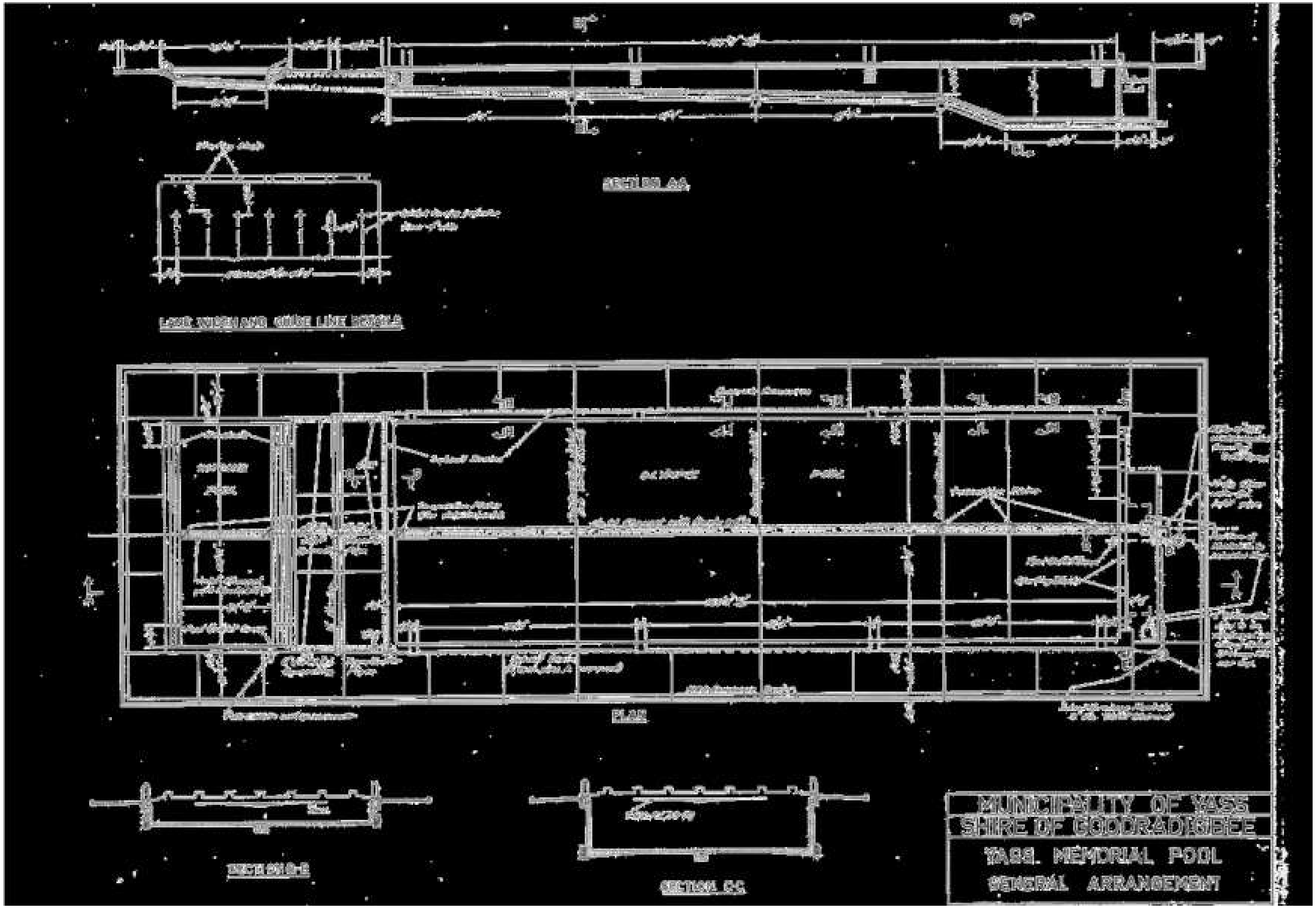
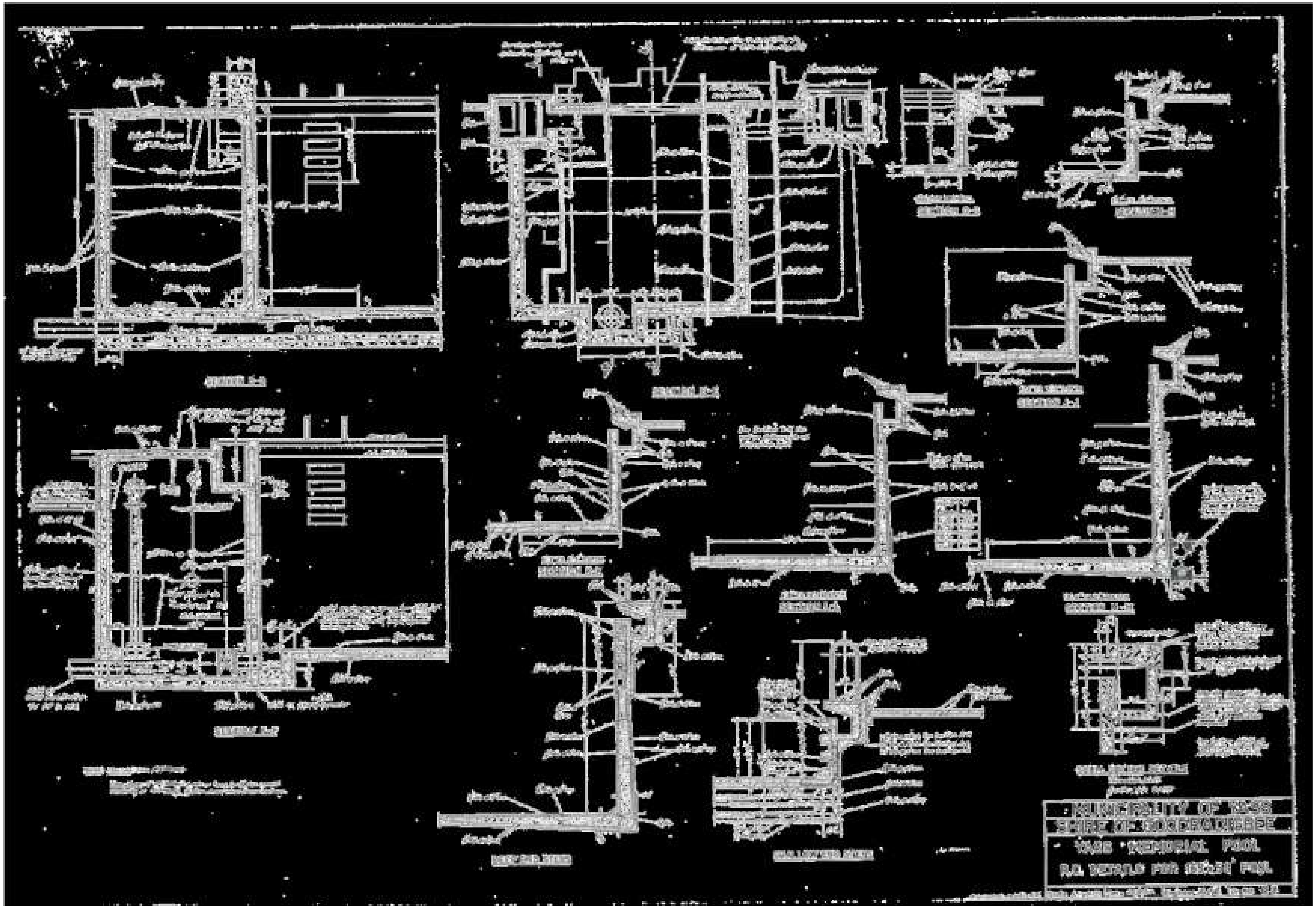
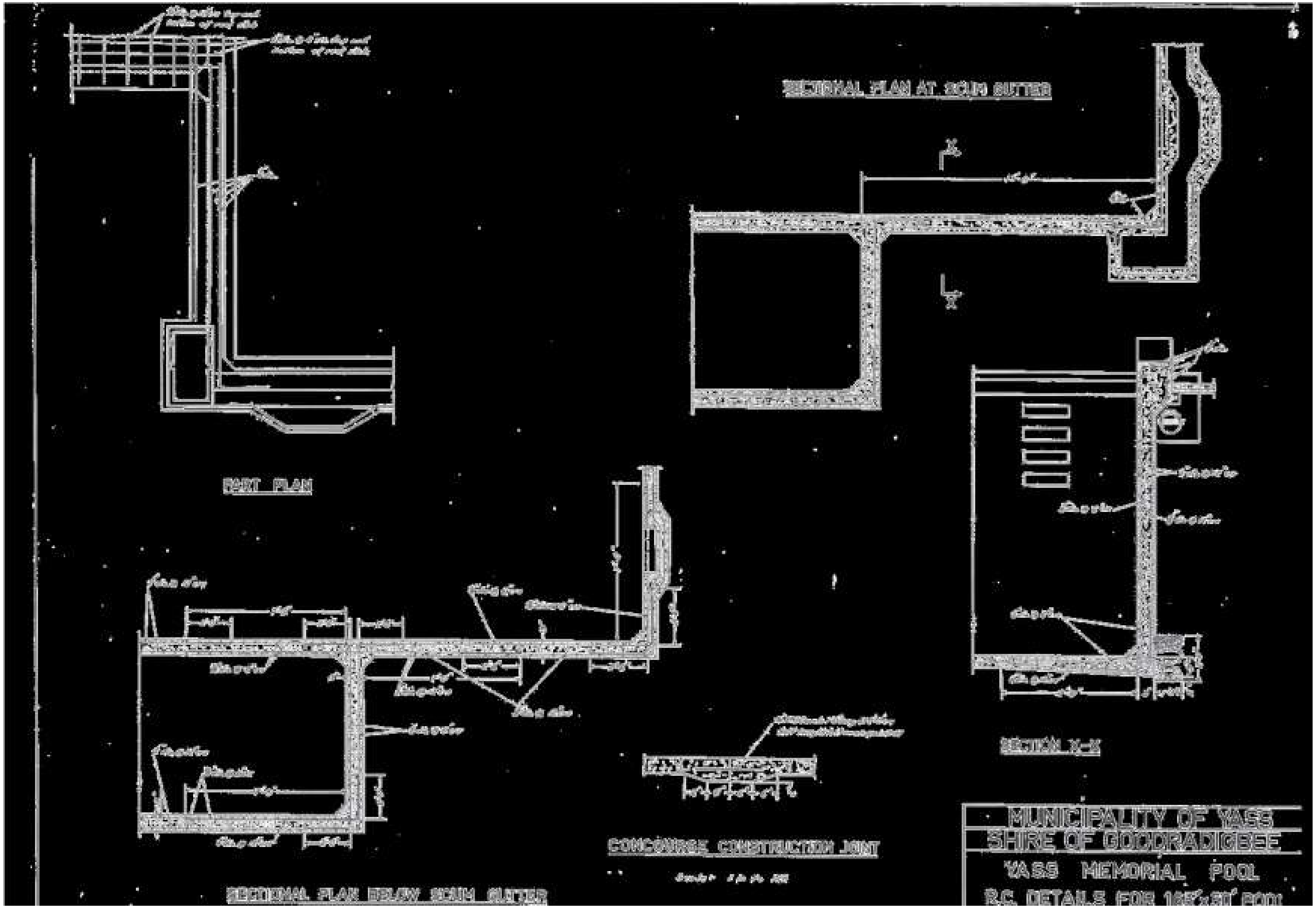
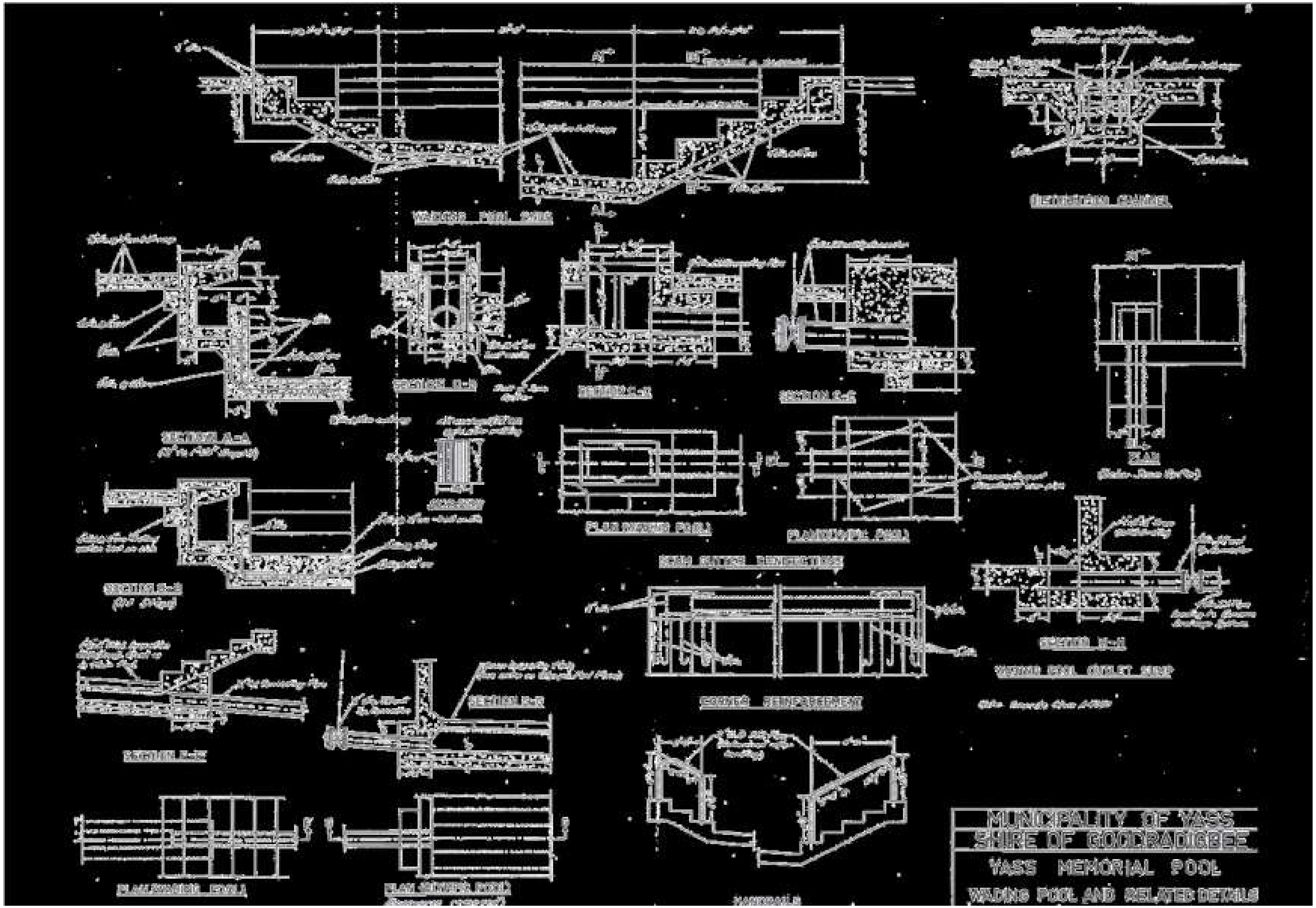
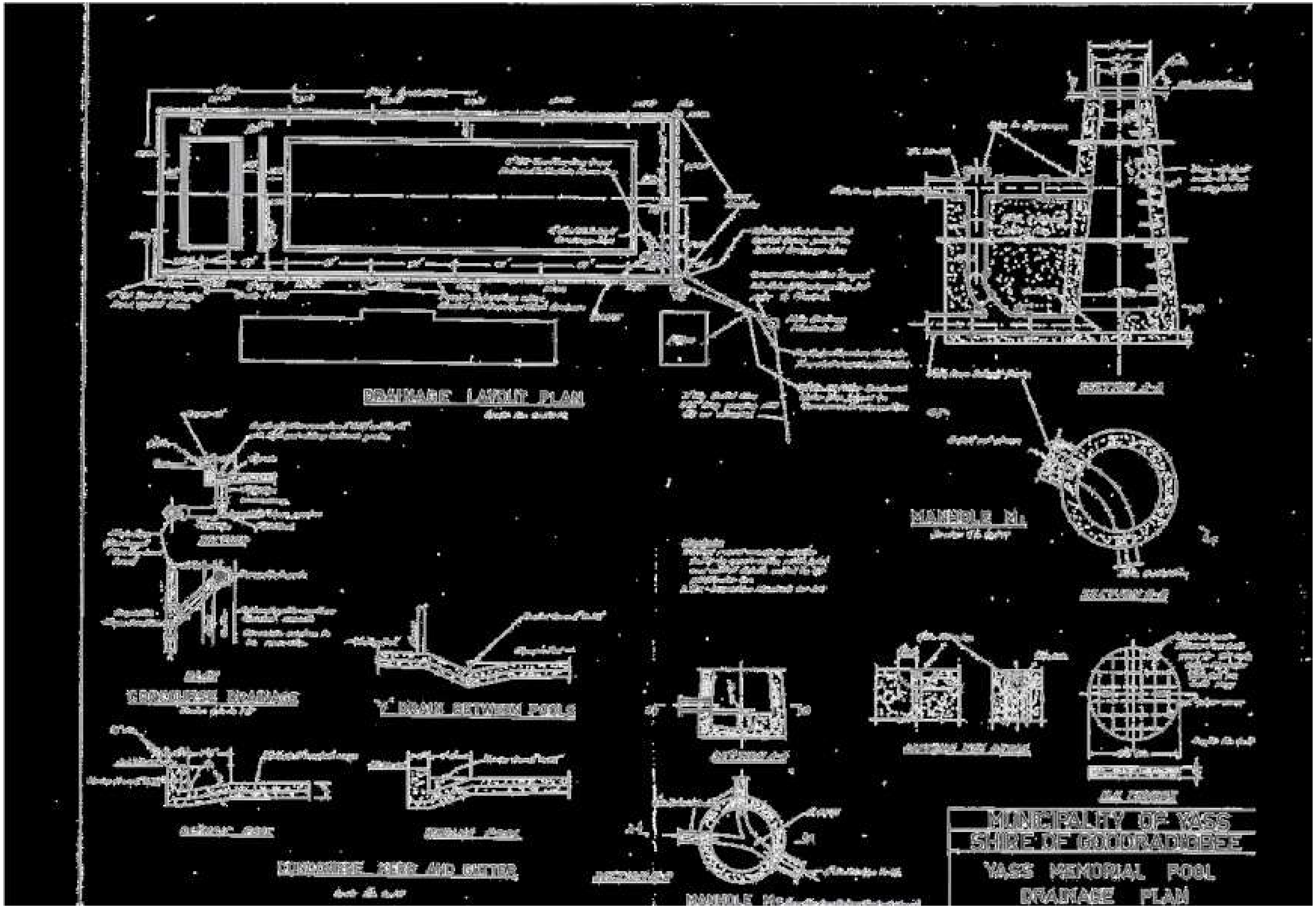

YASS SWIMMING POOL
MUNICIPALITY OF YASS
SHIRE OF GOODRADIGBEE
YASS MEMORIAL POOL
LOCATION PLAN

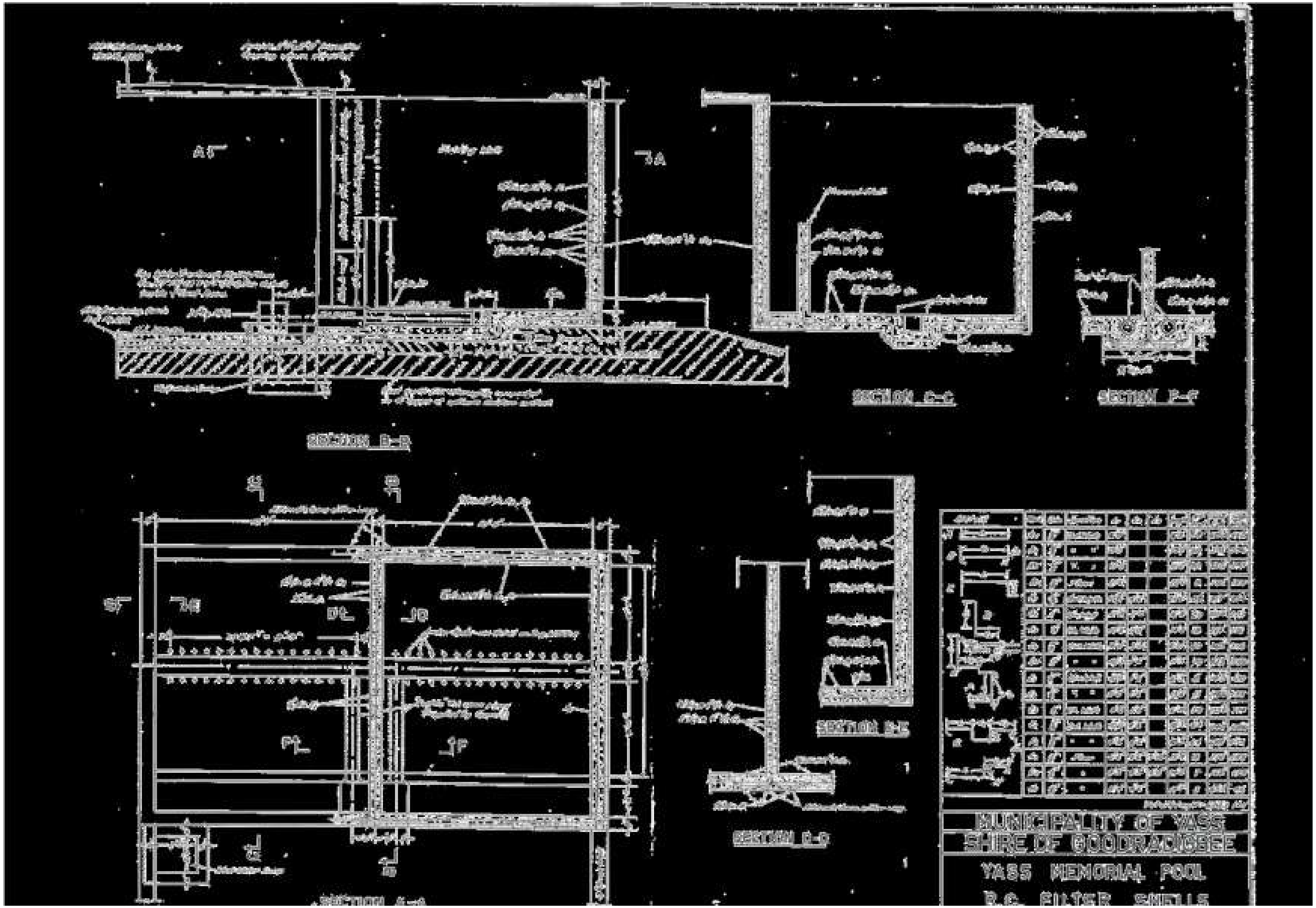

SECTION AA
PLAN
SECTION CC
MUNICIPALITY OF YASS
SHIRE OF GOODRADIGBEE
YASS. MEMORIAL POOL
GENERAL ARRANGEMENT

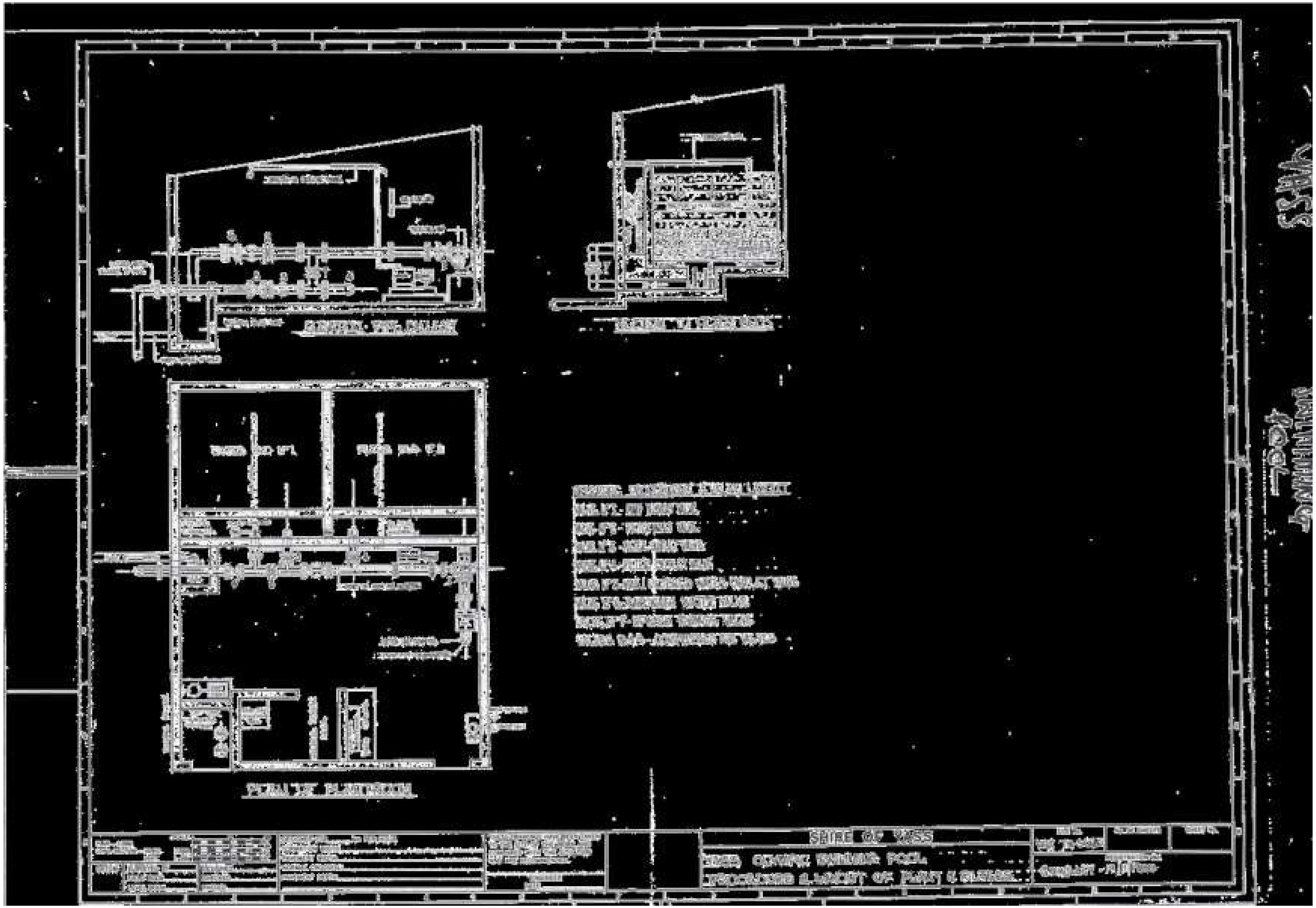


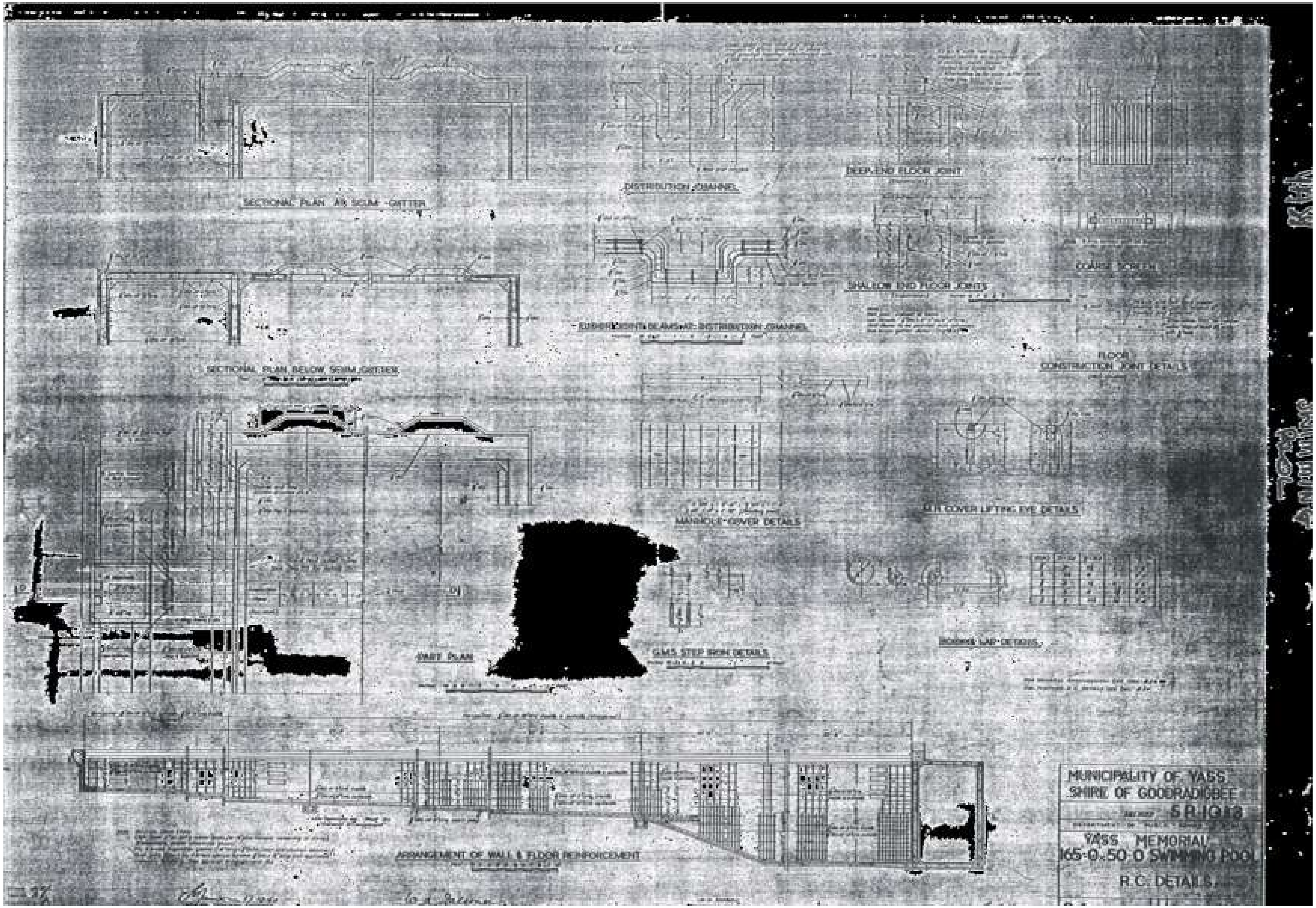

SECTIONAL PLAN AT SCUM GUTTER
PART PLAN
SECTION X-X
CONCOURSE CONSTRUCTION JOINT
SECTIONAL PLAN BELOW SCUM GUTTER
MUNICIPALITY OF YASS
SHIRE OF GOODRADIGBEE
YASS MEMORIAL POOL
R.C. DETAILS FOR 165'x50' POOL


MUNICIPALITY OF YASS
SHIRE OF GOODRADIGBEE
YASS MEMORIAL POOL
WADING POOL AND RELATED DETAILS
CORNER REINFORCEMENT


DRAINAGE LAYOUT PLAN
CONCOURSE DRAINAGE
"V" DRAIN BETWEEN POOLS
MANHOLE No.
MUNICIPALITY OF YASS
SHIRE OF GOODRADIGBEE
YASS MEMORIAL POOL
DRAINAGE PLAN


SECTION C-C
SECTION F-F
MUNICIPALITY OF YASS
SHIRE OF GOODRADIGBEE
YASS MEMORIAL POOL
R.C. FILTER SHELLS


SHIRE OF YASS


SECTIONAL PLAN AT SCUM GUTTER
DISTRIBUTION CHANNEL
DEEP END FLOOR JOINT
SHALLOW END FLOOR JOINTS
COARSE SCREEN
SECTIONAL PLAN BELOW SCUM GUTTER
FLOOR CONSTRUCTION JOINT DETAILS
MANHOLE COVER DETAILS
LIFTING EYE DETAILS
PART PLAN
G.M.S. STEP IRON DETAILS
ARRANGEMENT OF WALL & FLOOR REINFORCEMENT
MUNICIPALITY OF YASS
SHIRE OF GOODRADIGBEE
YASS MEMORIAL
165-0 x 50-0 SWIMMING POOL
R.C. DETAILS

Crago Mill Precinct

Initial Submissions

What item are you making a submission on? * Civic precinct 209 Comur St

Submission *

I support the redevelopment of the civic precinct (209 Comur St/ Crago Mill) to provide improved administration office space and chamber for the Council, community library and community meeting spaces, as generally outlined.

Redevelopment should include the whole of the area to Polding St, to provide adequate parking and access off Polding St.

The site should be designed as a whole and add to the Comur streetscape – rather than detract, as the current Council offices and Aldi do.

Design should enhance Yass's heritage assets. The building(s) should not crowd onto Comur St, but should be sited to provide some open space and sense of scale – the Crago Mill should not be built out, but should be a feature. It will be interesting to see whether and how the Mill should be restored or used in some way.

1

Perhaps the civic centre could incorporate a museum space as well as the library. Perhaps a museum space could be associated with an information centre and the Historical Society/community archives (in the Crago Mill?), with all associated with/linked to the new library – the current arrangements are ad hoc, disjointed and dysfunctional. This is an opportunity to make more of these information assets and provide a boost to Yass tourism opportunities and community knowledge.

Removing the library from its current location at the rear of the Memorial Hall provides an opportunity to think about the re-use/redevelopment of that whole site.

Clearly the Memorial Hall should be retained. It needs to be fully restored as the important community asset it is.

However, perhaps the supper room, library space and public toilets (which are run-down and woefully inadequate) should be re-developed/re-purposed in a way that enhances the Memorial Hall and also public access to and use of Banjo Paterson Park.

The rear of the Memorial Hall/library space could perhaps be developed to not only better provide for concerts, but also to provide properly for repertory performances and convention/community meetings, with proper changing rooms and toilets linked to the Hall and supper room and public toilets for Park users.

With good design, it may be possible to provide a small performance space where the current public toilets are located that is elevated & open to the Park (& with access to the Hall's change rooms and toilets). The alley linking the Park to Comur Street could become a feature and the parking behind the NRMA removed.

No doubt all costly – but there needs to be some overall vision & long-term goal – works need to be well designed and staged, perhaps over many years. Rome wasn't built in a day!

To Whom it may concern

Hi
I read in the Yass Valley Times on Wednesday Sept 2 that council are hoping to have a new civic precinct which is great for the town and hoping that local contractors of all fields will be used to support the community at this difficult time.

I agree with 209 Comur St being the site.

There are some thoughts I have which I hope will be included in the building which I have attached in a document.

I am glad council are now asking for community feedback on this and hope it continues.

1

Ideas/Suggestions - New Civic Precinct for Yass

I do agree the best place for the council building is 209 Comur Street as it is a nice and central location.

No Accommodation should be at this place as council should support existing local businesses and use these accordingly.

Details of building site in/out should include –

Underground parking for staff
Plenty of parking for clients

Solar panels and any other eco friendly environment features

Entry and Exit doors should be separate and automatic (no handles on doors – ready for next virus!) for entry with easy grade ramps
Within the building too there should be automatic doors (again with no handles)

Foyer should have a public lift
Foyer should have public toilets, suitable access for disabilities including baby changing room

Great a new library to be included within this building – hope it contains:-
. Dedicated young children area for books, craft, story time etc
. Dedicated study area with desks and computers
. Dedicated general reading area for magazines and newspapers
. Dedicated Large Print area
. Very good lighting
. Hours of opening of the library should have at least one day of early opening i.e.8am and at least one late closing 7pm

Housing of Archives should also be in this building rather than in a present location in tunnel near old library. If it was a friendly atmosphere and located alongside/near proposed new library then it will probably get used more often with client friendly hours of opening.

SUBMISSION ON COUNCIL'S CIVIC PROJECT

Dear Councillors with copy to fellow ratepayers,

As a ratepayer born and bred locally and as a student of Council's behavioural history I feel that I am qualified to provide background and comment on the call by Council for public submissions on the proposed "civic precinct for Yass", or as it probably should say, Yass Valley Local Government Area. Over 20 years ago the brainwave came to Council of a new beaut showpiece of how great we are. Council then began a procurement process diverting ratepayer money away from such things as roads, bridges and community infrastructure to fund the land purchases of land surrounding Council.
In rough date order,

- 1997 207 Comur St $115,000
- 2000 209 Comur St $ 75,000
- 2005 10 Adele St $715,000
- 2005 205 Comur St $335,000
- 2006 197 Comur St $1,200,000
- 2006 221 Comur St $1,210,000
- Undisclosed details of the land swap deals within the surrounds of Council that are now are a supermarket, car park, Council owned access to car park and provision for rear access to other land acquired. Some of the surrounding residences were also approached.
- Council has recently consolidated all the land and in doing so washed the individual purchase prices into a book value a fraction of the total paid.

Council has not provided any ongoing disclosure as to why the purchases were being made and more recently admitted, in writing, that all purchases were done with no commercial, independent or indeed any valuations. In one instance Council paid over 7 times the previous owners purchase price of 5 years prior.

If you add to the sum of the Council's purchases, compounding interest, the loss of rate revenue plus insurance and holding costs the ratepayers are out of pocket around 4 million dollars and growing. Let us no forget the 2014 Council cry for rate rises while sitting on these millions in real estate and the $3,200,000 paid in 2010 for the Hawthorn property at Murrumbateman where again funds were diverted..

Now we ratepayers now are supposed to suck it up and believe that this is all for us.

1

Council current advertised "wish list" is a new library, community meeting rooms, exhibition spaces, eCommerce small business centre/hub, office accommodation, short term accommodation for Council contractors, retention on Crago's Mill and an open area plaza.

As an example of why ratepayers should be watchful of any Council "wish list" an eye is immediately drawn to "short term accommodation for Council contractors". So we are led to believe that this proposed short term accommodation is to reduce Council's motel accommodation costs.

Consider,

- For Council to include a motel, no matter how small, there is the building cost, the ongoing running cost and in this case the lost opportunity cost of not having the space and the money put to another use.
- Council has put out no figures on how much Council currently spend on accommodation costs for contractors and might I say that most contractors would want to organise their own accommodation as a Council offering would not generally fit machinery parking nor match worker/ room numbers.
- If Council want to go into the motel business with ratepayer money and compete with local suppliers then an arms length business case needs to be provided as part of the community consultation process.

I am very much used to looking under the rock that is Yass Valley Council. What I see is a sub process to promote a ratepayer funded crash pad in Yass for tired and weary public servants. Rather than have the long drive home out of Yass Valley the option of a fully serviced free motel room would seem a good one.

I am not against Yass Valley getting a new beaut civic centre but I am against what is not in the best interests of the community. One needs only to look back to the community consultation for the Park and Ride and the Fit for the Future 8.5% year on year rate rises to see examples of predetermined outcomes and scripted meetings run by hired professionals under supervision.

Under the rock again were the benefits of a car park adjacent to a new beaut civic precinct. How lucky would that have been if Park and Ride had ended up across the street?

Council has a broad integrity problem and especially with community consultation that is highlighted in studying what a voted Council resolution actually means.

Minutes of the Ordinary Meeting of Council held on 26 August 2020.
RESOLVED that :

1. Council commence an immediate cross media strategy to publicise to the Yass Valley public its intention to begin work on a civic precinct project. The strategy to highlight

a. The favoured location – 209 Comur Street, Yass

b. The scope of the intended works to include but not limited to a new library, community meeting rooms, small business centre/work hub, short term accommodation, space for long term government tenants

2. Feedback from the public be received by submissions through a range of suitable mechanisms including a forum

3. A procurement process be undertaken to engage a suitably qualified and experienced consultant for the project

Do we believe that the system will provide a forum / community consultation? Let me provide an example of what can happen.

Minutes of the Ordinary Meeting of Council held on 27 February 2019

RESOLVED that Council seek the owner's consent to conduct a community forum, followed by a council workshop, on options for the Liberty Theatre.

There has never been any community consultation for the Liberty Theatre nor a retraction of the motion yet the resolution says go do it and it didn't happen.

2

It begs the question as to why we should believe that the two decades of silence on land purchases and the community rumblings of what is affectionately called the TAJ will result in true community involvement.

If it looks like a duck, smells like a duck and tastes like a duck then it is probably Council ducking.

Somebody or some people at Council need to come clean and be prepared to bare what has gone on and be prepared to cop some flack. This cleansing process is needed if we ratepayers are to begin to believe that we are being told the truth and that we actually will be listened to. Without such disclosure there can be no building of trust and no confidence in a just outcome.

This submission calls on Council to appoint and Independent Ombudsman or such and stand aside.

This is not a new concept as Council has done this many times over the years when conflict of interest has been perceived or real. There is so much at stake, so much secrecy, so much Council baggage and the risks so high that an independent body needs to provide oversight via a public report on events to date, then run the community consultation and finally provide recommendations as how to proceed. The cost of such a process would certainly be recouped from savings at planning level and is the only way to clear the air on what is currently heading towards a near total $30 million project.

What item are you making a submission on? * Civic Precinct Ideas

Submission *

Hello, thank you for providing this forum to hear from the public.

The old rail line going through town is a bit of an eyesore and in need of attention. I think turning attention towards revamping this would be an act of preservation of the towns' history and an embrace of future travel around a growing town.

My suggestion is that this be converted into a walking/cycling path, including the old train bridge, which would receive lots of traffic. The old bridge is beautiful and without any consideration, it will undoubtedly become dilapidated and dangerous. If it once took the weight of a train, it shouldn't require much work to take the weight of foot/cycle traffic.

If there was space somewhere along this path, which could encompass a "lap" of town, where a business or two (similar to that of the pop-up village ANU once had) was able to perch and serve coffee or lunch around a seating

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area beside the bridge, this would surely be a popular tourist and local haunt.

2

The Expression of Interest process has commenced for qualified designers to undertake the design and project management of the Civic Precinct. Under this process we do not specify who they employ to undertake the project however I am aware that many of the companies likely to submit an Expression of Interest do engage recent graduates or persons working toward their qualification.

I would encourage you to monitor the progress of this project and once an announcement has been made on the preferred design firm make an approach to that organisation. You may also wish to make inquiries with other design firms about their graduate positions and internships.

I wish you well with your endeavours to progress a career in building design.

Hi,

I've come across a article about the civic precinct.

In reading this it mentions that qualified designers should apply.

I am currently studying building design and was wondering if you would incorporate a student to work with a qualified designer to design this new precinct. I could provide you with teacher references if you require.

I am a Yass local and have a pure love for the old buildings and heritage in our community.
The old mill site, if structurally sound would make a beautiful shopping terrace.

I would love to be apart of this project if I am able to.

[EXTERNAL] Please exercise caution when clicking on links or attachments from external sources.

Dear Council,

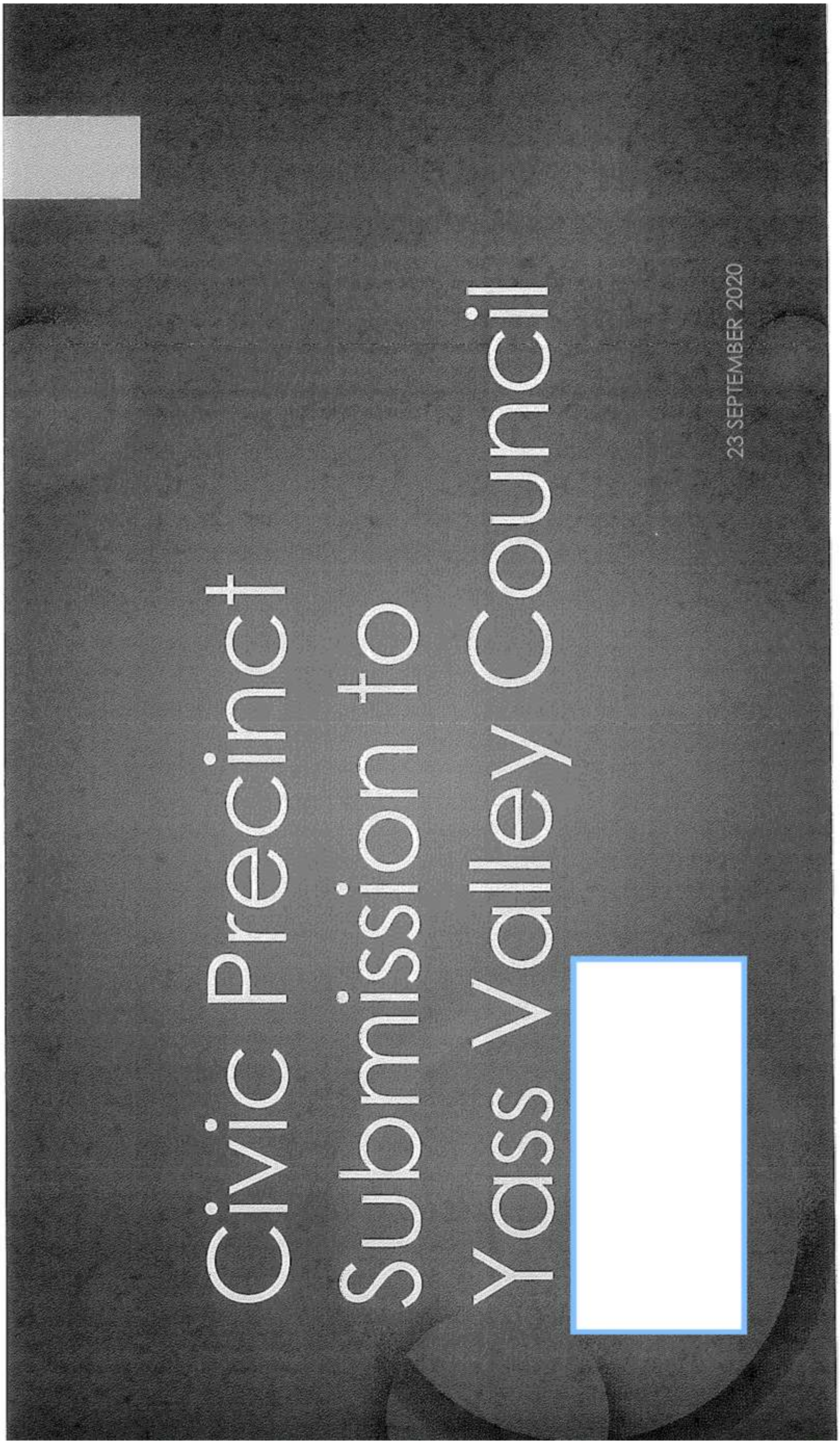
Please find attached a submission on the proposed new Council Precinct. It's short and dot-pointed, like the paper Councillors received on this matter. It even has pictures, lest anyone struggle to imagine a brighter future for the Yass Valley.

I look forward to the public Forum being held soon, as per the Council decision. I reiterate the need to consult the public at every stage of the process to ensure we get the results the community wants and needs.

I'd expect that Council will run the Forum in a very open and transparent way, and before a contractor is selected or any decisions are made. Not like the well-attended public meeting for a Heated Pool some years ago - when a former staff member told the room what we could and could not have - and everyone left deflated but unsurprised. And here we are, still no heated pool despite genuine efforts by community members.

It is not impossible to get community support to build and pay for new public buildings. With the right approach and genuine consultation, and genuine efforts to get grants, you can take people with you. And we will end up for a flexible, future focused facility that everyone can use for years to come.

Happy to discuss, of course.


Civic Precinct Submission to Yass Valley Council
23 SEPTEMBER 2020

Council buildings belong to the community across Yass Valley LGA

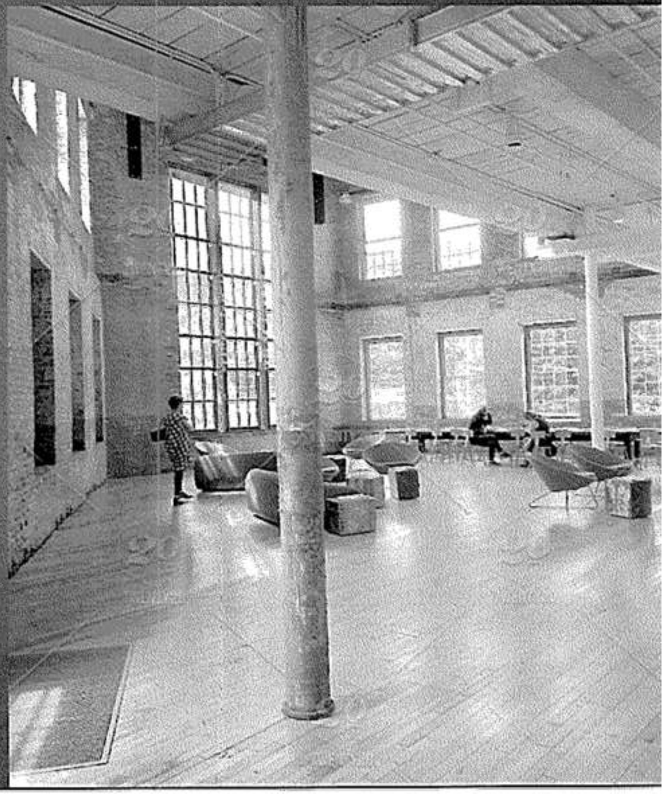
- **Key Points**
  - Council should include the following in the Precinct:
    - Library, co-located with/next to open plan co-working spaces/Country University Centre;
    - Council Services Shopfront/Desk (combined with Library check-out desk?)
    - Council Chamber and Office Space for staff that is light, bright and flexible.
    - Youth Centre and community meeting rooms - bookable and after hours access through an app, for free.
    - Short-term office spaces for start-ups or short-term business leasing (to encourage new businesses to open in the Yass Valley).
  - Accommodation **should not** be included in the Precinct.
    - Council is not, and has never been, a provider of accommodation services.
    - Other businesses in town will lose trade if Council competes in this space.
    - Employing or diverting time for existing Council staff to make reservations and clean rooms will negate any possible financial benefit.

1st Preference site:

- **Rossi Street - Transborder Bus Depot site**
  - A land swap offer could be made to Transborder for existing Council-owned land on Laidlaw Street/Wargeila Road, reducing noise.
  - A new Council building on Rossi St would still be in the CBD, and could be designed to withstand flooding with carparks underneath.
  - A new **Outdoor Stage** (with change rooms and toilets) could face the oval and the river, to be used for live performances, school and dance concerts, Carols by Candlelight, yoga, Parkrun, markets, festivals, community events, etc. Please see images following.
  - Library and community rooms above the stage could have a deck and large windows overlooking the river, and staff offices/Chamber could be above that.

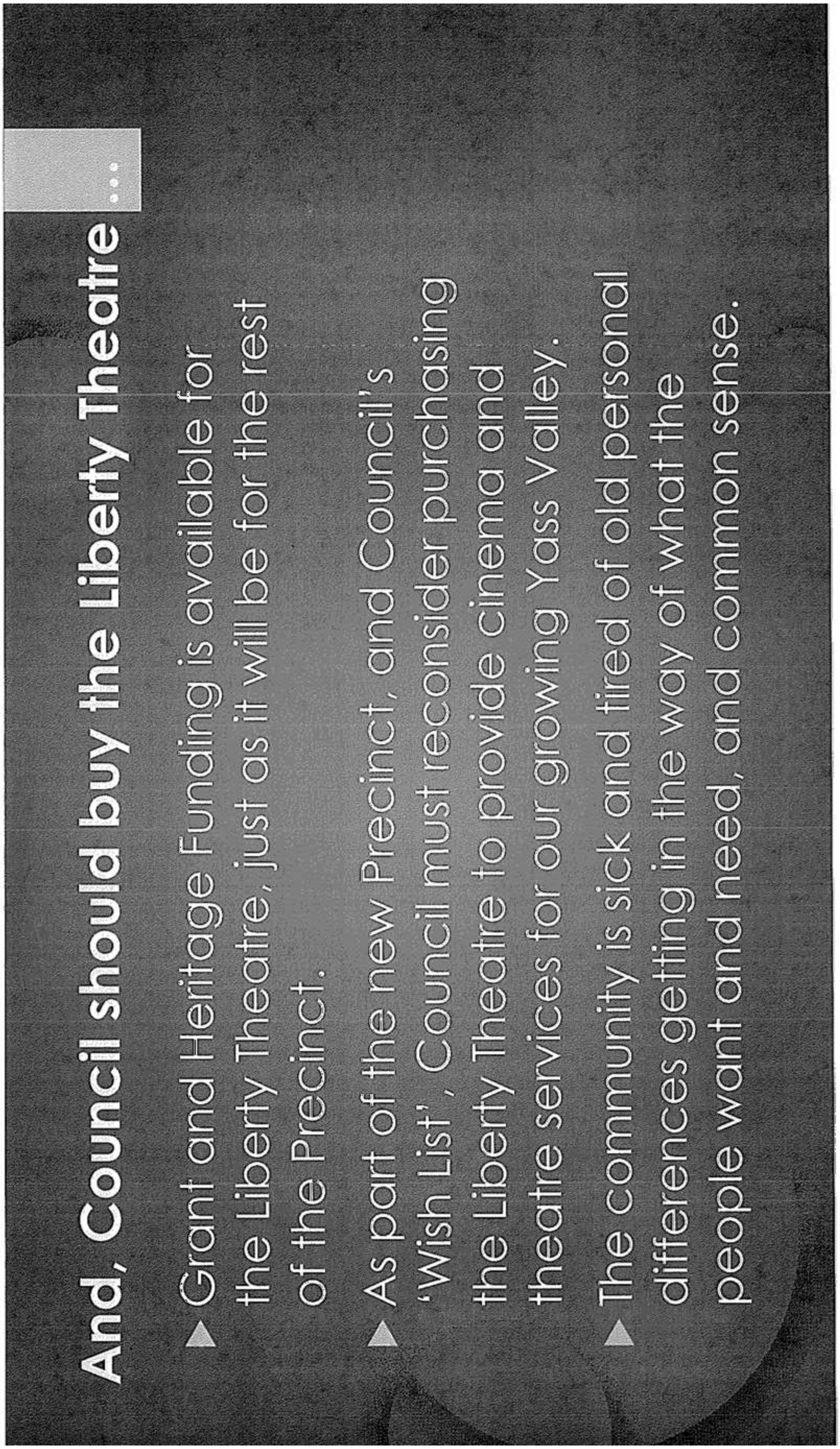
2nd Preference: 209 Comur St

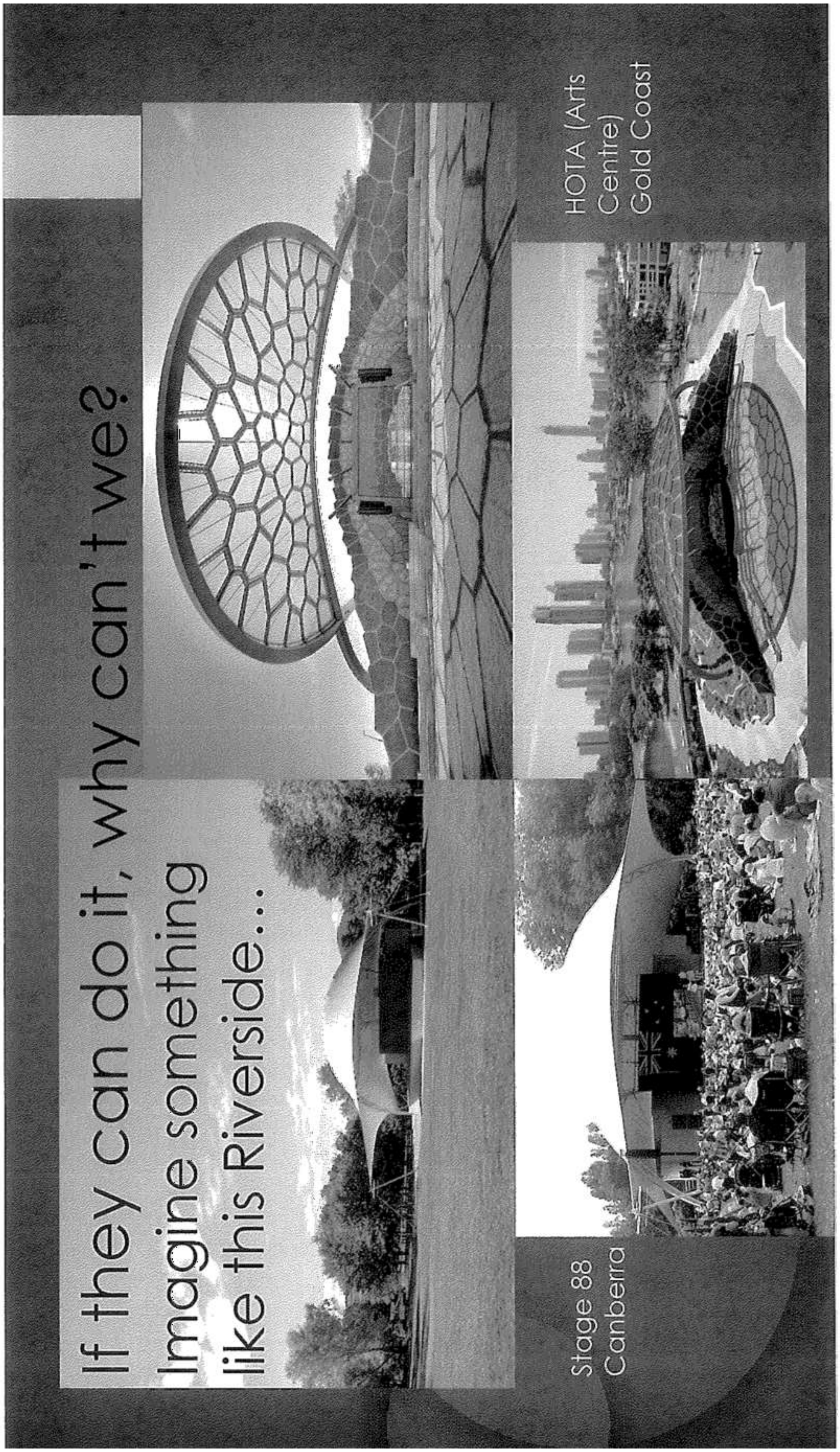
- If Comur Street is chosen, **Crago Mill** must be used as part of the Precinct, not just left to rot.
- Creative architects and engineers can ensure safety and a modern use, integrated into the precinct and not just 'preserved' until it falls down.
  - The Mill could include open plan internal office space for staff with a 'NYC Warehouse' feel.
  - Ground level could be used for community rooms/functions, Chamber/Gallery; or a Youth Centre.
  - Please see more images below for ideas.
- Shopfronts on Comur Street could ensure business or retail space with foot traffic, and street presence can be leased for good returns to ratepayers, and improve the streetscape which is so long overdue.

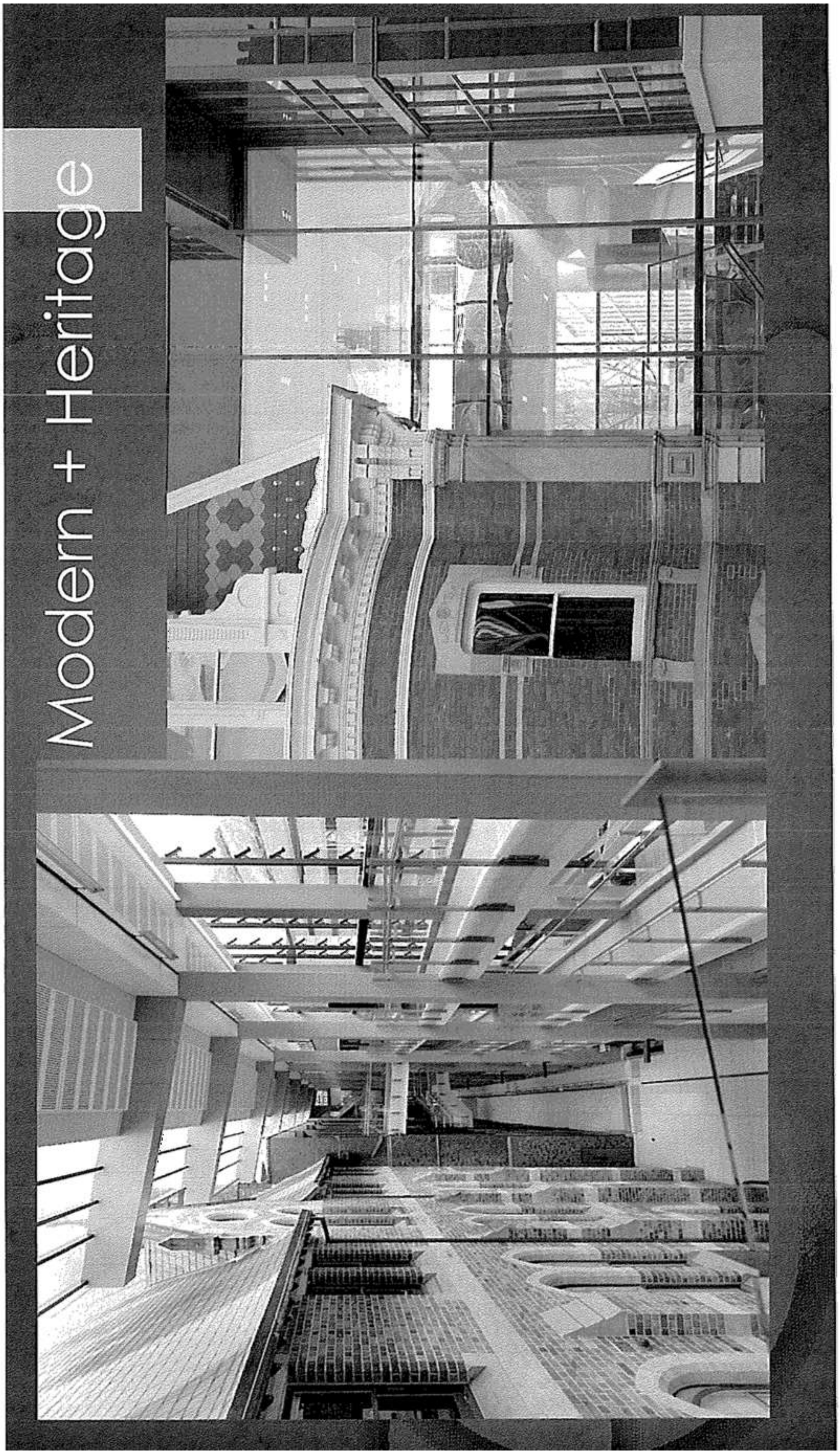


While progressing the Precinct, Council also need to progress a Sport and Recreation Centre and Heated Pool

- Council is already well aware that young people need more facilities in the Valley and prospective funding must be available.
- Council should consider purchasing the old Landmark building as a **Yass Valley Youth Centre/Sport and Recreation Centre.**
- **OR** – these could be included in the **Heated Pool Project**:
  - It should include indoor netball/basketball/volleyball/soccer/cricket courts
  - A large open gym space, leased to Yass Gymnastics for low fees.
  - Rooms for classes run by small local businesses, such as Streetbeat Dance; Dazzle Dance, Yoga, Tai Chi, Meditation, etc leased for low fees.


And, Council should buy the Liberty Theatre …
Grant and Heritage Funding is available for the Liberty Theatre, just as it will be for the rest of the Precinct.
As part of the new Precinct, and Council's 'Wish List', Council must reconsider purchasing the Liberty Theatre to provide cinema and theatre services for our growing Yass Valley.
The community is sick and tired of old personal differences getting in the way of what the people want and need, and common sense.


If they can do it, why can't we?
Imagine something like this Riverside...
HOTA (Arts Centre) Gold Coast
Stage 88 Canberra


Modern + Heritage


It can be done with a little
creativity and co-operation.

What item are you making a submission on? * Civic Precinct

Submission *

I am generally supportive of this proposal particularly if it is complementary to the main street heritage values and if grant funding can be accessed to support the development.

The existing premises have probably reached their use by date and a new building as well as addressing the various needs of both council and the community, would be a vote of confidence in the future of Yass and could help to galvanise some attention to buildings and the general CBD by both council and property owners.

I consider the existing site as the most appropriate one and I regard it of critical importance that Cragos mill is incorporated as an important component, if not the focal point of any redevelopment.

What item are you making a submission on? * Civic Precinct/Library

Submission *

New library (purpose built to reflect contemporary design)

I highly support this.

- Please include:

- a dedicated designed youth area for 11-18 yr olds, distinct from childrens area and after school youth programs to encourage visitation and interaction with the new spaces and facilities.

- an upgraded technology hub with access to ipads and tech that will assist people who may not usually have access.

- a small gift shop with a small but clever range of books, quirky gifts for kids, teens, young adults, wrap, cards.

Community meeting rooms and exhibition spaces

- I highly support this concept and think this would be great for Yass. Bathurst Library does this well, attracting some really interesting travelling exhibitions into a small exhibit space. It would generate more 'Staycation' tourism for Yass.

1

- Please plan to include trees in the mix and a welcoming central courtyard outdoor space for people to congregate in for the exhibition openings.

Please consider incorporating principles of place making to get a broad engagement from Yass community. The City Renewal Authority has recently developed a Great Place Guide great-place-guide.pdf

2

What item are you making a submission on? * Civic Precinct and Soldiers' Memorial Hall

Submission *

Civic Precinct

. Location should remain the same as land has already been purchased for the purpose of expanding the Council precinct.

· Heritage issues – the site is within the Conservation area. Retention and redevelopment of Crago's mill is mandatory.

· Mill could be redeveloped as public meeting or exhibition spaces.

· Street frontage should be harmonious in scale with the existing building (ie two floors) but not an imitation of a nineteenth century building. This is an opportunity to enhance the streetscape with a well planned community facility.

· Adequate office accommodation for present and future staff on upper floor.

· Ground floor public spaces – council shopfront for payment of accounts and services etc, visitor's centre, library, exhibition space, community support organisations and meeting rooms.

1

· Central landscaped internal courtyard area to maximise natural light in all areas of the building.

· Lift access is a must with all areas wheelchair friendly.

. Solar energy is a must.

· It is not Council's responsibility to provide accommodation for contractors – counter-productive to the interests of local accommodation businesses.

· Cost could be offset with rental from several commercial office spaces suited eg government departments or community work hub. Office space to accommodate future increased staff could be rented out in the interim.

· With the exception of a number of disabled parking spaces conveniently located, all other parking should be located on the perimeter of the complex and not visible from ground level within it.

Soldiers Memorial Hall

· Long overdue restoration work on the Soldiers Memorial Hall, the town's most significant twentieth century building, to improve facilities and increase income potential.

· Relocation of the YDHS archives to site of present library.

· Enhancement of the library laneway and redevelopment of the exterior area and public toilets to create a performance space for public events in Banjo Paterson Park.

What item are you making a submission on? * Civic Centre

Submission *

I think the new Civic Centre needs to be 4 to 6 stories high, ground floor- Commercial spaces for rent, available to YVC shop front, business development and the Library, although the Library could also be situated in the renovated Crago's Mill. Floors 1 and 2 could be utilised as Council Offices, flexible meeting rooms, as well as social/kitchen space for staff. Large and small meeting rooms could be made available for lease to the community for larger meetings/rehearsal space.

I would like to make the point that the largest population increase in Yass is families with children and services/ programs for youth are going to need space as well. it is essential that this need is also planned and future proofed. Yass will be standing on its own and not considered a subset of the ACT in the future, even if the largest percentage of the population works in the ACT.

Council needs to be planning for and adding necessary infrastructure Now, to be able to get the job done. Plan it build it and it will be utilised. Why not start with pathways.

Floors 3 and above would be perfect for development as 1 to 2 Br apartments, and then sold to residents to offset the building cost. Currently there are no other such developments currently available in Yass and it would meet a

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need for first home buyers in the area. Council could then retain 1 – 3 apartments for its own use for visiting contractors, at a small rent and then if vacant could be offered at market value. The view would be phenomenal.

A Civic Centre that is worth looking at is Wagga Wagga, other efficient well designed buildings include CSIRO – Discovery Building, ABS Building Belconnen. All of these buildings provide ideas of different aspects of how good design can work and make buildings pleasant to work in, as well as energy efficiency. Other buildings that combine commercial and residential can be found in Amaroo, ACT.

It's up to you to think what will be needed for the next 20 to 30 years not just what is achievable now, and public /private partnerships can work very well.

What item are you making a submission on? * Plans for new Council Precinct

Submission *

This submission is presented on behalf of the Yass Valley Business Chamber in my capacity as Vice-President in consultation with the Committee.

The submission concerns the issue of having the Precinct resilient enough to support the Town in the event of a natural disaster.

I attended a Emergency Consequence Management course run by Emergency Management Australia and during the course we were briefed by Mary Farrow, the Director of Resilience at Emerald Community House in Victoria. She talked about the impact of the Bushfires on her community and what they had learned from the experience and what steps they had taken to improve Council buildings for future support to a community threatened by disaster.

The following constitute ideas that we as the YVBC would urge Council to consider for the future precinct with comments by Mary:

A Solar power system with battery for storage and diesel generator to back up the battery - needs to have external power point for generator and battery designed to be backed up with the generator.

1

If the generator is on a trailer then you can help more people after you back up your battery. For example, the local petrol station may not have backup power which means that others can't get fuel either for their own generators when power goes out. If you can assist the local petrol station with your generator for a few hours to help others to pump fuel then you too can get your fuel too, right from the pump and then return your generator to your site. Or your generator can be taken to where there is fuel in another town rather than transport the fuel. This is really an early days scenario and is a bonus design feature. We are still trying to get the generator component.

Emerald are building solid shade structures in all playgrounds and then installing solar panels on the roof to add to sustainable power and provide emergency shelter.

· Water tanks (we have 12000 litres, need power to pump them or just by gravity/pressure)
· Outdoor power points on all council buildings for others to recharge anything (can be locked up if you are worried about it. Ours is accessible to anyone 24/7)
· Free Wifi in all council buildings
· Showers designed near to entrance/exit routes for disability access (anyone can use it)
· Washing machines and dryers (bonus item)
· Registered or commercial kitchen (for providing food support)
· Printing service , free laptop access

You would be surprised how popular the shower and washing machine/dryer are when the power goes out for days especially if there is no laundromat close by.

Most of these things would get some sort of inclusion in a new build or could be easily included. Sustainable power, water tanks, wifi and disability toilet w/shower are pretty common design features nowadays. You will be glad that you did it the first time you need these things. It reduces the time that people are impacted. Power outage is the most common show-stopping occurrence and can happen any time of the year. It also usually precedes the next calamity such as grid failure/power shedding because of an extreme heat event, wind/storm damage, flood, bushfire, etc.

If Council is applying for a grant(s) then the above are exactly what should be costed into the design as resilience measures based on the wisdom of those who have suffered before.

2

Crago Mill Precinct

Masterplan Submissions

Crago Mill Precinct Public Consultation #1

DATE CREATED – PUBLIC
7 Jun 2021 at 8:39
8:39:19 PM UTC+10:00

Name *	
Address *	
Email *	
Phone *	
What community activities do you believe the Crago Mill Precinct should cater for?	Meeting Rooms that can be booked by community groups such as Yass Business Mums and Friends and art groups like VASY. Public Art installations. Education Re Indigenous history.
What elements have we not included that you believe are needed for the precinct?	Public Art. Cycle access. Particularly through to Miles Franklin Park where Council will be building a Learn to Ride Your Bike track with a recently received grant. Where are the trees? Parent's room. Powered entirely with renewables? Use of recycled materials. Move the tourist info centre down or join it up somehow?

What elements have we included that you do not believe should be part of the precinct?	The name. Use of the word 'civic' is technically correct but clearly confusing for some. If it is a town centre can it be called that?
What activities should be catered for in the commercial building for the precinct?	No opinion.
Additional comments and feedback	The way in which the investment is 'sold' to the community needs to be improved so that the community can look forward to the benefits it will bring.

Crago Mill Precinct Public Consultation #2

DATE CREATED – PUBLIC
12 Jun 2021 at 2:54
2:54:16 PM UTC+10:00

Name *	
Address *	
Email *	
Phone *	
What community activities do you believe the Crago Mill Precinct should cater for?	I believe the Crago Mill Precinct provides an opportunity to support the visual arts in Yass. a) At present there are few, if any, small to medium sized venues for community art classes. b) A small gallery/display space should be incorporated into the plan. c) This should be made available to community groups at a minimal cost or free of charge.
What elements have we not included that you believe are needed for the precinct?	A dedicated arts hub open to the whole community but particularly catering to the needs of young people in the region.
What elements have we included that you do not believe should be part of the precinct?	A cafe. Yass already has many cafes. A cafe in the Crago Mill Precinct would operate in direct competition to them.
What activities should be catered for in the commercial building for the precinct?	Meeting spaces for community business groups and spaces with internet access for small businesses.
Additional comments and feedback	Overall the plan is impressive but needs a little "tweeking". As no funds have yet been secured for the project I think this needs to be

done first. Also the council does not have a street plan for Comur street so how will the new precinct fit in?

[redacted]

Crago Mill Precinct Public Consultation #3

DATE CREATED – PUBLIC
17 Jun 2021 at 9:13
9:13:20 AM UTC+10:00

Name *	[redacted]
Address *	[redacted]
Email *	[redacted]
Phone *	[redacted]
What community activities do you believe the Crago Mill Precinct should cater for?	Council offices, library and as a community hub.
What elements have we not included that you believe are needed for the precinct?	The precinct is an ideal location for our community radio station.
What elements have we included that you do not believe should be part of the precinct?	
What activities should be catered for in the commercial building for the precinct?	
Additional comments and feedback	Incorporating Yass FM would provide an ongoing human presence in the precinct beyond office hours. It would also complement the Library as another community information resource. Co-location of these two resources will allow the station to easily draw on Council and Library information resources as well as provide a unique communication outlet for Council and the community.

[redacted]

Crago Mill Precinct Public Consultation #4

DATE CREATED – PUBLIC
17 Jun 2021 at 10:30
10:30:37 AM UTC+10:00

Name *	
Address *	
Email *	
Phone *	
What community activities do you believe the Crago Mill Precinct should cater for?	1. Meeting spaces for community groups. 2. Market or fundraising stall space similar to the Rotary one on Millers Pharmacy Corner 3.Digital Community Noticeboard 4.Yass FM studio production and broadcasting facilities. 5.Arts and Crafts Groups
What elements have we not included that you believe are needed for the precinct?	Yass FM studio production and broadcasting facilities.
What elements have we included that you do not believe should be part of the precinct?	Accommodation.
What activities should be catered for in the commercial building for the precinct?	Local artisans Cultural activities Yass FM

Additional comments and feedback	The inclusion of Yass FM as a communications tool would be beneficial in providing a permanent home for this community group. The potential to enhance Council communications within the shire through Yass FM. The provision of a permanent home for Yass FM could also provide more public awareness of the station as well as potential links with local education facilities with media training and the like.

Crago Mill Precinct Public Consultation #5

DATE CREATED – PUBLIC
17 Jun 2021 at 11:06
11:06:09 AM UTC+10:00

Name *	
Address *	
Email *	
Phone *	
What community activities do you believe the Crago Mill Precinct should cater for?	Art Gallery Community meeting rooms Space for community classes (Dance, presentations) Co-working space Library
What elements have we not included that you believe are needed for the precinct?	Do a master plan for the main street first before undertaking the design and build of the Crago Mill. To build this facility without having plans for how it fits into the master plan means that it's not taking into account the overall plan for Yass's residents and businesses needs in the future. Council must establish a greater plan, to be shovel ready, for grants to upgrade the main street before building this. Consultation and planning is required first, which Council has stated that it hasn't done, and therefore wasn't able to apply for the full

	funding in the recent grants for Main Streets. Do things in the right order so we are not caught out again. We know Council needs new offices, but Council must do the planning to meet Yass's needs first. It's proven that this hasn't been a priority before, and now you can really see the need for this. If this had been done earlier, you would have had a shovel ready plan in place and been able to win the millions of dollars in grants. Don't waste this time by proceeding on a build when you don't have plans in place for the overall main street!
What elements have we included that you do not believe should be part of the precinct?	The accommodation facility planned takes away potential business income from local accommodation providers. This is a bad look for Council. Council should be assisting local accommodation providers by giving them business, not building it themselves at tax payers expense. Perhaps if those Council employees using the service paid commercial rates and those funds went back into the Community (as a Not For Profit) it could be a different story.
What activities should be catered for in the commercial building for the precinct?	Service NSW and other Government Agencies could be housed
Additional comments and feedback	This is a really frustrating project, because we know the Council chambers have been outgrown, but the contributions by the Yass Valley Business Chamber's working group on the main street has not been actioned or leveraged by Council. It's been left, and now you have a new priority that suddenly you have the time to devote. What about the main street of Yass, which is an eye sore and is neglected with any development and improvement? Please put in a consultation to create a master plan for Yass main street, create shovel ready plans so that we can take advantage of further main street funding. Once that is complete, please only then proceed with the new Precinct.

[redacted]

Crago Mill Precinct Public Consultation #6

DATE CREATED – PUBLIC
17 Jun 2021 at 2:27
2:27:22 PM UTC+10:00

Name *	[redacted]
Address *	[redacted]
Email *	[redacted]
Phone *	[redacted]
What community activities do you believe the Crago Mill Precinct should cater for?	The Mill Community Hub would be an ideal location from which the Yass Community Radio Association Inc could operate the YassFM Community Radio Station. The recent Council condemnation of the Old Waterworks Building in Cooks Hill Road and other significant problems with that venue mean that the existing studio and technical facility will not be able to continue to operate in the Council-provided facility; relocation of YassFM to a different venue is required. The Association relies 100% on community volunteer presenters and support, but even with the Council-provided facilities and electricity, on-going low levels of Community business sponsorship mean that the Association continuously struggles to make ends meet for necessary technical and logistics costs. Relocation to another Council-provided venue will be essential for continued financial viability of the Yass Valley's Community radio station. Provision of two studios, a technical equipment room and a production area in the Mill Community Hub would provide an excellent solution for the re-location and viability challenge.

	In-turn, locating the studio into what will become the central Community precinct of Yass will provide the visual exposure that the Association needs to attract Community listeners and business sponsorship, both of which are essential for long-term viability of the station. In-turn, the visible Community radio station will also provide a sense of Community pride and satisfaction to the residents of the Yass Valley, and will be a point of attraction for people considering relocating to a country home. Yass township and the Yass Valley needs a vibrant and modern central Community space - the proposed Precinct will provide such a facility, and inclusion of the YassFM Community radio station in the Precinct at the Mill Community Hub almost goes without saying.
What elements have we not included that you believe are needed for the precinct?	Development of the proposed Precinct will be an opportunity to improve both the look and feel of the Yass township. For maximum leverage, the space will need to be both visually attractive and provide reasons to attract people to visit and spend time there. Appropriate soft landscaping, public art, multiple commercial cafe-style and similar attracting venues, shaded rest and play areas, free WiFi and possibly the relocation of the Tourist Information venue to the Precinct will help achieve that. Longer-term development of surrounding areas as a parkland would compliment the facility. A similar venue has been built in a parkland at Benalla in Victoria - and the Benalla Art Gallery is now the destination for many visitors to the town. Yass too could do the same - providing the venue is attractive and provides incentive for travellers to leave the Hume Highway and visit our town.
What elements have we included that you do not believe should be part of the precinct?	None - this is a very comprehensive and appropriate proposal.
What activities should be catered for in the commercial building for the precinct?	Opportunity for various commercial cafe-style and similar tourist- and local-attracting venues, and relocation of the Tourist Information venue to the Precinct will help make the area attractive, will improve the image of Yass and the Yass Valley, and will provide a source of Council funding for on-going development of this current sad-looking area.
Additional comments and feedback	If demand for the Mill Community Hub meant that YassFM could not be relocated there, an option would be for relocation of the Tourist Information Centre to the Precinct, and for the Community radio station to re-locate to the existing Tourist Information building. Thank you for the opportunity to contribute - this is a very exciting opportunity for the Yass Valley.

Crago Mill Precinct Public Consultation #7

DATE CREATED – PUBLIC
17 Jun 2021 at 2:49
2:49:56 PM UTC+10:00

Name *	
Address *	
Email *	
Phone *	
What community activities do you believe the Crago Mill Precinct should cater for?	See below
What elements have we not included that you believe are needed for the precinct?	
What elements have we included that you do not believe should be part of the precinct?	See below
What activities should be catered for in the commercial building for the precinct?	
Additional comments and feedback	Crago Mill Precinct • Conservation and adaptive re-use of Crago Mill is strongly supported. • Giving Crago Mill prominence, space and visual connection to Comur Street is supported.

- Note that the rail line only extended a short distance east of the former mill and did not extend through to Comur Street.

- Commercial and start-up offices facing Comur Street extends the town's historic 'main street' development and is supported.

- The commercial development also has the potential to activate the walkway between it and Aldi. Currently the walkway is unattractive and underutilised. Activation could be by way of shop entries, café etc.

- Apartments above the commercial offices on Comur are consistent with historic development, although often end up not used for residential because of noise and other factors. It might make more sense to put the residential on Adele Street, or allow the space above the commercial offices to be easily adapted to additional commercial if residential proves to be unpopular.

- From a heritage point of view the administration building and council chambers should align to Comur Street, not Crago Mill. Aligning buildings to the rail line does nothing to reinforce 'main street'.

- To some extent the council chambers should bookend the remarkable collection of buildings along Comur Street, with the courthouse at one end and the council chambers at the other. The building on the corner of Polding/Adele and Comur streets does not have to be as grandiose as the courthouse but should have some worthy architectural expression. It should address the intersection and have a landmark presence.

- In the current proposal the triangular parks around the building may prove to be meaningless and unused. While a green edge is appropriate as an interface between the road, footpath and buildings, the 'left over' triangular spaces would be better allocated to the civic square.

- The library can be a key generator of activity and is appropriate in its proposed location where it will be accessible to both the Aldi and Council carparks, as well as foot traffic through the Civic Square.

- There would also be a strong argument to relocate it to front onto Comur Street and the civic square, and for the council offices to occupy the rear location. The only part of the Council offices that engages with the public is the entry foyer and associated committee rooms. The staff offices are private, not public.

- Moving the library to Comur Street is a sign that Council values the role that a library plays in community life. It also makes for easy casual "drop-in" use.

These options are shown schematically below

(Note sketches would not insert–

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[redacted]

Crago Mill Precinct Public Consultation #8

DATE CREATED – PUBLIC
17 Jun 2021 at 6:57
6:57:57 PM UTC+10:00

Name *	[redacted]
Address *	[redacted]
Email *	[redacted]
Phone *	[redacted]
What community activities do you believe the Crago Mill Precinct should cater for?	The Crago Mill Community Space would be a good new home for the Yass FM community radio station. For the same WHS reasons Council need to move premises, Yass FM has the same problems with their existing space provided by Council at the Yass Water Works. The radio station is an ideal integration with the objectives of the Mill for exhibition, performance, music and events. Space for housing the radio station operations should be specifically considered within this identified list of potential uses.
What elements have we not included that you believe are needed for the precinct?	I would have liked to see photos and more detail about the Mill building in the consultation materials to assist with identifying potential purposes. Preservation and making a feature of the railway line at the Mill should be included. It is disappointing ALDI were able to build a carpark over the heritage line and the remaining rail at the Mill that has not been built over should be retained for its heritage interest. An example of how short lengths of railway line are preserved at a heritage building can be observed at the Kingston Fitters Workshop in the ACT.
What elements have we included that you do not believe should be part of the precinct?	The Gunghalin library space in the ACT is very similar in concept but has some drawbacks that could be learned from. That library is set back from other buildings with vast paved walking areas surrounding

	it which may look good on site plans but are impractical to use for any other purpose and detach the library from adjacent services, detach it from more vibrant areas nearby further up the street and do not integrate with the grass field and performance area adjacent. A fact finding tour of that venue by the site planners would be beneficial to avoid a similar mistake of partitioning a library off that was hoped to be more integrated.
What activities should be catered for in the commercial building for the precinct?	If Yass FM radio station could not be accommodated in the Mill building then consider allocating space in the Commercial building among the Startup Offices. An example of an approach to startup offices is the Eveleigh Railway Workshops in Sydney.
Additional comments and feedback	It would be good to have some indication in the consultation materials as to the expected opening date of the facility.

Crago Mill Precinct Public Consultation #9

DATE CREATED – PUBLIC
18 Jun 2021 at 11:59
11:59:08 AM UTC+10:00

Name *	
Address *	
Email *	
Phone *	
What community activities do you believe the Crago Mill Precinct should cater for?	Because this will be a prestigious precinct it is a waste of opportunity to build a single storey council office The council offices should be part of a large business building and should incorporate the libary for the general public use but also as an important business tool. In this way, it is possible to provide future proof for Council's growth. It also gives Council enough space to attract major businesses to Yass or even state and federal departments should parts of these be moved to regional areas. Those government depts already in Yass such as Services NSW could be housed in the large building in this more central precinct. The library should not be a silo building but incorporated into the 3 storey building to allow for public access and contain a business hub that would allow business/ community group/government meetings and a business incubator and allow library resources to be easily used by council staff and staff of business/government depts renting office space Car parking should be underground

	The Crago Mill itself would be an excellent innovative art space adding to the prestige of the area
What elements have we not included that you believe are needed for the precinct?	Until a demand analysis study is completed we are uncertain... any suggestions are dreams essentially I would like the precinct to be part of the Main Street Masterplan - a plan which should ensure the smooth intergration of any development pertaining to the main street, including this precinct Because I have to rely on the second hand information and online information as there has been no general workshop on the precinct for the community, I do not feel Council is really interested in the views of the general public. Given the lack of trust within the community for council staff, not having a workshop for the public is a big mistake. This is a prestigious project for Yass and Council must bring the community along with it. Public enthusiasm for the project is a key factor currently not included but essential if this is to succeed.
What elements have we included that you do not believe should be part of the precinct?	any aspect that currently competes with the business community eg accommodation; if accommodation is tight it is better to have a separate preferably privately owned and run new asset within the town not in the precinct. the council building should not be a flat one storey and unimpressive building; Council is a major employer in the town and should aim for a building that is aesthetically pleasing to look at and work within and has future capacity for growth. How good would the synergies be if the council office were large enough to incorporate the library, a business hub and rentable offices.
What activities should be catered for in the commercial building for the precinct?	a business hub business incubator reading room rentable office spaces for businesses This precinct should be high vis, highly desirable area for businesses A concern with the current layout is that activity is siloed - the library with its research capacity should be connected to the above suggestions. The council offices should be big enough to allow for future growth and should be within a building that includes rentable office space. In fact council offices should be part of a 3 storey building that complements the Crago Mill and is impressive.
Additional comments and feedback	are supportive of the redevelopment of the Crago Mill precinct with new Council Chambers because a properly scoped and aesthetically designed development would raise the standard for development in Yass and potentially be a dynamic hub within an area of the main street that has looked neglected for years

impacting negatively on both day to day business and business opportunity.

We do however think the rushed public consultation is a huge mistake. Two weeks to consider the plans on line and no public discussion and explanation from senior Council staff and Council's design team, means the ratepayers and citizens of the Yass Valley are poorly prepared to offer their insights or suggestions, let alone their support.

We note that it is proposed to create a single floor Council Chambers. We feel that this is short sighted; in the last 20 years Council has grown considerably With the continued growth of the town and surrounding villages and the devolution of responsibilities from the State Government to Local Government, we predict that Council will grow further. While it may not use all its office space in a two or three storey complex, it could obtain income by renting out the extra space until such time as it may be required. Further we feel that a taller building, complements the Crago Mill and would give architectural prominence to the whole precinct within a main street composed of two storey buildings and with an old cinema building at least 3 storeys high. The proposed open space would enhance the tall structures.

We also note that Council is unsure whether to include commercial uses. Rather than rush the design stage and submit a development application before the September Council elections, we feel that more time should be allocated to allow for a demand analysis study and a Masterplan for the whole main street from the bridge to Petit Street to be finalised. An overall Main Street Masterplan sets the relationship of this project within its context and smooths out any underlying issues, rather than creating or compounding potential problems.

These two important documents are crucial for the Crago Mill / Council Chambers precinct development, greatly helping Councillors in their decision making. Further, these documents together with meaningful public consultation should win the support of ratepayers and citizens for this expensive but significant project.

[redacted]

Crago Mill Precinct Public Consultation #10

DATE CREATED – PUBLIC
18 Jun 2021 at 3:50
3:50:21 PM UTC+10:00

Name *	[redacted]
Address *	[redacted]
Email *	[redacted]
Phone *	[redacted]
What community activities do you believe the Crago Mill Precinct should cater for?	
What elements have we not included that you believe are needed for the precinct?	
What elements have we included that you do not believe should be part of the precinct?	
What activities should be catered for in the commercial building for the precinct?	I agree with the wonderful concept for the new Library/administration area for the future governance and benefit for all Yass Valley residents. However I have been concerned for some 50 years over the total neglect of Crago Mill. I endorse the proposed development of the Mill with the following comment. Some 20 or so years ago the group that created the very successful Junee Chocolate Factory expressed an interest in having a similar retail business in our Crago Mill. The idea was to lease the site

	from Council for a peppercorn rent in exchange for conducting a full heritage restoration and fit out for a café/retail business. This would have been a win/win solution for everyone with the development at no cost to the Yass Valley ratepayers. However the Council of the time had no vision for the tourism and economic potential of the proposal and it was never fully investigated. I would urge Council to follow up the potential of this idea with the proprietors of the hugely successful tourism gold mine in Junee.
Additional comments and feedback	With the construction of the new library I would suggest the old site would be perfect for the relocation of the valuable archives currently stored upstairs in the Memorial Hall.

Dear Mr Dugdell,

I write to as you seem to be the one at Council given the job to sell the pre-determined outcome of Council building whatever it is that Council want to build at the now consolidated allotment of 209 Comur St.

I find it very hard, as do the majority of those I confer with, to believe anything that Council does or has to say in relation to the proposed development. I am sitting here looking at a sketch of a "Business / Cultural Precinct- 209 Comur St" dated 2014 by Cox Architects, can look at some others that I have copies of, and despair at the monies present and past being spent without any disclosure of intent going back decades.

ie:
Council purchased a butchery and turned it into offices - 1997 $115K
Council purchased a Bakery and turned it into offices - 2005 $335k
Council purchased a service station - 2006 $1.2 mil
Council purchased a Hardware store - 2006 $1.2 mil
and lets not forget Council purchased tennis courts in Adele St in 2005 for only $715 k in 2005.

Lets not forget that all were purchases without any market appraisal / valuation and some were purchases at prices that well exceeded market prices at the time. Lets not forget that the lack of valuations was admitted by Council in writing and the sneaky way of hiding the losses by consolidating the land into one allotment, once again without community disclosure or involvement. Current VG less than $1 million yet over $3 million spent?

So we have a Council who for decades has hidden it's agenda to create something which we know not what costing a figure disclosed over a decade ago of $20 million or so. So we have a Council who has provided little to no disclosure of intent and the bill is now over $30 million.(please correct me if I am wrong)

We now have you,Mr Dugdell, trying to sell us what is known to already be decided. We have had numerous designs, lots of consultants and even some belated geo-tec on the inground fuel tanks we ratepayers bought included in the $1.2 million now costing at least $100k + to remove let alone staff costs and lets not forget the lost opportunities if priorities where elsewhere.

The way forward, and the only way forward that provides us with any sense of process, is to put a hold on everything until Council elections. Then we have some community meetings and proper and real community consultation as we ratepayers and constituents of Yass Valley are not stupid and are able to process the many aspects of needs and wants of Council and the community at the same time.

As we have never met I am happy to discuss the dodgy ways of Council past and show you why it is impossible to believe what is put before us in the current environment of mistrust.

A good start would be a total list of all monies spent to date on land purchases, legals, consolidation, insurances, lost rate revenue, repairs, architects, surveys, staff time, etc etc. In other words if you or anyone at Council wants to actually have a proper conversation with ratepayers and the people of Yass valley then come clean with what has been going on for decades and create a fresh start.

The many I confer with and the many who send me stuff can see that none of what has gone before was on your watch but it is now your watch to own and transparency is what is needed.

Hello James,

I'm sorry I wasn't able to put a submission in yesterday. I'm only just back to work this week. The project details seem to have gone from the website already,
but I do have a few ideas:

- no more paid work on this project til new council is elected. New council being presented with a fair accompli architectural drawing is presumptive and will put next councillors in difficult position of either accepting it or 'wasting money' by redoing it.
This has been councils modus operandi for many years and needs to stop.
- split level buildings require lifts etc and are not best practice for people with disability children and the aged. We need public meeting rooms/workshop rooms downstairs as the two local meeting rooms for public use are already upstairs and difficult for elderly and people with a disability (ie. The rooms at the Services Club and The Clubhouse hotel).
- Yass Historical Society needs a new home. Crago Mill could be that home, and potentially the Museum as well. And the public square in front called 'Crago Square' for community use. A single heritage site (with function/gallery space) would get required NSW Gov tourism and heritage funding (new round just announced, see Wendy Tuckerman). All subject to Yass Historical Society views, of course.
and
- the Library desk and the Councils public facing front office should be combined. No reduction in staff over all, but a Service NSW style "front desk" for all Council services would be more efficient.
AND/OR
- Yass Historical Society collocates in the library.

Importantly, this development is the perfect opportunity for Council to overhaul its operations ahead of its accommodations to a 'user-centred design'. Many Gov agencies of all levels have used experts for this - and before

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architects do more work, it would be worth Council meeting with https://www.meldstudios.com.au/ (I have no relationship with them) or similar experts to see what they can offer. Cost savings and time/service efficiencies would most likely result. Staff ideas are key here. And then design the buildings around that model.

We need absolute best practice here and future flexibility. This is a once in a lifetime opportunity to get this right and Council is not bringing the community with it. And yet we will have to pay for it.

Happy to discuss. Thanks for consulting. This in itself is a big step for council and we appreciate you taking it.

Name *

Address *

Email *

Phone Number *

What item are you making a submission on? * Plans for new Council Precinct

Submission *

This submission is presented on behalf of the Yass Valley Business Chamber in my capacity as Vice-President in consultation with the Committee.

The submission concerns the issue of having the Precinct resilient enough to support the Town in the event of a natural disaster.

I attended a Emergency Consequence Management course run by Emergency Management Australia and during the course we were briefed by , the Director of Resilience at Emerald Community House in Victoria. She talked about the impact of the Bushfires on her community and what they had learned from the experience and what steps they had taken to improve Council buildings for future support to a community threatened by disaster.

The following constitute ideas that we as the YVBC would urge Council to consider for the future precinct with comments by

A Solar power system with battery for storage and diesel generator to back up the battery - needs to have external power point for generator and battery designed to be backed up with the generator.

1

If the generator is on a trailer then you can help more people after you back up your battery. For example, the local petrol station may not have backup power which means that others can't get fuel either for their own generators when power goes out. If you can assist the local petrol station with your generator for a few hours to help others to pump fuel then you too can get your fuel too, right from the pump and then return your generator to your site. Or your generator can be taken to where there is fuel in another town rather than transport the fuel. This is really an early days scenario and is a bonus design feature. We are still trying to get the generator component.

Emerald are building solid shade structures in all playgrounds and then installing solar panels on the roof to add to sustainable power and provide emergency shelter.

- Water tanks (we have 12000 litres, need power to pump them or just by gravity/pressure)
- Outdoor power points on all council buildings for others to recharge anything (can be locked up if you are worried about it. Ours is accessible to anyone 24/7)
- Free Wifi in all council buildings
- Showers designed near to entrance/exit routes for disability access (anyone can use it)
- Washing machines and dryers (bonus item)
- Registered or commercial kitchen (for providing food support)
- Printing service , free laptop access

You would be surprised how popular the shower and washing machine/dryer are when the power goes out for days especially if there is no laundromat close by.

Most of these things would get some sort of inclusion in a new build or could be easily included. Sustainable power, water tanks, wifi and disability toilet w/shower are pretty common design features nowadays. You will be glad that you did it the first time you need these things. It reduces the time that people are impacted. Power outage is the most common show-stopping occurrence and can happen any time of the year. It also usually precedes the next calamity such as grid failure/power shedding because of an extreme heat event, wind/storm damage, flood, bushfire, etc.

If Council is applying for a grant(s) then the above are exactly what should be costed into the design as resilience measures based on the wisdom of those who have suffered before.

2

Mr Chris Berry
The General Manager
Yass Valley Shire Council
Comur St Yass 2582

Dear Chris,

are supportive of the redevelopment of the Crago Mill precinct with new Council Chambers because a properly scoped and aesthetically designed development would raise the standard for development in Yass and potentially be a dynamic hub within an area of the main street that has looked neglected for years impacting negatively on both day to day business and business opportunity.

We do however think the rushed public consultation is a huge mistake. Two weeks to consider the plans on line and no public discussion and explanation from senior Council staff and Council's design team, means the ratepayers and citizens of the Yass Valley are poorly prepared to offer their insights or suggestions, let alone their support.

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1

to Local Government, we predict that Council will grow further. While it may not use all its office space in a two or three storey complex, it could obtain income by renting out the extra space until such time as it may be required. Further we feel that a taller building, complements the Crago Mill and would give architectural prominence to the whole precinct within a main street composed of two storey buildings and with an old cinema building at least 3 storeys high. The proposed open space would enhance the tall structures.

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Yours sincerely

Crago Mill Precinct

- Conservation and adaptive re-use of Crago Mill is strongly supported.
- Giving Crago Mill prominence, space and visual connection to Comur Street is supported.
- Note that the rail line only extended a short distance east of the former mill and did not extend through to Comur Street.
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- The commercial development also has the potential to activate the walkway between it and Aldi. Currently the walkway is unattractive and underutilised. Activation could be by way of shop entries, café etc.
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- To some extent the council chambers should bookend the remarkable collection of buildings along Comur Street, with the courthouse at one end and the council chambers at the other. The building on the corner of Polding/Adele and Comur streets does not have to be as grandiose as the courthouse but should have some worthy architectural expression. It should address the intersection and have a landmark presence.
- In the current proposal the triangular parks around the building may prove to be meaningless and unused. While a green edge is appropriate as an interface between the road, footpath and buildings, the 'left over' triangular spaces would be better allocated to the civic square.
- The library can be a key generator of activity and is appropriate in its proposed location where it will be accessible to both the Aldi and Council carparks, as well as foot traffic through the Civic Square.
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These options are shown schematically below

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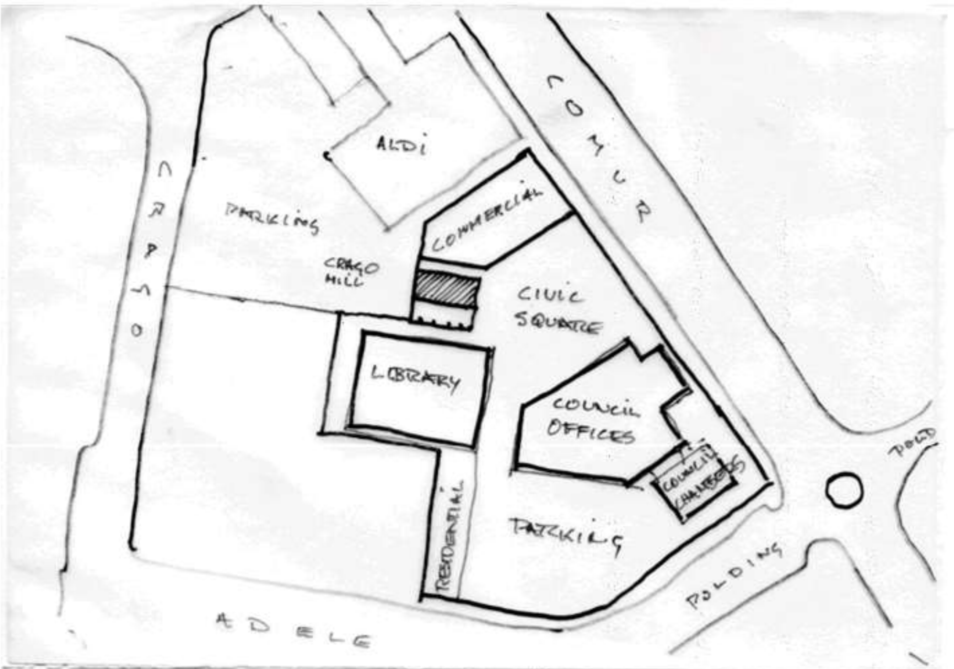
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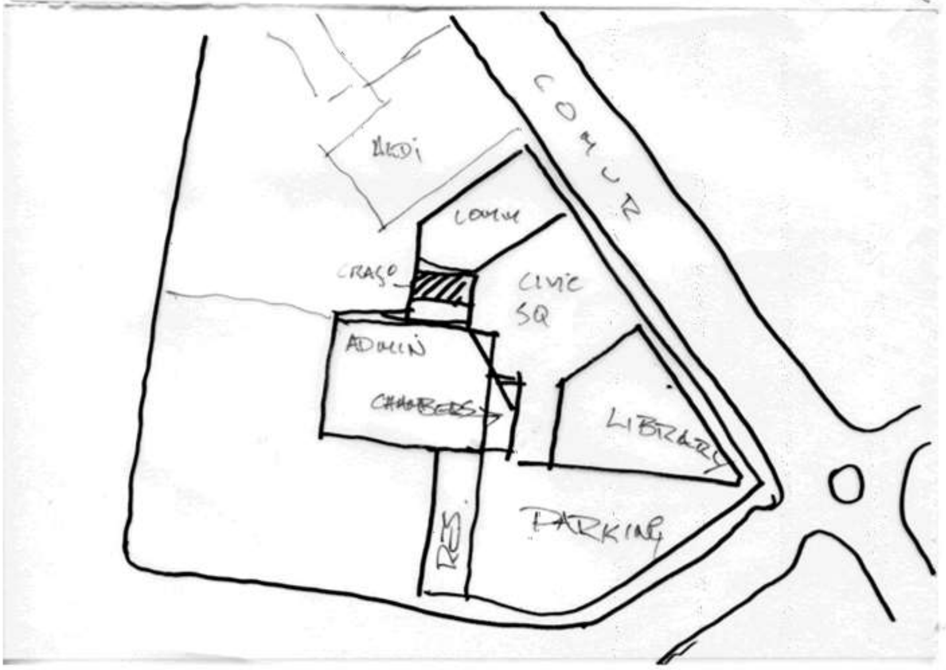
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2

Crago Mill Precinct

Concept Design Submissions

Hello James. Thanks for organising the zoom call. I got a lot out of it and would hope that it becomes a common practice for the council. I've got a couple of comments

EV charging. With respect, I think the viability of your proposed approach has a horizon of no more than 5-10 years. After that, charging infrastructure will be expected as we expect street lighting today. and the transition to EVs was a very important topic for us. I'd be happy to sit down and explain why the rate of change in the vehicle fleet will accelerate massively over the next five years]. Frankly, a car park without charging infrastructure will not be acceptable to anybody. Similarly with the e-scooters that we see around Canberra today. The precinct really does need a place to secure bikes and scooters out of the weather, and with plugs for charging both bikes and scooters.

Library and Co-Working: I was very impressed with the proposed approach to both those facilities. One aspect that was only tangentially touched upon is 24-hr access and operation. The shift to remote working does not just mean working away from the office, but also "away from the time-zone". One of the painful discoveries from the COVID period is that not being able to travel overseas means conducting zoom calls with your colleagues in the US, Europe and Asia. This means, for example, business meetings at 3am. The structure and operation of both facilities needs to accommodate trusted access to at least part of the facility when needed.

Open spaces and Climate Change. Work by Landcare and others point out that our region will become hotter and more arid in the next 5-10 years. Consequently, the idea that open areas without shade will remain viable in Spring-Summer is quite untenable. While I really like the open spirit of the landscaping, there needs to be provision for either retractable sunshading, or much more agressive use of deciduous trees. In fact, the best solution might be to plant something like a mini-forest using the Miyawaki approach (see https://www.theguardian.com/environment/2020/jun/13/fast-growing-mini-forests-spring-up-in-europe-to-aid-climate).

Main Street Strategy. I look forward to becoming involved in that work when it starts. In the meantime, I applaud the idea of the precinct being one of the "anchors" of the main street. However, we are also going to need an anchor of similar status/scale at the other end. I have not seen any discussion of such a development, but look forward to any ideas that emerge during the consultation process.

Once again, thanks for this excellent communications initiative.

cheers

Thank you for the opportunity to participate in the Zoom Design Concept meeting last evening. Presenting the general design really brings this project to life. The potential is enormous and I think is well captured in what Andrew's team are doing.

A couple of thoughts:

1) Instead of a clock tower may I suggest a solar powered, recycling water feature. The idea of running water references the Aboriginal connection to the name of the town. I am very interested in the significance of the original inhabitants of our district and to our district and can see this as a means of making this major development have meaning for the Ngunnawal/Wallabalooa people as well. A Civic Centre is a meeting place after all! I am not discounting the reference along the Library wall walkway from Adele street.

If such a feature was situated in the current clock tower position it could have quite a visual impact from the Canberra entry end of the main street. The process to determine the design of such a feature would be crucial to its success and part of that success would be the sense of involvement of the local Aboriginal people. This would have to be carefully handled to design something that was subtle and referenced the whole Yass community.

For what it's worth, I can see a pile of stacked boulders perhaps 3 to 4 metres high with water running at random down though and over the pile, definitely no pool at the bottom but the water disappearing through perforated grid at a slightly indented footpath level kept very close to the base of the pile. Aboriginal iconography could be subtly included at various levels and points in and around the boulder stack.

Alternatively, a very much more formal structure could be used. Perhaps a curved solid granite "wall" maybe with an angle at the top that echoes the pitch of the roofline on the Administration building and the curves. Water can cascade down this "wall" to the same sort of sink as above. The wall could have iconography carved into it.

I prefer the boulder stack; its "natural", rural, references a natural watercourse but also Burrinjuck Dam.

2) The upright posts supporting the veranda along the Library side of the Crago Mill. Can they be simplified to maybe just three uprights, one either end and one in the middle. Obviously engineering comes into it. Whilst the industrial nature of the Mill needs to be maintained the multiple uprights seem to clutter the visual impact and "cut off" the Mill from the Library. The engineering could consider steel beam work that would add interest and reference the railway line aspect of the "siding" as well as the industrial nature of the old building.

3) I am sure you have got his one! Sighting the public toilets in the corner of the Commercial building is brilliant. There obviously needs to be enough cubicles in each to cope with events in the public space. But I cant see the Civic precinct development has any responsibility to solve Aldi toilet issues!!

Basically I love your design. This is just what Yass needs. I would be more than happy to discuss further any of the above.

Kind regards,

Thanks very much James again for that presentation. I particularly like the chamber being viewable from outside as a symbol of open democracy. And the multi-use prospect of the chamber as a meeting space. Perhaps that external window facing Comur St could become a massive sliding glass door, not used daily, but able to be opened up onto that plaza area for indoor/outdoor events.

The open desk area just inside the main entry may be too public for many people wanting to privately discuss proposed developments or debts/finance issues and such. That open corner could become a few opaque glass cubicles, like in banks.

Also glad apartments are off the table.

Key now, in my view, will be actively seeking views of our indigenous community as to what they would like to see reflected in overall design and usage.

I hope you're able to use some of that $1.7mil for the trail/bridge to realise some of that pedestrian/bike link from Cragos all the way down to the Junction train station that would be fantastic. Kind of like a Yass version of New York's High Line. If not, it seems like a very expensive playground replacement at Riverbank. I'd personally like to see some of that money spent on a great playground in Murrumbateman. Long overdue.

Noting it's a work in progress, I share the views of others that the facade as drawn now doesn't seem to reflect our heritage or 'speak' to our rural/country location. It doesn't have to be a faux Victorian or such, as Andrew derided, but there would be ways to have a better modern reflection of our important heritage than curved metal. Though the river is very important to many people.

Where will council work from while this is being built? I assume you're doing lots of close consultation with staff on their workspaces.

This project could be a real game changer for councils relationship with the public, and for exponentially improving staff morale. It seems well on the way to physically and metaphorically opening up the closed shop that council has been for many years.

Thank you for your open and considered approach.

Lyall & Associates

yass valley council
the country the people

NEXUS
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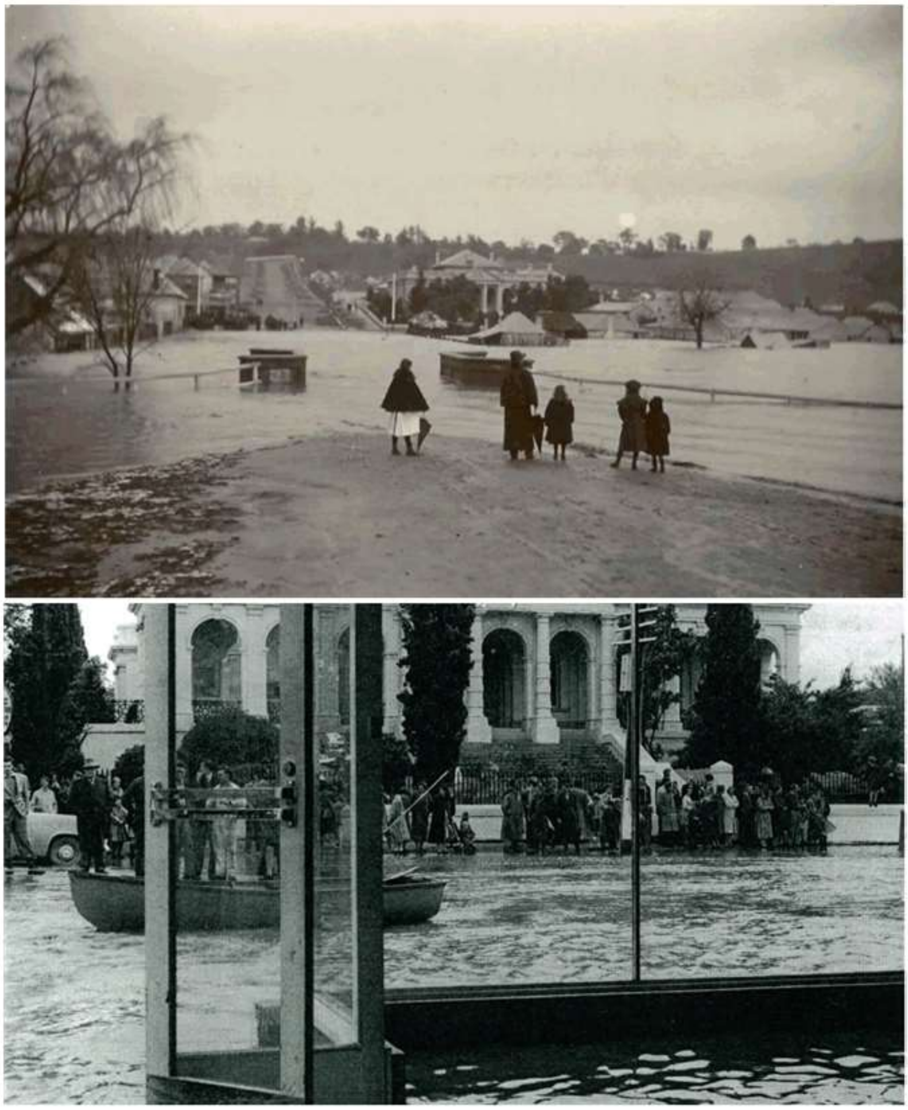
YASS
FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN

VOLUME 1 – REPORT

JULY 2021



The flood that occurred in July 1900 (refer top photo) is believed to be the flood of record at Yass, while the flood that occurred in October 1959 which peaked 0.3 metres lower (refer bottom photo) was equivalent to about a 1 in 100 year event.

Job No: ES447 File: YFRMS_V1_Report_[Rev 1.6].doc	Date: July 2021 Rev No: 1.6	Principals: SAB Authors: TDR/SAB

FOREWORD

NSW Government's Flood Policy

The NSW Government's Flood Policy is directed at providing solutions to existing flooding problems in developed areas and to ensuring that new development is compatible with the flood hazard and does not create additional flooding problems in other areas.

Under the Policy, the management of flood liable land remains the responsibility of local government. The State subsidises flood mitigation works to alleviate existing problems and provides specialist technical advice to assist councils in the discharge of their floodplain management responsibilities. The Policy provides for technical and financial support by the State through the following four sequential stages:

1.	Data Collection and Flood Study	Collects flood related data and undertakes an investigation to determine the nature and extent of flooding.
2.	Floodplain Risk Management Study	Evaluates management measures for the floodplain in respect of both existing and proposed development.
3.	Floodplain Risk Management Plan	Involves formal adoption by Council of a plan of management for the floodplain.
4.	Implementation of the Plan	Construction of flood mitigation works to protect existing development. Use of Local Environmental Plans to ensure new development is compatible with the flood hazard. Improvements to flood emergency management procedures.

Presentation of Study Results

The results of the *Updated Flood Study* investigation commissioned by Yass Valley Council are presented in **Appendix C** of this report. Both the *Updated Flood Study* and the *Floodplain Risk Management Study* have been prepared under the guidance of the Floodplain Risk Management Committee comprising representatives from Yass Valley Council, the NSW Department of Planning, Industry and Environment, the NSW State Emergency Service and community representatives.

ACKNOWLEDGEMENT

Yass Valley Council has prepared this document with financial assistance from the NSW Government through its Floodplain Management Program. This document does not necessarily represent the opinions of the NSW Government or the Department of Planning, Industry and Environment.

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APPENDICES

LIST OF FIGURES
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ABBREVIATIONS

AEP	Annual Exceedance Probability (%)
AHD	Australian Height Datum
ARI	Average Recurrence Interval (years)
ARR 1987	Australian Rainfall and Runoff (1987 Edition)
ARR 2019	Australian Rainfall and Runoff (2019 Edition)
BoM	Bureau of Meteorology
Council	Yass Valley Council
DECC	Department of Environment and Climate Change
DPIE	Department of Planning, Industry and Environment
FDM	Floodplain Development Manual, 2005
FRMC	Floodplain Risk Management Committee
FPL	Flood Planning Level
FPA	Flood Planning Area
FRMS	Floodplain Risk Management Study
FRMP	Floodplain Risk Management Plan
FRMS&P	Floodplain Risk Management Study and Plan
LEP	Local Environmental Plan
LiDAR	Light Detection and Ranging (survey)
MHFL	Minimum Habitable Floor Level
NSWG	New South Wales Government
NSW SES	New South Wales State Emergency Service
PMF	Probable Maximum Flood

SUMMARY

S1 Study Objectives

Yass Valley Council (**Council**) commissioned the preparation of a Floodplain Risk Management Study and Plan for the township of Yass. The overall objectives of the *Yass Floodplain Risk Management Study* (***Yass FRMS***) were to assess the impacts of flooding, review existing Council policies as they relate to development of land in flood liable areas, consider measures for the management of flood affected land and to develop the *Yass Floodplain Risk Management Plan* (***Yass FRMP***) which:

i) Proposes modifications to existing Council policies to ensure that the development of flood affected land is undertaken so as to be compatible with the flood hazard and risk.

ii) Sets out the recommended program of works and measures aimed at reducing over time, the social, environmental and economic impacts of flooding.

iii) Provides a program for implementation of the proposed works and measures.

The study area for the *Yass FRMP* applies to areas that are affected by the following two types of flooding at Yass:

- **Main Stream Flooding**, which occurs when floodwater surcharges the inbank area of the existing river and creek systems. Main Stream Flooding is typically characterised by relatively deep and fast flowing floodwater, but may be shallower and slower moving in flood fringe areas.

- **Major Overland Flow** which occurs during storms which result in the surcharge of the existing piped drainage system. It is also present in the upper reaches of the study catchments.

Figure 1.1 (2 sheets) is a location and catchment plan, while **Figure 2.1** (4 sheets) shows the key features of the existing stormwater drainage system at Yass.

S2 Study Activities

The activities undertaken in this FRMS included:

1. Undertaking a consultation program over the course of the study to ensure that the Yass community was informed of the objectives, progress and outcomes over the course of the study (**Chapter 1** and **Appendix A**).

2. Review and updating of flooding patterns in Yass for flood events up to the Probable Maximum Flood (**PMF**). (**Chapter 2**, as well as **Appendices B** and **C**).

3. Assessment of the economic impacts of flooding, including the numbers of affected properties and estimation of flood damages (**Chapter 2** and **Appendix D**).

4. Review of current flood related planning controls for Yass and their compatibility with flooding conditions (**Chapter 2**).

5. Strategic review of potential floodplain risk management works and measures aimed at reducing flood damages, including an economic assessment of the most promising measures (**Chapter 3** and **Appendix E**).

6. Ranking of works and measures using a multi-objective scoring system which took into account economic, financial, environmental and planning considerations (**Chapter 4**).

7. Preparation of the *Yass FRMP* (**Chapter 5**).

S3 Summary of Flood Impacts

Figures 2.2 and **2.3** show the indicative extent and depths of inundation of both the 1% Annual Exceedance Probability (**AEP**) and PMF events, respectively, while **Figure 2.4** shows design water surface profiles along the Yass River, Chinamans Creek and Bango Creek. **Figure 2.5** shows the time of rise of floodwaters, while **Figure 2.6** shows the indicate extent of flooding at Yass for flood of between 20% and 0.2% AEP events, as well as the PMF event.

At the 1% AEP level of flooding, 23 dwellings and 34 commercial/industrial buildings are subjected to above-floor inundation, noting that no public buildings are above-floor inundated during a flood of this magnitude. The total flood damages in Yass amounts to $6.59 Million in the event of a 1% AEP flood, increasing to about $154 Million in a PMF event. **Figures 2.2** and **2.3** show the location and indicative depth of above-floor inundation in properties that are affected by the 1% AEP and PMF events, respectively.

The "*Present Worth Value*" of damages resulting from all floods up to the magnitude of the 1% AEP at a seven per cent discount rate and a 50 year economic life is about $3.5 Million. This amount represents the amount of capital spending which would be justified if a particular flood mitigation measure prevented flooding for all properties up to the 1% AEP event.

While the flood range in areas subject to Major Overland Flow is relatively small, it is relatively large in areas subject to Main Stream Flooding, especially in those areas that are subject to flooding from the Yass River. For example, the peak 1% AEP flood level on the Yass River at Yass is over 5 m higher than the corresponding peak 20% AEP flood level, while the peak PMF level is about 15 m higher than the corresponding peak 1% AEP flood level.

This large flood range in combination with the relatively rapid response time of the catchment to flood producing rain and the absence of an effective flood warning system for Yass poses a significant risk to life for occupiers of those areas that are subject to Main Stream Flooding. It also poses problems for agencies such as NSW State Emergency Services (**NSW SES**) given the relatively short period of time that is available to evacuate people from areas that could, depending on the intensity of the storm event, be subject to hazardous and life threatening flooding conditions.

S4 Flood Risk and Development Controls

An approach which uses the concepts of *flood hazard* and *hydraulic categorisation*, and is aimed at imposing a graded set of controls over development according to the flood risk has been recommended for incorporation in a new valley-wide Development Control Plan which Council is currently in the process of preparing. The delineation of flood planning constraint categories is based on the proximity to flow paths, depths and velocities of flow, the rate of rise of floodwaters and ease of evacuation from the floodplain in the event of a flood emergency.

Figure E1.1 in **Appendix E** is an extract from the *Flood Planning Map* relating to Yass. The extent of the Flood Planning Area (**FPA**) (the area subject to flood related development controls) has been defined as follows:

- In areas subject to Main Stream Flooding, the FPA is based on the traditional definition of the area inundated by the 1% AEP plus freeboard (where a freeboard of 1.2 m was adopted for defining the extent of the FPA along the Yass River, while a freeboard of 0.5 m was adopted for defining the extent of the FPA along its major tributaries).

- In areas subject to Major Overland Flow, the FPA is defined as the extent of areas which act as a floodway, as well as areas where depths of inundation exceed 0.1 m in a 1% AEP event.

Minimum habitable floor level requirements would be imposed on future development in properties that are identified as lying either partially or wholly within the extent of the FPA shown on the *Flood Planning Map*. The minimum habitable floor levels for all land use types with the exception of "critical uses and facilities" is the level of the 1% AEP flood event plus 0.5 m freeboard in the case of areas affected by Main Stream Flooding and plus 0.3 m freeboard in areas affected by Major Overland Flow.

S5 Yass Floodplain Risk Management Plan

The *Yass FRMP* showing recommended flood management measures for the study area is presented in **Chapter 5**, with the recommended works and measures summarised in **Table S1** at the end of this Summary. The recommended works and measures have been given a provisional priority ranking, confirmed by the Floodplain Risk Management Committee, according to a range of criteria, details of which are set out in **Section 4** of the report.

The *Yass FRMP* comprises four "non-structural" management measures which could be implemented by Council with the assistance of NSW SES using existing data and without requiring Government funding. The measures are as follows:

- **Measure 1** – Inclusion of a new special flood considerations clause in the *Yass Local Environmental Plan 2013 (**Yass LEP 2013**)* which would apply to land which lies between the FPA and the extent of the PMF, noting that the wording in clause 6.2 titled *Flood planning* will be automatically updated by the NSW Government on 14 July 2021. The changes to *Yass LEP 2013* will provide flexibility in defining the Flood Planning Level (**FPL**) in areas subject to different types of flooding across the whole of the Local Government Area and also for ease of implementing **Measure 2**.
- **Measure 2** - The application of a graded set of planning controls for future development that recognise the location of the development within the floodplain; to be applied through a new valley-wide Development Control Plan. Suggested wording for inclusion in the new Development Control Plan is set out in **Appendix E**.
- **Measures 3** - Improvements in the NSW SES's emergency planning, including use of the flood related information contained in this study to update the *Yass Valley Local Flood Plan*. Information in this present report which would be of assistance to NSW SES includes data on the nature and extent of flooding at Yass, times of rise of floodwaters, duration and depths of inundation at major road crossings for a range of flood events and properties affected by flooding.
- **Measure 4** - Council should take advantage of the information on flooding presented in this report, including the flood mapping, to inform occupiers of the floodplain of the flood risk. This could be achieved through the preparation of a *Flood Information Brochure* which could be prepared by Council with the assistance of NSW SES containing both general and site specific data and distributed with rate notices.

In addition to the above measures, the *Yass FRMP* includes the following two additional "non-structural" type measures which would require Government Funding:

- **Measure 5**, which involves the investigation and design of an integrated flood warning system for the Yass Valley which would include the installation of a network of pluviographic rain gauges, along with a series of telemetered stream gauges. An automated alarm and public announcement system should be linked to the telemetered stream gauges warning residents and business owners that a key trigger level(s) has been reached and to monitor and take action where required. Other improvements include the installation of manual read water level gauges at Sutton, Gundaroo and Yass, as well as the installation of warning signs and self-deploying boom gates on river and creek crossings.
- **Measure 6**, which involves the implementation of the abovementioned integrated flood warning system for the Yass Valley.

While several potential flood modification works in the form of upgrades to the existing stormwater drainage system and the construction of a detention basin in publically owned land were assessed as part of the *Yass FRMS*, none were considered to provide sufficient benefit in terms of a reduction in flood affectation and hazard in existing development to justify their inclusion in the *Yass FRMP*. However, the *Yass FRMS* did conclude that there is merit in developing and implementing a *Vegetation Management Plan* for Chinamans Creek where it runs through the urbanised parts of Yass, noting that while the removal of dense vegetation from inbank areas would not have a significant impact on peak 1% AEP flood levels, it would reduce the frequency of nuisance flooding and the risk of blockage of hydraulic structures (**Measure 7**).

S6 Timing and Funding of FRMP Measures

The total estimated cost to implement the *Yass FRMP* is **$0.82 Million**, exclusive of Council, NSW SES and Bureau of Meteorology staff costs. The timing of the measures will depend on Council's overall budgetary commitments and the availability of both Local and State Government funds.

Assistance for funding qualifying projects included in the *Yass FRMP* may be available upon application under the Commonwealth and State funded floodplain management programs, currently administered by NSW Department of Planning, Industry and Environment.

S7 Council Action Plan

1. Council to update *Yass LEP 2013* and prepare a new valley-wide Development Control Plan incorporating the suggested form of wording set out in **Appendix E** of this report (**Measures 1** and **2** of the *Yass FRMP*).
2. NSW SES to update the *Yass Valley Local Flood Plan* using information on flooding patterns, peak flood levels, times of rise of floodwaters and flood prone areas identified in this report (**Measure 3** of the *Yass FRMP*).
3. Council to inform residents of the flood risk, based on the information presented in the *Yass FRMS*. (e.g. displays of flood mapping at Council offices, preparation of *Flood Information Brochure* for distribution with rate notices, etc) (**Measure 4** of the *Yass FRMP*).
4. Council to commission the investigation, design and implementation of an integrated flood warning system for the Yass Valley (**Measure 5** and **6** of the *Yass FRMP*).
5. Council to develop and implement a *Vegetation Management Plan* for Chinamans Creek (**Measure 7** of the *Yass FRMP*).

TABLE 9.1
RECOMMENDED MEASURES FOR INCLUSION IN YASS FLOODPLAIN RISK MANAGEMENT PLAN

Measure	Required Funding	Features of the Measure	Priority
1. Update of Yass LEP 2013	Council's staff costs	➢ A new special flood considerations clause should be incorporated in Yass LEP 2013 which applies to land that lies between the FPA and the PMF. The new clause relates to development with particular evacuation or emergency response issues (e.g. group homes, residential aged care facilities, etc). It is also aimed at protecting the operational capacity of emergency response facilities and critical infrastructure during extreme flood events. ➢ It is noted that the wording in clause [illegible] of Yass LEP 2013 titled *Flood planning* will be automatically updated by the NSW Government on [illegible] July 2021 as part its recent reform of the *NSW Flood Prone Land Package*.	High Priority: this measure is designed to mitigate the flood risk to future development and has a high priority for inclusion in the Yass *FRMP*. It does not require Government funding.
2. Incorporate recommended approach to managing future development on flood prone land in new valley-wide Development Control Plan.	(Council's staff costs)	▪ Graded set of flood controls based on the type of development and their location within the floodplain, defined as land inundated by the PMF. ▪ Floodplain divided into five zones based on the assessed flood hazard and hydraulic category function. ▪ The minimum floor levels for all land use types is the level of the 1% AEP flood event plus 0.5 m freeboard in the case of areas affected by Main Stream Flooding and plus 0.3 m freeboard in areas affected by Major Overland Flow. ▪ Additional controls applied to development that is located on land which lies above the Flood Planning Level where the large flood range is considered to pose a significant risk to life.	High Priority: this measure is designed to mitigate the flood risk to future development and has a high priority for inclusion in the Yass *FRMP*. It does not require Government funding.
3. Ensure flood data in the Yass FRMS are available to the NSW SES for improvement of flood emergency planning.	NSW SES costs	➢ NSW SES should update the *Yass Valley Local Flood Plan* using information on flooding patterns, times of rise of floodwaters and flood prone areas identified in this report.	High Priority: this measure would improve emergency response procedures and has a high priority. It does not require Government funding.
4. Implement flood awareness and education program	Council staff costs	➢ Council to inform residents of the flood risk, based on the information presented in the Yass *FRMS* (e.g. displays of flood mapping at Council offices, preparation of *Flood Information Brochure* for distribution with rate notices, etc).	High Priority: this measure would improve the flood awareness of the community and has a high priority. It does not require Government funding.
5. Investigate and design an integrated flood warning system for the Yass Valley	$[illegible] Million	➢ The installation of a network of telemetered pluviographic rain gauges in combination with a series of telemetered stream gauges would assist BoM and NSW SES in providing more accurate and timely flood warnings for urbanised areas in the Yass Valley. ➢ The linking of an alarm and public announcement system to the telemetered stream gauges (where applicable) would warn residents and business owners that a key trigger level(s) has been reached and to monitor and take action where required. ➢ The installation of manually read water level gauges at key locations would allow NSW SES to monitor river and creek levels during a flood event. ➢ The installation of warning signs and self-deploying boom gates at river and creek crossings would prevent motorists from accessing inundated roads.	High Priority: this measure would reduce flood damages by providing advance warning of potential flooding.
6. Implement integrated flood warning system for the Yass Valley	$[illegible] Million		
7. Develop and implement Vegetation Management Plan for Chinamans Creek	$[illegible] Million	➢ The Vegetation Management Plan will identify the reaches of Chinamans Creek which require regular maintenance. It will also describe the scope of any rehabilitation works which would be required following the completion of any bulk works. ➢ The required funding would permit the development of the Vegetation Management Plan, the removal of dense vegetation from the bank area of the watercourse and the implementation of a regular maintenance program over a five year period.	Low Priority: this measure would reduce the risk of a blockage being experienced at the various road crossings, as well as reduce the frequency of nuisance flooding.
Total Estimated Cost	$[illegible] Million		

1 INTRODUCTION

1.1 Study Background

Yass Valley Council (**Council**) commissioned the preparation of the *Yass Floodplain Risk Management Study and Plan* (***Yass FRMS&P***) in accordance with the New South Wales Government's *Flood Prone Land* policy. **Figure 1.1** (2 sheets) shows the location of Yass, as well as the extent of the catchment contributing to flow in the Yass River at the town. It also shows the extent of the catchments which contribute to the two major creek systems which are located in the study area.

The *Yass FRMS&P* focuses on the following two types of flooding which are present in different parts of the study area:

- **Main Stream Flooding**, which occurs when floodwater surcharges the inbank area of the existing river and creek systems. Main Stream Flooding is typically characterised by relatively deep and fast flowing floodwater, but may be shallower and slower moving in flood fringe areas.
- **Major Overland Flow** which occurs during storms which result in the surcharge of the existing piped drainage system in Yass. It is also present in the upper reaches of the study catchments.

The *Yass Floodplain Risk Management Study (**Yass FRMS**)* reviewed baseline flooding conditions, including an assessment of economic impacts and the feasibility of potential measures which are aimed at reducing the impact of flooding on both existing and future development. The review was based on flood behaviour which was defined using updated versions of the flood models that were originally developed as part of the *Yass Flood Study* (WMAWater, 2016a) (herein referred to as the ***Updated Flood Study***). This process allowed the formulation of the *Yass Floodplain Risk Management Plan* (***Yass FRMP***) for the study area.

1.2 Background Information

The following documents were used in the preparation of this report.

- *Floodplain Development Manual* (New South Wales Government (NSWG), 2005)
- *Yass Local Environmental Plan, 2013* (*Yass LEP 2010*)
- *Yass Shire Council – Multi-unit Residential Development* (*Yass DCP 2003*)
- *Yass Dam 3.0 m Raising Concept Design Report* (NSW Department of Commerce (**DoC**), 2010)
- *Yass Valley Local Flood Plan* (NSW State Emergency Service (**NSW SES**), 2013) (***Yass Valley Local Flood Plan***)
- *Extreme Flood Discharge Estimate for Yass Dam* (WRM Water + Environment, 2015)
- *Yass Flood Study* (WMAWater, 2016a)
- *Gundaroo Floodplain Risk Management Study and Plan* (WMAwater, 2016b)
- *Sutton Floodplain Risk Management Study and Plan* (WMAwater, 2016c)
- *Dam Safety Emergency Plan for Yass Dam* (NSW Public Works, 2016)
- *Hydraulic Assessment at Location of Proposed Causeway Crossing of Yass River* (Lyall & Associates, 2019)

1.3 Overview of Yass FRMS Report

The results of the *Yass FRMS* and the *Yass FRMP* are set out in this report. Contents of each Chapter of the report are briefly outlined below:

- **Chapter 2, Baseline Flooding Conditions**. This Chapter includes a description of the existing drainage system at Yass, as well as the nature of flood behaviour in the study area based on the findings of the *Updated Flood Study*. The Chapter also summarises the economic impacts of flooding on existing urban development, reviews Council's flood planning controls and management measures and NSW SESs flood emergency planning.
- **Chapter 3, Potential Floodplain Management Measures**. This Chapter reviews the feasibility of floodplain management measures for their possible inclusion in the *Yass FRMP*. The list of measures considered is based on input from the Community Consultation process, which sought the views of residents and business owners in the study area in regard to potential flood management measures which could be included in the *Yass FRMP*. The measures are investigated at the strategic level of detail, including indicative cost estimates of the most promising measures and benefit/cost analysis.
- **Chapter 4, Selection of Floodplain Management Measures**. This Chapter assesses the feasibility of potential floodplain management strategies using a multi-objective scoring procedure which was developed in consultation with the Floodplain Risk Management Committee (**FRMC**) and outlines the preferred strategy.
- **Chapter 5, Yass Floodplain Risk Management Plan** presents the *Yass FRMP* which comprises a number of structural and non-structural measures which are aimed at increasing the flood awareness of the community and ensuring that future development is undertaken in accordance with the local flood risk.
- **Chapter 6** contains a glossary of terms used in the study.
- **Chapter 7** contains a list of References.

Five technical appendices provide further information on the study results:

Appendix A – Community Consultation and Historic Flooding summarises residents' and business owners' views on potential flood management measures which could be incorporated in the *Yass FRMP*.

Appendix B - Photos Showing Historic Flooding at Yass contains a series of plates which show the nature of Main Stream Flooding which was experienced in parts of Yass during the major floods that occurred in 1900, 1925 and 1959. Also included are a number of photos showing the flooding that was experienced on the Yass River at Yass during the recent flood that occurred in August 2020.

Appendix C – Hydrologic and Hydraulic Modelling Update deals with the update of the hydrologic and hydraulic models that were developed as part of WMAwater, 2016a based on the procedures set out in the 2019 edition of Australian Rainfall and Runoff (Geoscience Australia, 2019) (**ARR 2019**).

Appendix D – Flood Damages is an assessment of the economic impacts of flooding to existing residential, commercial and industrial development, as well as public buildings at Yass. The damages have been re-assessed using the results of the updated flood modelling, as well as surveyed and estimated floor levels, the latter which were derived from a combination of a "drive-by" property survey, as well as data from LiDAR survey.

Appendix E – Suggested Wording for Inclusion in Yass Valley Development Control Plan presents guidelines for the control of future urban development in flood prone areas in the Yass Local Government Area (**LGA**). The guidelines cater for both Main Stream Flooding of the river and creek systems, as well as Major Overland Flow resulting from surcharging of the stormwater drainage systems in the overland flow paths draining the urbanised parts of the LGA.

1.4 Community Consultation

Following the Inception Meeting of the Floodplain Risk Management Committee (**FRMC**), a *Community Newsletter* was prepared by the Consultants and distributed to residents and business owners by Council. A *Community Questionnaire* was also distributed by Council seeking details from residents and business owners regarding their attitudes toward potential floodplain management measures. Community responses are summarised in **Chapter 3** of this report, with supporting information in **Appendix A**. The views of the community on potential flood management measures to be considered in the study were also taken into account in the assessment presented in **Chapter 3** of this report.

The FRMC reviewed the potential flood management measures developed in **Chapter 3** and assessed the measures using the proposed scoring system of **Chapter 4**. The *Yass FRMS* and accompanying *Yass FRMP* were also reviewed by the FRMC and amended prior to the preparation of the public exhibition report.

The draft *Yass FRMS&P* report was placed on public exhibition over the period 23 May 2021 to 25 June 2021, while a "drop-in" session was held between 6-8 pm on 16 June 2021. Two pop-up displays that provided a visual representation of the large flood range at Yass were also set up, one near the carpark on Riverbank Park (adjacent to Cobblestone Cottage) and the other on the corner of Comur Street and Rossi Street outside the Yass Court House.

A total of five (5) written submissions were received from the public during the exhibition period, three of which were supportive of the findings and recommendations set out in the document, while another requested that location specific peak flood and ground level data be provided prior to the "drop-in" session.[1] The remaining submission related to the frequent inundation that is currently being experienced in private property that is located on the northern (downstream) side of Browne Street as a result of flow which surcharges an adjacent transverse drainage structure.

While the present study found that the aforementioned transverse drainage structure is surcharged during storms that are more frequent than 20% AEP (the most frequent storm event assessed as part of the present study) and that flooding in the downstream property is exacerbated by the fact that the low point in the road is not centred on the downstream reach of channel, it was concluded that due to the relatively shallow nature of the flow and the limited flood damages that would be experienced in private property during storm events which surcharge the existing transverse drainage structure, any upgrade works would not be eligible for funding under the NSW Government's floodplain management program. While its ineligibility for State Government funding has resulted in it not being incorporated in the *Yass FRMP*, it is recommended that Council further investigate the capacity of the existing transverse drainage structure as based on the findings of the present study its hydrologic standard appears to be too low and therefore there would be merit in its future upgrade by Council.[2]

[1] It is noted that the requested data were provided to the respondent prior to the drop-in session.
[2] It is noted that Council has previously considered a report on this matter.

During presentations that were given by the Consultant to both the FRMC and Councillors on the findings and recommendations set out in the draft *Yass FRMS&P* report, concerns were raised in relation to the controls that would be imposed on "Sensitive Uses and Facilities", namely for this type of development to be located off the floodplain. These controls were considered to have an unacceptable impact on the ability for people housed in this type of development to easily access essential community services in Yass. In the knowledge that the *Yass FRMP* includes the requirement to develop and implement an integrated flood warning system for the Yass Valley, Council requested that the controls for Main Stream Flooding be amended to more closely reflect those for residential type development, noting that it would still be a requirement for an Applicant to demonstrate that users could be evacuated from the proposed development to flood free land in a safe and orderly manner.

Following a review of the draft *Yass FRMS&P* report, the Department of Planning, Industry and Environment (**DPIE**) recommended that the wording be updated to reflect the State Government's new *NSW Flood Prone Land Package* and how its introduction will affect future flood and floodplain risk management planning at Yass.

1.5 Flood Frequency and Terminology

In this report, the frequency of floods is referred to in terms of their Annual Exceedance Probability (**AEP**). The frequency of floods may also be referred to in terms of their Average Recurrence Interval (**ARI**). The approximate correspondence between these two systems is:

Annual Exceedance Probability (AEP) – %	Average Recurrence Interval (ARI) – years
0.2	500
0.5	200
1	100
2	50
5	20
10	10
20	5

The AEP of a flood represents the percentage chance of its being equalled or exceeded in any one year. Thus a 1% AEP flood, which is equivalent to a 100 year ARI, has a 1% chance of being equalled or exceeded in any one year and would be experienced, on the average, once in 100 years; similarly, a 20 year ARI flood has a 5% chance of exceedance, and so on.

The 1% AEP flood (plus freeboard) is usually used to define the Flood Planning Level (**FPL**) and Flood Planning Area (**FPA**) for the application of flood related controls over residential and commercial/industrial development. While a 1% AEP flood is a major flood event, it does not define the upper limit of possible flooding. Over the course of a human lifetime of, say 70 years, there is a 50 per cent chance that a flood at least as big as a 1% AEP event will be experienced. Accordingly, a knowledge of flooding patterns in the event of larger flood events up to the Probable Maximum Flood (**PMF**), the largest flood that could reasonably be expected to occur, is required for land use and emergency management planning purposes. In the *Updated Flood Study*, flooding patterns in the study area have been assessed for design floods ranging between 20% AEP event and the PMF.

2 BASELINE FLOODING CONDITIONS

2.1 Physical Setting

The township of Yass has a population of about 6,400 and lies on the Yass River approximately 50 km north of Canberra in the Murrumbidgee River basin. **Figure 1.1**, sheet 1 shows that the headwaters of the Yass River are located about 80 km to the south-east of Yass in the vicinity of the village of Sutton. The Yass River flows in a westerly direction through Yass where it discharges to Burrinjuck Dam which is located about 25 km to the west of the township. The Yass River catchment is characterised by hilly pastoral land and has an area of about 1,230 km^2 at the town.

The developed parts of Yass are drained primarily by Chinamans Creek and Bango Creek (refer **Figure 1.1**, sheet 2). While the majority of development at Yass is situated on high ground, as will be explained later in this chapter, a large number of properties are subject to hazardous flooding conditions during very rare and extreme flood events due to the large flood range in the Yass River.

2.2 Drainage System

Figure 2.1 (4 sheets) shows the existing stormwater drainage system at Yass. The majority of the urbanised part of Yass that is located to the south of the Yass River is drained by a series of roadside gutters and stormwater pipes that discharge to Chinamans Creek. Chinamans Creek has a catchment area of about 3.7 km^2 at the point at which it discharges to the Yass River. **Figure 2.1**, sheet 2 shows that Chinamans Creek has been enclosed where it flows beneath existing roads and development. Two on-site stormwater detention basins have recently been constructed in the headwaters of the catchment as part of residential subdivisions that are located in the vicinity of Colls Close and Nicholson Drive.

Figure 2.1, sheet 4 shows the extent of a 1.5 km^2 catchment that may have originally drained to Chinamans Creek, but has been diverted to the Yass River via a single 1200 mm diameter pipe that runs in a northerly direction along Dutton Street.

Figure 2.1, sheet 3 shows that the urbanised part of the town that is located on the northern side of the Yass River is drained by piped drainage systems that discharge to the river at the southern ends of O'Brien Street and Hume Street, or via piped culverts that are located beneath the disused railway line at the western ends of Grapian Street, Mount Street and Orion Street. Existing development that is located north of Orion Street drains to Bango Creek via a piped drainage system that is located along Yass Valley Way.

Figure 2.1, sheets 3 and 4 show that Bango Creek drains the largely undeveloped rural land that is located to the north of the town and has a catchment area of about 67 km^2 at its point of discharge to the Yass River. The Hume Highway and the Main Southern Railway runs in an east-west direction through the Bango Creek catchment.

2.3 Flood History

2.3.1 Gauge History

The *Yass River at Yass* stream gauge (GS 410026) (**Yass stream gauge**) was first established in August 1915 when daily gauge heights were manually-read until it was decommissioned in 1956 and replaced by another manually-read gauge that was located approximately 3.5 km downstream at the Railway Weir (refer **Figure 2.1**, sheet 3 for location).

In 1961 the aforementioned stream gauge was decommissioned and a new telemetered stream gauge installed on the right bank of the Yass River about 100 m downstream of Flat Rock Crossing.

2.3.2 Historic Flood at Yass

Yass has experienced several large floods that have inundated the floodplain and isolated parts of the town since settlement occurred in the 1830s. While stream gauge records only extend back to 1915, archival information contained in WMAwater, 2016a indicates that major flood events occurred in July 1852, July 1864, April 1870, June 1891 and July 1900.

Table 2.1 over provides a comparison of the maximum water levels that have been reached in the Yass River at the location of the various stream gauges with peak design floods levels derived as part of the present study at the location of the current telemetered stream gauge for a range of design flood events. The gauge heights corresponding with Minor, Moderate and Major Floods as advised by NSW SES are also shown.

The July 1900 flood event is estimated to be the flood of record at Yass. While details of the extent of flooding during this event are limited, archival newspaper articles indicate that significant damage occurred at Yass and at least fifteen residential properties were inundated.

The October 1959 flood event is the largest to occur since official records began in 1915. Archival news footage from 1959 indicates that a dozen residential premises were evacuated during the event and three service stations, as were "several" shops in Comur Street. The floodwaters reached the steps of the Yass Court House in Rossi Street. The October 1959 flood event reached RL 5.9 m on the Railway Weir stream gauge which is equivalent to about 10.0 m on the Yass stream gauge.[3] **Table 2.1** shows that the October 1959 flood event was equivalent to a design flood event with an AEP of 1 per cent. It is noted that time-based water level data at the Yass stream gauge are not available for the October 1959 flood event.

The third largest flood event on record at Yass occurred in May 1925. Archival newspaper articles indicate that the flood occurred after almost nine inches of rain were recorded over the preceding days. As shown on the adjacent stage hydrograph, water levels in the river commenced to rise around mid-day on 26 May 1925, continuing into the night. Reports state that by sunrise the Yass River was approximately a quarter of a mile (about 400 m) wide at the location of the Hume Bridge, with the floodwater said to have begun receding at about 14:00 hours on the 27 May. There are no records of the number of properties that were impacted by the May 1925 flood event.

Appendix B contains a series of photos that show the flooding that was experienced in Yass during the 1900, 1925 and 1959 floods. Also included are a number of photos showing the flooding that was experienced at Yass during the recent flood that occurred in August 2020 which is estimated to have had an AEP slightly larger than 10 per cent.

[3] Source: WMAwater, 2016

TABLE 2.1
FLOOD HISTORY AND DESIGN FLOOD LEVELS[1,2]
YASS RIVER STREAM GAUGE (GS 410026)

Flood Event	Height on Yass Stream Gauge (m)[3]
PMF Event without Dam Failure[4]	25.5
0.2% AEP	13.1
0.5% AEP	11.3
July 1900[5]	10.3
1% AEP	10.1
October 1959[5]	10.0
May 1925[5]	9.75
June 1891[5]	>8.8
June 1952[5]	8.8
April 1870[5]	8.8
2% AEP	8.8
Major Flood[6]	8.0
August 1974[5]	7.6
5% AEP	7.2
July 1922[5]	7.0
October 1934[5]	7.0
April 1950[5]	7.0
Moderate Flood[6]	6.0
10% AEP	5.9
20% AEP	4.7
Minor Flood[6]	4.6

1. Peak historic flood levels which pre-date the installation of the current telemetered stream gauge are either estimates or relate to the earlier manually-read stream gauges that were not necessarily located at the same location along the river.
2. Design peak flood levels relate to the findings of the *Updated Flood Study*.
3. Gauge zero on Yass gauge = 475.52 m AHD.
4. While failure of the Yass Dam was assessed as part of NSW Public Work, 2016, the approximate gauge height reached during the assessed dam break scenarios was not reported.
5. Source: WMAwater, 2016a
6. NSW SES provided written advice on the Major/Moderate/Minor classifications for Yass as they are not defined in the *Yass Valley Local Flood Plan*.

2.4 Design Flood Behaviour

2.4.1 Background to Previous Studies

WMAwater, 2016a defined the nature of flooding in the study area for design storms ranging between 20% and 0.5% AEP, as well as the PMF event. Flood behaviour was defined using a three-staged approach to design flood estimation at Yass:

1. A flood frequency analysis which was undertaken for the Yass stream gauge using the TUFLOW Flike software.
2. The development and running of a hydrologic model of the local catchments in and around Yass which was based on the DRAINS rainfall-runoff software.
3. The development and running of a hydraulic model of the Yass River, Chinamans Creek and Bango Creek, as well as their minor tributaries which was based on the TUFLOW software.

The flood frequency analysis was used to derive design peak flow estimates at the Yass stream gauge. The ordinates of the discharge hydrograph that was recorded at the stream gauge during a flood event that occurred on March 1989 were factored to match the flood frequency derived design peak flow estimates. These hydrographs were then applied to the upstream boundary of the TUFLOW hydraulic model.

The DRAINS model was used to generate design discharge hydrographs which were also applied to the TUFLOW hydraulic model. The design discharge hydrographs were based on design storms that were derived based on procedures set out in the 1987 edition of *Australian Rainfall and Runoff* (Institute of Engineers, Australia (**IEAust**), 1987) (**ARR 1987**).

The TUFLOW model used a two-dimensional (in plan), grid-based representation of the natural surface based on LiDAR survey data, as well as piped drainage data that were provided by Council. Field survey was also used to capture details of the existing stormwater drainage system.

It was not possible to calibrate the DRAINS model as there are no stream gauges in the Chinamans Creek or Bango Creek catchments. Rather it was necessary to adopt an iterative approach whereby the hydrologic and hydraulic models were run in series, with changes made to model parameters until a reasonable match was achieved between modelled and observed flood behaviour for a storm event that occurred in December 2010. The TUFLOW model was also calibrated to observed peak flood levels from the March 1989 flood event.

An "envelope" approach was adopted for defining design water surface elevations and flow patterns throughout the study area. The procedure involved running the model for the 60 minute storm duration which was found to be critical for maximising peak flood levels along Chinamans Creek and Bango Creek and the factored March 1989 discharge hydrographs on the Yass River to define the upper limit (i.e. the envelope) of expected flooding for each design flood frequency.

Lyall & Associates recently undertook a flooding investigation for a planned privately owned bridge crossing of the Yass River upstream of Yass (Lyall & Associates, 2019). The DRAINS software was used to develop a RAFTS based hydrologic model of the Yass River catchment upstream of the Yass stream gauge. The hydrologic model was tuned to the flood frequency relationship presented in WMAwater, 2016a for the Yass stream gauge, with design storm losses based on the median pre-burst depths which were sourced from the *ARR Data Hub*. The hydrologic model was used to derive peak flows and design discharge hydrographs at the proposed bridge site.

2.4.2 Background to Development of Updated Flood Models

The hydrologic and hydraulic models that were developed as part of WMAwater, 2016a were updated as part of the present study using the procedures set out in ARR 2019. The structure of the models was also updated to improve the definition of flood behaviour in several areas.

The hydrologic model that was developed as part of Lyall & Associates, 2019 was also updated to incorporate the probability-neutral burst initial loss values which have recently been released for use in NSW.

The updated flood models were used to define the nature of flooding in Yass for design storms of between 20% and 0.2% AEP, as well as the PMF event. **Appendix C** of this report sets out the details of the hydrologic and hydraulic modelling that was undertaken as part of the present study.

2.4.3 Design Flooding Patterns

Figures 2.2 and **2.3** show the nature of flooding at Yass for the 1% AEP and PMF events, respectively, while **Figures C4.1** to **C4.6** in **Appendix C** of this report show similar information for the 20%, 10%, 5%, 2%, 0.5% and 0.2% AEP flood events. These figures show the indicative extent and depth of inundation along the Yass River, Chinamans Creek and Bango Creek, as well as along the Major Overland Flow paths for the assessed design flood events. Also shown on these figures are Peak Flow Locations (**PFLs**) which are referred to in the following discussion. Peak flows for the assessed design flood events at each PFL are tabulated in **Table C1** in **Attachment C3** of **Appendix C**.

Figure 2.4 shows water surface profiles along the Yass River, Chinamans Creek and Bango Creek for the assessed design flood events, while **Table 2.1** sets out the design peak flood levels at the Yass stream gauge. **Figure 2.5** shows the time of rise of floodwater at key locations throughout the study area, including at several major road crossings.

The key features of flooding on the Yass River at Yass are as follows:

- Floodwater is contained within the river banks in a 20% AEP flood event.
- Floodwater commences to surcharge the southern bank of the river at its confluence with Chinamans Creek in a 10% AEP design flood event.
- Access between the northern and southern sides of Yass is cut in a 5% AEP flood event as floodwater commences to surcharge Comur Street at the low point that is located about 80 m to the north of its intersection with Rossi Street. Floodwater backs up Chinamans Creek and inundates Rossi Street to a depth of about 0.5 m.
- Rossi Street is inundated to a depth of about 3.5 m in a 1% AEP flood event. .
- Floodwater commences to surcharge the right bank of the Yass River in the vicinity of its confluence with Bango Creek where it would inundate Yass Valley Way to a depth of about 0.9 m in a 1% AEP event.
- Peak 0.5% and 0.2% AEP flood levels in the Yass River are respectively 1.2 m and 3.0 m higher than corresponding peak 1% AEP flood levels.
- Peak PMF flood levels on the Yass River are about 15 m higher than corresponding peak 1% AEP flood levels.

The key features of flooding along Chinamans Creek are as follows:

- Floodwater is generally contained within the banks of the creek in a 20% AEP event with the exception of the following locations:
    - in the vicinity of Perry Street where floodwater surcharges onto the road and flows in an easterly direction before turning and flowing in a northerly direction along Brennan Street; and
    - in Cobham Street, where floodwater inundates an existing commercial building that is located on the northern side of the road (refer PFL Q08 on sheet 2 of series).
- Floodwater commences to surcharges onto Green Street in a 10% AEP event (refer PFL Q07 on sheet 2).
- Floodwater commences to surcharge MacDonald Street in a 5% AEP event (refer PFL Q10 on sheet 2). Floodwater that surcharges the creek at this location flows in a northerly direction through existing commercial development before discharging back to the creek on the northern side of Petit Street.
- Floodwater also commences to surcharge the creek at a location about 100 m to the south of Meehan Street (refer PFL Q13 on sheet 2) in a 5% AEP event where it will flow in a northerly direction across the Yass Soldiers Club carpark.
- The 420 m long piped reach of Chinamans Creek immediately downstream of Browne Street (refer PFL Q11 on sheet 2) commences to surcharge in a 1% AEP event. Floodwater that surcharges the creek at this location flows in a northerly direction along Comur Street where it discharges to the Yass River in the vicinity of the Hume Bridge.
- The peak flow in the Chinamans Creek for the PMF is about 10 times that of the 1% AEP flood event.

The key features of flooding in the Bango Creek are as follows:

- Floodwater is generally contained within the creek banks in a 20% AEP flood event with the exception of the following locations:
    - in the vicinity of the upstream extent of the model (refer PFL Q34 on sheet 4) where the floodplain is about 150 m wide; and
    - at a location about 350 m north of Yass Valley Way where floodwater that surcharges the western bank of the creek inundates Wargeila Road to a depth of about 0.4 m.
- Fairy Hole Road is inundated in the vicinity of Fairy Hole Creek (refer PFL Q42 on sheet 4) and one its tributaries that is located about 200 m to the south (refer PFL Q45 on sheet 4) in a 20% AEP event, resulting in the isolation of the dwellings that are located in the headwaters of the Bango Creek catchment.
- The Hume Highway generally remains flood free in a 0.2% AEP event except at a location about 230 m west of the Fairy Hole Road crossing where shallow overland flow surcharges onto the road and flows in a westerly direction before discharging to Fairy Hole Creek.
- Shallow overland flow surcharges onto the Main Southern Railway in the vicinity of its junction with the Disused Railway Line in a 5% AEP event. Floodwater also surcharges the Main Southern Railway at a location about 800 m further to the north in a 2% AEP event.
- The peak flow in Bango Creek for the PMF is about 12 times that of the 1% AEP flood event.

The key features of Major Overland Flow in Yass are as follows:

- The existing stormwater drainage system generally has a 20% AEP capacity with the exception of the following locations:
  - the low point in Browne Street in the vicinity of its intersection with Demestre Street (refer PFL Q16 on sheet 2);
  - in the vicinity of the intersection of Polding Street and Pritchard Street where floodwater surcharges the piped drainage system and flows through existing residential development;
  - on the northern side of Lead Street where overland flow overtops the northern kerb and flows through existing residential development between Pritchard Street and Chinamans Creek;
  - in the vicinity of the Lead Street crossing of Chinamans Creek where overland flow surcharges the right bank of the concrete lined channel in the vicinity of the TAFE and flows in a northerly direction through existing development;
  - at the eastern end of the Disused Railway (refer PFL Q23 on sheet 2) where flow that surcharges the piped drainage system discharges in a northerly direction along Dutton Street before flowing through existing commercial development toward Comur Street;
  - through existing residential development that is bounded by Rossi Street to the north, Pritchard Street to the east, Meehan Street to the south and Church Street to the west; and
  - in the vicinity of the intersection of Reddall Street and Yass Valley Way where flow that surcharges the existing piped drainage system flows in a northerly direction along Yass Valley Way towards Bango Creek.
- Overland flow commences to surcharge the existing piped drainage system at the intersection of Grand Junction Road and Cobham Street (refer PFL Q15 on sheet 2) in a 10% AEP event where it flows in a north-westerly direction through existing commercial development.
- Overland flow commences to surcharge the existing piped drainage system in the intersection of Green Street and Nicholls Drive in a 10% AEP event where it flows in a westerly direction through existing commercial development
- Overland flow commences to surcharges the existing piped drainage system in the vicinity of the intersection of Links Road and Cliff Street in a 5% AEP event where it flows in an easterly direction through existing residential development.
- Depths of overland flow along the abovementioned flow paths are generally less than 0.5 m in a 1% AEP event, except in locations where floodwater ponds on the upstream side of road crossings and buildings where greater depths of inundation are experienced.

2.5 Existing Flood Mitigation Measures

Apart from two stormwater detention basins that have recently been constructed in the upper reaches of the Chinamans Creek catchment as part of two new residential subdivisions, there are no other formal flood mitigation measures in Yass.

2.6 Economic Impacts of Flooding

The economic consequences of floods are discussed in **Appendix D** of this report, which assesses flood damages to residential, commercial and industrial property, as well as public buildings in areas affected by both Main Stream Flooding and Major Overland Flow. There were only limited data provided by respondents to the *Community Questionnaire* on historic flood damages to the urban sectors in the study area. Accordingly, it was necessary to use data on damages experienced as a result of historic flooding in other urban centres. The residential flood damages were based on the publication *Floodplain Risk Management Guideline No. 4, 2007* (**Guideline No. 4**) published by the Department of Environment and Climate Change (**DECCW**) (now DPIE). Damages to industrial and commercial development, as well as public buildings were evaluated using data from previous floodplain risk management investigations in NSW.

It is to be noted that the principal objectives of the damages assessment were to gauge the severity of urban flooding likely to be experienced at Yass and also to provide data to allow the comparative economic benefits of various flood modification measures to be evaluated in **Chapter 3** of the report. As explained in **Appendix D**, it is not the intention to determine the depths of inundation or the damages accruing to *individual properties*, but rather to obtain a reasonable estimate of damages experienced over the extent of the urban area in the town for the various design flood events. The estimation of damages using *Guideline No. 4* (in lieu of site specific data determined by a loss adjustor) also allows a uniform approach to be adopted by Government when assessing the relative merits of measures competing for financial assistance in flood prone centres in NSW.

Damages were estimated for the design flood levels determined from the hydraulic modelling undertaken as part of the present study. The elevations of 2,068 building floors levels were based on information contained in the property database that was developed as part of WMAwater, 2016a, with adjustments made where necessary by adding the height of floor above a representative natural surface within the allotment (as estimated by visual inspection) to the natural surface elevation determined from LiDAR survey. The number of properties predicted to experience "above-floor" inundation in Yass, together with estimated flood damages is listed in **Table 2.2** over.

At the 1% AEP level of flooding, 23 dwellings and 34 commercial/industrial buildings are subjected to above-floor inundation, noting that no public buildings are above-floor inundated during a flood of this magnitude (refer **Figure 2.2** for the location of affected properties). During a PMF event, 276 dwellings, 152 commercial buildings and 32 public buildings would experience above-floor inundation (refer **Figure 2.3** for the location of affected properties).

The maximum depth of above-floor inundation in the worst affected residential and commercial properties increases from about 4 m for a 1% AEP flood event to about 17 m for the PMF.

The total flood damages in Yass amounts to $6.59 Million in the event of a 1% AEP flood, increasing to about $154 Million in a PMF event. For a discount rate of 7% pa and an economic life of 50 years, the *Present Worth Value* of damages for all flood events up to the 1% AEP flood is about $3.5 Million. Therefore one or more schemes costing up to this amount could be economically justified if they eliminated damages in Yass for all flood events up to this level. While schemes costing more than this value would have a benefit/cost ratio less than 1, they may still be justified according to a multi-objective approach which considers other criteria in addition to economic feasibility. Flood management measures are considered on a multi-objective basis in **Chapter 4**.

TABLE 2.2
FLOOD DAMAGES

Design Flood Event (% AEP)	Residential			Commercial			Public			Total Damage ($ Million)
	Number of Properties		Damage ($Million)	Number of Properties		Damage ($Million)	Number of Properties		Damage ($Million)	
	Flood Affected	Flooded Above Floor Level		Flood Affected	Flooded Above Floor Level		Flood Affected	Flooded Above Floor Level		
20%	8	0	0.13	8	1	0.06	1	0	0.02	0.21
10%	18	1	0.31	9	3	0.25	1	0	0.02	0.58
5%	23	3	0.84	25	14	0.70	1	0	0.02	1.56
2%	48	12	1.76	42	18	2.04	1	0	0.02	3.82
1%	63	23	3.14	56	34	3.39	4	0	0.06	6.59
0.5%	84	32	4.02	80	60	6.57	6	3	0.21	10.80
0.2%	103	44	6.40	109	80	10.50	13	7	1.27	18.17
PMF	442	276	35.22	180	182	91.98	32	32	28.87	156.06

2.7 Impact of Flooding on Vulnerable Development and Critical Infrastructure

Figure 2.6 (4 sheets) shows the location of vulnerable development and critical infrastructure relative to the extent of inundation resulting from the assessed flood events, while **Table 2.3** over the page sets out the frequency of floods which would impact this type of development/infrastructure in Yass.[4]

Community Assets

The sewage pump station SS2 that is located on the western side of Laidlaw Street opposite the extension of Grampian Street would be impacted by Major Overland Flow during storms as frequent as 20% AEP. Sewage pump stations SS4 and SS6 would be impacted by 1% AEP and 2% AEP floods, respectively, while the remainder would be impacted by less frequent flood events. Several road crossings are also inundated by floodwater during floods that are more frequent than 1% AEP, further details of which are set out in **Section 2.8** below.

Emergency Services

The NSW Police, Fire & Rescue NSW and Ambulance stations are located on land which is impacted by a 0.2% AEP flood event on the Yass River, as is the Yass Soldiers Club which is identified as an evacuation centre in the *Yass Valley Local Flood Plan*. The NSW SES Local Unit headquarters is impacted by riverine type flooding during a PMF event, as is a portion of the Yass High School which is also nominated in the *Yass Valley Local Flood Plan* as an evacuation centre.

Vulnerable Development

The Yass Early Childhood Centre (CC3) which has been built over an enclosed section of Chinamans Creek north of Meehan Street is impacted by riverine type flooding during a 1% AEP flood event, while the TAFE NSW campus (EF5) on Church Street is impacted by Major Overland Flow during a 0.2% AEP storm event. The Yass Little Learners (CC2) and Goodstart Early Learning Yass (CC4) child care centres are impacted by the PMF event, as is the Yass Public, Yass High, Berinba Public and Mt. Carmel schools.

All of the existing aged care facilities in Yass (AC1, AC2 and AC3) are located off the floodplain, with the exception of Apex Homes (AC4) which is impacted by a 2% AEP flood. While the majority of the Yass District Hospital (MC1) is located off the floodplain, the Atherfield Medical Centre (MC3) on the northern side of Lead Street is impacted by Major Overland Flow in a 0.5% AEP storm event, while the Old Linton (MC2) and Yass (MC4) medical centres are impacted by riverine type flooding during a PMF event.

2.8 Hydrologic Standard of Existing Road Network

Both major and minor roads in the study area are vulnerable to inundation during flood events as frequent as 20% AEP. Identification of such roads is important to providing knowledge to NSW SES, identifying hazardous areas during floods, and evacuation planning.

[4] Critical infrastructure has been split into two categories; community assets and emergency services.

TABLE 2.3
IMPACT OF FLOODING ON VULNERABLE DEVELOPMENT AND CRITICAL INFRASTRUCTURE LOCATED IN THE STUDY AREA[2]

Type	Development/Structure	Location Identifier[1]	Design Flood Event							
			20% AEP	10% AEP	5%AEP	2% AEP	1% AEP	0.5%	0.2%	PMF
Community Assets	Telephone Exchange	-	O	O	O	O	O	O	O	X
	Sewerage System (Yass Sewage Treatment Plant)	SS1	O	O	O	O	O	O	O	X
	Sewerage System (Pump Station)	SS2	X	X	X	X	X	X	X	X
	Sewerage System (Pump Station)	SS3	O	O	O	O	O	O	X	X
	Sewerage System (Pump Station)	SS4	O	O	O	O	X	X	X	X
	Sewerage System (Pump Station)	SS5	O	O	O	O	O	O	O	X
	Sewerage System (Pump Station)	SS6	O	O	O	X	X	X	X	X
	Sewerage System (Pump Station)	SS7	O	O	O	O	O	X	X	X
	Water Supply (Pump Station)	-	O	O	O	O	O	O	X	X
	Major Road Crossing ([illegible] Road (Flat Rock Crossing))	RC1	X	X	X	X	X	X	X	X
	Major Road Crossing (Comur Street)	RC2	O	O	X	X	X	X	X	X
	Major Road Crossing (Yass Valley Way)	RC3	O	O	O	O	X	X	X	X
	Major Road Crossing (Hume Highway)	RC4	O	O	O	O	O	O	O	X
Emergency Services	RFS Brigade	-	O	O	O	O	O	O	O	X
	Police Station	-	O	O	O	O	O	O	X	X
	Fire & Rescue NSW Station	-	O	O	O	O	O	O	X	X
	Ambulance Station	-	O	O	O	O	O	O	X	X
	NSW SES Facility	-	O	O	O	O	O	O	O	X
	Evacuation Centre (Yass Soldiers Club)	EC1	O	O	O	O	O	O	X	X
	Evacuation Centre (Yass High School)	EC2	O	O	O	O	O	O	O	X
Vulnerable Development	Educational Facility (Yass Public School)	EF1	O	O	O	O	O	O	O	X
	Educational Facility (Yass High School)	EF2	O	O	O	O	O	O	O	X
	Educational Facility (Berinba Public School)	EF3	O	O	O	O	O	O	O	X
	Educational Facility (Mt. Carmel School)	EF4	O	O	O	O	O	O	O	X

Refer over for footnotes to table

TABLE 3.3 (Cont'd)
IMPACT OF FLOODING ON VULNERABLE DEVELOPMENT AND
CRITICAL INFRASTRUCTURE LOCATED IN THE STUDY AREA(1)

Type	Development/Structure	Location Identifier[1]	Design Flood Event							
			20% AEP	10% AEP	5%AEP	2% AEP	1% AEP	0.5%	0.2%	PMF
Vulnerable Development	Educational Facility (TAFE NSW - Yass)	EF6	O	O	O	O	O	O	X	X
	Child Care Facility (Yass Pre-Kindergarten)	CC1	O	O	O	O	O	O	O	O
	Child Care Facility (Yass Little Learners)	CC2	O	O	O	O	O	O	O	X
	Child Care Facility (Yass Early Childhood Centre)	CC3	O	O	O	O	X	X	X	X
	Child Care Facility (Goodstart Early Learning Yass)	CC4	O	O	O	O	O	O	O	X
	Child Care Facility (Yass Montessori Preschool)	CC5	O	O	O	O	O	O	O	O
	Tourist Park (Yass Caravan Park)	-	O	O	O	O	O	O	O	O
	Aged Care Facility (Horton House and Warrangdon Lodge)	AC1	O	O	O	O	O	O	O	O
	Aged Care Facility (Thomas Eccles Garden)	AC2	O	O	O	O	O	O	O	O
	Aged Care Facility (Linton Village Yass)	AC3	O	O	O	O	O	O	O	O
	Aged Care Facility (Apex Houses)	AC4	O	O	O	X	X	X	X	X
	Medical Centre (Yass District Hospital)	MC1	O	O	O	O	O	O	O	O
	Medical Centre (Old Linton Medical Centre)	MC2	O	O	O	O	O	O	O	X
	Medical Centre (Mansfield Medical Centre)	MC3	O	O	O	O	O	X	X	X
	Medical Centre (Yass Medical Centre)	MC4	O	O	O	O	O	O	O	X

1. Refer Figure 3.3 (4 sheets) for location of vulnerable development and critical infrastructure.
"O" = Infrastructure not impacted by flooding.
"X" = Infrastructure impacted by flooding.

While the Warrambalulah Road crossing (Flat Rock Crossing) (RC1) is inundated during freshes in the Yass River, the results of the hydraulic modelling show that a section of Comur Street immediately south of the Hume Bridge (RC2) would be inundated during a 5% AEP flood on the Yass River, with the town cut in two for a period of over half a day in the case of a 1% AEP flood event. Yass Valley Road at its crossing of Bango Creek (RC3) is inundated by backwater flooding from the Yass River during a 1% AEP flood event, which would prevent vehicle movements into and out of Yass from the north for a period of several hours.

2.9 Potential Impacts of a Change in Hydraulic Roughness

An analysis was undertaken to assess the sensitivity of flood behaviour to potential changes in hydraulic roughness. **Figure 2.7** (4 sheets) shows the impact that a 20% increase in the "best estimate" hydraulic roughness values would have on flood behaviour for a 1% AEP flood event.

The analysis showed that peak 1% AEP flood levels along the Yass River and Bango Creek would typically be increased in the range 0.5 to 0.7 m and 0.2 to 0.4 m, respectively. Increases in the depth of Major Overland Flow would generally be in the range 10 to 50 mm, with increases in the range 50 to 100 mm present in a number of isolated locations

While the above finding would indicate that the adoption of a 0.5 m freeboard for setting minimum floor levels in future development would generally cater for any potential increases in peak 1% AEP flood levels associated with changes in hydraulic roughness, further consideration of the freeboard requirements for future development which takes these potential impacts into account is presented in **Section 3.5.1.2** of this report.

2.10 Potential Impacts of a Partial Blockage of Hydraulic Structures

The mechanism and geometrical characteristics of blockages in hydraulic structures and piped drainage systems are difficult to quantify due to a lack of recorded data and would no doubt be different for each system and also vary with flood events. Realistic scenarios would be limited to waterway openings becoming partially blocked during a flood event (no quantitative data are available on instances of blockage of the drainage systems which may have occurred during historic flood events).

A blockage assessment was undertaken based on the procedures set out in ARR 2019. A blockage factor of 50% was found to be applicable for the minor piped drainage lines within the urbanised parts of Yass, while blockage factors of 10% to 50% were found to be applicable for the culvert / bridge crossings of the major watercourses. Based on this finding, a constant blockage factor of 50% was applied to all hydraulic structures in the study area for the purpose of the sensitivity analysis.[5]

Figure 2.8 (4 sheets) shows the afflux for a 1% AEP storm resulting from a partial blockage of hydraulic structures at Yass. While increases in peak 1% AEP flood levels of greater than 0.5 m occur upstream of several hydraulic structures that are located to the north of the Yass River, the impacts are confined to *Primary Production* (RU1), *Large Lot Residential* (R5) and *Infrastructure* (SP2) land that is presently undeveloped. In all other areas the increase in peak 1% AEP flood

[5] Based on the procedures set out in ARR 2019, a non-floating blockage factor of 25% was found to be applicable at the Hume Bridge crossing of the Yass River as the "Site Based Debris Potential" is classified as "High". It is considered unrealistic that the Hume Bridge would be subject to 25% blockage due to non-floating debris considering the high flow velocities (greater than 3 m/s) in the river at this location. As such, the assessed blockage factor at the Hume Bridge of 10% is based on the floating debris potential only.

levels is generally less than 0.1 m, with the exception of along the enclosed reach of Chinamans Creek upstream of Lead Street where increases of up to 0.3 m could occur at specific locations.

While the above finding would indicate that the adoption of a 0.5 m freeboard for setting minimum floor levels in future development would generally cater for any potential increases in peak 1% AEP flood levels associated with a partial blockage of hydraulic structures, further consideration of the freeboard requirements for future development which is subject to flooding from the Yass River is presented in **Section 3.5.1.2** of this report.

2.11 Potential Impacts of Future Urbanisation

Future urbanisation has the potential to increase the rate and volume of runoff conveyed by the various watercourses, as well as increase the frequency of surcharge of the local stormwater drainage system. It is also likely to result in changes to the existing drainage system. For example, while existing minor watercourses are likely to be retained and formalised in drainage reserves, piped drainage systems associated with urban subdivisions will result in significant amendments to existing overland flow paths leading to the watercourses.

While there is evidence that Council is requiring developers to incorporate flow control measures such as detention basins in residential subdivisions, infill development at an individual allotment scale has the potential to increase flow in the receiving drainage lines. As there is presently no Development Control Plan or policy in place for Yass which sets out the maximum permissible hard stand area within an individual allotment (refer **Section 2.15** of this report for further details), it has been assumed that a value of 70% would apply for the purpose of assessing the impact that future infill development could have on flood behaviour. While **Figure 2.9** shows that an increase in hard stand area to a maximum of 70% in individual allotments would not have a significant impact on peak 1% AEP flood levels in the urbanised parts of Yass, it can be expected that infill type development would have a greater impact on flooding resulting from more frequent storm events given the disproportionate increase in rainfall excess.

2.12 Potential Impacts of Future Climate Change

DPIE recommends that its guideline *Practical Consideration of Climate Change, 2007* be used as the basis for examining climate change in projects undertaken under the State Floodplain Management program and the *FDM, 2005*. The guideline recommends that until more work is completed in relation to the climate change impacts on rainfall intensities, sensitivity analyses should be undertaken based on increases in rainfall intensities ranging between 10 and 30 per cent.

On current projections the increase in rainfalls within the service life of developments or flood management measures is likely to be around 10 per cent, with the higher value of 30 per cent representing an upper limit which may apply near the end of the century. Under present day climatic conditions, increasing the 1% AEP design rainfall intensities by 10 per cent would produce about a 0.5% AEP flood; and increasing those rainfalls by 30 per cent would produce about a 0.2% AEP event.

For the purpose of the present study, the impact 10% and 30% increases in design 1% AEP rainfall intensities would have on flooding behaviour was assessed by comparing the peak flood levels which were derived from the flood modelling for design events with AEP's of 1, 0.5 and 0.2 per cent.

Figures 2.10 and **2.11** (4 sheets each) show the increase in peak 1% AEP flood levels that would occur if rainfall intensities were to increase by 10% and 30% as a result of future climate change, respectively, while **Figure 2.12** (4 sheets) shows the impact these potential changes would have on the extent of a 1% AEP flood event.

The impact of a potential 10% increase in 1% AEP rainfall intensities on flooding patterns in the study area may be summarised as follows:

- Peak flood levels on the Yass River would be increased by over a 1 m, with the impacts extending south as far as Meehan Street.
- Depths of Major Overland Flow in the Chinamans Creek catchment would generally not be increased by more than 50 mm, although increases in the range 100-200 mm could be expected to occur where the main arm of the creek runs between Petit Street and Polding Street.
- Increases in peak 1% AEP flood levels in the range 50-500 mm would occur along Bango Creek and parts of Fairy Hole Creek.
- There would be a relatively minor increase in the extent of inundation due to the relatively steep sided nature of the floodplain at Yass.

The impact of a potential 30% increase in 1% AEP rainfall intensities on flooding patterns in the study area may be summarised as follows:

- Peak flood levels on the Yass River would generally be increased in the range 2-3 m, with slightly greater increases shown to occur in the vicinity of the Hume Bridge.
- Depths of Major Overland Flow in the Chinamans Creek catchment would generally be increased in the range 100-200 mm, although increases in the range 200-500 mm could be expected to occur where the main arm of the creek runs between Petit Street and Polding Street.
- Increases in peak 1% AEP flood levels in the range 50-500 mm would occur along Bango Creek and parts of Fairy Hole Creek.
- There would be a relatively minor increase in the extent of inundation due to the relatively steep sided nature of the floodplain at Yass.

While the above finding would indicate that the adoption of a 0.5 m freeboard for setting minimum floor levels in future development would not necessarily cater for increases in peak 1% AEP flood levels associated with future climate change, especially in the case of riverine type flooding at Yass, further consideration of the freeboard requirements for future development which takes these potential impacts into account is presented in **Section 3.5.1.2** of this report.

2.13 Flood Hazard Vulnerability and Hydraulic Categorisation of the Floodplain

2.13.1 General

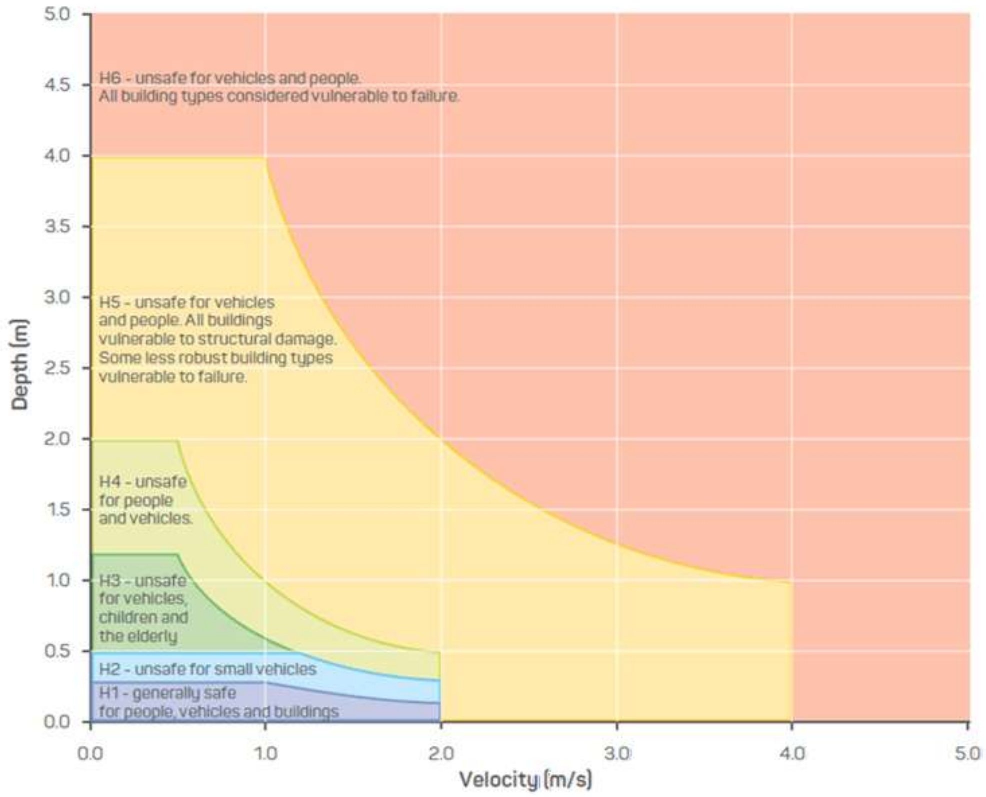
According to Appendix L of *NSWG, 2005*, in order to achieve effective and responsible floodplain risk management, it is necessary to divide the floodplain into areas that reflect:

1. The impact of flooding on existing and future development and people. To examine this impact it is necessary to divide the floodplain into *"flood hazard vulnerability"* categories, which are assessed on the basis of the velocity and depth of flow. This task was undertaken as part of the present study where the floodplain was divided into six flood hazard vulnerability zones. **Section 2.13.2** below provides details of the adopted procedure.

2. The impact of future development activity on flood behaviour. Development in active flow paths (i.e. *"floodways"*) has the potential to adversely re-direct flows towards adjacent properties. Examination of this impact requires the division of flood prone land into various *"hydraulic categories"* to assess those parts which are effective for the conveyance of flow, where development may affect local flooding patterns. While hydraulic categorisation of the floodplain was undertaken as part of WMAwater, 2016a, it was reviewed and updated as part of the present study. **Section 2.13.3** below summarises the adopted procedure.

2.13.2 Flood Hazard Vulnerability Categorisation

Flood hazard categories may be assigned to flood affected areas in accordance with the definitions contained in the publication entitled "*Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia*" (Australian Institute for Disaster Resilience (**AIDR**), 2017). Flood prone areas may be classified into six hazard categories based on the depth of inundation and velocity of flow that relate to the vulnerability of the community when interacting with floodwater, as shown in the illustration over which has been taken from AIDR, 2017:



Figures 2.13 and **2.14** show the *Flood Hazard Vulnerability Classification* based on the procedures set out in AIDR, 2017 for the 1% AEP and PMF events, respectively, while **Figures C4.7** to **C4.8** in **Appendix C** of this report show similar information for the 5% and 0.5% AEP flood events.

While areas classified as H5 and H6 are generally limited to the inbank areas of the major watercourses and incised flow paths in a 1% AEP flood event, they do extend out onto the left bank of the Yass River immediately upstream of the Hume Bridge where a number of residential and commercial allotments are located.

The flooding that is experienced at the road crossings of the major watercourses that are inundated in a 1% AEP event falls within the H1 category with the following exceptions:

- Brennan Street and MacDonald Street crossings of Chinamans Creek where the overtopping flow is categorised as H2;
- Petit Street, Lead Street and Meehan Street crossings of Chinamans Creek where the overtopping flow is categorised as H5;
- Wargeila Road where the overtopping flow is categorised as H5;
- Mont Street crossing of the overland flow path through the Yass Golf Course where the overtopping flow is categorised as H5; and
- Fairy Hole Road crossing of fairy Hole Creek where the overtopping flow is categorised as H6.

The Major Overland Flow paths in the urbanised parts of Yass are generally classified as either H1 or H2 in a 1% AEP event, with the exception of areas where floodwater ponds on the upstream side of roads where it is generally classified as either H3 or H4.

For the PMF event, the width of the H5 and H6 hazard zones increases significantly, mainly along the Yass River and its major tributaries. The hazard category along the majority of the remaining drainage lines increases to between H3 and H5 during a flood of this magnitude.

2.13.3 Hydraulic Categorisation of the Floodplain

According to the *FDM*, the floodplain may be subdivided into the following three hydraulic categories:

- Floodways;
- Flood storage; and
- Flood fringe.

Floodways are those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with obvious naturally defined channels. Floodways are the areas that, even if only partially blocked, would cause a significant re-distribution of flow, or a significant increase in flood level which may in turn adversely affect other areas. They are often, but not necessarily, areas with deeper flow or areas where higher velocities occur.

Flood storage areas are those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. If the capacity of a flood storage area is substantially reduced by, for example, the construction of levees or by landfill, flood levels in nearby areas may rise and the peak discharge downstream may be increased. Substantial reduction of the capacity of a flood storage area can also cause a significant redistribution of flood flows.

Flood fringe is the remaining area of land affected by flooding, after floodway and flood storage areas have been defined. Development in flood fringe areas would not have any significant effect on the pattern of flood flows and/or flood levels.

Floodplain Risk Management Guideline No. 2 Floodway Definition, offers guidance in relation to two alternative procedures for identifying floodways. They are:

- **Approach A**. Using a *qualitative approach* which is based on the judgement of an experienced hydraulic engineer. In assessing whether or not the area under consideration was a floodway, the qualitative approach would need to consider; whether obstruction would divert water to other existing flow paths; or would have a significant impact on upstream flood levels during major flood events; or would adversely re-direct flows towards existing development.
- **Approach B**. Using the hydraulic model, in this case TUFLOW, to define the floodway based on *quantitative experiments* where flows are restricted or the conveyance capacity of the flow path reduced, until there was a significant effect on upstream flood levels and/or a diversion of flows to existing or new flow paths.

One quantitative experimental procedure commonly used is to progressively encroach across either floodplain towards the channel until the designated flood level has increased by a significant amount (for example 0.1 m) above the existing (un-encroached) flood levels. This indicates the limits of the hydraulic floodway since any further encroachment will intrude into that part of the floodplain necessary for the free flow of flood waters – that is, into the floodway.

The *quantitative assessment* associated with **Approach B** is technically difficult to implement. Restricting the flow to achieve the 0.1 m increase in flood levels can result in contradictory results, especially in unsteady flow modelling, with the restriction actually causing reductions in computed levels in some areas due to changes in the distribution of flows along the main drainage line.

Accordingly the *qualitative approach* associated with **Approach A** was adopted, together with consideration of the portion of the floodplain which conveys approximately 80% of the total flow and also the findings of *Howells et al, 2004* who defined the floodway based on velocity of flow and depth. Based on the findings of a trial and error process, the following criteria were adopted for identifying those areas which operate as a "floodway" in a 1% AEP event:

- Velocity x Depth greater than 0.15 m^2/s **and** Velocity greater than 0.25 m/s; or
- Velocity greater than 1 m/s.

Flood storage areas were identified as those areas which do not operate as floodways in a 1% AEP event but where the depth of inundation exceeds 400 mm. The remainder of the flood affected area was classified as flood fringe.

Figures 2.15 and **2.16** show the division of the floodplain into floodway, flood storage and flood fringe areas for the 1% AEP and PMF events, respectively, while **Figures C4.9** to **C4.10** in **Appendix C** of this report show similar information for the 5 and 0.5% AEP flood events.

As the hydraulic capacity of the river and creek channels is not large enough to convey the 1% AEP flow, a significant portion of the total flow is conveyed on the floodplain. As a result, areas which lie on the overbank area also function as a floodway during the 1% AEP flood event. Floodways are also generally present along the Major Overland Flow paths described in **Section 2.4.3**.

Flood storage areas are confined to the major ponding areas which are located on the upstream side of existing road and rail embankments.

2.14 Environmental Considerations

The Yass River, along with the main arms of Bango Creek and Fairy Hole Creek are largely in their natural state where they run through Yass, while Chinamans Creek has been highly modified south of the river.

Rivers of Carbon[6] has set up a project called the *Yass River Linkages* which supports and extends the efforts of the Yass Area Network of Landcare Groups and others to restore and rehabilitate the Yass River and many of its tributaries where they have become degraded as a result of the negative impacts of vegetation loss and flow regulation. The project is in its second phase and is partially funded by the NSW Environmental Trust.

2.15 Council's Existing Planning Instruments and Policies

2.15.1 General

The *Yass Local Environmental Plan, 2013* (***Yass LEP 2013***) is the principal statutory planning document used by Council for controlling development by defining zoning provisions, establishing permissibility of land use and regulating the extent of development in the Yass LGA.

While Council is in the process of preparing a comprehensive Development Control Plan for the LGA, currently there are only two gazetted Development Control Plans for Yass which relate to exempt and complying development and multi-unit residential development, noting that the latter document does not include any flood related development controls. While Council has also adopted a set of policies which relate to development in the LGA, none of these contain any flood related development controls.

Council advised that it has been applying the flood related development controls that are set out in WMAwater, 2016b.

2.15.2 Land Use Zoning – Yass Local Environmental Plan 2013

Figure 2.17 (2 sheets) shows the zonings that are incorporated in *Yass LEP 2013* for the study area. The study area comprises a mixture of *General Residential (R1)* and *Large Lot Residential (R2)* zoned areas, as well as *Local Centre (B2)*, *Business Development (B5)* and *Enterprise Corridor (B6)* zoned areas.

2.15.3 Flood Provisions – Yass LEP 2013

Clause 6.2 of *Yass LEP 2013* entitled "Flood planning" outlines its objectives in regard to development of land that is at or below the FPL. It is similar to the standard Flood Planning Clause used in recently adopted LEPs in other NSW country centres and applies to land at or below the FPL.

[6] *Rivers of Carbon* is the on-ground component of the *Australian River Restoration Centre (ARRC)*, which is a registered charity recognised under the *Australian Charities & Not-for-profits Commission (ACNC)*.

The FPL currently referred to is the 1:100 ARI (or 1% AEP) flood plus an allowance for freeboard of 0.5 m. The area encompassed by the FPL (i.e. the FPA) denotes the area subject to flood related development controls, such as locating development outside high hazard areas and setting minimum floor levels for future residential development. It is currently standard practice for the residential FPL to be based on the 1% AEP flood plus an appropriate freeboard unless exceptional circumstances apply.

It is noted that the NSW Government will be automatically updating the wording in clause 6.2 on 14 July 2021 as part of recent reforms that it has introduced to its *NSW Flood Prone Land Package*. As a result of the update, Council will need to nominate the FPLs that it wishes to use to define the FPA, and make alternative arrangements for making flood planning maps publicly available where previously solely reliant on LEP flood overlay maps.

While clause 6.2 will be automatically updated by the NSW Government on 14 July 2021, it is recommended that the *special flood considerations* clause which forms part of the updated *NSW Flood Prone Land Package* also be incorporated in *Yass LEP 2013*. The objectives of the new clause are as follows:

- in relation to development with particular evacuation or emergency response issues (e.g. schools, group homes, residential care facilities, hospitals, etc.) to enable evacuation of land which lies above the FPL; and
- to protect the operational capacity of emergency response facilities and critical infrastructure during extreme flood events.

The new clause would apply to land which lies between the FPL and the level of the PMF. Suggested wording in relation to this new clause is given in **Section 3.5.1.4**.

2.15.4 Flood Related Development Controls

As mentioned, Council does not presently have a Development Control Plan or policy which sets out flood related controls that apply to future development within the LGA. Rather, Council advised that it is currently applying the flood related development controls that are set out in WMAwater, 2016b.

While the flood related development controls set out in WMAwater, 2016b are generally in accordance with contemporary best floodplain risk management practice, they are based on the Flood Risk Precinct type approach rather than the Flood Planning Constraint Category type approach set out in AIDR, 2017. Recommendations relating to the update of the approach set out in WMAwater, 2016b are set out in **Section 3.5.1.4**, while **Appendix E** of this report contains suggested wording for incorporating into the Development Control Plan which is presently being prepared for the Yass Valley.

2.16 Flood Warning and Flood Preparedness

2.16.1 Yass Valley Local Flood Plan

The NSW SES is nominated as the principal combat and response agency for flood emergencies in NSW. NSW SES is responsible for the issuing of relevant warnings (in collaboration with BoM), as well as ensuring that the community is aware of the flood threat and how to mitigate its impact.

The *Yass Valley Local Flood Plan* which is published by NSW SES covers preparedness measures, the conduct of response operations and the coordination of immediate recovery measures for all levels of flooding within the Yass local government area. *Yass Valley Local Flood Plan* is administered by the Yass Local Commander who controls flood operations within the Yass area. NSW SES maintains a local headquarters in Laidlaw Street near the northern limits of Yass.

Volume 1 of *Yass Valley Local Flood Plan* entitled '*Yass Valley Flood Emergency Sub Plan*' includes sections on flood preparedness, response and recovery. Volume 1 is divided into the following sections:

- ***Introduction***; this section of the document identifies the responsibilities of the NSW SES Local Controller and NSW SES members and supporting services such as the Police, BoM, Ambulance, Fire Brigades, State Water Corporation, Council, etc. It also identifies the importance for NSW SES and Council to coordinate the development and implementation of a public education program to advise the population of the flood risk.
- ***Preparedness***; this section of the document deals with activities required to ensure the *Yass Valley Local Flood Plan* functions during the occurrence of the flood emergency. The Plan will devote considerable attention to flood alert and emergency response.
- ***Response***; The NSW SES maintains an operation centre at the Local NSW SES Headquarters in Laidlaw Street. Response operations will commence: on receipt of a BoM Preliminary Flood Warning, Flood Warning, Flood Watch, Severe Thunderstorm Warning or a Severe Weather Warning for flash flooding; on receipt of a dam failure alert; or when other evidence leads to an expectation of flooding within the council area.
- ***Recovery***, involving measures to ensure the long term welfare for people who have been evacuated, recovery operations to restore services and clean up and de-briefing of emergency management personnel to review the effectiveness of the *Yass Valley Local Flood Plan*.

Annex A of the *Yass Valley Local Flood Plan* deals with the flood threat at Yass. **Table 2.4** over lists the peak design flood levels that are set out in the document for Yass, noting those derived as part of the present study are also listed for ease of comparison. By inspection, the peak flood levels set out in the *Yass Valley Local Flood Plan* are similar for floods with AEPs of 20% and 1%, but are significantly higher when compared to those derived as part of the present study for floods with AEPs of 10%, 5% and 2%.

Annex B of the *Yass Valley Local Flood Plan* deals with the effects of flooding on the Yass community. The document states that:

a) the majority of Yass is flood free, apart from parts of Riley Terrace and Comur, Church, Rossi and Warrambalulah Streets;

b) there is a small flood prone retirement village known as the Apex Homes, which consists of 20 units that are located adjacent to Chinamans Creek in Rossi Street; and

c) development in close proximity to Banjo Patterson Park on Rossi Street is generally the first to be affected.

Specific areas at risk are shown in Map 3 of the document which has been reproduced at the end of this Chapter.

TABLE 2.4
PEAK FLOOD HEIGHTS FOR YASS STREAM GAUGE[1]
AS SET OUT IN THE YASS VALLEY LOCAL FLOOD PLAN
(m)

Design Peak Flood Level	Yass Valley Local Flood Plan	Present Study
20% AEP	4.60	4.7
10% AEP	6.39	5.9
5% AEP	8.00	7.2
2% AEP	9.39	8.8
1% AEP	10.04	10.1

1. Gauge zero = 475.52 m AHD

Annex B provides the following description as an indication of the way in which flooding develops within Yass township:

- ***0.5 metres:*** *Level of the Flat Rock Crossing between North and South Yass.*
- ***2 metres:*** *An area along Warrambalulah Street upstream of Church Street is flooded.*
- ***4 metres:*** *Flood waters start to break out on the left bank between Church and Dutton Streets. Flooding begins along Chinamans Creek because of backup water from the river.*
- ***6 metres:*** *Some 5 commercial properties and 2 residences in Comur and Rossi streets are in danger of having flood waters exceed the floor levels.*
- ***7 metres:*** *An additional 3 residences (Church, Pritchett and Rossi streets) have water to their doorsteps.*
- ***8 metres:*** *The Apex Homes (retirement village) start to be inundated with water from Chinamans Creek.*

Extreme flooding larger than the 1% AEP flood is said to inundate additional areas of town, including the south western sections of Comur, Dutton and Church Streets; and parts of Meehan and Lead Streets. The document states that an estimated 307 dwellings would be inundated during a PMF. This compares to the 276 dwellings which the present study identified would be above-floor inundated during a PMF event, 201 of which relate to riverine type flooding.

2.16.2 Existing Flood Warning Network

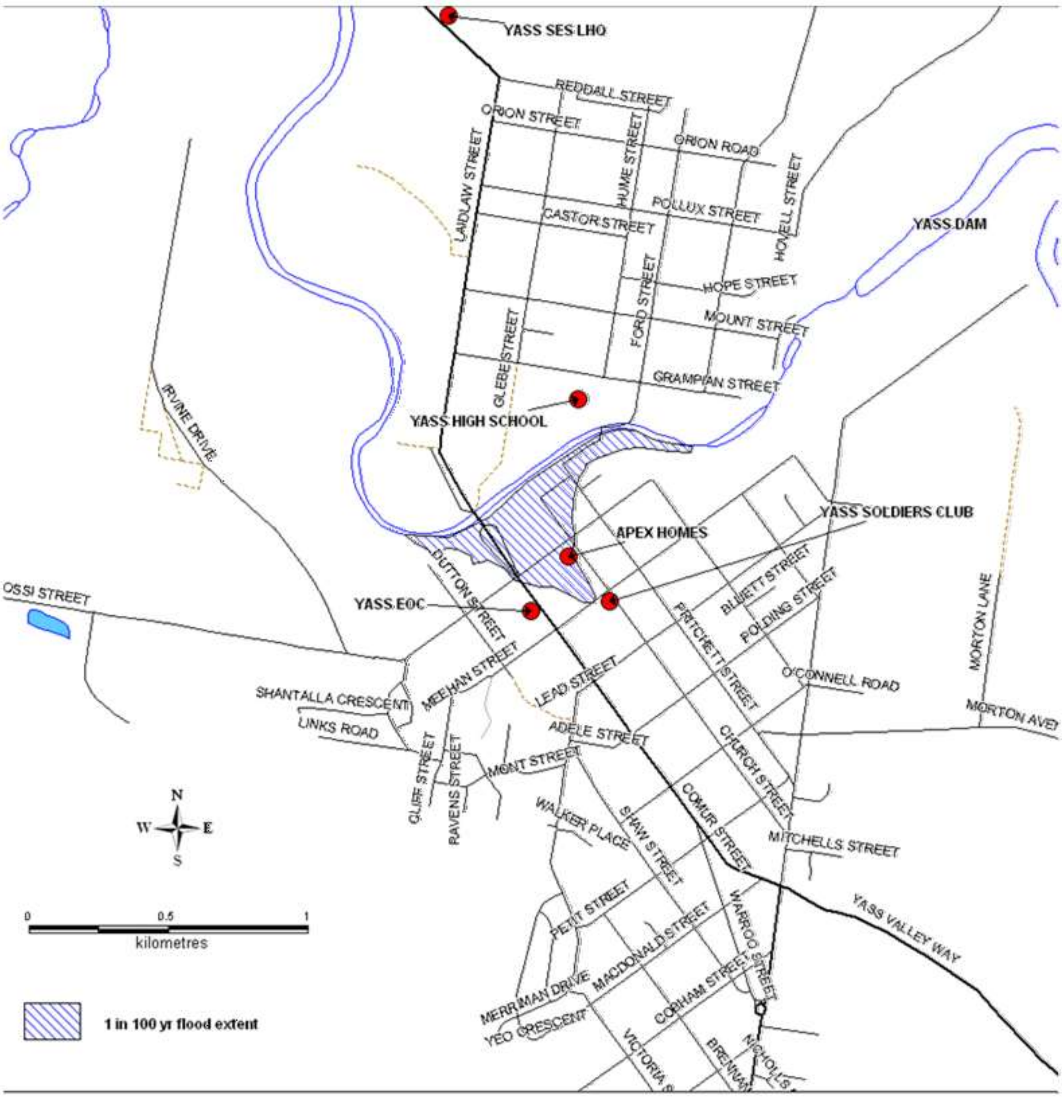
While BoM maintains a flood warning network for the Murrumbidgee Valley which includes the monitoring of a select number of rainfall and stream gauges, as well as the provision of location specific flood warnings and predicted flood level estimates, this service does not extend to the Yass Valley.

There are presently five stream gauges located in the Yass Valley, details of which are set out in **Table 2.5** over and the locations of which are shown on **Figure 1.1**, sheet 1. Of the three stream gauges that are located upstream of Yass, two record water levels in the Yass River, while the third is located on Williams Creek, a minor tributary of the Yass River. It is noted that the closest stream gauge on the Yass River upstream of Yass (i.e. the *Yass River at Gundaroo* stream gauge) controls only about a third of the total catchment at Yass, meaning it may not be a reliable indicator of the magnitude of flood flows that would be experienced at Yass.

Figure 1.1, sheet 1 also shows the location of existing daily read and pluviometric type rain gauges in the vicinity of the Yass Valley. While there are a number of daily read rain gauges located in the Yass Valley, the only pluviographic type rain gauge is located at Yass. There is also an absence of pluviographic type rain gauges to the east and north of the Yass Valley.

TABLE 2.5
DETAILS OF EXISTING STREAM GAUGE NETWORK IN THE YASS VALLEY

Gauge No.	Name	Installation Date	Upstream Catchment Area (km^2)
410851	Yass River at Macks Reef Road	20/02/1976	80
410090	Yass River at Gundaroo	22/09/1937	388
410026	Yass River at Yass	24/08/2015	1230
410176	Yass River U/S Burrinjuck	10/05/1999	1600
410160	Williams Creek at Whitehall	22/06/1988	9



Source: *Yass Valley Local Flood Plan*

3 POTENTIAL FLOODPLAIN MANAGEMENT MEASURES

3.1 Range of Available Measures

A variety of floodplain management measures can be implemented to reduce flood damages. They may be divided into three categories, as follows:

Flood modification measures change the behaviour of floods in regard to discharges and water surface levels to reduce flood risk. This can be done by the construction of levees, detention basins, channel improvements and upgrades of piped drainage systems in urban areas. Such measures are also known as "structural" measures as they involve the construction of engineering works. Vegetation management is also classified as a flood modification measure.

Property modification measures reduce risk to properties through appropriate land use zoning, specifying minimum floor levels for new developments, voluntary purchase of residential property in high hazard and/or floodway areas, or raising existing residences in the less hazardous areas. Such measures are largely planning (i.e. "non-structural") measures, as they are aimed at ensuring that the use of floodplains and the design of buildings are consistent with flood risk. Property modification measures could comprise a mix of structural and non-structural methods of damage minimisation to individual properties.

Response modification measures change the response of flood affected communities to the flood risk by increasing flood awareness, implementation of flood warning and broadcast systems and the development of emergency response plans for property evacuation. These measures are entirely non-structural.

3.2 Community Views

Comments on potential flood management measures were sought from the community by way of the *Community Questionnaire* which was distributed at the commencement of the study. The responses are summarised in **Appendix A** of this report. Question 8 in the *Community Questionnaire* outlined a range of potential flood management measures. The responses are shown on **Table 3.1** over the page together with initial comments on the feasibility of each measure. The measures are discussed in more detail in later sections of this Chapter.

The Community favoured the following measures:

- Management of vegetation along creek corridors.
- Advice of flood affectation via Planning Certificates for properties located in flood liable areas.
- Improved flood warning, evacuation and flood response procedures.
- Improvements in the stormwater system.
- Flood related controls over future development in flood liable areas.
- Community education to promote flood awareness.

TABLE [illegible]
COMMUNITY VIEWS ON POTENTIAL FLOOD MANAGEMENT MEASURES

	Flood Management Measure	Classification[1]	Respondent's Views			Comments
			Yes	No	Don't Know	
a)	Management of vegetation along creek corridors to provide flood mitigation, stability, aesthetic and habitat benefits	FM	65	4	18	While riparian vegetation is presently maintained along the banks of the Yass River where it runs through the town, there is merit in better managing vegetation along Chinamans Creek given the impact that flow which discharges its [illegible] area has on existing residential and commercial development. The merits of developing and implementing a Vegetation Management Plan for Chinamans Creek is assessed in Section [illegible].
b)	Widening of watercourses	FM	28	30	26	While this measure would increase the capacity of Chinamans Creek where it runs through the urbanised parts of Yass, the close proximity of existing development would mean that any widening works would likely require the concrete lining of the watercourse. Due to the impact that the lining of the watercourse would have on existing flora and fauna, its implementation has not been assessed as part of the Yass FRMS.
c)	Construct detention basins to temporarily store stormwater runoff and reduce impacts of flooding on existing development	FM	40	10	32	While this option is favoured by the community, it was identified that there is insufficient public land available to construct detention basins in areas which would reduce the impact of flooding on existing development. The one exception is a parcel of land which lies to the south of the Yass Railway Museum in the Chinamans Creek catchment. The benefits that the construction of a detention basin at this one location are assessed in Section [illegible].
d)	Improve the stormwater system within the town area	FM	57	1	20	While this measure is strongly supported by the community, the assessment of measures aimed at improving the stormwater drainage system at Yass found that they did not provide sufficient benefit in terms of a reduction in flood affectation and hazard to existing development to justify their inclusion in the Yass FRMP. Details of the assessment that was undertaken as part of the Yass FRMS are set out in Section [illegible].
e)	Construct permanent levees along the rivers and creeks within the town area	FM	22	30	29	The community is not in favour of this option and there is limited scope to construct a levee that would protect existing development from either Main Stream Flooding or Major Overland Flow. Based on this finding, the construction of flood protection levees at Yass was not considered further.
f)	Voluntary scheme to purchase property in high hazard areas	PM	33	28	32	This option is often adopted to remove residential property in high hazard areas of the floodplain. The results of the present investigation show that there are eleven dwellings that are subject to highly hazardous flooding conditions. While the community is generally not in favour of this option it is reviewed in Section [illegible].
g)	Provide funding or subsidies to raise houses above major flood level in low hazard areas	PM	18	41	28	The community is generally not in favour of this option. This option would have application for timber framed houses located in low hazard areas on the floodplain and is reviewed in Section [illegible].
h)	Specify controls on future development in flood-liable areas (eg. Controls on extent of filling, minimum floor levels)	PM	58	6	23	The community strongly supports this option, which is an essential part of the Yass FRMP. This issue is covered in Section [illegible], with the suggested approach for controlling development on flood prone land set out in Appendix [illegible].
i)	Improve flood warning and evacuation procedures both before and during a flood.	RM	65	3	22	Deficiencies in the rain and stream gauge network in the Yass Valley which limit the ability of NSW SES and BoM to monitor and issue flood warnings for urban centres that are located in the Yass Valley. The installation of a number of new telemetered rain and stream gauges, along with the implementation of a series of other measures would provide significant improvements to the existing flood warning system for the Yass Valley. This measure is strongly supported by the community and is considered further in Sections [illegible] and [illegible].
j)	Community education, participation and flood awareness programs.	RM	48	10	20	Promotion of awareness of the flood risk is strongly favoured among the community. This option is reviewed in Section [illegible].
k)	Providing a Planning Certificate to purchasers in flood prone areas, stating that the property is flood affected	PM	64	4	20	Provision of information on flood affectation of properties is strongly favoured by the community. This may be achieved by notation of flood affectation of allotments on Section 149.7 Planning Certificates. This option is reviewed in Section [illegible].

FM = Flood Modification Measure
PM = Property Modification Measure
RM = Response Modification Measure

3.3 Outline of Chapter

A range of potential flood management measures were examined at the strategic level of detail and where appropriate, tested for feasibility on a range of assessment criteria in **Chapter 4**. Following consideration of the results by the Floodplain Risk Management Committee, selected measures were included in the *Yass FRMP* in **Chapter 5**.

The assessment of potential flood modification measures was limited to the possible upgrade of the existing stormwater drainage system at three locations, a possible stormwater detention basin south of the Yass Railway Museum on landed zoned *RE1 – Public Recreation* and the management of vegetation along the channel reaches of Chinamans Creek.

The property modification measures considered as part of this study include controls over future development, voluntary purchase of residential properties and the raising of dwellings. Response modification measures such as improvements to emergency planning and responses and public awareness programs have also been considered for Yass.

3.4 Flood Modification Measures

3.4.1 Stormwater Drainage Upgrades

General

Stormwater drainage systems are an effective means of preventing frequent flooding of urban areas by local catchment runoff. Stormwater drainage systems are usually designed to convey flows associated with more frequent rainfall events. Flows resulting from rarer events will usually exceed the capacity of the stormwater drainage system and travel along flow paths as local overland flow. While upgrading key elements of a stormwater drainage system may prevent nuisance flooding in low lying properties or inundation of low points in roads due to small storms that occur frequently, it is generally not a cost effective or practical way to mitigate damaging flooding that results from intense, rare storm events.

While a number of buildings would be subject to shallow above-floor inundation during storms which result in the surcharge of the existing stormwater drainage system in Yass, the majority of these are of a commercial/industrial nature. The exception is two dwellings that are located near the intersection of Lead Street and Church Street, and a third which is located on the eastern side of Pritchett Street at its intersection with Polding Street. Council also advised that it has been liaising with a land owner in regards the apparent frequent inundation of two contiguous properties that are located on the northern side of Browne Street approximately midway between its intersection with Pritchett Street and Demestre Street. While the affected properties are zoned *General Residential (R1)*, they are presently being used by the single owner to store building materials. A large metal shed is also located on one of the affected properties.

Residential

In regards the two affected residential properties near the intersection of Lead Street and Church Street, the removal of above-floor flooding would require the installation of a new stormwater drainage system in Lead Street which would extend from its intersection with Pritchett Street to the main arm of Chinamans Creek (denoted herein as the "**Lead Street Stormwater Drainage Upgrade**"). **Figure 3.1** shows the layout of the Lead Street Stormwater Drainage Upgrade which is estimated to cost about $0.8 Million to construct, as well as the impact that it would have on both the extent and depth of inundation for design storms of 20%, 5% and 1% AEP.

While the Lead Street Stormwater Drainage Upgrade would remove above-floor inundation in the two existing dwellings for storms up to 1% AEP in intensity, it could not be justified economically as its benefit cost ratio is only about 0.4. Coupled with the relatively infrequent and low hazard nature of the flooding that is experienced in the two properties, the inclusion of the Lead Street Stormwater Drainage Upgrade in the *Yass FRMP* is not recommended.

In regards the third affected residential property that is located near the intersection of Pritchett Street and Polding Street, there is limited, if any opportunity to upgrade the existing stormwater drainage system given the close proximity of the recently constructed dwelling and adjacent retaining wall to the existing 1050 mm diameter pipe. While increasing the waterway area of the existing pipe might be possible through the adoption of non-standard (and expensive) trenching techniques, it is questionable whether sufficient inlet capacity could be incorporated in the privately owned land to its east to ensure that the upgraded drainage line runs full.

While a low wall and fence has been constructed around the perimeter of the affected property where it borders the existing pipe, it is noted that the flood hazard vulnerability classification of the overland flow in the narrow flow path which is present between it and the opposing retaining wall increases from H2 in a 5% AEP storm event to H5 in a 1% AEP storm event, with H3 conditions present at the rear of the dwelling. It is critical that Council impose controls on future development in the catchment which lies upstream of the affected dwelling to ensure that flooding conditions are not exacerbated in the affected property and if possible contribute to the cost of constructing future detention basins which are aimed at reducing peak flows in the downstream drainage system when compared to present day conditions.

In regards the two contiguous *General Residential (R1)* zoned properties that are located on the northern side of Browne Street, Council commissioned a site specific survey of the existing stormwater drainage system as part of the present study which included details of the four cell 450 mm diameter pipes which cross Browne Street immediately to the south of the eastern-most property, as well as a stormwater channel which runs along its eastern boundary. The extent of the detailed ground survey that was commissioned by Council is shown on **Figure C2.1**, sheet 2 in **Appendix C** of this report.

The detailed flood modelling that was undertaken as part of the present study found that the four cell 450 mm diameter pipes that cross Browne Street would be surcharged during storms as frequent as 20% AEP (the most frequent storm event assessed as part of the present study), with the result that shallow overland flow would inundate a portion of the unsealed internal access track, as well as the area which lies between it and the stormwater channel, noting that the flooding is exacerbated by the fact that the low point in the road is offset from the downstream reach of channel. The modelling found that overland flow discharging through the eastern-most property would generally not exceed 0.15 m during storms up to 1% AEP in intensity.

While the upgrade of the four cell 450 mm diameter pipes crossing Browne Street would reduce the frequency and rate at which overland flow discharges to the two properties, given the relatively shallow nature of the flow and the limited flood damages that would be experienced in the two properties during a storm event which surcharges the existing transverse drainage structure, the upgrade works would not be eligible for funding under the NSW Government's floodplain management program. As a result, they have not been incorporated in the *Yass FRMP*.[7]

[7] Refer **Section 1.4** of this report for further background and discussion on this particular issue.

Commercial/Industrial

In regards the affected commercial/industrial properties, there is limited opportunity to upgrade the existing stormwater drainage system for those that are located along Comur Street between Lead Street and Rossi Street given the distance to the river and the relatively large flow which would need to be conveyed by the upgraded drainage system in order to mitigate the flood related impacts (in the order of $5m^3/s$).

The other commercial/industrial damage centre is located along the main arm of Chinamans Creek where it runs between Cobham Street and Petit Street. While it might be feasible to upgrade the main trunk line where it runs between Cobham Street and Shaw Street, noting that there are three residential properties that are also flood affected in this area, there is limited opportunity to upgrade it where it runs between MacDonald Street and Petit Street due to the presence of several large commercial buildings that have been constructed over it. Given these constraints and the fact that the existing trunk drainage where it runs between MacDonald Street and Petit Street does not surcharge during storms less than 10% AEP in intensity, its upgrade at this location is not recommended.

The upgrade of the section of trunk drainage line which runs between Cobham Street and Shaw Street (denoted herein as the "**Cobham Street to Shaw Street Stormwater Drainage Upgrade**") would require the replacement of the existing 2000 mm wide by 600 mm high box culvert with twin 1500 mm diameter pipes where it runs through one residential property that is located on Cobham Street and a commercial property that is located on Shaw Street, with the two pipes linking with the existing twin 1500 mm diameter pipes which cross Shaw Street. **Figure 3.2** shows the layout of the trunk drainage upgrade, as well as the impact that it would have on both the extent and depth of inundation for design storms of 20%, 5% and 1% AEP.

While the Cobham Street to Shaw Street Stormwater Drainage Upgrade would reduce the frequency and depth of inundation in existing development that is located between Cobham Street and Shaw Street, the improvements would increase peak flows and hence flood levels further downstream, thereby exacerbating flooding conditions in existing development. Based on this finding, the Cobham Street to Shaw Street Stormwater Drainage Upgrade is not recommended for inclusion in the *Yass FRMP*.

3.4.2 Detention Basins

While the construction of detention basins in the upper and middle reaches of the Chinamans Creek catchment would increase the hydrologic standard of the existing stormwater drainage system where it runs through the urbanised parts of Yass and thereby reduce the impact that flooding has on existing development, Council advised that the majority of suitable vacant land is privately owned, with several residential subdivisions proposed at a number of locations.

A review of the available publically owned land identified a location immediately to the south of the Yass Railway Museum, where flow which surcharges the existing stormwater drainage system impacts mainly commercial development that is located along Comur Street between Lead Street and Rossi Street during storms as frequent as 20% AEP. An assessment was undertaken using the hydraulic model that was developed as part of the present study to quantify the flood mitigation benefits which could be achieved by constructing a detention basin at this location. The following two potential detention basin arrangements were assessed:

- **Yass Railway Museum Detention Basin Option 1**, which comprises the construction of a maximum 2 m high earth embankment which would contain flow which discharges through the *RE1 Public Recreation* zoned land. The existing stormwater drainage system would be configured in the vicinity of the basin to manage the rate at which flow discharges from the basin and also to prevent backwater flooding in Cargo Street.
- **Yass Railway Museum Detention Basin Option 2**, which is identical to Option 1, but includes the lowering of natural surface levels within the footprint of the basin in order to increase the volume of temporary flood storage.

Figures 3.3 and **3.4** show the layout of Yass Railway Museum Detention Basin Options 1 and 2, respectively, as well as the impact that their construction would have on the extent and depth of inundation for design storms of 20%, 5% and 1% AEP. The figures also show the location of buildings that would be rendered free of above-floor inundation as a result of the scheme. **Table 3.2** gives the peak inflows and outflows to the detention basin, as well as the maximum depth of ponding upstream of its embankment for design storms of 20%, 5% and 1% AEP.

TABLE 3.2
SUMMARY OF PEAK FLOWS AND PONDING DEPTHS

Design Storm Event (% AEP)	Yass Railway Museum Detention Basin Option 1			Yass Railway Museum Detention Basin Option 2		
	Peak Inflow (m^3/s)	Peak Outflow(1) (m^3/s)	Maximum Ponding Depth (m)	Peak Inflow (m^3/s)	Peak Outflow(1) (m^3/s)	Maximum Ponding Depth (m)
20	4.25	3.31 [P] 0.0 [S]	2.73	4.23	3.07 [P] 0 [S]	2.49
5	10.17	3.91 [P] 4.67 [S]	3.53	10.18	3.89 [P] 3.04 [S]	3.46
1	15.26	3.97 [P] 9.46 [S]	3.69	15.20	3.96 [P] 9.23 [S]	3.68

1. [P] = piped flow [S] flow over spillway

Due to the constraints imposed on its size, as well as the elevation of its invert level and embankment, it is not possible to provide sufficient storage to prevent the operation of its spillway for all but relatively frequent storm events. As a result, the basin would only have a limited benefit in terms of reducing the impact that flooding has on existing development, especially for the less frequent storm events.

It is estimated that the *Present Worth Value* of damages saved by the basin for all storms up to 1% AEP in intensity would only be about $0.1 Million. By inspection, the cost of constructing the basin would be significantly greater than this value, meaning that it could not be justified on economic grounds. Coupled with the low hazard nature of the flooding that is experienced in mainly commercial development, the inclusion of this measure in the *Yass FRMP* is not recommended

3.4.3 Vegetation Management

Management programs in creeks typically involve maintenance of batters, the removal of sediment, removal of dense vegetation and the clearance of flood debris after significant flow events. Clearance of debris within the stream corridor reduces the potential for future capture by the flow and blockage of culverts.

While there is merit in removing flood debris on the Yass River after significant flow events as this would reduce its blocking effect on future flood flows, the main concern is Chinamans Creek where there is a large number of culvert crossings which could experience a partial blockage if flood debris is allowed to build up on the floodplain.

The overbank area of the Yass River is generally devoid of dense riparian vegetation, with the exception of the reach of river which runs between the Warrambalulah Street and Laidlaw Street crossings. While the northern overbank is densely vegetated in this area, it is relatively steep and therefore conveys only a small portion of the total flow in the river. As a result, the removal of dense vegetation along this reach of the river would not result in a significant reduction in peak flood levels.

The removal of dense vegetation along the inbank area of Chinamans Creek, especially in its lower reaches would reduce its frequency of surcharge. **Figure 3.5** shows that while reducing the Manning's n hydraulic roughness value of the inbank area of Chinamans Creek to a value of 0.05 (presently assessed as being 0.09) would generally reduce both the extent and depth of inundation in a number of properties, it would result in a minor increase in peak flood levels along the main arm of the creek downstream of Brown Street and Lead Street.[8]

While the implementation of a vegetation management strategy would not reduce the flood risk in Yass from a Main Stream Flooding point of view, there is merit in its application to Chinamans Creek given it would reduce the frequency of surcharge of the inbank area of the watercourse and reduce the risk of the existing culvert structures experiencing a partial blockage during a flood event. For this reason it has been included in the *Yass FRMP*.

3.5 Property Modification Measures

3.5.1 Controls over Future Development

3.5.1.1 Current Government Policy

The NSW Government has recently finalised reforms of the *NSW Flood Prone Land Package*. As part of the reform, the wording in the flood planning clause of all NSW Councils will be updated on 14 July 2021. As part of the reform, Council will need to nominate the FPL or levels that it wishes to define the FPA and make alternative arrangements for making flood planning maps publicly available where previously solely reliant on LEP flood overlay maps. The reforms also include an optional clause titled *special flood considerations* which applies to land which lies between the FPA and the extent of the Extreme Flood. The adopted form of wording for the flood planning and special flood considerations clauses, the former which will automatically come in effect on the 14 July 2021 and the latter which is recommended for inclusion in *Yass LEP 2013* is set out in **Section 3.5.1.4** of this report.

3.5.1.2 Considerations for Setting Freeboard Requirements at Yass

Selection of the FPL for an area is an important and fundamental decision as the standard is the reference point for the preparation of floodplain risk management plans. It is based on the adoption of the peak level reached by a particular flood plus an appropriate allowance for freeboard. It involves balancing social, economic and ecological considerations against the consequences of flooding, with a view to minimising the potential for property damage and the

[8] Note that this increase is relative to current conditions when the inbank area of the creek could be considered to be overgrown in nature.

risk to life and limb. If the adopted FPL is too low, new development in areas outside the FPA (particularly where the difference in level is not great) may be inundated relatively frequently and damage to associated public services will be greater. Alternatively, adoption of an excessively high FPL will subject land that is rarely flooded to unwarranted controls.

Councils are responsible for determining the appropriate FPLs within their local government area. *Yass LEP 2013* currently nominates the "*1:100 ARI (average recurrence interval) flood event plus 0.5 metre freeboard*" as the FPL.

Freeboard provides reasonable certainty that the risk exposure selected in deciding on a particular flood is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Design variables that are typically incorporated in the derivation of freeboard typically comprise the following:

- increases in peak flood levels due to wind and wave action;
- increases in peak flood levels due to local water surge;
- uncertainties in the design flood level estimates due to the confidence limits associated with the design peak flow estimate, inaccuracies in the LiDAR survey data and possible variations in key parameters such as hydraulic roughness; and
- increases in peak flood levels due to future climate change.

Table 3.4 provides a summary of a joint probability analysis that was undertaken to assess the freeboard allowance which should be incorporated in the FPL for areas at Yass that are affected by flooding from the Yass River, noting the methodology for deriving the various components of the freeboard allowance is based on the approach set out in NSW Public Works, 2010.

TABLE 3.4
SUMMARY OF FREEBOARD ANALYSIS
AREAS AFFECTED BY YASS RIVER FLOODING

Design Variable [A]	Probability of Occurrence [B]	Maximum Allowance (m) [C]	Joint Probability Allowance (m) [D]
Wave Action (Run-up)	20%[1]	0.30	0.06
Wave Action (Set-up)	50%	0.02	0.01
Local Water Surge	50%	0.00	0.00
Inaccuracies in Peak 1% AEP Flood Level Estimate			
- LiDAR survey data	100%	0.15	0.15
- Peak flow estimate	50%	0.40	0.20
- Hydraulic roughness	25%	0.60	0.15
Future Climate Change	50%	1.20	0.60
TOTAL			**1.17**

1. Based on no wave run-up in the case of vertical buildings and that the majority of the urbanised area of Yass is located in an embayment.

The maximum allowance for uncertainties in the peak 1% AEP flood level estimate is comprised of the following:

- inaccuracies in the LiDAR survey data (+0.15 m);
- provision for a 10% increase in the best-estimate peak 1% AEP flow derived by the flood frequency analysis (+0.4 m)[9]
- increase in peak flood levels associated with a possible 20% increase in the best-estimate hydraulic roughness values (+0.6 m).

In regards the potential impacts of future climate change on flood behaviour at Yass, the *ARR Data Hub* gives the following interim climate change factors for Representative Concentration Pathways (**RCPs**) of 4.5 and 8.5 in the years 2050 and 2090:

Year	**RCP 4.5**	**RCP 8.5**
2050	6.3%	11.4%
2090	9.2%	20.2%

It is noted that the design rainfall intensity for the 12 hour 0.5% AEP and 0.2% AEP storm events at Yass is respectively about 15% and 37% higher than the corresponding 1% AEP design rainfall. By comparison with the interim climate change factors, the adoption of the 0.5% AEP would provide a reasonable indicator of the potential for future climate change to impact peak 1% AEP flood levels (+1.2 m).

As mentioned, the Department of Planning Guideline confirmed that unless exceptional circumstances applied, councils should adopt the 1% AEP flood with appropriate freeboard as the FPL for residential development.

While there is a large flood range at Yass, the valley is relatively steep sided with rising ground generally located on either side of the river. As a result, provided future residential and commercial development is set out appropriately and an effective flood warning system is implemented in the Yass Valley, then this should facilitate the safe and orderly evacuation of occupiers of the floodplain in advance of the flood wave.

Having addressed risk-to-life considerations, the other major concern for Yass is the cost that flooding would impose on the community, mainly in regard property related flood damages. In regards Yass River flooding, the adoption of the 1% AEP flood plus a 1.2 m freeboard for setting the FPL[10] means that flood related development controls can be applied to land which could potentially be subject to:

- increased flooding due to future climate change; and
- H5 and H6 type flooding conditions during floods that are slightly larger than the 1% AEP event.

Absent the allowance for the effects of future climate change, it can be seen from the values given in column D of **Table 3.4** that the provision of a 0.5 m freeboard when setting minimum habitable floor levels would account for uncertainties in the peak 1% AEP flood level estimate on the Yass River at Yass. Appreciating that the hydrologic standard of development which is set at this level would reduce over time as a result of future climate change, this would simply impose a

[9] While not included in the joint probability analysis, it should be noted that the 90% confidence limit for the 1% AEP best peak estimate is +1.2 m.

[10] Note that the FPL and hence the FPA simply defines the extent over which flood related development controls apply to future development (i.e. it does not define minimum elevations for future development (e.g. minimum habitable floor levels)).

greater cost on the community in terms of increased flood damages. In order to reduce the costs associated with design flood uncertainty, a control has been imposed on future development that is located on land that is located at or below the FPL which requires the structure to be designed to withstand the forces that would be imposed by floods up to 0.2% AEP in magnitude, noting that the flood modelling indicates that the adoption of a 1.2 m freeboard for setting the FPL as a proxy for the 1% AEP flood plus freeboard would capture land that would be subject to H5 and H6 type flooding during a flood of this magnitude.

While the flood range in the other watercourses which traverse the study area is such that the traditional 0.5 m freeboard is appropriate for setting the FPL, its adoption in areas affected by Major Overland Flow would lead to the FPA extending onto land which would not experience damaging or hazardous flooding during a 1% AEP storm event, even allowing for all the variables which comprise freeboard.

Considerable reduction in the number of properties in Major Overland Flow areas classified as "flood affected" would result by the adoption of a threshold depth of inundation under 1% AEP conditions of 0.1 m as the criterion for defining area which would be subject to the majority of flood related development controls, compared with the traditional approach. Properties with depths of inundation 0.1 m or greater, or in a floodway (i.e. traversed by significant overland flows which may in some cases be less than 0.1 m in depth) would therefore be considered to lie within the FPA. Properties with depths of inundation under 1% AEP conditions of less than 0.1 m would be classified as "Local Drainage" and, as such would be subject to controls such as the Building Code of Australia (**BCA**) requirements, rather than attracting a flood affectation notice. This approach is supported by NSWG, 2005 and would not adversely impact on Council's duty of care in regard to management of flood prone lands. The proposed categorisation of the floodplain, terminology and controls are shown on **Table 3.5**.

TABLE 3.5
PROPOSED CATEGORISATION OF THE FLOODPLAIN

Category (FDM, 2005)	Proposed Terminology used to define inundation in the *FRMS&P* report	Are Development Controls Required?	Is Section S10.7 Notification Warranted?
Main Stream Flooding	"Main Stream Flooding"	Yes	Yes
Local Overland Flooding - Local Drainage - Major Drainage	 "Local Drainage" "Major Overland Flow"	 No (ref. footnote 1). Yes (ref. footnote 2).	 No (ref footnote 1) Yes (ref footnote 3)

1. Inundation in Local Drainage areas is accommodated by the minimum floor level requirement of 0.15 m above finished surface level contained in the BCA and does not warrant a flood affectation notice in S10.7 Planning Certificates.
2. These are the deeper flooded areas with higher flow velocities. Development controls are specified in **Appendix E**.
3. Depth and velocity of inundation in Major Overland Flow areas are sufficient to warrant a flood affectation notice in S10.7 Planning Certificates. Inundation is classified as "flooding".

Figure E1.1 in **Appendix E** is an extract from the *Flood Planning Map* at Yass. The figure includes areas subject to both Main Stream Flooding and Major Overland Flow in the town. The extent of the FPA (the area subject to flood related development controls) is shown in a solid mauve (Main Stream Flooding) and green (Major Overland Flow) colour in **Figure E1.1** and has been defined as follows:

- In areas subject to Main Stream Flooding, the FPA is based on the traditional definition of the area that lies at or below by the 1% AEP plus freeboard (where a freeboard of 1.2 m was adopted for defining the extent of the FPA along the Yass River, while a freeboard of 0.5 m was adopted for defining the extent of the FPA along its major tributaries).
- In areas subject to Major Overland Flow, the FPA is defined as the extent of areas which act as a floodway, as well as areas where depths of inundation exceed 0.1 m in a 1% AEP event.

Also shown in **Figure E1.1** is the extent of the Outer Floodplain, which is the area of land which lies between the extent of the FPA and the PMF.

3.5.1.3 Proposed Planning Controls for Yass

As mentioned, Council does not presently have a Development Control Plan or policy which sets out flood related controls which apply to future development within the LGA. Rather, Council advised that it is currently applying the flood related development controls that are set out in WMAwater, 2016b when assessing applications for new development on the floodplain.

Based on a review of WMAwater, 2016b and in a knowledge of the flood behaviour at Yass, an updated set of planning controls have been recommended for adoption in the Development Control Plan that Council advised is currently being prepared for the Yass Valley (refer **Appendix E** of this report for details).

It is proposed that properties intersected by the extent of the FPA (i.e. the extent of land which lies below the FPL) would be subject to S10.7 flood affectation notification and planning controls graded according to flood hazard and evacuation constraints. NSWG, 2005 suggests wording on S10.7 (2) Planning Certificates along the following lines:

> *"Council considers the land in question to be within the Flood Planning Area and therefore subject to flood related development controls. Information relating to this flood risk may be obtained from Council. Restrictions on development in relation to flooding apply to this land as set out in Council's Development Control Plan which is available for inspection at Council offices or website."*

Annexures 2A and **2B** in **Appendix E** set out the graded set of flood related planning controls which have been developed for areas that are subject to Main Stream Flooding and Major Overland Flow, respectively. **Figure E1.1** in **Appendix E** shows the areas where the graded set of flood related planning controls set out in **Annexures 2A** and **2B** apply.

Minimum habitable floor level (**MHFL**) requirements would be imposed on future development in properties that are identified as lying either partially or wholly within the extent of the FPA shown on **Figure E1.1**. The MHFLs for residential land use types is the level of the 1% AEP flood event plus freeboard, whereas for commercial and industrial land use types the MHFL is to be as close to the 1% AEP flood level plus freeboard as practical, but no lower than the 5% AEP flood level plus freeboard. In situations where the MHFL is below the 1% AEP flood level plus freeboard, a mezzanine area equal to 30% of the total habitable floor area is to be provided, the elevation of which is to be set no lower than the 1% AEP flood level plus freeboard.[11]

[11] Freeboard is equal to 0.5 m for development being assessed in areas affected by Main Stream Flooding and 0.3 m for development being assessed in areas affected by Major Overland Flow.

For areas outside the FPA shown on **Figure E1.1**, the MHFL for all land use types is the level of the 1% AEP flood event plus 0.5 m freeboard, with the exception of "critical uses and facilities" which are critical for flood response and recovery where the MHFL is the level of the PMF.

Figure E1.2 in **Appendix E** is an extract of the *Flood Planning Constraint Category Map* for the Yass Valley which shows the subdivision of the floodplain into the following four categories which have been used as the basis for developing the graded set of planning controls:

- **Flood Planning Constraint Category 1 (FPCC 1)**, which comprises areas where factors such as the depth and velocity of flow, time of rise, and evacuation problems mean that the land is unsuitable for most types of development. The majority of new development types are excluded from this zone due to its potential impact on flood behaviour and the hazardous nature of flooding.
- **Flood Planning Constraint Category 2 (FPCC 2)**, which comprises areas which lie within the extent of the FPA where the existing flood risk warrants careful consideration and the application of significant flood related controls on future development.
- **Flood Planning Constraint Category 3 (FPCC 3)**, which comprises areas which lie within the extent of the FPA but outside areas designated FPCC1 and FPCC2. Areas designated FPCC3 are more suitable for new development and expansion of existing development provided it is carried out in accordance with the controls set out in this document.
- **Flood Planning Constraint Category 4 (FPCC 4)**, which comprises the area which lies between the extent of the FPA and the PMF. Flood related controls in areas designated FPCC4 are typically limited to flood evacuation and emergency response, although additional controls apply to "critical uses and facilities" which are critical for response and recovery.

The derivation of the four FPCCs firstly involved the derivation of a number of sub-regions which were based on the nature of flooding at Yass, the sub-categories of which are set out in **Table 3.6** over. These sub-regions were then combined, with the resulting extents further refined in order to improve the area over which each FPCC applied.

A *Special Flood Consideration Zone* has also been included which relates to areas where the flood risk is considered to be high enough to require additional controls to be applied to future development that is located on land which lies between the Main Stream Flooding FPA and the PMF. The *Special Flood Consideration Zone*, the extent of which is shown on **Figures E1.1** and **E1.2**, has been defined as the extent of land where the flood hazard vulnerability classification for the PMF is H3 or higher, noting that the resulting extent was further refined in order to improve its definition in a number of places. The additional controls in this area relate to the safe and orderly evacuation of people who would be occupying the floodplain at the time of a flood event.

3.5.1.4 Revision of Yass LEP 2013 by Council

Both the *Yass FRMS* and *Yass FRMP* have been developed giving consideration to the following amended form of wording which will automatically come into effect on 14 July 2021:

"6.2 Flood planning

(1) The objectives of this clause are as follows—

TABLE 3.6
KEY ELEMENTS COMPRISING FLOOD PLANNING CONSTRAINT CATEGORIES FOR YASS

Flooding	FPCC	Sub-category	Constraint
Main Stream Flooding	1	a	1% AEP Main Stream Flooding (MSF) Floodway
		b	1% AEP MSF Flood Hazard Vulnerability Classification H6
	2	a	1% AEP MSF Flood Storage
		b	1% AEP MSF Flood Hazard Vulnerability Classification H5
		c	0.2% AEP MSF Flood Hazard Vulnerability Classification H5 and H6 trimmed to the extent of the Main Stream Flooding FPA
		d	1% AEP Flood Emergency Response Classification (Flooded - Isolated - Submerged)
		e	1% AEP Flood Emergency Response Classification (Flooded - Isolated - Elevated)
	3	-	Flood Planning Area
	4	-	Extent of PMF
Major Overland Flow	1	-	1% AEP Floodway AND Flood Hazard Vulnerability Classification H4 - H6
	2	a	1% AEP Floodway AND Flood Hazard Vulnerability Classification H1 - H3
		b	1% AEP Flood Storage Area
		c	0.2% AEP Flood Hazard Vulnerability Classification H5 and H6
		d	1% AEP Flood Emergency Response Classification (Flooded - Isolated - Submerged)
		e	1% AEP Flood Emergency Response Classification (Flooded - Isolated - Elevated)
	3	-	Flood Planning Area
	4	-	Extent of PMF

(a) to minimise the flood risk to life and property associated with the use of land,

(b) to allow development on land that is compatible with the flood function and behaviour on the land, taking into account projected changes as a result of climate change,

(c) to avoid adverse or cumulative impacts on flood behaviour and the environment,

(d) to enable the safe occupation and efficient evacuation of people in the event of a flood.

(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development—

(a) is compatible with the flood function and behaviour on the land, and

(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and

(c) *will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and*

(d) *incorporates appropriate measures to manage risk to life in the event of a flood, and*

(e) *will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.*

(3) *In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters—*

(a) *the impact of the development on projected changes to flood behaviour as a result of climate change,*

(b) *the intended design and scale of buildings resulting from the development,*

(c) *whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,*

(d) *the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.*

(4) *A word or expression used in this clause has the same meaning as it has in the Considering Flooding in Land Use Planning Guideline unless it is otherwise defined in this clause.*

(5) *In this clause—*

Considering Flooding in Land Use Planning Guideline means the *Considering Flooding in Land Use Planning Guideline* published on the Department's website on 14 July 2021.

flood planning area has the same meaning as it has in the Floodplain Development Manual.

Floodplain Development Manual means the *Floodplain Development Manual* (ISBN 0 7347 5476 0) published by the NSW Government in April 2005.

It is also recommended that the optional *special flood considerations* clause be added to *Yass LEP 2013* as follows:

Special flood considerations

(1) *The objectives of this clause are as follows—*

(a) *to enable the safe occupation and evacuation of people subject to flooding,*

(b) *to ensure development on land is compatible with the land's flood behaviour in the event of a flood,*

(c) *to avoid adverse or cumulative impacts on flood behaviour,*

(d) *to protect the operational capacity of emergency response facilities and critical infrastructure during flood events,*

(e) *to avoid adverse effects of hazardous development on the environment during flood events.*

(2) This clause applies to—

(a) for sensitive and hazardous development—land between the flood planning area and the probable maximum flood, and

(b) for development that is not sensitive and hazardous development—land the consent authority considers to be land that, in the event of a flood, may—

(i) cause a particular risk to life, and

(ii) require the evacuation of people or other safety considerations.

(3) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the development—

(a) will not affect the safe occupation and efficient evacuation of people in the event of a flood, and

(b) incorporates appropriate measures to manage risk to life in the event of a flood, and

(c) will not adversely affect the environment in the event of a flood.

(4) A word or expression used in this clause has the same meaning as it has in the Considering Flooding in Land Use Planning Guideline unless it is otherwise defined in this clause.

(5) In this clause—

***Considering Flooding in Land Use Planning Guideline**—see clause 5.21(5).*

***flood planning area**—see clause 5.21(5).*

***Floodplain Development Manual**—see clause 5.21(5).*

***probable maximum flood** has the same meaning as it has in the Floodplain Development Manual.*

***sensitive and hazardous development** means development for the following purposes—*

[list land uses]

Direction— Only the following land uses are permitted to be included in the list—

(a) boarding houses,

(b) caravan parks,

(c) correctional centres,

(d) early education and care facilities,

(e) eco-tourist facilities,

(f) educational establishments,

(g) emergency services facilities,

(h) group homes,

(i) hazardous industries,

(j) hazardous storage establishments,

(k) hospitals,

(l) hostels,

(m) information and education facilities,

(n) respite day care centres,

(o) seniors housing,

(p) sewerage systems,

(q) tourist and visitor accommodation,

(r) water supply systems

The steps involved in Council amending *Yass LEP 2013* following the finalisation and adoption of the *Yass FRMS&P* are:

1. Council Planning Staff consider the conclusions of the *Yass FRMS&P* and suggested amendments to *Yass LEP 2013*.
2. Council resolves to amend *Yass LEP 2013* in accordance with the *Yass FRMS&P*.
3. Council prepares a Planning Proposal in accordance with NSW Planning and Environment Guidelines. Planning Proposal submitted to NSW Planning and Environment in accordance with section 3.33 of the EP&A Act, 1979.
4. Planning Proposal considered by DPIE and determination made in accordance with section 3.34(2) of the EP&A Act, 1979 as follows:
   (a) whether the matter should proceed (with or without variation),
   (b) whether the matter should be resubmitted for any reason (including for further studies or other information, or for the revision of the planning proposal),
   (c) community consultation required before consideration is given to the making of the proposed instrument (the community consultation requirements),
   (d) any consultation required with State or Commonwealth public authorities that will or may be adversely affected by the proposed instrument,
   (e) whether a public hearing is to be held into the matter by the Planning Assessment Commission or other specified person or body,
   (f) the times within which the various stages of the procedure for the making of the proposed instrument are to be completed.
5. Planning Proposal exhibited for public comment.
6. Planning Proposal reviewed following public submissions and submissions from relevant State and Commonwealth authorities.
7. Final Local Environmental Plan with proposed amendments drafted.
8. Amending Local Environmental Plan made by the Minister and gazetted.

3.5.2 Voluntary Purchase of Residential Properties

Removal of housing from high hazard floodway areas in the floodplain is generally accepted as a cost effective means of correcting previous decisions to build in such areas. The Voluntary Purchase of residential property in hazardous areas has been part of subsidised floodplain risk management programs in NSW for over 20 years.[12] After purchase, land is subsequently cleared and the site re-developed and re-zoned for public open space or some other flood compatible use. A further criterion applied by State Government agencies in assessing eligibility for funding is that the property must be in a high hazard floodway area, that is, in the path of flowing floodwaters where the depth and velocity at the peak of the flood are such that life could be threatened, damage of property is likely and evacuation difficult.

Under a Voluntary Purchase scheme the owner is notified that the body controlling the scheme, Council in the present case, is prepared to purchase the property when the owner is ready to sell. There is no compulsion whatsoever to sell at any time. The price is determined by independent valuers and the Valuer General, and by negotiation between Council and the owners. Valuations are not reduced due to the flood affected nature of the site.

Prior to progressing to the purchase of a property, it would first be necessary to hold discussions with each eligible and agreeable property owner, as well as a detailed assessment of each property to determine a priority order and costing for each.

There are eleven (11) existing dwellings in Yass that are subject to between 1 m and 4 m depth of above-floor inundation in a 1% AEP flood on the Yass River. All of the properties are located on the southern side of the river on land that has a flood hazard vulnerability classification of H5. While the acquisition of these properties cannot be justified on economic grounds due to an estimated cost of about $7.0 Million, the hazardous nature of the flooding and the associated risk to life should people become trapped in the affected dwellings warrants their consideration for inclusion in the NSW Government's Voluntary Purchase Scheme.

A confidential report was prepared as part of the present study which highlighted the flood risk in each of the eleven properties. The confidential report then formed the basis of discussions which were held by the FRMC prior to the finalisation of the draft *Yass FRMP*. Based on the outcome of the discussions it was decided the eleven properties should not be recommended for inclusion in the NSW Government's Voluntary Purchase Scheme and rather the risk to life in these properties should be managed through the implementation of the following measures:

i) Design and implementation of an integrated flood warning system for the Yass Valley (refer **Section 3.6.1** of this report for further details, noting this comprises Measures 5 and 6 of the *Yass FRMP*).

ii) Updating of the *Yass Valley Local Flood Plan* to ensure that these properties are identified as needing to be evacuated in the early stages of a major flood on the Yass River (refer **Section 3.6.2** of this report, noting this forms part of Measure 3 of the *Yass FRMP*).

iii) Council to liaise directly with the eleven property owners (and tenants if applicable) advising them of the flood risk and the need for them to evacuate in a safe and orderly manner during the early stages of a major flood on the Yass River (refer **Section 3.6.3** of this report, noting this forms part of Measure 4 of the *Yass FRMP*).

iv) Council to investigate altering the zoning of one or more of the affected properties from a residential to a commercial land use.

[12] State government funding is only available for properties where the buildings were approved and constructed prior to 1986 when the original Floodplain Development Manual was gazetted. Properties built after this date should have been constructed in accordance with the principles in the manual.

The effectiveness of the above measures at reducing the risk to life in the eleven properties should be reviewed when the *Yass FRMS&P* is next updated, as by this time they should have been implemented and possibly tested in a real flood situation.

3.5.3 Raising Floor Levels of Residential Properties

The term "house raising" refers to procedures undertaken, usually on a property by property basis, to protect structures from damage by floodwaters. The most common process is to raise the affected house by a convenient amount so that the floor level is at or above the MHFL. For weatherboard and similar buildings this can be achieved by jacking up the house, constructing new supports, stairways and balconies and reconnecting services. Alternatively, where the house contains high ceilings, floor levels can be raised within rooms without actually raising the house. It is usually not practical to raise brick or masonry houses. Most of the costs associated with this measure relate to the disconnection and reconnection of services. Accordingly, houses may be raised a considerable elevation without incurring large incremental costs.

State and Federal Governments have agreed that flood mitigation funds will be available for house raising, subject to the same economic evaluation and subsidy arrangements that apply to other structural and non-structural flood mitigation measures. In accepting schemes for eligibility, the Government has set out the following conditions:

- House raising should be part of the adopted Floodplain Risk Management Plan.
- The scheme should be administered by the local authority.

State government funding is only available for properties where the buildings were approved and constructed prior to 1986 when the original Floodplain Development Manual was gazetted. Properties built after this date should have been constructed in accordance with the principles in the manual. The Government also requires that councils carry out ongoing monitoring in areas where subsidised voluntary house raising has occurred to ensure that redevelopment does not occur to re-establish habitable areas below the design floor level. In addition, it is expected that councils will provide documentation during the conveyancing process so that subsequent owners are made aware of restrictions on development below the design floor level.

Council's principal role in subsidised voluntary house raising would be to:

- Define a habitable floor level, which it will have already done in exercising controls over new house building in the area.
- Guarantee a payment to the builder after satisfactory completion of the agreed work.
- Monitor the area of voluntary house raising to ensure that redevelopment does not occur to re-establish habitable areas below the design floor level.

Prior to progressing to the raising of a dwelling, it would be necessary to hold discussions with each eligible and agreeable property owner, as well as a detailed assessment of each property to determine a priority order and costing for each.

The current cost to raise a medium sized (150 m^2) house is about $100,000 based on recent experience in other centres.

While there are three existing dwellings that are subject to above-floor inundation due to surcharge of the local stormwater drainage system, the relatively shallow depth, short duration and low hazard nature of the flow would not warrant their inclusion in a voluntary house raising scheme.

While there are two existing dwellings that are located in high hazard flood storage areas on the Yass River, only one would qualify for voluntary house raising given its weatherboard type construction. As the depth of above-floor inundation in a 1% AEP flood is presently 0.4 m, it would be necessary to raise the floor level of the dwelling by 0.9 m, noting that the current floor level is presently set about 0.7 m above the adjacent ground level. While the raising of the floor level of the dwelling could not be justified on economic grounds (i.e. because the *Present Worth Value* of the damages saved by raising it above the peak 1% AEP flood level would be negligible), there is merit in raising its floor level above the peak 1% AEP flood level on social grounds.

The inclusion of the single dwelling in the NSW Government's Voluntary House Raising Scheme was discussed at the FRMC meeting which was held prior to the finalisation of the draft *Yass FRMP*. Given the ongoing damages that would be incurred in the eleven residential properties that were identified for potential inclusion in the NSW Government's Voluntary Purchase Scheme, it was decided that there was no justification for the inclusion of the single dwelling in the NSW Government's Voluntary House Raising Scheme.

3.6 Response Modification Measures

3.6.1 Improvements to Flood Warning System

Improvements to the flood warning and response procedures were strongly favoured by the community during the community consultation process. An effective flood warning system has three key components, i.e. a flood forecasting system, a flood warning broadcast system and a response/evacuation plan. All systems need to be underpinned by an appropriate public flood awareness program.

Presently warnings regarding the potential for flooding to occur at Yass are limited to BoMs *Severe Thunderstorm Warning* and *Severe Weather Warnings for Flash Flooding* alert services which are publically available via the internet or on smart phones via free Apps.

Funding to establish local flash flood warning systems has traditionally been made available on the basis of no Council contribution to the initial capital cost in recognition of the high maintenance costs which Council would have to meet. The costs of maintaining the system would include such items as rain and river gauges, warning communication systems and ongoing public awareness/education programs. The maintenance obligations need to be identified and included in any initial funding grant. An operation and maintenance manual would need to be prepared for the system. Reference to the system would also need to be incorporated into the *Yass Valley Local Flood Plan*.

BoM has indicated that it would be supportive of improvements to the flood warning system for the Yass Valley, noting that WMAwater, 2016b and WMAwater, 2016c include recommendations for improvements to be made to the flood warning systems for the villages of Gundaroo and Sutton. It is envisaged that improvements to the flood warning system for the Yass Valley which take into account the recommendations of WMAwater, 2016b and WMAwater, 2016c would comprise:

- The installation of a network of pluviographic rain gauges both within and adjacent to the Yass Valley which would allow BoM to monitor rainfall depths and intensities in real time.

- The installation of alarms on the Macks Reef Road, Gundaroo and Yass stream gauges which would be triggered when key water levels are reached during a flood event. In the case of Gundaroo and Yass, an automated public announcement system could be linked to the key trigger levels, warning residents and business owners that a key trigger level(s) has been reached in the river and to monitor and take action where required.
- The installation of two new stream gauges upstream of Yass, one on the Yass River and the other on Murrumbateman Creek. While locating a single stream gauge on the Yass River downstream of its confluence with Murrumbateman Creek would control a large portion of the catchment which lies upstream of Yass, its location only a short distance upstream of the town would not provide sufficient advance warning of the magnitude of an approaching flood. Rather, the provision of a gauge on Murrumbateman Creek a short distance upstream of its confluence with the Yass River (Catchment Area = 184 km^2) in combination with another gauge which could be located further upstream at say the Greenwood Road crossing of the Yass River (Catchment Area = 800 km^2) would provide sufficient coverage of the catchment and advance warning time of an approaching flood.
- Installation of manual read water level gauges at Sutton, Gundaroo and Yass.
- Installation of warning signs and self-deploying boom gates on river and creek crossings.

Given the potential for hazardous flooding to impact existing development at Yass, coupled with the recommendations set out in WMAwater, 1016b and WMAwater, 2016c, the development of a comprehensive flood warning system for the Yass Valley has been included in the *Yass FRMP*.

3.6.2 Improved Emergency Planning and Response

As mentioned in **Section 2.16**, the *Yass Valley Local Flood Plan* provides detailed information regarding preparedness measures, conduct of response operations and coordination of immediate recovery measures for all levels of flooding.

NSW SES should ensure information contained in this report on the impacts of flooding on urban development, as well as recommendations regarding flood warning and community education are used to update Volume 2 of the *Yass Valley Local Flood Plan*. Volume 2 should include the following sections:

<u>**Annex A – The Flood Threat**</u> includes the following sub-sections:

Land Forms and River Systems – ref. **Sections 2.1** and **2.2** of the report for information on these topics.

Characteristics of Flooding – Indicative extents of inundation for the 1% AEP and PMF events and the typical times of rise of floodwaters at key locations on the major watercourses are shown on **Figures 2.2**, **2.3** and **2.5**. The location of vulnerable development and critical infrastructure relative to the flood extents is shown on **Figure 2.6**.

Flood History – Recent flood experience at Yass is discussed in **Section 2.3** of the report.

Design Flood Heights – The design flood heights for the Yass stream gauge should be updated based on the design peak flood levels set out in **Table 2.4** of the report.

Flood Mitigation Systems – Apart of two stormwater detention basins that have been constructed in the upper reaches of the Chinamans Creek catchment as part of two relatively new residential subdivisions, there are no other formal flood mitigation measures in Yass.

Extreme Flood Events – The PMF was modelled and the indicative extent and depth of inundation presented on **Figure 2.3**.

Annex B – Effects of Flooding on the Community

Information on the properties affected by the 1% AEP design flood are included in this report (**Figure 2.2**), noting that the floor level data used in this assessment were a combination of field survey and estimates which were made from the LiDAR survey and "drive by" survey. A separate confidential report was also issued to the FRMC identifying the eleven dwellings that are subject to hazardous flooding conditions and which would need to be evacuated in the early stages of a major flood on the Yass River.

Figure 2.5 shows stage hydrographs at road crossings at Yass, the locations of which are shown on **Figure 2.2**, sheets 2 and 3.

Figure 2.6 shows the location of vulnerable development and critical infrastructure in Yass relative to the flood extents ranging between 20% and 0.2% AEP, as well as the PMF. Refer **Section 2.7** for details of affected infrastructure.

Figures 3.6, **3.7** and **3.8** show the flood emergency response planning classifications for the 5% AEP, 1% AEP and PMF events, respectively, based on the definitions set out in AIDR, 2017.

Figures 3.9, **3.10** and **3.11** show the indicative extent and depth of inundation associated with flooding on the Yass River corresponding to NSW SES's interim Minor (4.6 m), Moderate (6.0 m) and Major (8.0 m) flood levels on the Yass stream gauge, while **Table 3.7** over provides a description of the flood related consequences at each level.

3.6.3 Public Awareness Programs

Community awareness and appreciation of the existing flood hazards in the floodplain would promote proper land use and development in flood affected areas. A well informed community would be more receptive to requirements for flood proofing of buildings and general building and development controls imposed by Council. Council should also take advantage of the information on flooding presented in this report, including the flood mapping, to inform occupiers of the floodplains of the flood risk.

One aspect of a community's preparedness for flooding is the "flood awareness" of individuals. This includes awareness of the flood threat in their area and how to protect themselves against it. The overall level of flood awareness within the community tends to reduce with time, as memories fade and as residents move into and out of the floodplain. The improvements to flood warning arrangements described above, as well as the process of disseminating this information to the community, would represent a major opportunity for increasing flood awareness in Yass.

Means by which community awareness of flood risks can be maintained or may be increased include:

- displays at Council offices using the information contained in the present study and photographs of historic flooding in the area; and
- talks by NSW SES officers with participation by Council and longstanding residents with first-hand experience of flooding in the area.
- preparation of a *Flood Information Brochure* which could be prepared by Council with the assistance of NSW SES containing both general and site specific data and distributed with rate notices.

The community should also be made aware that a flood greater than historic levels or the flood planning level can, and will, occur at some time in the future.

In addition to the above, Council and/or NSW SES should liaise with the owners (and also the tenants if applicable) of the eleven residential properties that were identified for possible inclusion in the NSW Government's Voluntary Purchase Scheme and advise them of the existing flood risk and the need for them to evacuate their properties during the early stages of a major flood on the Yass River.

TABLE 3.7
IMPACTS RELATING TO INTERIM FLOOD LEVEL CLASSIFICATIONS
YASS RIVER FLOODING AT YASS

Flood Level Classification	Gauge Height (m)	Consequence
Minor	4.6	• Flat Rock Crossing inundated to a depth of about 4.4 m.
Moderate	6.0	• Flat Rock Crossing inundated to a depth of about 5.8 m. • Floodwater surcharges the left bank of Yass River immediately upstream of Comur Street and inundates Riverbank Park to depths of up to 1 m.
Major	8.0	• Flat Rock Crossing inundated to a depth of about 7.8 m. • Riverbank Park inundated to depths of up to 3 m. • Rossi Street inundated to a depth of about 1.4 m at the low point between Church Street and Comur Street. • Banjo Patterson Park inundated to depths of up to 1.6 m. • Low point in Comur Street 80 m north of its intersection with Rossi Street inundated to a depth of about 1.1 m.[1] • Wargeila Road on the verge of being inundated at a location about 160 m north of its intersection with Yass Valley Way. • Three dwellings and six commercial buildings in undated above-floor level.

1. Note: Comur Street will commence to be inundated at this location when the water level reaches 6.9 m on the Yass stream gauge.

4 SELECTION OF FLOODPLAIN MANAGEMENT MEASURES

4.1 Background

NSWG, 2005 requires a Council to develop a Floodplain Risk Management Plan based on balancing the merits of social, environmental and economic considerations which are relevant to the community. This chapter sets out a range of factors which need to be taken into consideration when selecting the mix of works and measures that should be included in the *Yass FRMP*.

The community will have different priorities and, therefore, each needs to establish its own set of considerations used to assess the merits of different measures. The considerations adopted by a community must, however, recognise the State Government's requirements for floodplain management as set out in NSWG, 2005 and other relevant policies. A further consideration is that some elements of the *Yass FRMP* may be eligible for subsidy from State and Federal Government sources and the requirements for such funding must, therefore, be taken into account.

Typically, State and Federal Government funding is given on the basis of merit, as judged by a range of criteria:

- The magnitude of damage to property caused by flooding and the effectiveness of the measure in mitigating damage and reducing the flood risk to the community.
- Community involvement in the preparation of the Floodplain Risk Management Plan and acceptance of the measure.
- The technical feasibility of the measure (relevant to structural works).
- Conformance of the measure with Council's planning objectives.
- Impacts of the measure on the environment.
- The economic justification, as measured by the benefit/cost ratio of the measure.
- The financial feasibility as gauged by Council's ability to meet its commitment to fund its part of the cost.
- The performance of the measure in the event of a flood greater than the design event.
- Conformance of the measure with Government Policies (e.g. NSWG, 2005 and Catchment Management objectives).

4.2 Ranking of Measures

A suggested approach to assessing the merits of various measures is to use a subjective scoring system. The chief merits of such a system are that it allows comparisons to be made between alternatives using a common "currency". In addition, it makes the assessment of alternatives "transparent" (i.e. all important factors are included in the analysis). The system does not, however, provide an absolute "right" answer as to what should be included in the *Yass FRMP* and what should be left out. Rather, it provides a method by which Council can re-examine the measures and if necessary, debate the relative scoring given to aspects of the *Yass FRMP*.

Each measure is given a score according to how well the measure meets the considerations discussed above. In order to keep the scoring simple, the following system is proposed:

+2 Measure rates very highly

+1 Measure rates well

0 Measure is neutral

- 1 Measure rates poorly

- 2 Measure rates very poorly

The scores are added to get a total for each measure.

Based on considerations outlined in this chapter, **Table 4.1** presents a suggested scoring matrix for the measures reviewed in **Chapter 3**. This scoring has been used as the basis for prioritising the components of the *Yass FRMP*.

4.3 Summary

Table 4.1 indicates that there are good reasons to consider including the following elements into the *Yass FRMP*:

- An update of e *Yass LEP 2013* to allow better management of the floodplain
- Improved planning controls through the development of a Development Control Plan for the Yass Valley which incorporates the recommendations set out in this report.
- Incorporation of the catchment specific information on flooding impacts contained in this report in NSW SES Response Planning and Flood Awareness documentation for the study area.
- Improvements to the flood warning system for the Yass Valley through the installation of a number of telemetered pluviographic rain gauges, as well as a number of telemetered stream gauges upstream of the town.
- Improved public awareness of flood risk in the community.
- Development and implementation of a *Vegetation Management Plan* for Chinamans Creek.

TABLE 4.1
ASSESSMENT OF POTENTIAL FLOODPLAIN MANAGEMENT MEASURES FOR INCLUSION IN YASS FLOODPLAIN RISK MANAGEMENT PLAN

Measure	Impact on Flooding/ Reduction in Flood Risk	Community Acceptance	Technical Feasibility	Planning Objectives	Environ. Impacts	Economic Justification	Financial Feasibility	Extreme Flood	Government Policies and TCM Objectives	Score
Flood Modification										
Cobham Street to Shaw Street Stormwater Drainage Upgrade	-1	+2	+1	+1	0	-2	0	0	-1	0
Lead Street Stormwater Drainage Upgrade	+1	+2	+2	+1	0	-2	0	0	+1	+5
Browne Street Trunk Drainage Upgrade	+1	+2	+2	+1	+1	-2	0	0	+1	+6
Yass Railway Museum Detention Basin Option 1	+1	+1	+2	+1	0	-2	0	0	+1	+4
Yass Railway Museum Detention Basin Option 2	+1	+1	+2	+1	0	-2	0	0	+1	+4
Vegetation Management	+1	+2	+2	+2	+2	-1	0	0	+2	+10
Property Modification										
Controls over Future Development (via a new Development Control Plan for the Yass Valley)	+2	+2	+2	+2	0	0	0	+1	+2	+11
Voluntary Purchase of Residential Property Subject to Highly Hazardous Flooding Conditions	+2	-1	+2	+2	0	-2	-2	+2	+2	+7
House Raising in Areas Subject to Less Hazardous Conditions	+1	-2	+2	+2	0	+1	+1	0	+1	+6
Response Modification										
Improvements to Flood Warning System	+2	+2	+2	+1	0	0	0	+2	+2	+11
Improved Emergency Planning and Response	+2	+2	+2	+1	0	0	0	+2	+2	+11
Public Awareness Programs	+1	+2	+2	+1	0	0	0	+1	+2	+9

5 YASS FLOODPLAIN RISK MANAGEMENT PLAN

5.1 The Floodplain Risk Management Process

The *Yass Floodplain Risk Management Study* (***Yass FRMS***) and *Yass Floodplain Risk Management Plan* (***Yass FRMP***) have been prepared for the township of Yass (**study area**) as part of a Government program to mitigate the impacts of major floods and reduce the hazards in the floodplain. The *Yass FRMP* which is set out in this Chapter has been prepared as part of the Floodplain Risk Management Process in accordance with the NSW Government's Flood Prone Land Policy.

The first steps in the process of preparing the *Yass FRMP* were the collection of flood data and the review and update of the *Yass Flood Study* (WMAwater, 2016a) (***Updated Flood Study***), details of which are set out in **Appendix B** of the *Yass FRMS* report.

5.2 Purpose of the Plan

The overall objectives of the *Yass FRMS* were to assess the impacts of flooding, review policies and measures for the management of flood affected land and to develop the *Yass FRMP* which:

- Sets out the recommended program of works and measures aimed at reducing over time, the social, environmental and economic impacts of flooding and establishes a program and funding mechanism for the *Yass FRMP*.
- Proposes amendments to Yass Valley Council's (**Council's**) existing policies to ensure that the future development of flood affected land in the study area is undertaken so as to be compatible with the flood hazard and risk.
- Ensures the *Yass FRMP* is consistent with NSW State Emergency Services (**NSW SES's**) local emergency response planning procedures.
- Ensures that the *Yass FRMP* has the support of the community.

5.3 The Study Area

The study area for the *Yass FRMP* applies to areas that are affected by the following two types of flooding at Yass:

- **Main Stream Flooding**, which occurs when floodwater surcharges the inbank area of the existing river and creek system. Main Stream Flooding is typically characterised by relatively deep and fast flowing floodwater, but may be shallower and slower moving in flood fringe areas.
- **Major Overland Flow** which occurs during storms which result in the surcharge of the existing stormwater drainage system. It is also present in the upper reaches of the study catchments.

Figure 1.1 (2 sheets) is a location and catchment plan, while **Figure 2.1** (4 sheets) shows the key features of the existing stormwater drainage system at Yass.

5.4 Community Consultation

The Community Consultation process provided valuable direction over the course of the investigations, bringing together views from key Council staff, other departments and agencies, and importantly, the views of the community gained through:

- the delivery of a *Community Newsletter and Questionnaire* to property occupiers in the study area which allowed the wider community to gain an understanding of the issues being addressed as part of the study;
- meetings of the Floodplain Risk Management Committee to discuss results as they became available;
- a community "drop-in" session which was held during the exhibition of the draft *Yass FRMS&P* report.; and
- a one-on-one meeting with a concerned resident in Browne Street.

A summary of the responses to the questions contained in the *Community Questionnaire* is contained in **Appendix A** of the *Yass FRMS&P report*.

5.5 Existing Flood Behaviour

Yass has experienced several large floods that have inundated the floodplain and isolated parts of the town since settlement occurred in the 1830s. While stream gauge records only extend back to 1915, archival information indicates that major flood events occurred in July 1852, July 1864, April 1870, June 1891 and July 1900.

The July 1900 flood event is estimated to be the flood of record at Yass, while the October 1959 flood event is the largest to have occurred since official records began in 1915. The July 1900 flood reached about 10.3 m on the Yass stream gauge, while the October 1959 reached about 10.0 m. The October 1959 flood was equivalent to about a 1% (1 in 100) Annual Exceedance Probability (**AEP**) flood event.

Appendix B of the *Yass FRMS* report contains a series of photos which show the flooding that was experienced in parts of Yass during the major floods that occurred in 1900, 1925 and 1959, while **Figures 2.2** and **2.3** show the indicate extent and depth of inundation for the 1% AEP and Probable Maximum Flood (**PMF**) events, respectively. **Figure 2.4** shows design water surface profiles along the Yass River, Chinamans Creek and Bango Creek, **Figure 2.5** shows the time of rise of floodwaters at a number of key locations at Yass. **Figure 2.6** shows the indicate extent of flooding at Yass for floods of between 20% and 1% AEP, as well as the PMF event.

The relatively confined nature of the Yass River at Yass results in a relatively large difference in peak flood levels for floods of varying magnitude. For example, the peak 1% AEP flood level on the river is over 5 m higher than the corresponding peak 20% AEP flood level, while the peak PMF level is about 15 m higher than the corresponding peak 1% AEP flood level.

This large flood range in combination with the relatively rapid response time of the catchment to flood producing rain and the absence of an effective flood warning system for Yass poses a significant risk to life for occupiers of those areas that are subject to Main Stream Flooding. It also poses problems for agencies such as NSW SES given the relatively short period of time that is available to evacuate people from areas that could, depending on the intensity of the storm event, be subject to hazardous flooding conditions.

In addition to parts of Yass being impacted by relatively deep and potentially fast flowing floodwater which surcharges the Yass River and its tributaries (i.e. as a result of Main Stream Flooding), it is also subject to relatively shallow and slower moving overland flow which occurs during storms which result in the surcharge of the existing stormwater drainage system, principally within the Chinamans Creek catchment (i.e. as a result of Major Overland Flow).

5.6 Existing Flood Mitigation Measures

Apart from two stormwater detention basins that have recently been constructed in the upper reaches of the Chinamans Creek catchment as part of two new residential subdivisions, there are no other formal flood mitigation measures in Yass.

5.7 Economic Impacts of Flooding

Table 5.1 shows the number of properties that would be flooded to above-floor level and the damages experienced in residential and commercial/industrial development, as well as public buildings in the study area.

At the 1% AEP level of flooding, 23 dwellings and 34 commercial/industrial buildings are subjected to above-floor inundation, noting that no public buildings are above-floor inundated during a flood of this magnitude. The maximum depth of above-floor inundation in the worst affected residential and commercial property increases from about 4 m for a 1% AEP flood event to about 17 m for the PMF.

The total flood damages in Yass amounts to $6.59 Million in the event of a 1% AEP flood, increasing to about $154 Million in a PMF event. For a discount rate of 7% pa and an economic life of 50 years, the *Present Worth Value* of damages for all flood events up to the 1% AEP flood is about $3.5 Million.

TABLE 5.1
ECONOMIC IMPACTS OF FLOODING IN STUDY AREA

Design Flood Event (% AEP)	Properties Flooded Above-Floor Level						Total Flood Damages
	Residential		Commercial/Industrial		Public		
	No.	$ Million	No.	$ Million	No.	$ Million	$ Million
20%	0	0.13	1	0.06	0	0.02	0.21
10%	1	0.31	3	0.23	0	0.02	0.56
5%	3	0.64	14	0.70	0	0.02	1.36
2%	12	1.76	18	2.04	0	0.02	3.82
1%	23	3.14	34	3.39	0	0.06	6.59
0.5%	32	4.62	60	5.67	3	0.21	10.50
0.2%	44	6.40	80	10.50	7	1.27	18.17
PMF	276	35.22	152	91.99	32	26.67	153.88

5.8 Structure of Yass Floodplain Risk Management Plan

A summary of the *Yass FRMP* proposed for the study area along with broad funding requirements for the recommended measures are shown in **Table S1** at the commencement of the *Yass FRMS* report. These measures comprise preparation of planning documentation by Council, improvements to the flood warning system and community education on flooding by Council and NSW SES to improve flood awareness and response, and the management of vegetation along sections of Chinamans Creek. The measures will over time achieve the objectives of reducing the flood risk to existing and future development for the full range of floods.

The *FRMP* is based on the following mix of measures which have been given a provisional priority ranking according to a range of economic, social, environmental and other criteria set out in **Table 4.1** of the report:

- **Measure 1** – Update wording in the Yass Local Environmental Plan, 2013 (***Yass LEP 2013***)
- **Measure 2** – Improvements to planning and development controls for future development in flood prone areas
- **Measure 3** – Improvements to emergency response planning
- **Measure 4** – Increase public awareness of the risks of flooding in the community
- **Measure 5** – Investigation and design of an integrated flood warning system for the Yass Valley
- **Measure 6** – Implementation of an integrated flood warning system for the Yass Valley
- **Measure 7** – Development and implementation of a *Vegetation Management Plan* for Chinamans Creek

5.9 Planning and Development Controls

The results of the *Yass FRMS* indicate that an important measure for Council to adopt in the floodplain would be strong floodplain risk management planning applied consistently by all of its branches.

5.9.1 Revision of Yass LEP 2013

Clause 6.2 of *Yass LEP 2013* entitled "Flood planning" outlines its objectives in regard to development of flood prone land. The Flood Planning Level (**FPL**) referred to is the 1% AEP flood plus an allowance for freeboard of 0.5 m. The area encompassed by the FPL is known as the Flood Planning Area (**FPA**) and denotes the area subject to flood related development controls, such as locating development outside high hazard areas and setting minimum floor levels for future residential development.

The NSW Government recently finalised reforms of the *NSW Flood Prone Land Package* which included an update of the flood planning clause in all NSW Council Local Environmental Plans which will come into effect on 14 July 2021. While the wording of the flood planning clause in the *Yass LEP 2013* will be automatically updated on this date, it is recommended that the new special flood considerations clause set out in the *NSW Flood Prone Land Package* also be included in *Yass LEP 2013* (**Measure 1**). The objectives of the new clause are as follows:

- in relation to development with particular evacuation or emergency response issues (e.g. group homes, residential care facilities, etc.) to enable evacuation of land subject to flooding in events exceeding the flood planning level; and
- to protect the operational capacity of emergency response facilities and critical infrastructure during extreme flood events.

The new clause would apply to land identified as FPCC4 (i.e. land which lies between the FPA and the extent of the PMF). Wording in relation to this new clause is given in **Section 3.5.1.4**.

5.9.2 Yass Valley Development Control Plan

The recommended approach to managing future development in the study area uses the concepts of *flood hazard* and *hydraulic categorisation* to develop controls for future development in flood prone land (**Measure 2**). **Figure E1.1** in **Appendix E** is an extract from the *Flood Planning Map* relating to the study area. The extent of the FPA has been defined as follows:

- In areas subject to Main Stream Flooding on the Yass River at Yass, the FPA is based on the area inundated by the 1% AEP plus 1.2 m freeboard, while in other areas it is based on the traditional definition of the area inundated by the 1% AEP plus 0.5 m freeboard.
- In areas subject to Major Overland Flow, the FPA is defined as the extent of floodway areas, as well as areas where depths of inundation in a 1% AEP event exceed 0.1 m.

It is proposed that properties intersected by the extent of the FPA would be subject to S10.7 flood affectation notification and planning controls graded according to flood hazard and hydraulic categorisation. **Annexures 2A** and **2B** in **Appendix E** set out the graded set of flood related planning controls which apply to development in areas that are affected by Main Stream Flooding and Major Overland Flow, respectively. **Figure E1.1** in **Appendix E** shows the areas where the graded set of flood related planning controls set out in **Annexures 2A** and **2B** apply.

Minimum habitable floor level (**MHFL**) requirements would be imposed on future development in properties that are identified as lying either partially or wholly within the extent of the FPA shown on **Figure E1.1**. The MHFLs for residential land use types is the level of the 1% AEP flood event plus freeboard, whereas for commercial and industrial land use types the MHFL is to be as close to the 1% AEP flood level plus freeboard as practical, but no lower than the 5% AEP flood level plus freeboard. In situations where the MHFL is below the 1% AEP flood level plus freeboard, a mezzanine area equal to 30% of the total habitable floor area is to be provided, the elevation of which is to be set no lower than the 1% AEP flood level plus freeboard.[13]

Figure E1.2 in **Appendix E** is an extract of the *Flood Planning Constraint Category Map* for Yass. The figure shows the subdivision of the floodplain into the following four categories which have been used as the basis for developing the graded set of planning controls:

- **Flood Planning Constraint Category 1 (FPCC 1)**, which comprises areas where factors such as the depth and velocity of flow, time of rise, and evacuation problems mean that the land is unsuitable for most types of development. The majority of new development types are excluded from this zone due to its potential impact on flood behaviour and the hazardous nature of flooding.

[13] Freeboard is equal to 0.5 m for development being assessed in areas affected by Main Stream Flooding and 0.3 m for development being assessed in areas affected by Major Overland Flow.

- **Flood Planning Constraint Category 2 (FPCC 2)**, which comprises areas which lie within the extent of the FPA where the existing flood risk warrants careful consideration and the application of significant flood related controls on future development.
- **Flood Planning Constraint Category 3 (FPCC 3)**, which comprises areas which lie within the extent of the FPA but outside areas designated FPCC1 and FPCC2. Areas designated FPCC3 are more suitable for new development and expansion of existing development provided it is carried out in accordance with the controls set out in this document.
- **Flood Planning Constraint Category 4 (FPCC 4)**, which comprises the area which lies between the extent of the FPA and the PMF. Flood related controls in areas designated FPCC4 are typically limited to flood evacuation and emergency response, although additional controls apply to "critical uses and facilities" which are critical for response and recovery.

A *Special Flood Consideration Zone* has also been included which relates to areas where the flood risk is considered to be high enough to require additional controls to be applied to future development which is located on land that lies above the FPL. The *Special Flood Consideration Zone*, the extent of which is shown on **Figures E1.1** and **E1.2**, has been defined as the extent of land where the flood hazard vulnerability classification for the PMF is H3 or higher, noting that the resulting extent was further refined in order to improve its definition in a number of places. The additional controls in this area relate to the safe and orderly evacuation of people who would be occupying the floodplain at the time of a flood event.

5.10 Improvements to Flood Warning, Emergency Response Planning and Community Awareness

Three measures are proposed in the *Yass FRMP* to improve flood warning, emergency response planning and community awareness to the threat posed by flooding.

Measure 3 involves the update by NSW SES of the *Yass Valley Local Flood Plan* using information on flooding patterns, peak flood levels, times of rise of floodwaters and flood prone areas identified in this report. Figures have been prepared showing indicative extents of flooding, high hazard areas, expected rates of rise of floodwaters in key areas and locations where flooding problems would be expected. **Section 3.6.2** references the locations of key data within this report.

Council should also take advantage of the information on flooding presented in this report, including the flood mapping, to inform occupiers of the floodplains of the flood risk (included as **Measure 4** of the *Yass FRMP*). This information could be included in a *Flood Information Brochure* to be prepared by Council with the assistance of NSW SES containing both general and site specific data and distributed with the rate notices. The community should also be made aware that a flood greater than historic levels or the planning level can, and will, occur at some time in the future.

Measure 5 involves the investigation and design of an integrated flood warning system for the Yass Valley which would include the installation of a network of pluviographic rain gauges, along with a series of telemetered stream gauges. An automated alarm and public announcement system should be linked to the telemetered stream gauges warning residents and business owners that a key trigger level(s) has been reached and to monitor and take action where required. Other improvements include the installation of manual read water level gauges at Sutton, Gundaroo and Yass, as well as the installation of warning signs and self-deploying boom gates on river and creek crossings. **Measure 6** involves the implementation of an integrated flood warning system for the Yass Valley.

5.11 Flood Modification Works

While several potential flood modification works in the form of upgrades to the existing stormwater drainage system and the construction of a detention basin in publically owned land were assessed as part of the *Yass FRMS*, none were considered to provide sufficient benefit in terms of a reduction in flood affectation and hazard in existing development to justify their inclusion in the *Yass FRMP*. The assessed measures could also not be justified on economic grounds.

The *Yass FRMS* concluded that there is merit in developing and implementing a *Vegetation Management Plan* for Chinamans Creek where it runs through the urbanised parts of Yass, noting that while the removal of dense vegetation from inbank areas would not have a significant impact on peak 1% AEP flood levels, it would reduce the frequency of nuisance flooding and the risk of blockage of hydraulic structures (**Measure 7**).

5.12 Implementation Program

The steps in progressing the floodplain management process from this point onwards are:

1. Council adopts *Yass FRMP* and submits an application for funding assistance.
2. Assistance for funding qualifying projects included in the *Yass FRMP* may be available upon application under the Commonwealth and State funded floodplain management programs, currently administered by the Department of Planning, Industry and Environment.
3. As funds become available from Government agencies and/or Council's own resources, implement the measures in accordance with the established priorities.

The *Yass FRMP* should be regarded as a dynamic instrument requiring review and modification over time. The catalysts for change could include new flood events and experiences, legislative change, alterations in the availability of funding, reviews of Council's planning strategies and importantly, the outcome of some of the studies proposed in this report as part of the *Yass FRMP*. In any event, a thorough review every ten years is warranted to ensure the ongoing relevance of *Yass FRMP*.

6 GLOSSARY OF TERMS

Note: For expanded list of definitions, refer to Glossary contained within the NSW Government Floodplain Development Manual, 2005.

TERM	DEFINITION
Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, for a flood magnitude having five per cent AEP, there is a five per cent probability that there would be floods of greater magnitude each year.
Australian Height Datum (AHD)	A common national surface level datum corresponding approximately to mean sea level.
Floodplain	Area of land which is subject to inundation by floods up to and including the Probable Maximum Flood (**PMF**) event, that is, flood prone land.
Flood Planning Area	The area of land that is shown to be in the Flood Planning Area on the *Flood Planning Map*.
Flood Planning Map	The *Flood Planning Map* shows the extent of land on which flood related development controls apply in a given area, noting that other areas may exist which are not mapped but where flood related development controls apply.
Flood Planning Constraint Category 1 (FPCC 1)	Comprises areas where factors such as the depth and velocity of flow, time of rise, and evacuation problems mean that the land is unsuitable for most types of development. The majority of new development types are excluded from this zone due to its potential impact on flood behaviour and the hazardous nature of flooding
Flood Planning Constraint Category 2 (FPCC 2)	Comprises areas which lie below the *Flood Planning Level* where the existing flood risk warrants careful consideration and the application of significant flood related controls on future development.
Flood Planning Constraint Category 3 (FPCC 3)	Comprises areas which lie below the *Flood Planning Level* but outside areas designated FPCC1 and FPCC2. Areas designated FPCC3 are more suitable for new development and expansion of existing development provided it is carried out in accordance with the controls set out in this document.
Flood Planning Constraint Category 4 (FPCC 4)	Comprises the area which lies above the *Flood Planning Level* (**FPL**) but within the extent of the PMF. Flood related controls in areas designated FPCC4 are typically limited to flood evacuation and emergency response, although additional controls apply to "critical uses and facilities" which are critical for response and recovery.
Flood Planning Level (FPL)	Flood levels selected for planning purposes, as determined by the relevant adopted floodplain risk management study and plan, or as part of a site specific study In the absence of an adopted floodplain risk management study and plan for a particular location, the FPL is defined as the peak 1% AEP flood level plus the addition of a 0.5 m freeboard.

TERM	DEFINITION
Flood Prone/Flood Liable Land	Land susceptible to flooding by the PMF. Flood Prone land is synonymous with Flood Liable land.
Floodway	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
Flood Storage Area	Those parts of the floodplain that may be important for the temporary storage of floodwaters during the passage of a flood. Loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation.
Freeboard	Provides reasonable certainty that the risk exposure selected in deciding a particular flood chosen as the basis for the *Flood Planning Level* is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Freeboard is included in the *Flood Planning Level*.
Habitable Room	In a residential situation: a living or working area, such as a lounge room, dining room, kitchen, bedroom or workroom. In an industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.
Local Drainage	Land on an overland flow path where the depth of inundation during the 1% AEP storm event is less than 0.1 m.
Main Stream Flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
Major Overland Flow	Where the depth of overland flow during the 1% AEP storm event is greater than 0.1 m.
Probable Maximum Flood (PMF)	The largest flood that could conceivably occur at a particular location. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain.

7 REFERENCES

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APPENDIX A

COMMUNITY CONSULTATION

TABLE OF CONTENTS

ATTACHMENTS

A1. INTRODUCTION

At the commencement of the *FRMS*, the Consultants prepared a *Community Newsletter* and a *Community Questionnaire*, both of which were distributed by Council to the residents and business owners in Yass (refer to **Attachment 1**). A media release was also prepared that introduced the project and encouraged the community to provide input to the study by responding to the Community Questionnaire. The media release was placed on Council's website and advertised in the local newspaper and radio station.

The purpose of the *Community Newsletter* was to introduce the objectives of the study and set the scene on flooding conditions so that the community would be better able to respond to the *Community Questionnaire* and contribute to the study process.

The *Newsletter* contained the following information:

- A plan showing the extent of the study area.
- A statement of the objectives of the FRMS&P; namely the development of a strategy for reducing the flood risk and minimising the long-term impact of flooding on the community.

The *Community Questionnaire* was structured with the objectives of:

- Determining residents' and business owners' attitudes to controls over future development in flood liable areas.
- Inviting community views on possible flood management options which could be considered for further investigation in the *FRMS* and possible inclusion in the resulting *FRMP*.
- Obtaining feedback on any other flood related issues and concerns which the residents and business owners cared to raise.

This **Appendix** to the *FRMS&P* report discusses the responses to the nine questions that were included in the *Community Questionnaire* and comments made by respondents.

Chapter A2 deals with the residents' and business owners' views on the relative importance of classes of development over which flood-related controls should be imposed by Council.

Chapter A3 identifies residents' and business owners' views on the suitability of the various options which could be considered in more detail in the *FRMS*.

Chapter A4 discusses the best methods by which the community could provide feedback to the consultants over the course of the study.

Chapter A5 summarises the findings of the community consultation process.

A2 RESIDENT PROFILE AND FLOOD AWARENESS

A2.1 General

Residents were requested to complete the *Community Questionnaire* and return it to the Consultants by 31 August 2018. The deadline was extended to include any submissions that were received after this date. The Consultants received 92 responses in total out of the 2950 that had been distributed.

The Consultants have collated the responses, which are shown in graphical format in **Attachment 2**.

A2.2 Respondent Profile

The first four questions of the *Community Questionnaire* canvassed resident information such as whether the respondent was a resident or business owner, length of time at the property, the type of property (e.g. house, unit/flat).

Of the 92 responses, 87 were residents and one was the principal of Yass Public School. A further six respondents were business owners, while one was a property developer (**Question 2**).

The majority of respondents occupied residential type property (**Question 3**), which included houses (77 respondents), units/flats/apartments (4), villas/townhouses (3) and semi-rural farms (2). Two responses received were concerned with property which is vacant land. Seven respondents owned non-residential type property, which included shops/commercial premises (2 respondents), industrial units (2), community buildings (2) and one warehouse or factory. Note that some responses were included in more than one property classification type.

The length of time respondents had been at the address was found to be varied, with approximately 24% of respondents having lived at the residence for between '1-5 years', 41% for '5 to 20 years', and 27% for 'more than 20 years' (**Question 4**). Note that 8% of respondents did not answer this question.

A2.3 Controls over Development in Flood Prone Areas

The respondents were asked to rank from 1 to 4 the classes of development which they consider should receive protection from flooding (**Question 5**). Rank 1 was the most important and rank 4 the least.

The classes in decreasing order of importance to respondents ranged from:

- vulnerable residential (e.g. aged persons accommodation);
- residential property;
- essential community facilities (e.g. schools, evacuation centres); and
- commercial/business type development.

These results gave a guide to the Consultants as to the appropriate location of future development of the various classes within the floodplain. For example, on the basis of community views, vulnerable residential type development would receive the highest level of protection by locating future development of this nature outside the floodplain.

In **Question 6**, respondents were asked what notifications Council should give about the flood affectation of individual properties. The community was strongly in favour of advising existing residents (47) and prospective purchasers (51) of the known potential flood threat, while 12 respondents favoured only advising those who enquire to Council about the known potential flood risk. No respondents favoured not providing any notification.

Respondents were also asked in **Question 7** about the level of control Council should place on new development to minimise flood-related risks. The most popular responses were to place restrictions on developments to reduce the potential for flood damage (e.g. minimum floor level controls or the use of compatible building materials) and prohibit all development on land with any potential to flood. The next most favoured response was to advise of the flood risks, but allow the individual the choice as to whether they develop or not provided they take steps to minimise the potential flood risks. Fourteen respondents felt that Council should prohibit all new development only in those locations that would be extremely hazardous to persons or property during floods.

A3 POTENTIAL FLOOD MANAGEMENT MEASURES

The respondents were asked for their opinion on potential flood management measures which could be evaluated in the *FRMS* (and if found to be feasible included in the *FRMP*), by ticking a "yes" or "no" to the eleven potential options identified in **Question 8**.

The options comprised a range of *structural flood management measures* (e.g. programs by Council to manage vegetation in the creek system to maintain hydraulic capacity; widening of watercourses; construction of detention basins; improving the stormwater system; levees to contain floodwaters, as well as various *non-structural management measures* (e.g. voluntary purchase of residential properties in high hazard areas; raising floor levels of houses in low hazard areas; flood related controls over new developments; improvements to flood warning and evacuation procedures; community education on flooding; flood advice certificates). The options were not mutually exclusive, as the adopted *FRMP* could, in theory, include all of the options set out in the *Community Questionnaire*, or indeed, other measures nominated by the respondents or the FRMC.

The most popular structural measures were the management of vegetation along the creek corridor and improving the stormwater system in the town. The construction of detentions basins was another popular structural measure.

Of the non-structural measures, improvement of flood warning and evacuation procedures, provision of a Planning Certificate to purchasers in flood prone areas, specifying controls on future development in flood-prone areas and community flood-awareness programs all received strong support.

A mostly negative response was given to the widening of watercourses and the construction of permanent levees. Providing subsidies for raising the floor level of properties and the implementation of a residential Voluntary Purchase scheme were also unpopular.

A4 INPUT TO THE STUDY AND FEEDBACK FROM THE COMMUNITY

In **Question 9,** residents were asked for their view on the best methods of their providing input to the Study and feedback to the Consultants over the course of the investigation. Newsletters and mail-outs were the most popular methods, followed by articles in the local media (newspaper, radio and TV) and via Council's website. Other suggestions raised by respondents include:

- Community meetings.
- Provide information on the legal rights and responsibilities of councils and land owners regarding stormwater management.
- Support an independent review process of the *Flood Study* that affected property owners can access.
- Engage with affected property owners directly to co-operatively formulate outcomes for the study.

A5 SUMMARY

Ninety-two responses were received to the *Community Questionnaire* which was distributed by Council to residents and business owners in Yass. The responses amounted to about 3 per cent of the total number of questionnaires that were distributed to the community.

The issues identified by the responses to the *Community Questionnaire* support the objectives of the study as nominated in the attached *Community Newsletter*, and the activities nominated in the Study Brief. Of interest is that about one-third (28) of the respondents to the questionnaire were in favour of prohibiting all new development on land with any potential to flood. This was matched by an almost equal number of respondents (27) who were in favour of Council advising of the flood risks, but allowing the individual a choice to develop so long as potential flood risks are minimised.

Of the *structural measures* which could be incorporated in the *FRMP*, the most popular were management of vegetation along creek corridors, improving the capacity of the stormwater system and the construction of detention basins. The construction of permanent levees along the banks of the Yass River and the widening of the watercourse received a mostly negative response.

Improvements of flood warning and evacuation procedures, provision of a Planning Certificate to purchasers in flood prone areas, specifying controls on future development in flood-prone areas and community flood-awareness programs were the most popular of the potential *non-structural measures* set out in the *Community Questionnaire*.

There were no new measures identified by the respondents to the questionnaire.

ATTACHMENT A1

COMMUNITY NEWSLETTER AND QUESTIONNAIRE

YASS FLOODPLAIN RISK MANAGEMENT STUDY & PLAN

Community Newsletter

Yass Valley Council has engaged consultants to undertake a Floodplain Risk Management Study and Plan for the township of Yass. The Floodplain Risk Management Study will assess options which are aimed at reducing the impacts of flooding on existing development and the establishment of a framework to manage flood liable land in accordance with current best floodplain management principles. The Plan will set out a recommended program of works and measures which will over time reduce the social, environmental and economic impacts of flooding at Yass.

The preparation of the Study and Plan is being jointly funded by Council and the NSW Office of Environment & Heritage. Council has established a Floodplain Risk Management Committee which is comprised of relevant council members, state government agencies and community representatives.

The Study and Plan will build on the results of the *Yass Flood Study* (completed in 2016) which defined flooding patterns and flood levels in Yass under present day conditions (an electronic copy of the *Yass Flood Study* can be accessed at https://www.yassvalley.nsw.gov.au).

The figure on the back of this questionnaire shows the indicative extent of the 1 in 100 annual exceedance probability (AEP) flood along the Yass River, Chinaman's Creek, Bango's Creek and Fairy Hole Creek, as well as the extent of flood prone land at Yass (as defined by the extent of the Probable Maximum Flood). The 1 in 100 AEP flood is a flood which has a 1% chance of occurrence in any one year, while the Probable Maximum Flood is the largest flood that could conceivably occur at Yass.

Have Your Say on Floodplain Management

An important first step in the preparation of a Floodplain Risk Management Study and Plan is to determine the flood issues which are important to the community. The attached **questionnaire** has been provided to residents and business owners to assist the consultants in gathering this important information. The questionnaire may also be completed online via Council's website (https://www.surveymonkey.com/r/YassFRMSP). All information provided will remain confidential and for use in this study only. Please return the completed questionnaire in the reply paid envelope provided by **Friday 31 August 2018**.

Contact: Yass Valley Council

Joseph Cleary | Design Engineer
Phone: (02) 6226 1477
Email: Council@yass.nsw.gov.au

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YASS
FLOODPLAIN RISK MANAGEMENT STUDY & PLAN

Community Questionnaire

This questionnaire is part of the *Yass Floodplain Risk Management Study and Plan*, which is currently being prepared by Yass Valley Council with the financial and technical support of the NSW Office of Environment & Heritage. Your responses to the questionnaire will help us determine the flood issues that are important to you.

Please return your completed questionnaire in the reply paid envelope provided by **Friday 31 August 2018**. No postage stamp is required. If you have misplaced the supplied envelope or wish to send an additional submission the address is:

Lyall & Associates Consulting Water Engineers
Reply Paid 85163
NORTH SYDNEY NSW 2060

Alternatively, the questionnaire can be completed online via the following link:

https://www.surveymonkey.com/r/YassFRMSP

1. Your Details:

Name (optional):______________________________

Address:______________________________

Email Address (optional):______________________________

Phone Number (optional):______________________________

About your property

2. Please tick as appropriate:

- ☐ I am a resident
- ☐ I am a business owner
- ☐ Other (please specify ______________)

3. What is your property?

- ☐ House
- ☐ Villa/Townhouse
- ☐ Unit/Flat/Apartment
- ☐ Vacant land
- ☐ Industrial unit in larger complex
- ☐ Stand alone warehouse or factory
- ☐ Shop
- ☐ Community building
- ☐ Other (______________________)

4. How long have you been at this address?

- ☐ 1 year to 5 years
- ☐ 5 years to 20 years
- ☐ More than 20 years (___ years)

Your attitudes to Council's development controls

5. Please rank the following development types according to which you think are the most important to protect from floods

(1=highest priority to 4=least priority)

Development Type	Rank
Commercial/Business	
Residential	
Vulnerable residential development (e.g. aged persons accommodation)	
Essential community facilities (e.g. schools, evacuation centres)	

6. What notifications do you consider Council should give about the potential flood affectation of individual properties?
(Tick one or more boxes)

- ☐ Advise every resident and property owner on a regular basis of the known potential flood threat
- ☐ Advise only those who enquire to Council about the known potential flood threat
- ☐ Advise prospective purchasers of property of the known potential flood threat.
- ☐ Provide no notifications
- ☐ Other (please specify)

____

____

7. What level of control do you consider Council should place on new development to minimise flood-related risks?

(Tick only one box)

(In addition to being favoured by the community, these options would also need to comply with legislation)

- ☐ Prohibit all new development on land with any potential to flood.
- ☐ Prohibit all new development only in those locations that would be extremely hazardous to persons or property due to the depth and/or velocity of floodwaters, or evacuation difficulties.
- ☐ Place restrictions on future developments to reduce the potential for flood damage (e.g. impose minimum floor level controls or the use of flood compatible building materials).
- ☐ Advise of the flood risks, but allow the individual a choice as to whether they develop or not, provided steps are taken to minimise potential flood risks.
- ☐ Provide no advice regarding the potential flood risks or measures that could minimise those risks.
- ☐ Other (please specify)

____

____

Your opinions on floodplain risk management measures

8. Below is a list of possible options that may be looked at to try to minimise the effects of flooding in the study area (see plan attached).

This list is not in any order of importance and there may be other options that you think should be considered. For each of the options listed, please indicate "yes" or "no" to indicate if you favour the option. Please leave blank if undecided.

Option	Yes	No
Management of vegetation along creek corridors to provide flood mitigation, stability, aesthetic and habitat benefits.		
Widening of watercourses.		
Construction of detention basins to temporarily store stormwater runoff and reduce the impacts of flooding on existing development.		
Improve the stormwater system within the town area.		
Construct permanent levees along the rivers and creeks to contain floodwaters.		
Voluntary scheme to purchase residential property in high hazard areas.		
Provide funding or subsidies to raise houses above major flood level in low hazard areas.		
Specify controls on future development in flood-liable areas (eg. controls on extent of filling, minimum floor levels.)		
Improve flood warning and evacuation procedures both before and during a flood.		
Community education, participation and flood awareness programs.		
Provide a Planning Certificate to purchasers in flood prone areas, stating that the property is flood affected.		
Other: ________________ ________________		

Other Information

9. What do you think is the best way for Council to get input and feedback from the local community about the results and proposals from this study?

(Tick one or more boxes)

- ☐ Council's website / social media pages
- ☐ Articles in local newspaper
- ☐ Announcements on local radio
- ☐ Through Council's Floodplain Risk Management Committee
- ☐ Mail outs / newsletters
- ☐ Other (please specify)

(________________________________
________________________________)

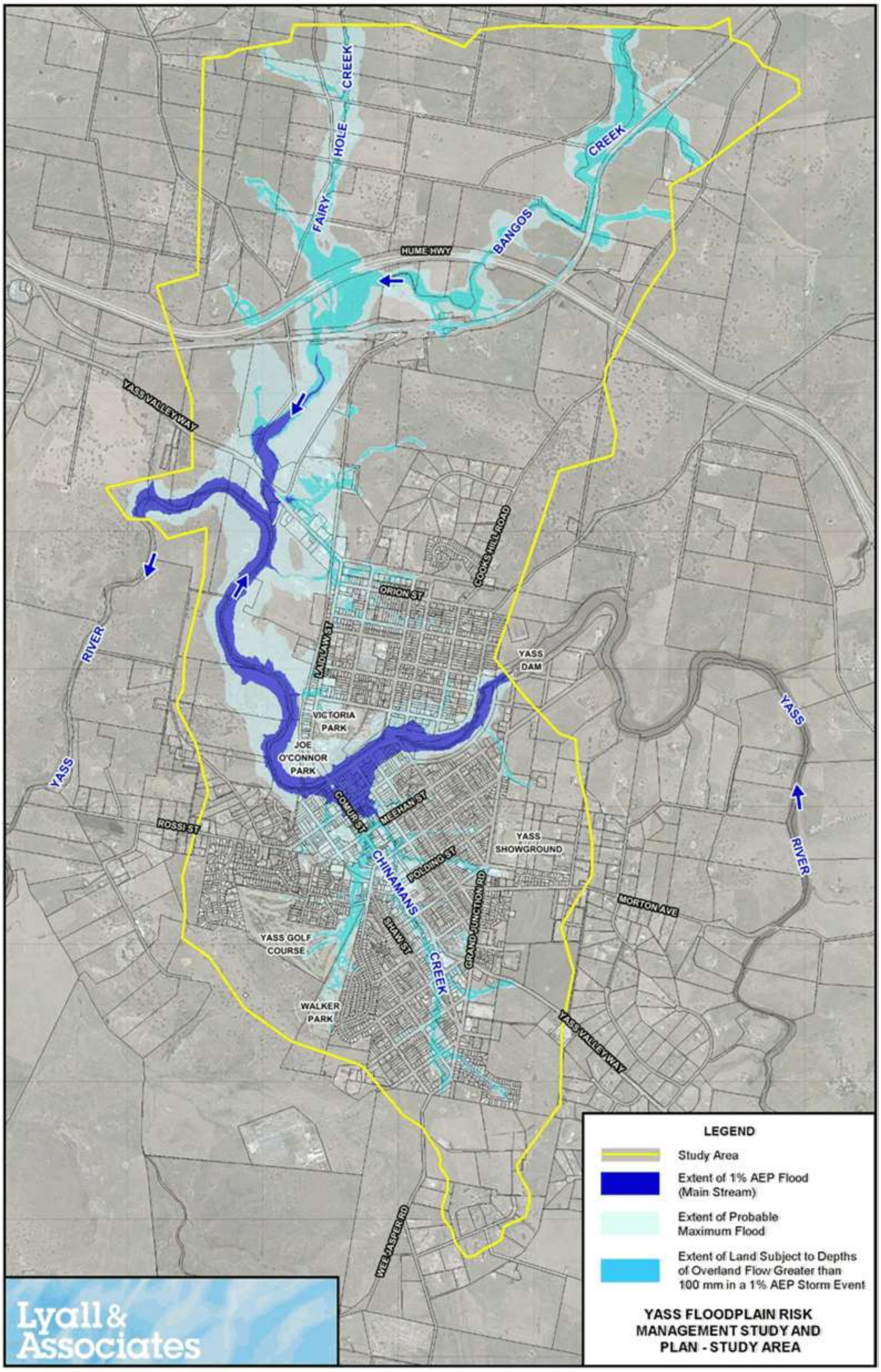
Who can I contact for further information?

Yass Valley Council
Joseph Cleary | Design Engineer
Phone: (02) 6226 1477
Email: Council@yass.nsw.gov.au

yass valley council
the country the people

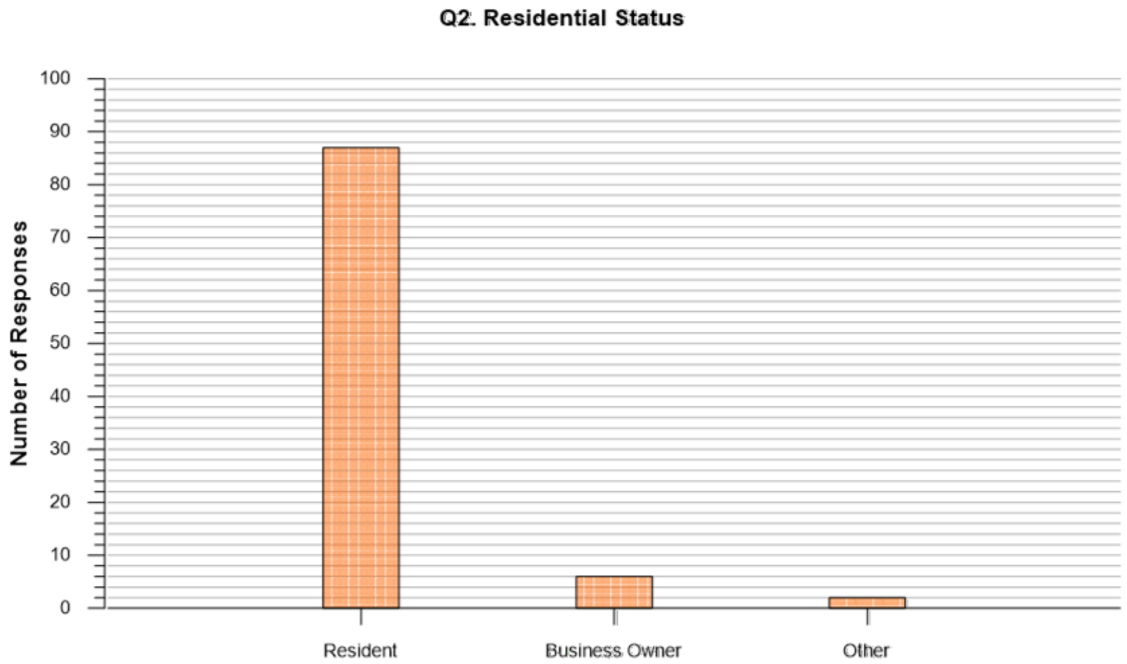
Additional Comments

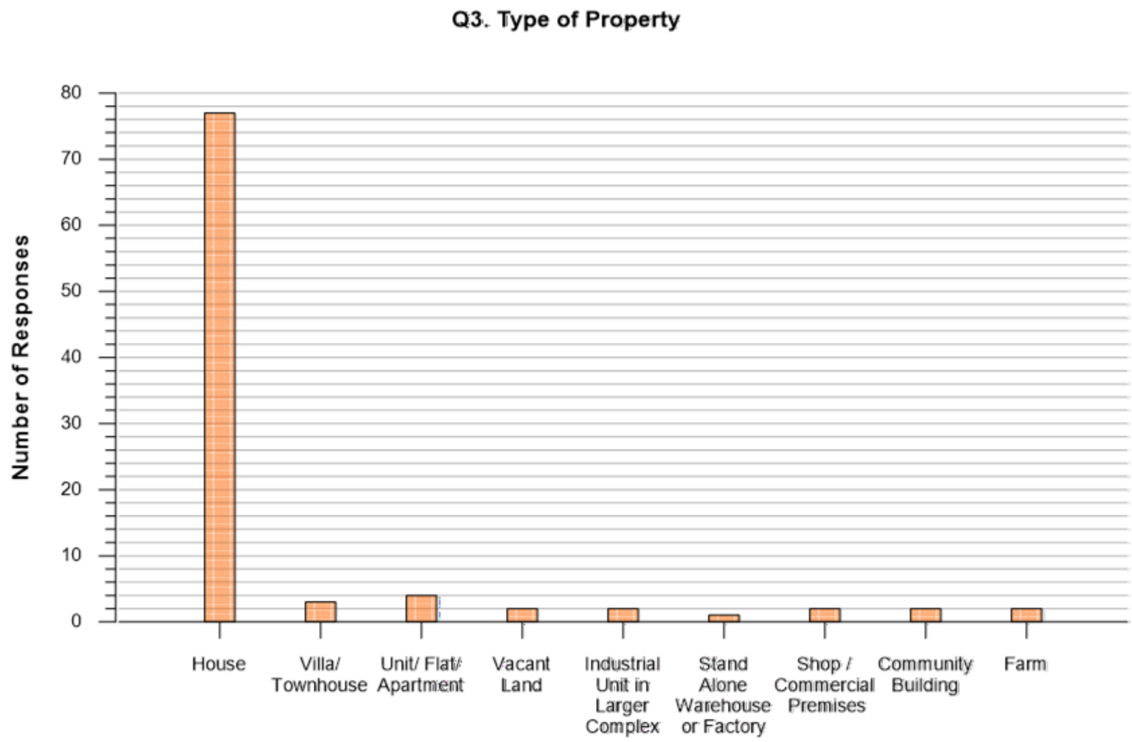
Please write any additional comments here:


FAIRY HOLE CREEK
BANGOS CREEK
HUME HWY
YASS VALLEY WAY
YASS RIVER
ORION ST
COOKS HILL ROAD
LAIDLAW ST
YASS DAM
YASS RIVER
VICTORIA PARK
JOE O'CONNOR PARK
COMUR ST
MEEHAN ST
ROSSI ST
CHINAMANS CREEK
FOLDING ST
YASS SHOWGROUND
GRAND JUNCTION RD
MORTON AVE
SHAW ST
YASS GOLF COURSE
WALKER PARK
YASS VALLEY WAY
WEE JASPER RD
LEGEND
Study Area
Extent of 1% AEP Flood (Main Stream)
Extent of Probable Maximum Flood
Extent of Land Subject to Depths of Overland Flow Greater than 100 mm in a 1% AEP Storm Event
YASS FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN - STUDY AREA
Lyall & Associates

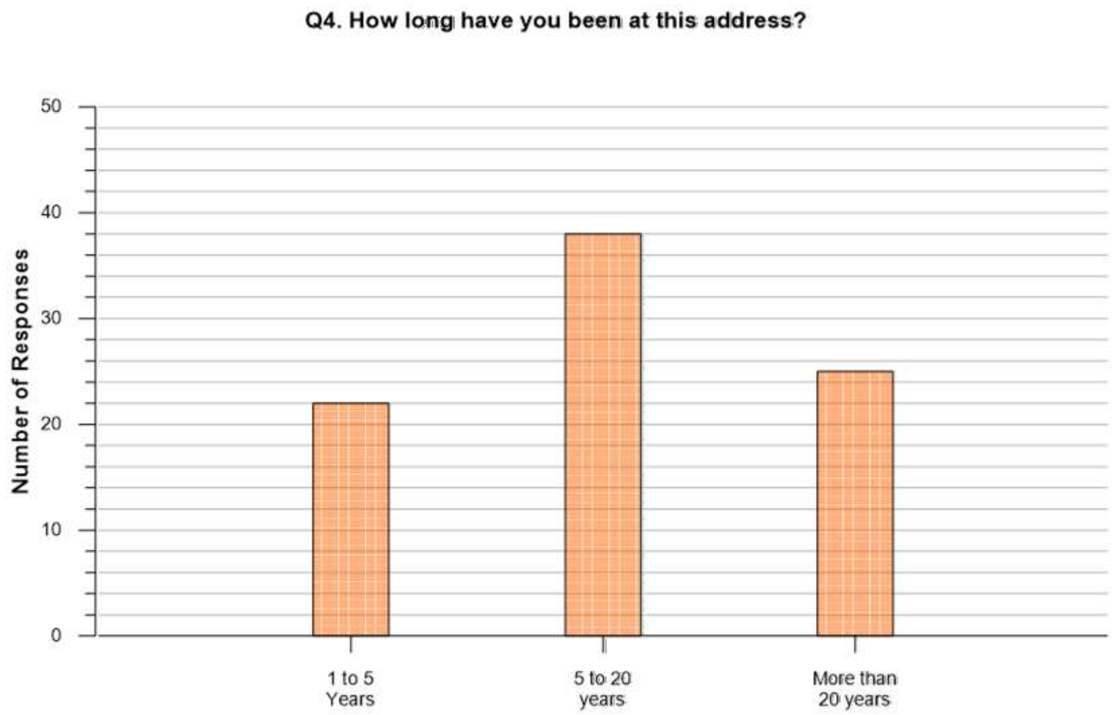
ATTACHMENT A2

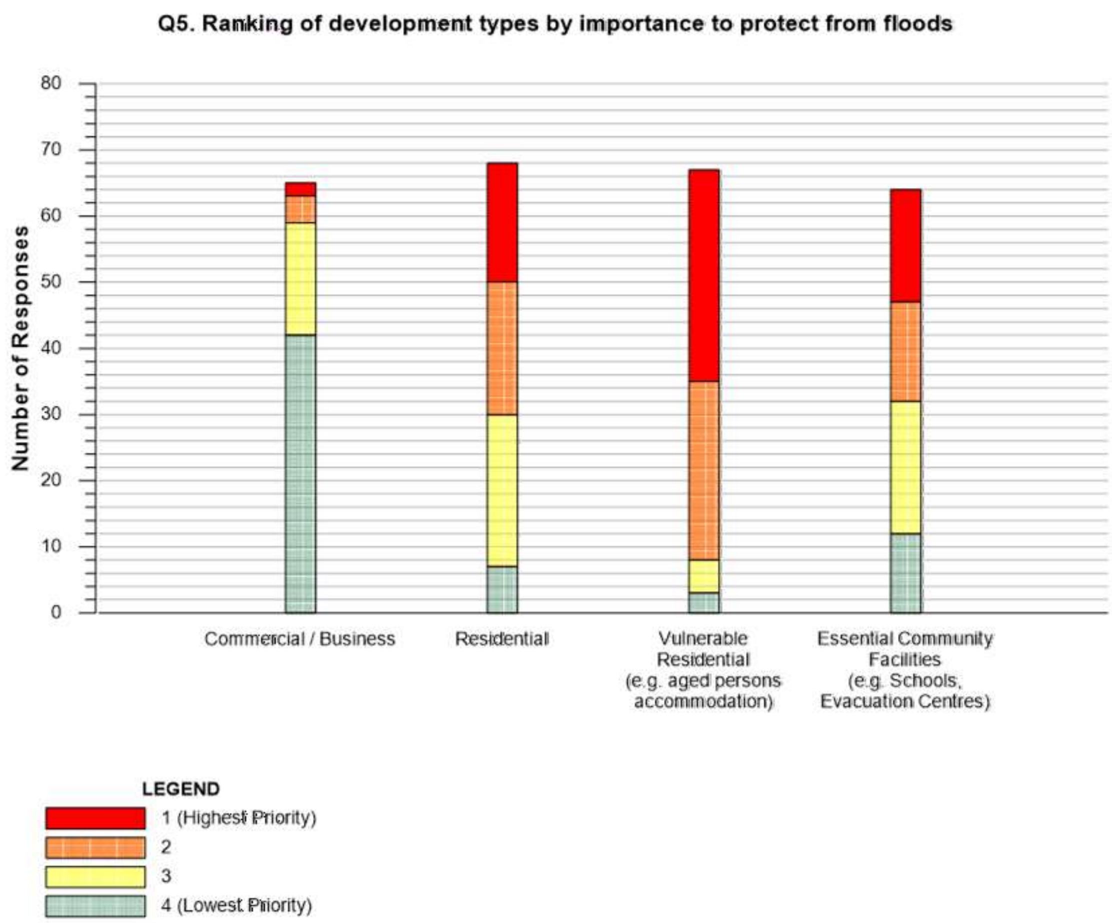
RESPONSES TO COMMUNITY QUESTIONNAIRE





RESPONSE TO COMMUNITY QUESTIONNAIRE





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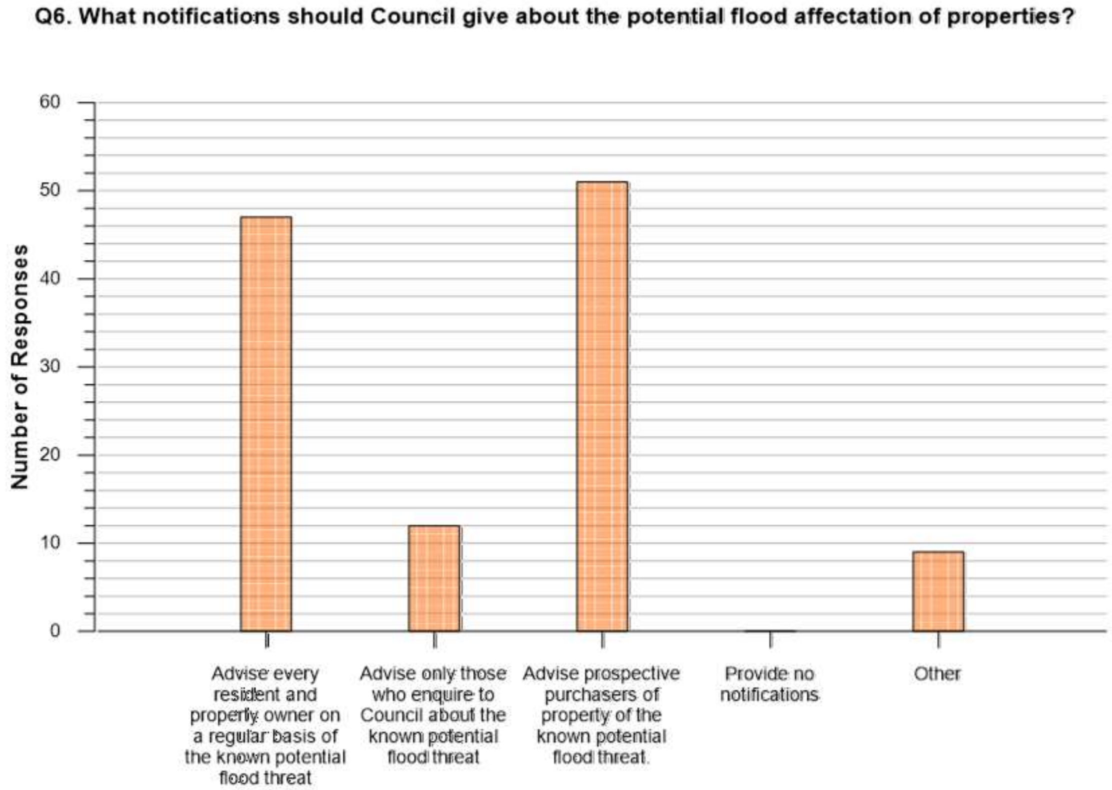
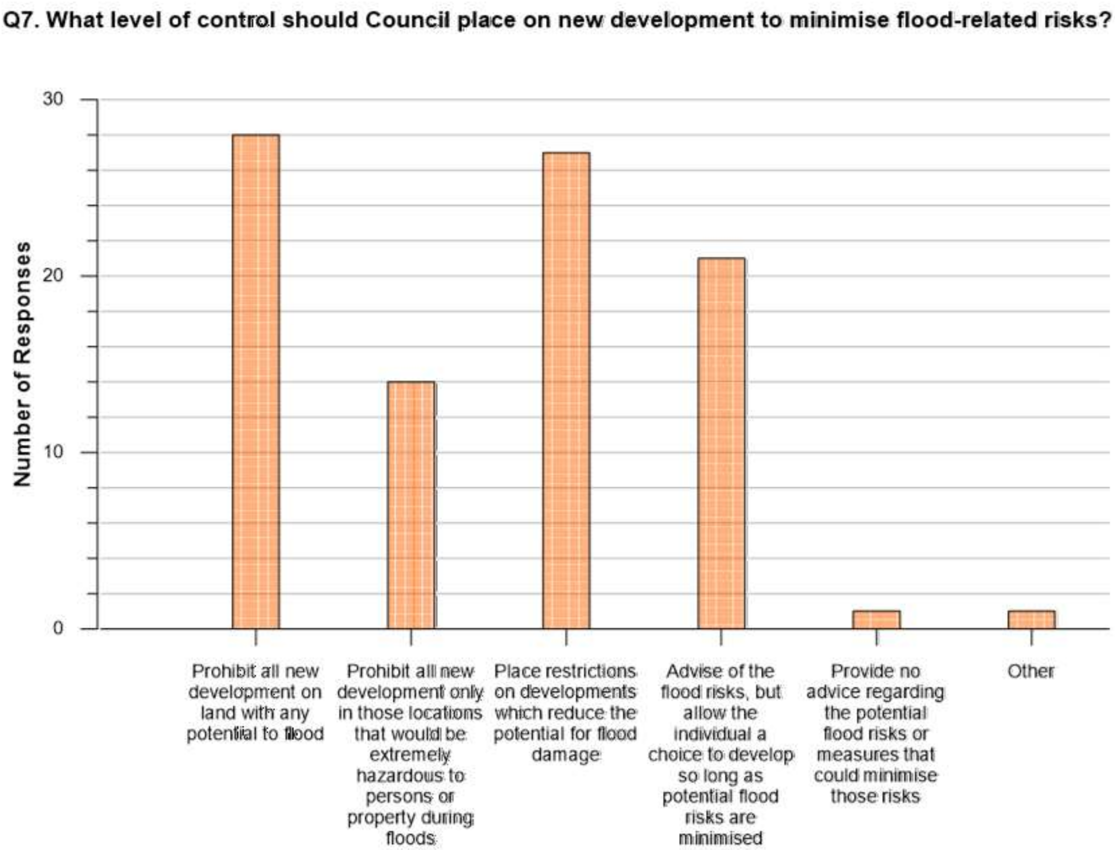
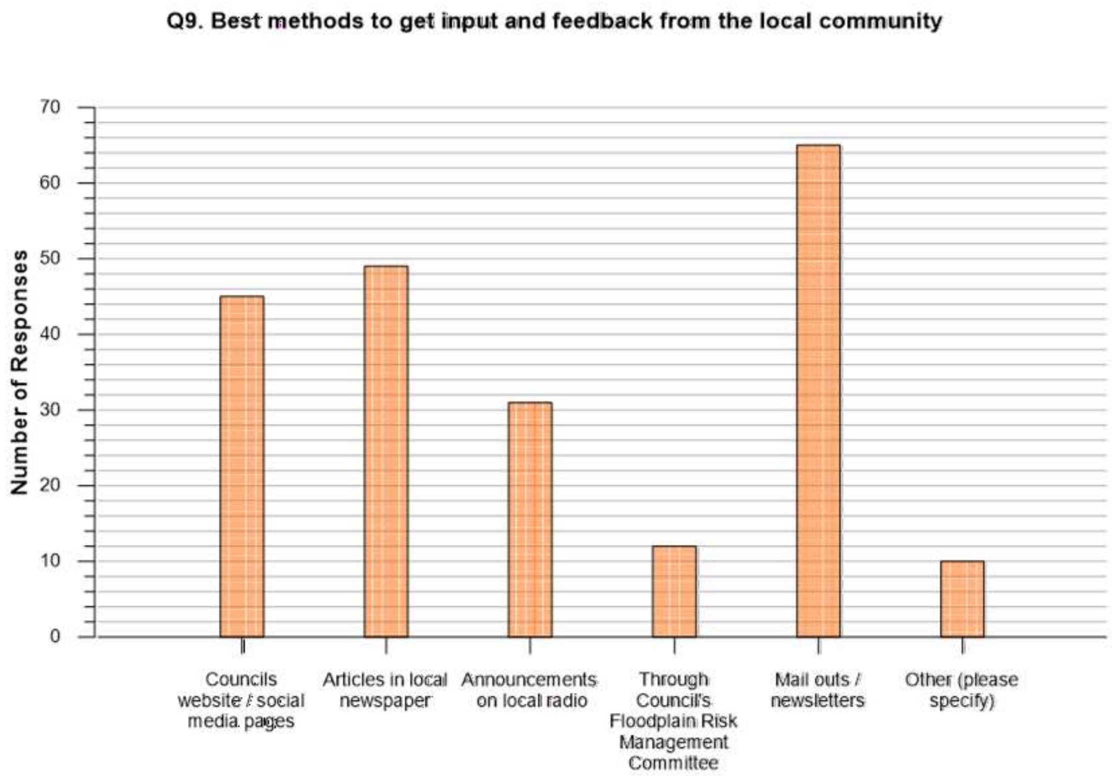




RESPONSE TO COMMUNITY QUESTIONNAIRE

RESPONSE TO COMMUNITY QUESTIONNAIRE


Q9. Best methods to get input and feedback from the local community
Number of Responses
0
10
20
30
40
50
60
70
Councils website / social media pages
Articles in local newspaper
Announcements on local radio
Through Council's Floodplain Risk Management Committee
Mail outs / newsletters
Other (please specify)

APPENDIX B

PHOTOGRAPHS SHOWING HISTORIC FLOODING AT YASS

YASS – July 1900

(Source: Yass Tribune, https://www.yasstribune.com.au/story/5879732/a-flood-of-rainy-memories/ , 2019)

Plate B1.1 – *"The major flood in 1900 saw people having to be rescued from their homes at night. Photo: Yass & District Historical Society Collection."*

YASS – May 1925

(Source: Yass Tribune, https://www.yasstribune.com.au/story/5879732/a-flood-of-rainy-memories/ , 2019)

Plate B2.1 – *"The flood of 1925, with people sheltering on the Courthouse steps. Photo: Yass & District Historical Society Collection."*

Plate B2.2 – *"The main thoroughfare underwater in 1925. Photo: Yass & District Historical Society Collection."*

Plate B2.3 – *"The view from the Courthouse in 1925. Photo: Yass & District Historical Society Collection."*

YASS – October 1959

(Source: Yass Tribune, https://www.yasstribune.com.au/story/5879732/a-flood-of-rainy-memories/ , 2019)

Plate B4.1 – *"Travelling by boat on the corner of Rossi and Comur Street, 1959. Photo: Yass & District Historical Society Collection."*

Plate B4.1 – *"Only the top of this cobblestone cottage was visible during the flood of 1959. Photo: Yass & District Historical Society Collection."*

YASS – October 1959

(Source: Yass Tribune, https://www.yasstribune.com.au/story/2800345/have-a-say-on-flood-studies/, 2015)

Plate B5.1 – *"The 1959 flood devastated Yass' main street. Locals now have the chance to help with studies on this and other floods that have occurred in the region."*

YASS – 9 August 2020

(Source: NSW SES – Yass Unit, 2020)

Plate B6.1 – Walmsley Crossing 9:15am

Plate B6.2 – In vicinity of 680 Yass River Road

Plate B6.3 – Buckmaster's Bridge 10:28am

Plate BC6.4 – Manton's Creek

Plate B6.5 – *"3:11pm road under bridge at riverbank park started flooding"*

Plate B6.6 – Buckmaster's Bridge 4:00pm

APPENDIX C

FLOOD STUDY UPDATE

TABLE OF CONTENTS

ATTACHMENTS

FIGURES
(BOUND IN VOLUME 2)

C1. HYDROLOGIC MODEL DEVELOPMENT AND CALIBRATION

C1.1. Updates to Yass River Hydrologic Model

A hydrologic model of the Yass River (**Yass River Hydrologic Model**) was developed as part of Lyall & Associates, 2019, the sub-catchment layout of which is shown on **Figure C1.1**. The RAFTS sub-model within the DRAINS software was used to convert rainfall to runoff and to route the discharge hydrographs to the location of the Yass stream gauge.

The outlets of each sub-catchment were linked, with the lag time derived by dividing the stream length by an assumed flow velocity of 3.5 m/s.[1] The following PERN values were adopted for the two principal land uses in the catchment:[2]

- wooded slopes = 0.08
- cleared pastoral land = 0.045

Design rainfall data, temporal patterns, aerial reduction factors and Probability Neutral Burst Initial Loss (**PNBIL**) values were input to the Yass River Hydrologic Model based on the procedures set out in ARR 2019. A copy of the data extracted from the ARR Data Hub for Yass is contained in **Attachment C1**.[3]

Continuing loss rates and the storage coefficient (**Bx**) were adjusted until a good match was achieved with the design peak flow estimates that were derived by way of the flood frequency analysis undertaken as part of WMAwater, 2016a for the Yass stream gauge. **Table C1.1** over shows that applying the continuing loss values shown in **Column B** along with a constant Bx of 0.8 to the Yass River Hydrologic Model provided a good fit with the design peak flow estimates derived as part of WMAwater, 2016a (refer **Column D**).

The recalibrated Yass River Hydrologic Model was used to derive the peak flow in the Yass River for the PMF as part of the present study (refer **Section B3.1.3** for details), while the peak flow in the Yass River for design flood events ranging between 50 and 0.5% AEP were taken from WMAwater, 2016a.

C1.2. Updates to Yass Town Hydrologic Model

The hydrologic (DRAINS) model that was developed as part of WMAwater, 2016a was updated using the ensemble approach to design flood estimation that is set out in ARR 2019. The following adjustments were also made to its structure:

---

[1] Preliminary runs of the TUFLOW model that was developed as part of the present study showed that flow velocities ranged between 2.5-4.5 m/s in the reach of the Yass River between the Yass Dam and the Railway Weir.

[2] A PERN value of 0.06 was applied to those sub-catchments which comprised a mixture of both wooded and cleared pastoral land

[3] The Yass River Hydrologic Model was originally developed using the procedures set out in the 2016 draft edition of Australian Rainfall and Runoff when the advice was to apply pre-burst rainfall loss values for design flood estimation. The model was subsequently updated as part of the present study using the NSW specific guidance on application of losses for design flood estimation.

- rural catchments in the Bango Creek catchment and in the headwaters of the Chinamans Creek catchment were modelled using the RAFTS sub-model in the DRAINS software;[4]
- additional sub-catchments were added to the model to more accurately define patterns of major overland flow in a number of areas; and
- the outlets of the sub-catchments in the upper reaches of the study catchments were linked and the lag times between each assumed to be equal to the distance along the main drainage path divided by an assumed flow velocity of 2 m/s.

Figure C1.2 (2 sheets) shows the layout of the sub-catchments which comprise the updated hydrologic model (**Yass Town Hydrologic Model**).

TABLE C1.1
COMPARISON OF PEAK FLOW ESTIMATES
YASS STREAM GAUGE

AEP (%) [A]	Adopted Continuing Loss (mm/hr) [B]	Peak Flow (m^3/s) WMAwater, 2016a [C]	Peak Flow (m^3/s) Yass River Hydrologic Model [D]
1	2.8	1,570	1,570
2	2.2	1,160	1,174
5	2.8	730	739
10	3.1	490	499
20	3.4	310	317
50	3.4	110	117

[4] The urbanised catchments within the study area were modelled using the ILSAX sub-model in the DRAINS software which is consistent with the adopted approach in the hydrologic model that was developed as part of WMAwater, 2016a.

C2. HYDRAULIC MODEL DEVELOPMENT AND CALIBRATION

C2.1. Updates to Yass TUFLOW Model

The TUFLOW hydraulic model that was developed as part of WMAwater, 2016a was reviewed and updated in order to refine several aspects of its structure and to improve the accuracy of the flood mapping. The following adjustments were made to its structure as part of the present study:

- The grid spacing was reduced from 5 m to 2 m to more accurately define the key features which influence patterns of major overland flow (e.g. crown in the road, kerb and gutter etc.).
- The model boundary was extended upstream to incorporate details of recent residential subdivisions.
- Revised inflow boundaries which reflected the revised sub-catchment layout that was incorporated in the Yass Town Hydrologic Model (refer **Section B1.2** for details).
- Detailed ground survey data in the vicinity of the intersection of Browne Street and Demestre Street that were captured as part of the present study (refer **Figure C2.1**, sheet 2 for extent of survey).
- Details of 41 culvert and bridge structures that were surveyed as part of the present study (refer **Figure C2.1**, sheets 3 and 4 for location).
- Up-to-date details of the existing stormwater drainage system, whereby pipe invert levels were reviewed and updated to ensure the drainage system was positively graded.
- The downstream boundary of the model was extend about 1 km further downstream on the Yass River.
- Material layers representing the various surface types along the major overland flow paths were revised based on detailed aerial photography. Hydraulic roughness parameters were also updated.

Figure C2.1 (4 sheets) shows the layout of the updated TUFLOW model (**Yass TUFLOW Model**). The Yass TUFLOW Model was run for the full range of events that were assessed as part of WMAwater, 2016a. While the Yass TUFLOW Model provides improved definition of major overland flow at Yass, as shown in **Table C2.1** it generates peak flood levels on the Yass River that are very similar to those derived as part of WMAwater, 2016a.

TABLE C2.1
COMPARISON OF MODELLED PEAK GAUGE HEIGHT AT YASS RIVER STREAM GAUGE

AEP (%) [A]	Gauge Height[1] (m)		Difference[2] (m) [D]
	WMAwater, 2016a [B]	Yass TUFLOW Model [C]	
1	11.30	11.32	0.02
2	9.98	10.08	0.10
5	8.74	8.84	0.10
10	7.09	7.18	0.09
20	5.86	5.94	0.08
50	4.62	4.67	0.05

1. Gauge zero = RL 475.52 m AHD.
2. A positive difference indicates the Yass TUFLOW Model generates peak flood levels that are higher than those presented in WMAwater, 2016a.

C3. DERIVATION OF DESIGN DISCHARGE HYDROGRAPHS

C3.1. Yass River Hydrology

C3.1.1. Previous Studies

Yass Dam 3.0 m Raising Concept Design Report (NSW Department of Commerce (DoC), 2010)

A calibrated RORB model that was originally developed as part of the *Yass Dam Flood Study* undertaken NSW Public Works in 1994 was used to derived design peak flow estimates at Yass dam. DoC, 2010 found that there was a significant variation in storage routing (Kc) parameters required to calibrate the RORB model.

Column B in **Table C3.1** sets out the design peak flow estimates that were generated by the RORB model using the procedures set out in ARR 1987. A peak flow estimate of 15,500 m^3/s was derived for the PMF based on application of both the Generalised Southeast Australia Method (**GSAM**) and Generalised Short Duration Method (**GSDM**), the procedures for which are set out in BoM, 2006 and BoM, 2003, respectively. The peak flow estimate was derived based on the lowest storage routing (Kc) parameter that formed part of the RORB model calibration process, hence providing a conservative estimate of the PMF at Yass.

TABLE C3.1
COMPARISON OF DESIGN PEAK FLOW ESTIMATES
YASS STREAM GAUGE

AEP (%)	DoC, 2010	WRM, 2015		WMAwater, 2016a	Present Study	
	RORB Model	Flood Frequency Analysis	XP-RAFTS Model	Flood Frequency Analysis	Flood Frequency Analysis	Yass River Hydrologic Model
[A]	[B]	[C]	[D]	[E]	[F]	[G]
20	130	Not Documented	Not Assessed	310	280	317
10	240			490	480	499
5	610			730	725	739
2	1,010			1,160	1,160	1,174
1	1,350	955	1,018	1,570	1,560	1,570
0.5	Not Assessed	Not Documented	Not Assessed	2,060	2,080	1,767
0.2			1,900	Not Assessed	2,950	2,243
PMF	15,500		8,459$^{(1)}$ 13,217$^{(2)}$	15,500$^{(3)}$	-	12,100

1. Based on adopted flow velocity of 1.5 m/s.
2. Based on adopted flow velocity of 3.5 m/s.
3. Based on peak PMF flow derived as part of DoC, 2010.

Extreme Flood Discharge Estimate for Yass Dam (WRM Water + Environment, 2015)

A flood frequency analysis was undertaken as part of WRM, 2015 for the Yass stream gauge using 95 years of annual peak flows. **Table C3.1** shows that WRM, 2015 found that the peak flow for the 1% AEP flood event at Yass was 995 m^3/s (Column C), which is about 25% lower than the corresponding peak flow derived as part of DoC, 2010.

A hydrologic (XP-RAFTS) model of the Yass River was developed as part WRM, 2015. The XP-RAFTS model was calibrated to flood events that occurred in August 1974, December 2010 and March 2012. An assumed flow velocity of 1.5 m/s was needed to achieve a good match between the modelled and recorded discharge hydrographs at the Yass stream gauge for the December 2010 and March 2012 flood events (equivalent to a 14 and 25% AEP flood event, respectively), while a flow velocity of 3.5 m/s was required to achieve a good match for the August 1974 flood event which was equivalent to a 4% AEP flood event. Based on the above, a flow velocity of 1.5 m/s was adopted for design flood estimation purposed as part of WRM, 2015.

Design rainfall data were input to the XP-RAFTS model using the procedures set out in ARR 1987, while the Probable Maximum Precipitation (**PMP**) data were input to the XP-RAFTS model for the GSAM (BoM, 2006). **Table C3.1** shows that the peak 1% AEP flow estimate generated by the XP-RAFTS model (Column D) is similar to results of the flood frequency analysis (Column C) and that the peak PMF flow at the Yass stream gauge was 8,459 m^3/s, which is 45% lower than the flow rate that was derived as part of DoC, 2010.

A sensitivity analyses was undertaken as part of WRM, 2015 whereby the XP-RAFTS model was run assuming a flow velocity of 3.5 m/s, which was required to calibrate the model to the 1974 flood event. The peak PMF flow at Yass using the higher flow velocity was 13,217 m^3/s.

Yass Flood Study (WMAwater, 2016a)

A review of the WaterNSW derived rating curve for the Yass stream gauge undertaken as part of WMAwater, 2016a found that the rating curves that were used to derive peak flow estimates prior to 1969 underestimated the flow for gauge heights higher than RL 5.0 m. Based on this finding, the peak flow estimates for the eleven historic floods that reached a gauge height higher than RL 5.0 m between 1915 (i.e. when the gauge was first established) and 1969 were revised using the most recent WaterNSW derived rating curve.

WMAwater, 2016a also found that there were five flood events that occurred between 1835 and 1915 which exceeded RL 6.0 m on the Yass stream gauge, including the 1900 flood which is considered to be the flood of record at Yass.

A log-Pearson Type 3 (**LP3**) distribution was fitted to the annual series of flood peaks for the period between 1915 and 2014 as part of WMAwater, 2016a. The period of record was extended to incorporate the flood of record in 1900. Column E of **Table C3.1** shows that the design peak flow estimates that were derived as part of WMAwater, 2016a, noting that the peak PMF flow of 15,500 m^3/s that was originally derived as part of DoC, 2010 was adopted.

The design discharge hydrographs that were used as input to the hydraulic model that was developed as part of WMAwater, 2016a at the location of the Yass Dam were derived by factoring the ordinates of the discharge hydrograph that was recorded by the Yass stream gauge for the March 1989 flood event so that their peaks matched the design peak flow rates that were derived as part of the flood frequency analysis.

C3.1.2. Review of Flood Frequency Analysis

A flood frequency analysis was undertaken as part of the present study using the annual series of flood peaks for the period between 1915 and 2019, as well as the flood of record in 1900. Column F of **Table C3.1** shows that incorporating the five additional years of data between 2015 and 2019 does not significantly alter the design peak flow estimates that were derived as part of WMAwater, 2016a.

Based on the above, the design discharge hydrographs for 20 to 0.5% AEP flood events that were originally derived as part of WMAwater, 2016a were utilised for the present investigation. The design discharge hydrograph for a flood event with an AEP of 0.2 per cent was derived as part of the present study by factoring the ordinates of the recorded March 1989 discharge hydrograph at the Yass stream gauge so that the peak matched the design peak flow rate that was derived as part of the flood frequency analysis that is presented in Column F of **Table C3.1**.

Figure C3.1 shows the design discharge hydrographs that were used as input to the Yass TUFLOW Model that was developed as part of the present study.

Table C3.1 shows that application of design rainfall data to the Yass River Hydrologic Model for the 0.5% and 0.2% AEP flood events results in design peak flow estimates that are substantially lower than those that were derived from the flood frequency analysis and input to the Yass TUFLOW Model as part of the present investigation. The design peak flows derived from the Yass River Hydrologic Model for the 0.5% and 0.2% are equivalent to an increase in the peak 1% AEP flow of 12% and 42%, respectively which is generally consistent with the percentage increase in rainfall intensity between these and the 1% AEP design storm events.

C3.1.3. Review of PMF Estimate

PMP data were input the Yass River Hydrologic Model based on the GSAM, procedures for which are set out in BoM, 2006. PMP rainfall depths for storm durations between 24 and 96 hours in duration were derived using the GSAM, while PMP rainfall depths for storm durations ranging between 9 and 24 hours were interpolated between the GSAM derived depth for the 24 hour duration storm and the GSDM derived depth for the 6 hour duration storm (refer **Figure C1.1** for extent of GSDM PMP ellipses).

As set out in BoM, 2006, the GSAM temporal patterns were adopted for all storm durations while the GSDM temporal patterns were also adopted for storm durations between 9 and 18 hours.

The peak PMF flow at the Yass stream gauge that was derived as part of the present study is 12,100 m^3/s, which is about 40% higher than the peak flow that was derived as part of WRM, 2015 and about 20% lower than the flow rate that was derived as part of DoC, 2010 and later adopted by WMAwater, 2016a.

The peak PMF flow of 8,459 m^3/s that was derived as part of WRM, 2015 is considered an under-estimate as the XP-RAFTS model was tuned to the results of a flood frequency that underestimated the peak 1% AEP flow by assuming a flow velocity of 1.5 m/s. The peak PMF flow derived as part of WRM, 2015 using a flow velocity of 3.5 m/s was 13,217 m^3/s which is comparable to that derived as part of the present study.

The peak PMF flow of 15,500 m^3/s derived as part of DoC, 2010 and later adopted as part of WMAwater, 2016a is considered an overestimate due to the high variance in storage routing (Kc) parameters that were required to calibrate the RORB model at the time.

Based on the above, a peak PMF flow of 12,100 m³/s has been adopted as part of the present study for defining the extent of the floodplain at Yass.

C3.2. Local Catchment Hydrology

C3.2.1. Rainfall Intensity

The procedures used to obtain temporally and spatially accurate and consistent Intensity-Frequency-Duration (**IFD**) design rainfall curves for the assessment of local catchment flooding at Yass are presented in ARR 2019. Design storms for frequencies of 20, 10, 5, 2, 1, 0.5 and 0.2% AEP were derived for storm durations ranging between 30 minutes and 36 hours. The IFD dataset was downloaded from BoMs *2016 Rainfall IFD Data System*.

C3.2.2. Areal Reduction Factors

The rainfalls derived using the processes outlined in ARR 2019 are applicable strictly to a point. In the case of a catchment of over tens of square kilometres area, it is not realistic to assume that the same rainfall intensity can be maintained. An Areal Reduction Factor (**ARF**) is typically applied to obtain an intensity that is applicable over the entire catchment.

While ARFs ranging between 0.96 and 1.0 are applicable on the Chinamans Creek catchment and between 0.75 and 1.0 on the Bango Creek catchment, a good match was achieved between the flows derived by the Yass Town Hydrologic Model and those derived by the Regional Flood Frequency Estimation (**RFFE**) Model, the procedures for which are set out in ARR 2019 using a single value of 1.0. As the purpose of the study was to also define the nature of major overland flow which is typically associated with smaller catchments, where point rainfall is more applicable, a global ARF value of 1.0 was adopted for design flood estimation purposes.

C3.2.3. Temporal Patterns

ARR 2019 prescribes the analysis of an ensemble of 10 temporal patterns per storm duration for various zones in Australia. These patterns are used in the conversion of a design rainfall depth with a specific AEP into a design flood of the same frequency. The patterns may be used for AEPs down to 0.2 per cent where the design rainfall data is extrapolated for storm events with an AEP less than 1 per cent.

The temporal pattern ensembles that are applicable to Frequent (more frequent than 14.4% AEP), Intermediate (between 3.2 and 14.4% AEP) and Rare (rarer than 3.2% AEP) storm events were obtained from the ARR Data Hub.[5] A copy of the data extracted from the ARR Data Hub for the Yass Town Hydrologic Model is contained in **Attachment C2**.

C3.2.4. Probable Maximum Precipitation

Estimates of PMP were made using the GSDM as described in BoM, 2003. This method is appropriate for estimating extreme rainfall depths for catchments up to 1,000 km² in area and storm durations up to six hours.

The steps involved in assessing PMP for 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.

[5] It is noted that the temporal pattern data set for the *Murray Basin* region is suitable for use at Yass.

- 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.

Figures C1.2, sheet 1 shows the location and orientation of the PMP ellipses that were used to derive the rainfall estimates at Yass, noting that two orientations were adopted to more accurately define the upper limit of flooding in both the Chinamans Creek and Bango Creek catchments.

C3.2.5. Design Rainfall Losses

The initial and continuing loss values to be applied in flood hydrograph estimation were derived using the NSW jurisdictional specific procedures set out in the ARR Data Hub. A copy of the raw ARR Data Hub data, which includes the Probability Neutral Burst Initial Loss values that were adopted for design flood estimation purposes is contained in **Attachment C2** of this Appendix. The continuing loss values set out in **Table C3.2** were adopted design flood estimation purposes (refer **Section B3.2.6** for further discussion).

C3.2.6. Derivation of Design Discharges

The Yass Town Hydrologic Model was run with the design rainfall data set out in **Sections C3.2.1** to **C3.2.5**, as well as the hydrologic parameters set out in **Section C1.2** in order to obtain design discharge hydrographs for input to the Yass TUFLOW Model.

Table C3.2 shows a comparison of design peak flow estimates derived from the Yass Town Hydrologic Model compared to those derived by the RFFE Model, while **Figure C1.2**, sheet 2 shows the location at which the comparisons were made. The peak flow comparison was undertaken for catchments that fit the following criteria:

- The total catchment area was greater than 0.5 km^2 and less than 1,000 km^2.
- The shape factor[6] and catchment area is comparable to those of the '*Nearby Catchments*' that are relied upon as part of the RFFE Model.[7]

Table C3.2 shows the Yass Town Hydrologic Model generally provides a good match to the RFFE Model for flood events with an AEP of less than 5 per cent, but provide a minor overestimate for more frequent flood events.

The storm duration of 30 minutes was generally found to be critical for maximising peak flows for individual sub-catchments where the catchment area is less than 30 ha, with the critical storm duration generally increasing with an increase in catchment area. Peak PMF flow rates for individual sub-catchments computed by the hydrologic model for the critical 15 minute PMP storm duration were generally between 11 and 13 times greater than the corresponding 1% AEP flow rates, with an upper and lower limit of 16.1 and 8.6, respectively. These values lie within the range of expected multiples for a small urban catchment.

[6] Defined as the shortest distance between catchment outlet and centroid divided by the square root of catchment area ARR 2019.

[7] *Nearby Catchments* are the 15 gauged catchments that are in close proximity to the study area and have been relied upon by the RFFE Model to estimate design peak flows at a given location.

TABLE C3.2
COMPARISON OF DESIGN PEAK FLOW ESTIMATES
YASS LOCAL CATCHMENTS

Identifier[1]	AEP (%)	RFFE Derived Peak Flow (m^3/s)	Model Derived Peak Flow (m^3/s)	Continuing Loss (mm/hr)	Discussion
RFFE_01 (Catchment Area = 25.8 km^2)	1	137	125	1.8	Achieves a good match between hydrologic and RFFE model derived design peak flows.
	2	106	106	1.8	
	5	71.8	71.6	3.1	
	10	51.2	50	4.4	
	20	34.3	35.7	4.4	
RFFE_02 (Catchment Area = 10.7 km^2)	1	68.1	68.6	1.8	Achieves a good match between hydrologic and RFFE model derived design peak flows.
	2	52.4	55.6	1.8	
	5	35.6	42.7	3.1	
	10	25.4	30.8	4.4	
	20	17.1	21.8	4.4	

1. Refer **Figure C1.2**, sheet 2 for location of peak flow comparison at Yass.

C4. HYDRAULIC MODELLING OF DESIGN STORMS

C4.1. Accuracy of Hydraulic Modelling

The accuracy of results depends on the precision of the numerical finite difference procedure used to solve the partial differential equations of flow, which is also influenced by the time step used for routing the floodwave through the system and the grid spacing adopted for describing the natural surface levels in the floodplain. The results are also heavily dependent on the size of the two-dimensional grid, as well as the accuracy of the LiDAR survey data, which have a design vertical accuracy of +/- 150 mm.

Given the uncertainties in the LiDAR survey data and the definition of features affecting the passage of flow, maintenance of a depth of flow of at least 100 mm is required for the definition of a "continuous" flow path in the areas subject to shallow overland flow. Lesser modelled depths of inundation may be influenced by the above factors and therefore may be spurious, especially where that inundation occurs at isolated locations and is not part of a continuous flow path. In areas where the depth of inundation is greater than the 100 mm threshold and the flow path is continuous, the likely accuracy of the hydraulic modelling in deriving peak flood levels is considered to be between 100 and 150 mm.

Use of the TUFLOW Model results when applying flood related controls to development proposals should be undertaken with the above limitations in mind. Proposals should be assessed with the benefit of a site survey to be supplied by applicants in order to allow any inconsistencies in results to be identified and given consideration. This comment is especially appropriate in the areas subject to shallow flow, where the errors in the LiDAR survey data or obstructions to flow would have a proportionally greater influence on the computed water surface levels than in the deeper flooded main stream areas.

Minimum floor levels for residential, commercial and industrial developments should be based on the 1% AEP flood level plus appropriate freeboard (i.e. the *FPL*), to cater for uncertainties such as wave action, effects of flood debris conveyed in the flow stream and precision of modelling. Note that a freeboard of 500 mm has been adopted for defining the *FPLs*.

The sensitivity studies and discussion presented in **Section B4.4** provide guidance on the suitability of the recommended allowance for freeboard under present day climatic conditions.

C4.2. Presentation of Results

Figures 2.2 and **2.3** of the Main Report show the nature of flooding at Yass for the 1% AEP and PMF events, respectively, while **Figures C4.1** to **C4.6** show similar information for the 20%, 10%, 5%, 2%, 0.5% and 0.2% AEP flood events. These diagrams show the indicative extent and depth of inundation along the Yass River, Chinamans Creek and Bango Creek, as well as along the major overland flow paths for the range of design flood events.

Figure 2.4 of the Main Report shows water surface profiles along the Yass River, Chinamans Creek and Bango Creek for the full range of design flood events, while **Table 2.1** of the Main Report sets out the design peak flood levels at the Yass stream gauge.

The key features of flooding at Yass are set out in **Section 2.4.3** of the Main Report.

C5. REFERENCES

Austroads, 1994. ***"Waterway Design. A Guide to the Hydraulic Design of Bridges, Culverts and Floodways"***

BoM (Bureau of Meteorology), 2003. ***"The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method"***

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DIPNR (Department of Infrastructure, Planning and Natural Resources), 2005. ***"Floodplain Development Manual – The Management of Flood Liable Land"***

Geoscience Australia, 2019. **"Australian Rainfall and Runoff, A Guide to Flood Estimation"**.

IEAust (The Institution of Engineers Australia), 1987. ***"Australian Rainfall and Runoff – A Guide to Flood Estimation"***, Volumes 1 and 2.

Howells et al, 2004, ***"Defining the Floodway – Can One Size Fit All?"***

Lyall & Associates, 2019. ***"Hydraulic Assessment at Location of Proposed Causeway Crossing of Yass River"***

NSW Public Works, 2016, ***"Dam Safety Emergency Plan for Yass Dam"***

WMAwater (**WMA**), 2016a. ***"Yass Flood Study"***

WRM Water + Environment (**WRM**), 2015. ***"Extreme Flood Discharge Estimate for Yass Dam"***

ATTACHMENT C1
DESIGN INPUT DATA FROM ARR DATA HUB FOR YASS RIVER HYDROLOGIC MODEL

ATTENTION: This site was updated recently, changing some of the functionality. Please see the changelog (./changelog) for further information.

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	149.154
Latitude	-35.013
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

Data

River Region

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

Layer Info

Time Accessed	10 June 2020 05:12PM
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
SE Coast	0.06	0.361	0.0	0.317	8.11e-05	0.651	0.0	0.0	0.0

Layer Info

Time Accessed	10 June 2020 05:12PM
Version	2016_v1

Short Duration ARF

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

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	16929.0
Storm Initial Losses (mm)	24.0
Storm Continuing Losses (mm/h)	3.8

Layer Info

Time Accessed	10 June 2020 05:12PM
Version	2016_v1

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

code	MB
Label	Murray Basin

Layer Info

Time Accessed	10 June 2020 05:12PM
Version	2016_v2

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

code	MB
arealabel	Murray Basin

Layer Info

Time Accessed	10 June 2020 05:12PM
Version	2016_v2

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-35.0125&longitude=149.1543&sdmin=true&s
to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	10 June 2020 05:12PM

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)	0.4 (0.021)	0.2 (0.009)	0.1 (0.004)	0.0 (0.000)	0.0 (0.000)	0.0 (0.001)
90 (1.5)	0.2 (0.009)	0.1 (0.004)	0.1 (0.002)	0.0 (0.001)	0.2 (0.004)	0.3 (0.006)
120 (2.0)	0.3 (0.013)	0.2 (0.007)	0.1 (0.004)	0.1 (0.002)	0.3 (0.006)	0.4 (0.008)
180 (3.0)	0.6 (0.022)	0.9 (0.027)	1.2 (0.029)	1.4 (0.030)	0.7 (0.012)	0.1 (0.002)
360 (6.0)	0.7 (0.020)	1.0 (0.023)	1.2 (0.023)	1.4 (0.023)	0.9 (0.013)	0.6 (0.007)
720 (12.0)	0.1 (0.002)	1.0 (0.018)	1.6 (0.024)	2.2 (0.028)	5.0 (0.053)	7.2 (0.066)
1080 (18.0)	0.0 (0.000)	0.6 (0.009)	0.9 (0.012)	1.3 (0.014)	5.4 (0.049)	8.5 (0.067)
1440 (24.0)	0.0 (0.000)	0.2 (0.003)	0.3 (0.004)	0.5 (0.005)	2.0 (0.017)	3.2 (0.023)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.3 (0.002)	0.6 (0.004)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.1 (0.000)	0.1 (0.001)
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	10 June 2020 05:12PM
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	10 June 2020 05:12PM
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 (0.000)	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	10 June 2020 05:12PM
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)	10.0 (0.559)	9.3 (0.384)	8.8 (0.310)	8.4 (0.256)	9.9 (0.261)	11.1 (0.263)
90 (1.5)	8.9 (0.435)	8.6 (0.312)	8.4 (0.259)	8.2 (0.220)	10.3 (0.236)	11.9 (0.245)
120 (2.0)	9.9 (0.440)	9.8 (0.324)	9.7 (0.273)	9.6 (0.235)	11.5 (0.239)	12.8 (0.240)
180 (3.0)	10.5 (0.408)	12.4 (0.360)	13.6 (0.335)	14.8 (0.316)	12.5 (0.226)	10.8 (0.174)
360 (6.0)	8.5 (0.260)	11.0 (0.253)	12.7 (0.246)	14.2 (0.238)	20.1 (0.279)	24.5 (0.298)
720 (12.0)	5.3 (0.127)	9.7 (0.175)	12.6 (0.191)	15.4 (0.198)	26.6 (0.282)	35.1 (0.322)
1080 (18.0)	3.4 (0.070)	7.4 (0.115)	10.0 (0.130)	12.5 (0.139)	22.5 (0.204)	29.9 (0.236)
1440 (24.0)	0.3 (0.006)	3.6 (0.051)	5.8 (0.068)	7.9 (0.079)	12.9 (0.106)	16.7 (0.120)
2160 (36.0)	0.0 (0.000)	1.5 (0.018)	2.5 (0.025)	3.4 (0.030)	7.3 (0.053)	10.3 (0.066)
2880 (48.0)	0.0 (0.000)	0.7 (0.008)	1.2 (0.011)	1.6 (0.013)	4.5 (0.031)	6.6 (0.040)
4320 (72.0)	0.0 (0.000)	0.1 (0.002)	0.2 (0.002)	0.3 (0.003)	0.3 (0.002)	0.3 (0.002)

Layer Info

Time Accessed	10 June 2020 05:12PM
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)	22.7 (1.262)	20.4 (0.840)	18.6 (0.681)	17.4 (0.532)	22.9 (0.602)	27.1 (0.642)
90 (1.5)	20.6 (1.002)	21.4 (0.775)	21.9 (0.678)	22.4 (0.603)	22.4 (0.514)	22.3 (0.461)
120 (2.0)	21.5 (0.955)	23.4 (0.775)	24.7 (0.695)	25.9 (0.634)	29.5 (0.615)	32.2 (0.600)
180 (3.0)	21.8 (0.847)	24.1 (0.703)	25.7 (0.634)	27.2 (0.581)	25.9 (0.467)	24.9 (0.400)
360 (6.0)	19.1 (0.583)	28.1 (0.646)	34.0 (0.661)	39.7 (0.663)	52.2 (0.725)	61.6 (0.749)
720 (12.0)	22.6 (0.538)	31.9 (0.572)	38.0 (0.573)	43.9 (0.564)	64.7 (0.684)	80.3 (0.737)
1080 (18.0)	14.7 (0.301)	20.3 (0.315)	24.1 (0.314)	27.7 (0.307)	46.9 (0.427)	61.3 (0.484)
1440 (24.0)	10.5 (0.195)	18.4 (0.258)	23.6 (0.278)	28.6 (0.286)	34.8 (0.287)	39.4 (0.283)
2160 (36.0)	4.1 (0.068)	10.0 (0.123)	13.9 (0.144)	17.6 (0.155)	22.7 (0.166)	26.5 (0.169)
2880 (48.0)	1.5 (0.023)	7.5 (0.084)	11.4 (0.109)	15.2 (0.124)	22.5 (0.153)	28.1 (0.167)
4320 (72.0)	1.7 (0.023)	6.4 (0.065)	9.5 (0.082)	12.5 (0.093)	10.5 (0.066)	9.1 (0.050)

Layer Info

Time Accessed	10 June 2020 05:12PM
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	10 June 2020 05:12PM
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	20	10	5	2	1
60 (1.0)	17.7	10.7	9.8	9.9	9.3	7.8
90 (1.5)	18.8	11.5	10.5	10.8	10.0	9.0
120 (2.0)	18.3	11.5	10.6	11.1	10.5	7.9
180 (3.0)	17.9	11.8	10.6	11.2	11.0	9.4
360 (6.0)	18.4	12.8	11.7	12.1	10.8	7.3
720 (12.0)	18.6	13.3	13.2	12.9	10.9	6.7
1080 (18.0)	20.4	15.5	15.5	16.0	12.4	6.4
1440 (24.0)	21.8	17.1	18.7	17.8	15.9	7.3
2160 (36.0)	23.7	19.2	19.2	21.8	17.9	12.1
2880 (48.0)	24.4	20.0	20.4	23.0	18.1	12.9
4320 (72.0)	24.6	20.7	21.6	24.2	22.9	17.6

Layer Info

Time Accessed	10 June 2020 05:12PM
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/f8850093-8829-4423-afba-d3bb9a310132.txt)

Download JSON (downloads/a3ff81b2-985c-4a53-9752-4f8315b5d2ce.json)

Generating PDF... (downloads/5e2b9791-1310-4130-8d6c-e60d07381e98.pdf)

ATTACHMENT C2
DESIGN INPUT DATA FROM ARR DATA HUB
FOR YASS TOWN HYDROLOGIC MODEL

ATTENTION: This site was updated recently, changing some of the functionality. Please see the changelog (./changelog) for further information.

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	148.939
Latitude	-34.786
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

Data

River Region

Division	Murray-Darling Basin
River Number	12
River Name	Murrumbidgee River
Shape Intersection (%)	99.9

Layer Info

Time Accessed	17 December 2019 04:39PM
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	Shape Intersection (%)
SE Coast	0.06	0.361	0.0	0.317	8.11e-05	0.651	0.0	0.0	0.0	100.0

Layer Info

Time Accessed	17 December 2019 04:39PM
Version	2016_v1

Short Duration ARF

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

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.

Storm Initial Losses (mm)	30.0
Storm Continuing Losses (mm/h)	4.4

Layer Info

Time Accessed	17 December 2019 04:39PM
Version	2016_v1

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

code	MB
Label	Murray Basin
Shape Intersection (%)	100.0

Layer Info

Time Accessed	17 December 2019 04:39PM
Version	2016_v2

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

code	MB
arealabel	Murray Basin
Shape Intersection (%)	100.0

Layer Info

Time Accessed	17 December 2019 04:39PM
Version	2016_v2

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-34.786128399&longitude=148.938718071&sc to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	17 December 2019 04:39PM

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)	0.1 (0.004)	0.0 (0.002)	0.0 (0.001)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
90 (1.5)	0.5 (0.025)	0.3 (0.010)	0.1 (0.004)	0.0 (0.000)	0.1 (0.001)	0.1 (0.002)
120 (2.0)	0.4 (0.018)	0.2 (0.009)	0.1 (0.005)	0.1 (0.002)	0.2 (0.006)	0.4 (0.008)
180 (3.0)	3.6 (0.151)	2.3 (0.072)	1.4 (0.038)	0.6 (0.014)	0.3 (0.007)	0.1 (0.002)
360 (6.0)	0.5 (0.016)	0.9 (0.022)	1.2 (0.024)	1.4 (0.025)	1.0 (0.014)	0.7 (0.008)
720 (12.0)	0.0 (0.000)	1.2 (0.022)	2.0 (0.031)	2.7 (0.036)	6.3 (0.068)	8.9 (0.085)
1080 (18.0)	0.0 (0.000)	0.6 (0.009)	0.9 (0.012)	1.3 (0.014)	5.8 (0.055)	9.3 (0.076)
1440 (24.0)	0.0 (0.000)	0.3 (0.005)	0.5 (0.006)	0.7 (0.007)	1.8 (0.016)	2.7 (0.020)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.3 (0.002)	0.5 (0.004)
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	17 December 2019 04:39PM
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	17 December 2019 04:39PM
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 (0.000)	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	17 December 2019 04:39PM
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)	7.9 (0.486)	6.7 (0.311)	5.9 (0.234)	5.2 (0.178)	6.3 (0.186)	7.2 (0.189)
90 (1.5)	10.5 (0.563)	9.4 (0.377)	8.6 (0.296)	7.9 (0.236)	9.8 (0.248)	11.2 (0.253)
120 (2.0)	13.1 (0.639)	12.3 (0.447)	11.7 (0.363)	11.2 (0.300)	11.9 (0.269)	12.4 (0.250)
180 (3.0)	15.0 (0.634)	13.4 (0.423)	12.4 (0.331)	11.4 (0.263)	10.5 (0.204)	9.9 (0.169)
360 (6.0)	7.9 (0.259)	11.9 (0.290)	14.6 (0.298)	17.2 (0.299)	20.4 (0.296)	22.9 (0.290)
720 (12.0)	2.9 (0.074)	8.8 (0.164)	12.7 (0.197)	16.5 (0.217)	28.1 (0.305)	36.8 (0.349)
1080 (18.0)	1.6 (0.035)	6.1 (0.097)	9.1 (0.121)	11.9 (0.135)	20.9 (0.195)	27.6 (0.225)
1440 (24.0)	1.2 (0.023)	4.6 (0.066)	6.8 (0.082)	9.0 (0.092)	11.4 (0.096)	13.1 (0.098)
2160 (36.0)	0.1 (0.002)	1.8 (0.022)	2.8 (0.030)	3.9 (0.035)	7.1 (0.054)	9.5 (0.064)
2880 (48.0)	0.0 (0.000)	0.2 (0.003)	0.4 (0.004)	0.5 (0.005)	4.4 (0.031)	7.2 (0.046)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.1 (0.000)

Layer Info

Time Accessed	17 December 2019 04:39PM
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)	19.0 (1.169)	21.5 (0.995)	23.1 (0.914)	24.7 (0.852)	25.1 (0.735)	25.3 (0.665)
90 (1.5)	22.0 (1.184)	21.9 (0.881)	21.8 (0.746)	21.7 (0.646)	22.3 (0.564)	22.8 (0.515)
120 (2.0)	27.9 (1.362)	26.9 (0.983)	26.3 (0.814)	25.7 (0.690)	25.7 (0.583)	25.7 (0.519)
180 (3.0)	33.5 (1.416)	30.0 (0.948)	27.8 (0.741)	25.6 (0.590)	25.0 (0.484)	24.6 (0.421)
360 (6.0)	18.9 (0.618)	27.4 (0.664)	33.0 (0.672)	38.4 (0.669)	50.5 (0.731)	59.6 (0.756)
720 (12.0)	17.5 (0.440)	29.8 (0.554)	38.0 (0.589)	45.9 (0.603)	63.9 (0.694)	77.4 (0.734)
1080 (18.0)	15.2 (0.330)	21.4 (0.343)	25.6 (0.340)	29.5 (0.333)	48.6 (0.454)	63.0 (0.514)
1440 (24.0)	11.7 (0.229)	18.6 (0.269)	23.2 (0.280)	27.6 (0.282)	31.1 (0.264)	33.7 (0.251)
2160 (36.0)	7.8 (0.134)	12.8 (0.163)	16.1 (0.172)	19.3 (0.175)	22.3 (0.170)	24.6 (0.165)
2880 (48.0)	1.4 (0.022)	5.7 (0.067)	8.5 (0.084)	11.2 (0.095)	20.7 (0.147)	27.8 (0.176)
4320 (72.0)	1.0 (0.015)	5.2 (0.056)	8.0 (0.073)	10.7 (0.084)	10.6 (0.070)	10.5 (0.062)

Layer Info

Time Accessed	17 December 2019 04:39PM
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	17 December 2019 04:39PM
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	20	10	5	2	1
60 (1.0)	16.3	13.8	11.5	11.0	10.8	9.9
90 (1.5)	18.7	13.4	11.8	11.7	12.0	11.3
120 (2.0)	20.5	12.4	11.2	11.8	11.9	11.5
180 (3.0)	21.3	11.9	11.8	13.2	13.1	12.8
360 (6.0)	23.8	15.8	14.0	14.4	12.6	9.4
720 (12.0)	24.8	17.9	16.0	16.3	13.1	7.1
1080 (18.0)	25.7	19.8	18.9	19.6	15.6	10.3
1440 (24.0)	26.8	21.3	20.7	22.3	19.2	13.2
2160 (36.0)	28.3	23.2	23.6	25.6	23.1	15.1
2880 (48.0)	29.9	25.0	26.2	27.4	24.2	15.8
4320 (72.0)	30.5	25.5	27.0	28.6	25.3	22.1

Download TXT (downloads/817cc517-cba4-45ba-adeb-9e7839f2cd7e.txt)

Download JSON (downloads/4d2b8d03-be0b-47ea-8693-31940d6c9365.json)

Generating PDF... (downloads/aa2bf836-3aee-4fbb-8582-fa8a687366e6.pdf)

Layer Info

Time Accessed	17 December 2019 04:39PM
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.

ATTACHMENT C3
DESIGN PEAK FLOWS

TABLE C1
DESIGN PEAK FLOWS(1)

Peak Flow Location Identifier(2)	Tributary/Catchment	Location	Design Flood Events																						
			20% AEP			10% AEP			5% AEP			2% AEP			1% AEP			0.5% AEP			0.2% AEP			PMF	
			Peak Flow (m^3/s)	Critical Storm Duration(3) (minutes)	Critical Storm Burst(4)	Peak Flow (m^3/s)	Critical Storm Duration(3) (minutes)	Critical Storm Burst(4)	Peak Flow (m^3/s)	Critical Storm Duration(3) (minutes)	Critical Storm Burst(4)	Peak Flow (m^3/s)	Critical Storm Duration(3) (minutes)	Critical Storm Burst(4)	Peak Flow (m^3/s)	Critical Storm Duration(3) (minutes)	Critical Storm Burst(4)	Peak Flow (m^3/s)	Critical Storm Duration(3) (minutes)	Critical Storm Burst(4)	Peak Flow (m^3/s)	Critical Storm Duration(3) (minutes)	Critical Storm Burst(4)	Peak Flow (m^3/s)	Critical Storm Duration(3) (minutes)
[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]	[K]	[L]	[M]	[N]	[O]	[P]	[Q]	[R]	[S]	[T]	[U]	[V]	[W]	[X]	[Y]	[Z]
Q01	Yass River	Downstream Dam	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540
Q02		Flat Rock Crossing	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1		
Q03		Hume Bridge	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1		
Q04		Disused Railway Line	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1		
Q05		Upstream Bango Creek	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540
Q06		Downstream Bango Creek	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540	1	[illegible]	540
Q07	[illegible] Creek	[illegible] Street	1.9	[illegible]	8	2.0	60	9	3.8	60	8	4.2	270	1	5.8	270	5	6.2	270	2	7.2	30	4	43.2	30
Q08		[illegible] Street	3.2	[illegible]	9	4.3	120	2	7.9	120	3	9.7	270	1	11.9	270	5	13.4	270	2	15.9	270	2		
Q09		[illegible] Street	3.1	[illegible]	9	6.2	120	2	7.3	90	9	9.7	270	1	13.8	270	5	14.6	270	2	17	270	3		
Q10		Petit Street	3.8	[illegible]	4	4.9	120	3	8.7	90	9	10.9	270	1	19.4	270	8	21.1	270	3	32.2	270	2		
Q11		[illegible] Street	5.3	[illegible]	8	9.6	120	2	11.9	120	3	14.3	360	2	20.8	270	1	25	270	1	60.4	270	2		
Q12		Upstream [illegible] Street	4.8	[illegible]	9	9.1	120	9	11.7	120	5	14.9	360	2	18.1	270	1	17.2	270	1	18.9	270	1		
Q13		Yass Soldiers Club	3.1	[illegible]	9	10.2	120	3	18.1	120	8	19.4	360	3	22.4	90	1	20.9	270	6	Subject to backwater flooding from the Yass River				
Q14		[illegible] Street	9	[illegible]	9	14.2	120	2	Subject to backwater flooding from the Yass River																
Q15	Major Overland Flow	Grand Junction Road	1.7	[illegible]	9	5.2	60	9	4.5	120	3	5.5	60	9	5.8	30	6	8.1	30	9	10.1	30	6	54.8	30
Q16		[illegible] Street	1.9	90	8	2	120	8	2.7	120	2	8.4	60	9	4.2	30	6	4.9	30	8	5.8	30	6		
Q17		Church Street	1.2	30	4	2.1	30	2	3.1	30	5	4.8	270	1	5.5	270	2	6.6	30	6	8.8	30	6		
Q18		Walker Park	1	90	8	2	120	3	3.0	120	7	5.8	30	9	4.8	30	6	4.7	30	9	7.2	30	8	58.6	15
Q19		Yass Golf Course	0.5	90	7	0.9	120	7	1.2	30	3	1.6	30	9	1.9	30	6	2.1	30	9	5.6	30	6	13.9	15

Refer over for footnotes of Table.

TABLE D1 (Cont'd)
DESIGN PEAK FLOWS[1]

Peak Flow Location Identifier[1]	Tributary/Catchment	Location	20% AEP Peak Flow (m³/s)	20% AEP Critical Storm Duration[1] (minutes)	20% AEP Critical Storm Burst[2]	10% AEP Peak Flow (m³/s)	10% AEP Critical Storm Duration[1] (minutes)	10% AEP Critical Storm Burst[2]	5% AEP Peak Flow (m³/s)	5% AEP Critical Storm Duration[1] (minutes)	5% AEP Critical Storm Burst[2]	2% AEP Peak Flow (m³/s)	2% AEP Critical Storm Duration[1] (minutes)	2% AEP Critical Storm Burst[2]	1% AEP Peak Flow (m³/s)	1% AEP Critical Storm Duration[1] (minutes)	1% AEP Critical Storm Burst[2]	0.5% AEP Peak Flow (m³/s)	0.5% AEP Critical Storm Duration[1] (minutes)	0.5% AEP Critical Storm Burst[2]	0.2% AEP Peak Flow (m³/s)	0.2% AEP Critical Storm Duration[1] (minutes)	0.2% AEP Critical Storm Burst[2]	PMF Peak Flow (m³/s)	PMF Critical Storm Duration[1] (minutes)
[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]	[K]	[L]	[M]	[N]	[O]	[P]	[Q]	[R]	[S]	[T]	[U]	[V]	[W]	[X]	[Y]	[Z]
C20	Major Overland Flow	Yass Golf Course	1	90	7	1.7	60	9	2.9	60	3	3.5	30	5	5.5	30	6	4.5	30	5	5.1	30	6	10.6	15
C21	Major Overland Flow	Mont Street	0.8	90	7	6.8	120	9	8.7	120	7	10.6	30	9	10.4	30	6	10.0	30	9	13.9	30	6		
C22	Major Overland Flow	MCF	4.2	180	8	7.3	120	2	10.1	120	7	11.0	120	6	10.2	30	6	10.5	30	8	22.6	30	6		
C23	Major Overland Flow	D6 Railway	1.8	180	8	4.4	120	2	7.0	120	3	8.9	270	6	12.2	30	6	10.2	30	6	10.2	30	6		
C24	Major Overland Flow	Comur Street	Not subject to flooding			0.1	30	7	9.4	30	7	8.7	270	1	9.7	270	1	8.6	270	1	11	270	5		
C25	Major Overland Flow	Comur Street	0	180	8	0.1	120	8	0.9	120	3	0.8	270	1	3.3	270	1	4.2	270	1	7.8	270	1		
C26	Major Overland Flow	Comur Street	0.1	30	2	1.1	120	2	2.8	120	2	4.4	270	6	9.8	270	8	Subject to backwater flooding from the Yass River							
C27	Major Overland Flow	Meehan Street	0.1	180	9	1.3	120	2	2.4	120	3	9.6	270	6	4.8	270	8	0.4	270	2	Subject to backwater flooding from the Yass River				
C28	Major Overland Flow	D6 Railway	0.8	90	7	1	30	4	1.4	30	7	1.8	30	9	1.9	30	8	2.1	30	9	3.8	30	8		
C29	Major Overland Flow	D6 Railway	0	90	7	0	60	1	0	30	8	0	30	8	0	30	8	0	30	8	Subject to backwater flooding from the Yass River				
C30	Major Overland Flow	D6 Railway	8	30	1	2.9	120	7	8.8	30	7	6.6	30	5	4.1	30	6	4.6	30	6	6	30	5	20.6	30
C31	Major Overland Flow	Yass Valley Way	1.1	180	9	1.8	60	9	3	60	3	2.4	60	5	2.8	30	6	5.2	30	9	9.7	30	6		
C32	Major Overland Flow	US Glebe Street	0.8	120	8	6.8	60	7	1	90	3	1.4	60	7	1.7	270	1	3	270	1	3.8	270	8		
C33	Major Overland Flow	Yass Valley Way	4.7	180	8	7.1	90	8	8.8	90	9	12.2	270	1	Subject to backwater flooding from the Yass River										
C34	[illegible] Creek		64.1	180	4	67.8	120	5	124	120	3	170	180	6	219	360	6	303	360	5	608	360	2	2,488	90
C35	[illegible] Creek		71.8	180	4	86.7	120	6	185	120	3	183	180	6	330	360	6	294	360	8	647	360	2	2,771	120
C36	[illegible] Creek	Hume Highway	71.8	180	4	97.7	120	8	187	120	8	188	180	6	241	360	6	297	360	6	684	360	2	2,004	120
C37	[illegible] Creek	Commissioners Hume Highway	72.2	180	4	98.8	120	5	186	120	3	190	180	6	246	360	6	292	360	9	591	360	2		
C38	[illegible] Creek	Main Southern Railway	82.8	180	4	118	120	9	180	120	3	229	180	9	338	360	6	391	360	9	426	360	3	5,646	120
C39	[illegible] Creek	Yass Valley Way	82.7	180	4	198	120	6	184	120	3	Subject to backwater flooding from the Yass River													

Refer over for footnotes of Table.

TABLE G1 (Cont'd)
DESIGN PEAK FLOWS[1]

Peak Flow Location Identifier[2]	Tributary/Catchment	Location	20% AEP Peak Flow (m³/s)	20% AEP Critical Storm Duration[1] (minutes)	20% AEP Critical Storm Burst[2]	10% AEP Peak Flow (m³/s)	10% AEP Critical Storm Duration[1] (minutes)	10% AEP Critical Storm Burst[2]	5% AEP Peak Flow (m³/s)	5% AEP Critical Storm Duration[1] (minutes)	5% AEP Critical Storm Burst[2]	2% AEP Peak Flow (m³/s)	2% AEP Critical Storm Duration[1] (minutes)	2% AEP Critical Storm Burst[2]	1% AEP Peak Flow (m³/s)	1% AEP Critical Storm Duration[1] (minutes)	1% AEP Critical Storm Burst[2]	0.5% AEP Peak Flow (m³/s)	0.5% AEP Critical Storm Duration[1] (minutes)	0.5% AEP Critical Storm Burst[2]	0.2% AEP Peak Flow (m³/s)	0.2% AEP Critical Storm Duration[1] (minutes)	0.2% AEP Critical Storm Burst[2]	PMF Peak Flow (m³/s)	PMF Critical Storm Duration[1] (minutes)
[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]	[K]	[L]	[M]	[N]	[O]	[P]	[Q]	[R]	[S]	[T]	[U]	[V]	[W]	[X]	[Y]	[Z]
Q10	Fairy Hole Creek		9.2	180	8	16.6	120	6	18.1	120	3	22.5	180	6	32.2	360	2	[illegible]	360	2	44.0	270	1	350	60
Q11			17.1	180	8	28.8	120	8	38.6	120	3	40.2	360	8	63.6	360	2	69	270	1	81.0	270	1	600	45
Q12		Fairy Hole Road	18.1	180	8	32.9	120	8	57.2	120	3	82.4	360	8	61.7	360	2	70.1	270	1	82.7	270	1		
Q13		Hume Highway	21.1	180	8	30.6	120	6	40.7	120	3	52.6	360	3	65.2	360	2	64.4	360	2	77.0	360	2		
Q14	Major Overland Flow	Hume Highway	4.8	180	8	7	120	6	8.8	120	3	16.1	360	6	15.0	360	2	16.4	270	1	20.8	270	1	170	45
Q15		Fairy Hole Road	3.8	180	8	4.4	60	9	8	60	5	7.8	270	1	8.2	270	5	12.3	270	1	16.8	270	1		
Q16		Yass River Stream Gauge	390	540	1	490	540	1	730	540	1	1100	540	1	1030	540	1	2200	540	1	2000	540	1	12,000	840

1. Peak flows less than 100m³/s have been quoted to one decimal place in order to show minor differences.
2. Refer to relevant figures in Volume 2 for location of Flow Location Identifiers.

APPENDIX D

FLOOD DAMAGES

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FIGURES
(BOUND IN VOLUME 2)

D1. INTRODUCTION AND SCOPE

D1.1. Introduction

Damages from flooding belong to two categories:

- **Tangible Damages**
- **Intangible Damages**

Tangible damages are defined as those to which monetary values may be assigned, and may be subdivided into direct and indirect damages. Direct damages are those caused by physical contact of floodwater with damageable property. They include damages to commercial and industrial and residential building structures and contents, as well as damages to infrastructure services such as electricity and water supply. Indirect damages result from the interruption of community activities, including traffic flows, trade, industrial production, costs to relief agencies, evacuation of people and contents and clean up after the flood.

Generally, tangible damages are estimated in dollar values using survey procedures, interpretation of data from actual floods and research of government files.

The various factors included in the **intangible damage** category may be significant. However, these effects are difficult to quantify due to lack of data and the absence of an accepted method. Such factors may include:

- inconvenience
- isolation
- disruption of family and social activities
- anxiety, pain and suffering, trauma
- physical ill-health
- psychological ill-health.

D1.2. Scope of Investigation

In the following sections, tangible damages to residential, commercial / industrial and public properties have been estimated resulting from flooding in Yass. Intangible damages have not been quantified. The threshold floods at which damages may commence to infrastructure and community assets have also been estimated, mainly from site inspection and interpretation of flood level data. However, there is no data available to allow a quantitative assessment of damages to be made to this category.

D1.3. Terminology

Definitions of the terms used in this Appendix are presented in **Chapter D8** which also summarises the value of Tangible Flood Damages.

D2. DESCRIPTION OF APPROACH

The damage caused by a flood to a particular property is a function of the depth of inundation above floor level and the value of the property and its contents. The warning time available for residents to take action to lift property above floor level also influences damages actually experienced. A spreadsheet model which has been developed by DPIE for estimating residential damages and an in-house spreadsheet model which has been developed for previous investigations of this nature for estimating commercial, industrial and public building damages were used to estimate damages on a property by property basis according to the type of development, the location of the property and the depth of inundation.

Using the results of the updated flood modelling, a peak flood elevation for each event was interpolated at each property. The interpolated property flood levels were input to the spreadsheet models which also contained property characteristics and depth-damage relationships. The depth of above-floor inundation was computed as the difference between the interpolated flood level and the floor elevation at each property. The elevations of 2,068 building floors levels were based on information contained in the property database that was developed as part of WMAwater, 2016a, with adjustments made where necessary by adding the height of floor above a representative natural surface within the allotment (as estimated by visual inspection) to the natural surface elevation determined from LiDAR survey. The type of structure were also based on the WMAwater, 2016a for residential properties, while modifications were to the non-residential property database. The various factors relating to potential property damage were also updated as part of the present study.

The depth-damage curves for residential damages were determined using procedures described in *Guideline No. 4*. Damage curves for other categories of development (commercial and industrial, public buildings) were derived from previous floodplain management investigations.

Damages to the non-residential sector depend on the nature of the enterprise, the depth of inundation over the floor area and the time available for owners to take action to mitigate losses to contents. A spreadsheet model was used which was similar to the residential model in terms of estimation of depths of inundation, but used typical unit damage data which had been adopted in similar studies in NSW in recent years.

It should be understood that this approach is not intended to identify individual properties liable to flood damages and the value of damages in individual properties, even though it appears to be capable of doing so. The reason for this caveat lies in the various assumptions used in the procedure, the main ones being:

- the assumption that computed water levels and topographic data used to define flood extents are exact and without any error;
- the assumption that the water levels as computed by the hydraulic model are not subject to localised influences;
- the estimation of property floor levels by visual inspection rather than by formal field survey;
- the use of "average" stage-damage relationships, rather than a unique relationship for each property;
- the uncertainties associated with assessing appropriate factors to convert *potential damages* to *actual flood damages* experienced for each property after residents have taken action to mitigate damages to contents.

The consequence of these assumptions is that some individual properties may be inappropriately classified as flood liable, while others may be excluded. Nevertheless, when applied over a broad area these effects would tend to cancel, and the resulting estimates of overall damages, would be expected to be reasonably accurate.

For the above reasons, the information contained in the spreadsheets used to prepare the estimates of flood damages for the catchments should not be used to provide information on the depths of above-floor inundation of individual properties.

D3. SOURCES OF DATA

D3.1. General

To estimate A*verage Annual Flood Damages* for a specific area it is necessary to estimate the damages for several floods of different magnitudes, i.e. of different frequencies, and then to integrate the area beneath the damage – frequency curve computed over the whole range of frequencies up to the PMF. To do this it is necessary to have data on the damages sustained by all types of property over the likely range of inundation. There are several ways of doing this:

- The ideal way would be to conduct specific damage surveys in the aftermath of a range of floods, preferably immediately after each. An example approaching this ideal is the case of Nyngan where surveys were conducted in May 1990 following the disastrous flood of a month earlier (DWR, 1990). This approach would not be practicable at Yass given the limited data that are available on historic flood damages.
- The second best way is for experienced loss adjusters to conduct a survey to estimate likely losses that would arise due to various depths of inundation. This approach is used from time to time, but it can add significantly to the cost of a floodplain management study (LMJ, 1985). It was not used for the present investigation.
- The third way is to use generalised data such as that published by CRES (Centre for Resource & Economic Studies, Canberra) and used in the Floodplain Management Study for Forbes (SKM, 1994). These kinds of data are considered to be suitable for generalised studies, such as broad regional studies. They are not considered to be suitable for use in specific areas, unless none of the other approaches can be satisfactorily applied.
- The fourth way is to adapt or transpose data from other flood liable areas. This was the approach used for the present study. As mentioned, the *Guideline No 4* procedure was adopted for the assessment of residential damages. The approach was based on data collected following major flooding in Katherine in 1998, with adjustments to account for changes in values due to inflation, and after taking into account the nature of development and flooding patterns in the study area. The data collected during site inspection in the flood liable areas assisted in providing the necessary adjustments. Commercial and industrial damages were assessed via reference to recent floodplain management investigations of a similar nature to the present study.

D3.2. Property Data

The properties were divided into three categories: residential, commercial / industrial, and public buildings.

For residential properties, the data used in the damages estimation included:

- the location/address of each property
- an assessment of the type of structure
- natural surface level
- floor level

For commercial / industrial and public properties, the required data included:

- the location of each property
- the nature of each enterprise
- an estimation of the floor area
- natural surface level
- floor level

The property descriptions were used to classify the commercial and public developments into categories (i.e. high, medium or low value properties) which relate to the magnitude of likely flood damages.

The total number of residential properties, commercial / industrial and public buildings is shown in **Table D3.1**.

TABLE D3.1
NUMBER OF PROPERTIES INCLUDED IN DAMAGES DATABASE

Development Type	Number of Properties
Residential(1)	1,831
Commercial / Industrial	194
Public	43
Total	**2,068**

1. Includes individual residential units

D3.3. Flood Levels Used in the Analysis

Damages were computed for the design flood levels determined from the hydraulic model that was developed as part of the present investigation. The design levels assume that the drainage system is operating at optimum capacity. They do not allow for any increase in levels resulting from wave action, debris build-ups in the channels which may cause a partial blockage of bridges and which may result in conversions of flow from the supercritical to the subcritical flow regime, as well as other local hydraulic effects. These factors are usually taken into account by adding a factor of safety (freeboard) to the "nominal" flood level when assessing the "level of protection" against flooding of a particular property. Freeboard could also include an allowance for the future effects of climate change.

D4. RESIDENTIAL DAMAGES

D4.1. Damage Functions

The procedures identified in *Guideline No 4* allow for the preparation of a depth versus damage relationship which incorporates structural damage to the building, damage to internals and contents, external damages and clean-up costs. In addition, there is the facility for including allowance for accommodation costs and loss of rent. Separate curves are computed for three residential categories:

- Single storey slab on ground construction
- Single storey elevated floor
- Two storey residence

The level of flood awareness and available warning time are taken into account by factors which are used to reduce "potential" damages to contents to "actual" damages. "Potential" damages represent losses likely to be experienced if no action were taken by residents to mitigate impacts. A reduction in the potential damages to "actual" damages is usually made to allow for property evacuation and raising valuables above floor level, which would reduce the damages actually experienced. The ability of residents to take action to reduce flood losses is mainly limited to reductions in damages to contents, as damages to the structure and clean-up costs are not usually capable of significant mitigation.

The reduction in damages to contents is site specific, being dependent on a number of factors related to the time of rise of floodwaters, the recent flood history and flood awareness of residents and emergency planning by the various Government Agencies (BoM and NSW SES).

Flooding in Yass is "flash flooding" in nature, with surcharge of the Yass River occurring within five hours after water levels commence to rise. Consequently, there would be very limited time in advance of a flood event in which to warn residents and business owners, and for them to take action to mitigate flood losses.

Provided adequate warning were available, house contents may be raised above floor level to about 0.9 m, which corresponds with the height of a typical table/bench height. The spreadsheet provides two factors for assessing damages to contents, one for above and one for below the typical bench height. The reduction in damages is also dependent on the likely duration of inundation of contents, which would be limited to no more than an hour for most flooded properties.

Table D4.1 over shows total flood damages estimated for the three classes of residential property using the procedures identified in *Guideline No. 4*, for typical depths of above-floor inundation of 0.3 m and 1.0 m (The maximum depth of above-floor inundation in Yass is about 3.9 m at the 1% AEP level of flooding). A typical ground floor area of 240 m^2 was adopted for the assessment. The values in **Table D4.1** allow for damages to buildings and contents, as well as external damages and provision for alternative accommodation.

D4.2. Total Residential Damages

Table D4.2 over summarises residential damages for the range of floods in Yass. The damage estimates were carried out for floods between the 20% AEP and the PMF, which were modelled hydraulically as part of the present study.

TABLE D4.1
DAMAGES TO RESIDENTIAL PROPERTIES

Type of Residential Construction	0.3 m Depth of Inundation Above Floor Level	1.0 m Depth of Inundation Above Floor Level
Single Storey Slab on Ground	$74,801	$102,386
Single Storey High Set	$68,074	$92,761
Double Storey	$47,652	$64,933

Note: These values allow for damages to buildings and contents, as well as external damages and provision for alternative accommodation.

TABLE D4.2
RESIDENTIAL FLOOD DAMAGES IN YASS

Design Flood Event (% AEP)	Number of Properties		Damages ($ Million)
	Flood Affected	Flood Above Floor Level	
20%	8	0	0.13
10%	18	1	0.31
5%	29	3	0.64
2%	48	12	1.76
1%	63	23	3.14
0.5%	84	32	4.62
0.2%	103	44	6.40
PMF	442	276	35.22

The threshold of above-floor flooding for residential type development in Yass is a 10% AEP flood, when a single dwelling which is located on Lead Street would be impacted by major overland flow.

An existing dwelling that is located on Lead Street would be subject to very minor above-floor inundation due to surcharge of the local stormwater drainage system during a 10% AEP storm event, while an additional two dwellings that are located on the southern overbank of the Yass River near the Hume Bridge would be subject to flooding during a 5% AEP flood event, when the depth of above-floor inundation would be a maximum of about 0.7 m.

A total of 23 dwellings would experience above-floor inundation at the 1% AEP level of flooding, increasing to 276 for the PMF event. The maximum depth of above-floor inundation in the worst affected dwelling would increase from about 4 m during a 1% AEP flood event to about 17 m in a PMF.

The total residential damages in Yass would increase from about $3.1 Million at the 1% AEP level of flooding to about $35 Million at the upper limit of flooding.

D5. COMMERCIAL / INDUSTRIAL DAMAGES

D5.1. Direct Commercial / Industrial Damages

The method used to calculate damages requires each property to be categorised in terms of the following:

- damage category
- floor area
- floor elevation

The damage category assigned to each enterprise may vary between "low", "medium" or "high", depending on the nature of the enterprise and the likely effects of flooding. Damages also depend on the floor area.

It has recently been recognised following the 1998 flood in Katherine that previous investigations using stage-damage curves contained in proprietary software tends to seriously underestimate true damage costs. DPIE are currently researching appropriate damage functions which could be adopted in the estimation of commercial and industrial categories as they have already done with residential damages. However, these data were not available for the present study.

On the basis of previous investigations the following typical damage rates are considered appropriate for potential external and internal damages and clean-up costs for both commercial and industrial properties. They are indexed to a depth of inundation of 2 metres. At floor level and 1.2 m inundation, zero and 70% of these values respectively were assumed to occur:

Low value enterprise	$280/m^2	(e.g. Commercial: small shops, cafes, joinery, public halls. Industrial: auto workshop with concrete floor and minimal goods at floor level, Council or Government Depots, storage areas.)
Medium value enterprise	$420/m^2	(e.g. Commercial: food shops, hardware, banks, professional offices, retail enterprises, with furniture/fixtures at floor level which would suffer damage if inundated. Industrial: warehouses, equipment hire.)
High value enterprise	$650/m^2	(e.g. Commercial : electrical shops, clothing stores, bookshops, newsagents, restaurants, schools, showrooms and retailers with goods and furniture, or other high value items at ground or lower floor level. Industrial: service stations, vehicle showrooms, smash repairs.)

The factor for converting potential to actual damages depends on a range of variables such as the available warning time, flood awareness and the depth of inundation. Given sufficient warning time, a well prepared business will be able to temporarily lift property above floor level. However, unless property is actually moved to flood free areas, floods which result in a large depth of inundation, will cause considerable damage to stock and contents.

For the present study, the potential damages described above were converted to actual damages using a multiplier which ranged from between 0.5 and 0.8 depending on the depth of above-floor inundation.

D5.2. Indirect Commercial and Industrial Damages

Indirect commercial and industrial damages comprise costs of removal of goods and storage, loss of trading profit and loss of business confidence.

Disruption to trade takes the following forms:

- The loss through isolation at the time of the flood when water is in the business premises or separating clients and customers. The total loss of trade is influenced by the opportunity for trade to divert to an alternative source. There may be significant local loss but due to the trade transfer this may be considerably reduced at the regional or state level.
- In the case of major flooding, a downturn in business can occur within the flood affected region due to the cancellation of contracts and loss of business confidence. This is in addition to the actual loss of trading caused by closure of the business by flooding.

Loss of trading profit is a difficult value to assess and the magnitude of damages can vary depending on whether the assessment is made at the local, regional or national level. Differences between regional and national economic effects arise because of transfers between the sectors, such as taxes, and subsidies such as flood relief returned to the region.

Some investigations have lumped this loss with indirect damages and have adopted total damage as a percentage of the direct damage. In other cases, loss of profit has been related to the gross margin of the business, i.e. turnover less average wages. The former approach has been adopted in this present study. Indirect damages have been taken as 50% of direct actual damages. A clean-up cost of $15/m^2$ of floor area of each flooded property was also included.

D5.3. Total Commercial and Industrial Damages

Table D5.1 over summarises estimated commercial and industrial damages in Yass.

The threshold of above-floor flooding in commercial and industrial type development in Yass is a flood that is slightly more frequent than 20% AEP, with one property located in Cobham Street shown to be impacted by major overland flow.

The floor level of an existing commercial/industrial type building that is located on Cobham Street would be inundated to a depth of about 0.2 m due to surcharge of the local stormwater drainage system during a 20% AEP storm event, while an additional two commercial/ industrial type buildings that are located in MacDonald Street and Warroo Road would be inundated to a similar depth during a 5% AEP storm event.

A total of 34 commercial/industrial type development would experience above-floor inundation at the 1% AEP level of flooding, increasing to 152 for the PMF event. Similar to the finding for residential development, the maximum depth of above-floor inundation in the worst affected property would increase from about 4 m during a 1% AEP flood event to about 17 m in a PMF.

The total commercial/industrial damages in Yass would increase from about $3.4 Million at the 1% AEP level of flooding to about $92 Million at the upper limit of flooding.

TABLE D5.1
COMMERCIAL AND INDUSTRIAL FLOOD DAMAGES IN YASS

Design Flood Event (% AEP)	Number of Properties		Damages ($ Million)
	Flood Affected	Flood Above Floor Level	
20%	3	1	0.06
10%	9	3	0.23
5%	23	14	0.70
2%	42	18	2.04
1%	56	34	3.39
0.5%	80	60	5.67
0.2%	103	80	10.50
PMF	160	152	91.99

D6. DAMAGES TO PUBLIC BUILDINGS

D6.1. Direct Damages – Public Buildings

Included under this heading are government buildings, churches, swimming pools and parks. Damages were estimated individually on an area basis according to the perceived value of the property. Potential internal damages were indexed to a depth of above-floor inundation of 2 m as shown below. At floor level and 1.2 m depth of inundation, zero and 70% of these values respectively were assumed to occur.

Low value	$280/m^2	
Medium value	$420/m^2	(e.g. council buildings, NSW SES HQ, fire station)
High value	$650/m^2	(e.g. schools)

These values were obtained from the Nyngan Study (DWR, 1990), as well as commercial data presented in the Forbes Water Studies report (WS, 1992) and adjusted for inflation. External and structural damages were taken as 4 and 10% of internal damages respectively.

D6.2. Indirect Damages – Public Buildings

A value of $15/m^2 was adopted for the clean-up of each property. This value is based on results presented in the Nyngan Study and adjusted for inflation. Total "welfare and disaster" relief costs were assessed as 50% of the actual direct costs.

D6.3. Total Damages – Public Buildings

Table D6.1 over summarises estimated damages to public buildings in Yass.

The threshold of above-floor flooding for public buildings in Yass is equivalent to about a 0.5% AEP flood, with the floor level of the Yass Local Court inundated to a depth of between 0.1-0.3 m by floodwater which originates from the Yass River, while the floor levels of the Hamilton Hume and Yass District Museums are inundated to a similar depth by Major Overland Flow.

The number of public buildings in Yass that are above-floor inundated increases from three at the 0.5% AEP level of flooding to 32 at the upper limit of flooding, when the maximum depth of above-floor inundation in the worst affected property (i.e. the Yass Local Court) would be about 12 m.

TABLE D6.1
PUBLIC FLOOD DAMAGES IN YASS

Design Flood Event (% AEP)	Number of Properties		Damages ($ Million)
	Flood Affected	Flood Above Floor Level	
20%	1	0	0.02
10%	1	0	0.02
5%	1	0	0.02
2%	1	0	0.02
1%	4	0	0.06
0.5%	8	3	0.21
0.2%	13	7	1.27
PMF	32	32	26.67

D7. DAMAGES TO INFRASTUCTURE AND COMMUNITY ASSETS

No data are available on damages experienced to infrastructure and community assets during historic flood events. However, a qualitative matrix of the effects of flooding on critical assets in Yass is presented in **Table 2.3** of the Main Report.

D8. SUMMARY OF TANGIBLE DAMAGES

D8.1. Tangible Damages

Floods have been computed for a range of flood frequencies from 20% AEP up to the PMF. From **Table D8.1**, the threshold for flood damages is a flood slightly smaller than a 20% AEP flood event. **Figure D8.1** shows the damage-frequency curves and cumulative distribution of above-floor depths of inundation at the 1% AEP flood level for residential, commercial and industrial and public buildings in Yass.

TABLE D8.1
TOTAL FLOOD DAMAGES IN YASS
$ MILLION

Design Flood Event (% AEP)	Residential	Commercial/ Industrial	Public	Total
20%	0.13	0.06	0.02	0.21
10%	0.31	0.23	0.02	0.56
5%	0.64	0.70	0.02	1.36
2%	1.76	2.04	0.02	3.82
1%	3.14	3.39	0.06	6.59
0.5%	4.62	5.67	0.21	10.50
0.2%	6.40	10.50	1.27	18.17
PMF	35.22	91.99	26.67	153.88

D8.2. Definition of Terms

Average Annual Damages (also termed "expected damages") are determined by integrating the area under the damage-frequency curve. They represent the time stream of annual damages, which would be expected to occur on a year by year basis over a long duration.

Using an appropriate discount rate, average annual damages may be expressed as an equivalent "*Present Worth Value*" of damages and used in the economic analysis of potential flood management measures.

A flood management scheme which has a design 1% AEP level of protection, by definition, will eliminate damages up to this level of flooding. If the scheme has no mitigating effect on larger floods then these damages represent the benefits of the scheme expressed on an average annual basis and converted to the *Present Worth Value* via the discount rate.

Using the procedures outlined in *Guideline No. 4*, as well as current NSW Treasury guidelines, economic analyses were carried out assuming a 50 year economic life for projects and discount rates of 7% pa. (best estimate) and 11% and 4% pa. (sensitivity analyses).

D8.3. Average Annual Damages

The average annual damages for all flood events up to the PMF are shown below in **Table D8.2**. Note that values have been quoted to two decimal places to highlight the relatively small recurring damages.

TABLE D8.2
AVERAGE ANNUAL DAMAGES IN YASS
$ MILLION

Design Flood Event (% AEP)	Residential	Commercial/ Industrial	Public	Total
20%	0.02	0.01	0.00	0.03
10%	0.04	0.02	0.00	0.06
5%	0.06	0.05	0.00	0.11
2%	0.10	0.09	0.01	0.20
1%	0.13	0.11	0.01	0.25
0.5%	0.14	0.14	0.01	0.29
0.2%	0.16	0.16	0.01	0.33
PMF	0.20	0.26	0.04	0.50

D8.4. Present Worth of Damages at Yass

The *Present Worth Value* of damages likely to be experienced for all flood events up to the 1% AEP and PMF, for a 50 year economic life and discount rates of 4, 7 and 11 per cent are shown in **Table D8.3**.

For a discount rate of 7% pa, the *Present Worth Value* of damages for all flood events up to the 1% AEP flood is about $3.5 Million, for a 50 year economic life. Therefore one or more schemes costing up to this amount could be economically justified if they eliminated damages in Yass for all flood events up to this level. While schemes costing more than this value would have a benefit/cost ratio less than 1, they may still be justified according to a multi-objective approach which considers other criteria in addition to economic feasibility. Flood management measures are considered on a multi-objective basis in **Chapter 3** of the Main Report.

TABLE D8.3
PRESENT WORTH VALUE OF DAMAGES IN YASS
$ MILLION

Discount Rate (%)	All Floods up to 1% AEP	All Floods up to PMF
4	5.4	10.8
7	3.5	6.9
11	2.3	4.5

D9. REFERENCES

DECC (Department of Environment and Climate Change, NSW) (2007) ***"Floodplain Management Guideline No 4. Residential Flood Damages"***.

DWR (Department of Water Resources, NSW) (1990) ***"Nyngan April 1990 Flood Investigation"***.

LMJ (Lyall, Macoun and Joy, Willing and Partners Pty Ltd) (1985) ***"Camden Floodplain Management Study"***.

SKM (Sinclair Knight Merz) (1994) ***"Forbes Floodplain Management Report and Draft Floodplain Management Plan, Volume 1"***.

WS (Water Studies) (1986) ***"The Sydney Floods of August 1986"***, Volume I Residential Flood Damage Survey, Report prepared for CRCE Water Studies Pty Ltd for the NSW PWD.

WS (Water Studies) (1992) ***"Forbes Flood Damage Survey, August 1990 Flood"***.

APPENDIX E

SUGGESTED WORDING FOR INCLUSION IN YASS VALLEY DEVELOPMENT CONTROL PLAN

TABLE OF CONTENTS

FIGURES
(BOUND IN VOLUME 2)

E1.1 Introduction

This section of the Plan sets out specific controls to guide development of flood liable land in the Yass Valley LGA. The approach to managing future development that is subject to flooding supports the findings of a series of location specific floodplain risk management studies and plans that have been prepared as part of the NSW Government's program to mitigate the impact of major floods and reduce the associated hazards in the floodplain.

E1.2 Objectives in Relation to Flood Risk Management

a) To minimise the potential impact of development and other activity upon the aesthetic, recreational and ecological value of the waterway corridors.

b) Increase public awareness of the hazard and extent of land affected by all potential floods, including floods greater than the 1% Annual Exceedance Probability (AEP) flood and to ensure essential services and land uses are planned in recognition of all potential floods.

c) Inform the community of Council's controls and policy for the use and development of flood prone land.

d) Reduce the risk to human life and damage to property caused by flooding through controlling development on land affected by potential floods.

e) Provide detailed controls for the assessment of applications lodged in accordance with the *Environmental Planning and Assessment Act 1979* on land affected by potential floods.

f) Provide different guidelines, for the use and development of land subject to all potential floods in the floodplain, which reflect the probability of the flood occurring and the potential hazard within different areas.

g) Apply a "merit-based approach" to all development decisions which takes account of social, economic and ecological considerations.

h) To control development and other activity within each of the individual floodplains within the LGA having regard to the characteristics and level of information available for each of the floodplains, in particular the availability of floodplain risk management studies and plans prepared in accordance with the *Floodplain Development Manual*, issued by the NSW Government.

i) Deal equitably and consistently with applications for development on land affected by potential floods, in accordance with the principles contained in the *Floodplain Development Manual*.

E1.3 Procedure for Determining What Controls Apply to Proposed Development

The procedure Council will apply for determining the specific controls applying to proposed development in flood liable areas is set out below. Upon enquiry by a prospective applicant, Council will make an initial assessment of the flood affectation and flood levels at the site using the following procedure:

- Assess whether the development is located on flood liable land from the **Flood Planning Map**.
- Determine which set of prescriptive flood related planning controls apply to the development from the **Flood Planning Map** (i.e. Main Stream Flooding or Major Overland Flow).

- Identify the category of the development from **Schedule1: Land Use Categories.**
- Determine the appropriate flood level at the site from the results of the location specific flood or floodplain risk management study.
- Determine which part of the floodplain the development is located in from the **Flood Planning Constraint Category Map**.
- Confirm that the development conforms with the relevant performance criteria, as well as the prescriptive controls set out in either **Schedule 2A** for Main Stream Flooding affected areas and **Schedule 2B** for Major Overland Flow affected areas.

With the benefit of this initial information from Council, the applicant will:

- Prepare the documentation to support the Development Application according to the requirements of **Section E1.9**.

A survey plan showing natural surface levels over the site will be required as part of the Development Application documentation. Provision of this plan by the applicant at the initial enquiry stage will assist Council in providing flood related information.

E1.4 Land Use Categories

The policy recognises seven different types of land use for which a graded set of flood related controls apply. They are included in **Schedule 1: Land Use Categories**.

E1.5 Flood Planning Constraint Categories

For those floodplains where Council has adopted a flood or floodplain risk management study, the identified flood liable land has been divided into the following four *Flood Planning Constraint Categories* (**FPCCs**):

- **Flood Planning Constraint Category 1 (FPCC 1)**, which comprises areas where factors such as the depth and velocity of flow, time of rise, and evacuation problems mean that the land is unsuitable for most types of development. The majority of new development types are excluded from this zone due to its potential impact on flood behaviour and the hazardous nature of flooding.
- **Flood Planning Constraint Category 2 (FPCC 2)**, which comprises areas which lie within the extent of the *Flood Planning Area* where the existing flood risk warrants careful consideration and the application of significant flood related controls on future development.
- **Flood Planning Constraint Category 3 (FPCC 3)**, which comprises areas which lie within the extent of the *Flood Planning Area* but outside areas designated FPCC1 and FPCC2. Areas designated FPCC3 are more suitable for new development and expansion of existing development provided it is carried out in accordance with the controls set out in this document.
- **Flood Planning Constraint Category 4 (FPCC 4)**, which comprises the area which lies between the extent of the *Flood Planning Area* and the Probable Maximum Flood (**PMF**). Flood related controls in areas designated FPCC4 are typically limited to flood evacuation and emergency response, although additional controls apply to "critical uses and facilities" which are critical for response and recovery.

A *Special Flood Consideration Zone* has also been included which relates to areas where the flood risk is considered to be high enough to require additional controls to be applied to future development which is located on land that lies above the FPL. The extent of the *Special Flood Consideration Zone* is shown on the Flood Planning and Flood Planning Constraint Category Maps. The additional controls in this area relate to the safe and timely evacuation of people who would be occupying the floodplain at the time of a flood event and only apply in areas categorised as FPCC4.

E1.6 Development Controls

The development controls have been graded relative to the severity and frequency of potential floods, having regard to the FPCCs determined by the relevant Floodplain Risk Management Study and Plan or, if no such study or plan exists, Council's interim considerations.

The objectives of the development controls are:

a) To require developments with high sensitivity to flood risk to be designed so that they are subject to minimal risk.
b) To allow development with a lower sensitivity to the flood hazard to be located within the floodplain, provided the risk of harm and damage to property is minimised.
c) To minimise the intensification of the high flood risk areas, and if possible, allow for their conversion to natural waterway corridors.
d) To ensure design and siting controls required to address the flood hazard do not result in unreasonable social, economic or environmental impacts.
e) To minimise the risk to life by ensuring the provision of reliable access from areas affected by flooding.
f) To minimise the damage to property arising from flooding.
g) To ensure the proposed development does not expose existing development to increased risks associated with flooding.

The performance criteria which are to be applied when assessing a proposed development are:

a) The proposed development should not result in any significant increase in risk to human life, or in a significant increase in economic or social costs as a result of flooding.
b) The proposal should only be permitted where effective warning time and reliable access is available to an area free of risk from flooding, consistent with any relevant Flood Plan or flood evacuation strategy.
c) Development should not significantly increase the potential for damage or risk other properties either individually or in combination with the cumulative impact of development that is likely to occur in the same floodplain.
d) Procedures would be in place, if necessary, (such as warning systems, signage or evacuation drills) so that people are aware of the need to evacuate are capable of identifying the appropriate evacuation route.
e) Development should not result in significant impacts upon the amenity of an area by way of unacceptable overshadowing of adjoining properties, privacy impacts (e.g. by unsympathetic house–raising) or by being incompatible with the streetscape or character of the locality.

The prescriptive controls which apply to development that is proposed on land affected by Main Stream Flooding and Major Overland Flow are set out in **Schedules 2A** and **2B**, respectively.

E1.7 Proposals to Modify Flood Planning Constraint Categories

In certain situations it may be feasible to modify existing flood behaviour through engineering works which in turn would enable the extent of the FPCCs to be modified at a particular location. Proposals to modify an FPCC at a particular location would need to be supported by a detailed flooding investigation, further details of which are set out in **Section E1.9** below. Proposals would also need to demonstrate consistency with the flood related objectives and performance criteria of both the *Yass Local Environmental Plan* and the *Yass Valley Development Control Plan*.

E1.8 Special Requirements for Fencing

The objectives are:

a) To ensure that fencing does not result in the undesirable obstruction of the free flow of floodwater.

b) To ensure that fencing does not become unsafe during floods so as to threaten the integrity of structures or the safety of people.

c) Fencing is to be constructed in a manner which does not significantly increase flood damage or risk on surrounding land.

The performance criterion which is to be applied when assessing proposed fencing are:

a) Fencing is to be constructed in a manner that does not affect the flow of floodwater so as to detrimentally increase flood affection on surrounding land.

b) Fencing shall be certified by an engineer specialising in hydraulic engineering, that the proposed fencing is adequately constructed so as to withstand the force of floodwater, or collapse in a controlled manner to prevent the undesirable impediment of floodwater.

The prescriptive controls which apply to any proposed fencing on land designated FPCC 1, FPCC 2 and FPCC 3 are:

a) An applicant will need to demonstrate that the fence (new or replacement fence) would create no impediment to the flow of floodwater. Appropriate fences must satisfy the following:

- an open collapsible hinged fence structure or pool type fence, or louvre fencing;
- must not be constructed of non-permeable materials; or
- must allow floodwaters to equalised on both sides and minimise entrapment of flood debris.

E1.9 Explanatory Notes on Lodging Applications

Follow these major steps to lodge the application:

a) Check the proposal is permissible in the zoning of the land by reference to any applicable environmental planning instruments.

b) Consider any other relevant planning controls of Council (e.g. controls in any other relevant part of the DCP).

c) Check whether your property is located either partially or wholly within the Flood Planning Area or Outer Floodplain, as defined on the **Flood Planning Map**.

d) Determine which set of prescriptive flood related planning controls apply to the development from the **Flood Planning Map**.

e) Determine which Flood Planning Constraint Category (FPCC) applies to the developable portion of your property by reference to the **Flood Planning Constraint Category Map**. Enquire with Council regarding existing flood risk mapping or whether a site–specific assessment may be warranted. A property may be located in more than one FPCC and the assessment must consider the controls that apply in each. The flow diagram below summarises this consideration process.

f) Determine the land use category relevant to the development proposal, by firstly confirming how it is defined by the relevant environmental planning instrument and secondly by ascertaining the land use category from **Schedule 1: Land Use Categories**.

g) Assess and document how the proposal will achieve the performance criteria for proposed development and associated fencing set out in **Sections E1.6** and **E1.8**.

h) Check if the proposal will satisfy the prescriptive controls for different land use categories in different FPCCs, as specified in either **Schedule 2A** or **Schedule 2B**.

i) If the proposal does not comply with the prescriptive controls, determine whether the performance criteria are nonetheless achieved.

j) Illustrations provided in this plan to demonstrate the intent of development controls are diagrammatic only. Proposals must satisfy all relevant controls contained in this plan and associated legislation.

k) The assistance of Council staff or an experienced engineer or planner may be required at various steps in the process to ensure that the flood risk management related requirements of this Plan are fully and satisfactorily addressed.

Note that compliance with all the requirements of this plan does not guarantee that an application will be approved.

Information required with an application to address this plan is as follows:

a) Applications must include information which addresses all relevant controls listed above, and the following matters as applicable.

b) Applications for alterations and additions (see either **Schedule 2A** or **Schedule 2B**) to an existing dwelling on flood liable land shall be accompanied by documentation from a registered surveyor confirming existing floor levels.

c) Development applications affected by this plan shall be accompanied by a survey plan showing:

   i. The position of the existing building/s or proposed building/s;

   ii. The existing ground levels to Australian Height Datum around the perimeter of the building and contours of the site; and

   iii. The existing or proposed floor levels to Australian Height Datum.

d) Applications for earthworks, filling of land and subdivision shall be accompanied by a survey plan (with a contour interval of 0.25 m) showing relative levels to Australian Height Datum.

e) For large scale developments, or developments where an existing catchment based flood study is not available, a flood study using a fully dynamic one or two dimensional computer model may be required. For smaller developments the existing flood study may be used if available and suitable (e.g. it contains sufficient local detail), or otherwise a flood study prepared in a manner consistent with the latest edition of *Australian Rainfall and Runoff* and the *Floodplain Development Manual*, will be required. From this study, the following information shall be submitted in plan form:

i. water surface contours;

ii. velocity vectors;

iii. velocity and depth product contours;

iv. delineation of flood risk precincts relevant to individual floodplains; and

v. show both existing and proposed flood profiles for the full range of events for total development including all structures and works (such as revegetation/ enhancements).

This information is required for the pre–developed and post–developed scenarios.

f) Where the controls for a particular development proposal require an assessment of structural soundness during potential floods, the following impacts must be addressed:

i. hydrostatic pressure;

ii. hydrodynamic pressure;

iii. impact of debris; and

iv. buoyancy forces.

Foundations need to be included in the structural analysis.

E1.10 Glossary of Terms

Note: For expanded list of definitions, refer to Glossary contained within the NSW Government Floodplain Development Manual, 2005.

TERM	DEFINITION
Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, for a flood magnitude having five per cent AEP, there is a five per cent probability that there would be floods of greater magnitude each year.
Australian Height Datum (AHD)	A common national surface level datum corresponding approximately to mean sea level.
Floodplain	Area of land which is subject to inundation by floods up to and including the Probable Maximum Flood (**PMF**) event, that is, flood prone land.
Flood Planning Area	The area of land that is shown to be in the Flood Planning Area on the *Flood Planning Map*.
Flood Planning Map	The *Flood Planning Map* shows the extent of land on which flood related development controls apply in a given area, noting that other areas may exist which are not mapped but where flood related development controls apply.
Flood Planning Constraint Category 1 (FPCC 1)	Comprises areas where factors such as the depth and velocity of flow, time of rise, and evacuation problems mean that the land is unsuitable for most types of development. The majority of new development types are excluded from this zone due to its potential impact on flood behaviour and the hazardous nature of flooding
Flood Planning Constraint Category 2 (FPCC 2)	Comprises areas which lie below the *Flood Planning Level* where the existing flood risk warrants careful consideration and the application of significant flood related controls on future development.
Flood Planning Constraint Category 3 (FPCC 3)	Comprises areas which lie below the *Flood Planning Level* but outside areas designated FPCC1 and FPCC2. Areas designated FPCC3 are more suitable for new development and expansion of existing development provided it is carried out in accordance with the controls set out in this document.
Flood Planning Constraint Category 4 (FPCC 4)	Comprises the area which lies above the *Flood Planning Level* (**FPL**) but within the extent of the PMF. Flood related controls in areas designated FPCC4 are typically limited to flood evacuation and emergency response, although additional controls apply to "critical uses and facilities" which are critical for response and recovery.
Flood Planning Level (FPL)	Flood levels selected for planning purposes, as determined by the relevant adopted floodplain risk management study and plan, or as part of a site specific study In the absence of an adopted floodplain risk management study and plan for a particular location, the FPL is defined as the peak 1% AEP flood level plus the addition of a 0.5 m freeboard.

TERM	DEFINITION
Flood Prone/Flood Liable Land	Land susceptible to flooding by the PMF. Flood Prone land is synonymous with Flood Liable land.
Floodway	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
Flood Storage Area	Those parts of the floodplain that may be important for the temporary storage of floodwaters during the passage of a flood. Loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation.
Freeboard	Provides reasonable certainty that the risk exposure selected in deciding a particular flood chosen as the basis for the *Flood Planning Level* is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Freeboard is included in the *Flood Planning Level*.
Habitable Room	In a residential situation: a living or working area, such as a lounge room, dining room, kitchen, bedroom or workroom. In an industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.
Local Drainage	Land on an overland flow path where the depth of inundation during the 1% AEP storm event is less than 0.1 m.
Main Stream Flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
Major Overland Flow	Where the depth of overland flow during the 1% AEP storm event is greater than 0.1 m.
Probable Maximum Flood (PMF)	The largest flood that could conceivably occur at a particular location. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain.

SCHEDULE 1
LAND USE CATEGORIES

Land Use Category	Subdivision	LEP Land Uses
Critical Uses and Facilities	*Community facilities which may provide an important contribution to the notification or evacuation of the community during flood events.*	Health services facility; Electricity generating works; Emergency services facility.
Sensitive Uses and Facilities	*Uses which involve vulnerable members of the community;* *Uses which may cause pollution of a watercourse or town water supply;* *Uses which if affected, would significantly affect the ability of community to return to normal after flood event;*	Bio-solids treatment facility; Cemeteries; Child care centre; Correctional centre; Heavy industrial storage establishment; Heavy industries; Highway service centre; Group home; Passenger transport facilities; Respite day care centre; Schools; Seniors housing; Service Stations; Sewage treatment plant; Veterinary hospital; Waste or resource management facility; Water treatment facility.
Subdivision	*Subdivision of land which involves* *the creation of new allotments, with* *potential for further development;*	Camping grounds; Caravan parks; Eco-tourist facilities; Home business/ child care/occupations; Residential accommodation (excluding Group Home and Seniors housing); Tourist and visitor accommodation.
Residential		
Commercial and Industrial		Amusement centre; Commercial premises (excluding Market); Crematorium; Depots; Entertainment facility; Freight transport facilities; Function centre; General industries; Industrial retail outlet; Industrial training facility; Light industries; Mortuaries; Place of public worship; Public administration building; Recreation facility (indoor & major); Registered club; Research station;

		Restricted premises; Sex services premises; Storage premises; Transport depots; Truck depots; Warehouse or distribution centre; Wholesale suppliers; Vehicle body repair workshops; Vehicle repair stations;
Recreation and Non-Urban		Agriculture (excluding intensive livestock agriculture); Animal boarding and training establishment; Boat sheds; Charter & tourism boating facilities; Car park; Community facility; Extractive industry; Forestry; Jetties; Market; Open cut mining; Recreation area; Recreation facility (outdoor).
Alterations and additions		Residential development: i. An addition or alteration to an existing dwelling of not more than 50m² to the habitable floor area which existed at the date of commencement of this Plan; ii. The construction of an outbuilding with a maximum floor area of 30m² or Rebuilt dwellings which substantially reduce flood risk having regard to property damage and personal safety; or iii. A change of use which does not increase flood risk having regard to property damage and personal safety. iv. Alterations and additions: i. An addition to existing premises of not more than 10% of the floor area which existed at the date of commencement of this DCP; ii. Rebuilding of a development which substantially reduces the extent of flood effects to the existing development; iii. A change of use which does not increase flood risk having regard to property damage and personal safety; or iv. Subdivision which does not involve the creation of new allotments with potential for further development.

SCHEDULE 2A

PRESCRIPTIVE FLOOD RELATED DEVELOPMENT CONTROLS – MAIN STREAM FLOODING AT YASS

Planning considerations	Flood Planning Constraint Category 1 (FPCC 1)							Flood Planning Constraint Category 2 (FPCC 2)							Flood Planning Constraint Category 3 (FPCC 3)							Flood Planning Constraint Category 4 (FPCC 4)						
	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions
Minimum Habitable Floor Level						A1	A2 A4		A5		A3	A6	A4	A2 A4		A5		A3	A6	A1	A2 A4	A4	A5					
Building Components						B2	B2		B5		B2	B2	B2	B2		B5		B2	B2	B2	B2	B1	B3					
Structural Soundness						C3	C2		C4		C2	C2	C3	C2		C4		C2	C2	C5	C2	C6	C1					
Flood Affectation						D1	D1		D1	D1	D1	D1	D1	D2		D1	D1	D1	D1	D1	D2							
Emergency Response						E4	E3 or E5		E2 E5	E1 E3	E3 E4	E3 E4	E3	E2 or E5		E2 E5	E4 E5	E2 E4	E2 E4	E4	E2 or E5	E2 or E5	E2 E4	E4 E5	E2 E4	E2 E4		E2 E4
Management and Design						F2 F3	F2 F3		F2 F3 F4	F1	F2	F2 F3 F4	F2 F3	F2 F3		F2 F3 F4	F1	F2	F2 F3 F4	F2	F2 F3	F2 F3	F2 F3 F4	F1	F2	F2 F3 F4	F2	F2
Stormwater							G3		G1 G2	G1 G2	G1 G3	G1 G2		G3		G1 G2	G1 G2	G1 G2	G1 G3		G2	G1	G1	G1		G1		
Parking and Driveway Access						H2 H4 H5 H7	H6 H7 H8		H1 H3 H5 H6 H7	H1 H3 H5 H6 H7	H1 H3 H5 H6 H7	H1 H3 H5 H6 H7	H2 H4 H6 H7	H6 H7 H8		H1 H3 H5 H6 H7	H1 H3 H5 H6 H7	H1 H3 H5 H6 H7	H1 H3 H5 H6 H7	H2 H4 H6 H7	H6 H7 H8	H5	H5					

Not Relevant	Unsuitable Land Use	Control only applies to development that is proposed on land which lies within the extent of the "Special Flood Considerations Zone" as defined on the Flood Planning and Flood Planning Constraint Category Maps

SCHEDULE 2B
PRESCRIPTIVE FLOOD RELATED DEVELOPMENT CONTROLS – MAJOR OVERLAND FLOW AT YASS

Planning considerations	Flood Planning Constraint Category 1 (FPCC 1)							Flood Planning Constraint Category 2 (FPCC 2)						
	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions
Minimum Habitable Floor Level						A4	A2 A5				A2	A3	A1	A2 A5
Building Components						B4	B1				B1	B1	B1	B1
Structural Soundness						C1	C1				C1	C1	C1	C1
Flood Affectation						D1	D1			D1	D1	D1	D1	D2
Emergency Response						E4	E1			E3				
Management and Design						F2	F2			F1 F3	F2	F2 F4	F2	F2
Stormwater										G1	G1	G1		
Parking and Driveway Access						H2 H6 H8 H7	H6 H7 H8			H1 H5 H8 H6 H7	H1 H3 H8 H9 H7	H1 H3 H5 H6 H7	H2 H4 H6 H7	H6 H7 H8

Planning considerations	Flood Planning Constraint Category 3 (FPCC 3)							Flood Planning Constraint Category 4 (FPCC 4)						
	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions
Minimum Habitable Floor Level	A4	A3		A2	A3	A4	A2 A5	A4	A3					
Building Components	B4	B3		B1	B1	B1	B1	B4	B3					
Structural Soundness	C3	C3		C1	C1	C1	C1	C3	C3					
Flood Affectation														
Emergency Response	E2 or E3	E2 E4	E3					E2 or E3	E2 E4	E4 E5	E2 E4	E2 E4		E2 E4
Management and Design	F2 F3	F2 F3 F4	F1 F3		F4			F2 F3	F2 F3 F4	F1	F2	F2 F3 F4	F2	F2
Stormwater	G1	G1	G1	G1	G1			G1	G1	G1				
Parking and Driveway Access			H1 H3 H6 H8	H1 H3 H6 H8	H1 H3 H5 H8	H2 H4 H8	H8 H9	H3	H3					

	Not Relevant		Unsuitable Land Use		Control only applies to development that is proposed on land which lies within the extent of the "Special Flood Considerations Zone" as defined on the Flood Planning and Flood Planning Constraint Category Maps

Prescriptive controls for [illegible] planning considerations [illegible] DCP

Minimum Habitable Floor Level A1 [illegible] A2 [illegible] A3 [illegible] A4 [illegible] A5 [illegible] A6 [illegible]	Building Components & Method B1 [illegible] B2 [illegible] B3 [illegible] B4 [illegible]	Structural Soundness C1 [illegible] C2 [illegible] C3 [illegible] C4 [illegible] C5 [illegible]
Flood Affectation D1 [illegible] D2 [illegible] Note: [illegible] 1. [illegible] 2. [illegible] 3. [illegible]	Emergency Response E1 [illegible] E2 [illegible] E3 [illegible] E4 [illegible] E5 [illegible]	Management and Design F1 [illegible] F2 [illegible] F3 [illegible] F4 [illegible]
Stormwater G1 [illegible] G2 [illegible]	Parking and Driveway Access H1 [illegible] H2 [illegible] H3 [illegible] H4 [illegible] H5 [illegible] H6 [illegible] H7 [illegible] H8 [illegible] H9 [illegible]	

1. [illegible]
2. [illegible]

SCHEDULE 3A
GENERAL BUILDING MATTERS

Electrical and Mechanical Equipment

For dwellings constructed on land to which this policy applies, the electrical and mechanical materials, equipment and installation should conform to the following requirements.

Main Power Supply

Subject to the approval of the relevant authority the incoming main commercial power service equipment, including all metering equipment, shall be located above the relevant elevation referred to in control B1 or B2 of **Schedules 2A** and **2B**. Means shall be available to easily isolate the dwelling from the main power supply.

Wiring

All wiring, power outlets, switches, etc, should be, to the maximum extent possible, located above the relevant elevation referred to in control B1 or B2 of **Schedules 2A** and **2B**. All electrical wiring installed below this level should be suitable for continuous underwater immersion and should contain no fibrous components. Earth leakage circuit breakers (core balance relays) must be installed. Only submersible type splices should be used below the relevant elevation referred to in control B1 or B2 of **Schedules 2A** and **2B**. All conduits located below the relevant designated flood level should be so installed that they will be self-draining if subjected to flooding.

Equipment

All equipment installed below or partially below the relevant elevation referred to in control B1 or B2 of **Schedules 2A** and **2B** should be capable of disconnection by a single plug and socket assembly.

Reconnection

Should any electrical device and/or part of the wiring be flooded it should be thoroughly cleaned or replaced and checked by an approved electrical contractor before reconnection.

Heating and Air Conditioning Systems

Where viable, heating and air conditioning systems should be installed in areas and spaces of the house above the relevant elevation referred to in control B1 or B2 of **Schedules 2A** and **2B**. When this is not feasible, every precaution should be taken to minimise the damage caused by submersion according to the following guidelines:

i) Fuel

Heating systems using gas or oil as a fuel should have a manually operated valve located in the fuel supply line to enable fuel cut-off.

ii) Installation

The heating equipment and fuel storage tanks should be mounted on and securely anchored to a foundation pad of sufficient mass to overcome buoyancy and prevent movement that could damage the fuel supply line. All storage tanks should be vented to the relevant elevation referred to in control B1 or B2 of **Schedules 2A** and **2B**.

iii) Ducting

All ductwork located below the relevant elevation referred to in control B1 or B2 of **Schedules 2A** and **2B** should be provided with openings for drainage and cleaning. Self-draining may be achieved by constructing the ductwork on a suitable grade. Where ductwork must pass through a watertight wall or floor below the relevant flood level, a closure assembly operated from above the relevant elevation set out under B1 or B2 of **Schedules 2A** and **2B** should protect the ductwork.

Sewer

All sewer connections to properties in flood prone areas are to be fitted with reflux valves.

SCHEDULE 3B
FLOOD COMPATIBLE MATERIALS

Building Component	Flood Compatible Material	Building Component	Flood Compatible Material
Flooring and Sub Floor Structure	• Concrete slab-on-ground monolith construction. Note: clay filling is not permitted beneath slab-on-ground construction which could be inundated. • Pier and beam construction or • Suspended reinforced concrete slab	**Doors**	• Solid panel with waterproof adhesives • Flush door with marine ply filled with closed cell foam • Painted material construction • Aluminium or galvanised steel frame
Floor Covering	• Clay tiles • Concrete, precast or in situ • Concrete tiles • Epoxy formed-in-place • Mastic flooring, formed-in-place • Rubber sheets or tiles with chemical set adhesive • Silicone floors formed-in-place • Vinyl sheets or tiles with chemical-set adhesive • Ceramic tiles, fixed with mortar or chemical set adhesive • Asphalt tiles, fixed with water resistant adhesive • Removable rubber-backed carpet	**Wall and Ceiling Linings**	• Brick, face or glazed • Clay tile glazed in waterproof mortar • Concrete • Concrete block • Steel with waterproof applications • Stone natural solid or veneer, waterproof grout • Glass blocks • Glass • Plastic sheeting or wall with waterproof adhesive
Wall Structure	Solid brickwork, blockwork, reinforced, concrete or mass concrete	**Insulation**	• Foam or closed cell types
Windows	Aluminium frame with stainless steel or brass rollers	**Nails, Bolts, Hinges and Fittings**	• Galvanised • Removable pin hinges

Lyall & Associates

yass valley council
the country the people

NEXUS Environmental Planning Pty Ltd

YASS FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN

JULY 2021

VOLUME 2 – FIGURES AND APPENDICES

July 1900 Flood

May 1925 Flood

May 1925 Flood

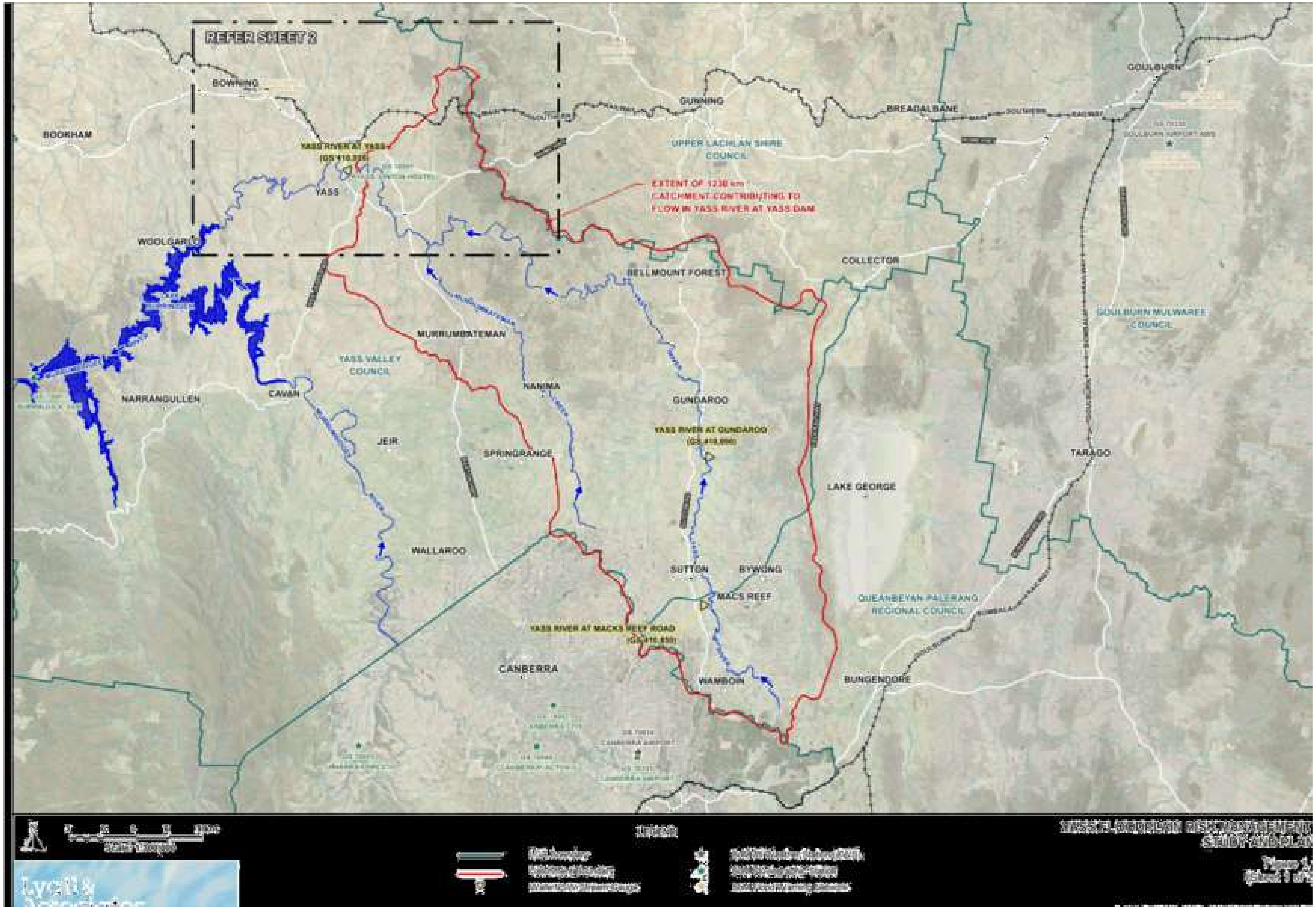
October 19[illegible] Flood

October 19[illegible] Flood

October 1959 Flood

Job No: E5447 File: YFRMS_V2_Figures_[Rev 1.6].docx	Date: July 2021 Rev No: 1.6	Principal: SAB Author: SAB/TDR

LIST OF FIGURES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BOOKHAM
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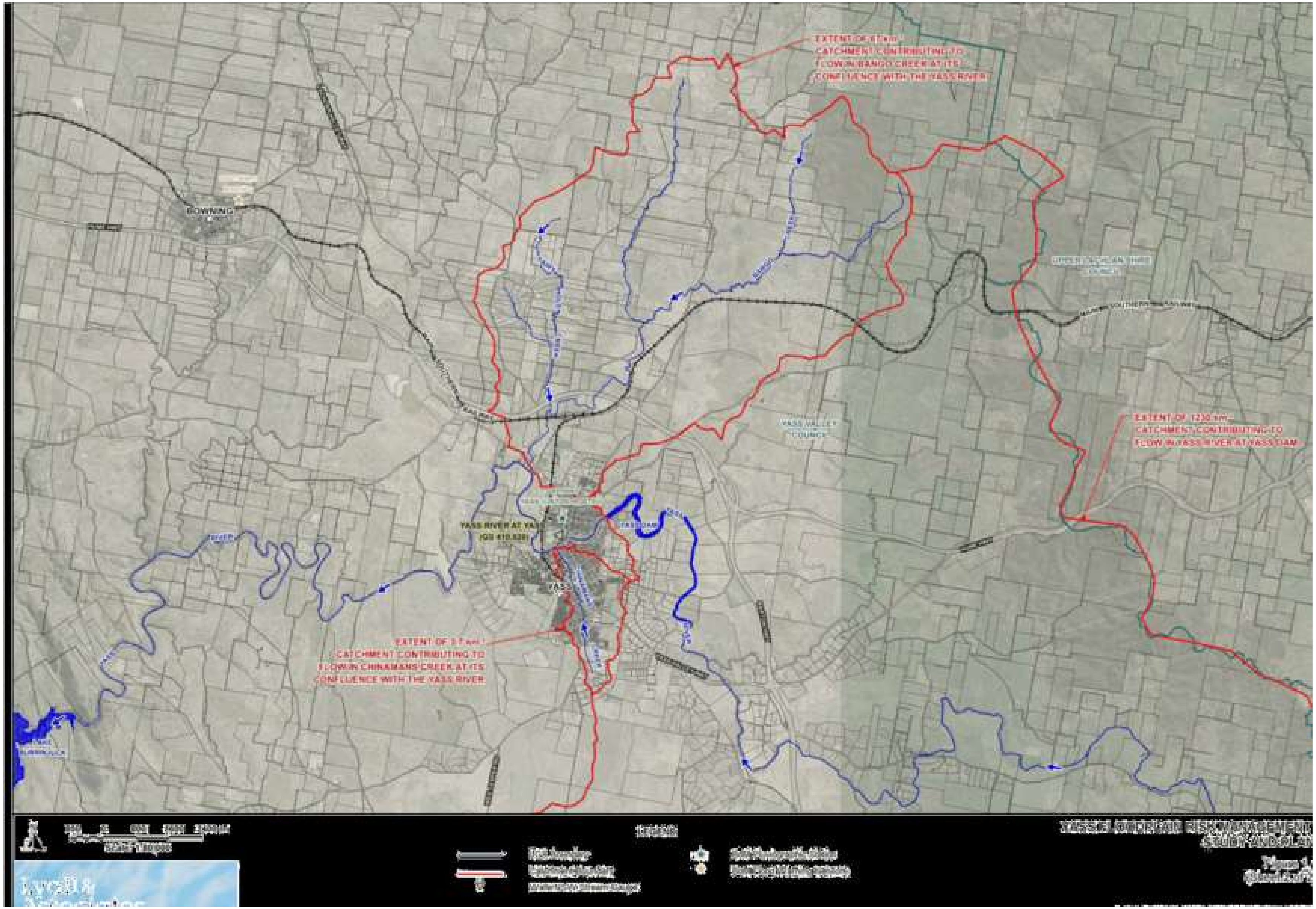
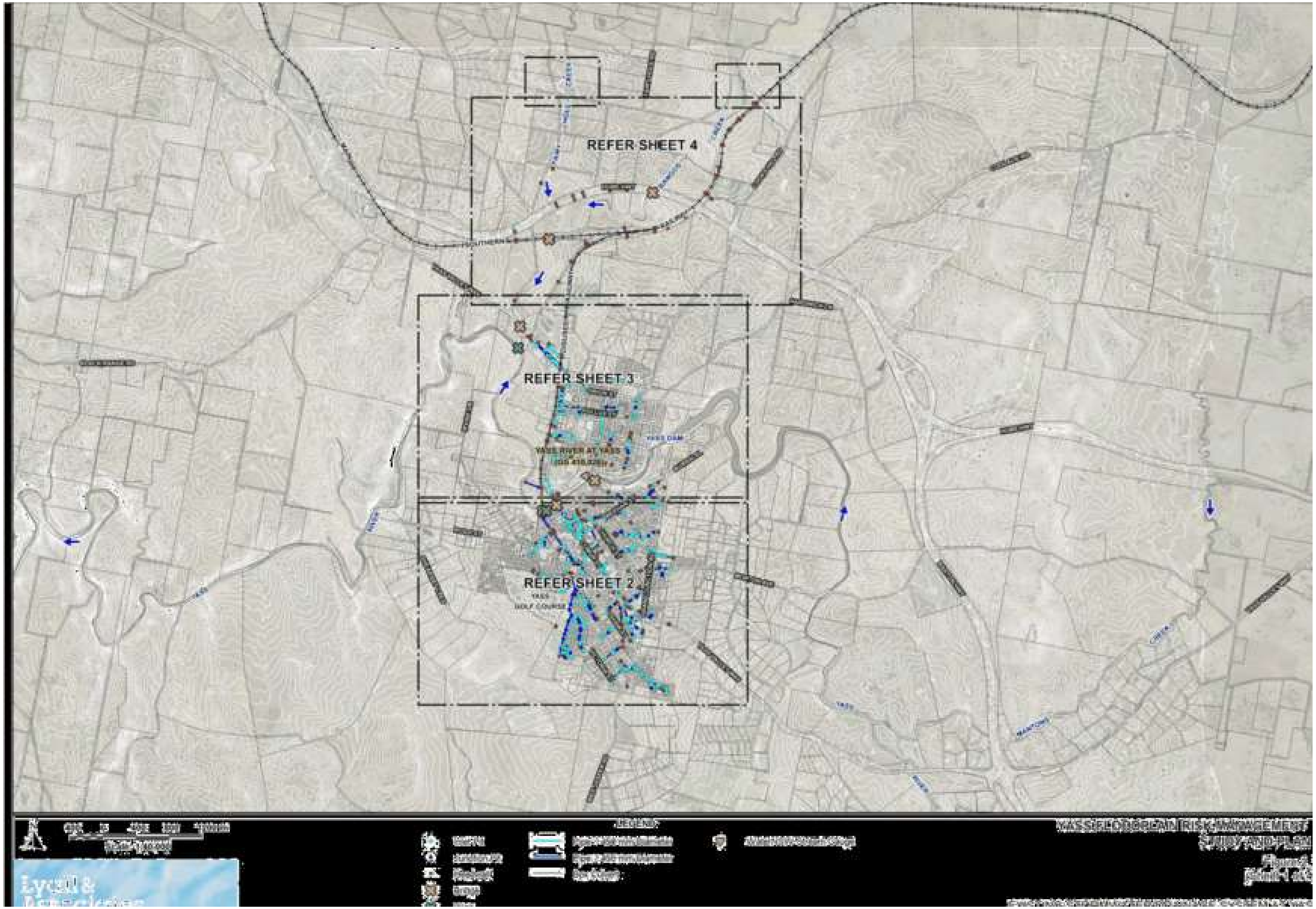
YASS
GUNNING
BREADALBANE
GOULBURN
UPPER LACHLAN SHIRE
COUNCIL
WOOLGARLO
BELLMOUNT FOREST
COLLECTOR
MURRUMBATEMAN
YASS VALLEY
COUNCIL
NANIMA
GOULBURN MULWAREE
COUNCIL
NARRANGULLEN
CAVAN
GUNDAROO
YASS RIVER AT GUNDAROO
JEIR
SPRINGRANGE
TARAGO
LAKE GEORGE
WALLAROO
SUTTON
BYWONG
MACS REEF
QUEANBEYAN-PALERANG
REGIONAL COUNCIL
YASS RIVER AT MACKS REEF ROAD
CANBERRA
WAMBOIN
BUNGENDORE


CATCHMENT CONTRIBUTING TO
FLOW IN BANGO CREEK AT ITS
CONFLUENCE WITH THE YASS RIVER
BOWNING
YASS VALLEY COUNCIL
CATCHMENT CONTRIBUTING TO
FLOW IN YASS RIVER AT YASS DAM
YASS RIVER AT YASS
YASS
CATCHMENT CONTRIBUTING TO
FLOW IN CHINAMANS CREEK AT ITS
CONFLUENCE WITH THE YASS RIVER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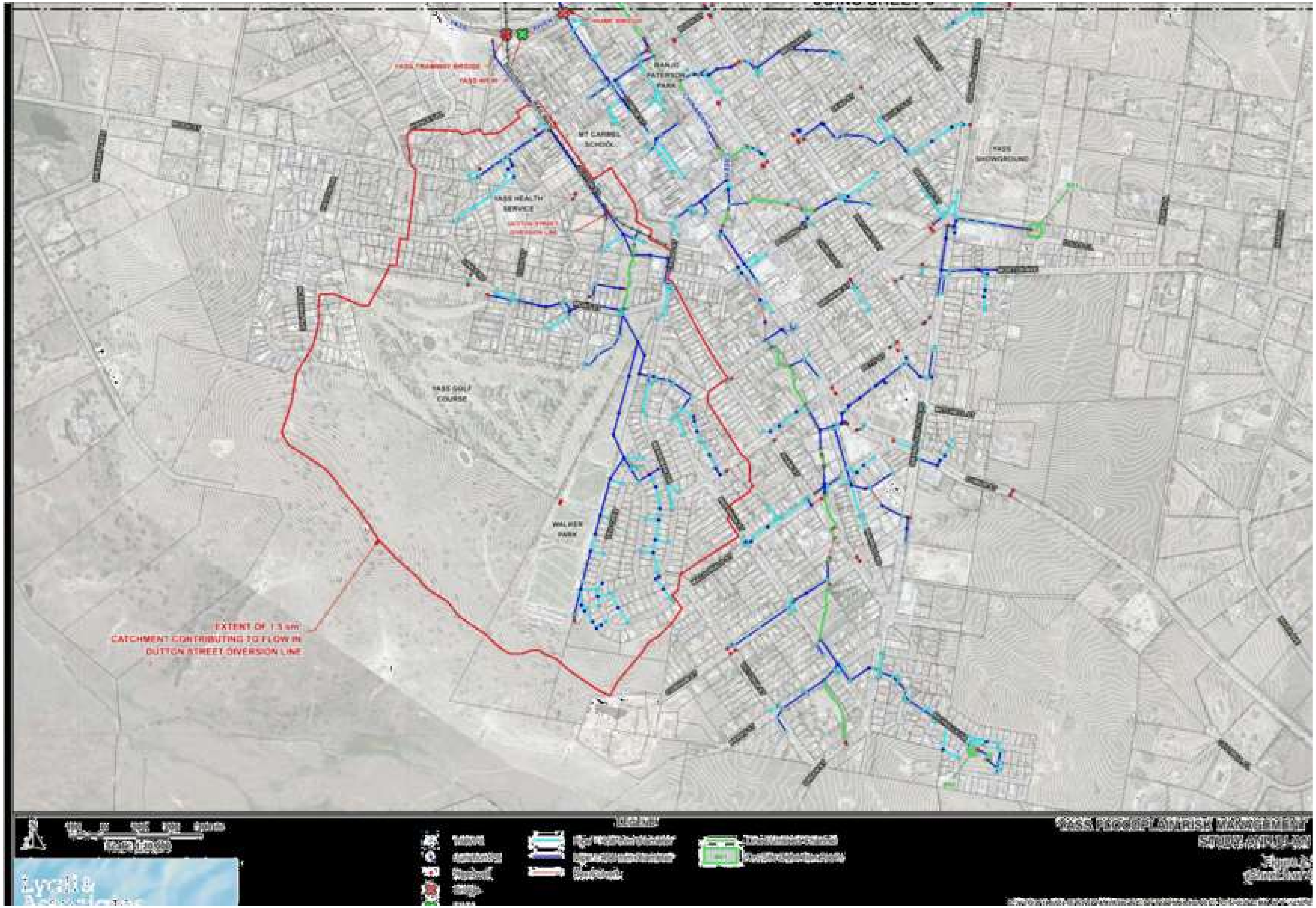
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YASS WEIR
BANJO PATERSON PARK
MT CARMEL SCHOOL
YASS HEALTH SERVICE
DUTTON STREET DIVERSION LINE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK
EXTENT OF 1.5 km
CATCHMENT CONTRIBUTING TO FLOW IN
DUTTON STREET DIVERSION LINE
LEGEND


JOINS SHEET 2
VICTORIA PARK
YASS HIGH SCHOOL
YASS RIVER AT YASS
JOINS SHEET 4
LEGEND


INSET 1
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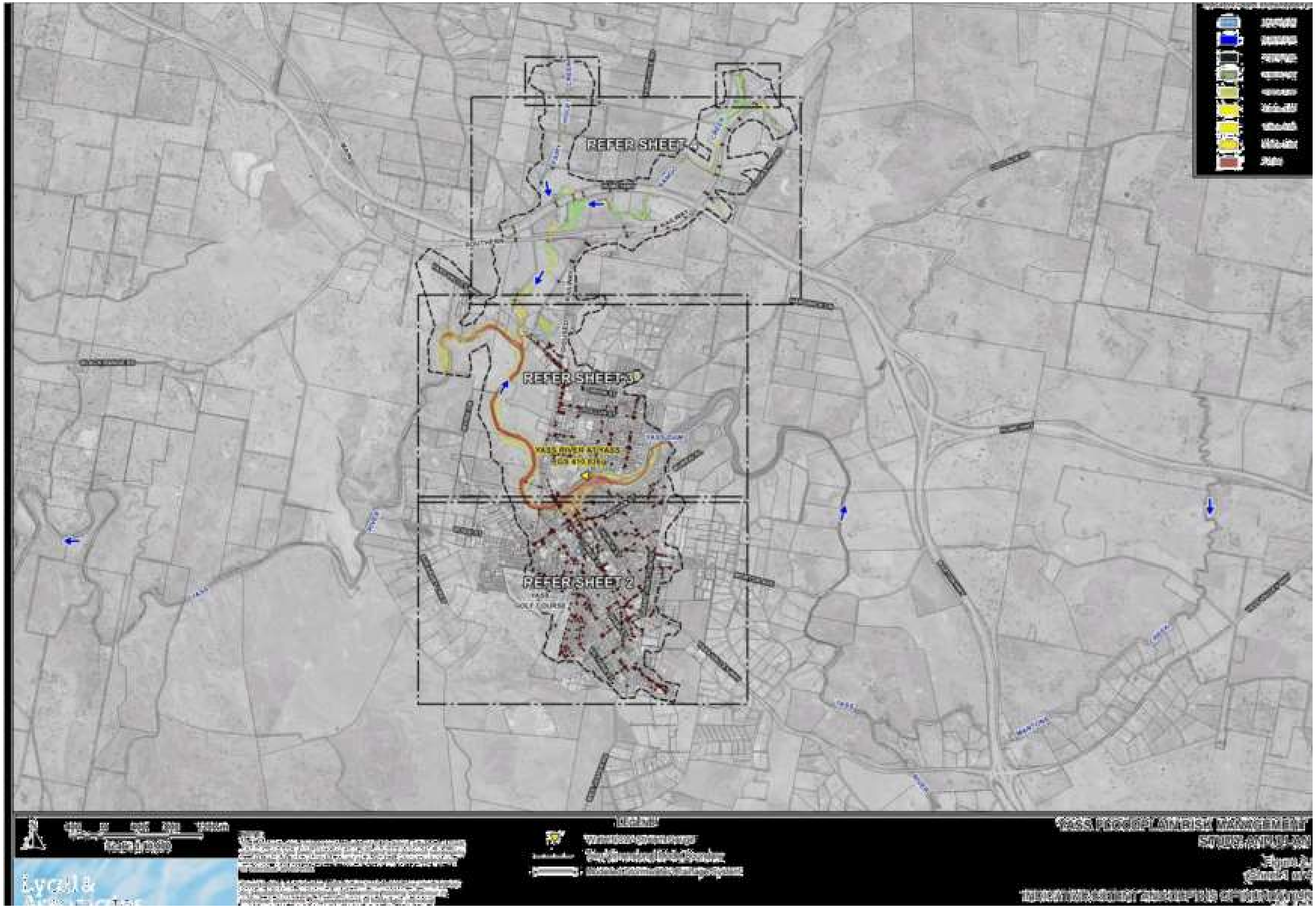
REFER INSET 2
INSET 2
JOINS SHEET 3
SOUTHERN
MAIN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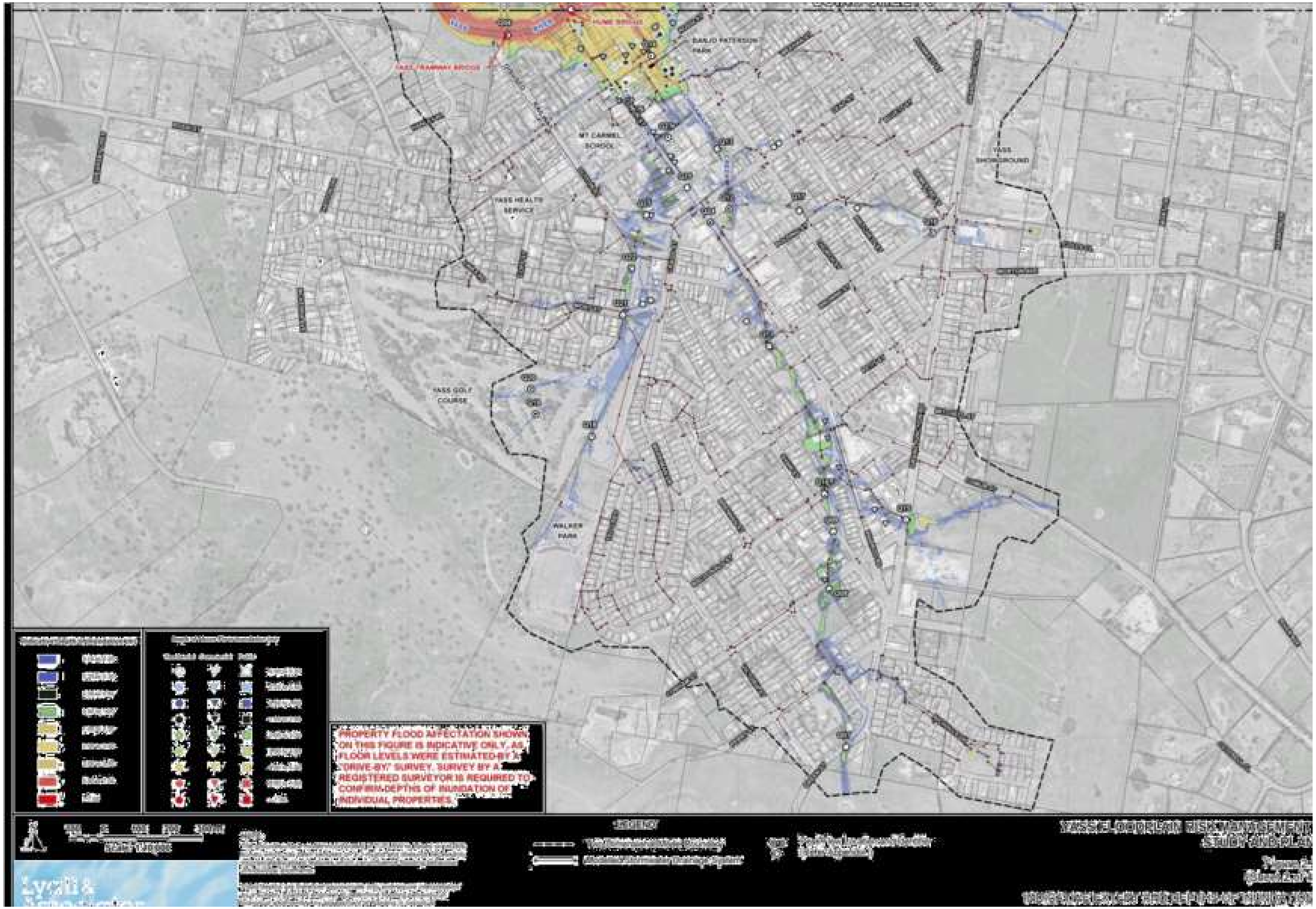
LEGEND


BANJO PATERSON PARK
MT CARMEL SCHOOL
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK
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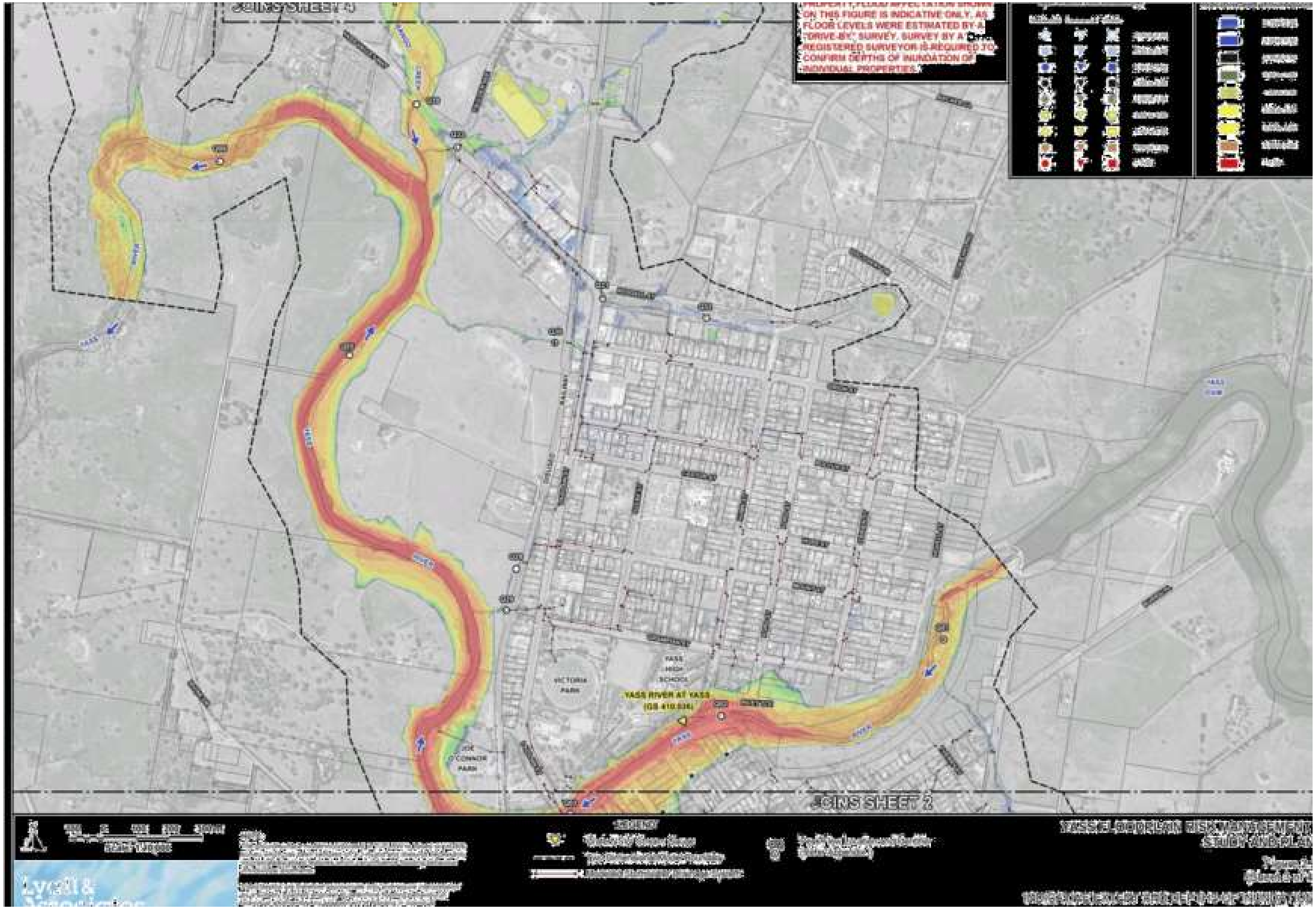
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VICTORIA PARK
YASS HIGH SCHOOL
JOE O'CONNOR PARK
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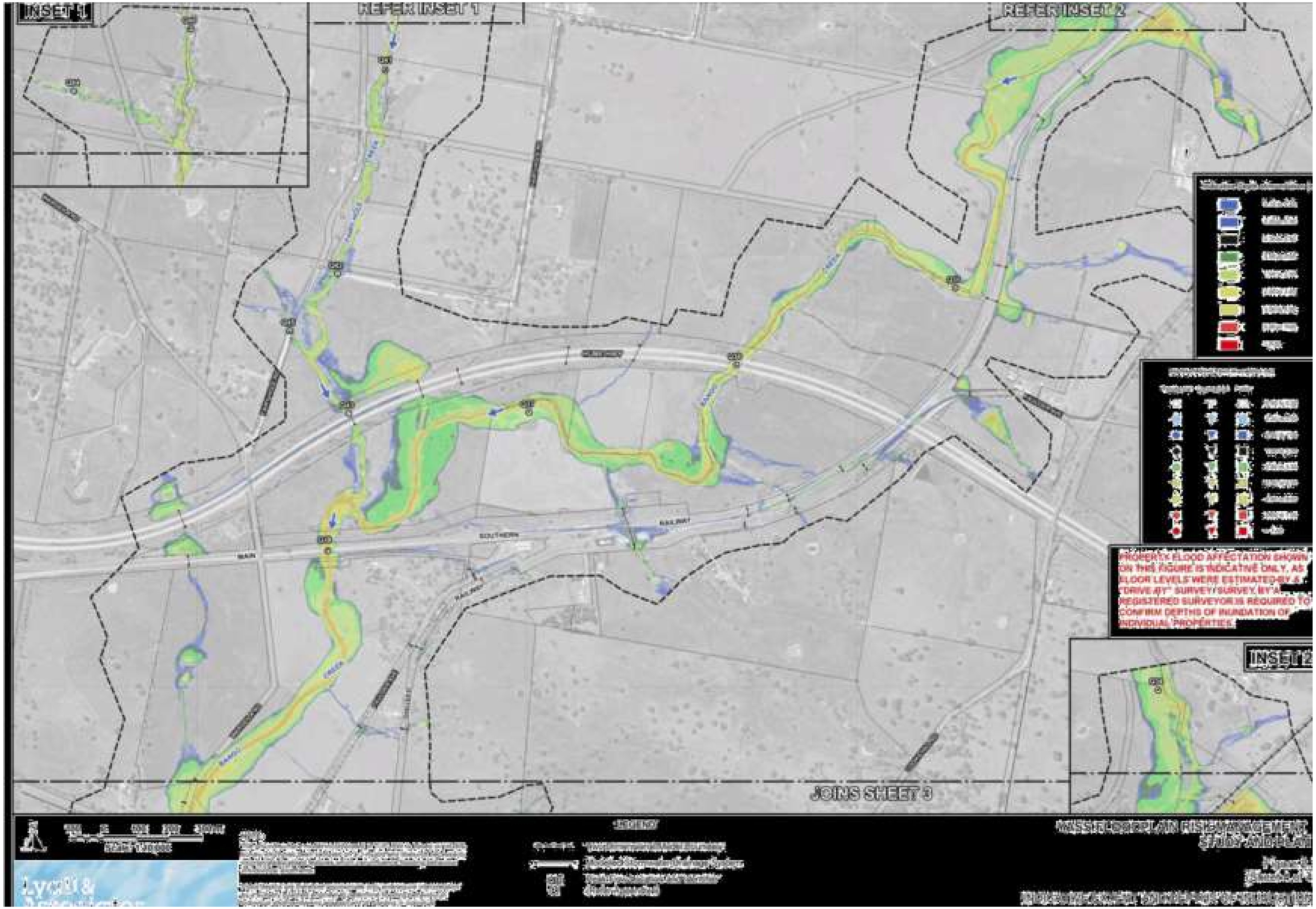
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SOUTHERN
RAILWAY
MAIN
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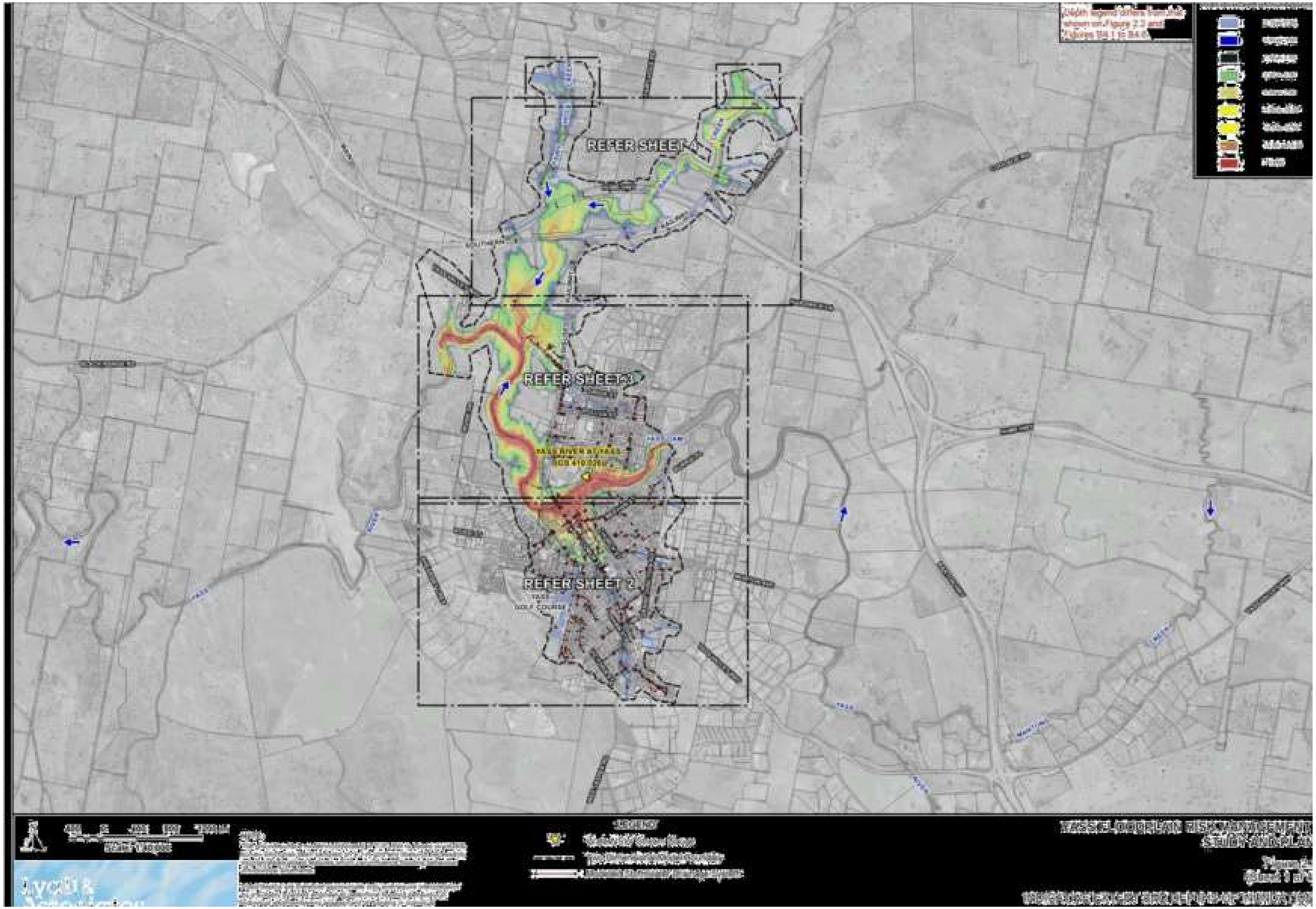
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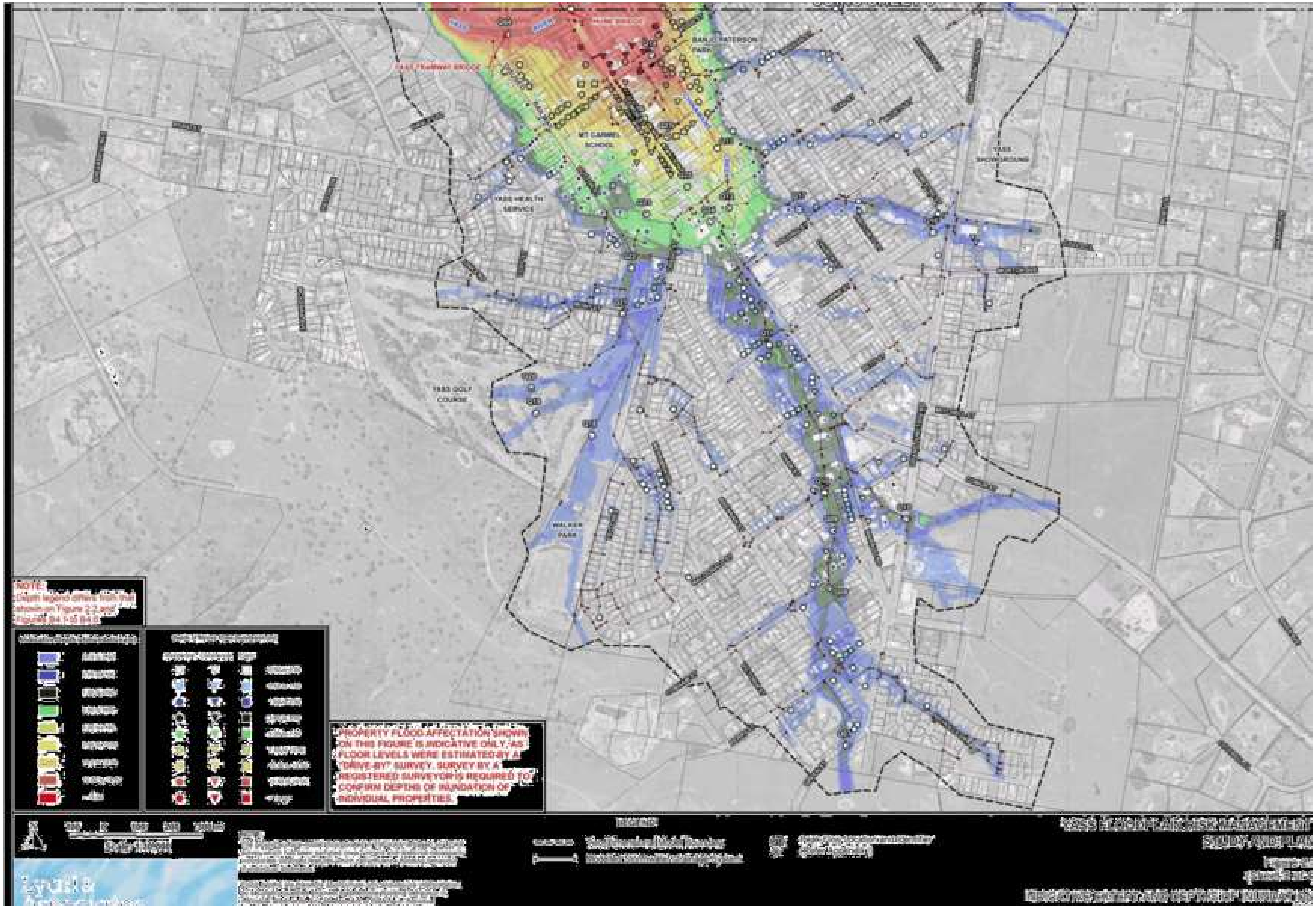
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YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK
NOTE:
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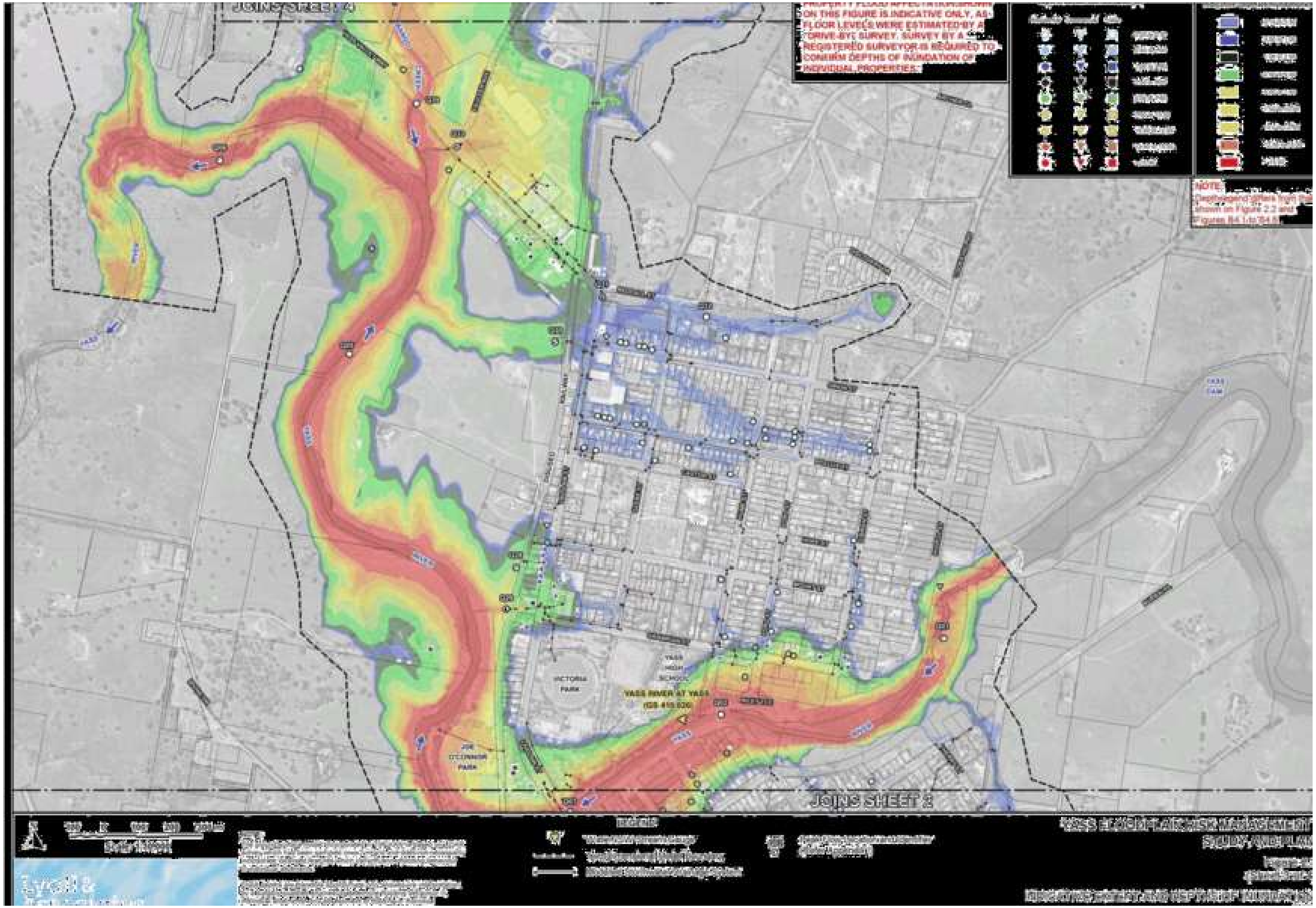
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NOTE:
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YASS HIGH SCHOOL
YASS RIVER AT YASS (GS 410 026)
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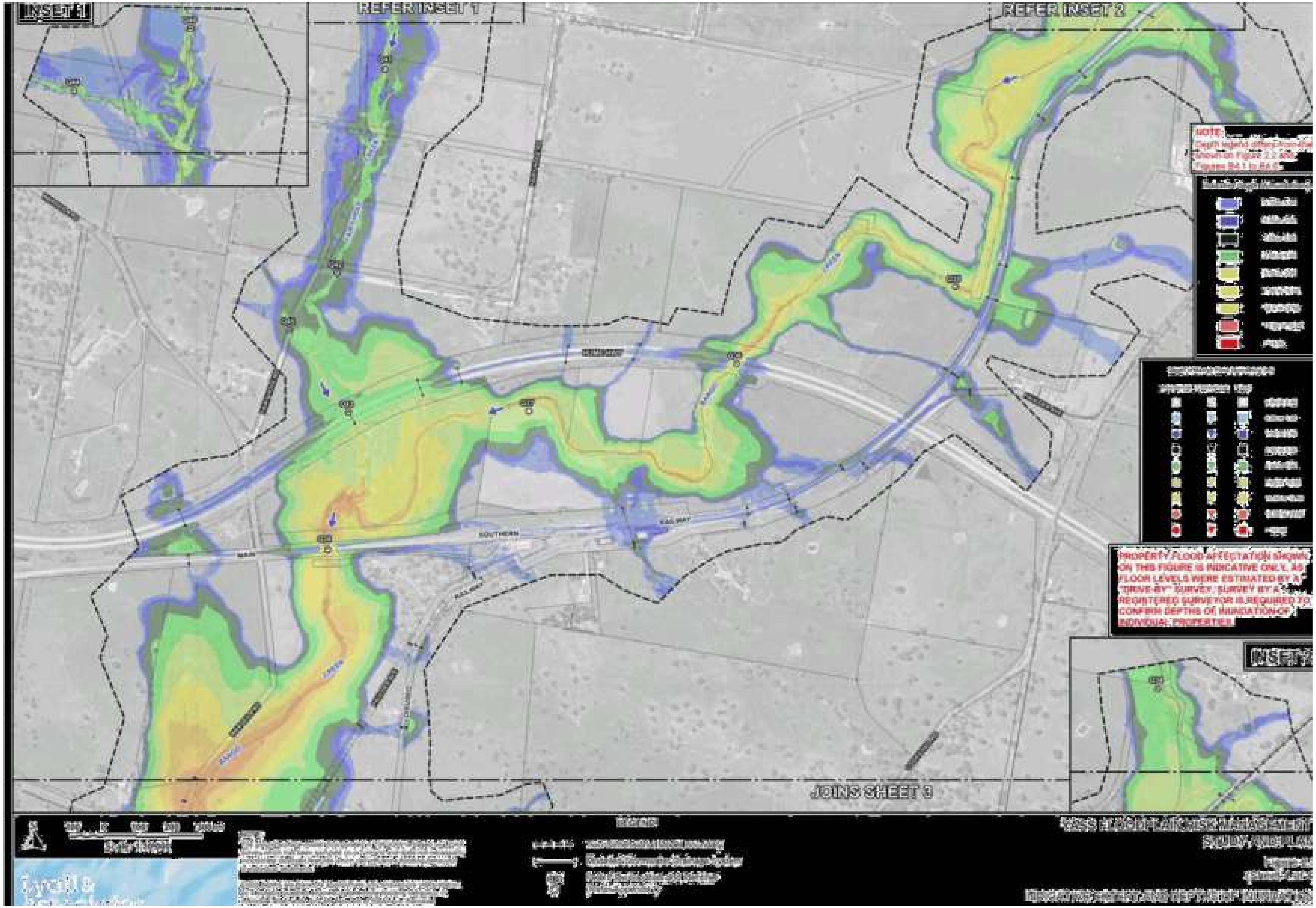
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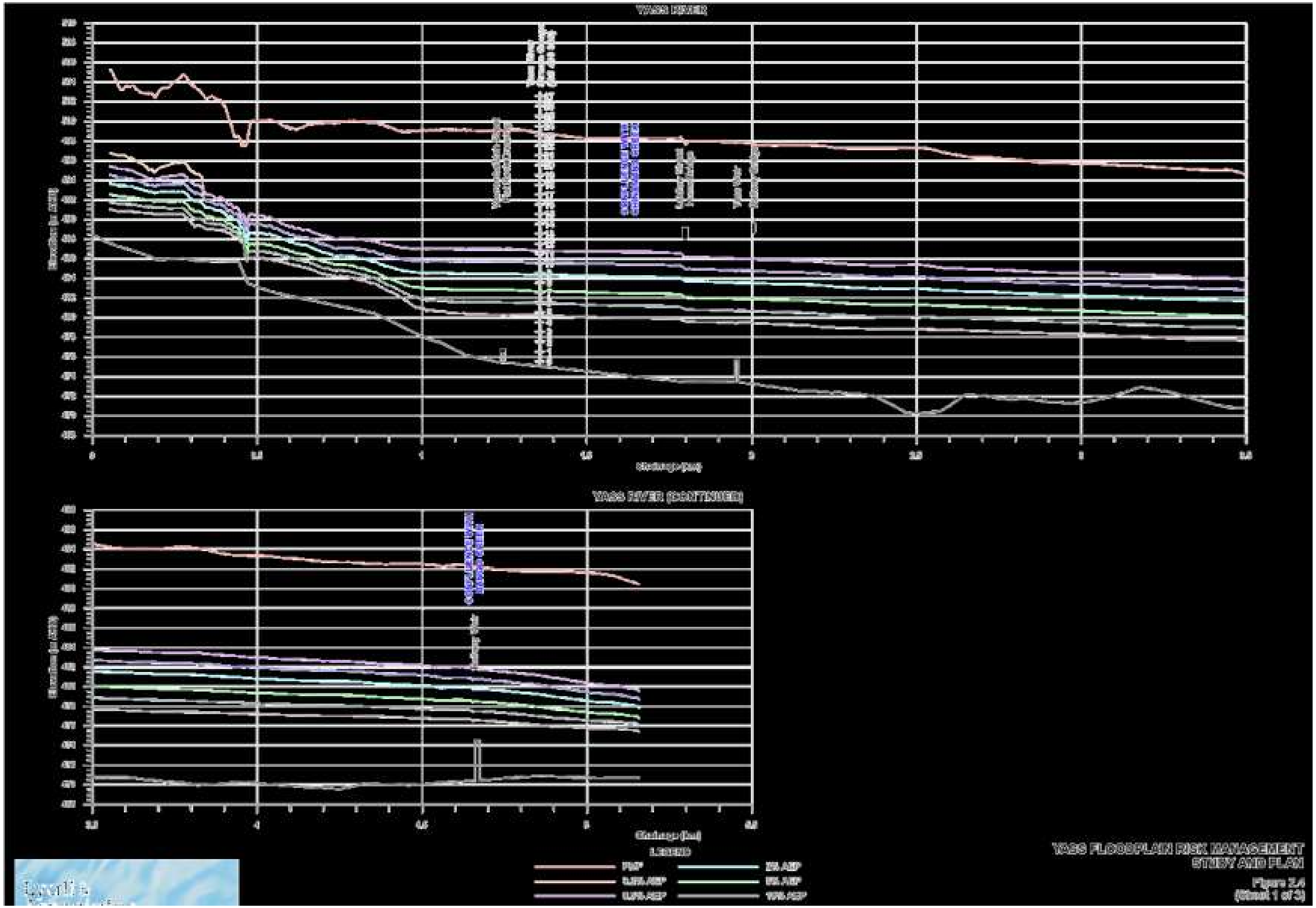
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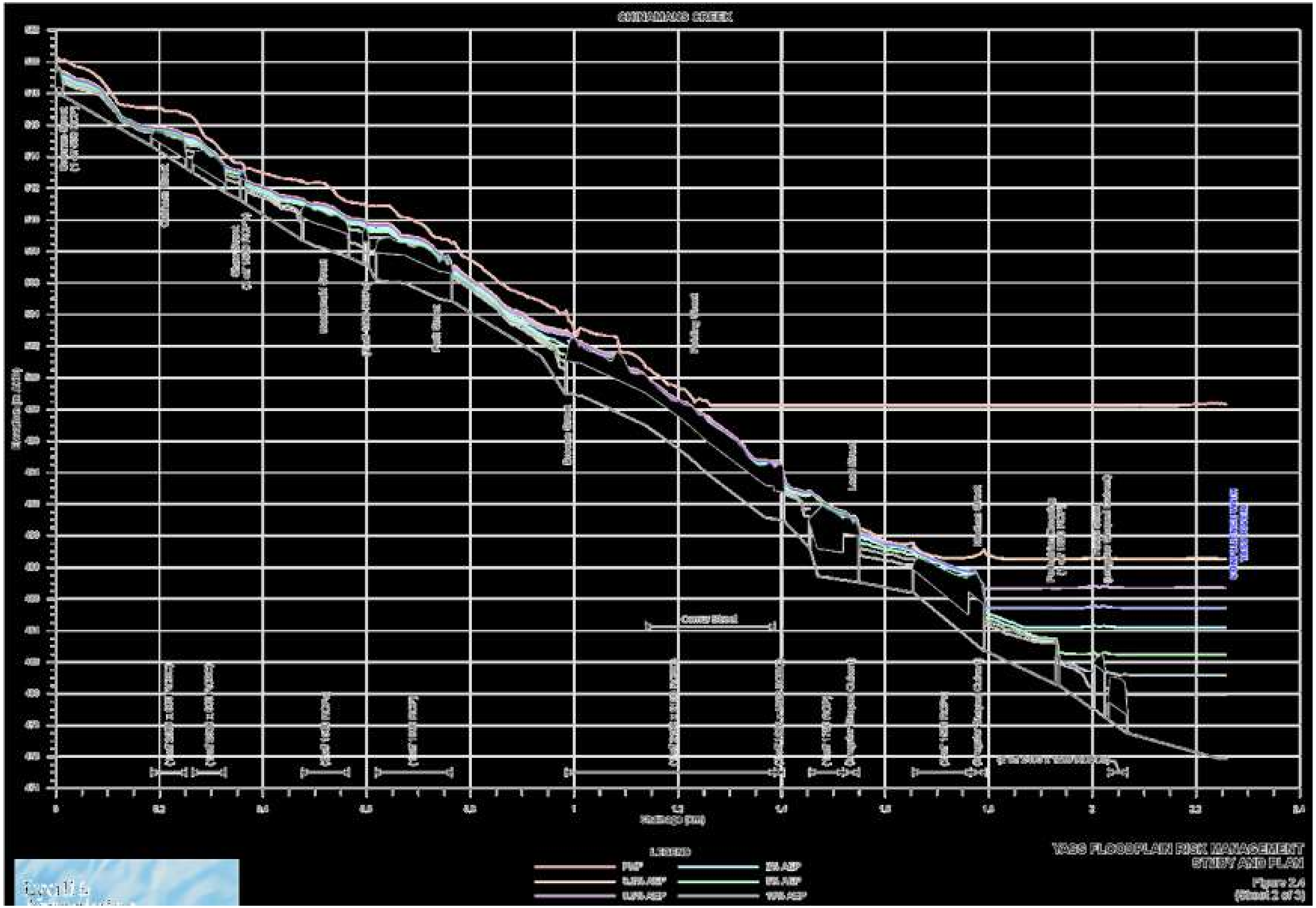
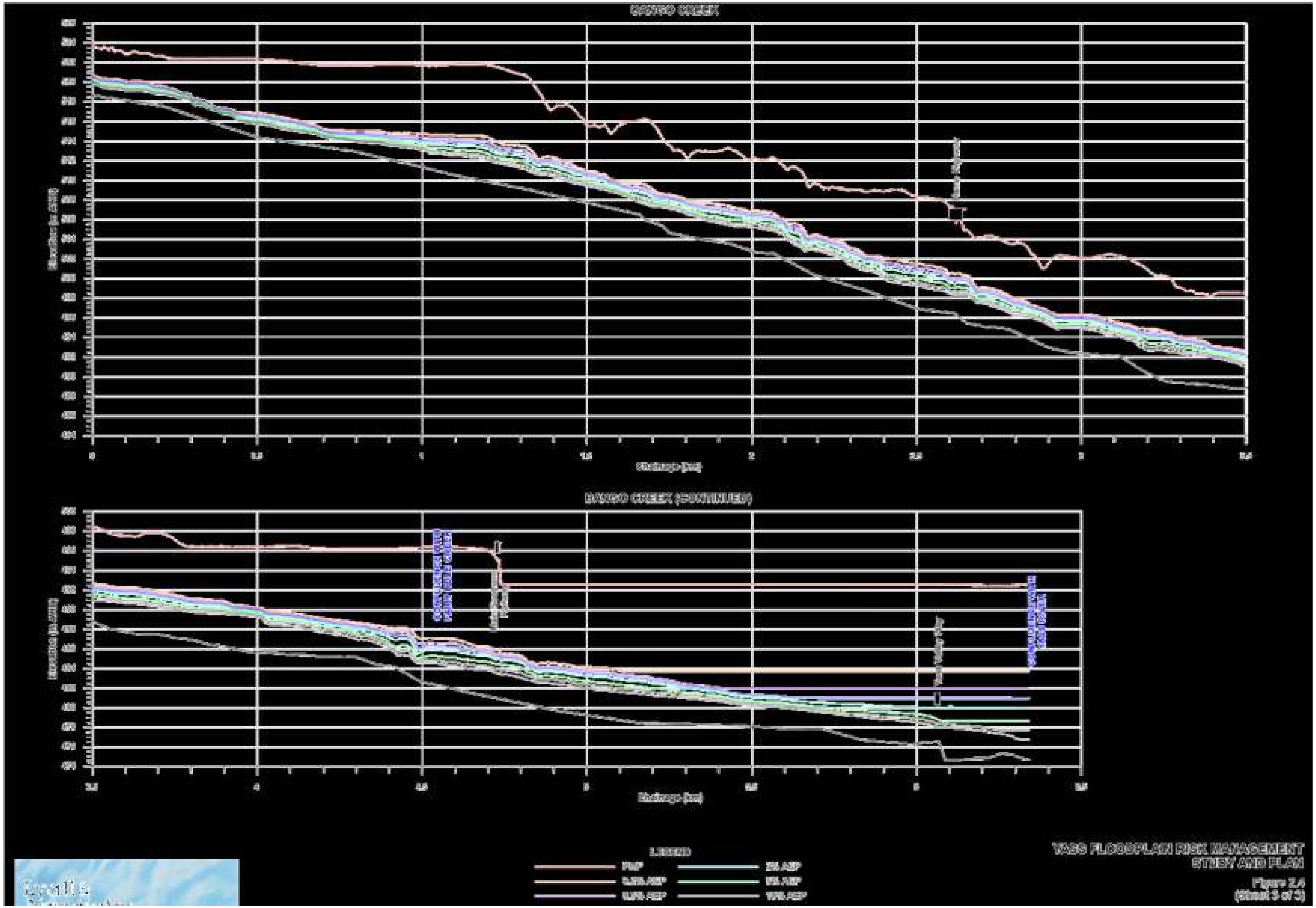
YASS RIVER (CONTINUED)
YASS FLOODPLAIN RISK MANAGEMENT
STUDY AND PLAN
Figure 2.4
(Sheet 1 of 3)


CHINAMANS CREEK
LEGEND
PMF
YASS FLOODPLAIN RISK MANAGEMENT
STUDY AND PLAN
Figure 2.4
(Sheet 2 of 3)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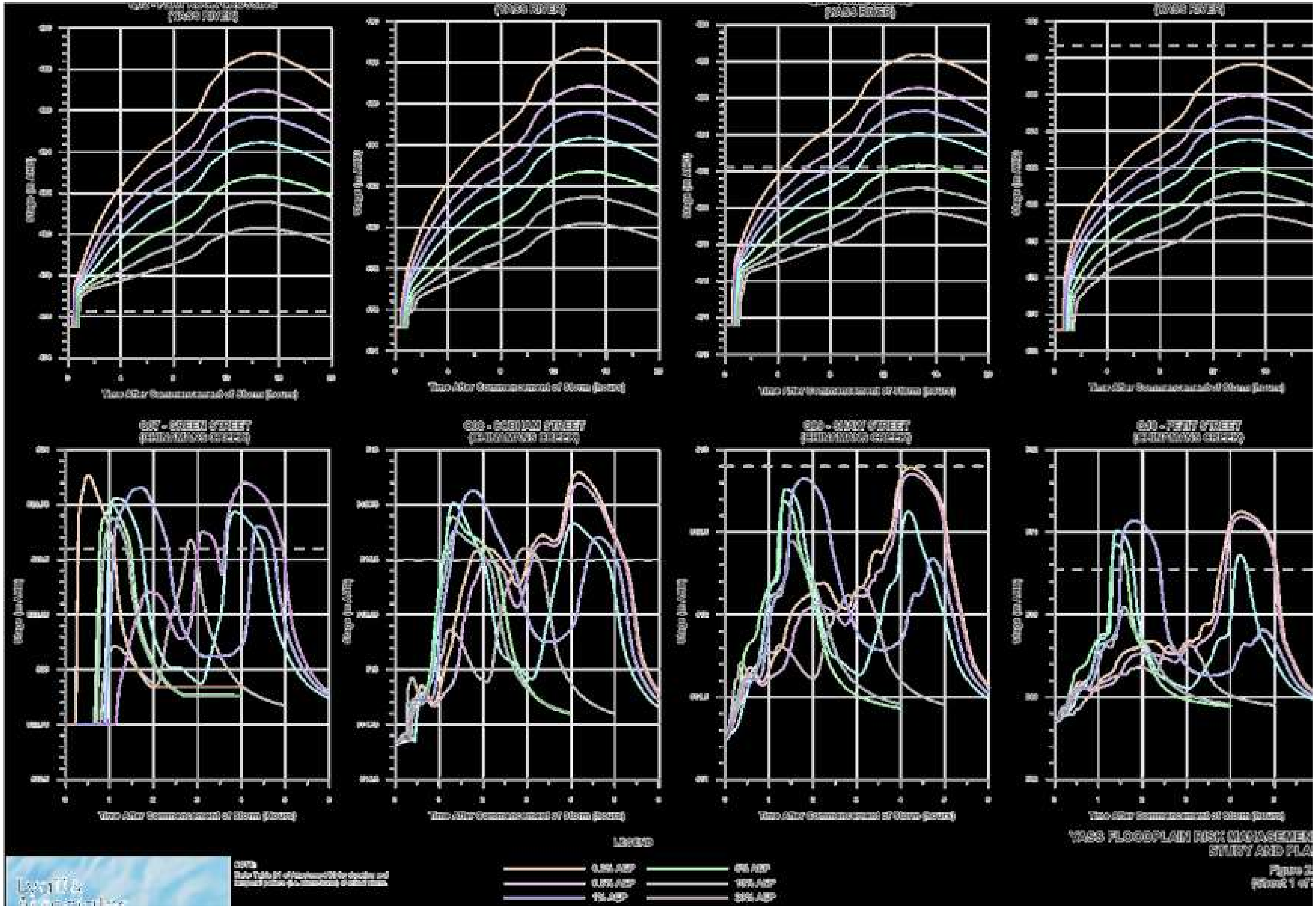
STUDY AND PLAN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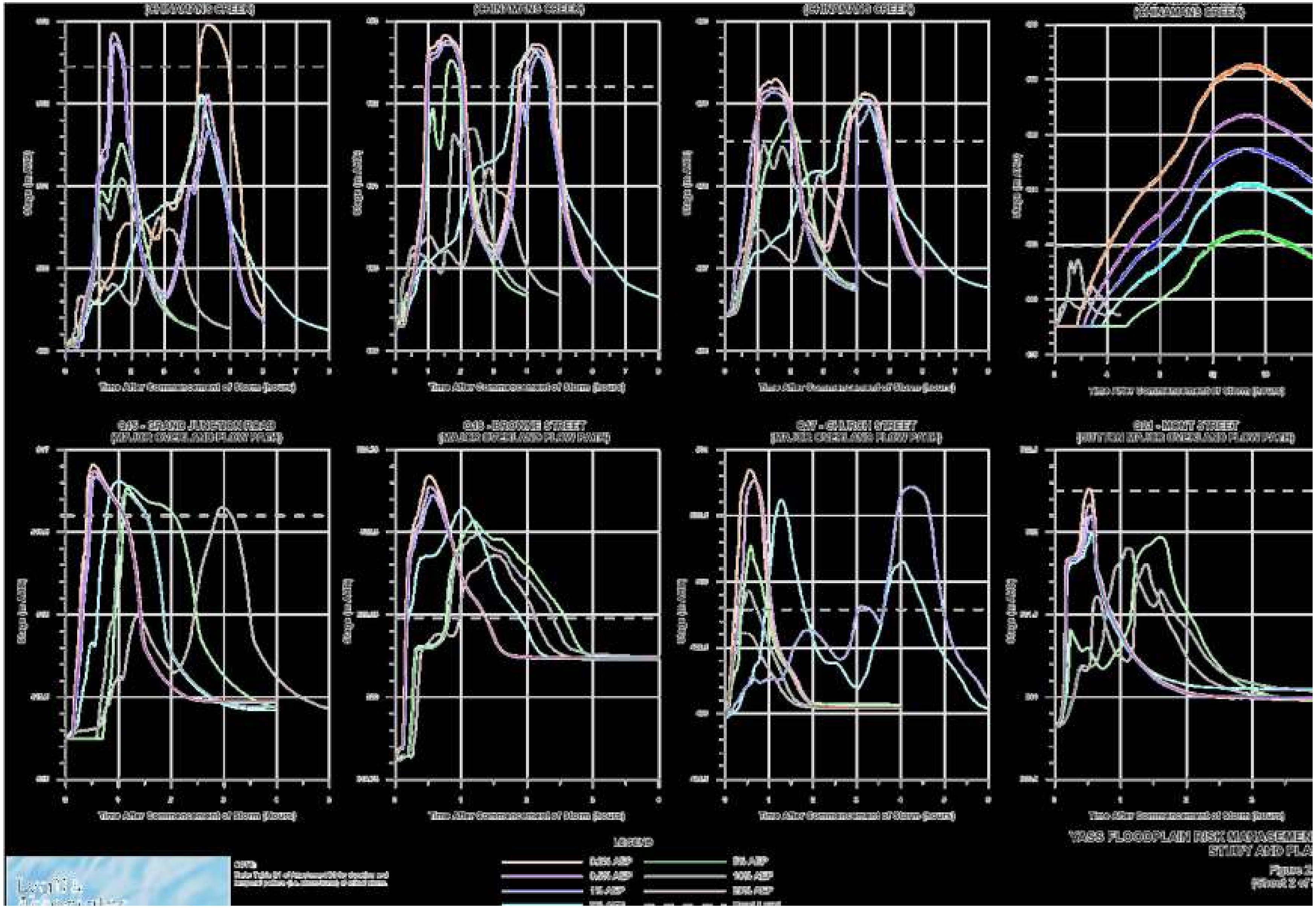
LEGEND
1% AEP
20% AEP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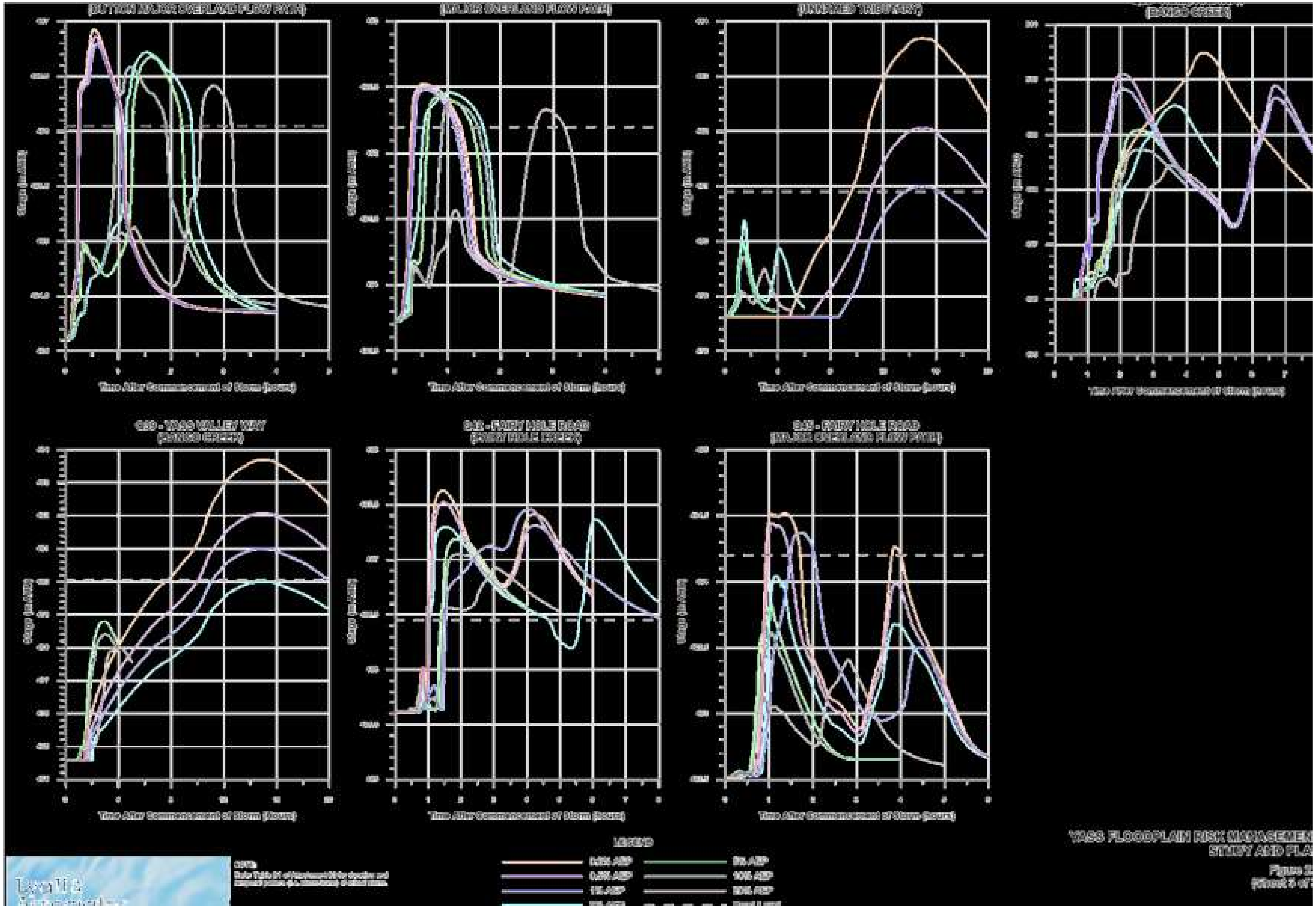
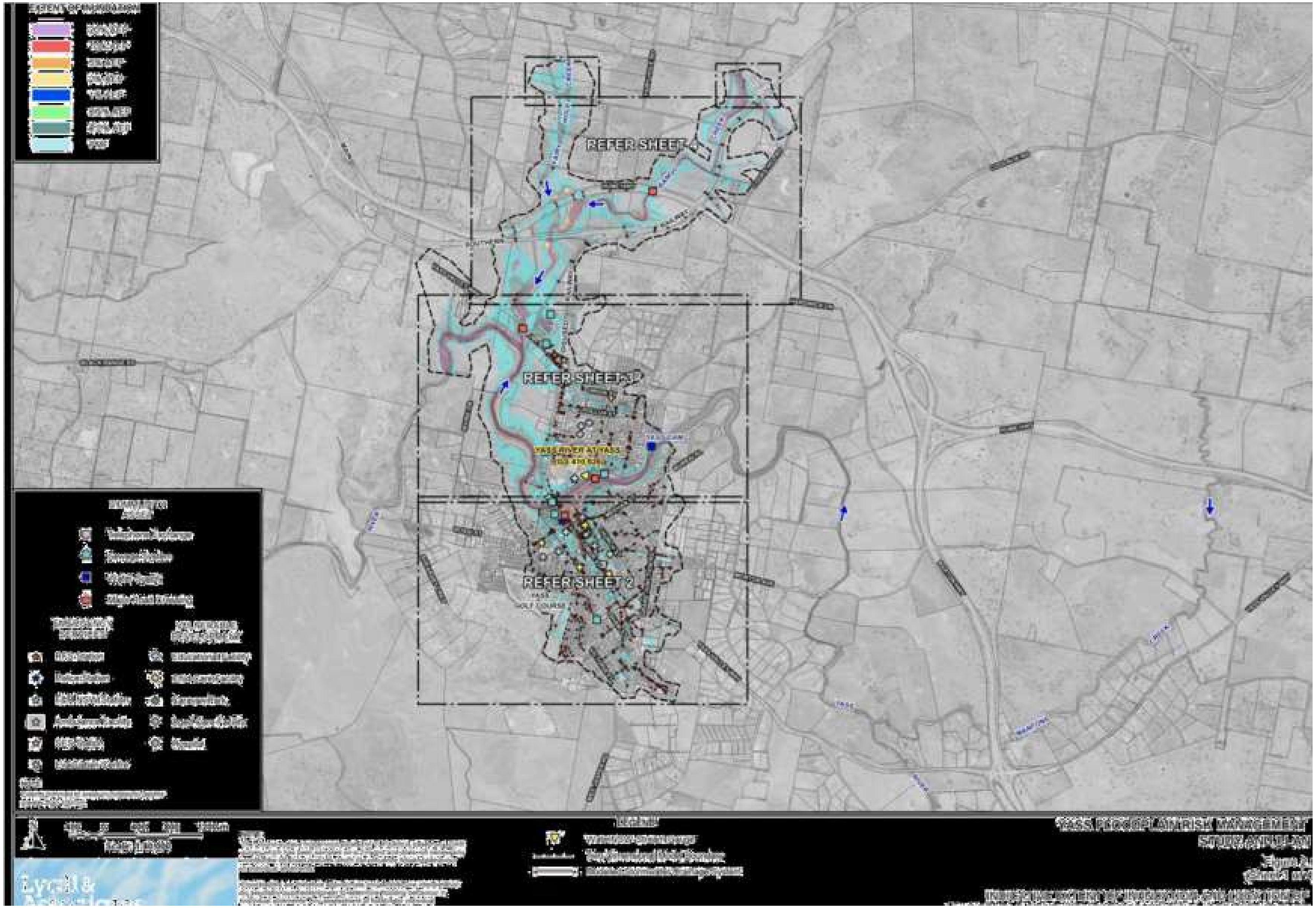
10% AEP

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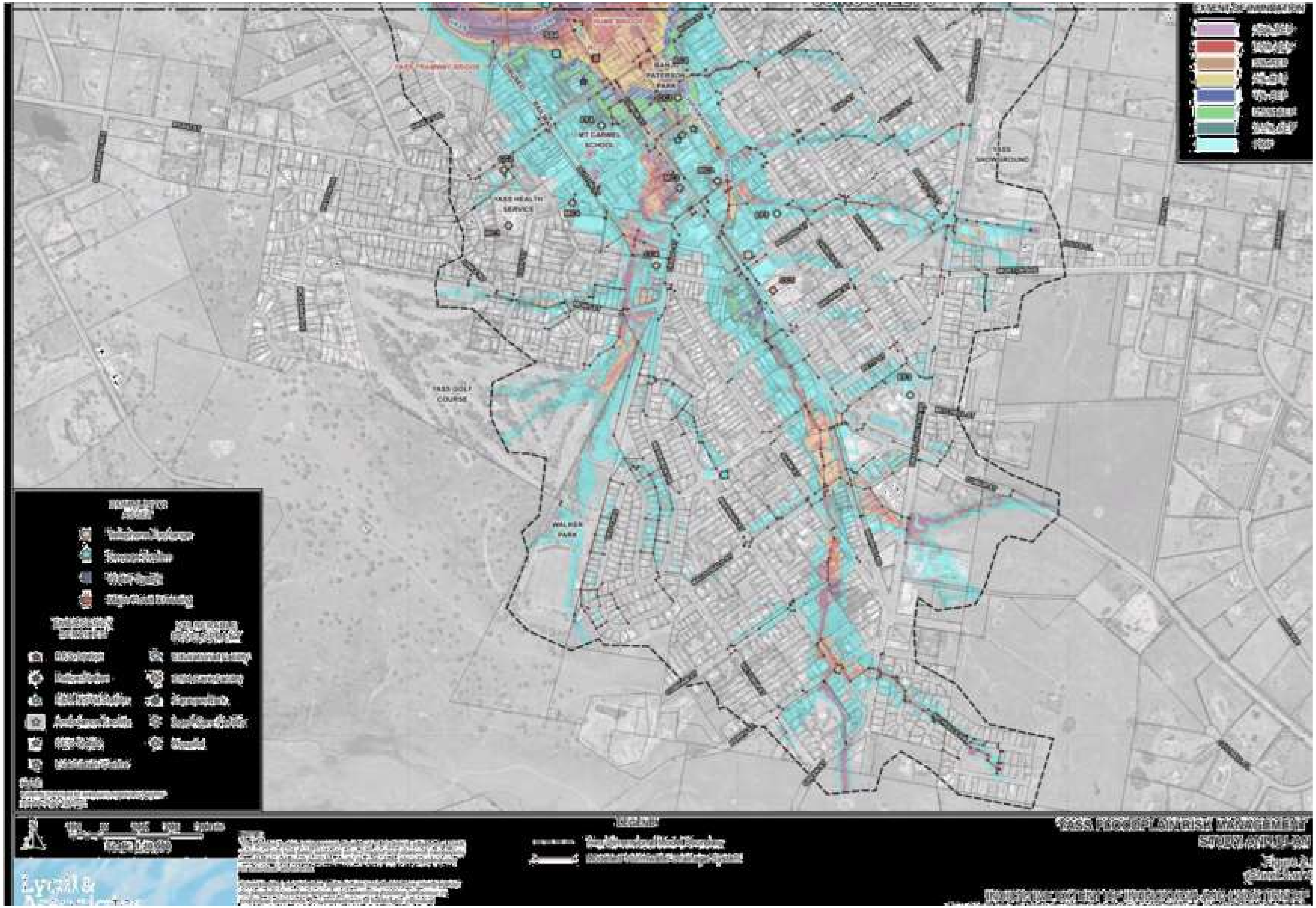
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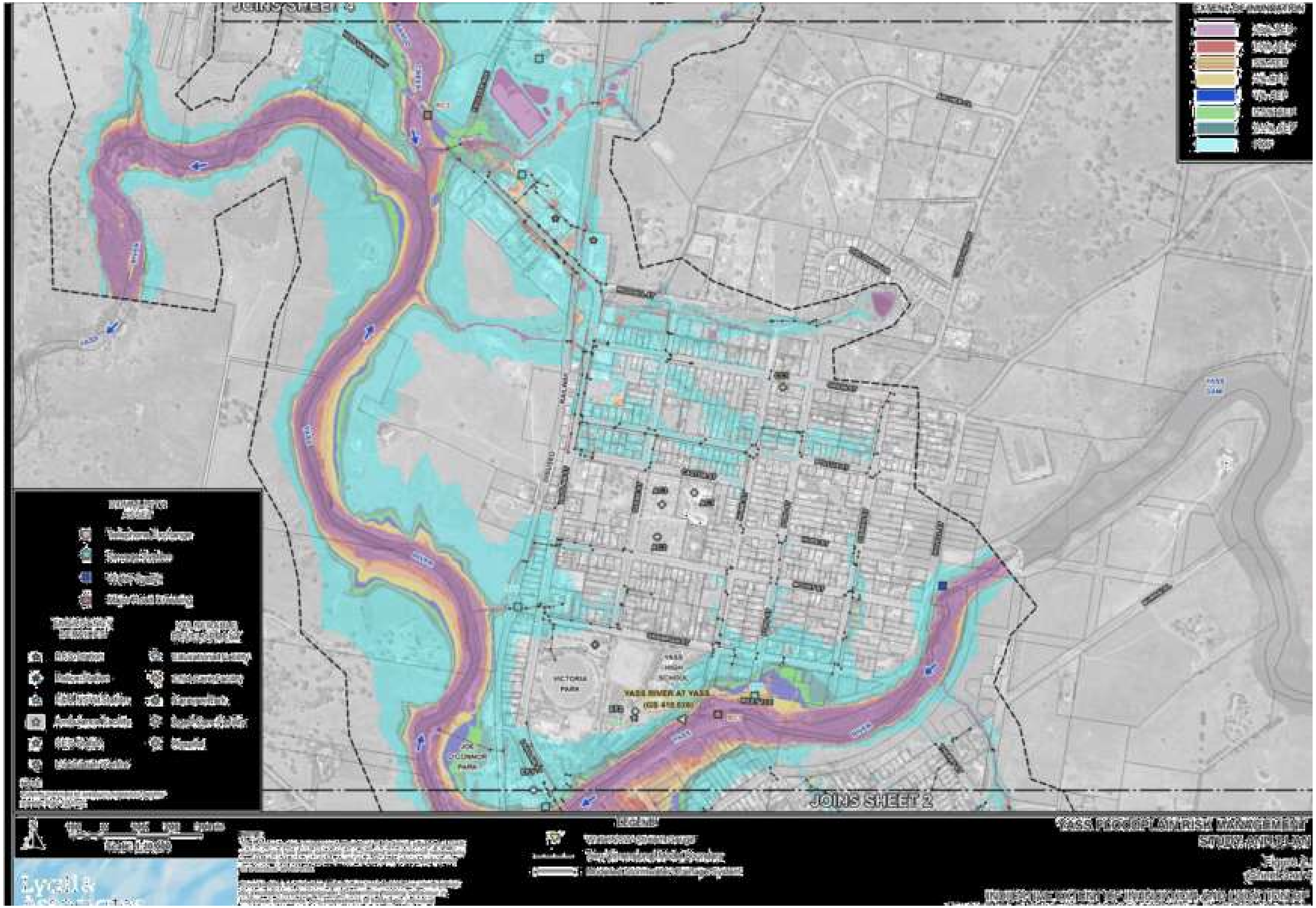
YASS HEALTH SERVICE
YASS GOLF COURSE
WALKER PARK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YASS RIVER AT YASS
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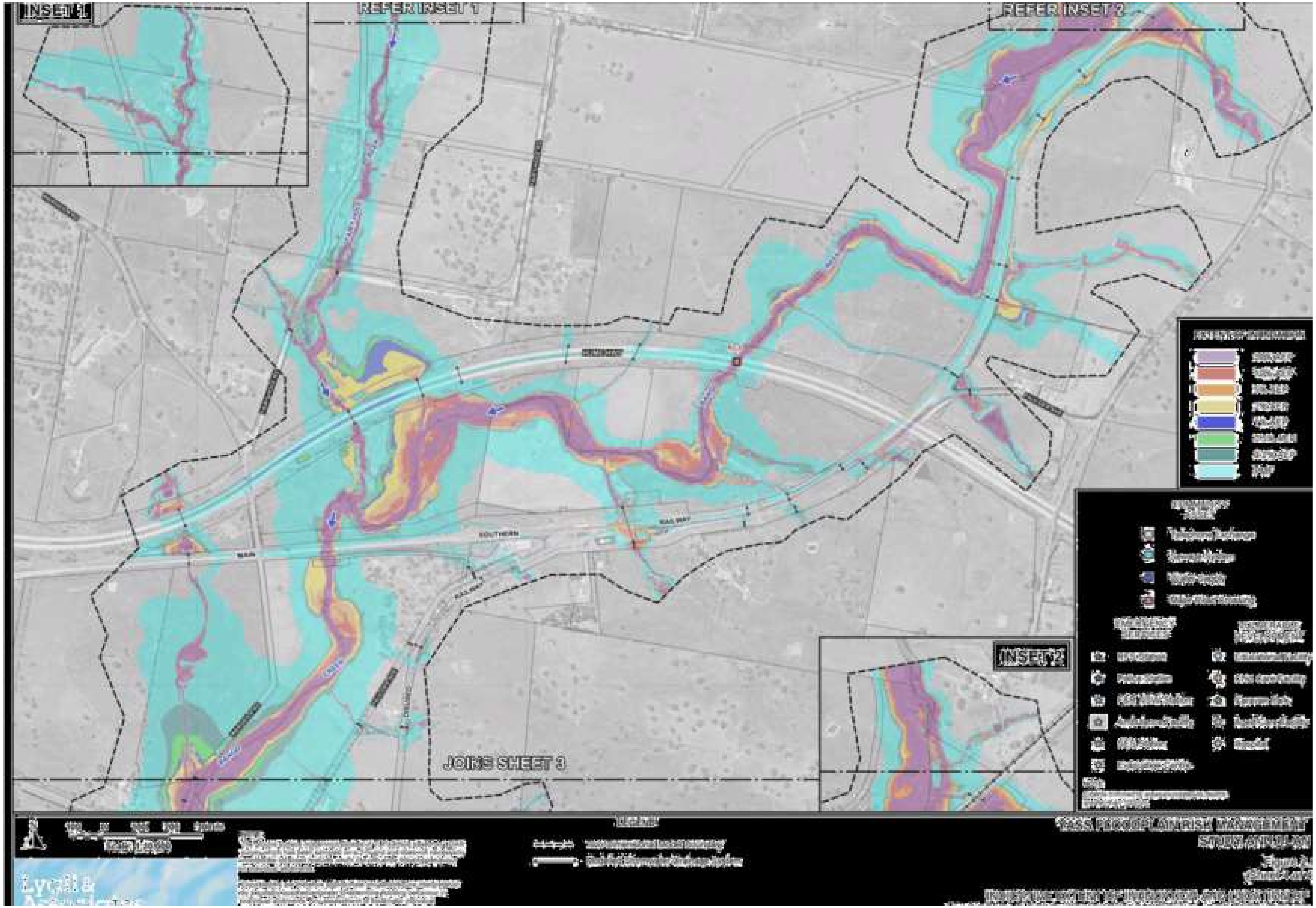
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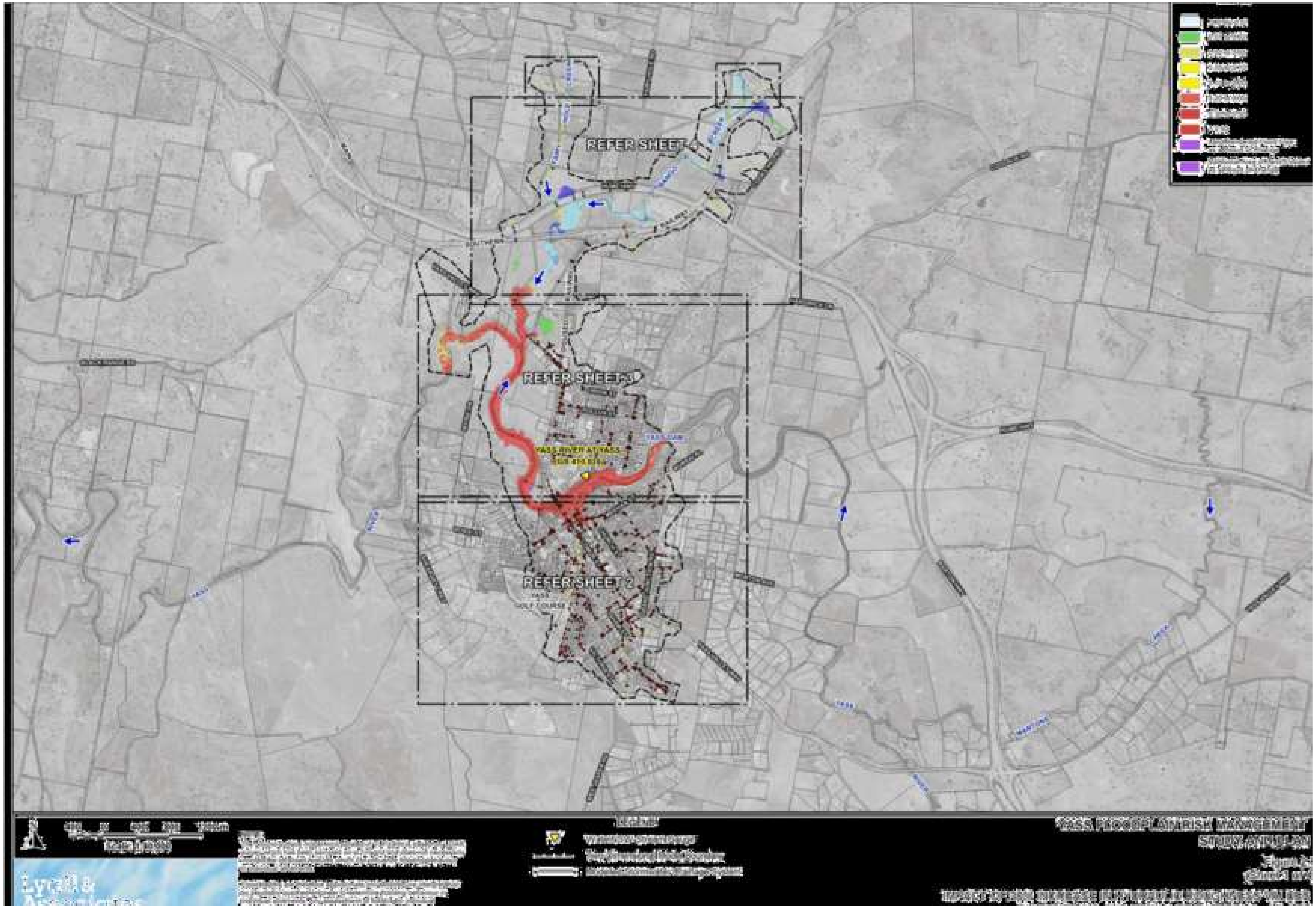
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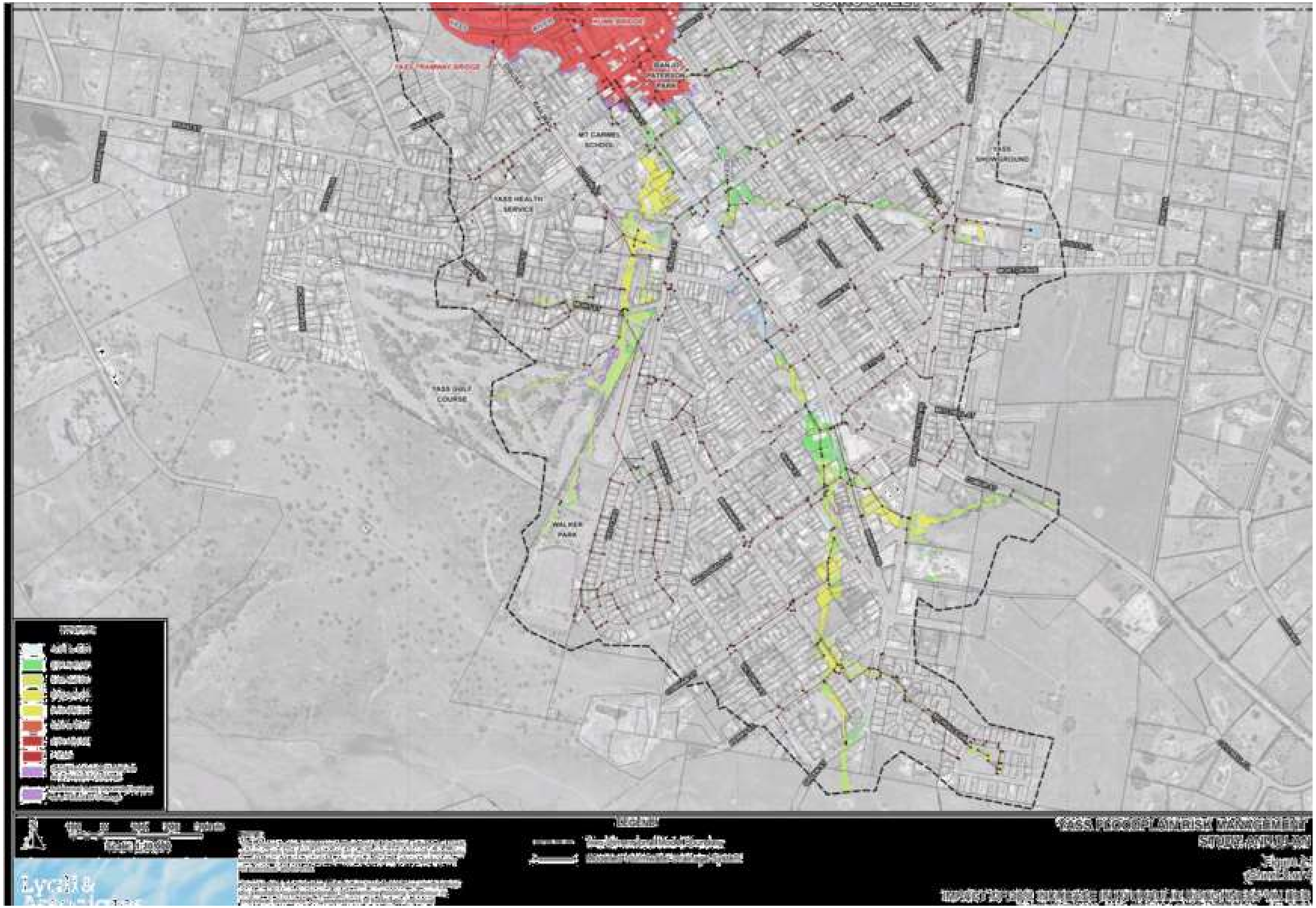
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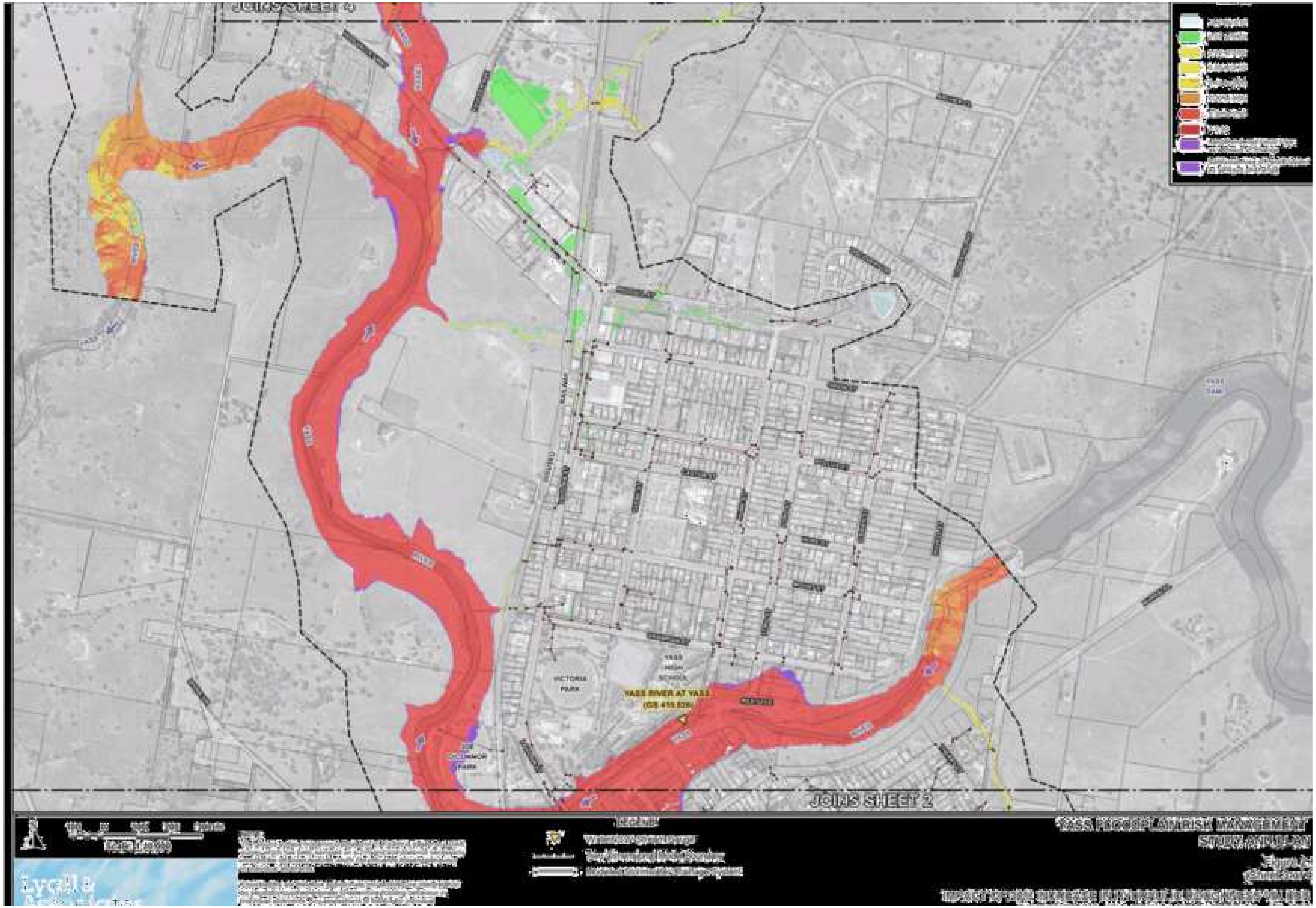
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK
LEGEND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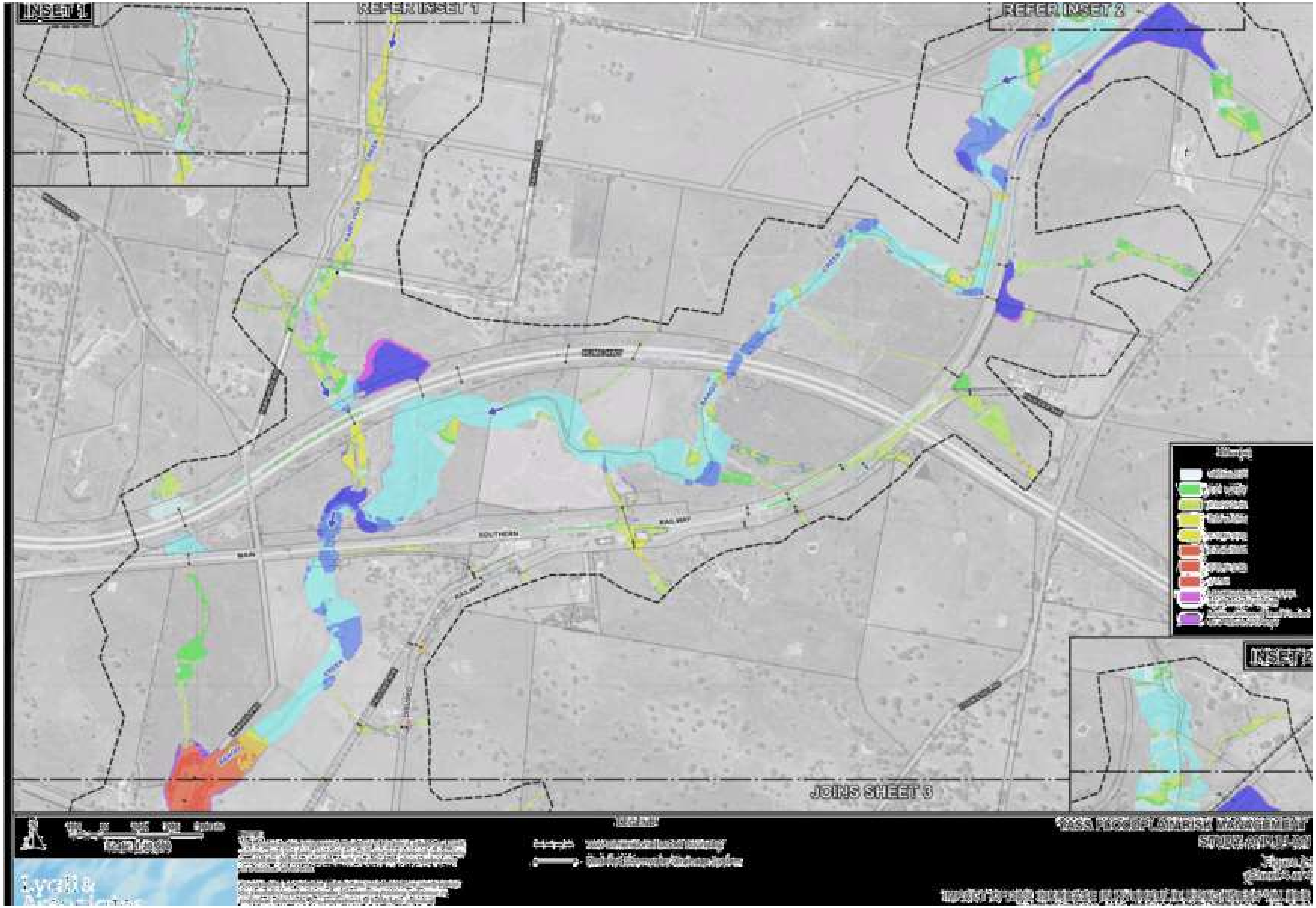
YASS RIVER AT YASS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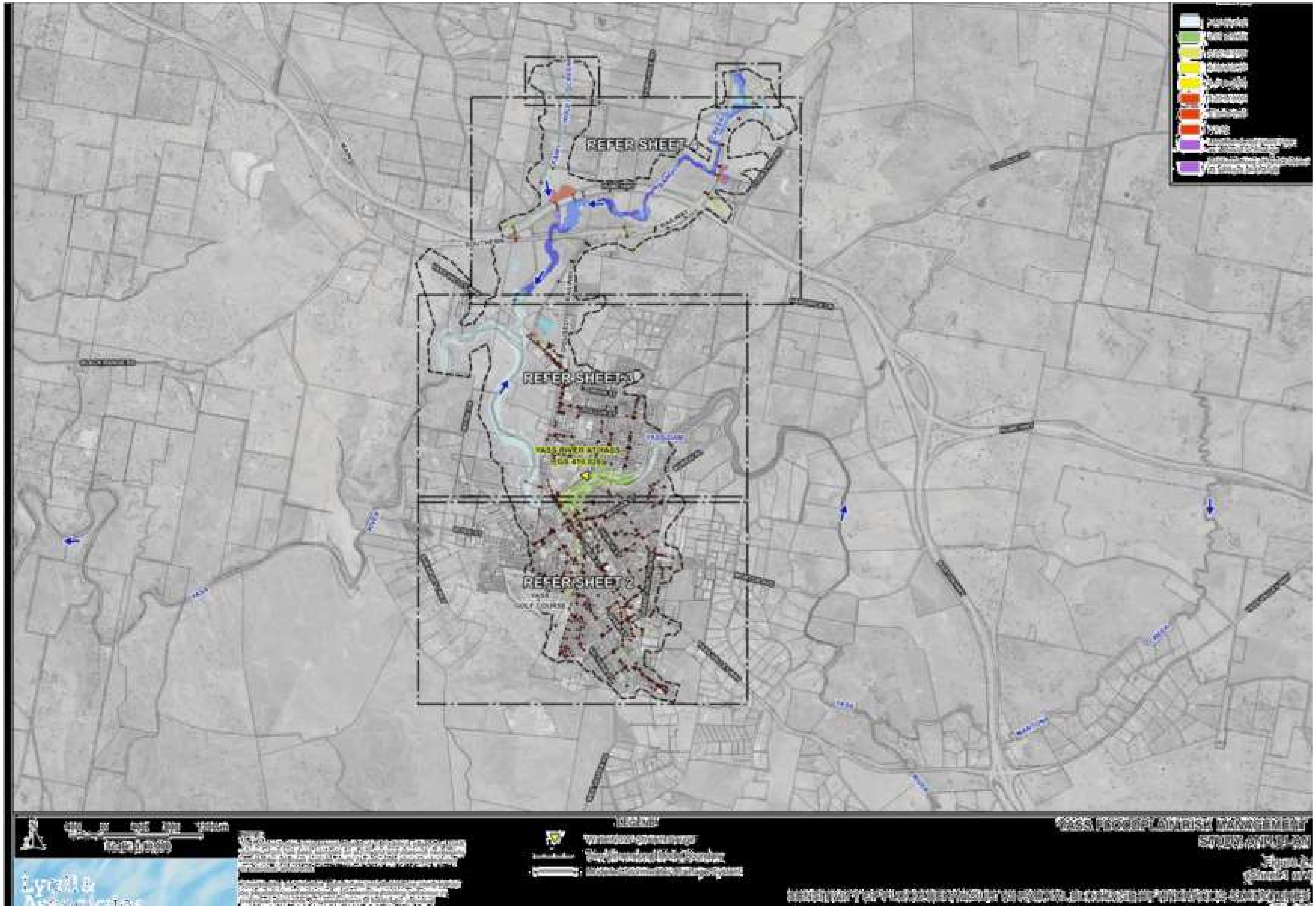
RAILWAY
MAIN
LEGEND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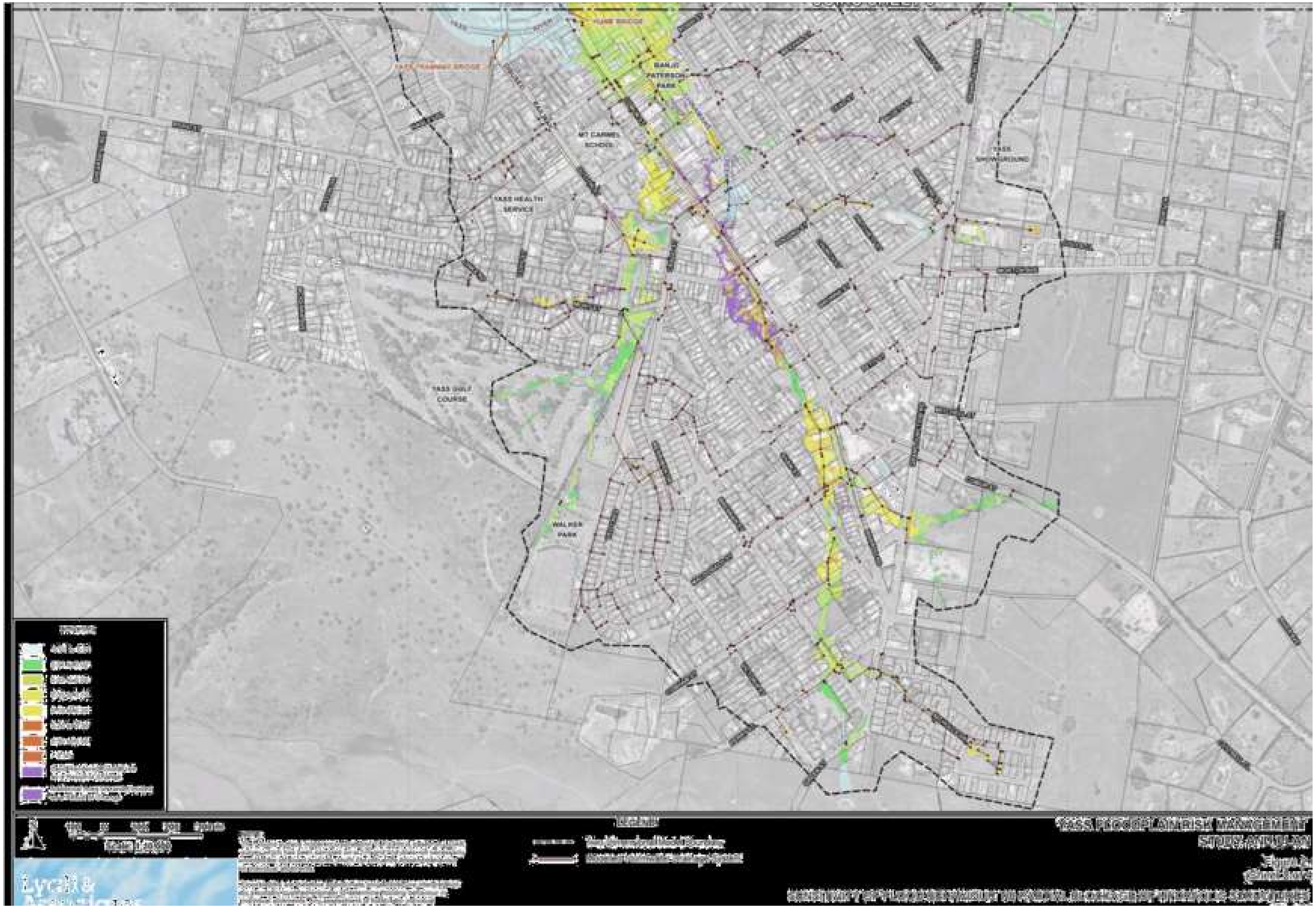
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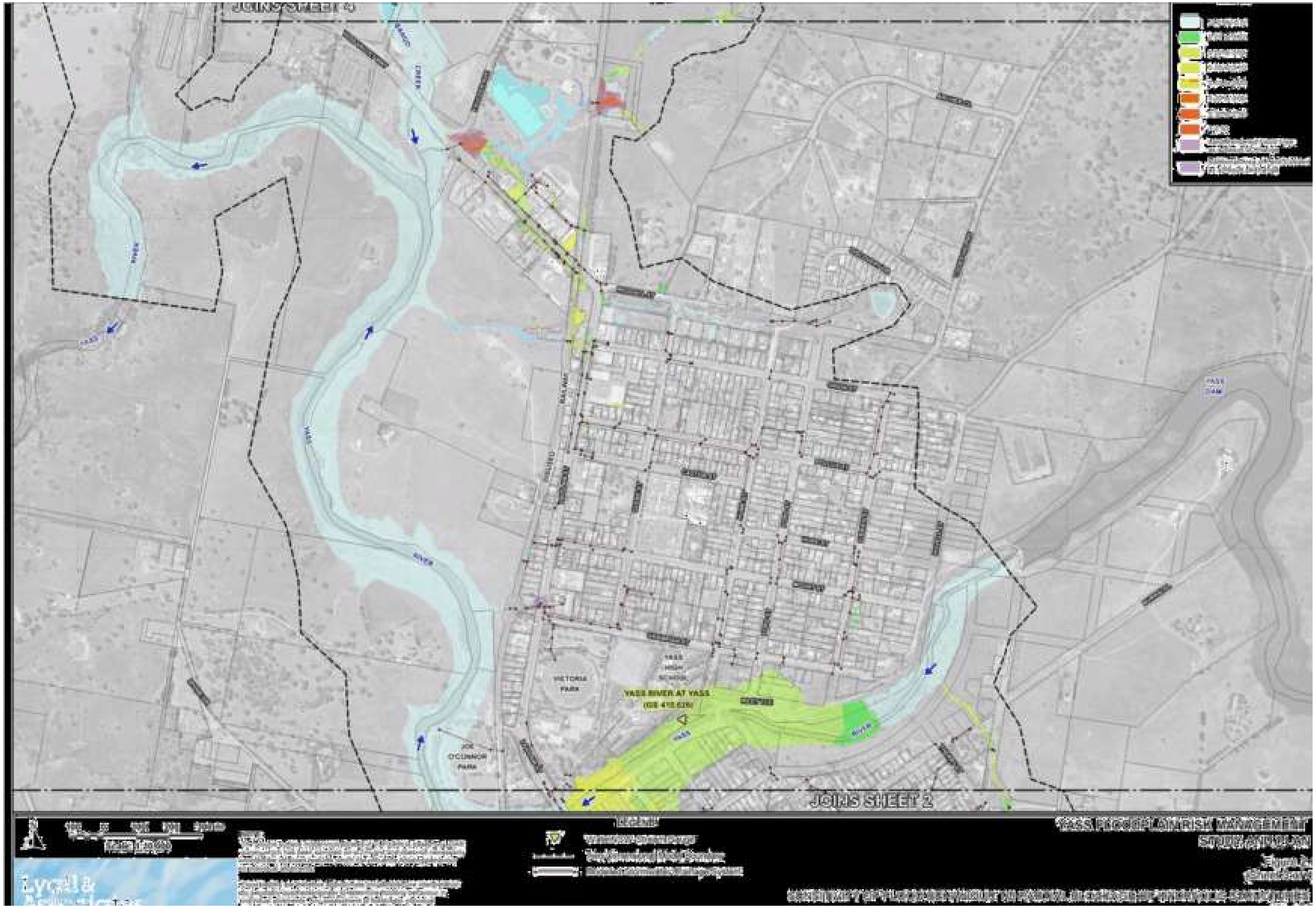
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK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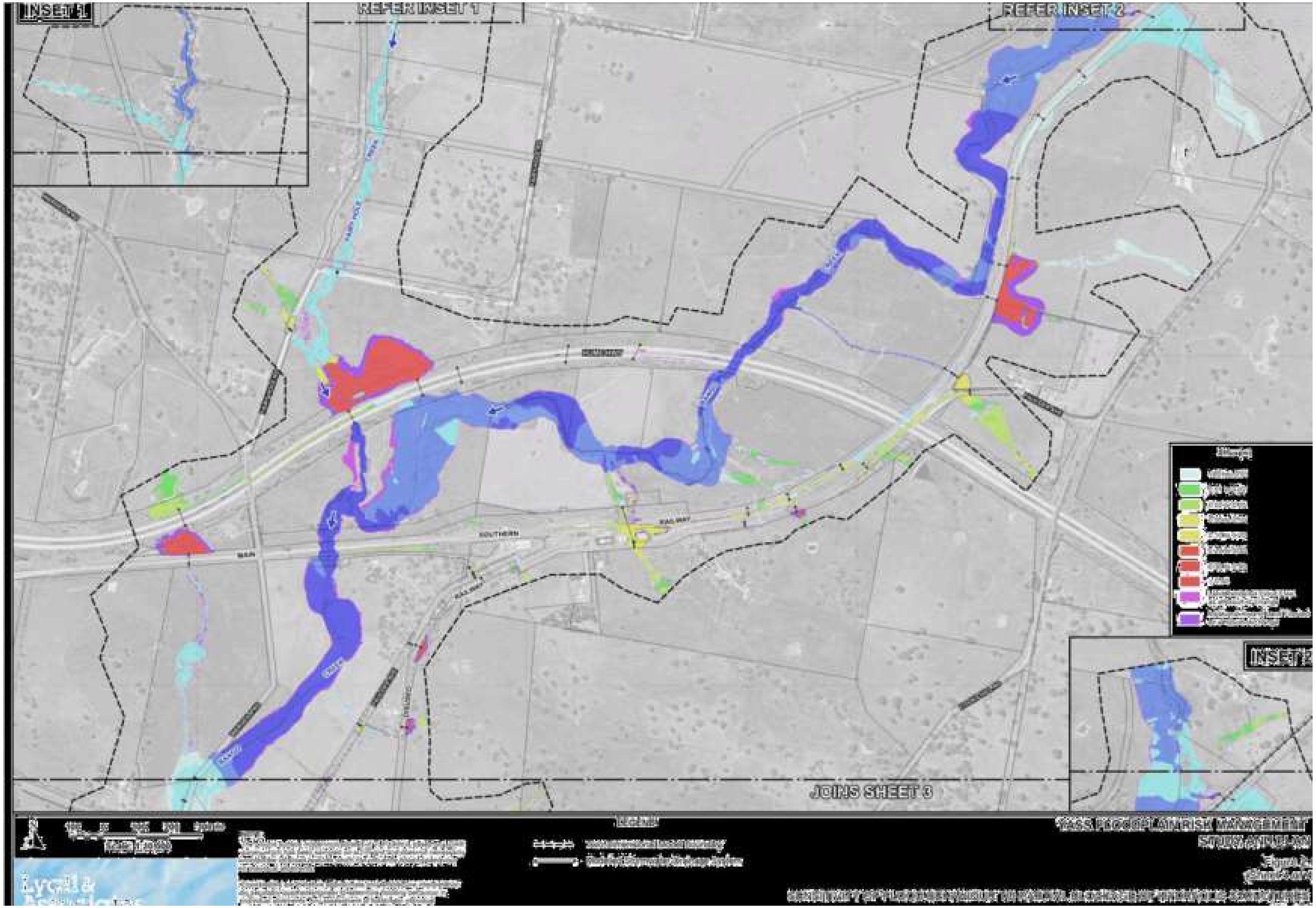
YASS RIVER AT YASS
JOINS SHEET 2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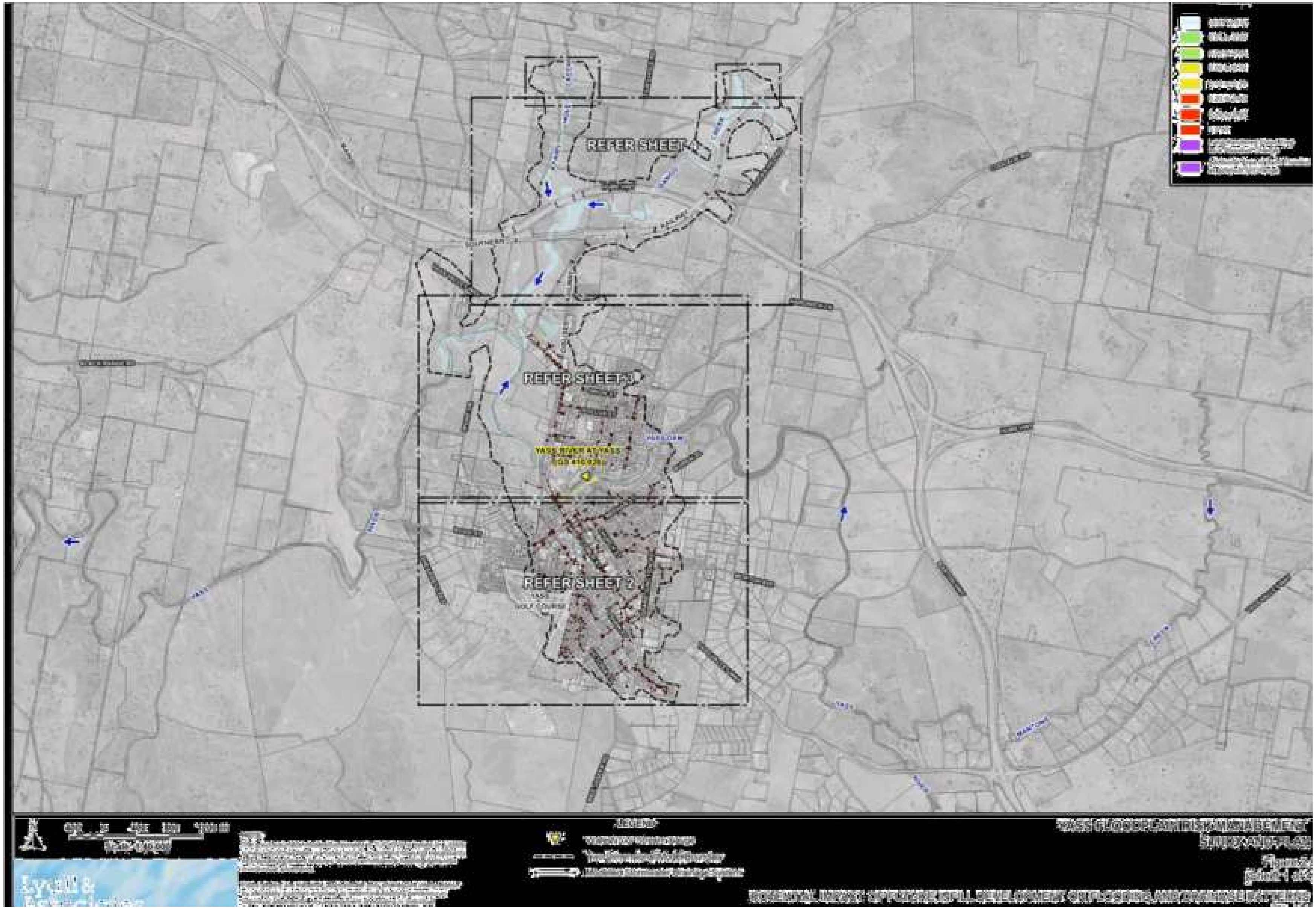
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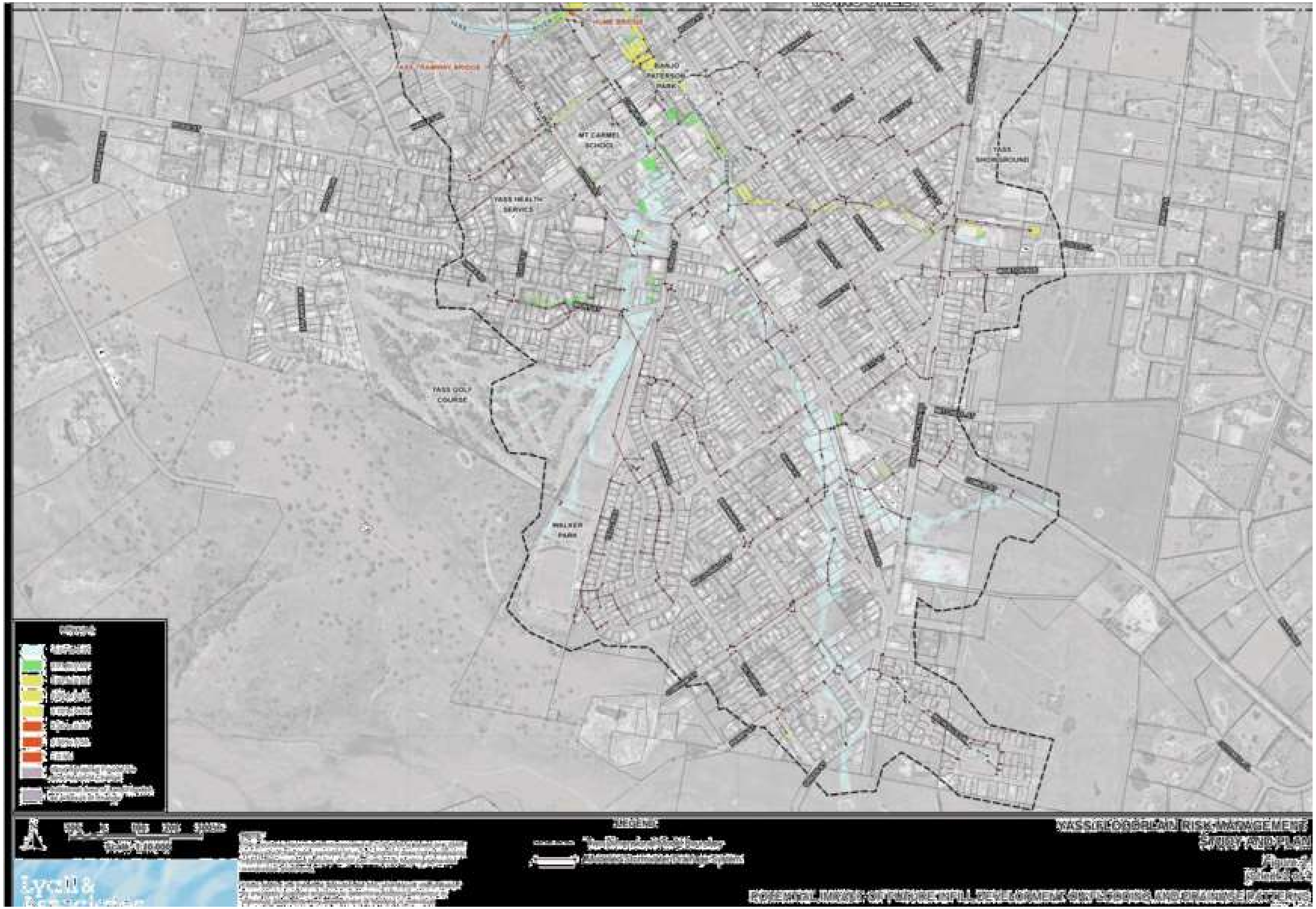
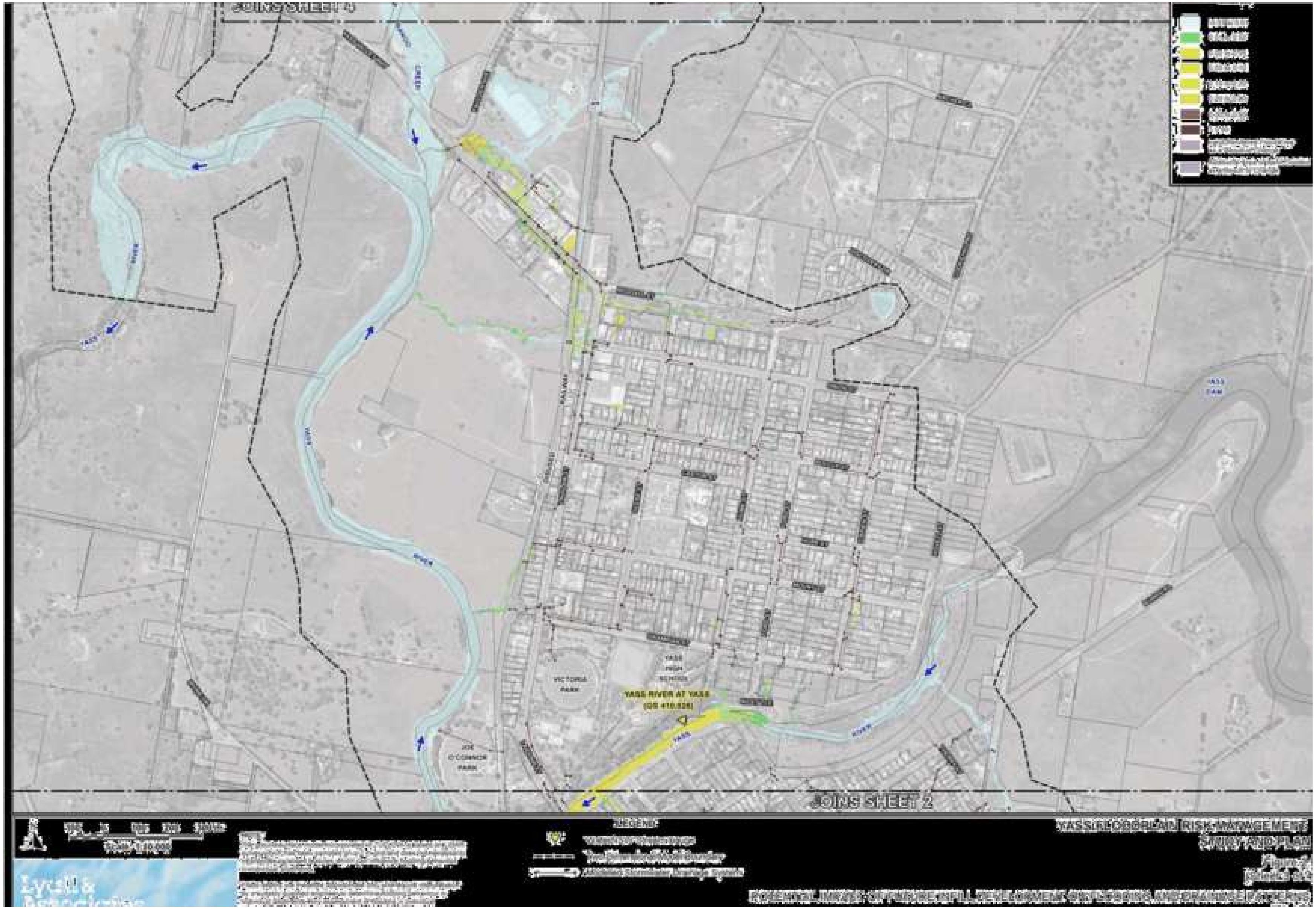
LEGEND


YASS TRAMWAY BRIDGE
BANJO PATERSON PARK
MT CARMEL SCHOOL
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK
LEGEND
YASS FLOODPLAIN RISK MANAGEMENT
STUDY AND PLAN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JOE O'CONNOR PARK
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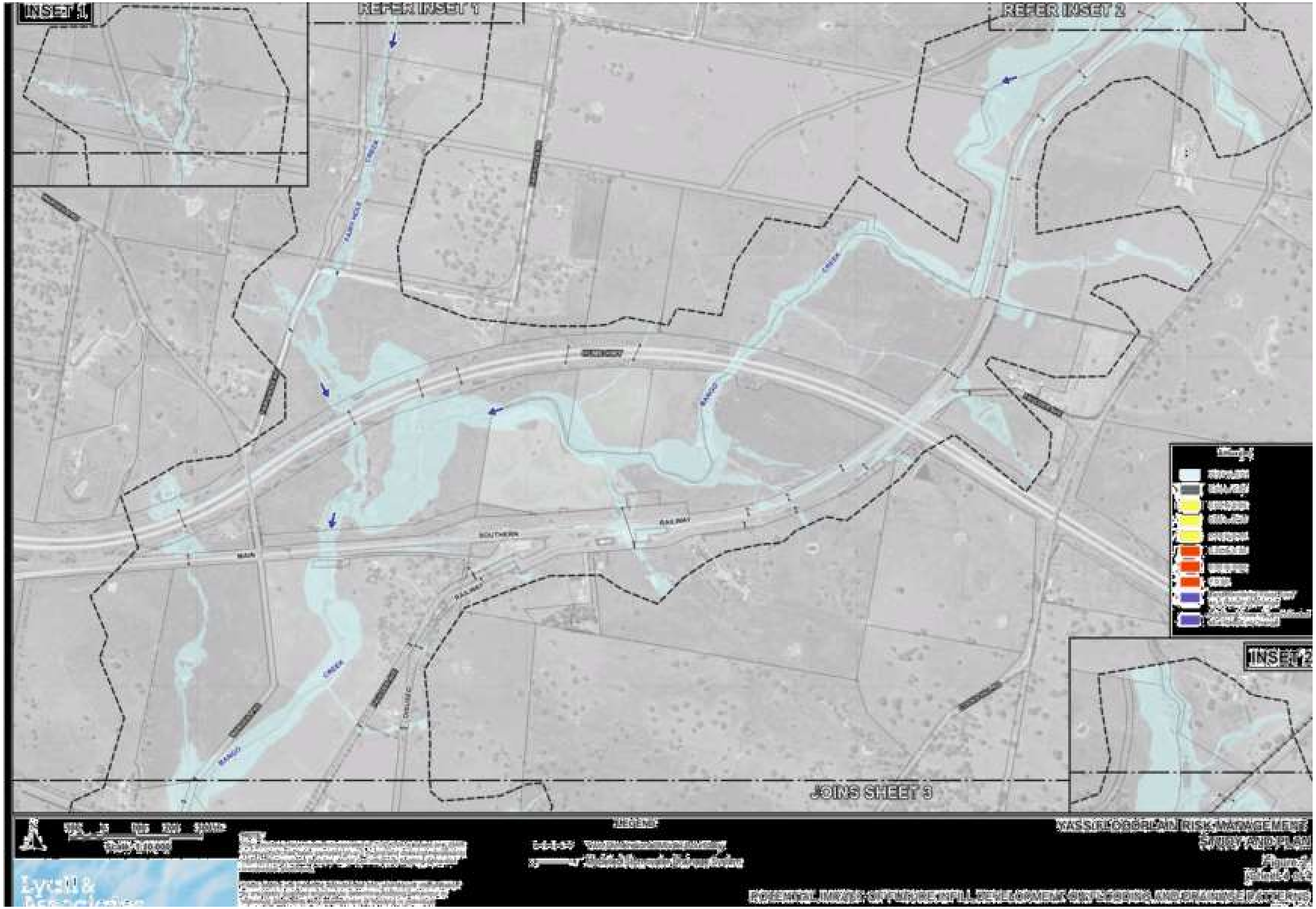
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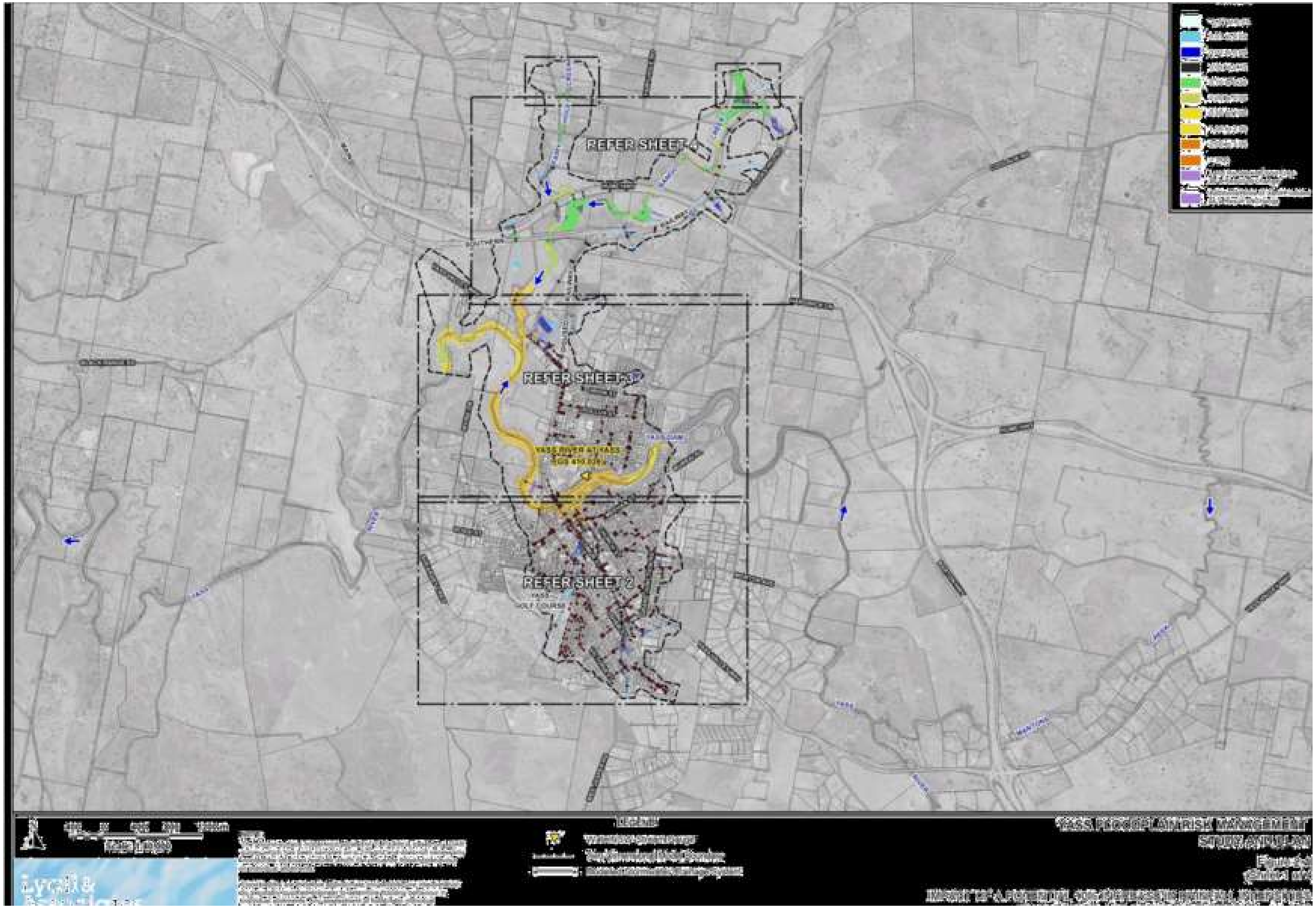
SOUTHERN
RAILWAY
MAIN
CREEK
LEGEND
YASS FLOODPLAIN RISK MANAGEMENT
STUDY AND PLAN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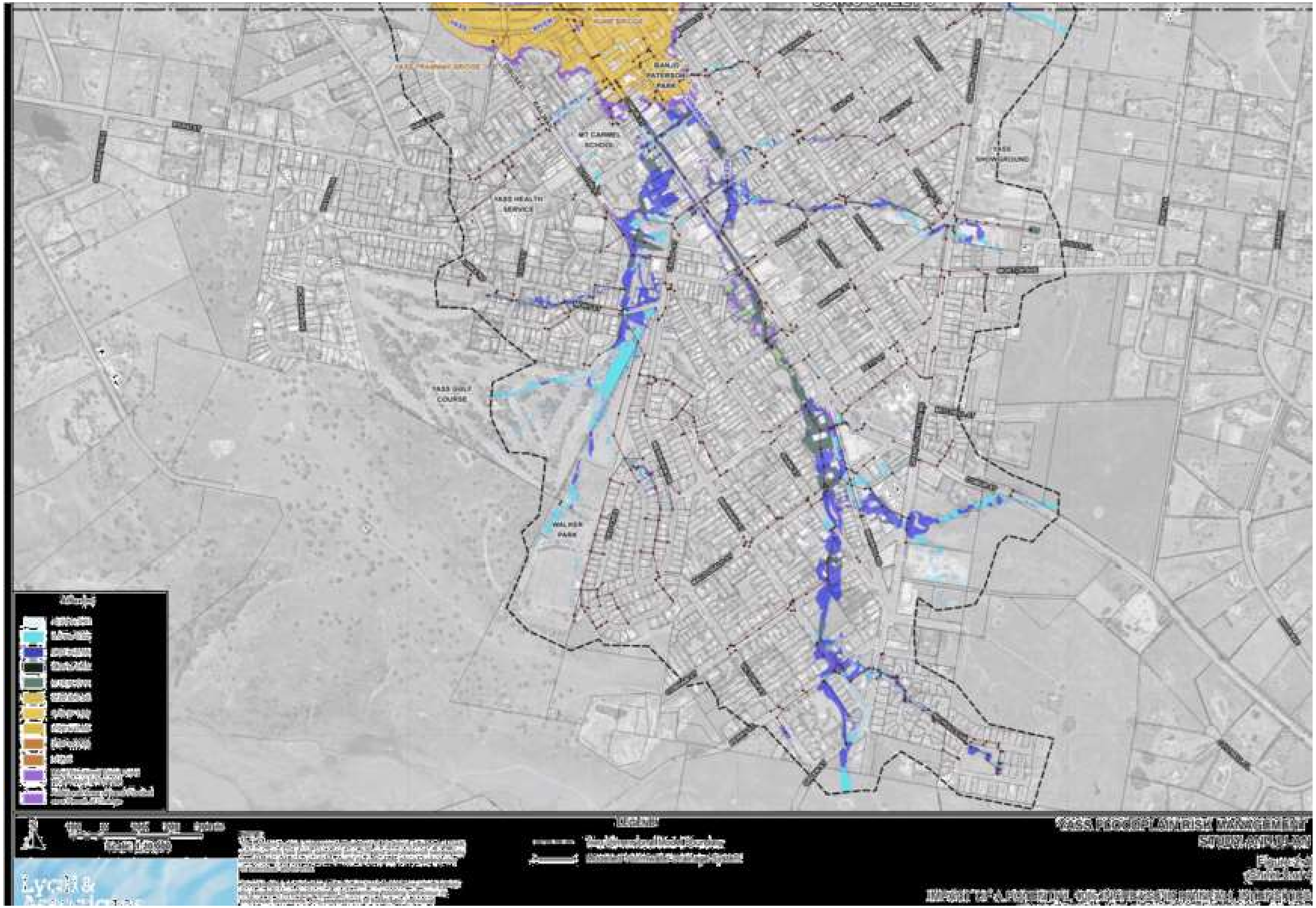
GOLF COURSE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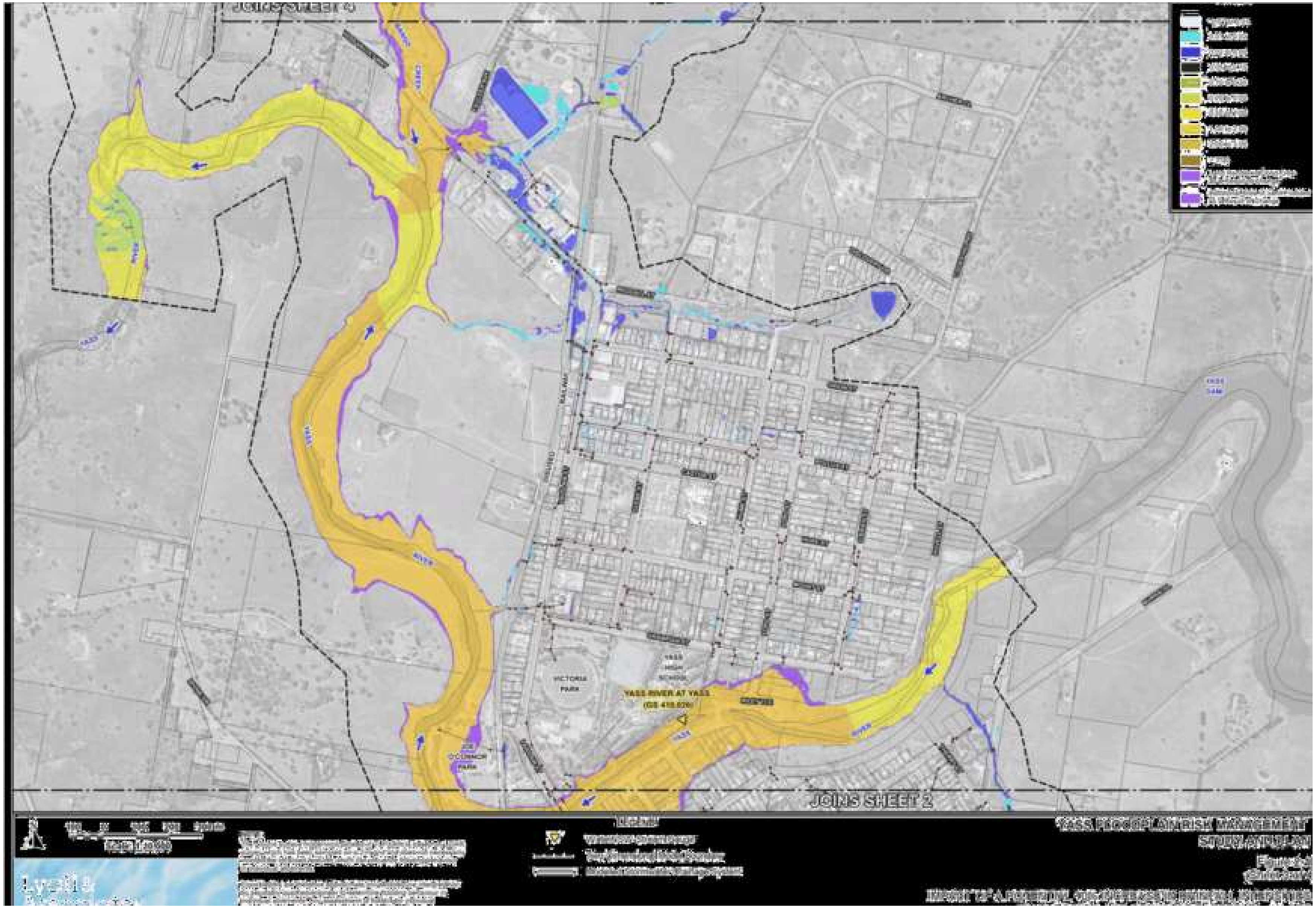
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK
LEGEND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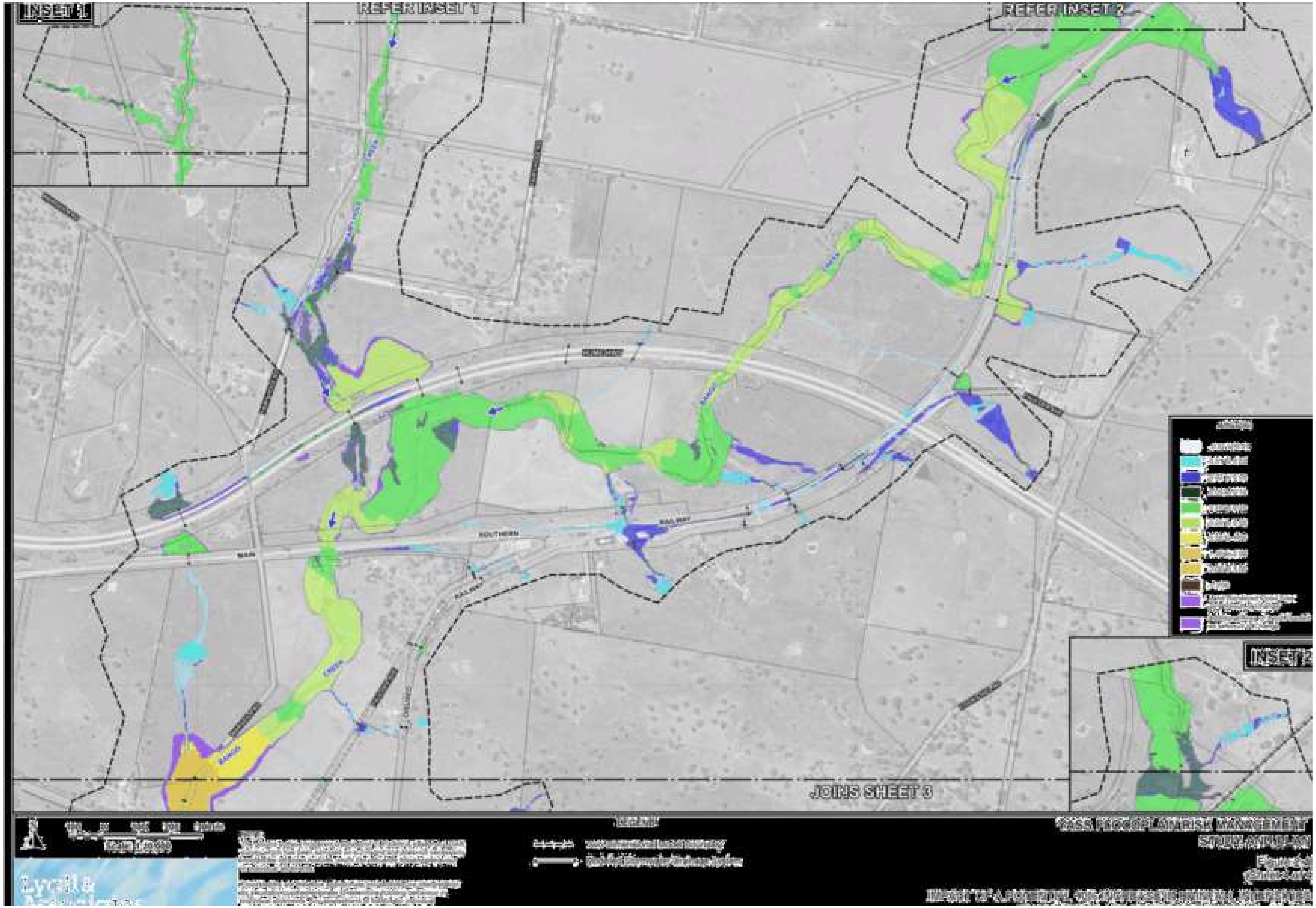
STUDY AND PLAN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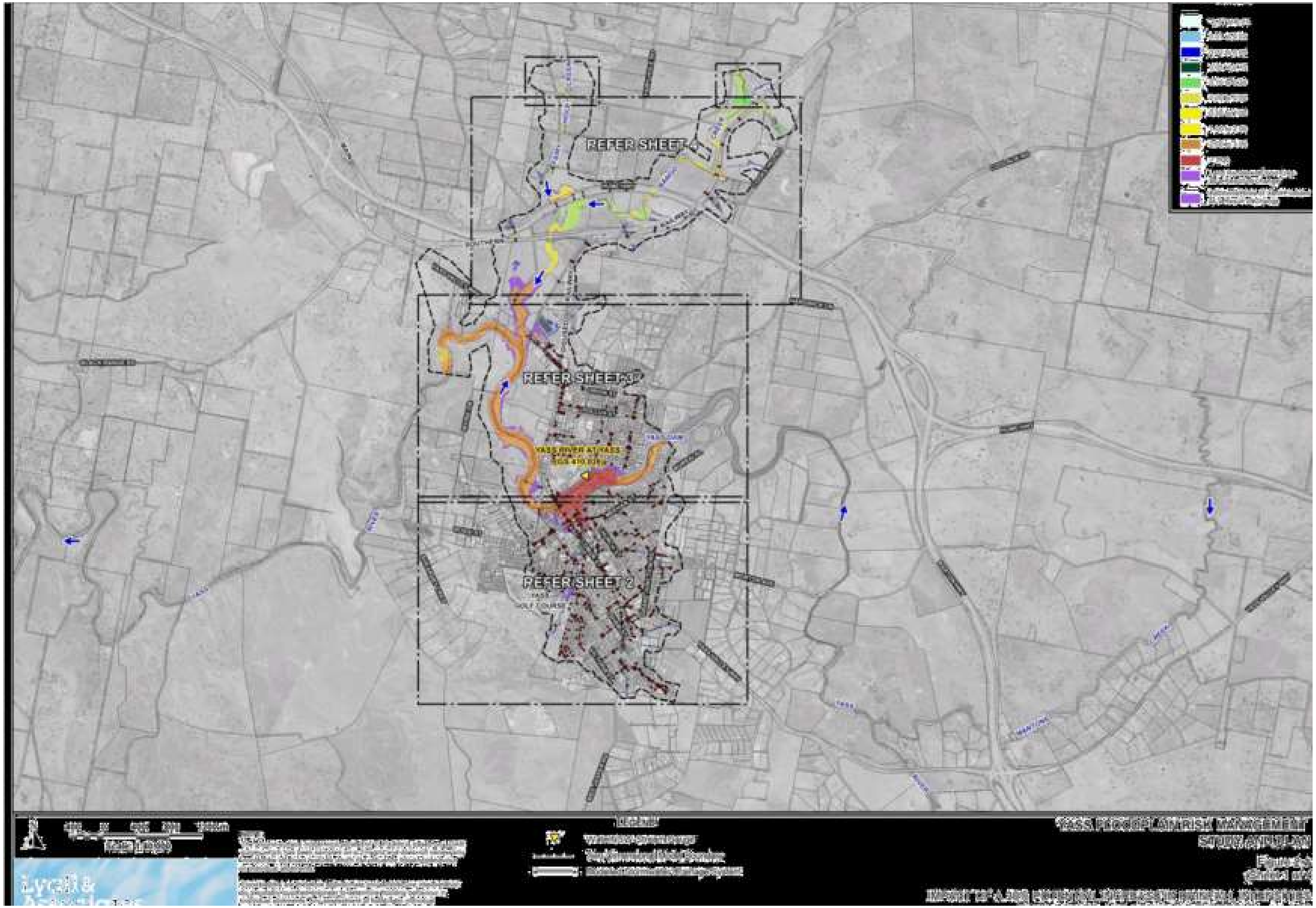
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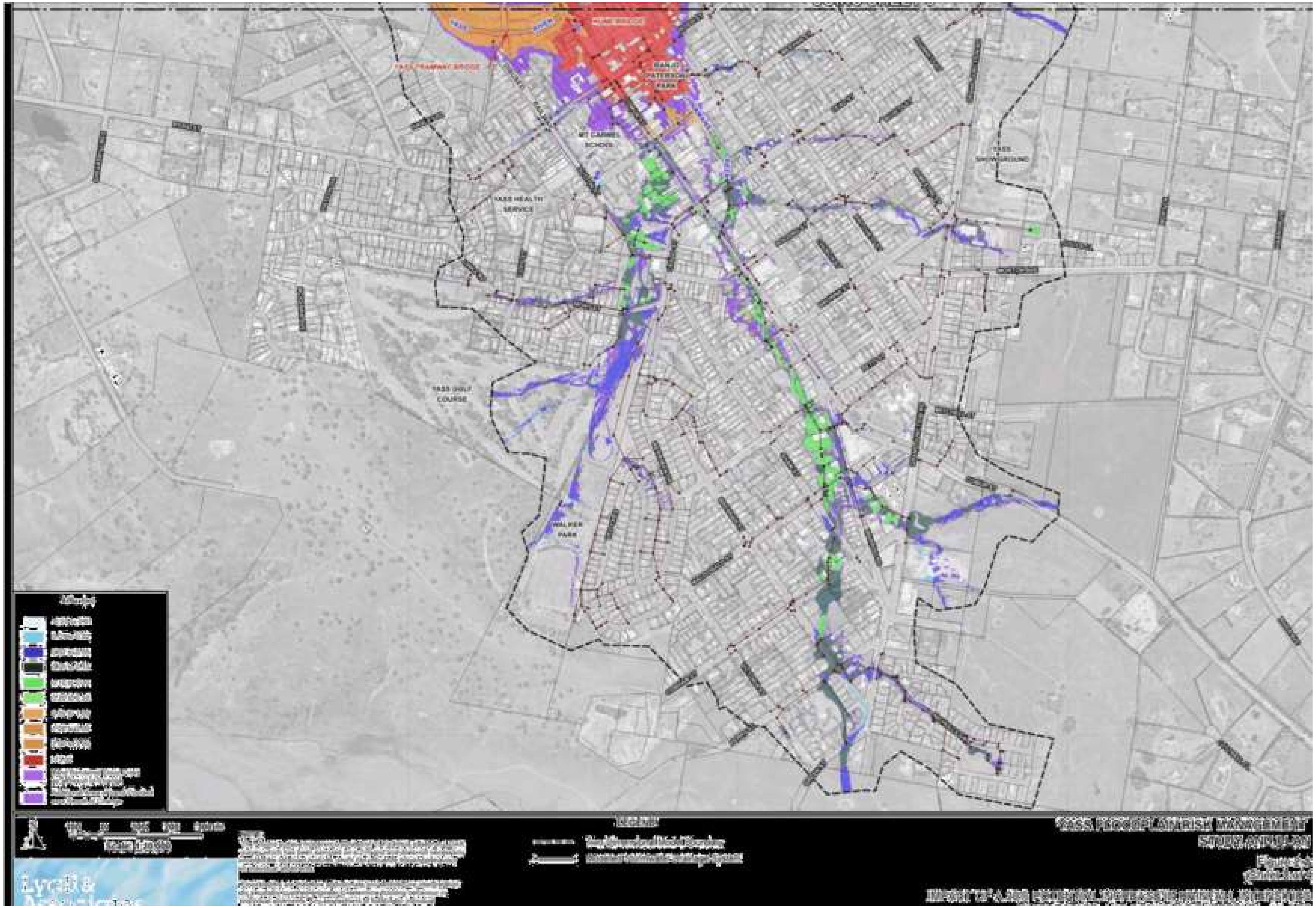
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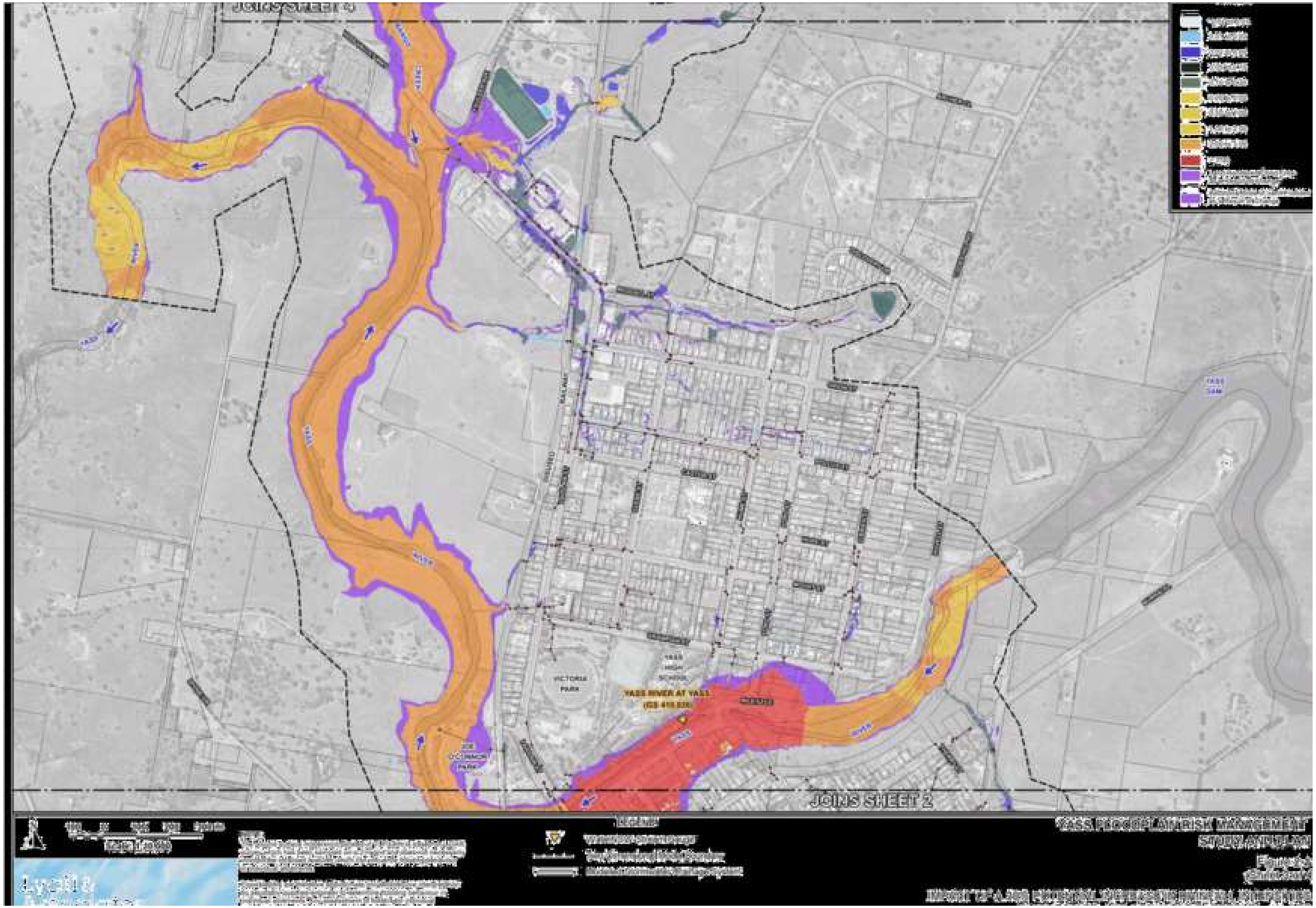
WALKER PARK
LEGEND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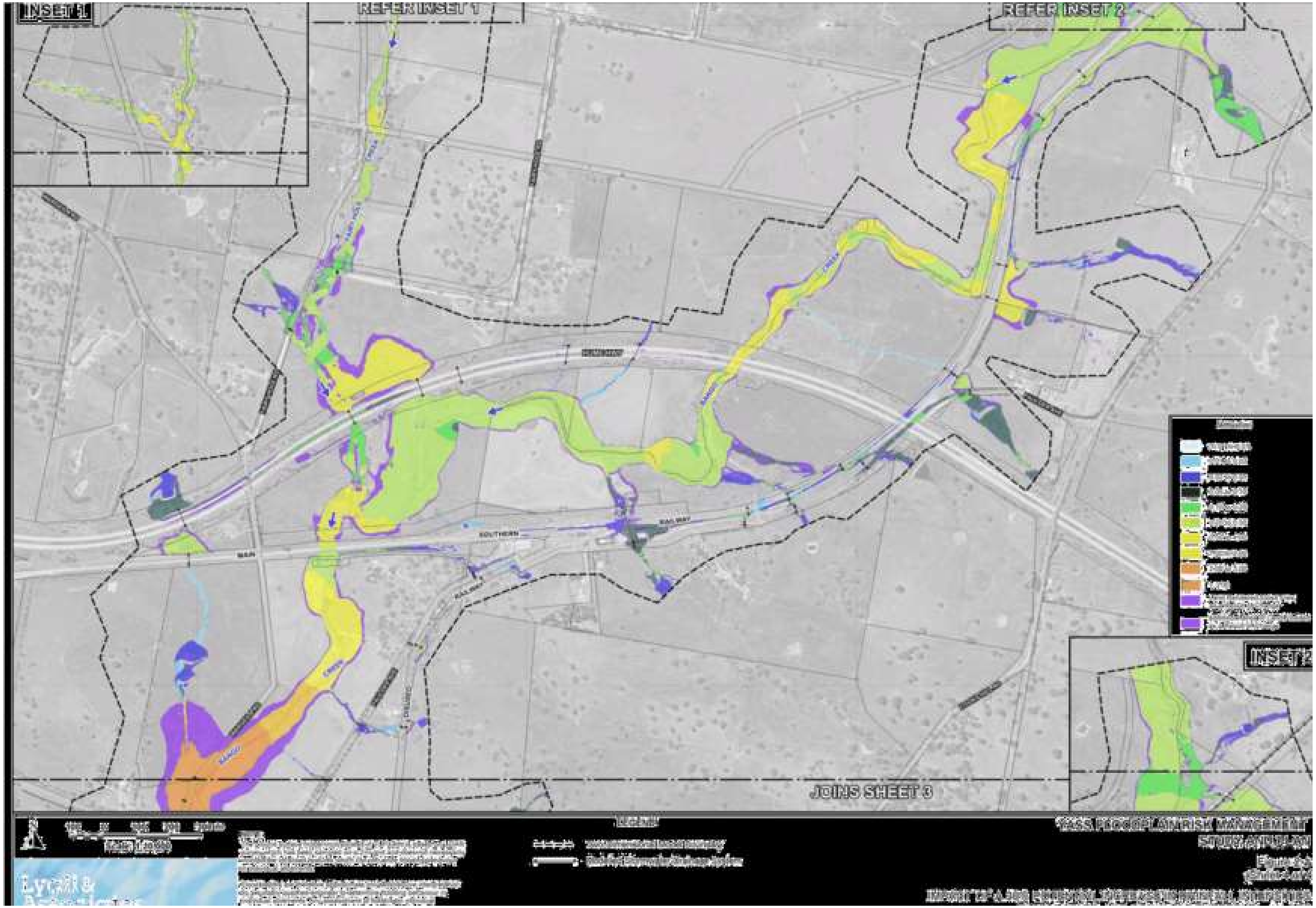
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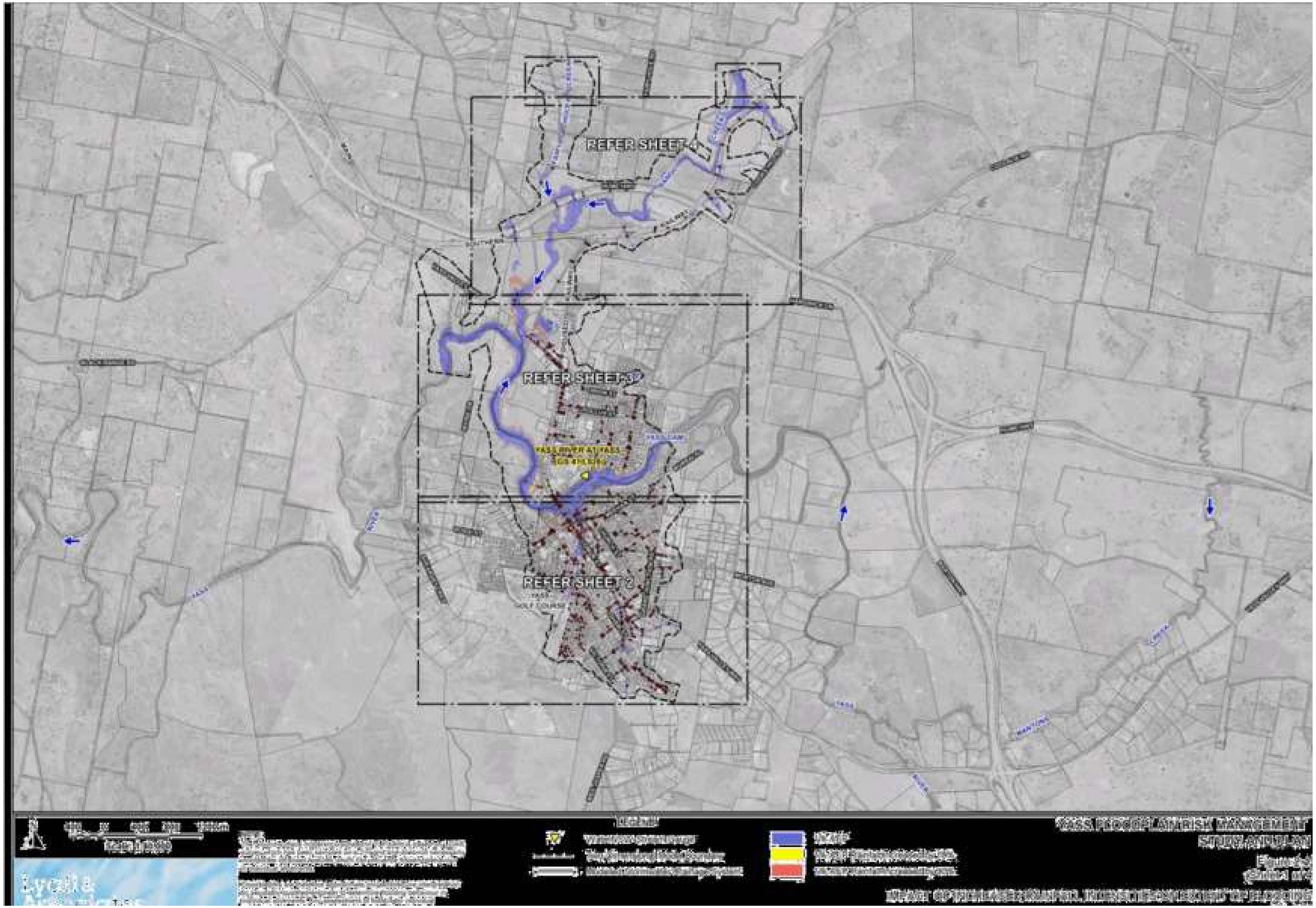
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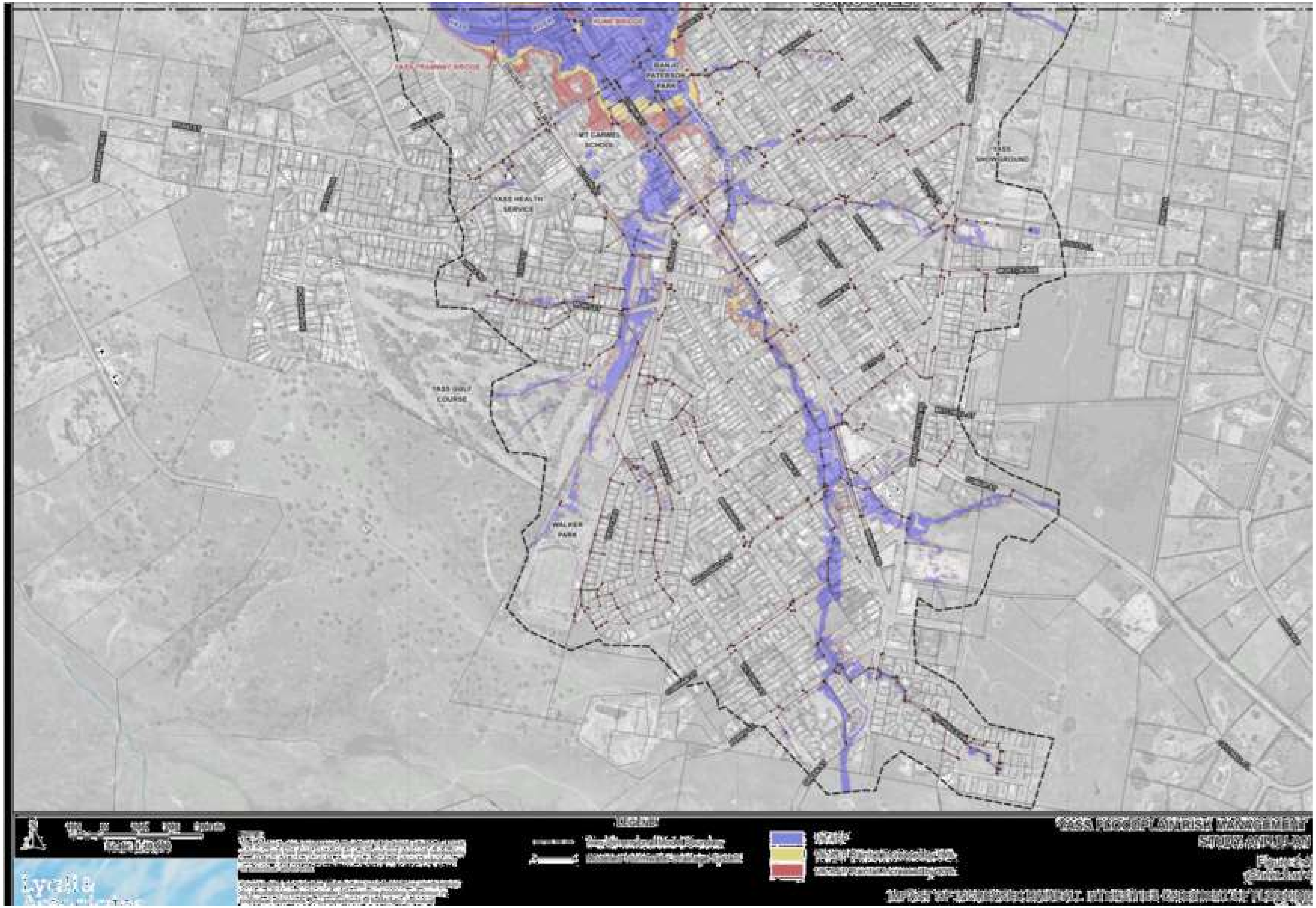
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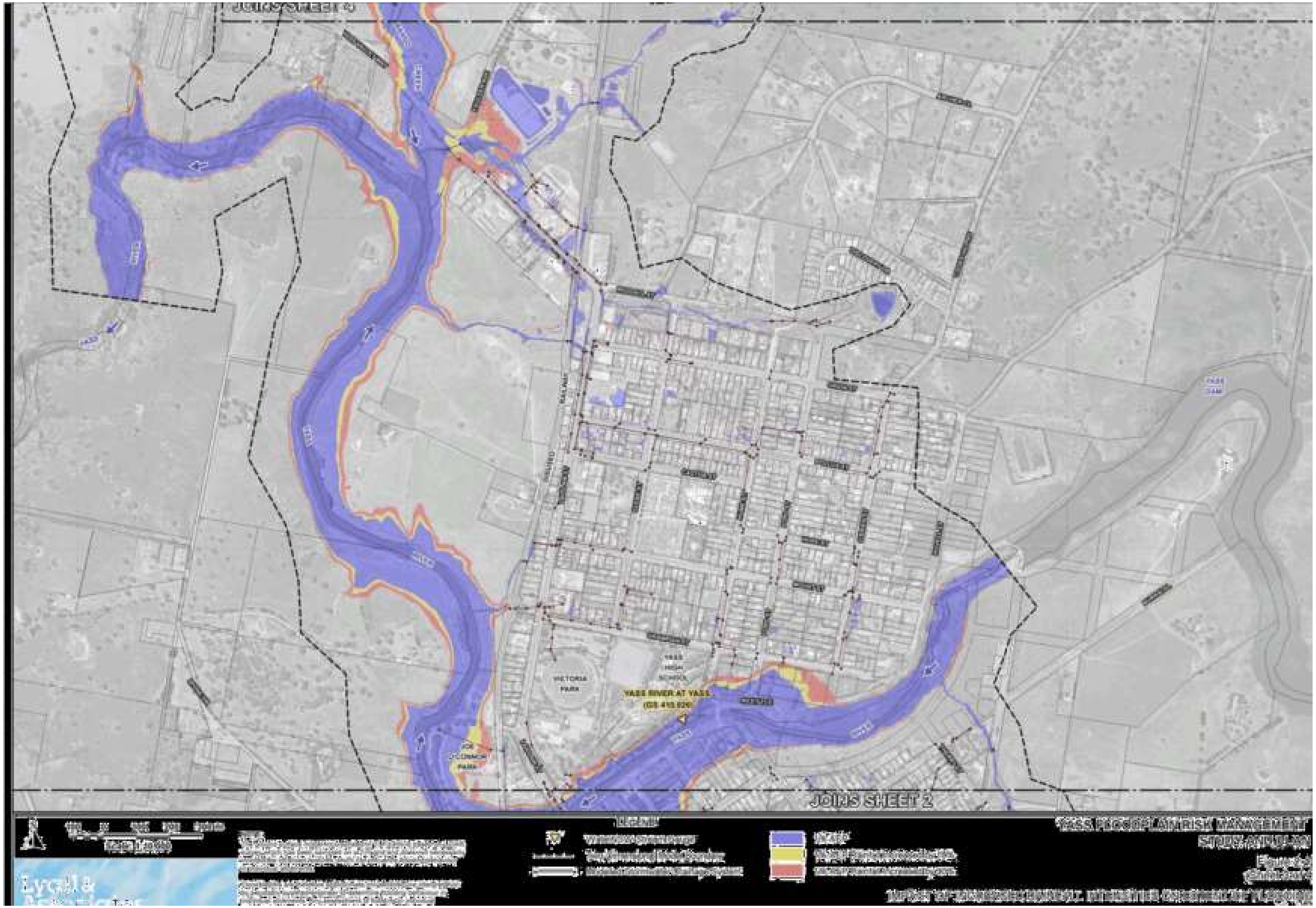
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK
LEGEND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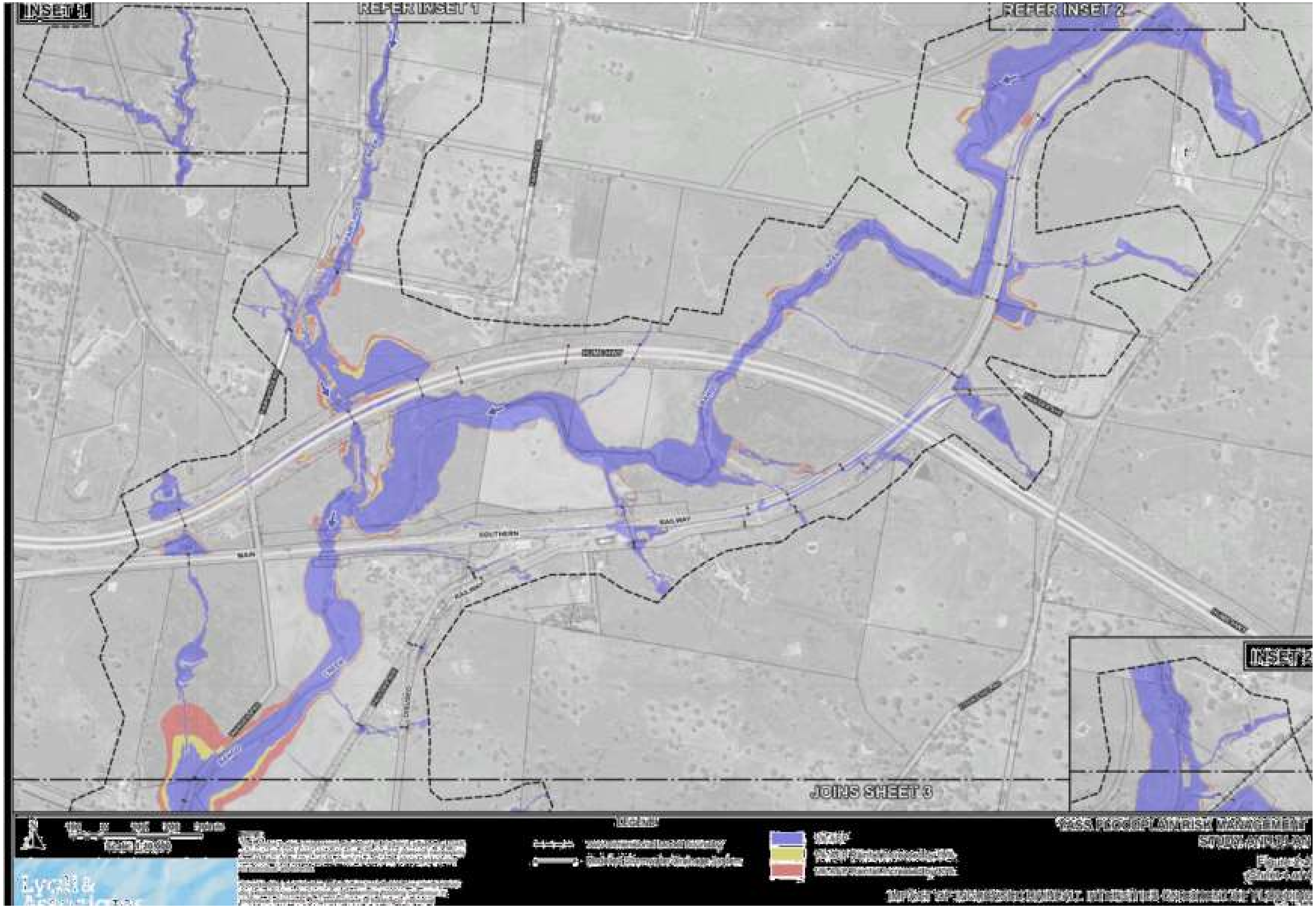
YASS RIVER AT YASS
LEGEND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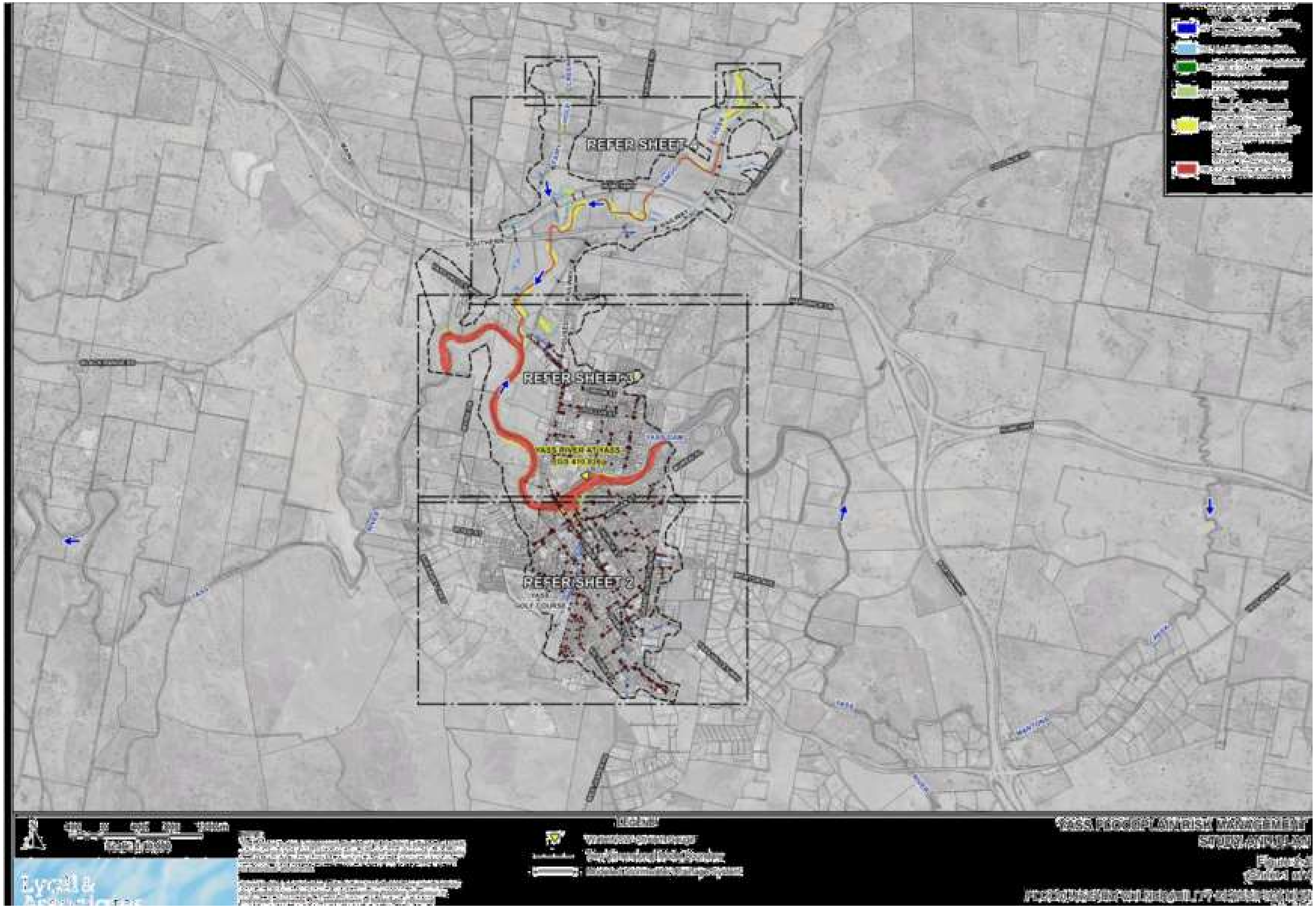
RAILWAY
MAIN
HUME HWY
LEGEND
YASS FLOODPLAIN RISK MANAGEMENT
STUDY AND PLAN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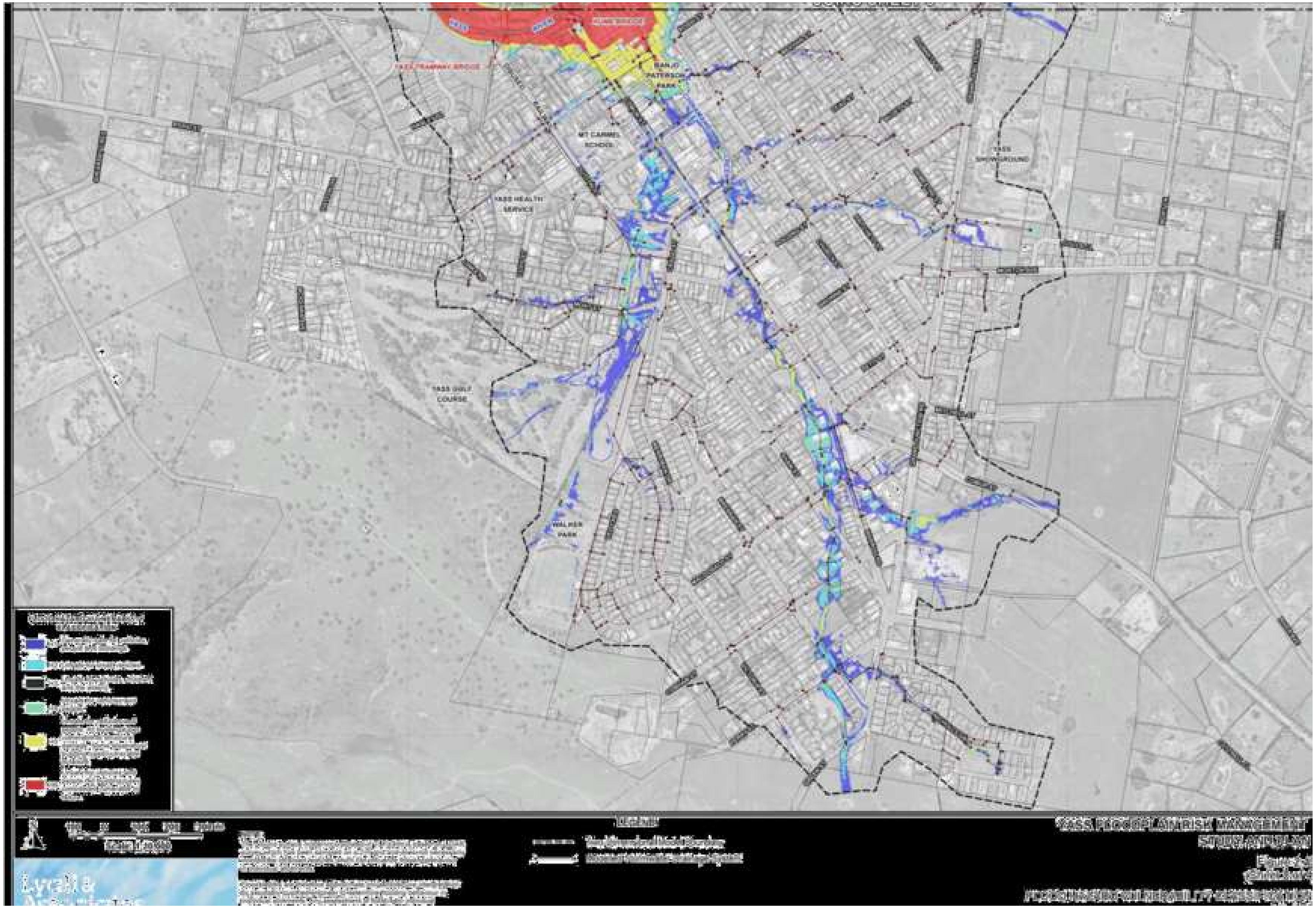
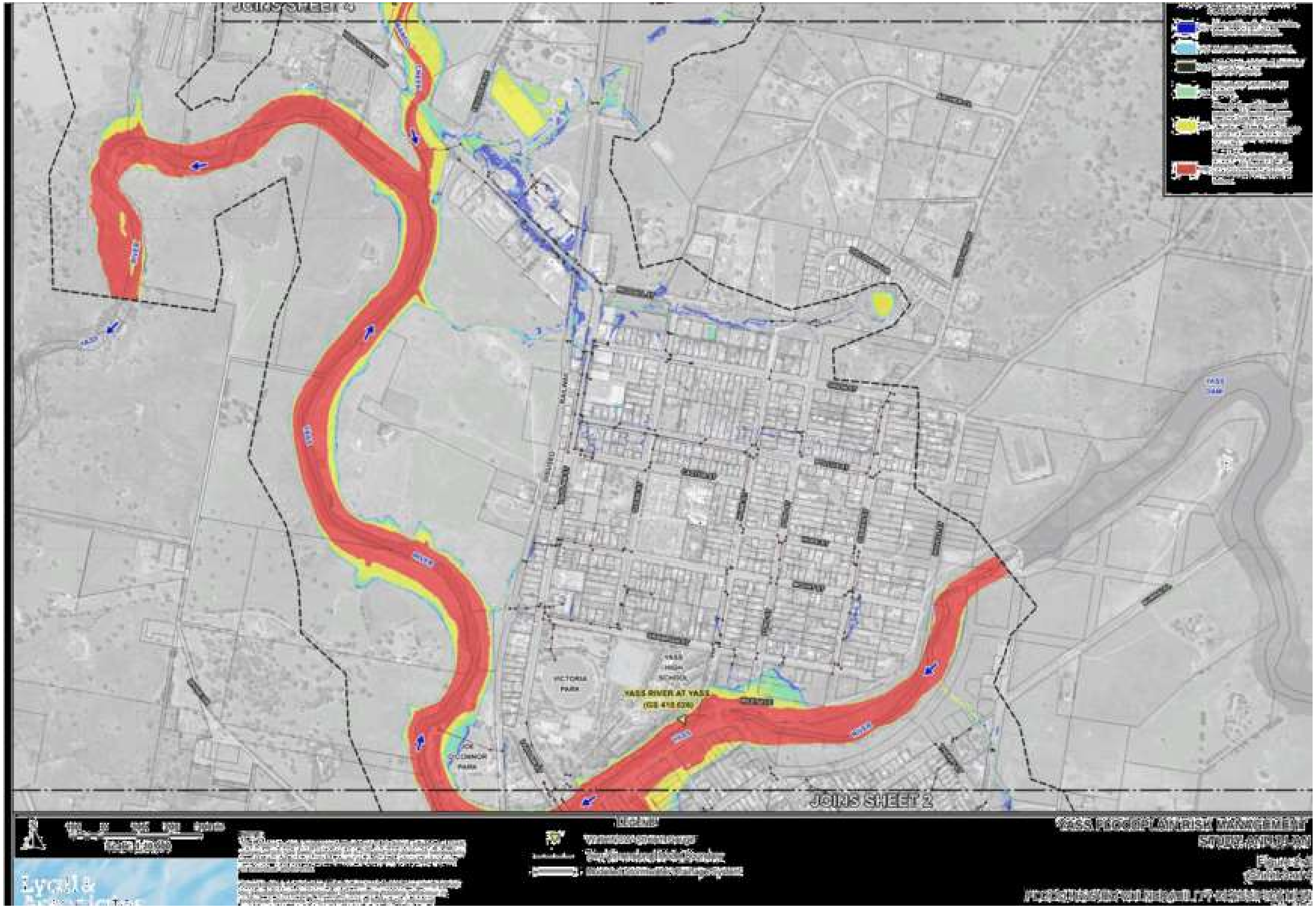
LEGEND
YASS FLOODPLAIN RISK MANAGEMENT
STUDY AND PLAN


BANJO
PATERSON
PARK
MT CARMEL
SCHOOL
YASS HEALTH
SERVICE
YASS
SHOWGROUND
YASS GOLF
COURSE
WALKER
PARK
LEGEND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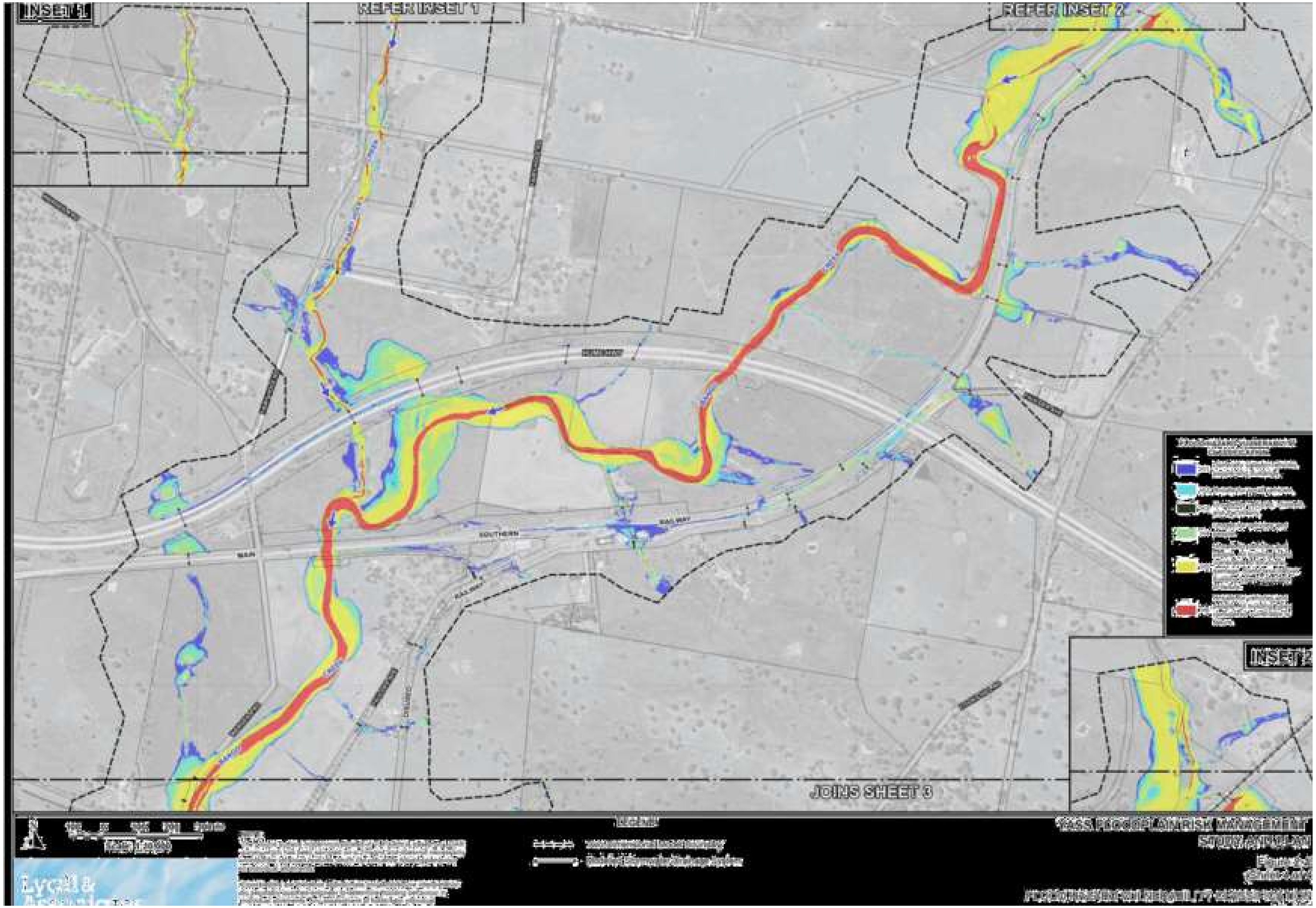
YASS RIVER AT YASS
JOINS SHEET 2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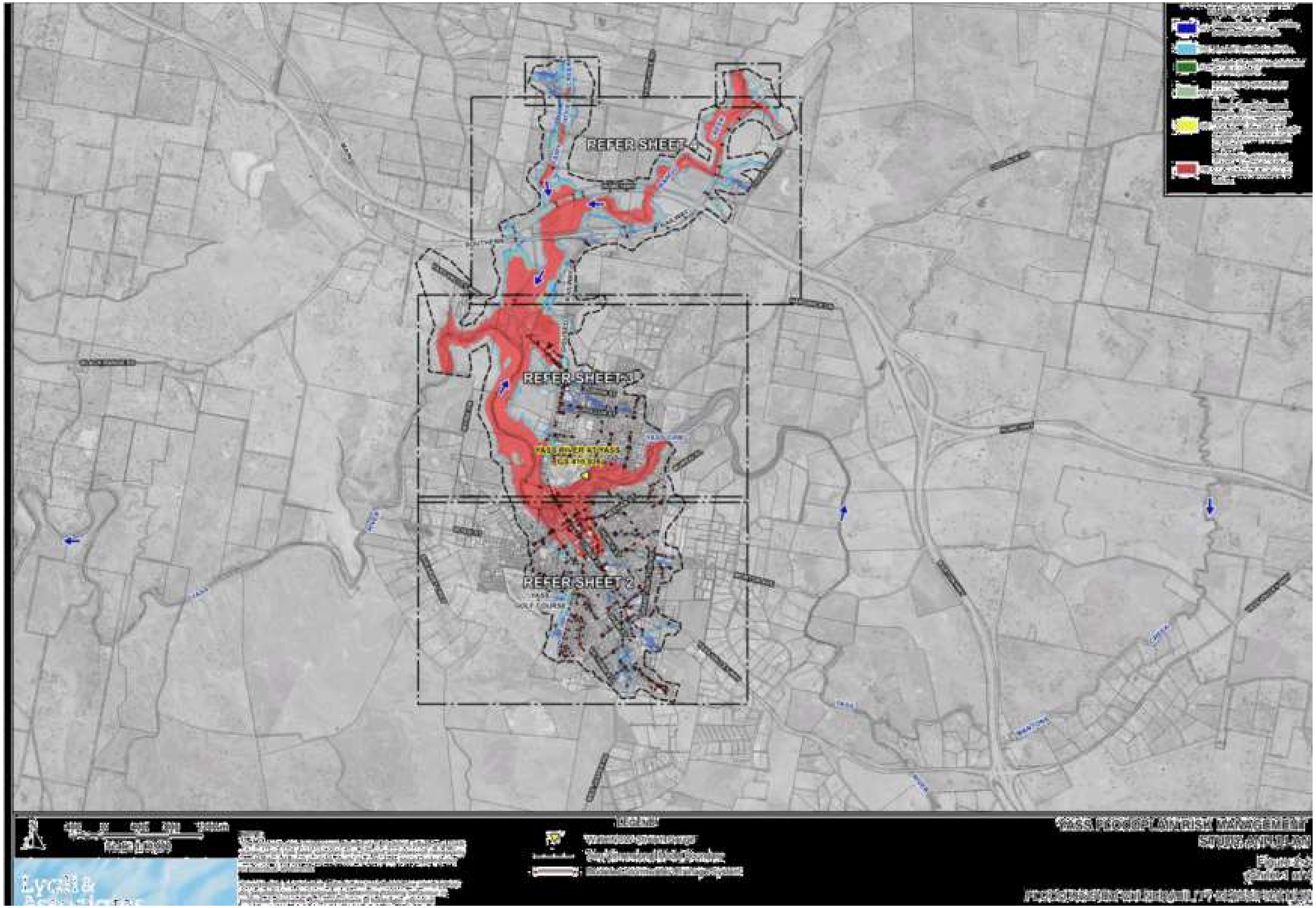
SOUTHERN
RAILWAY
MAIN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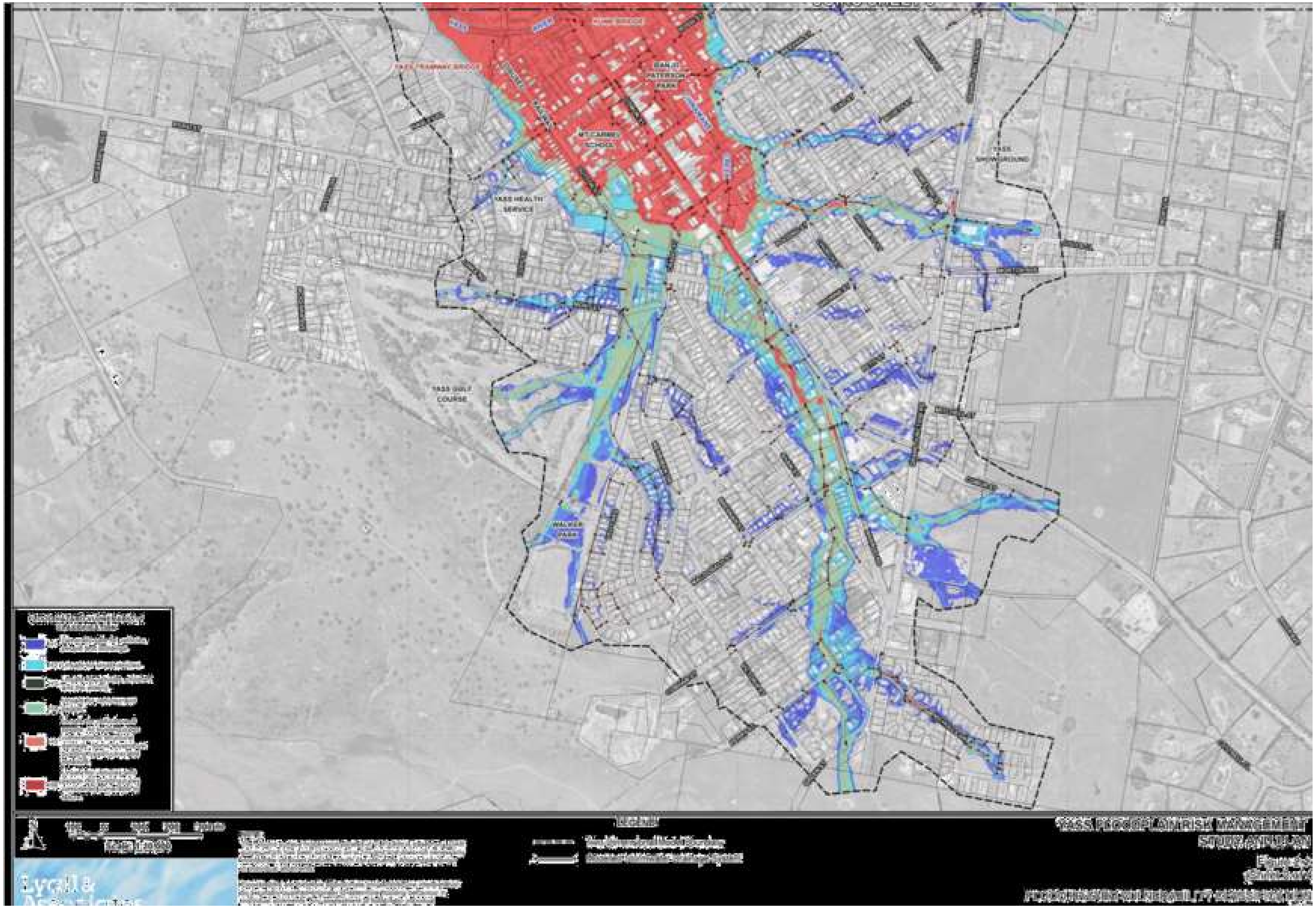
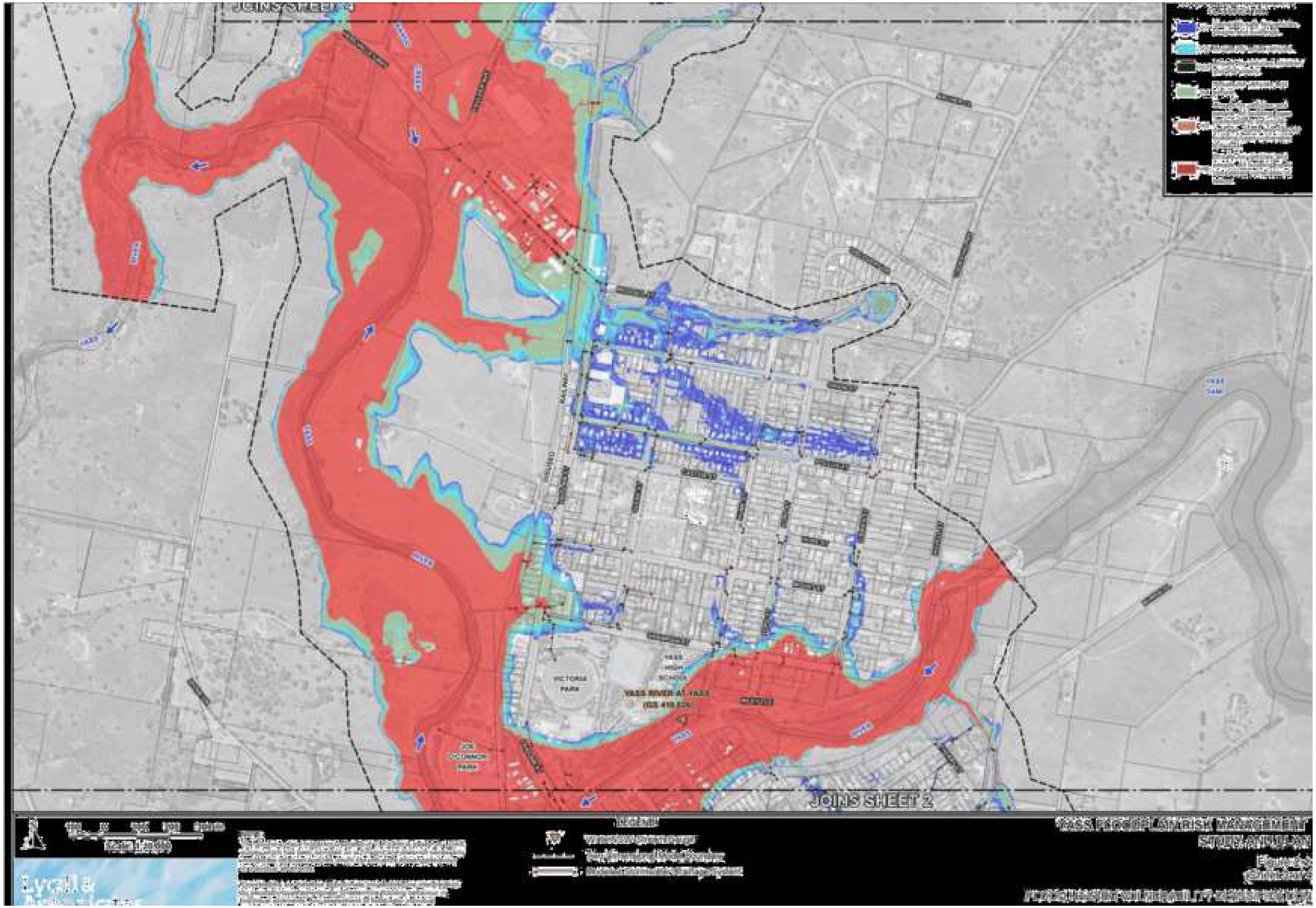

BANJO PATERSON PARK
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK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VICTORIA PARK
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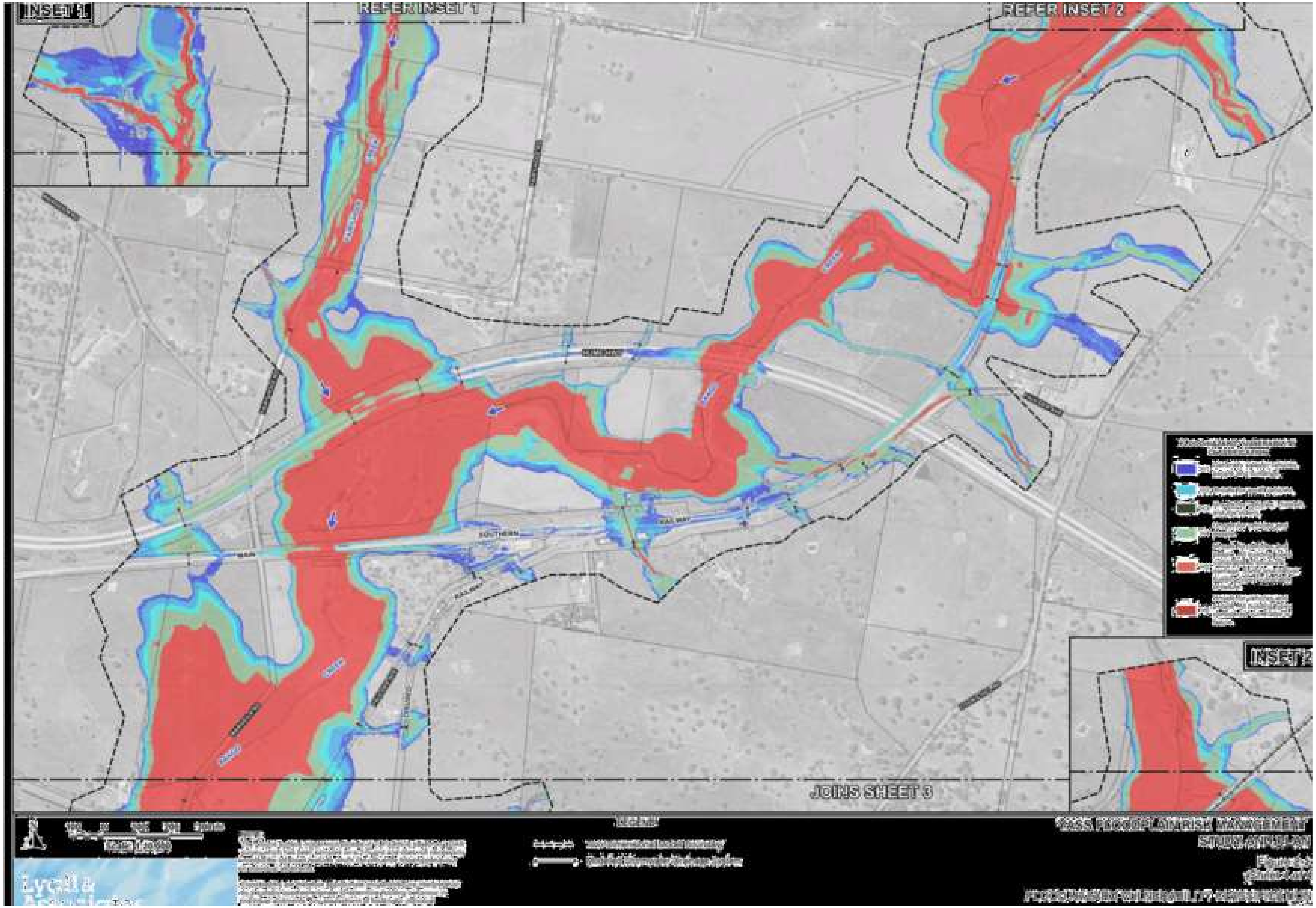
LEGEND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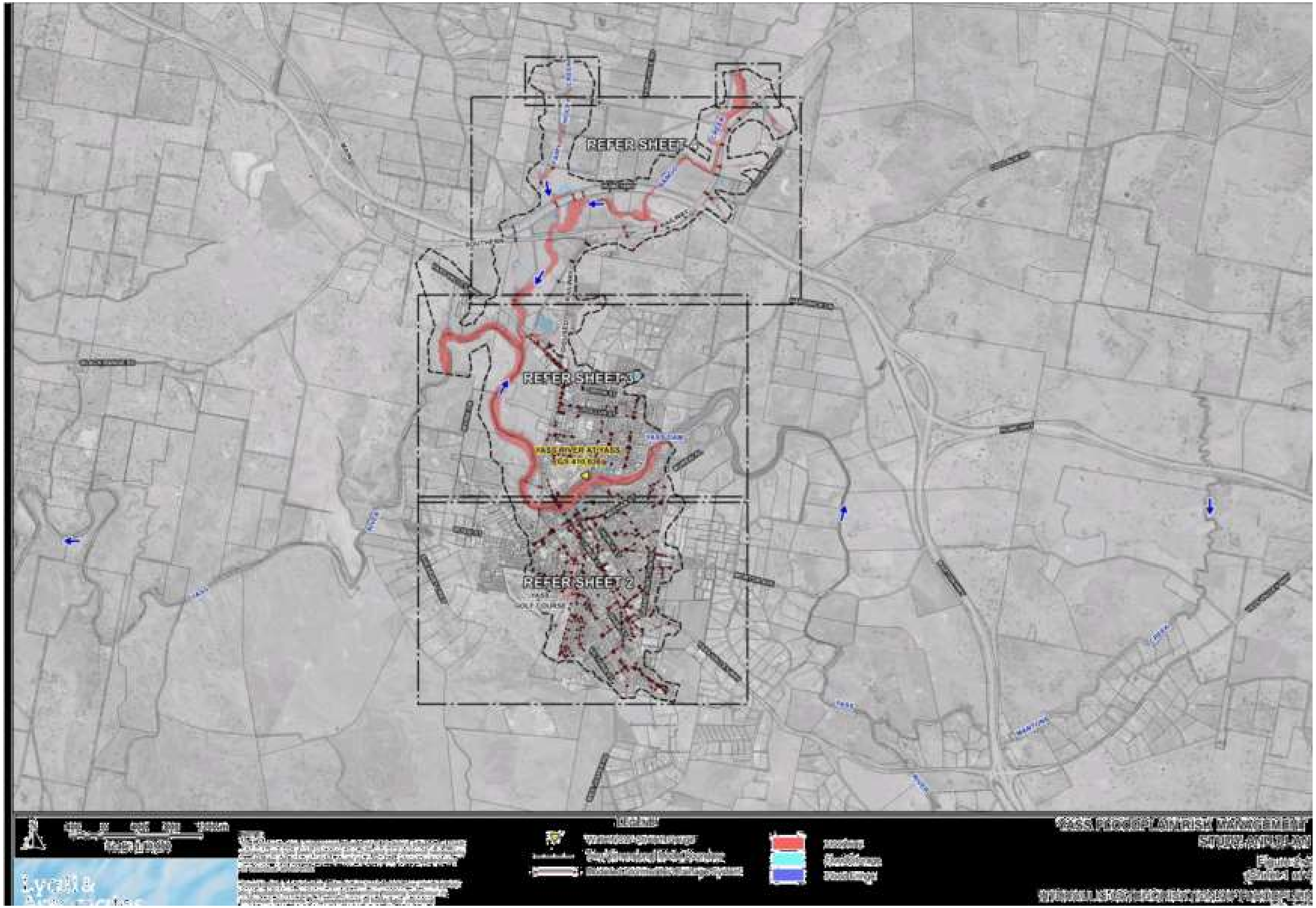
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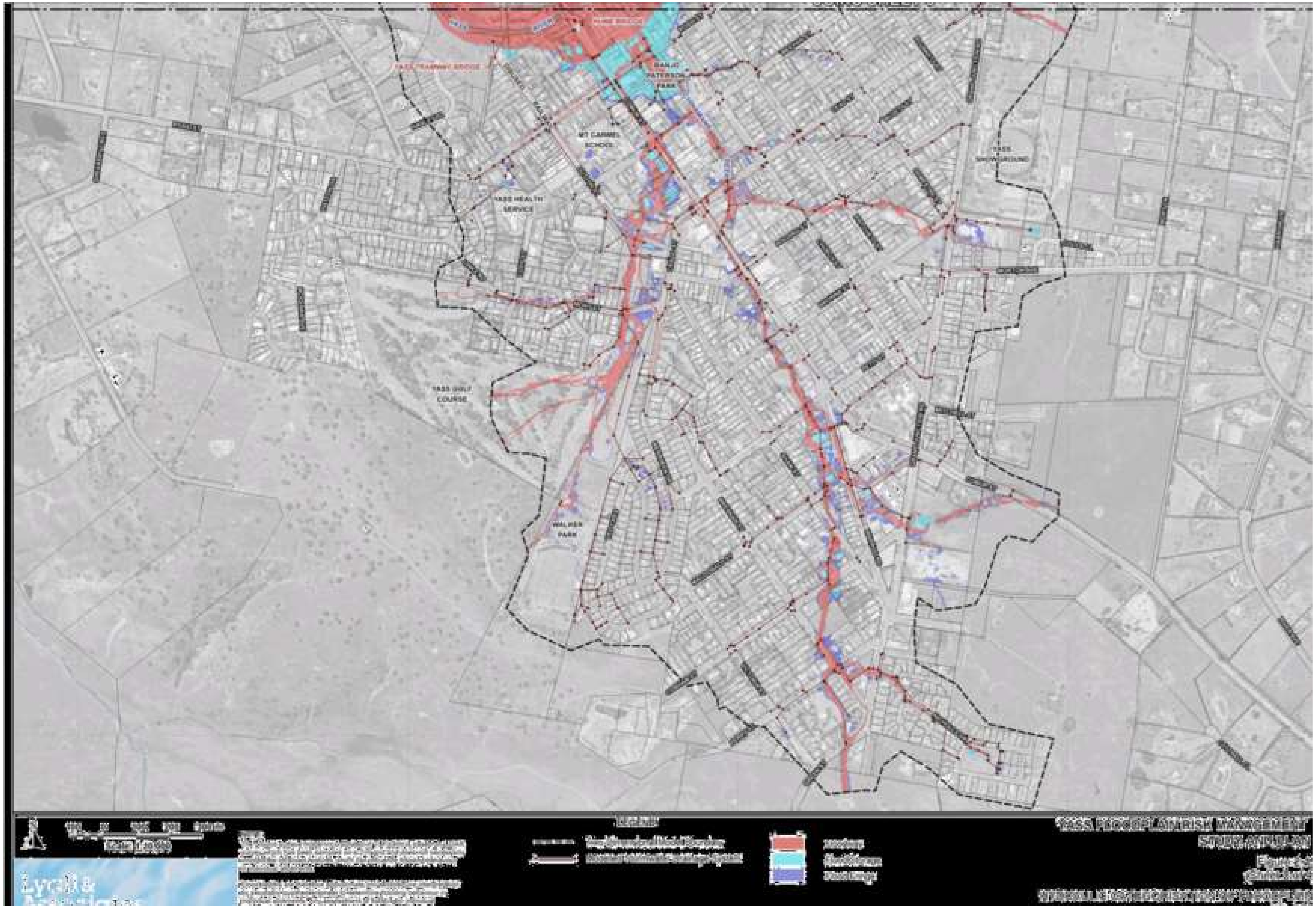
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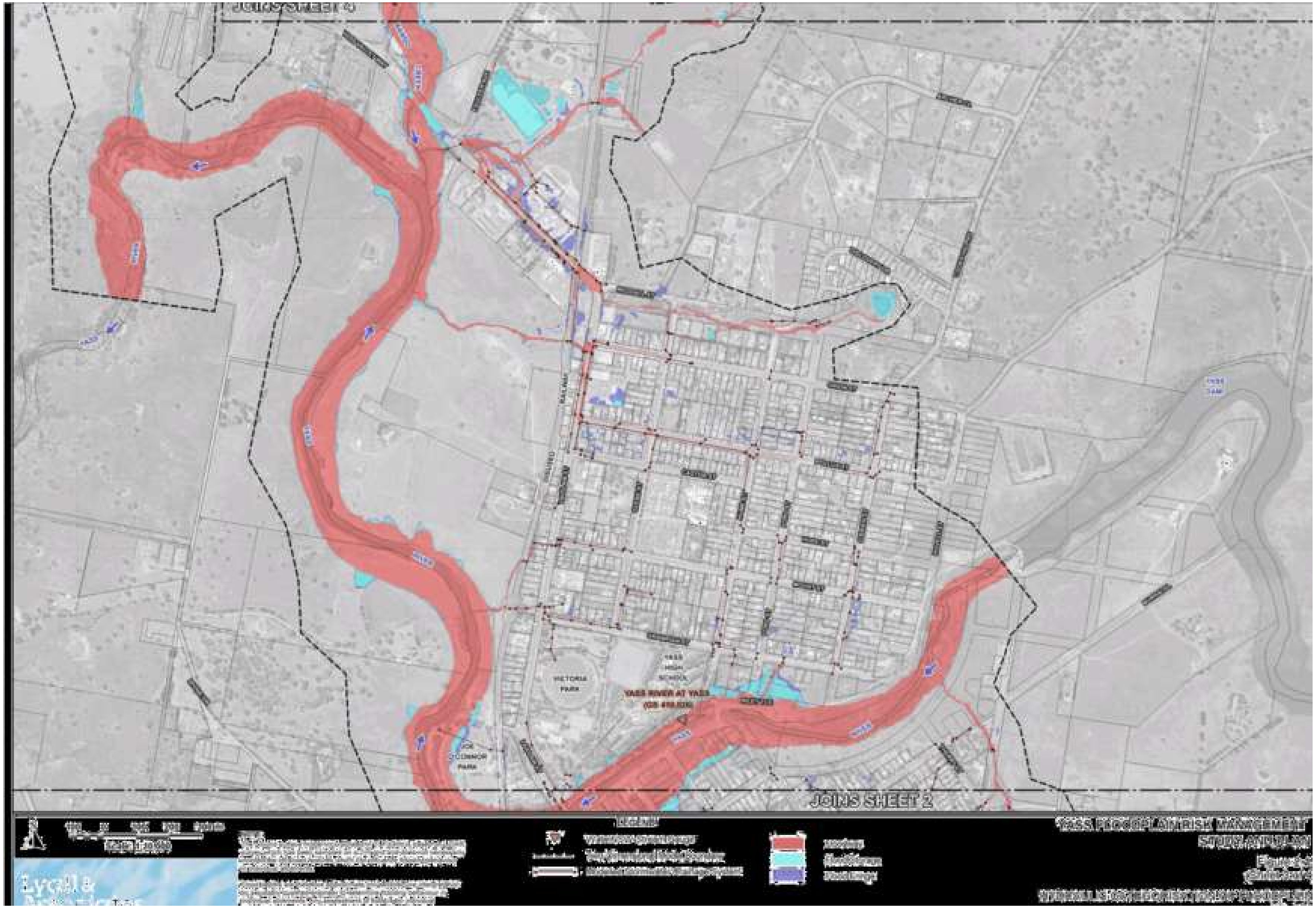
YASS HEALTH SERVICE
YASS GOLF COURSE
WALKER PARK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VICTORIA PARK
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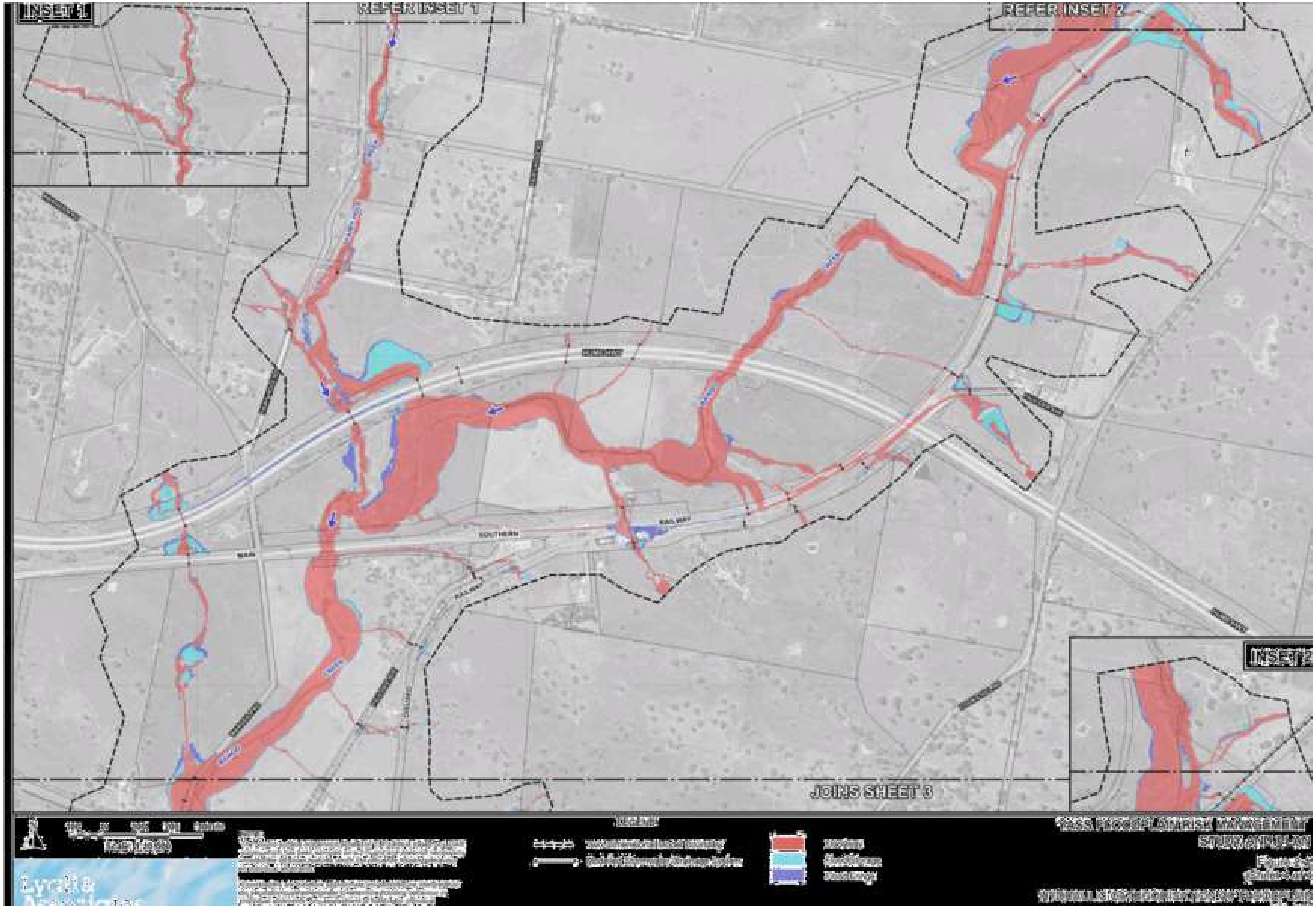
YASS RIVER AT YASS
O'CONNOR PARK
YASS DAM
LEGEND
YASS FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN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SOUTHERN
RAILWAY
MAIN
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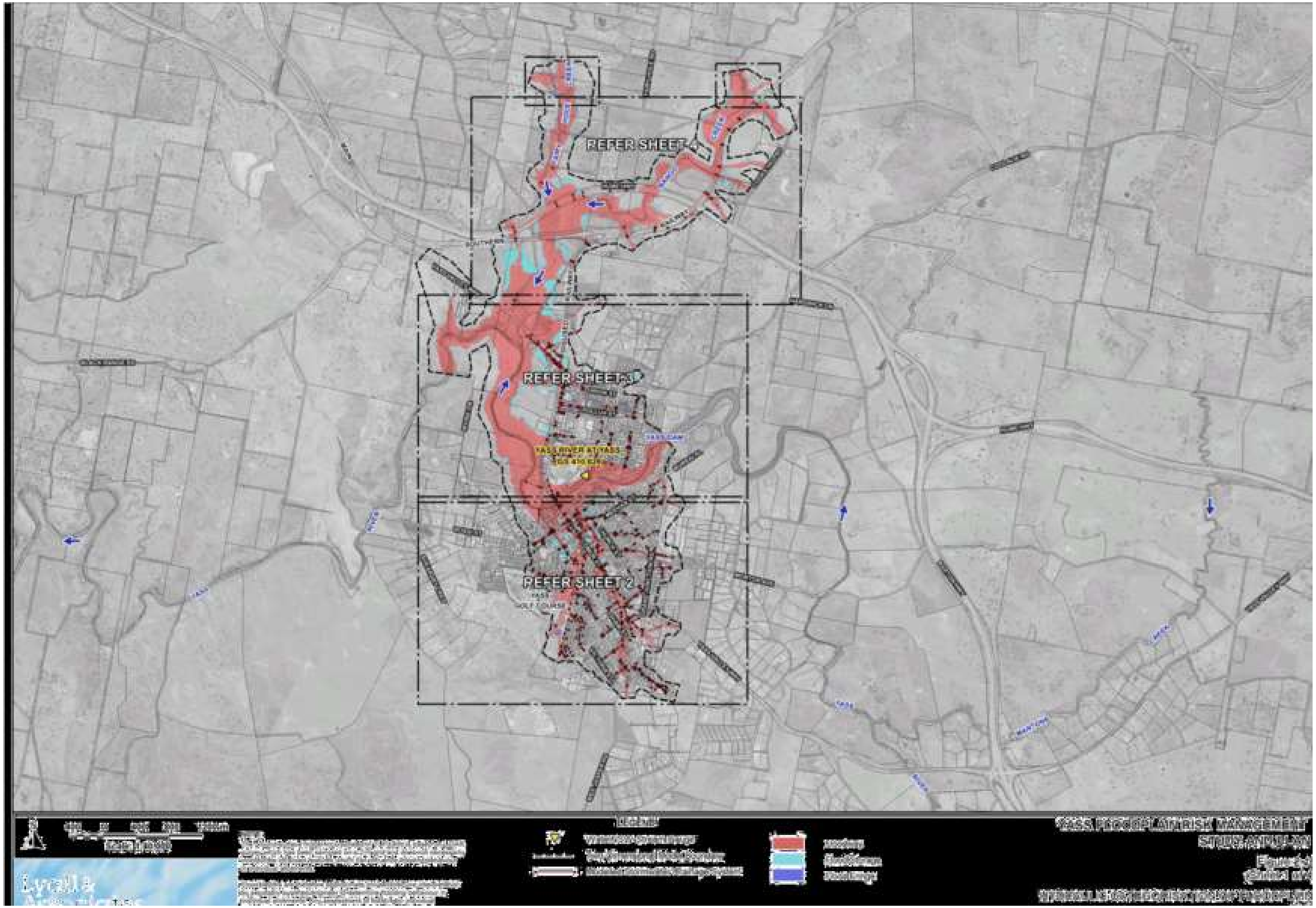
INSET 2
LEGEND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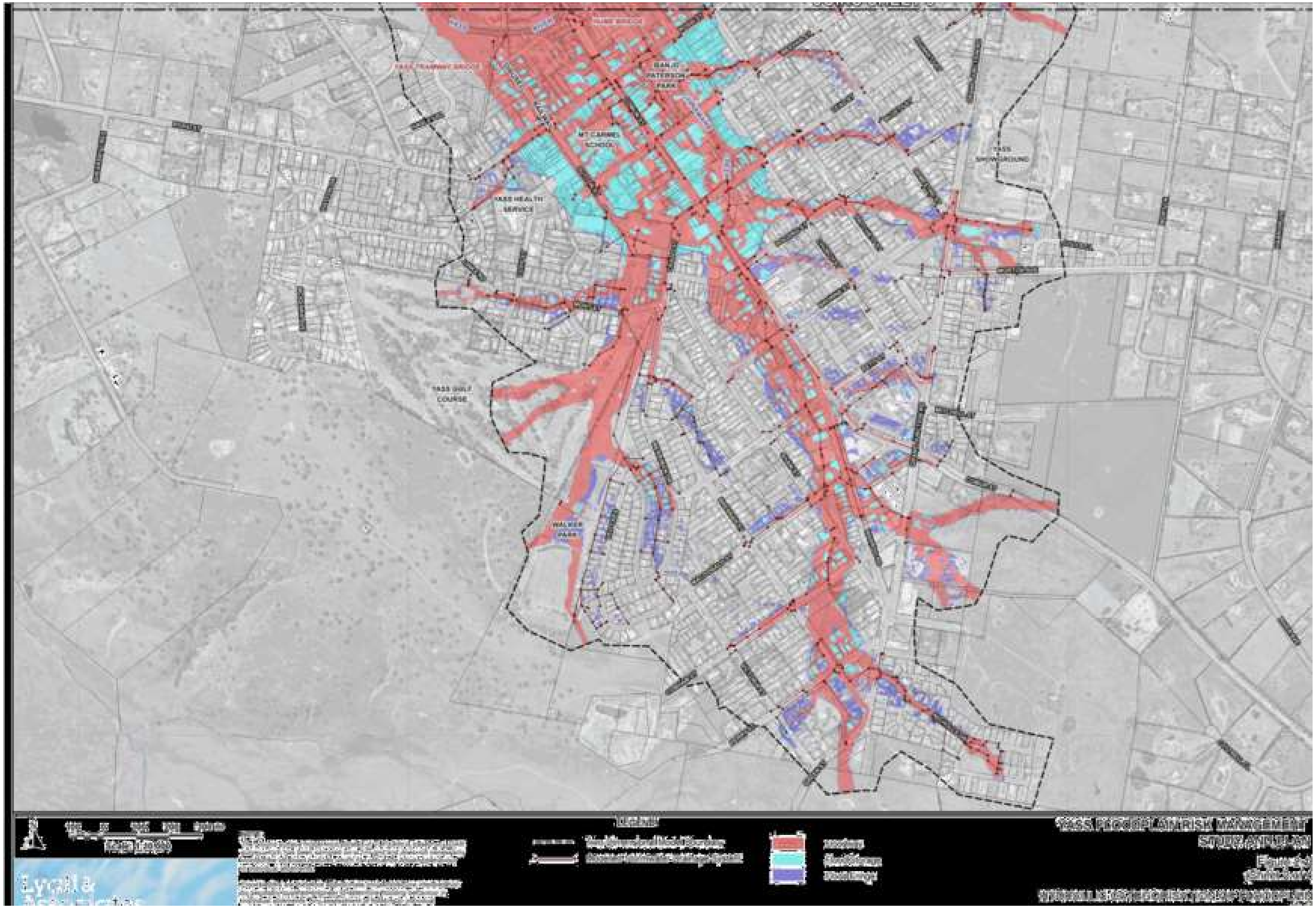
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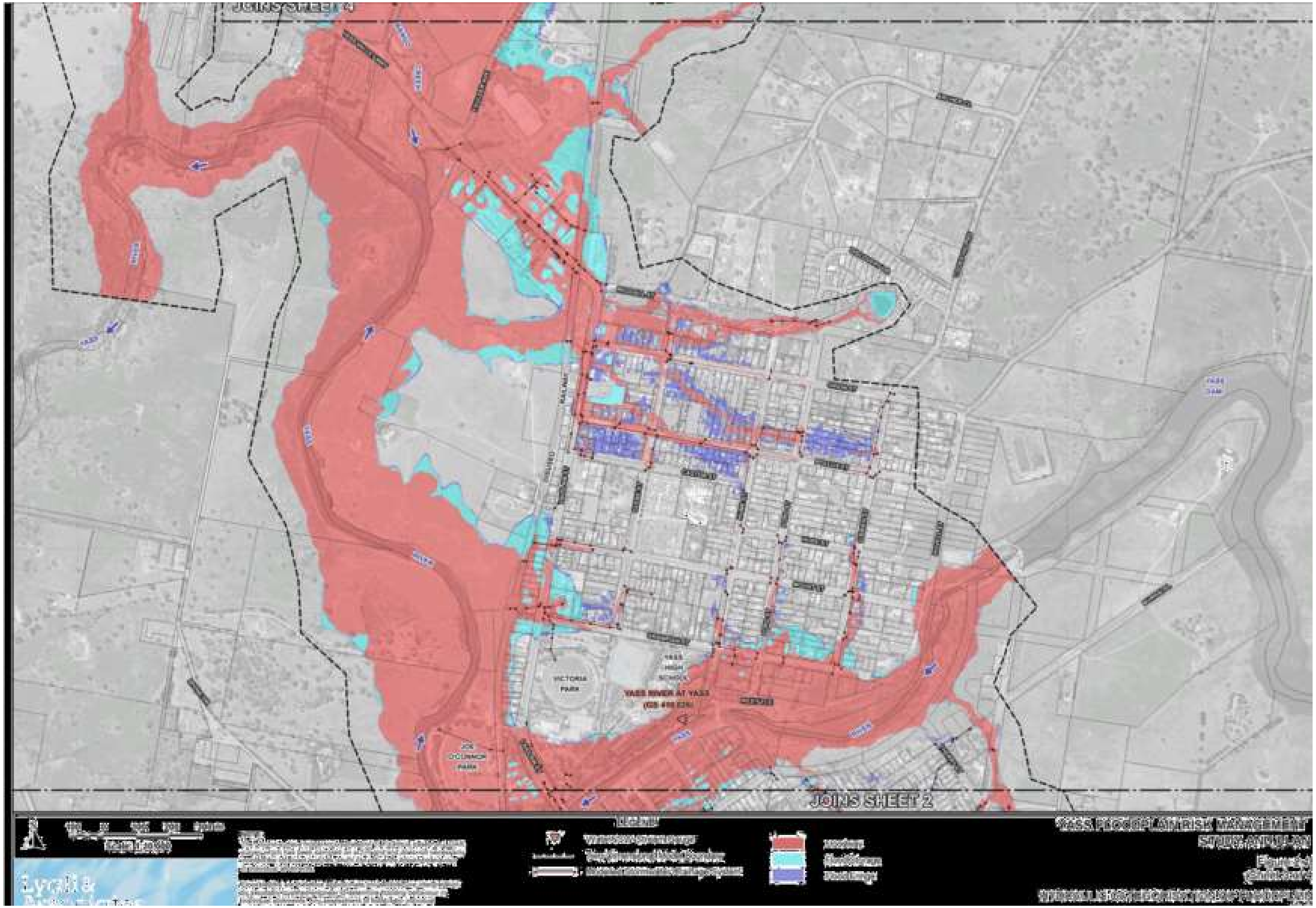
MT CARMEL SCHOOL
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK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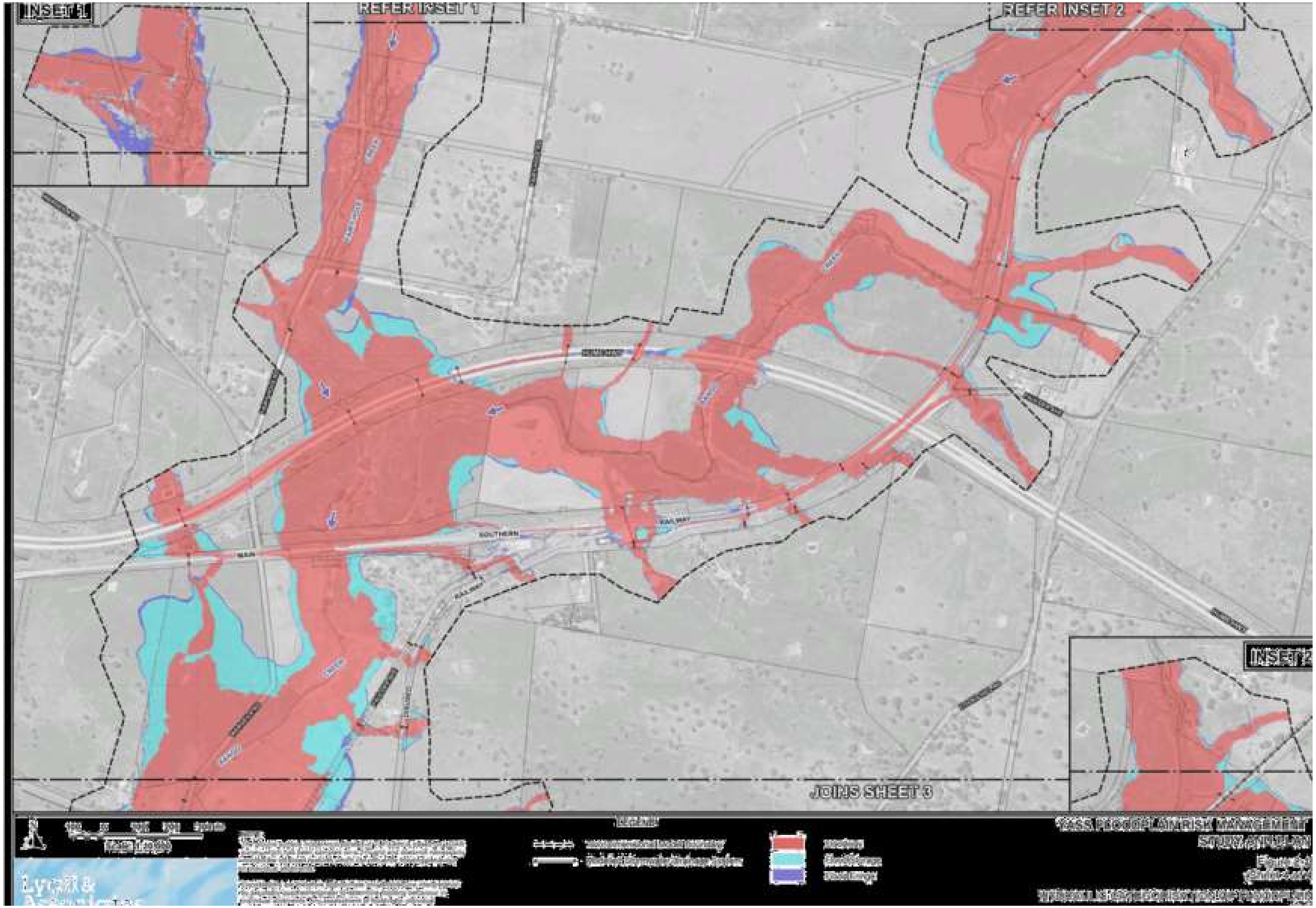
JOINS SHEET 2
LEGEND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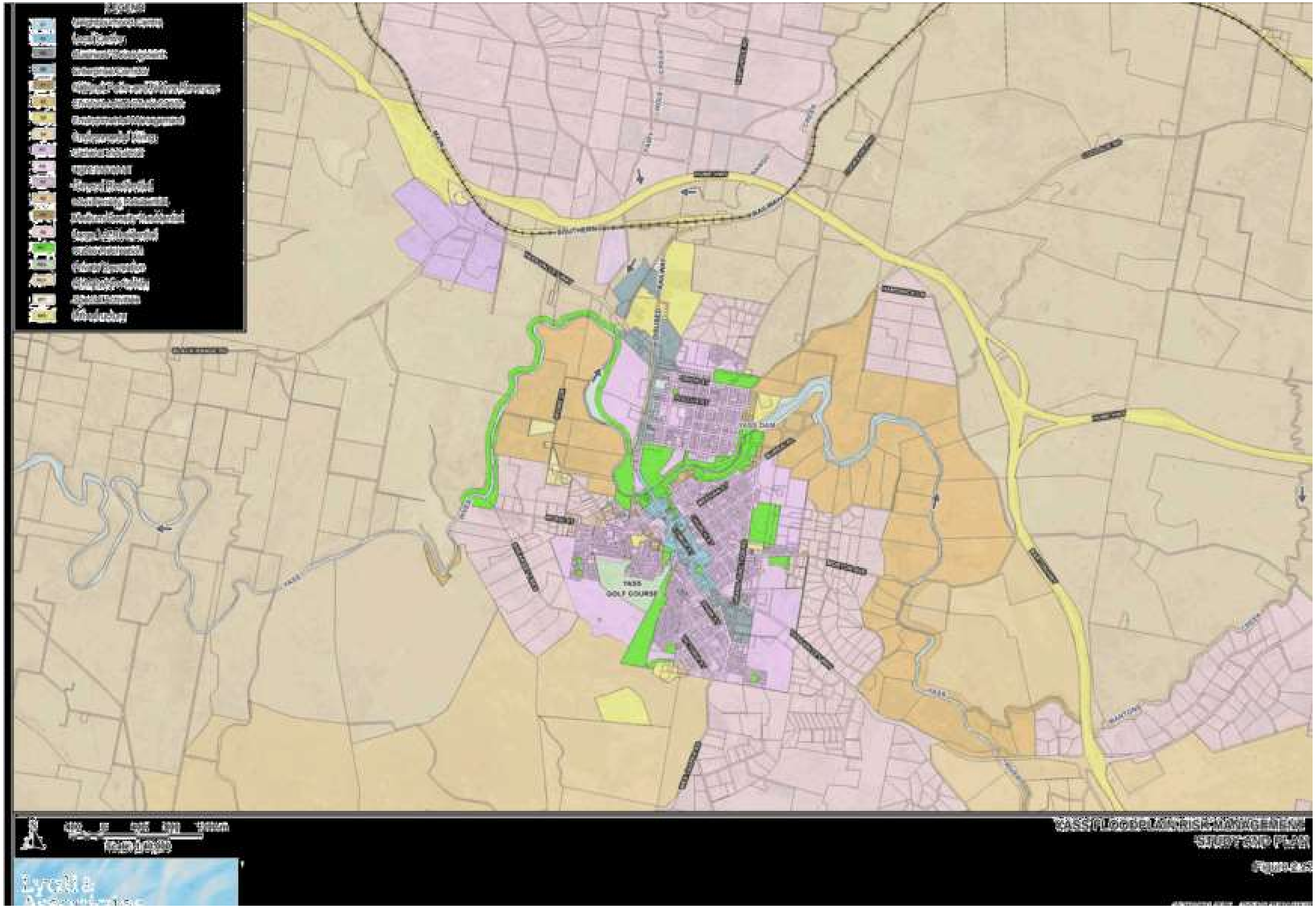
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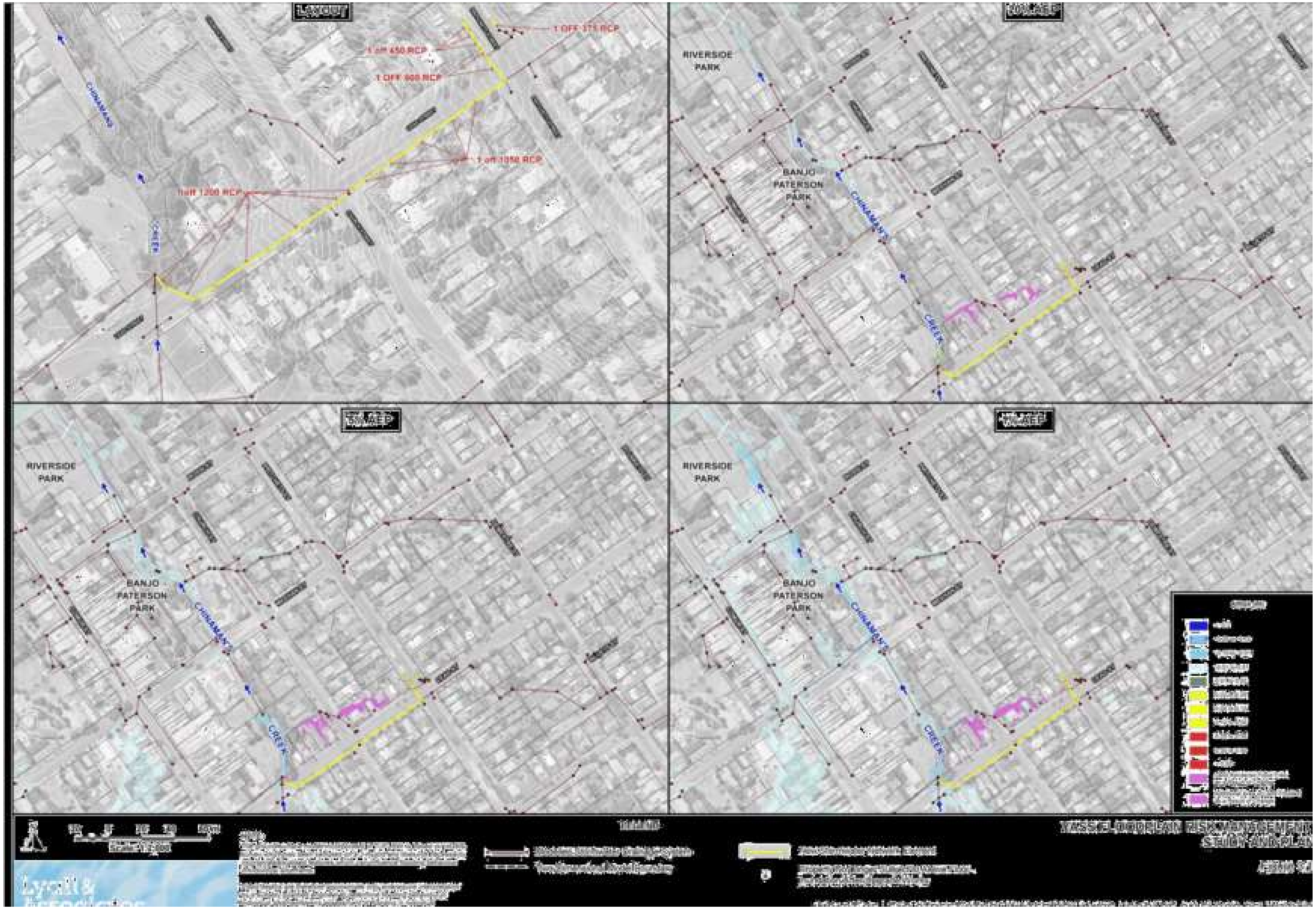
GOLF COURSE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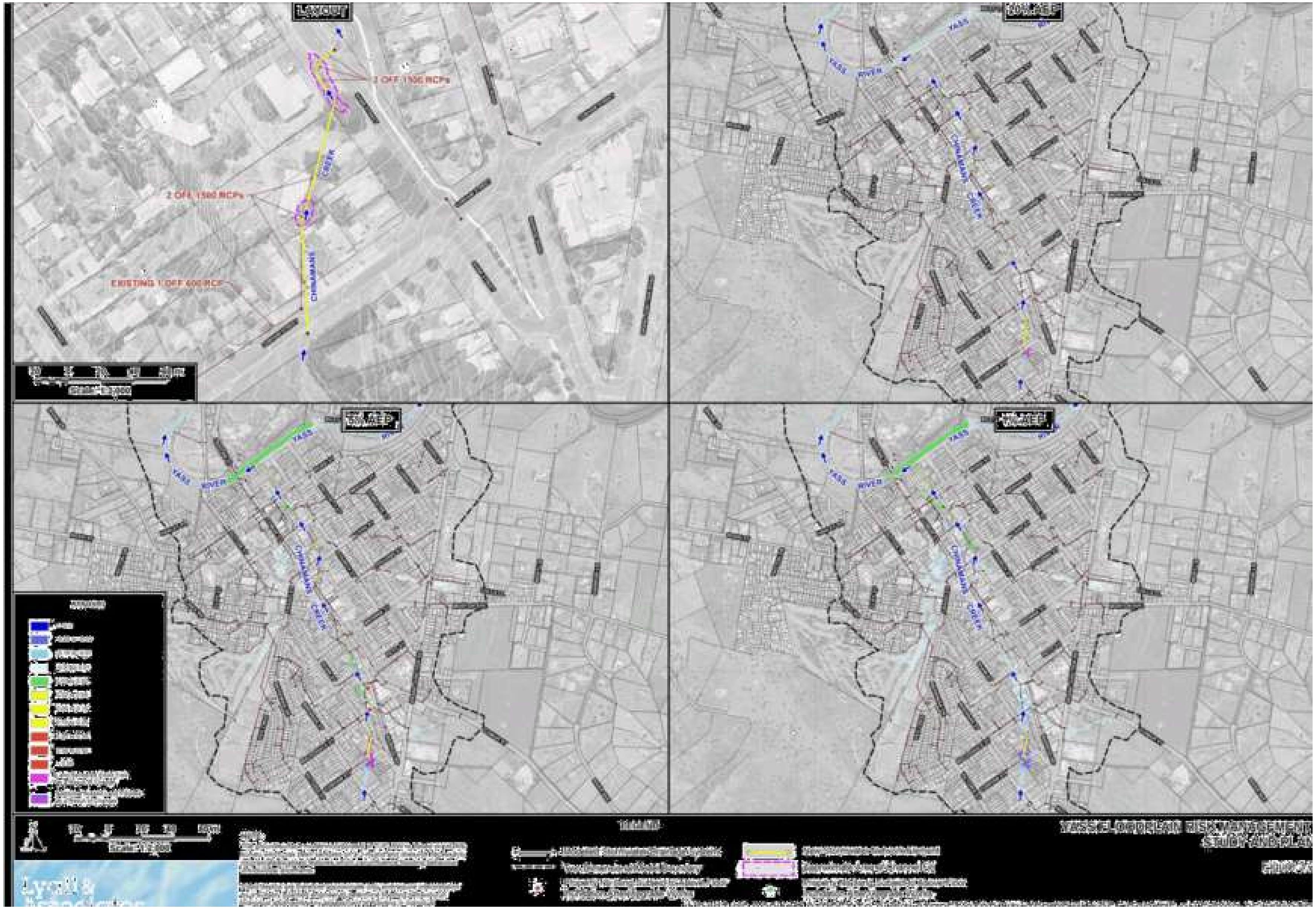
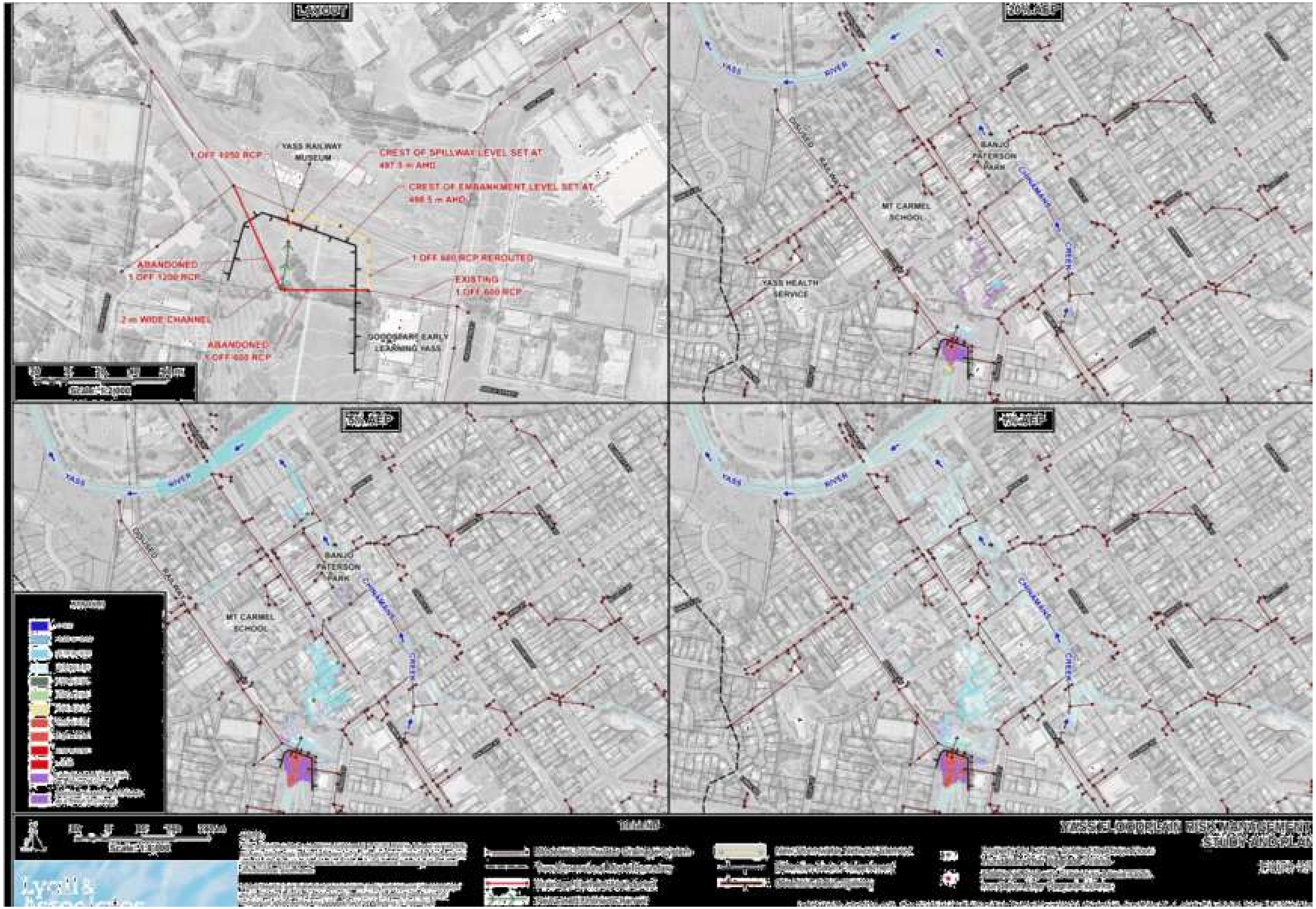
BANJO PATERSON PARK
CREEK


2 OFF 1500 RCPs
2 OFF 1500 RCPs
EXISTING 1 OFF 600 RCP
YASS
RIVER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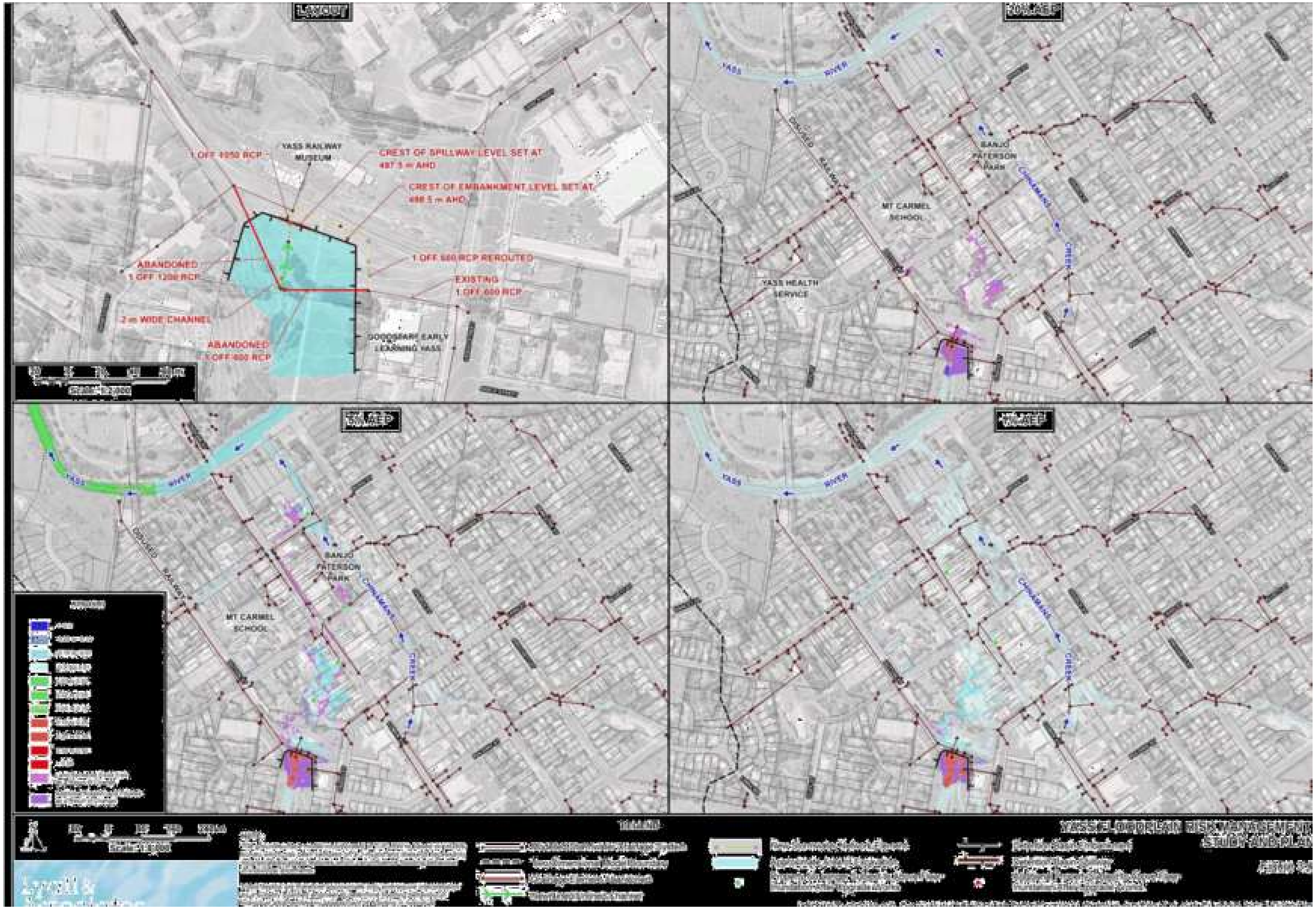
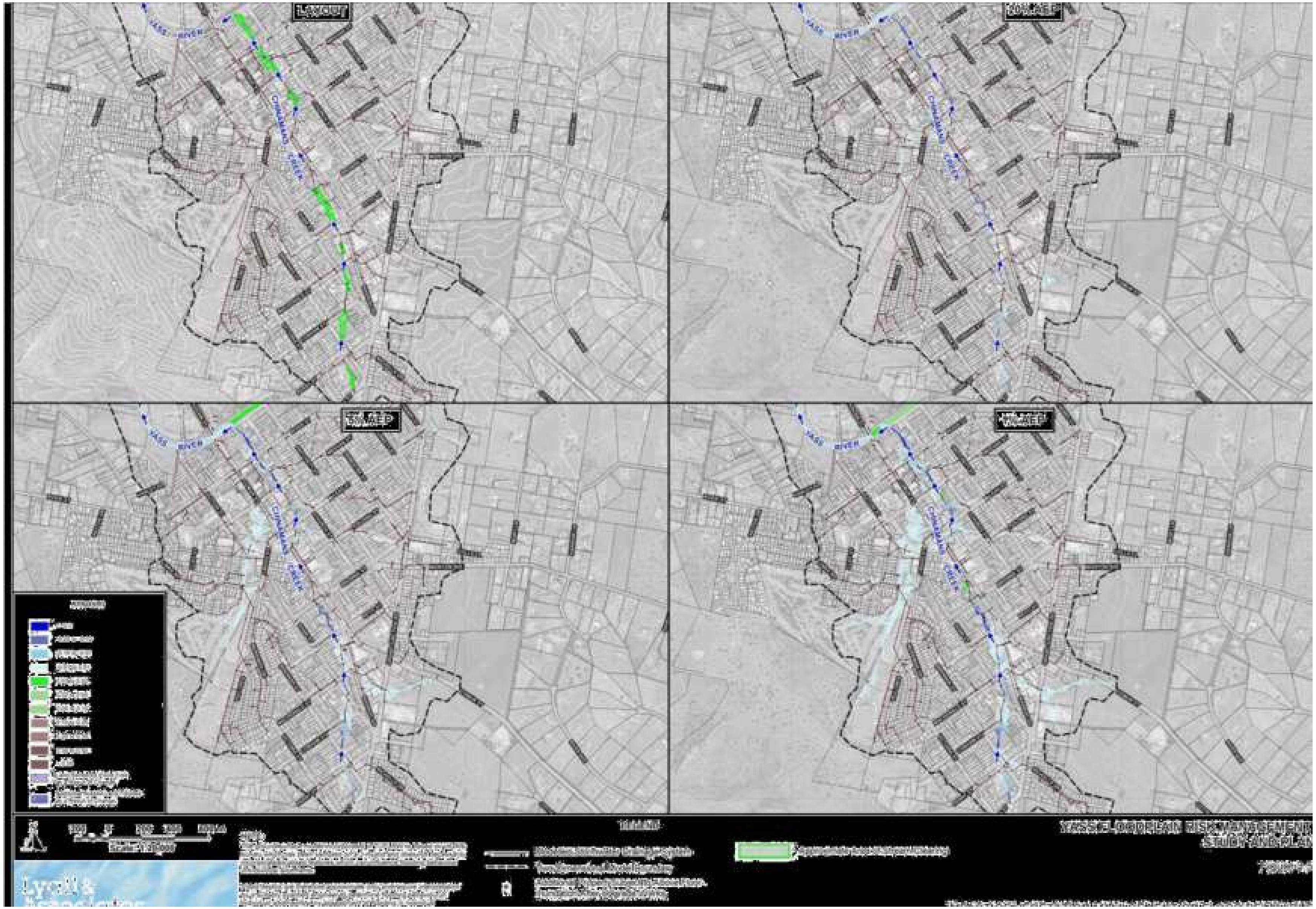
YASS RAILWAY MUSEUM
CREST OF SPILLWAY LEVEL SET AT 497.5 m AHD
CREST OF EMBANKMENT LEVEL SET AT 498.5 m AHD
1 OFF 600 RCP REROUTED
ABANDONED 1 OFF 1200 RCP
EXISTING 1 OFF 600 RCP
2 m WIDE CHANNEL
ABANDONED 1 OFF 600 RCP
GOODSTART EARLY LEARNING YASS
YASS RIVER
BANJO PATERSON PARK
MT CARMEL SCHOOL
YASS HEALTH SERVICE
CHINAMANS CREEK


YASS RAILWAY MUSEUM
1 OFF 1050 RCP
CREST OF SPILLWAY LEVEL SET AT
CREST OF EMBANKMENT LEVEL SET AT
1 OFF 600 RCP REROUTED
EXISTING
1 OFF 600 RCP
ABANDONED
1 OFF 1200 RCP
2 m WIDE CHANNEL
ABANDONED
1 OFF 600 RCP
GOODSTART EARLY LEARNING YASS
YASS RIVER
BANJO PATERSON PARK
CHINAMANS CREEK
MT CARMEL SCHOOL
YASS HEALTH SERVICE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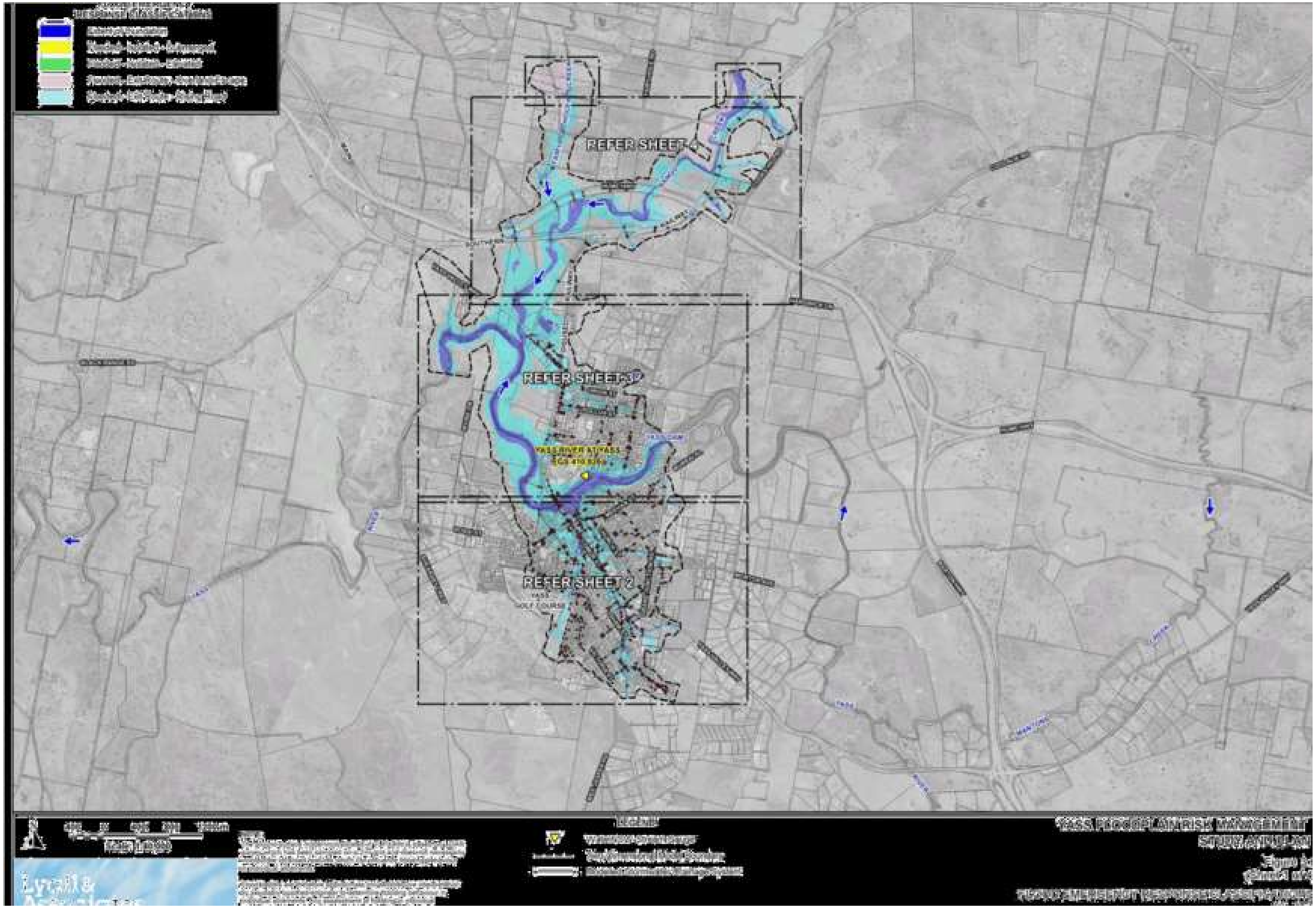
CHINAMANS CREEK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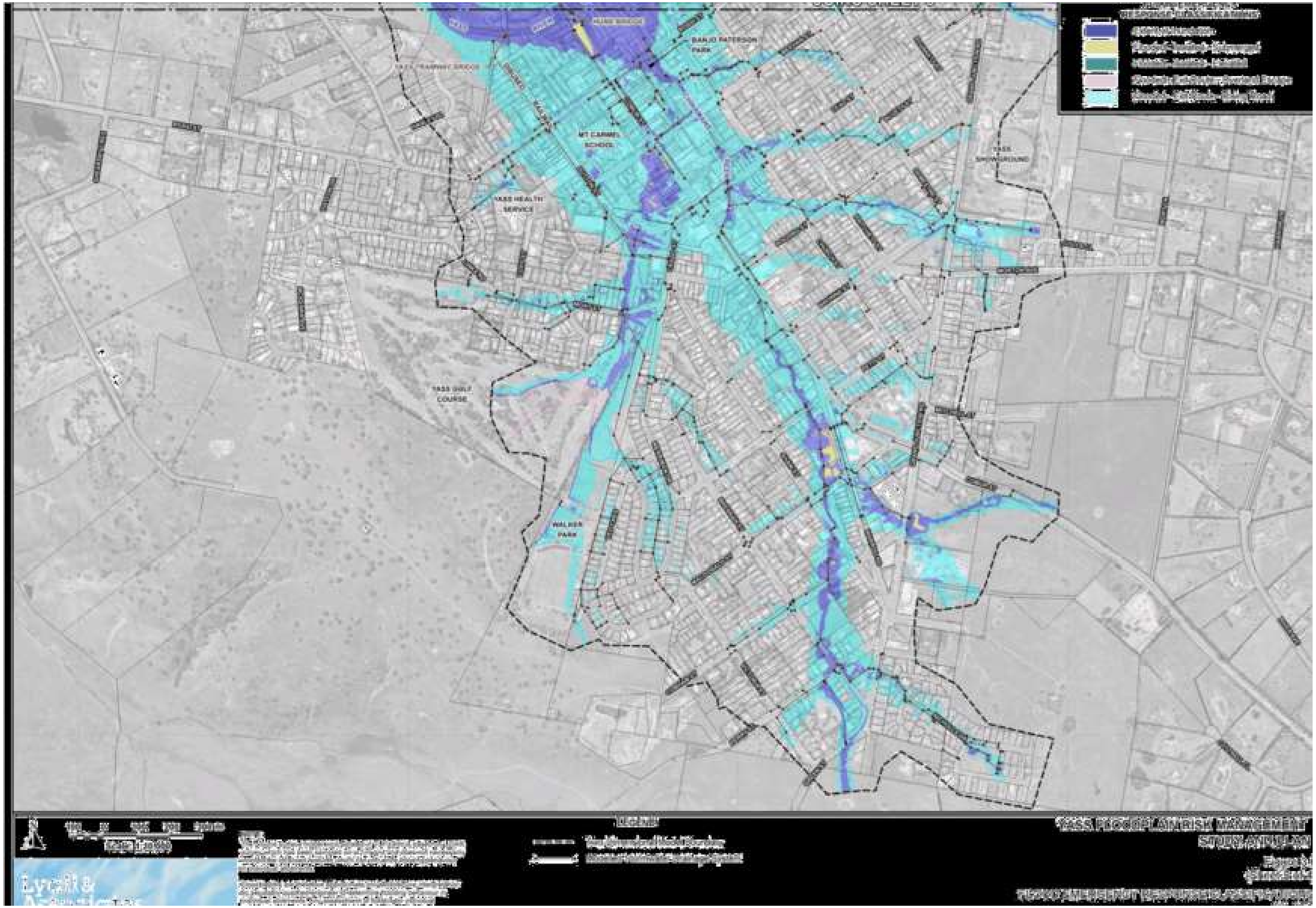
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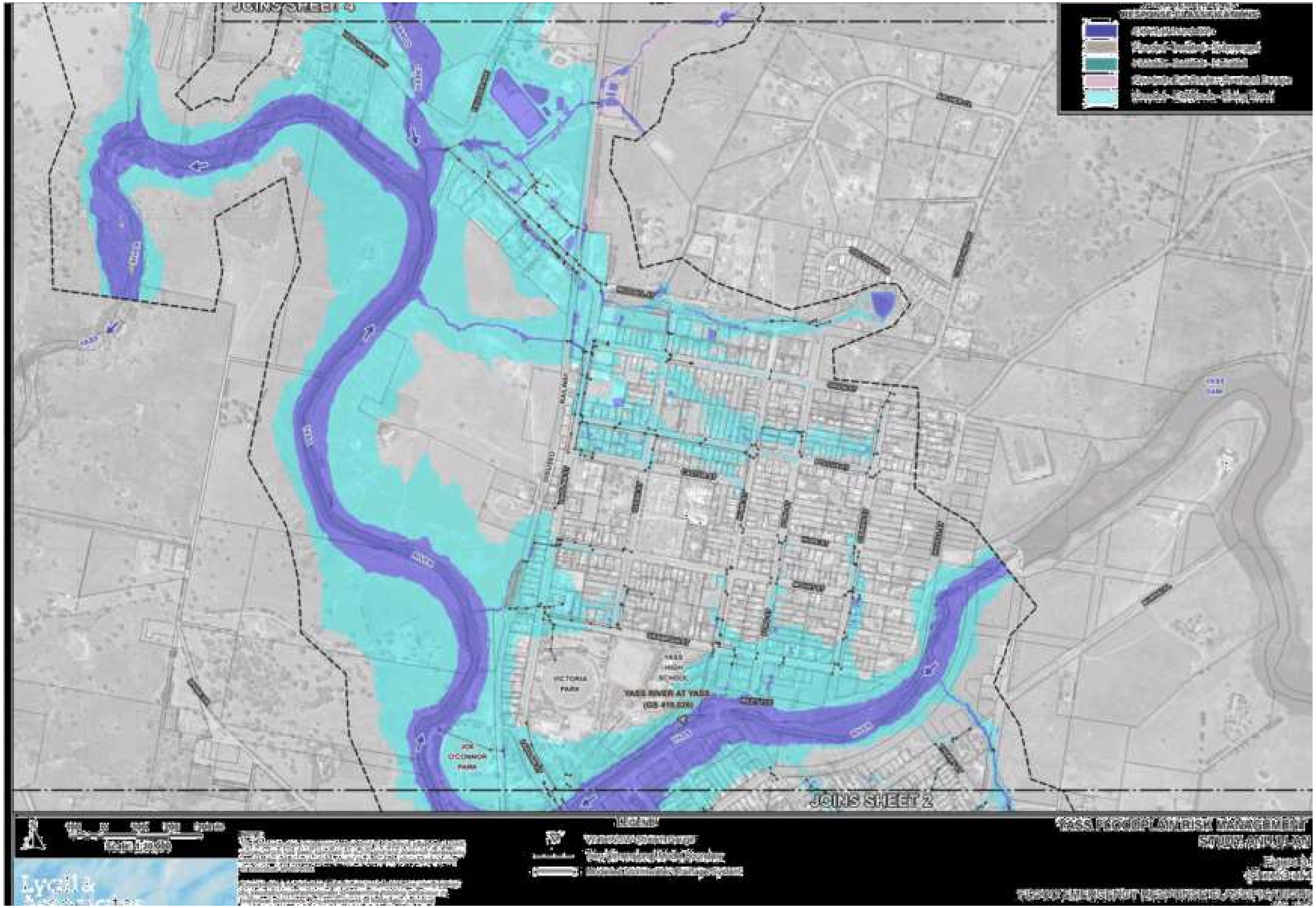
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK
LEGEND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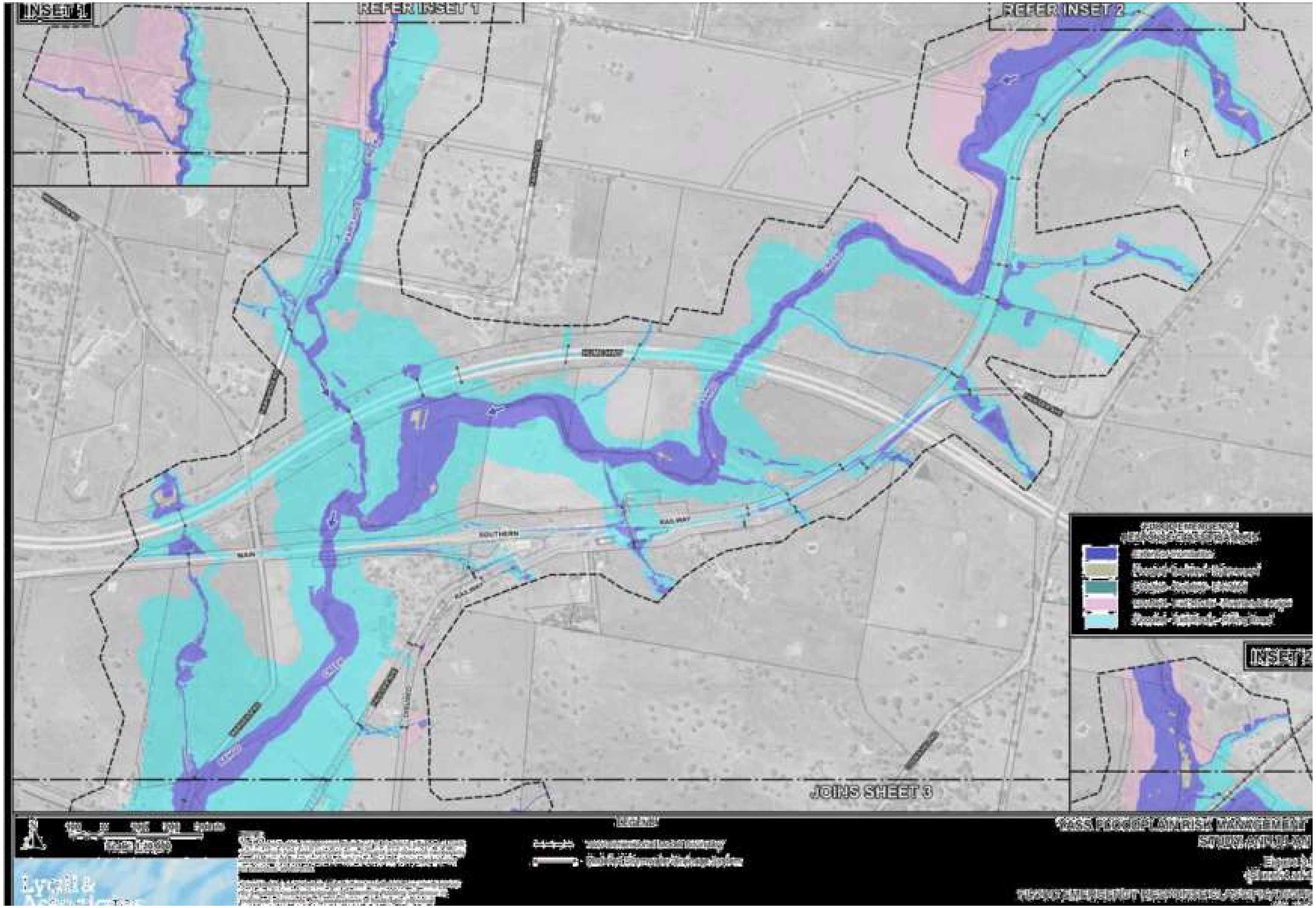
YASS RIVER AT YASS
JOINS SHEET 2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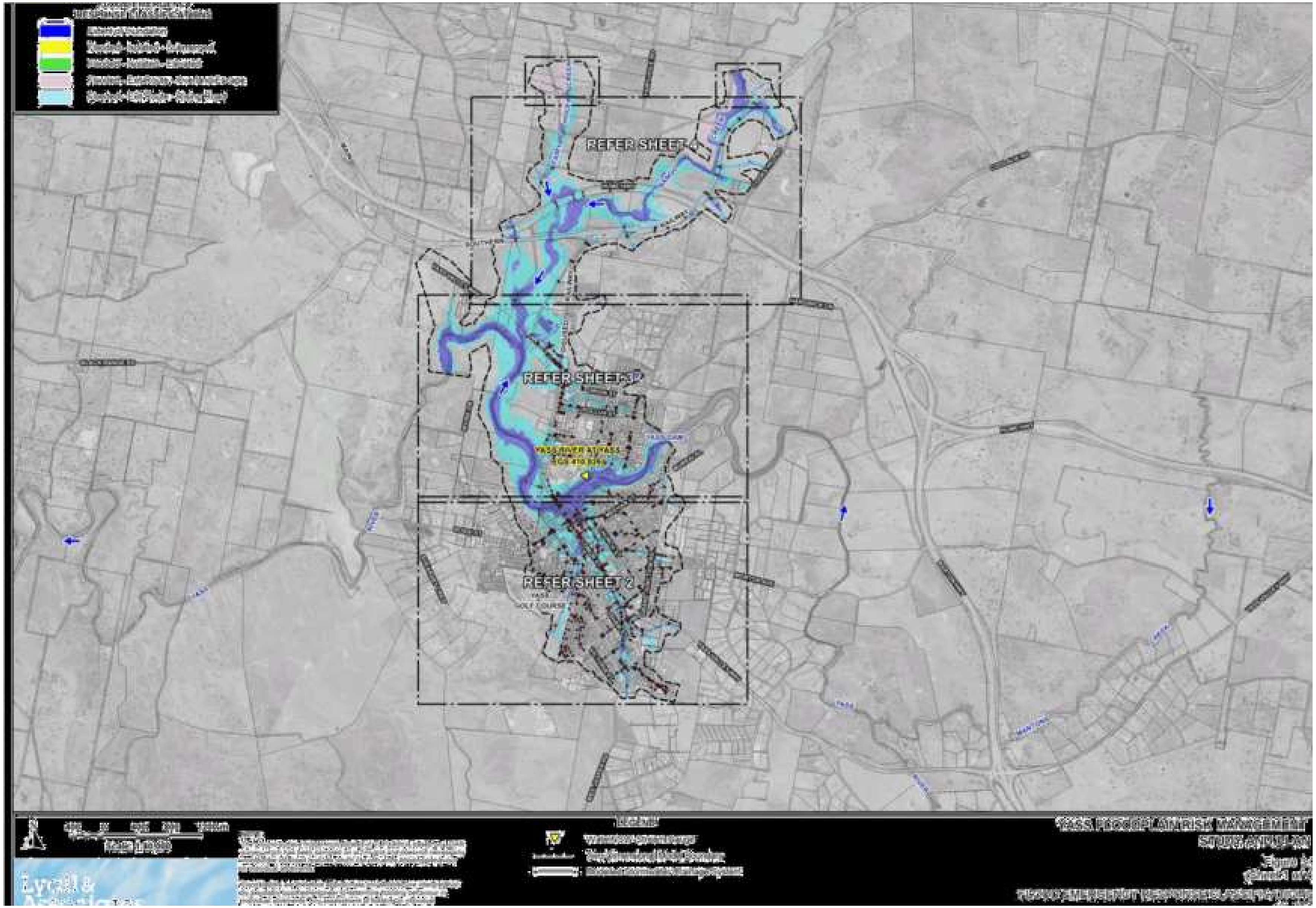
INSET 2
JOINS SHEET 3
SOUTHERN
RAILWAY
LEGEND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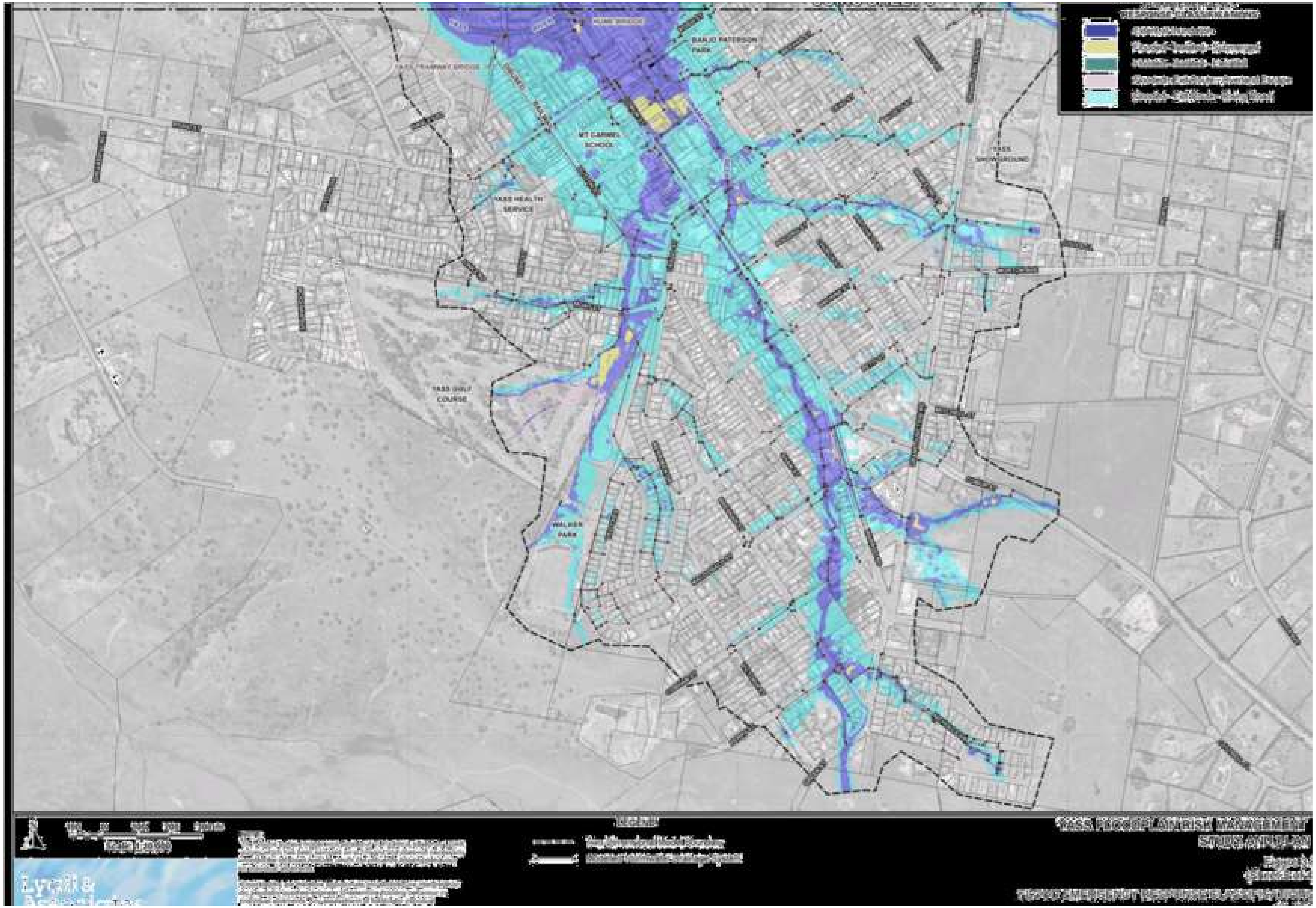
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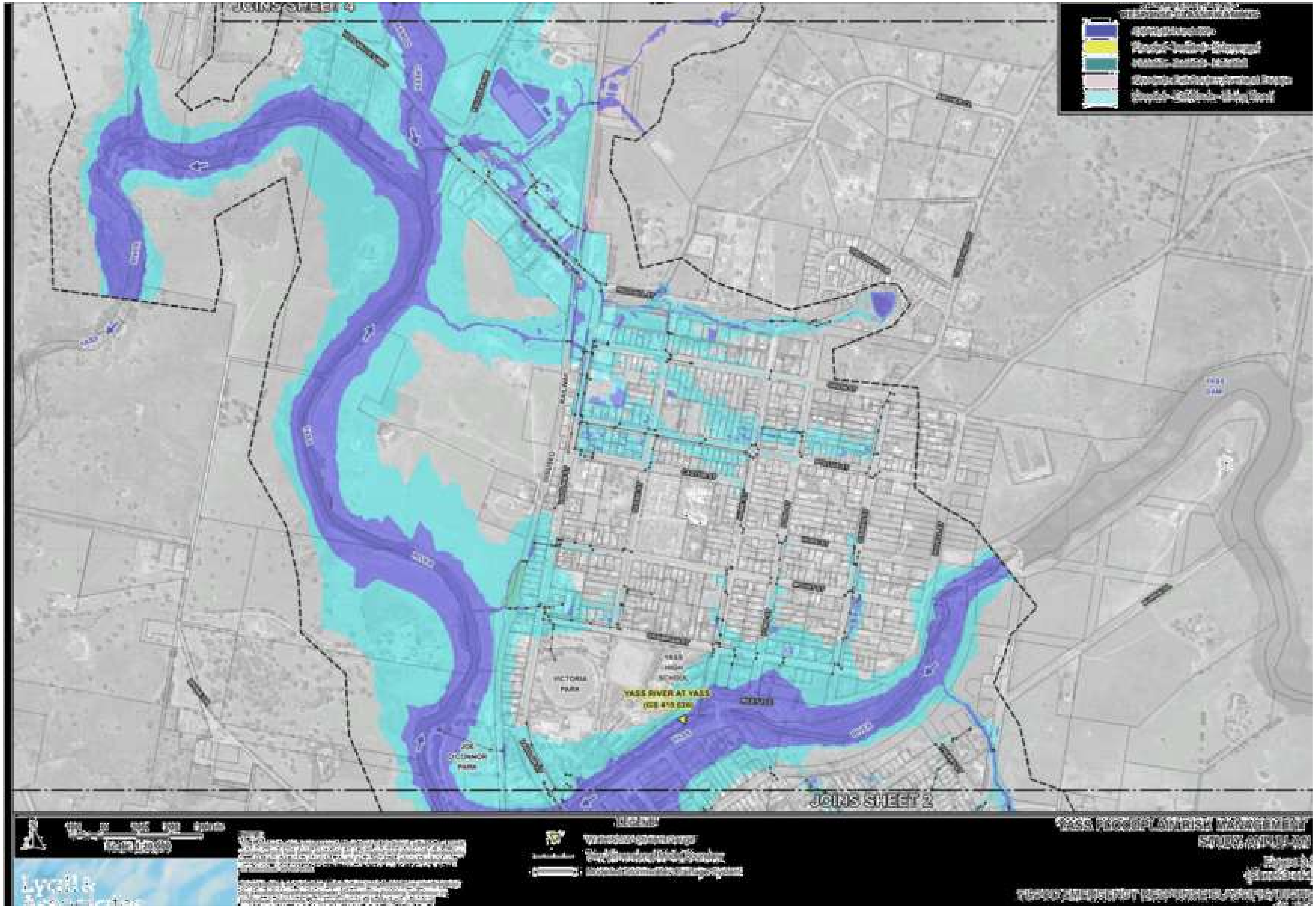
WALKER PARK
LEGEND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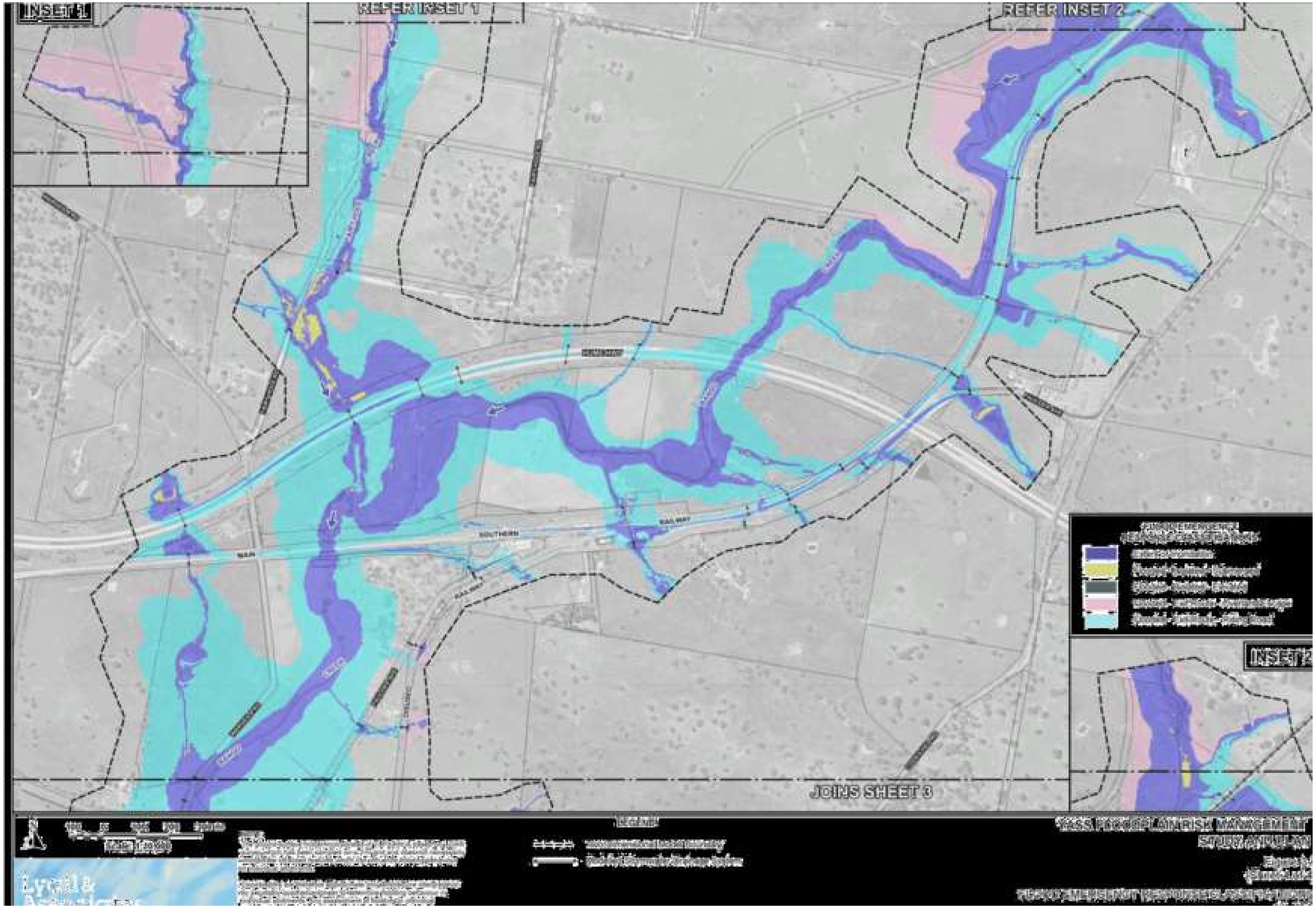
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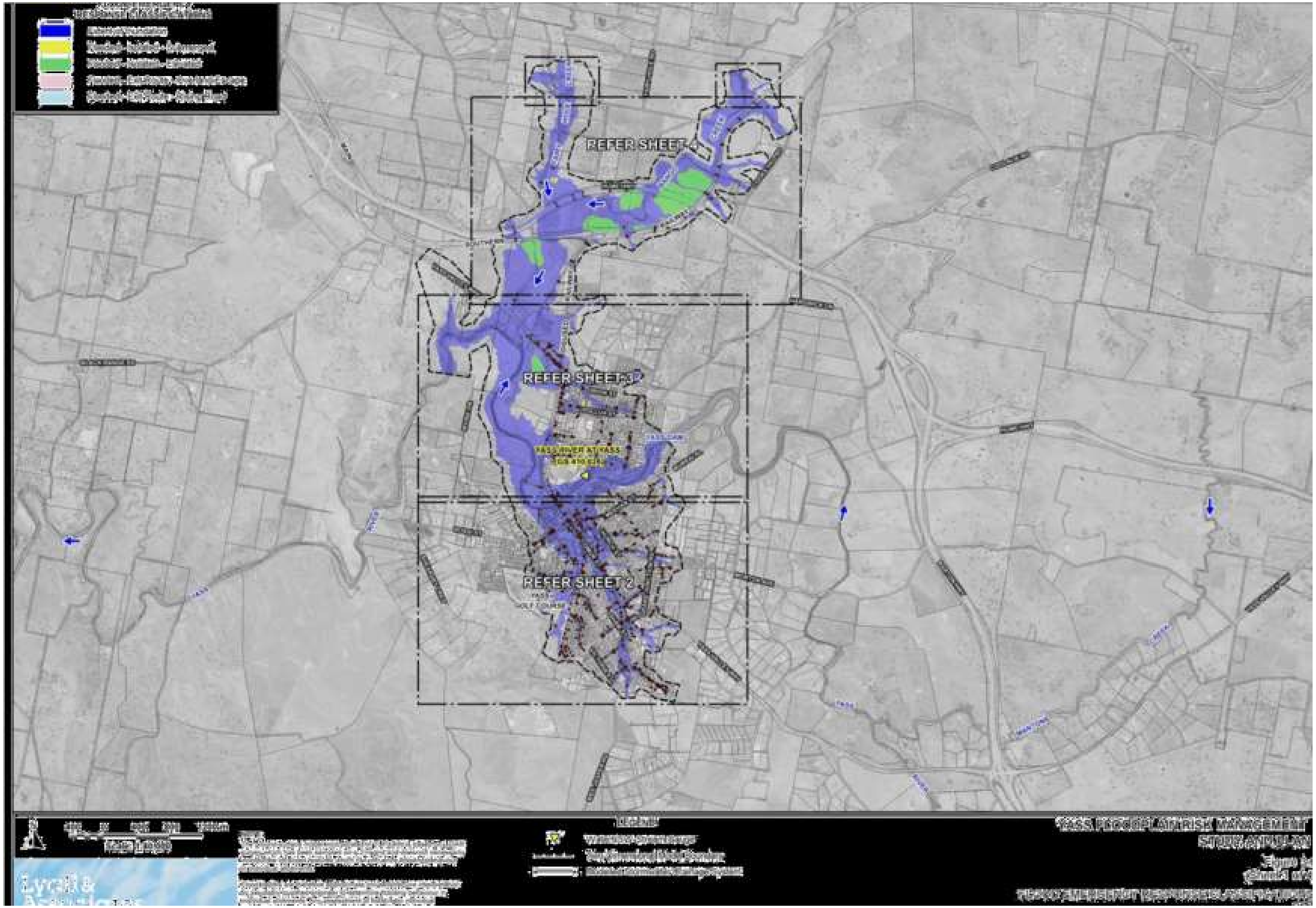
MAIN
RAILWAY
INSET 2
JOINS SHEET 3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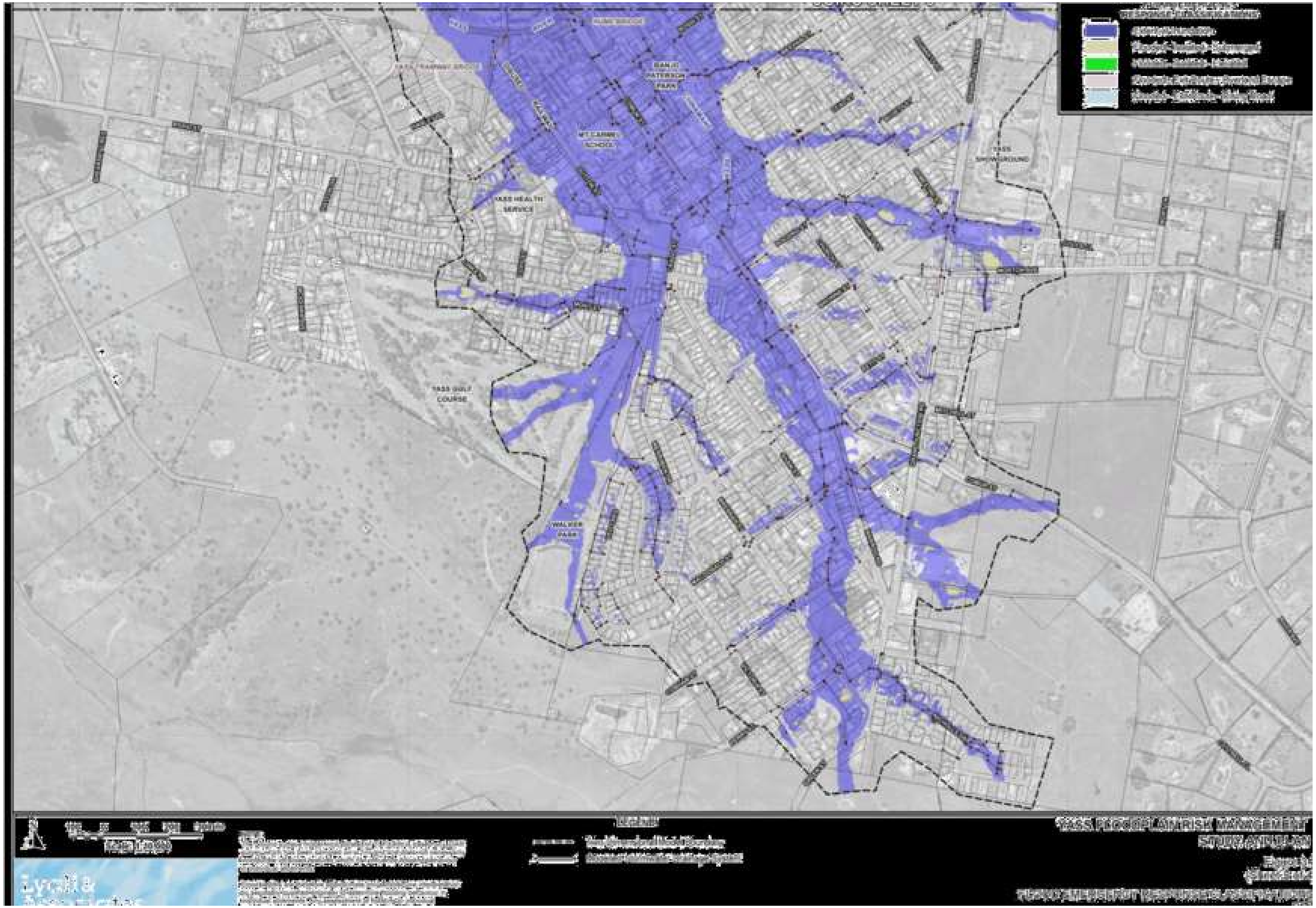
YASS RIVER AT YASS
LEGEND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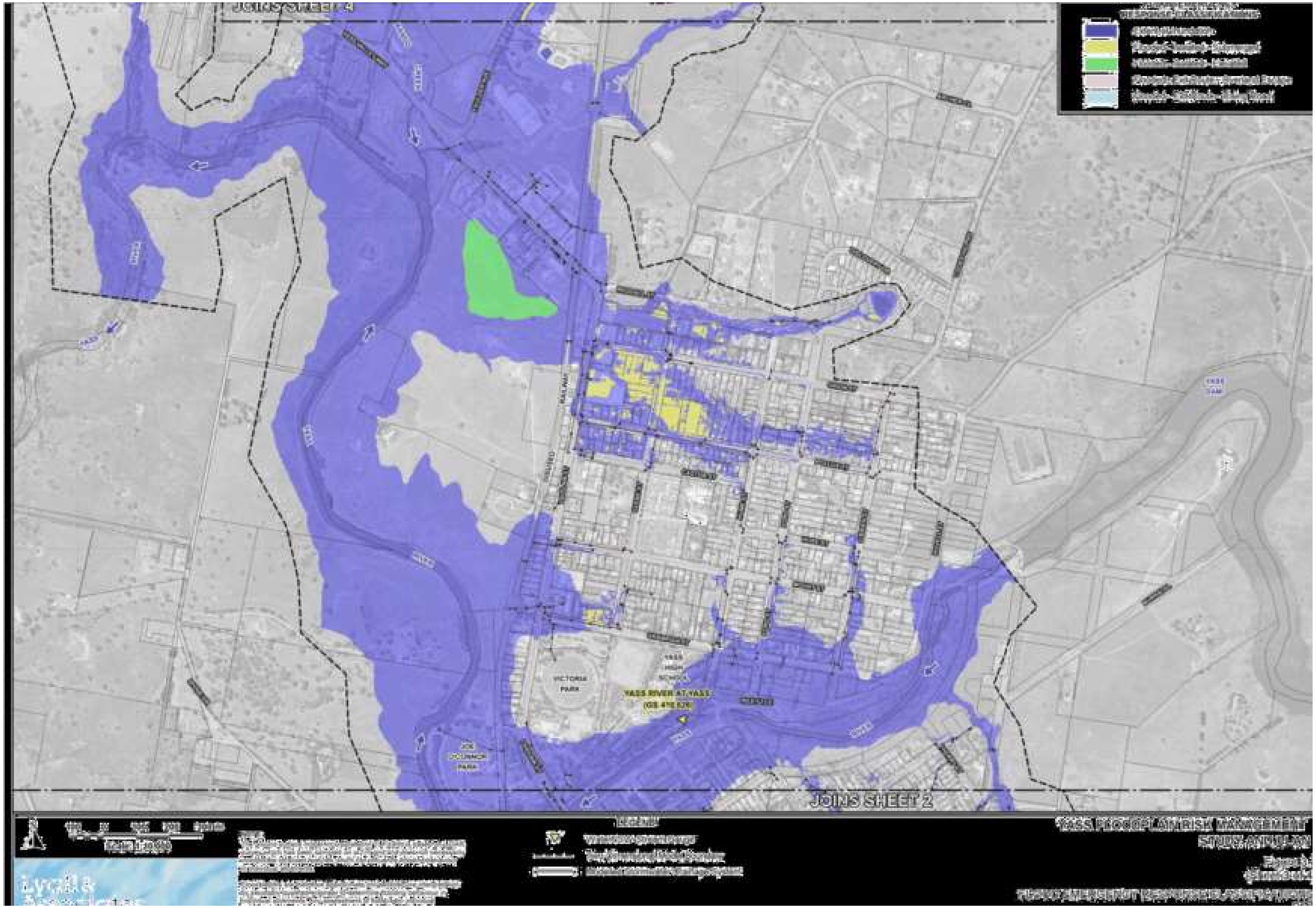
MT CARMEL SCHOOL
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK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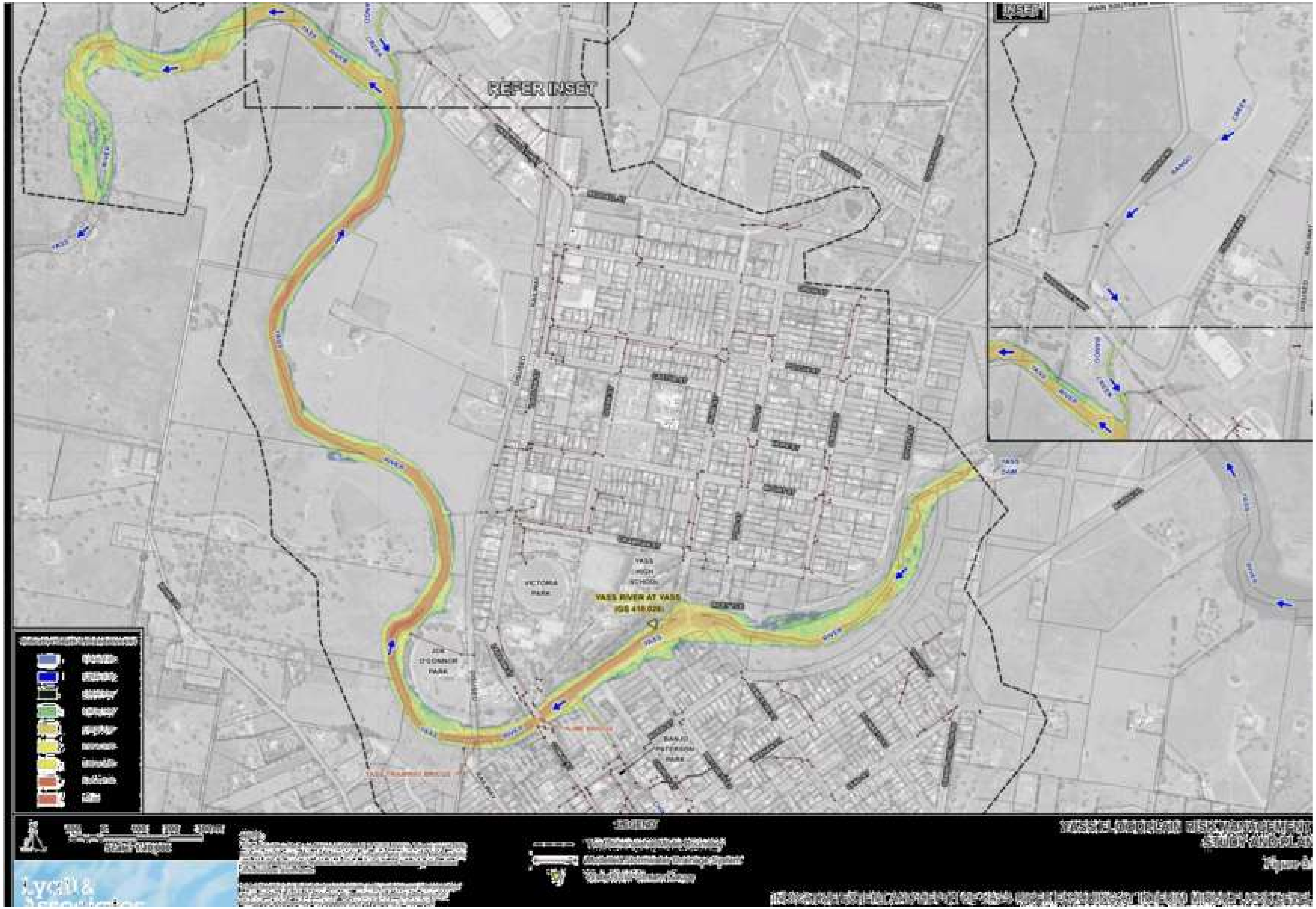
VICTORIA PARK
YASS HIGH SCHOOL
YASS RIVER AT YASS
JOINS SHEET 2
LEGEND
YASS FLOODPLAIN RISK MANAGEMENT


INSET 1
REFER INSET 1
REFER INSET 2
INSET 2
JOINS SHEET 3
SOUTHERN
LEGEND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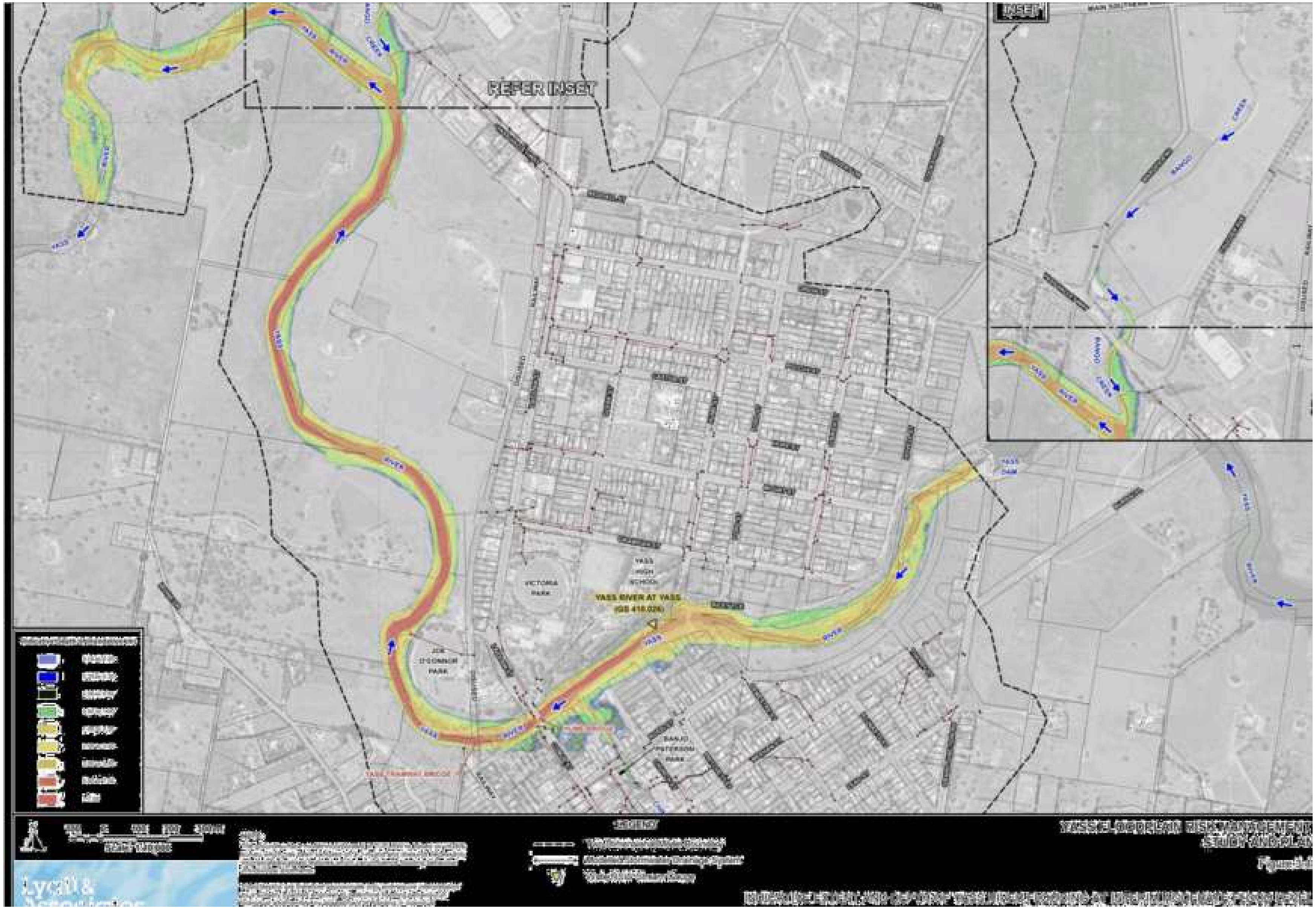
BANJO PATERSON PARK
YASS DAM
LEGEND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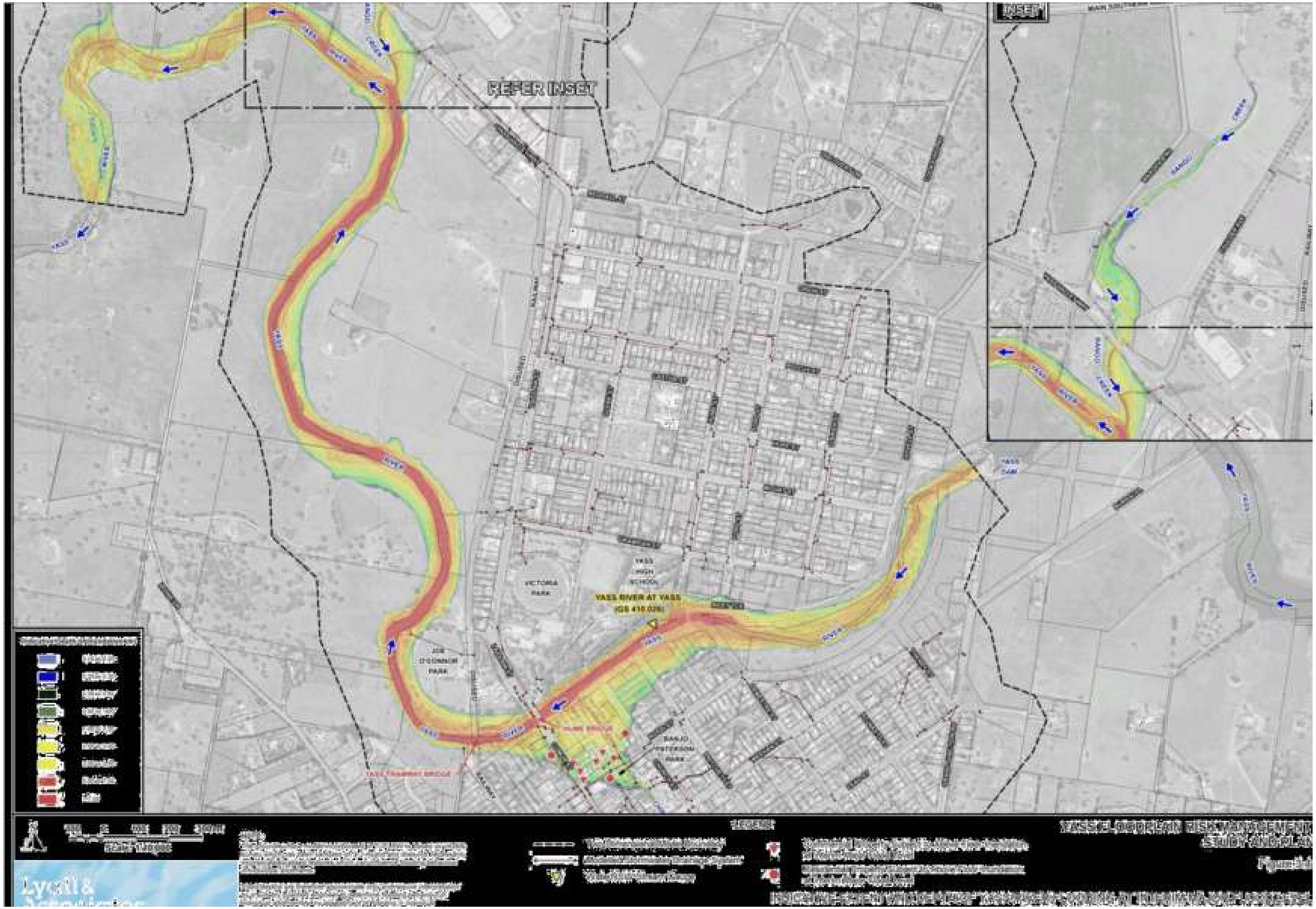
YASS RIVER AT YASS
JOE O'CONNOR PARK
BANJO PATERSON PARK
YASS RIVER
LEGEND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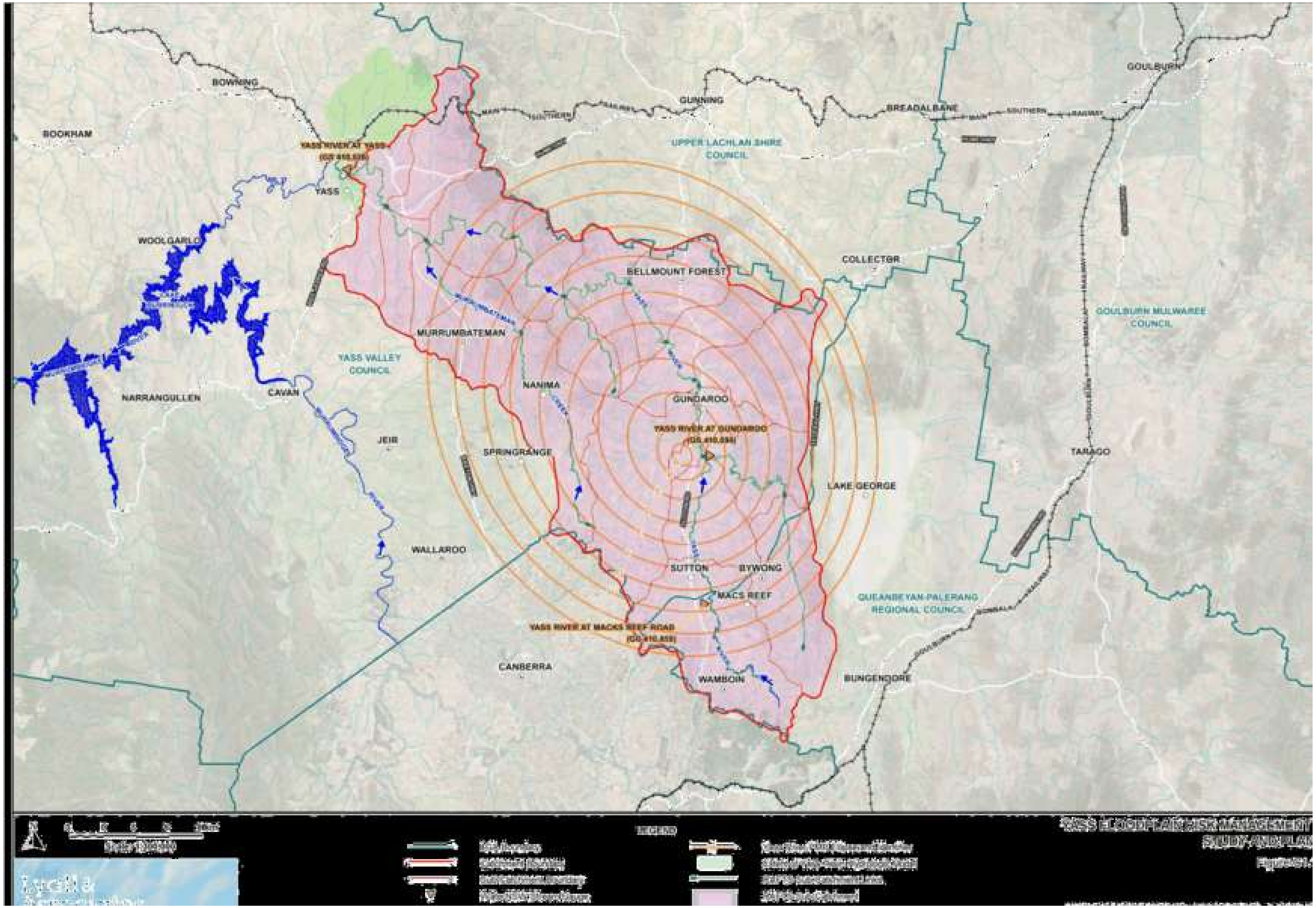
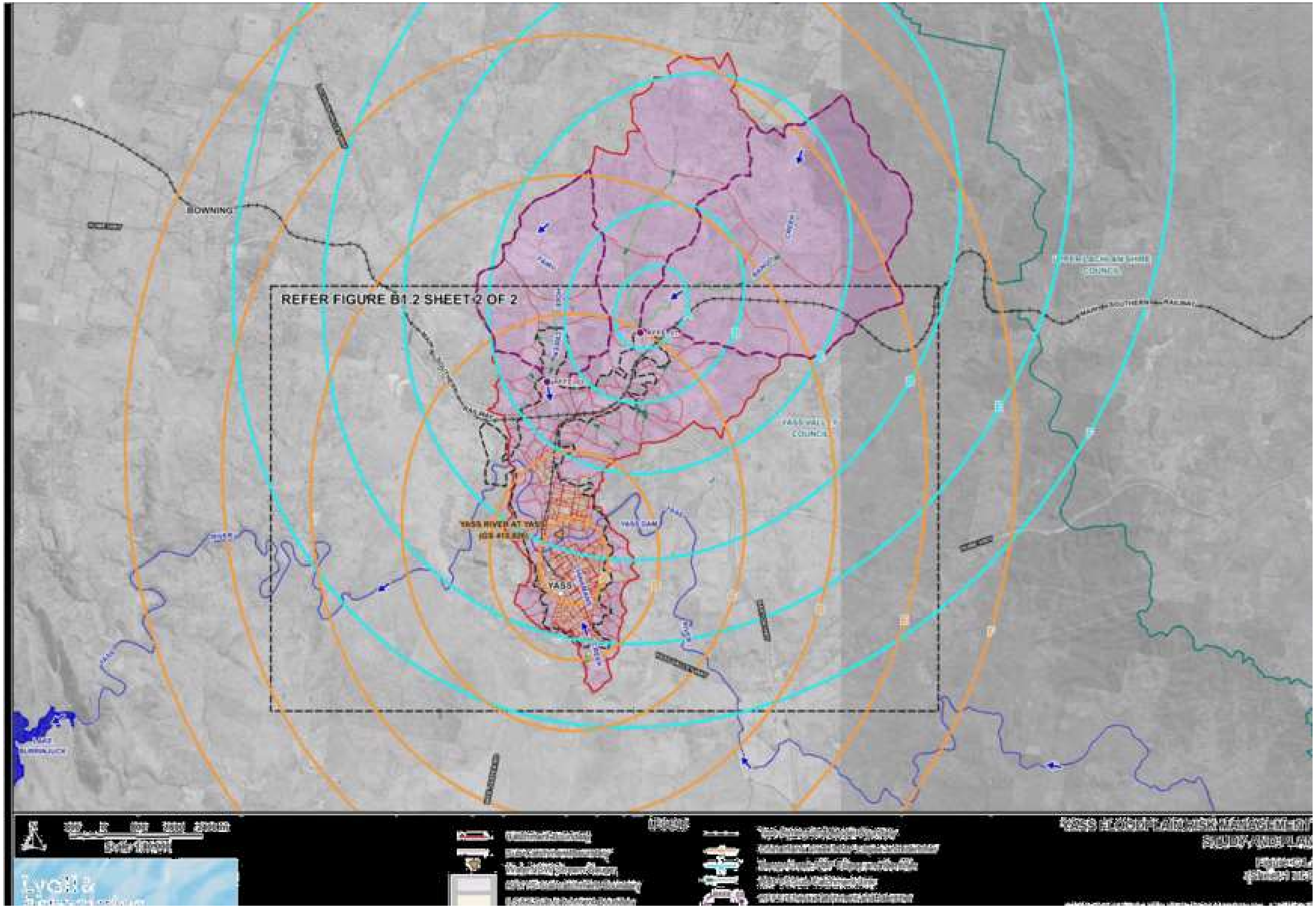
YASS RIVER AT YASS
VICTORIA PARK
YASS HIGH SCHOOL
JOE O'CONNOR PARK
YASS DAM

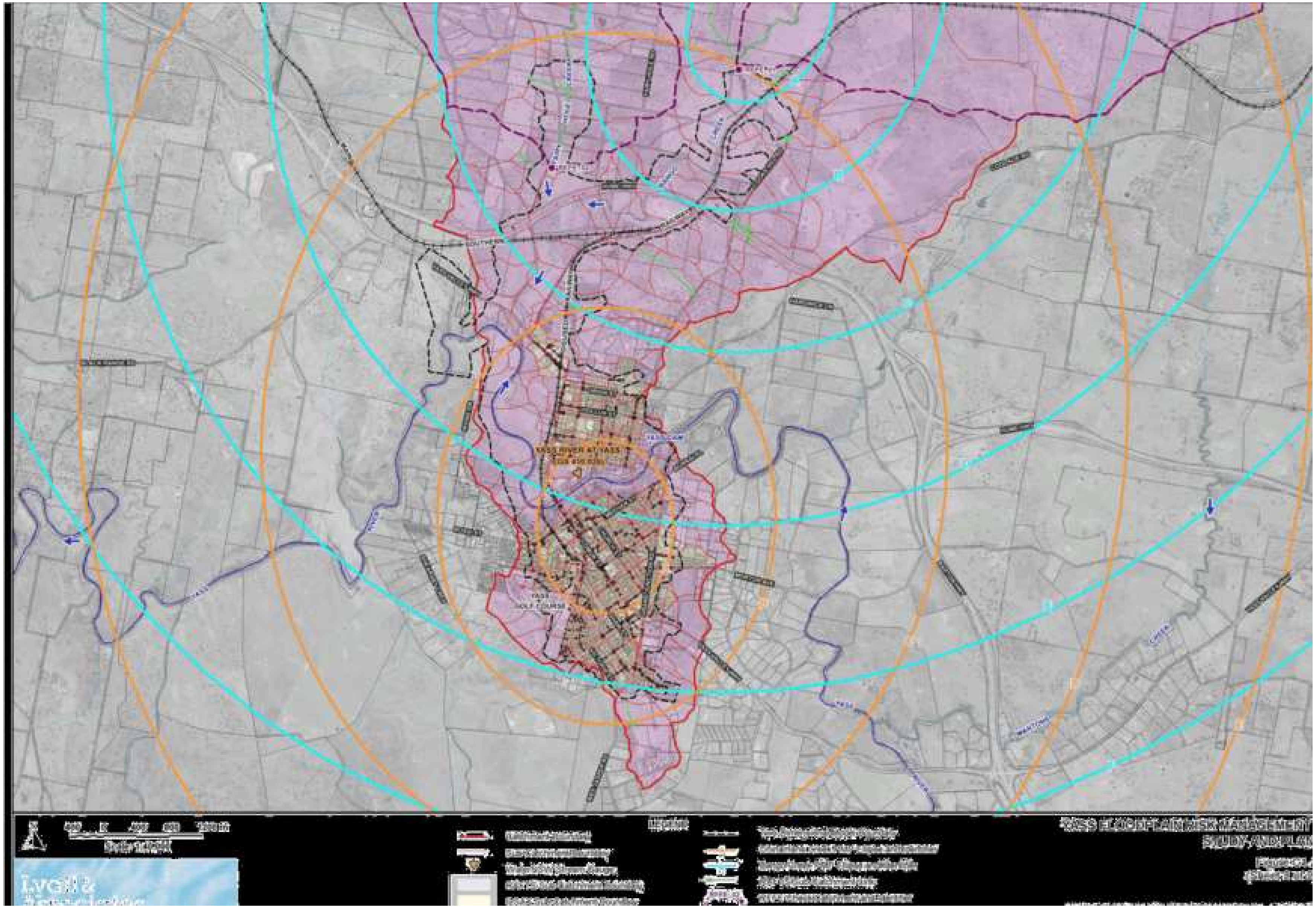
APPENDIX C

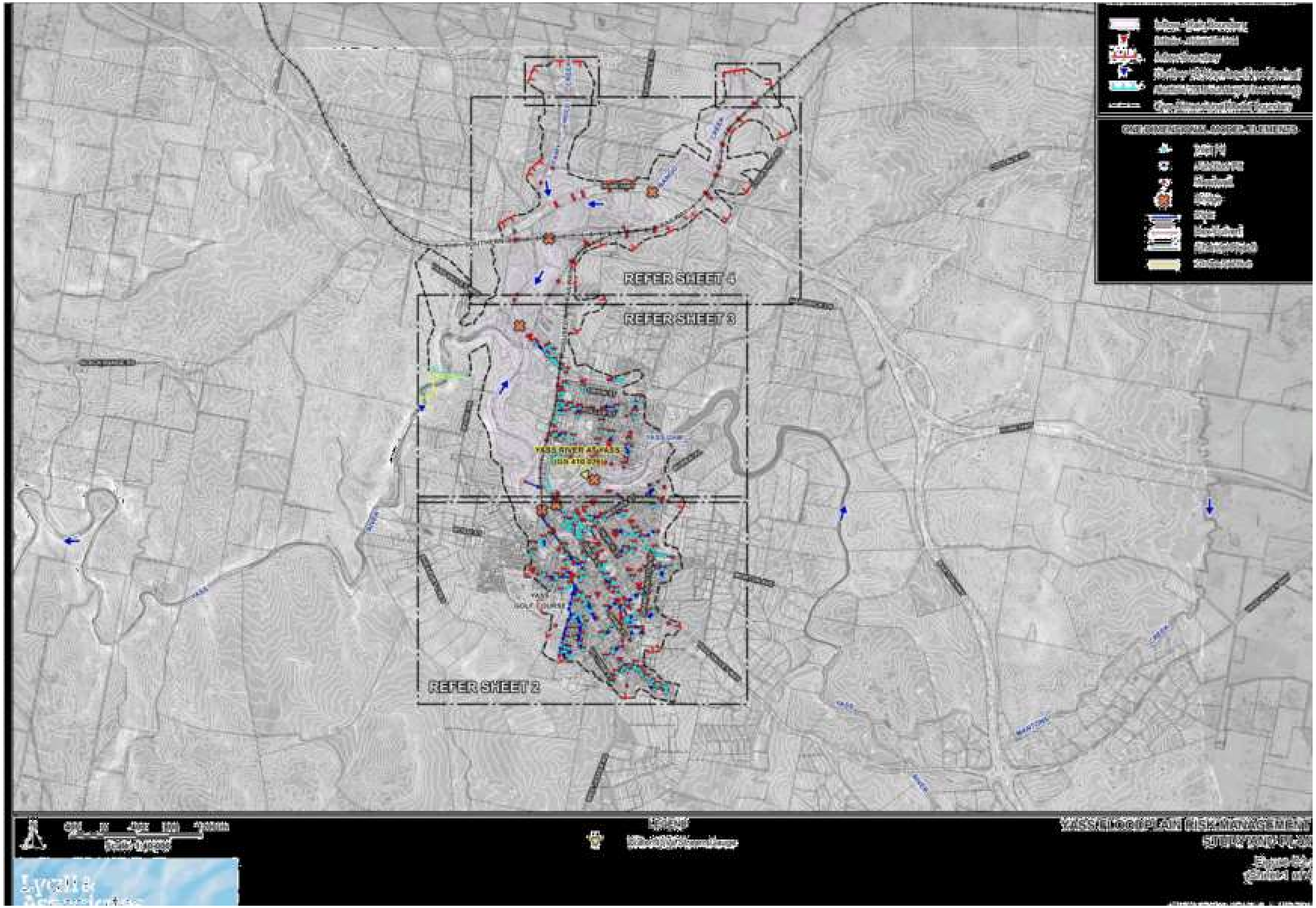
FLOOD STUDY UPDATE

LIST OF FIGURES (APPENDIX C


GOULBURN
BOWNING
GUNNING
BREADALBANE
BOOKHAM
YASS RIVER AT YASS
UPPER LACHLAN SHIRE COUNCIL
YASS
WOOLGARLO
COLLECTOR
BELLMOUNT FOREST
GOULBURN MULWAREE COUNCIL
MURRUMBATEMAN
YASS VALLEY COUNCIL
NANIMA
NARRANGULLEN
CAVAN
GUNDAROO
YASS RIVER AT GUNDAROO
JEIR
SPRINGRANGE
TARAGO
LAKE GEORGE
WALLAROO
SUTTON
BYWONG
MACS REEF
QUEANBEYAN-PALERANG REGIONAL COUNCIL
YASS RIVER AT MACKS REEF ROAD
CANBERRA
WAMBOIN
BUNGENDORE
LEGEND


BOWNING
REFER FIGURE B1.2 SHEET 2 OF 2
YASS VALLEY COUNCIL
YASS RIVER AT YASS
YASS DAM
YASS


YASS RIVER AT YASS
YASS
GOLF COURSE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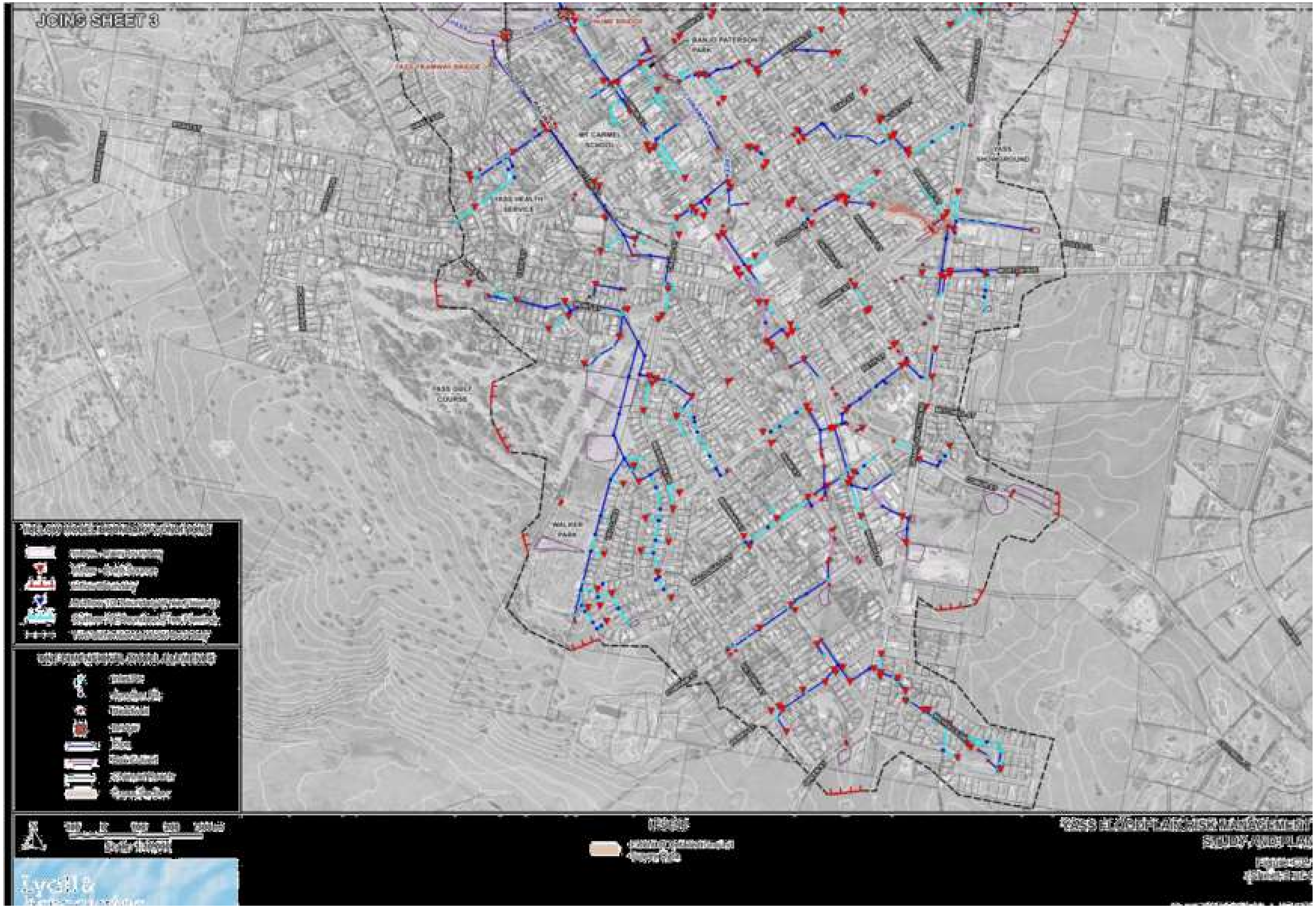
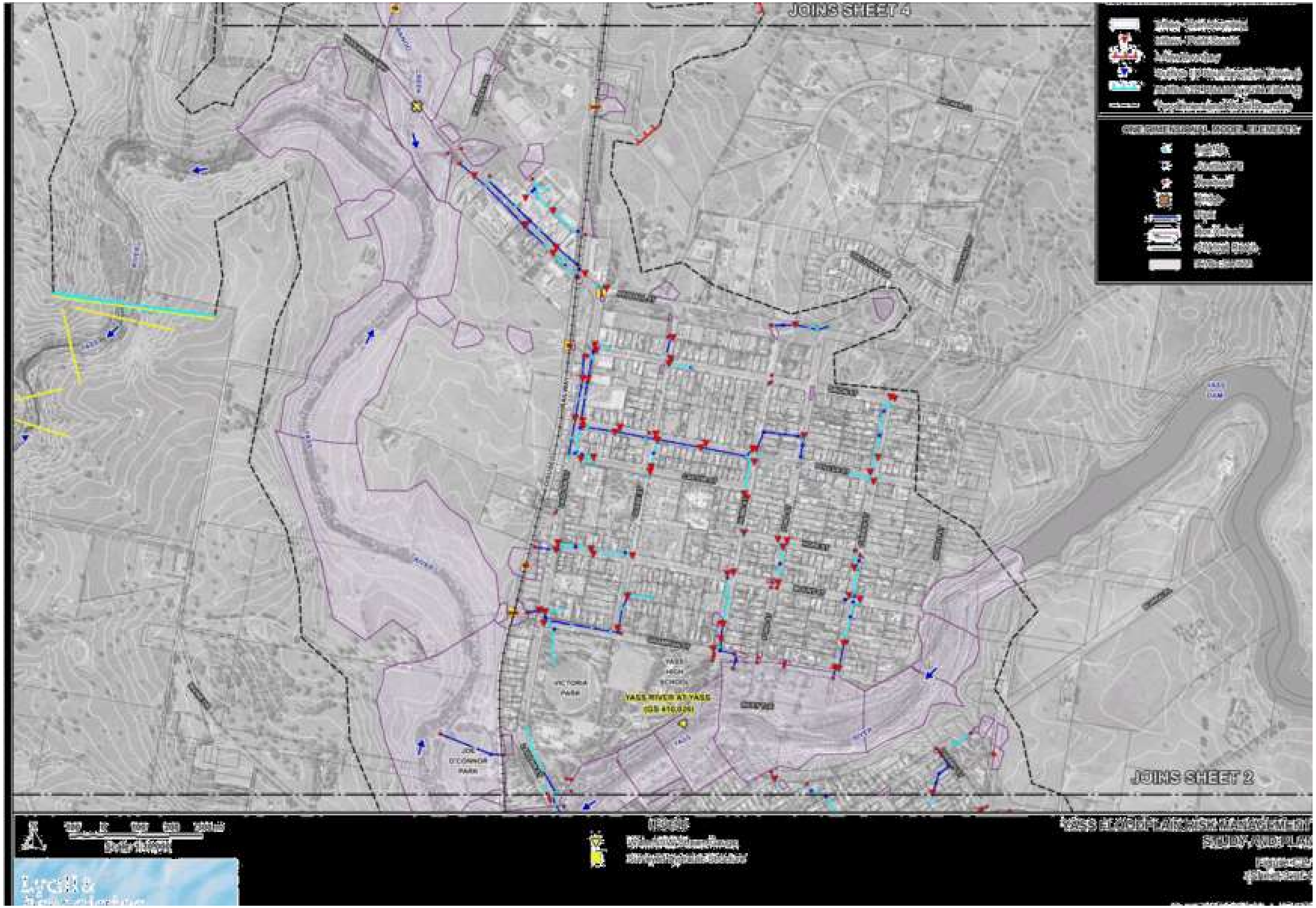
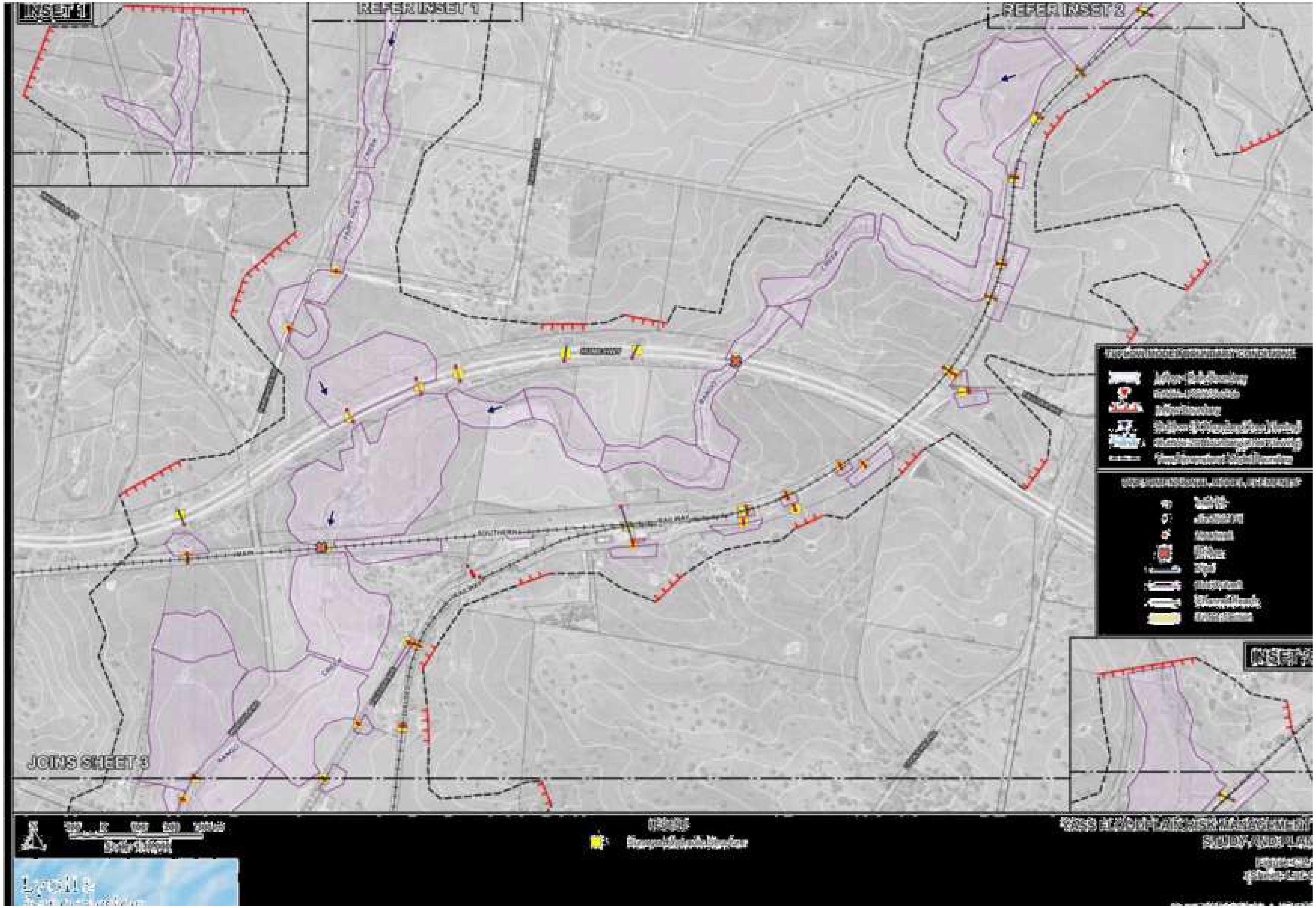
REFER SHEET 3
YASS RIVER AT YASS
REFER SHEET 2


JOINS SHEET 3
BANJO PATERSON PARK
MT CARMEL SCHOOL
YASS HEALTH SERVICE
YASS GOLF COURSE
WALKER PARK
YASS SHOWGROUND


JOINS SHEET 4
YASS RIVER AT YASS
VICTORIA PARK
YASS HIGH SCHOOL
JOE O'CONNOR PARK
JOINS SHEET 2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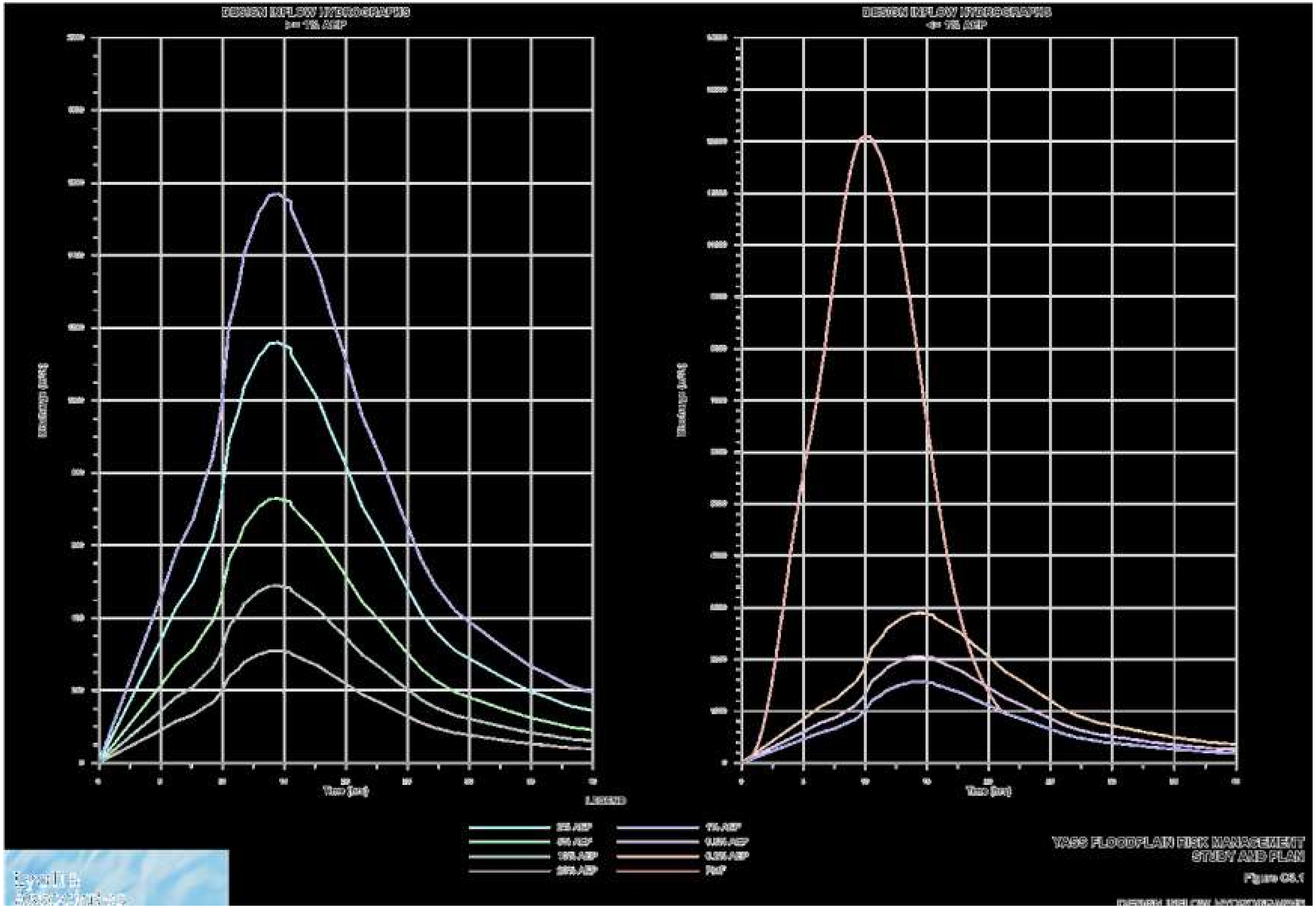
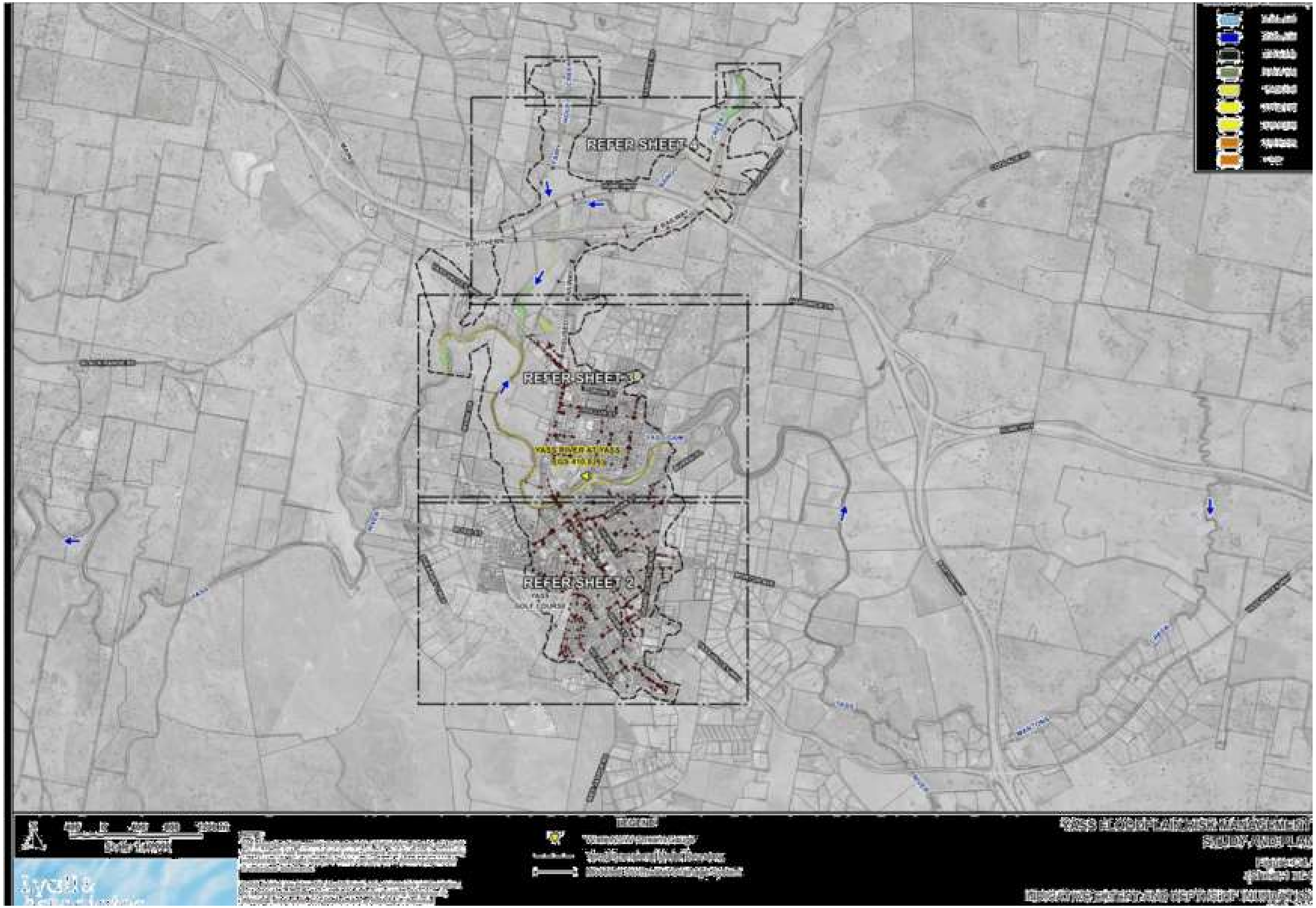
REFER INSET 2
JOINS SHEET 3


RIVERSIDE PARK
BANJO PATERSON PARK


DESIGN INFLOW HYDROGRAPHS
DESIGN INFLOW HYDROGRAPHS
LEGEND
1% AEP
PMF
YASS FLOODPLAIN RISK MANAGEMENT
STUDY AND PLAN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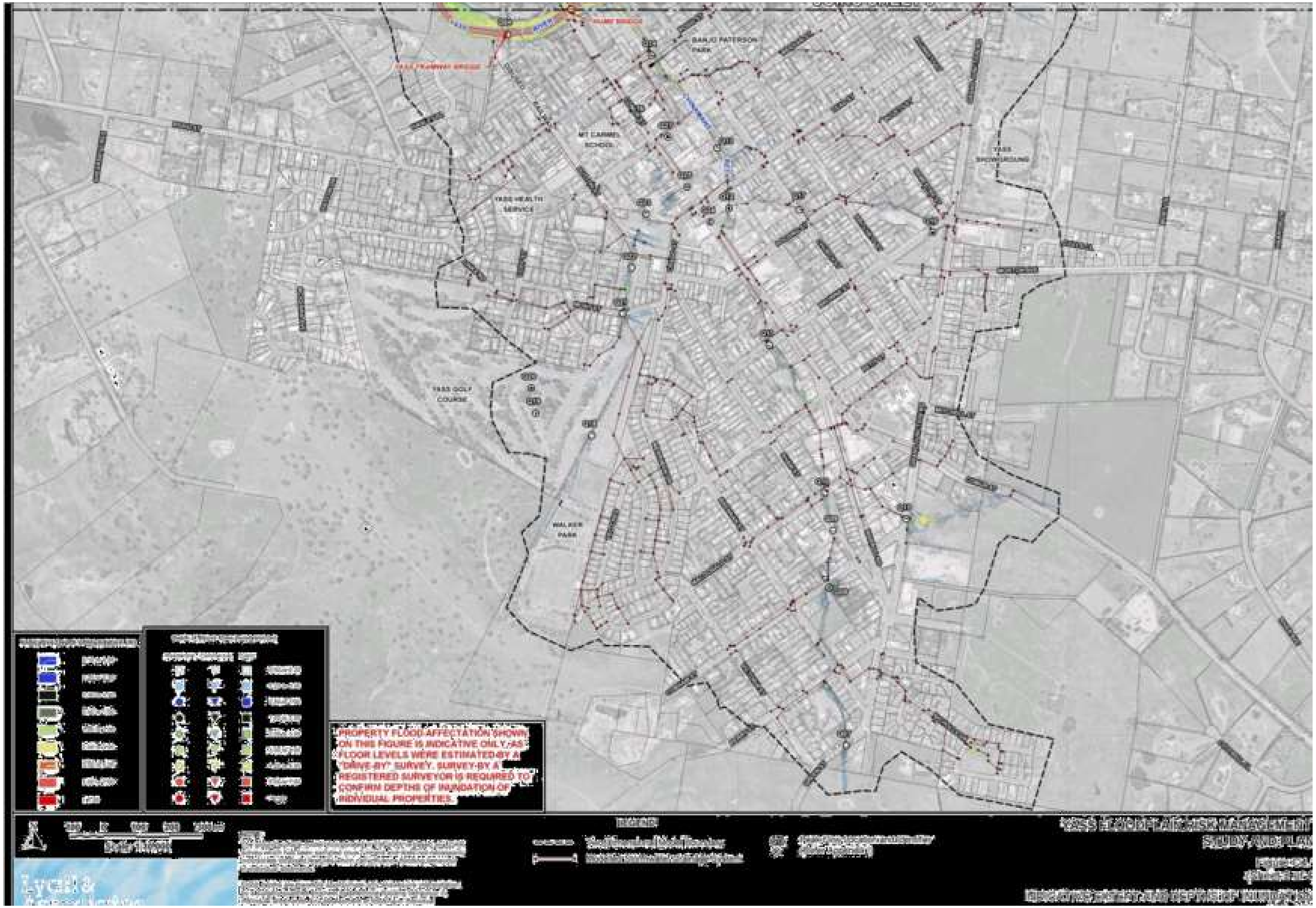
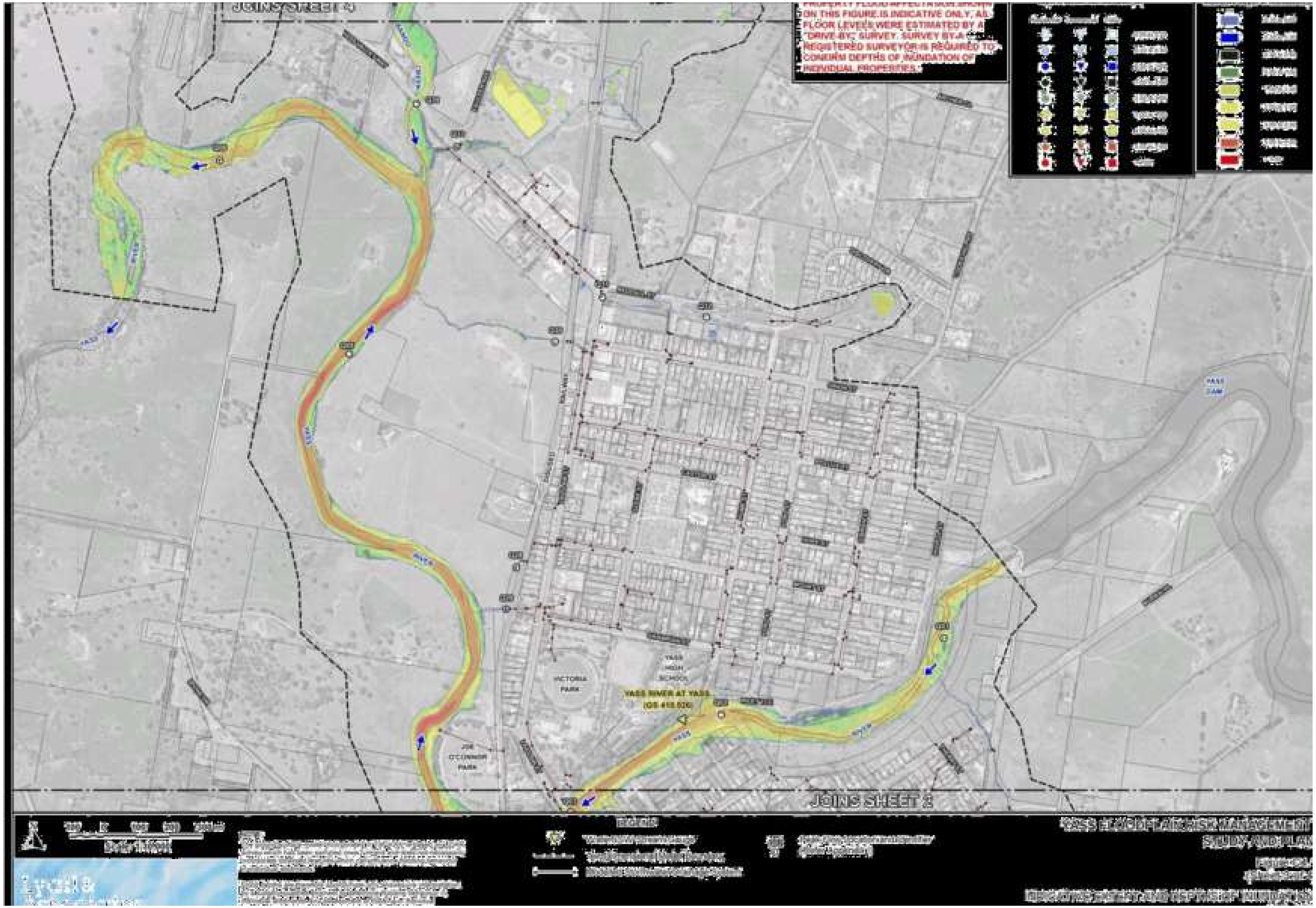
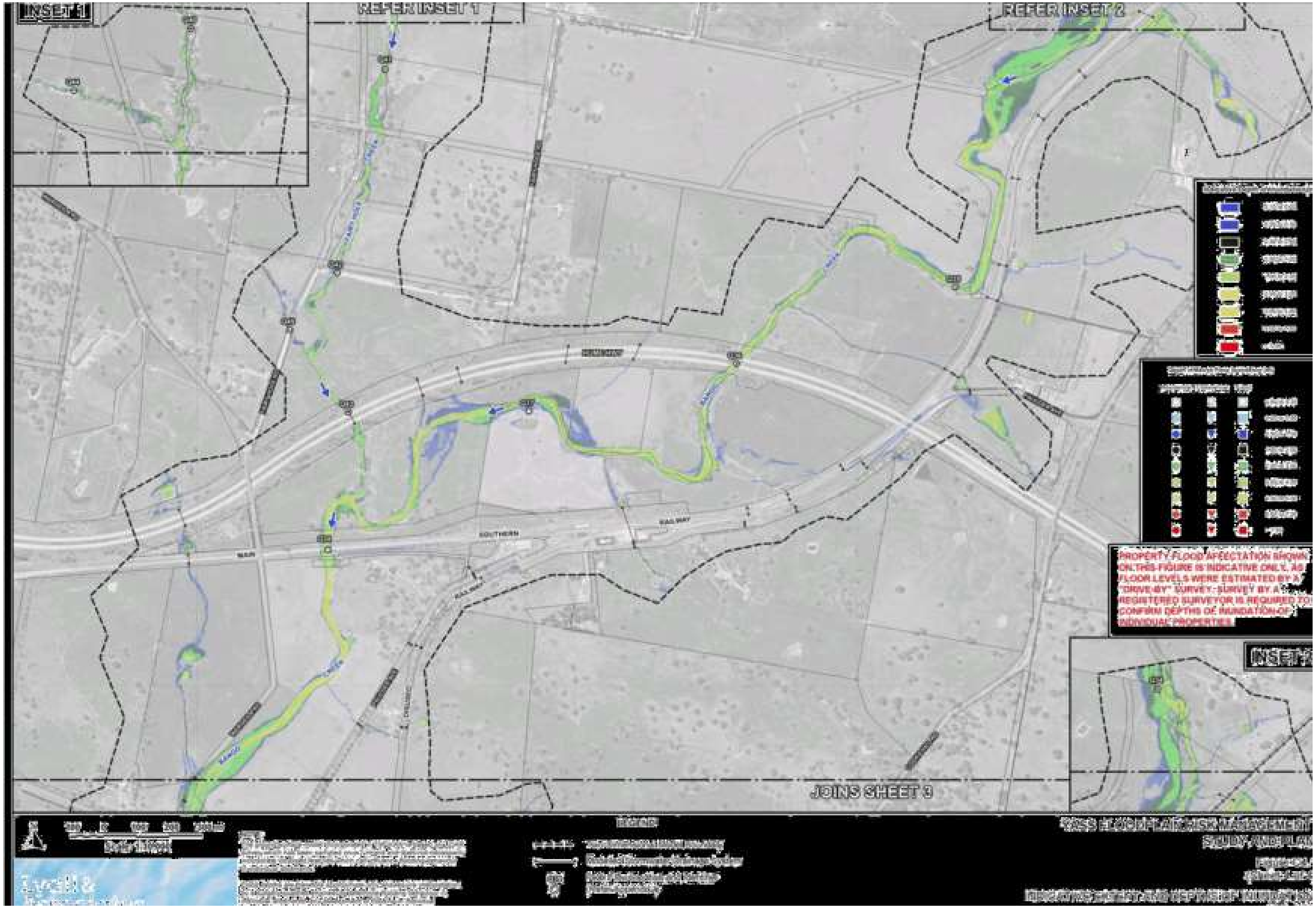
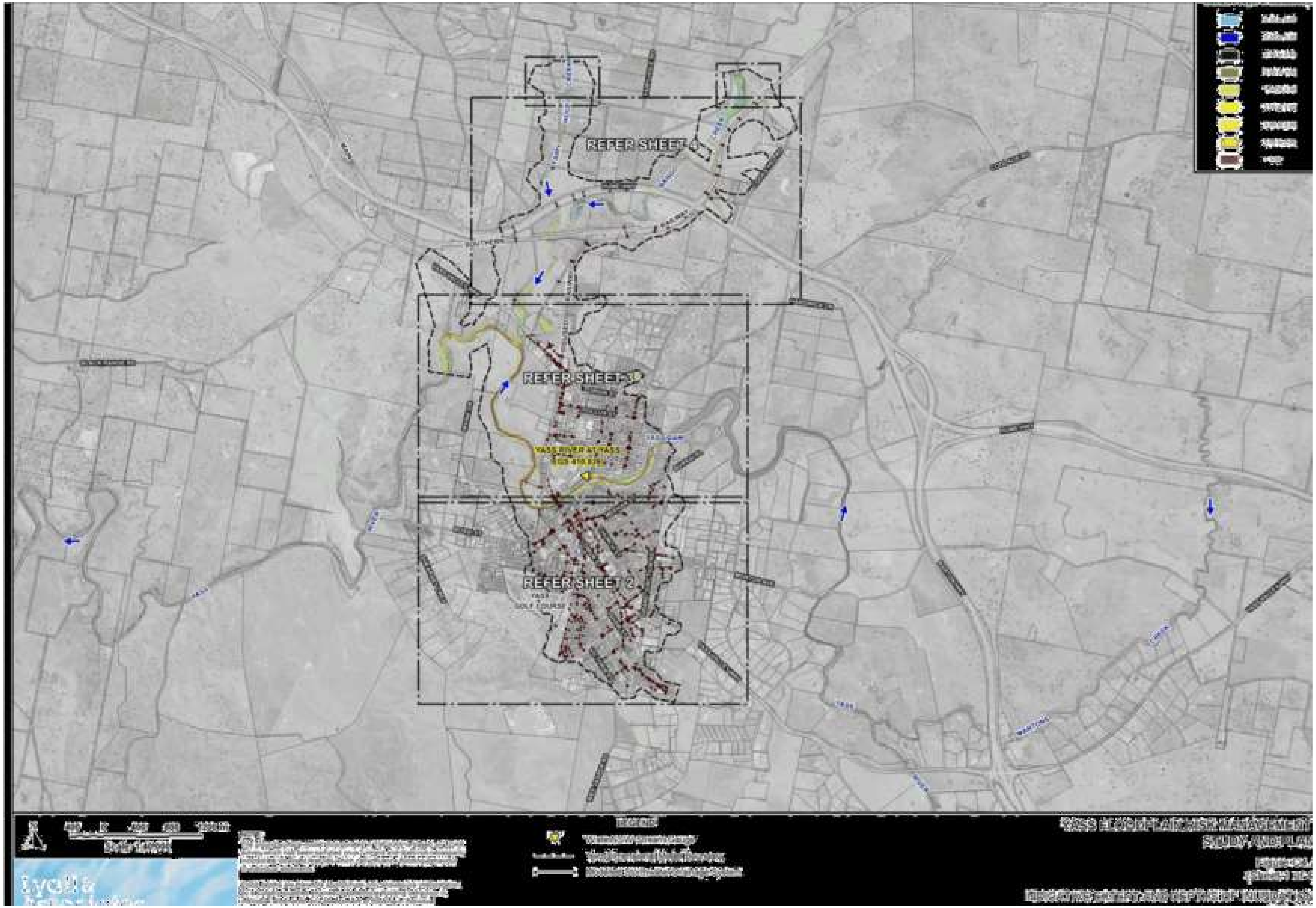
YASS RIVER AT YASS
REFER SHEET 2


BANJO PATERSON PARK
MT CARMEL SCHOOL
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK
PROPERTY FLOOD AFFECTATION SHOWN ON THIS FIGURE IS INDICATIVE ONLY AS FLOOR LEVELS WERE ESTIMATED BY A "DRIVE-BY" SURVEY. SURVEY BY A REGISTERED SURVEYOR IS REQUIRED TO CONFIRM DEPTHS OF INUNDATION OF INDIVIDUAL PROPERTIES.


ON THIS FIGURE IS INDICATIVE ONLY, AS
FLOOR LEVELS WERE ESTIMATED BY A
"DRIVE-BY" SURVEY. SURVEY BY A
REGISTERED SURVEYOR IS REQUIRED TO
CONFIRM DEPTHS OF INUNDATION OF
INDIVIDUAL PROPERTIES.
JOINS SHEET 2
YASS RIVER AT YASS
(GS 410.026)
VICTORIA PARK
YASS HIGH SCHOOL
JOE O'CONNOR PARK
YASS DAM


INSET 1
REFER INSET 1
REFER INSET 2
SOUTHERN
RAILWAY
PROPERTY FLOOD AFFECTATION SHOWN ON THIS FIGURE IS INDICATIVE ONLY, AS FLOOR LEVELS WERE ESTIMATED BY A "DRIVE-BY" SURVEY. SURVEY BY A REGISTERED SURVEYOR IS REQUIRED TO CONFIRM DEPTHS OF INUNDATION OF INDIVIDUAL PROPERTIES
JOINS SHEET 3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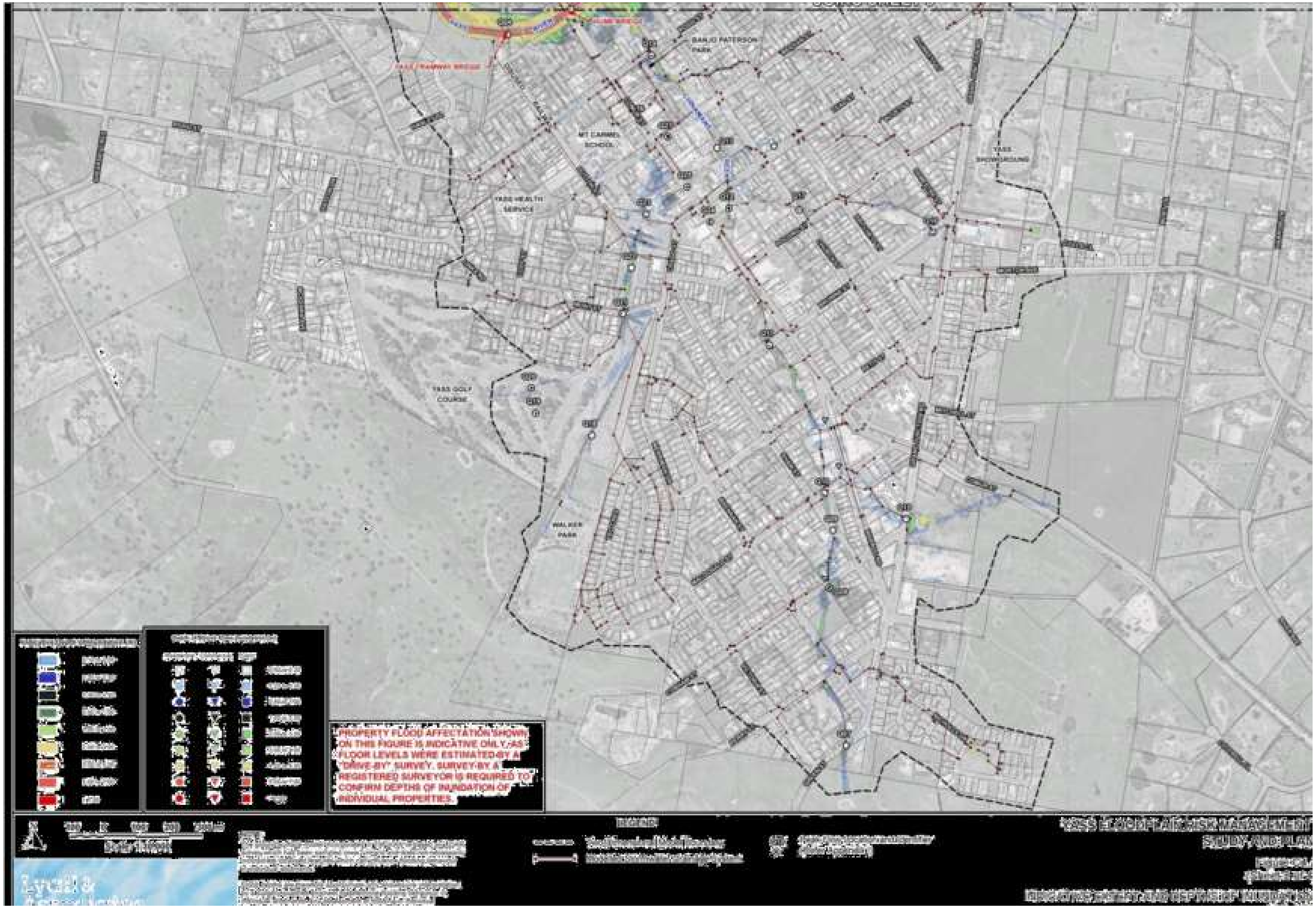
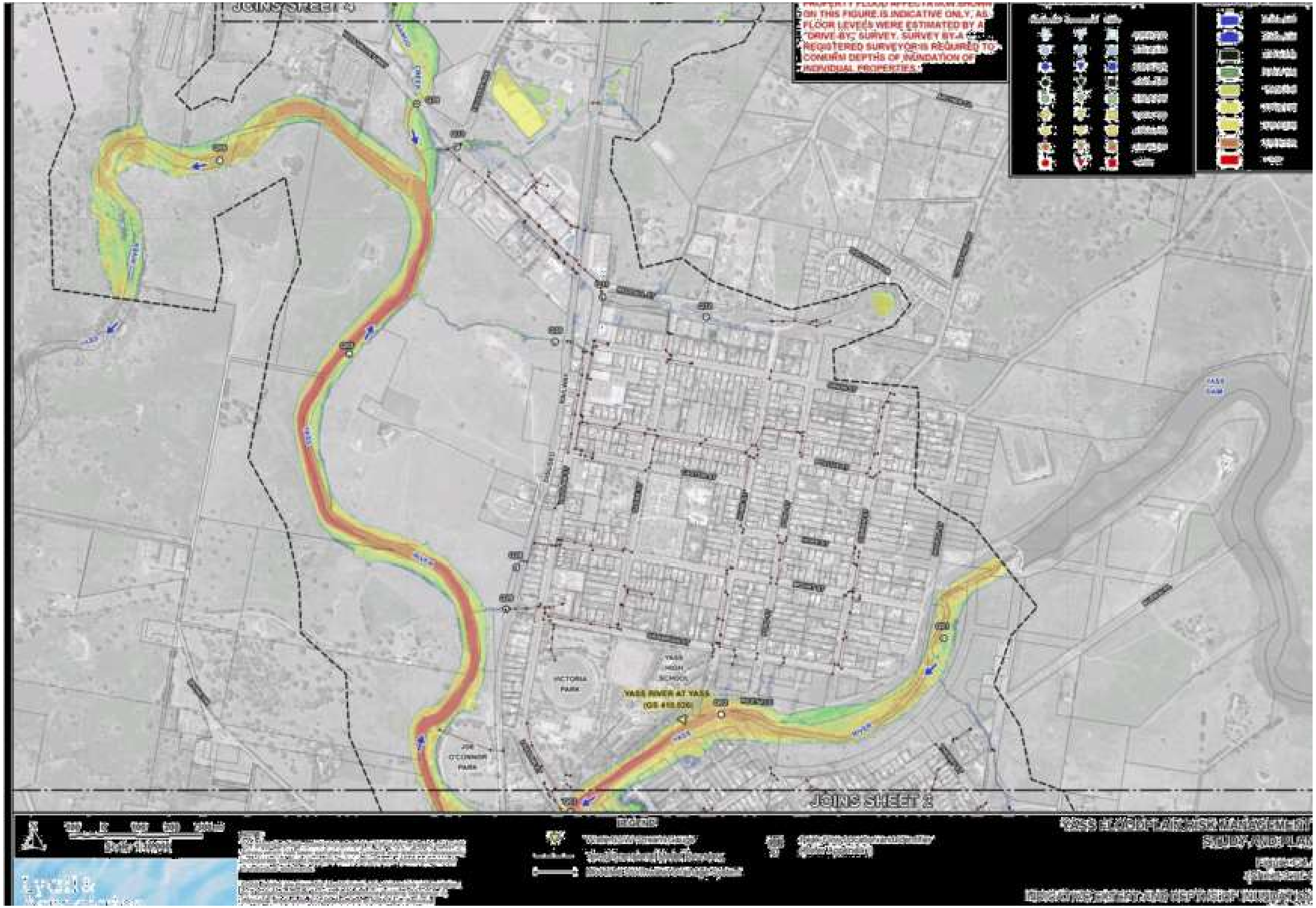
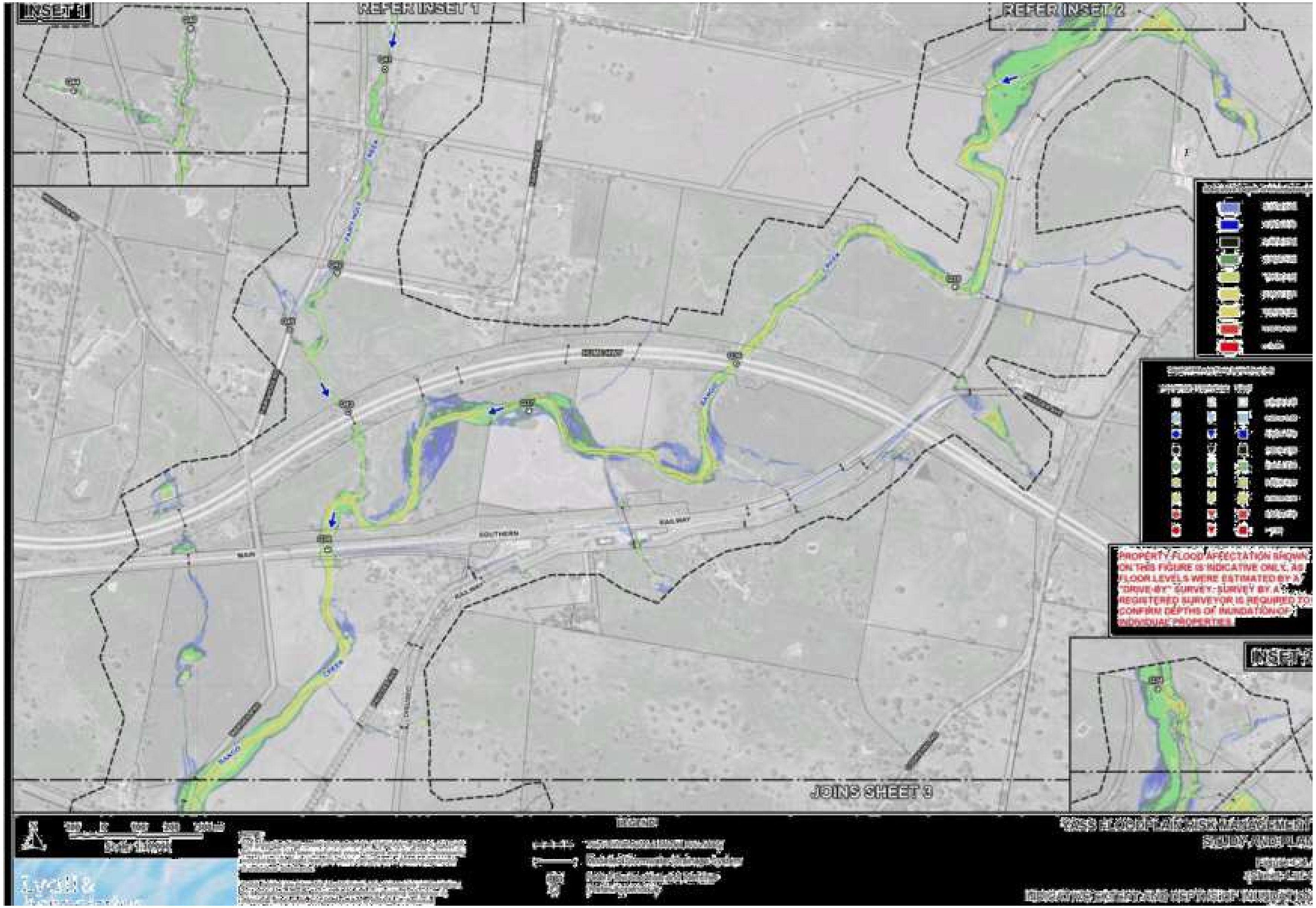
REFER SHEET 3
REFER SHEET 2
YASS RIVER AT YASS
YASS GOLF COURSE


BANJO PATERSON PARK
MT CARMEL SCHOOL
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK
PROPERTY FLOOD AFFECTATION SHOWN ON THIS FIGURE IS INDICATIVE ONLY, AS FLOOR LEVELS WERE ESTIMATED BY A "DRIVE-BY" SURVEY. SURVEY BY A REGISTERED SURVEYOR IS REQUIRED TO CONFIRM DEPTHS OF INUNDATION OF INDIVIDUAL PROPERTIES.


ON THIS FIGURE IS INDICATIVE ONLY; AS FLOOR LEVELS WERE ESTIMATED BY A "DRIVE-BY" SURVEY. SURVEY BY A REGISTERED SURVEYOR IS REQUIRED TO CONFIRM DEPTHS OF INUNDATION OF INDIVIDUAL PROPERTIES.
VICTORIA PARK
YASS HIGH SCHOOL
YASS RIVER AT YASS
JOE O'CONNOR PARK
JOINS SHEET 2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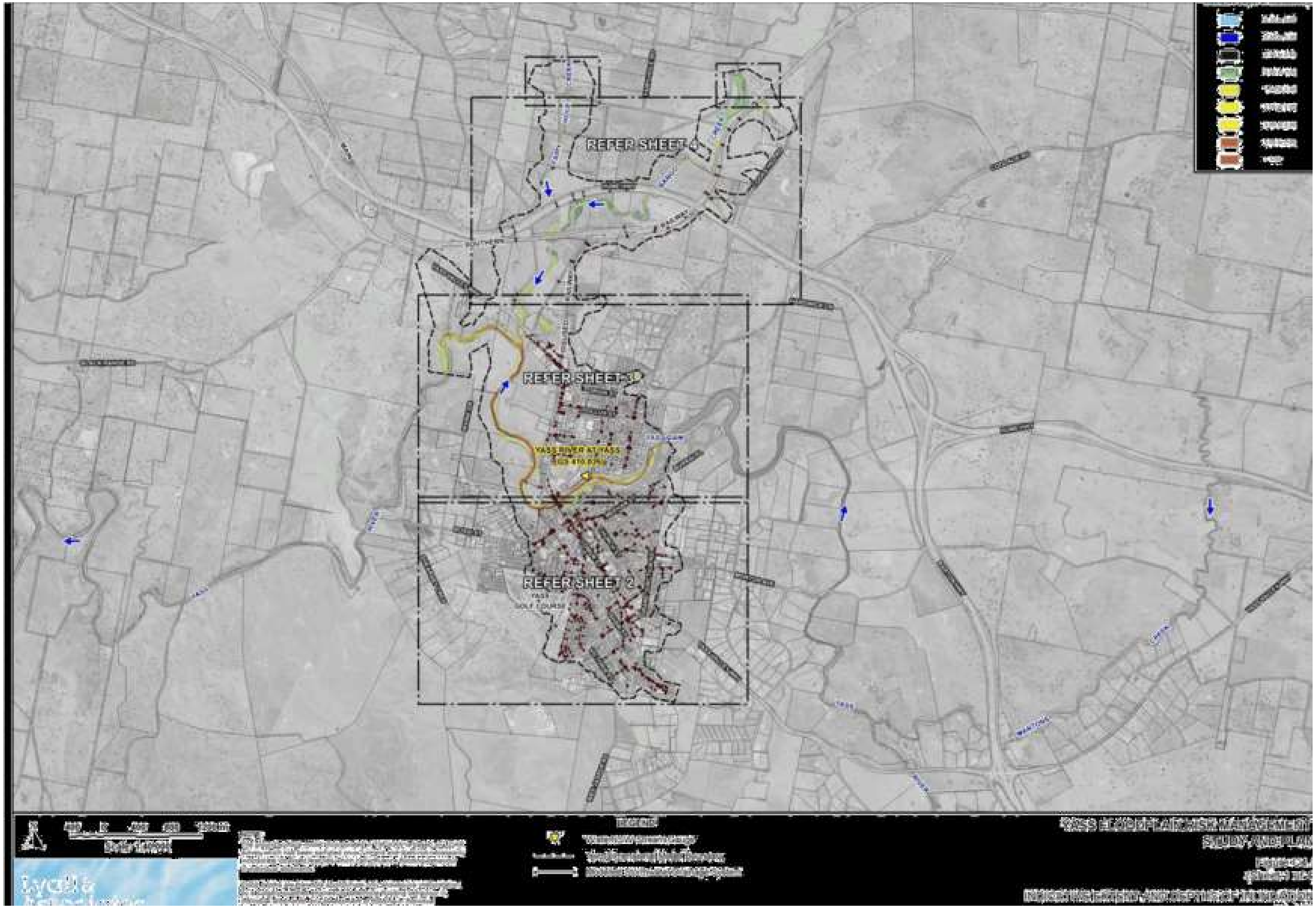
REFER INSET 2
PROPERTY FLOOD AFFECTATION SHOWN ON THIS FIGURE IS INDICATIVE ONLY, AS FLOOR LEVELS WERE ESTIMATED BY A "DRIVE-BY" SURVEY. SURVEY BY A REGISTERED SURVEYOR IS REQUIRED TO CONFIRM DEPTHS OF INUNDATION OF INDIVIDUAL PROPERTIES
JOINS SHEET 3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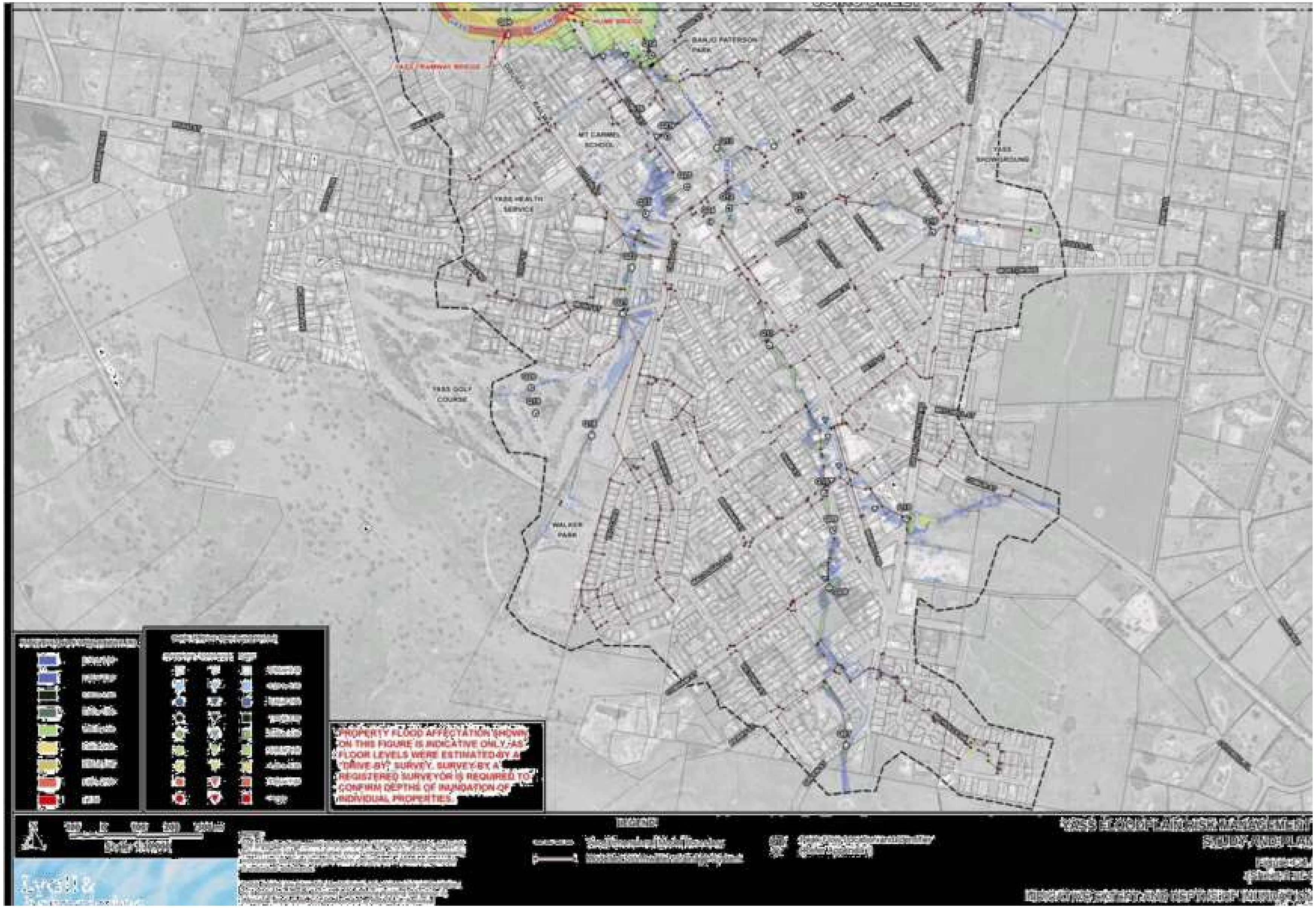
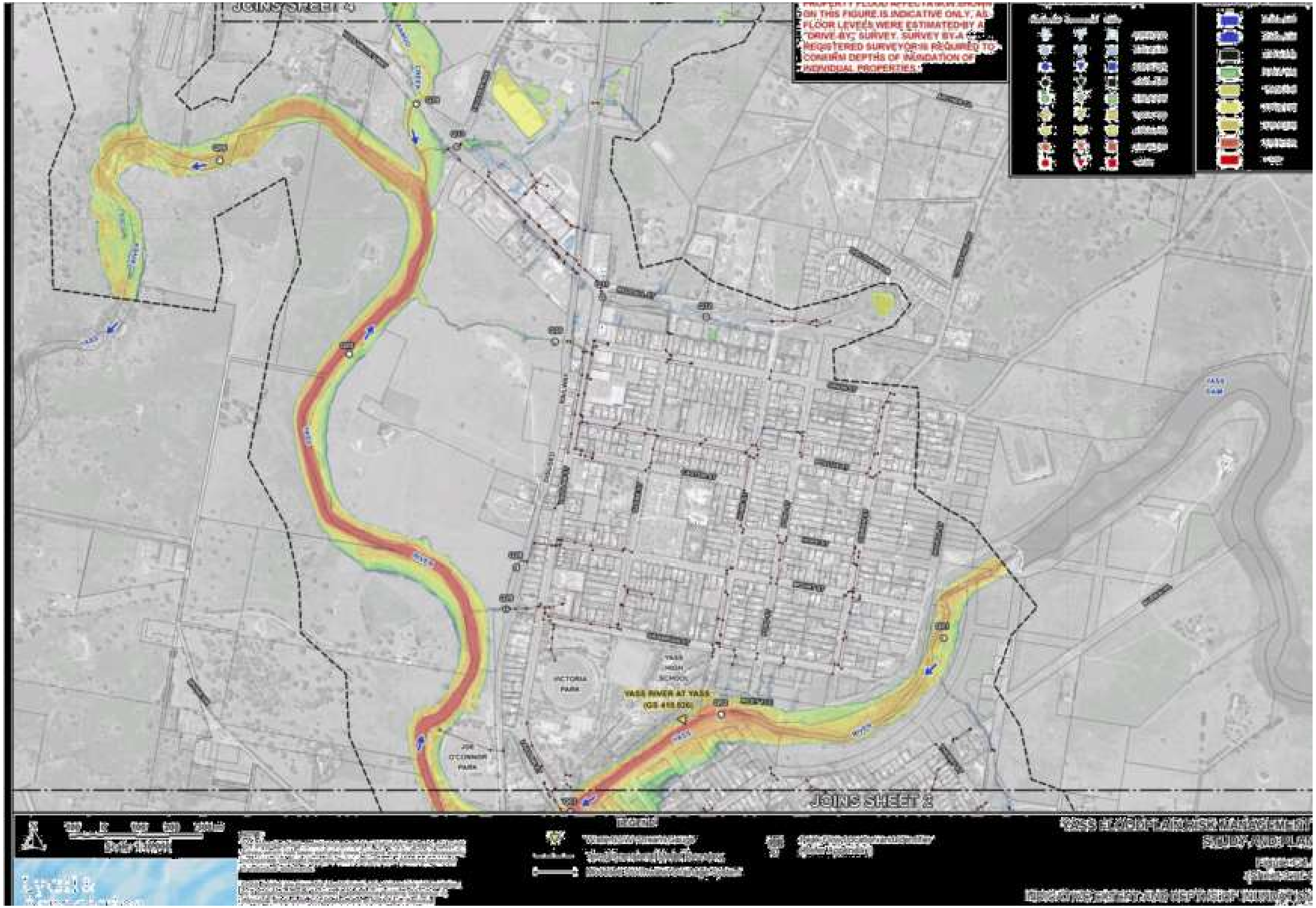
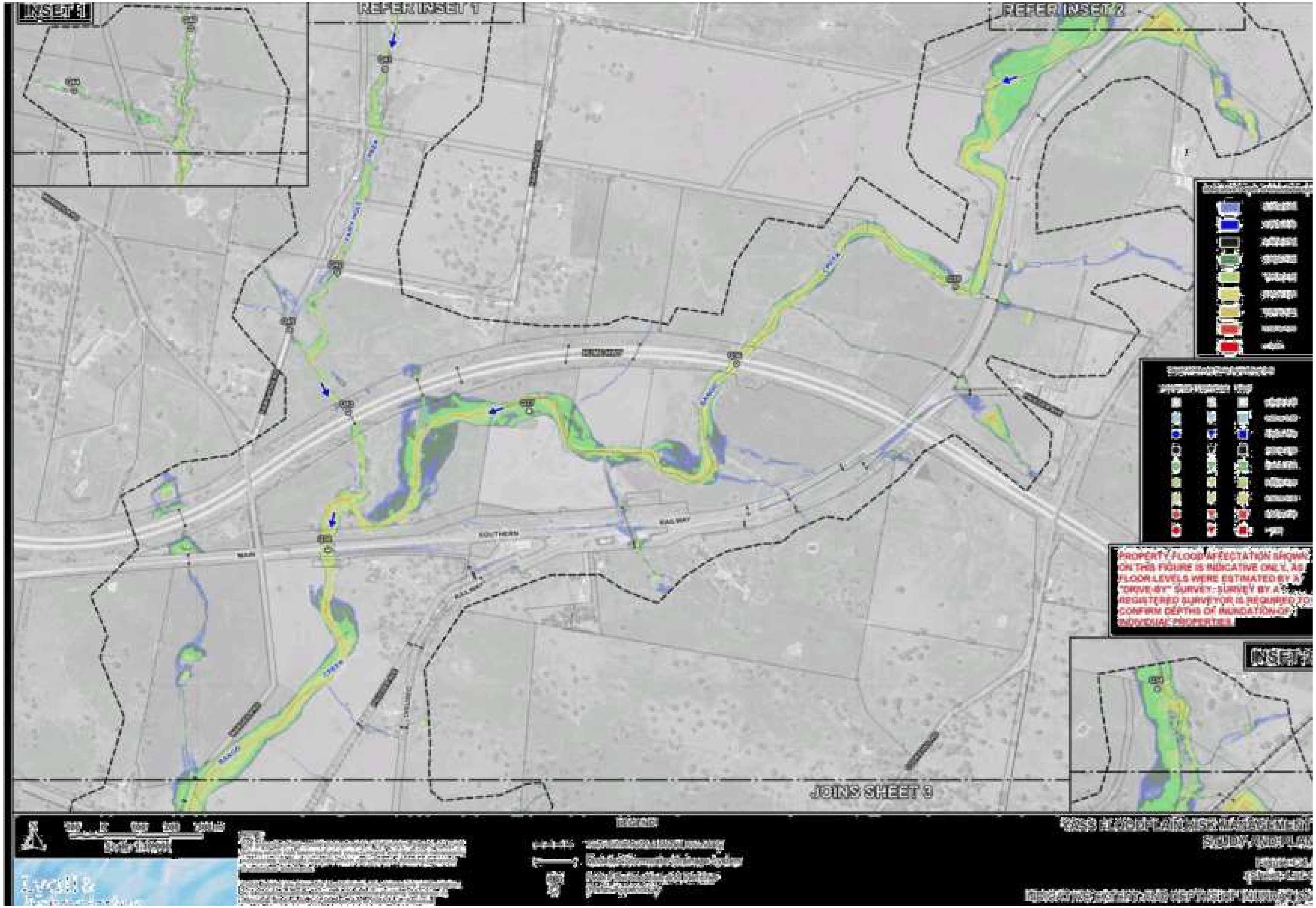
REFER SHEET 2
YASS RIVER AT YASS


HUME BRIDGE
YASS TRAMWAY BRIDGE
BANJO PATERSON PARK
MT CARMEL SCHOOL
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK
PROPERTY FLOOD AFFECTATION SHOWN ON THIS FIGURE IS INDICATIVE ONLY, AS FLOOR LEVELS WERE ESTIMATED BY A "DRIVE-BY" SURVEY. SURVEY BY A REGISTERED SURVEYOR IS REQUIRED TO CONFIRM DEPTHS OF INUNDATION OF INDIVIDUAL PROPERTIES.


JOINS SHEET 4
ON THIS FIGURE IS INDICATIVE ONLY, AS
FLOOR LEVELS WERE ESTIMATED BY A
"DRIVE-BY" SURVEY. SURVEY BY A
REGISTERED SURVEYOR IS REQUIRED TO
CONFIRM DEPTHS OF INUNDATION OF
INDIVIDUAL PROPERTIES.
VICTORIA PARK
YASS HIGH SCHOOL
YASS RIVER AT YASS
JOE O'CONNOR PARK
YASS DAM
JOINS SHEET 2



INSET 1
REFER INSET 1
REFER INSET 2
SOUTHERN
RAILWAY
MAIN
PROPERTY FLOOD AFFECTATION SHOWN ON THIS FIGURE IS INDICATIVE ONLY, AS FLOOR LEVELS WERE ESTIMATED BY A "DRIVE-BY" SURVEY. SURVEY BY A REGISTERED SURVEYOR IS REQUIRED TO CONFIRM DEPTHS OF INUNDATION OF INDIVIDUAL PROPERTIES.
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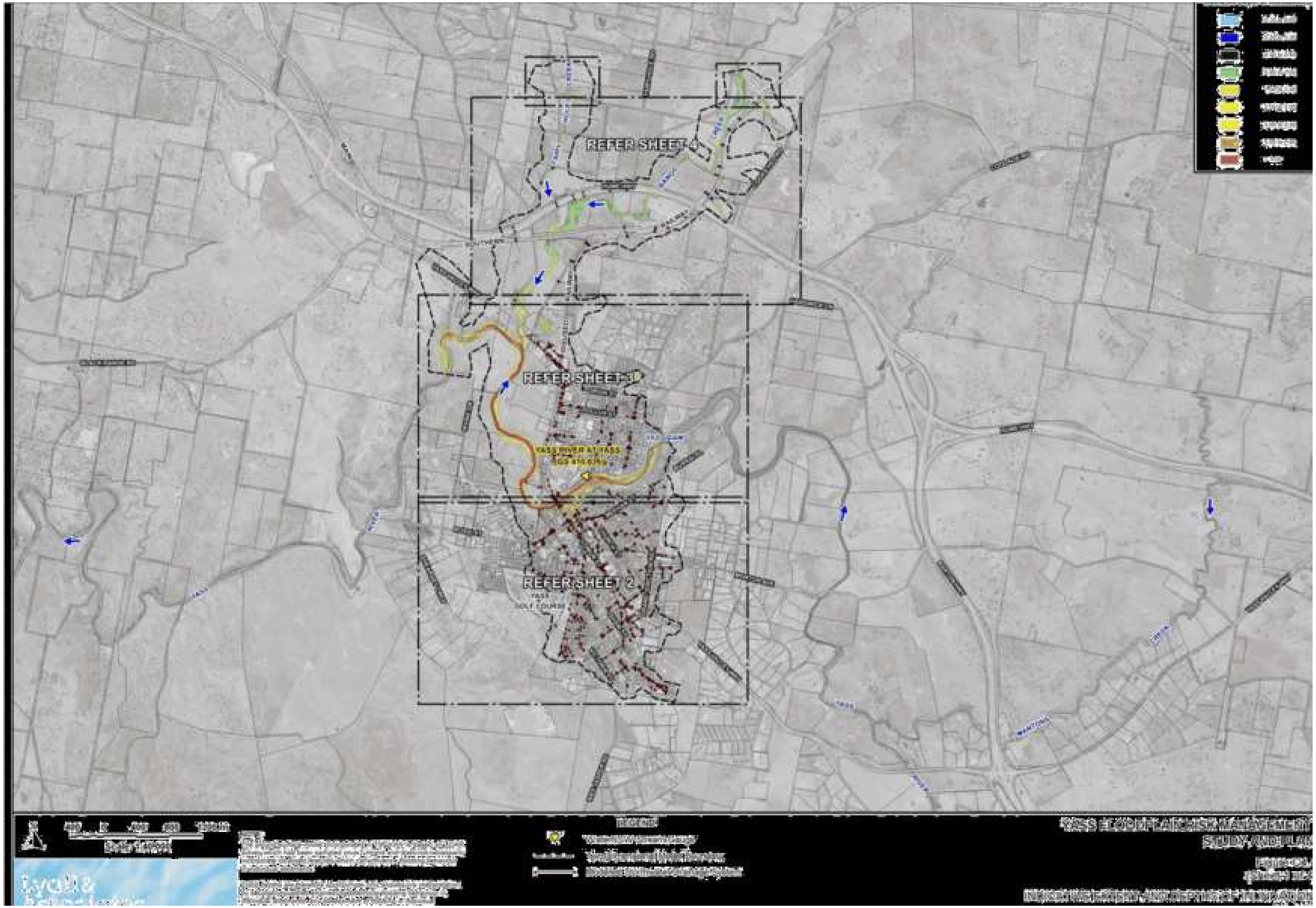
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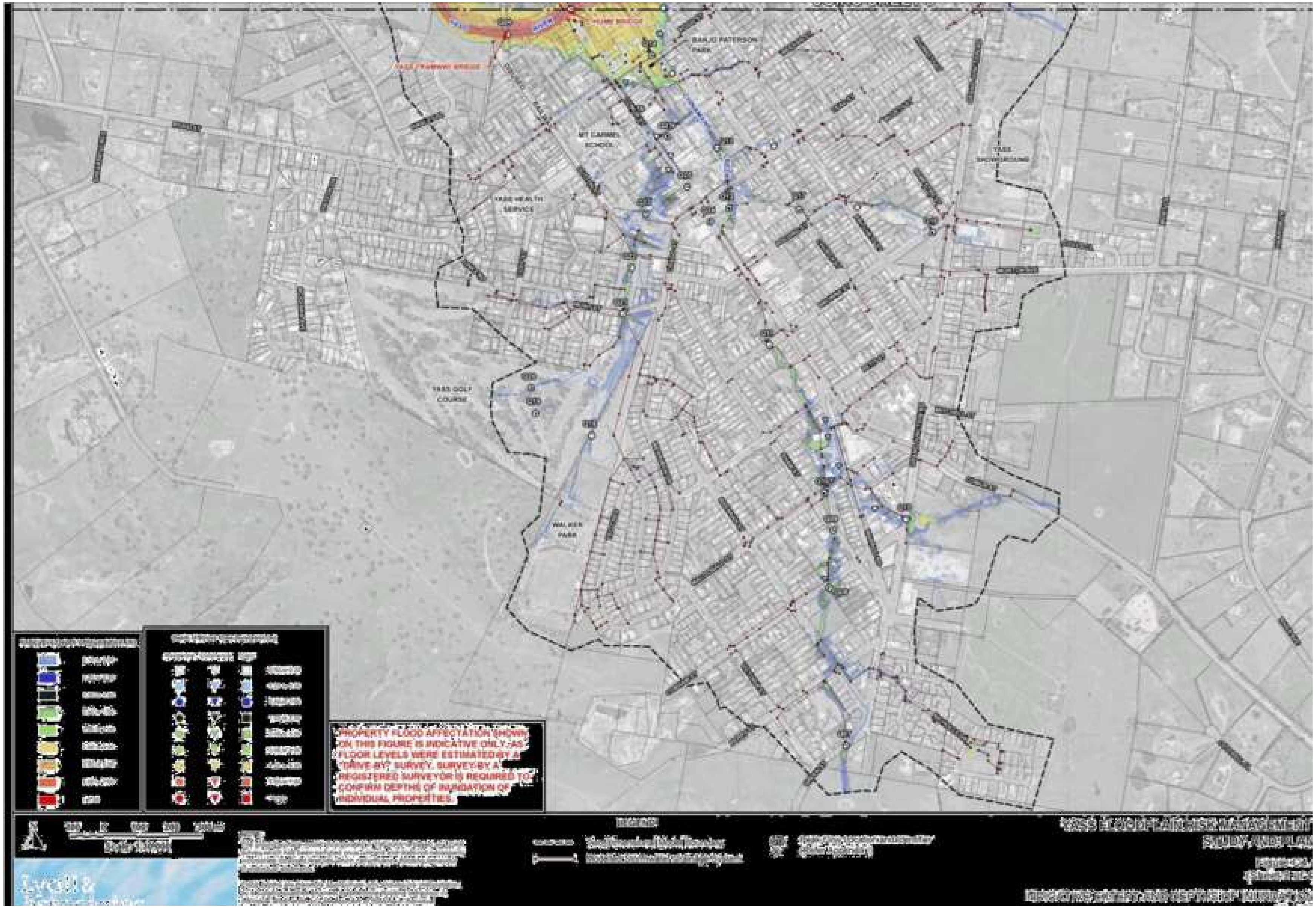
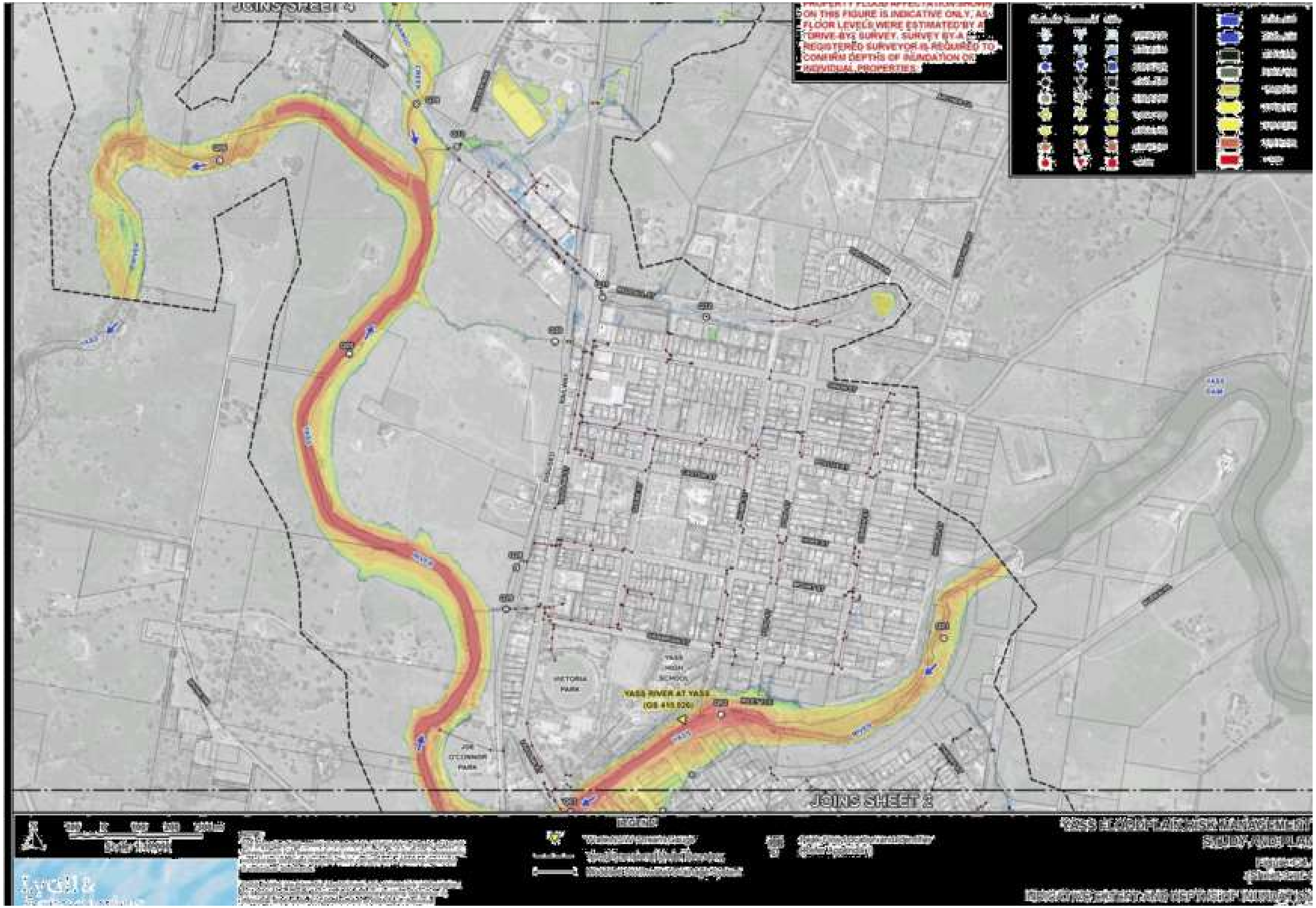
REFER SHEET 2
YASS FLOODPLAIN RISK MANAGEMENT
STUDY AND PLAN


BANJO PATERSON PARK
MT CARMEL SCHOOL
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK
PROPERTY FLOOD AFFECTATION SHOWN ON THIS FIGURE IS INDICATIVE ONLY AS FLOOR LEVELS WERE ESTIMATED BY A "DRIVE-BY" SURVEY. SURVEY BY A REGISTERED SURVEYOR IS REQUIRED TO CONFIRM DEPTHS OF INUNDATION OF INDIVIDUAL PROPERTIES.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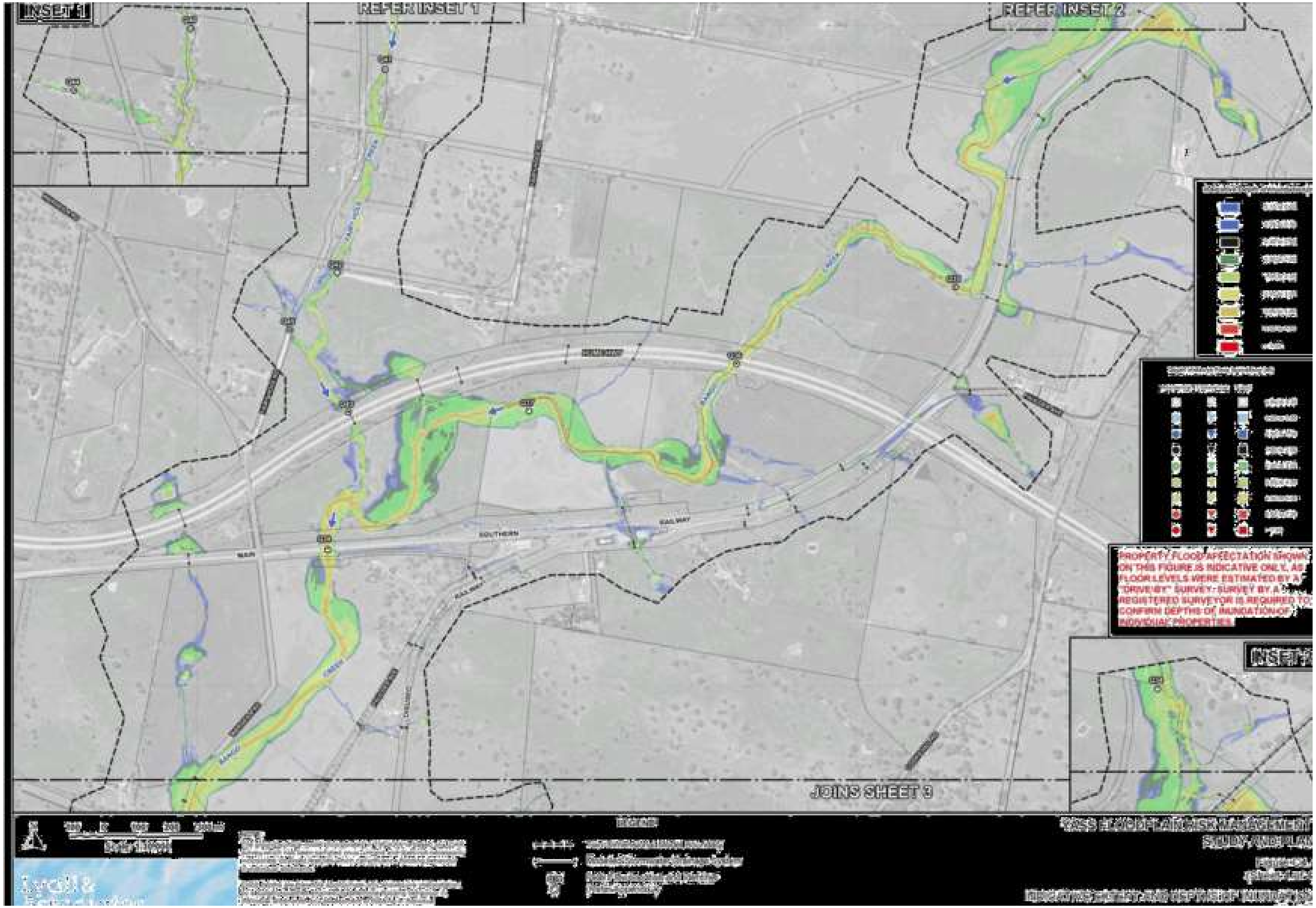
ON THIS FIGURE IS INDICATIVE ONLY, AS FLOOR LEVELS WERE ESTIMATED BY A 'DRIVE-BY' SURVEY. SURVEY BY A REGISTERED SURVEYOR IS REQUIRED TO CONFIRM DEPTHS OF INUNDATION OF INDIVIDUAL PROPERTIES
VICTORIA PARK
YASS HIGH SCHOOL
YASS RIVER AT YASS
JOE O'CONNOR PARK
JOINS SHEET 2
LEGEND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REFER INSET 2
SOUTHERN
RAILWAY
MAIN
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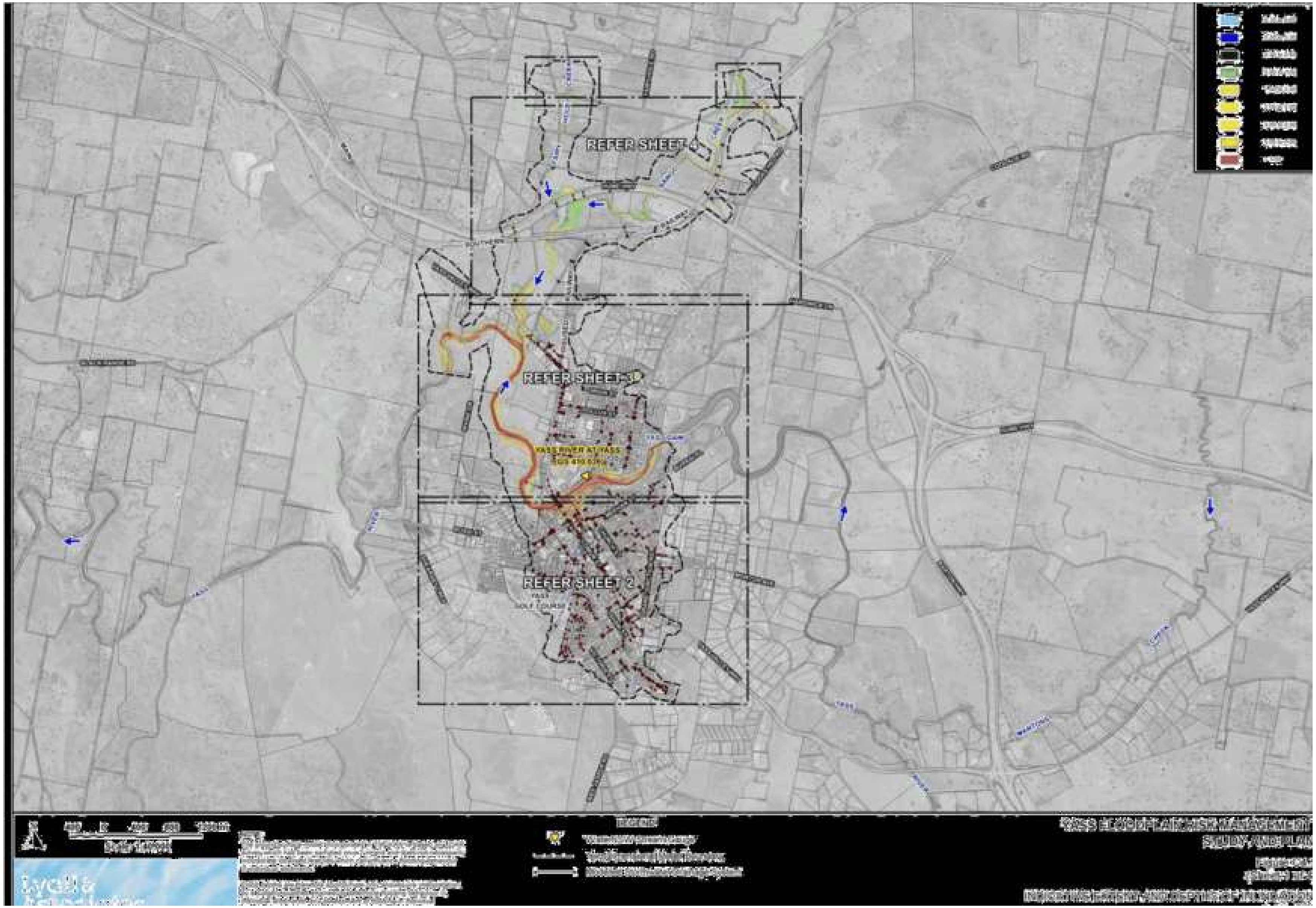
JOINS SHEET 3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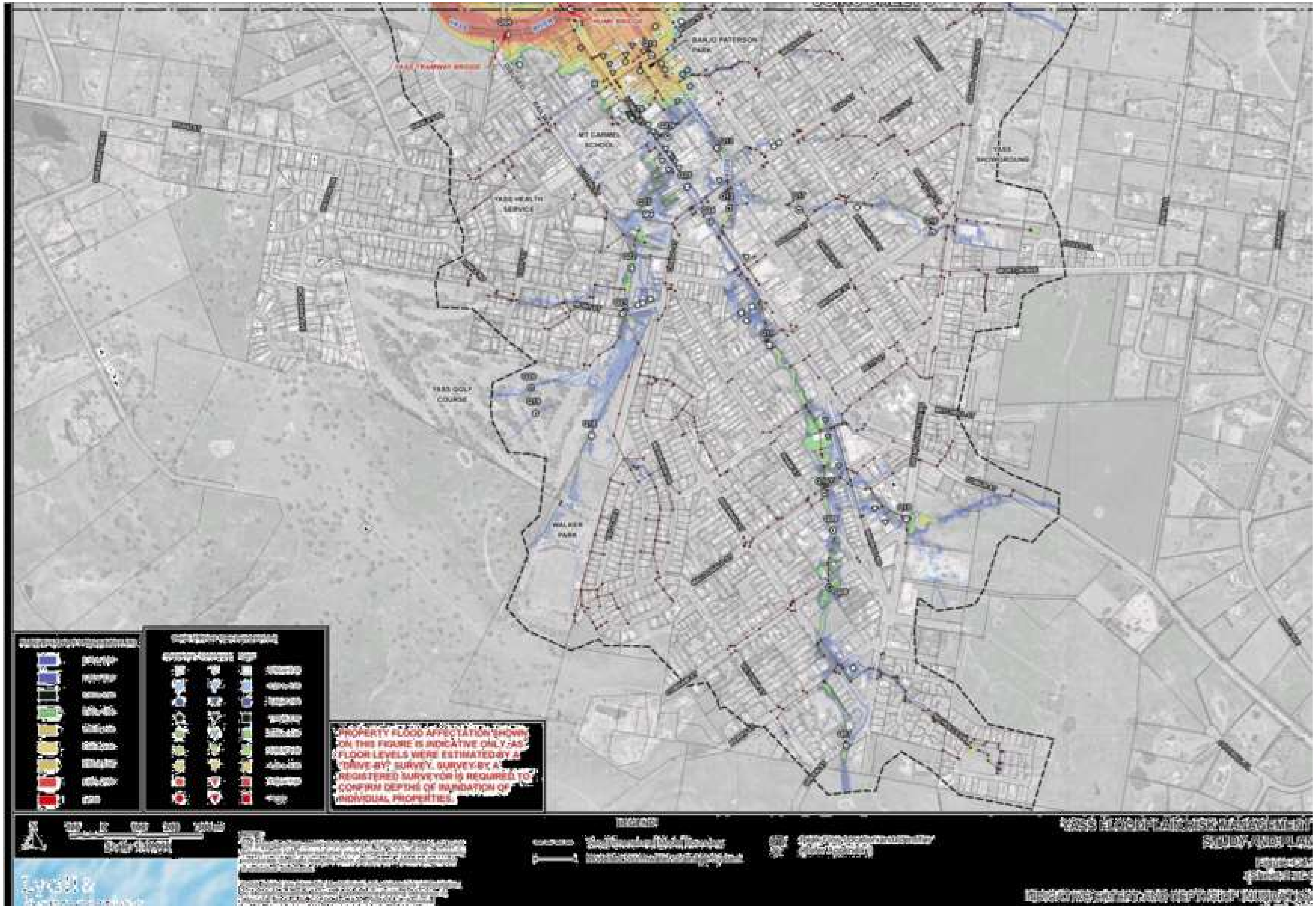
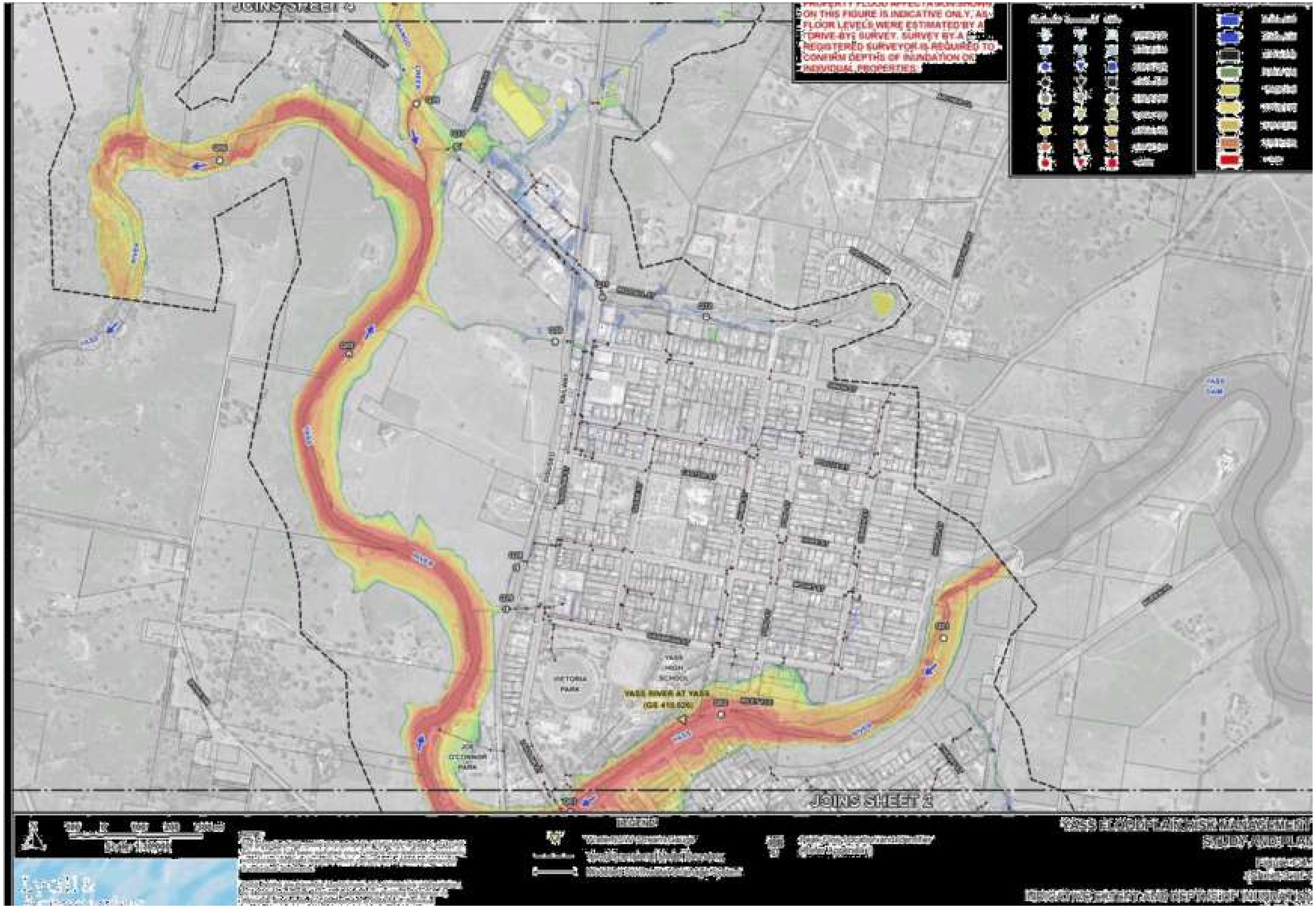
YASS RIVER AT YASS



BANJO PATERSON PARK
MT CARMEL SCHOOL
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK
PROPERTY FLOOD AFFECTATION SHOWN ON THIS FIGURE IS INDICATIVE ONLY AS FLOOR LEVELS WERE ESTIMATED BY A "DRIVE-BY" SURVEY. SURVEY BY A REGISTERED SURVEYOR IS REQUIRED TO CONFIRM DEPTHS OF INUNDATION OF INDIVIDUAL PROPERTIES.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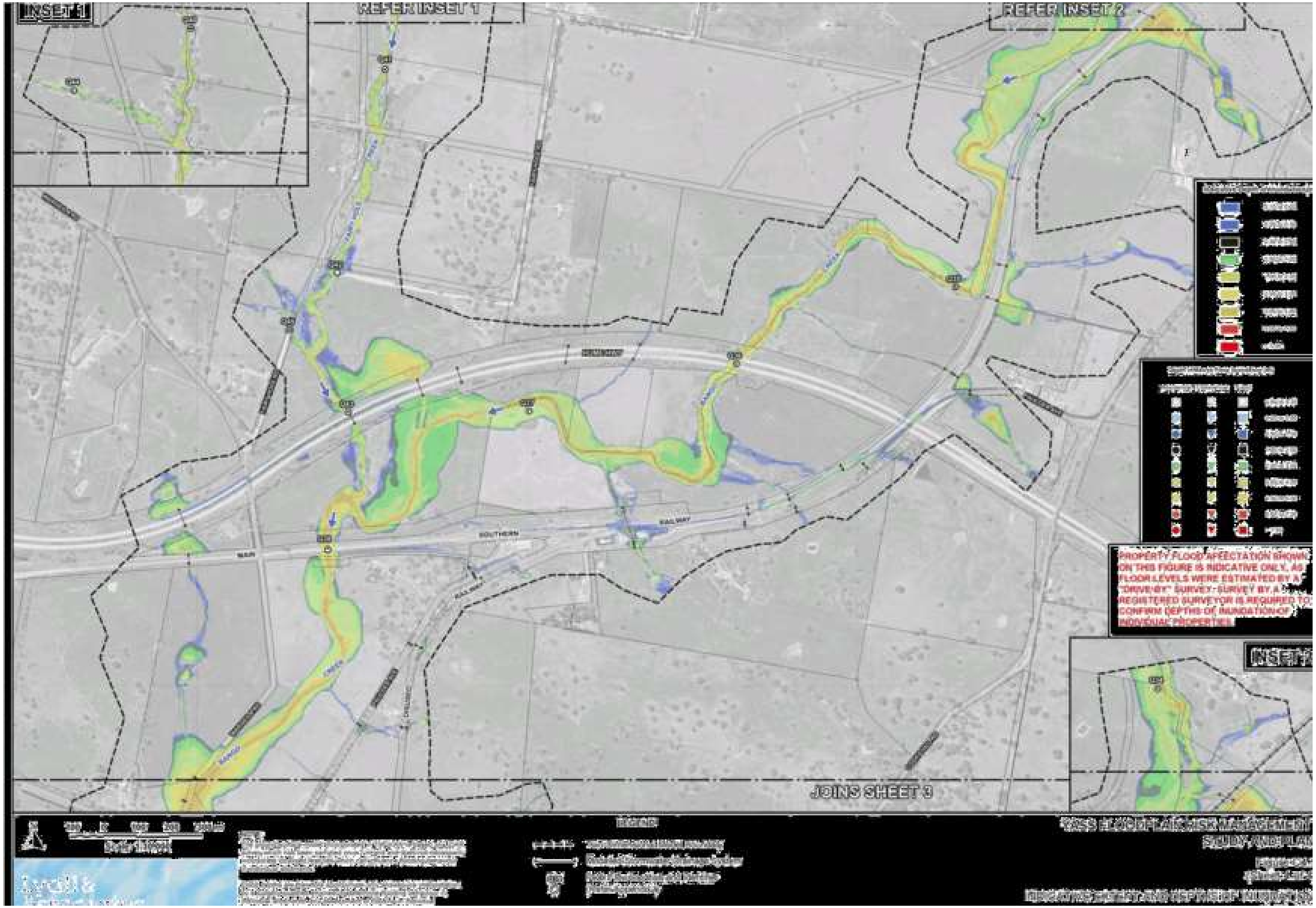
VICTORIA PARK
YASS HIGH SCHOOL
YASS RIVER AT YASS
JOE O'CONNOR PARK
JOINS SHEET 2
LEGEND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REFER INSET 2
SOUTHERN
RAILWAY
MAIN
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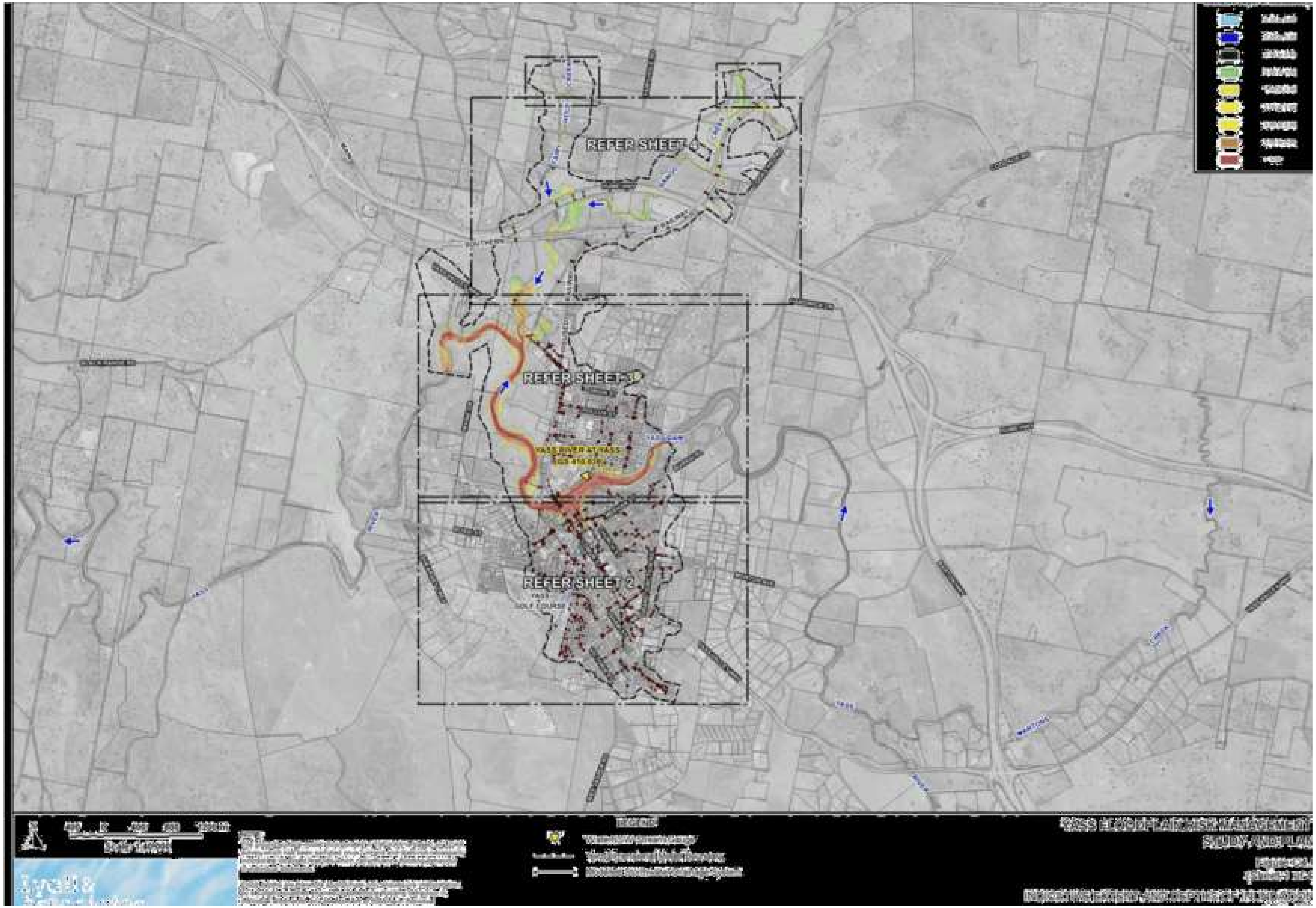
LEGEND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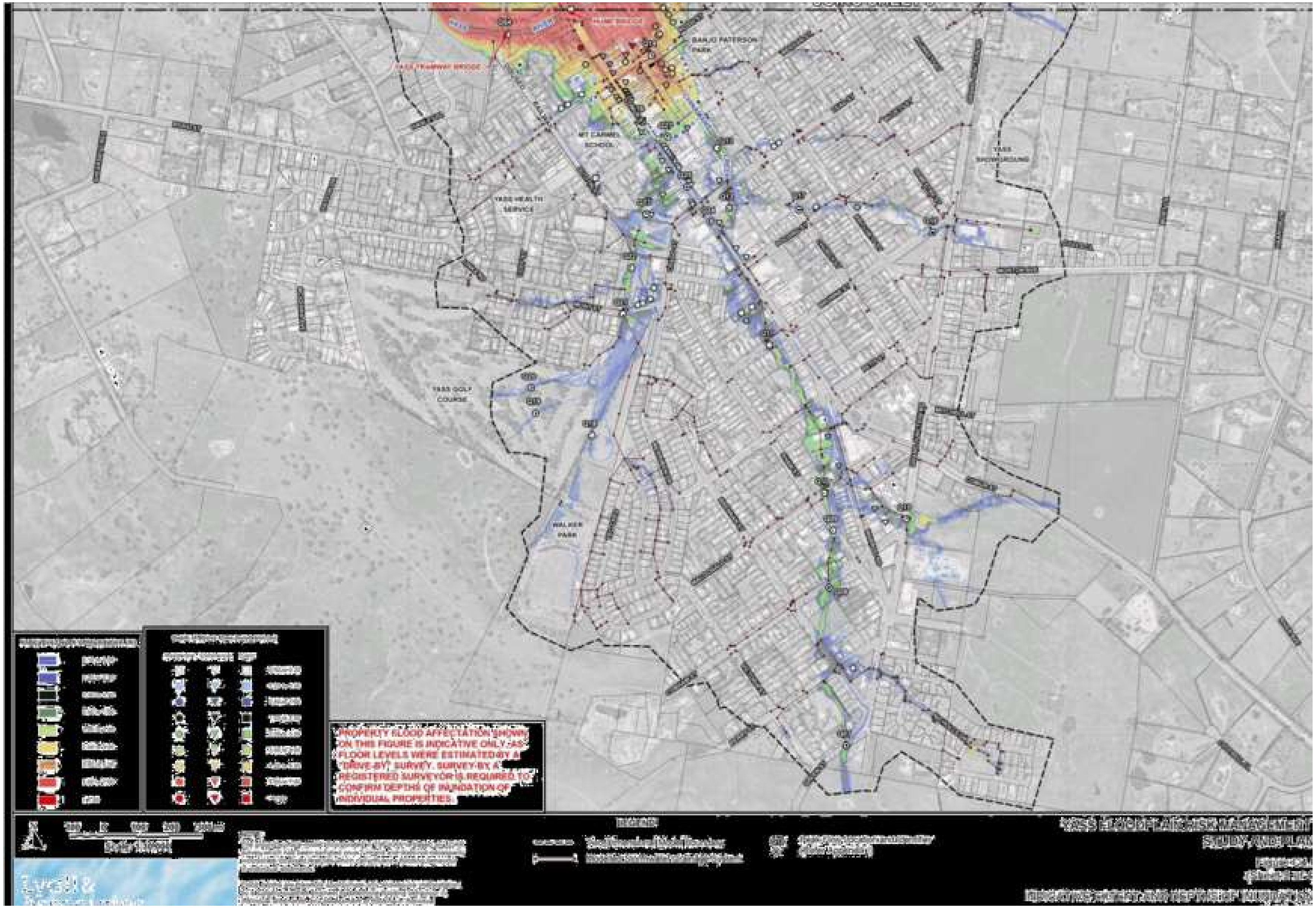
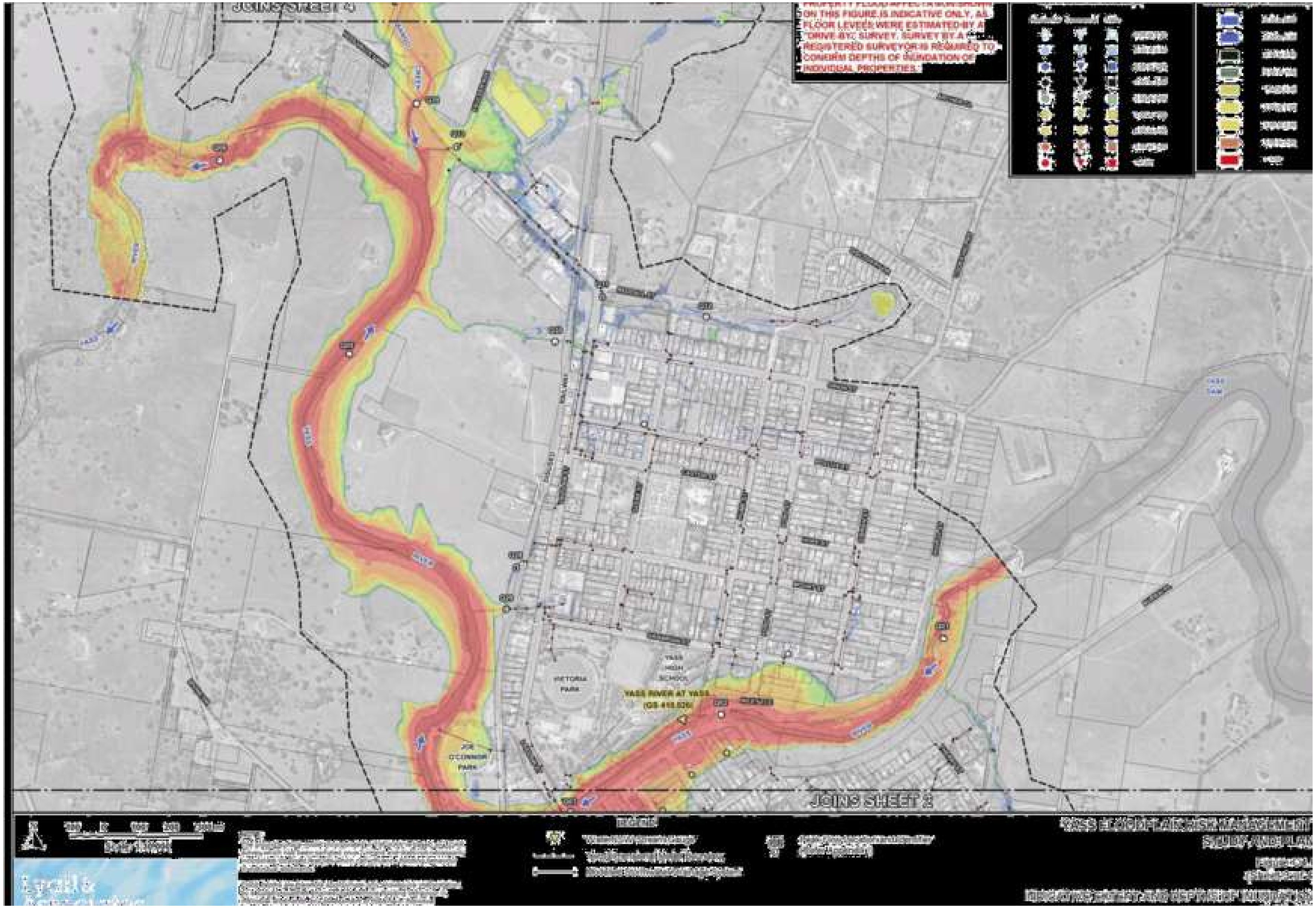
YASS GOLF COURSE


BANJO PATERSON PARK
YASS TRAMWAY BRIDGE
MT CARMEL SCHOOL
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK
PROPERTY FLOOD AFFECTATION SHOWN ON THIS FIGURE IS INDICATIVE ONLY, AS FLOOR LEVELS WERE ESTIMATED BY A "DRIVE-BY" SURVEY. SURVEY BY A REGISTERED SURVEYOR IS REQUIRED TO CONFIRM DEPTHS OF INUNDATION OF INDIVIDUAL PROPERTIES.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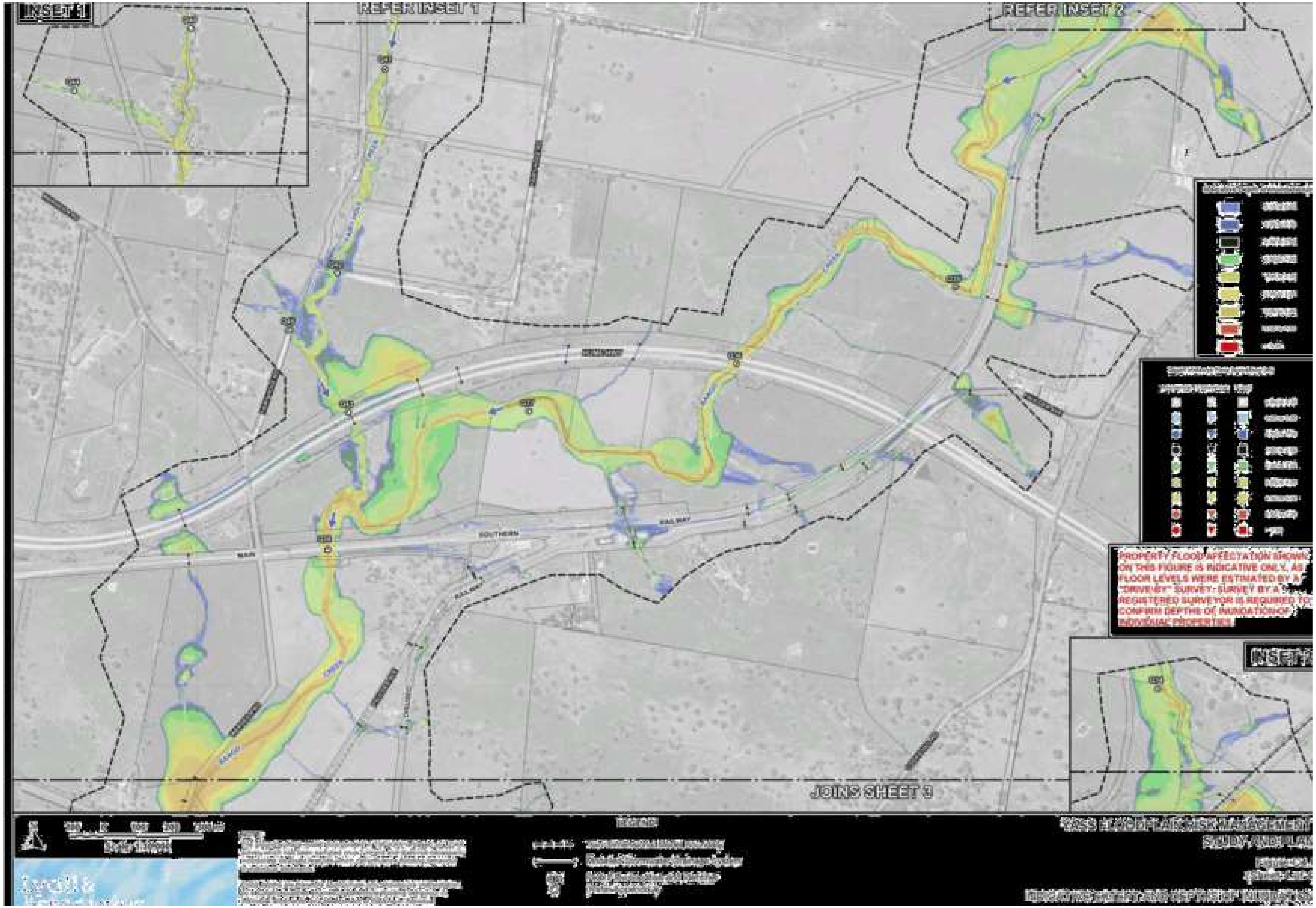
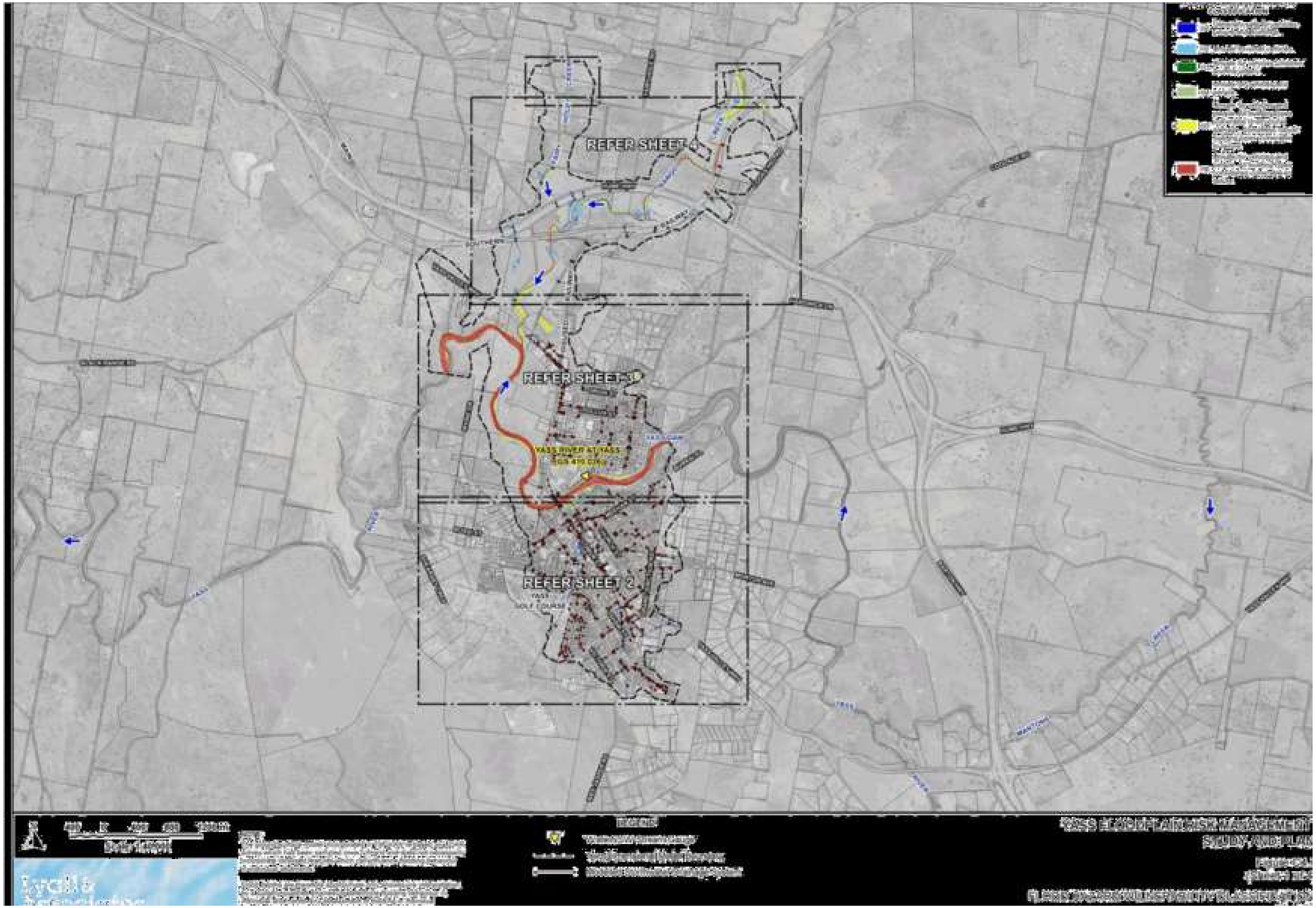
ON THIS FIGURE IS INDICATIVE ONLY, AS
FLOOR LEVELS WERE ESTIMATED BY A
"DRIVE-BY" SURVEY. SURVEY BY A
REGISTERED SURVEYOR IS REQUIRED TO
CONFIRM DEPTHS OF INUNDATION OF
INDIVIDUAL PROPERTIES.
VICTORIA PARK
YASS HIGH SCHOOL
YASS RIVER AT YASS (GS 410.026)
JOE O'CONNOR PARK
JOINS SHEET 2


INSET 1
REFER INSET 1
REFER INSET 2
MAIN
SOUTHERN
RAILWAY
PROPERTY FLOOD AFFECTATION SHOWN ON THIS FIGURE IS INDICATIVE ONLY, AS FLOOR LEVELS WERE ESTIMATED BY A "DRIVE-BY" SURVEY. SURVEY BY A REGISTERED SURVEYOR IS REQUIRED TO CONFIRM DEPTHS OF INUNDATION OF INDIVIDUAL PROPERTIES
JOINS SHEET 3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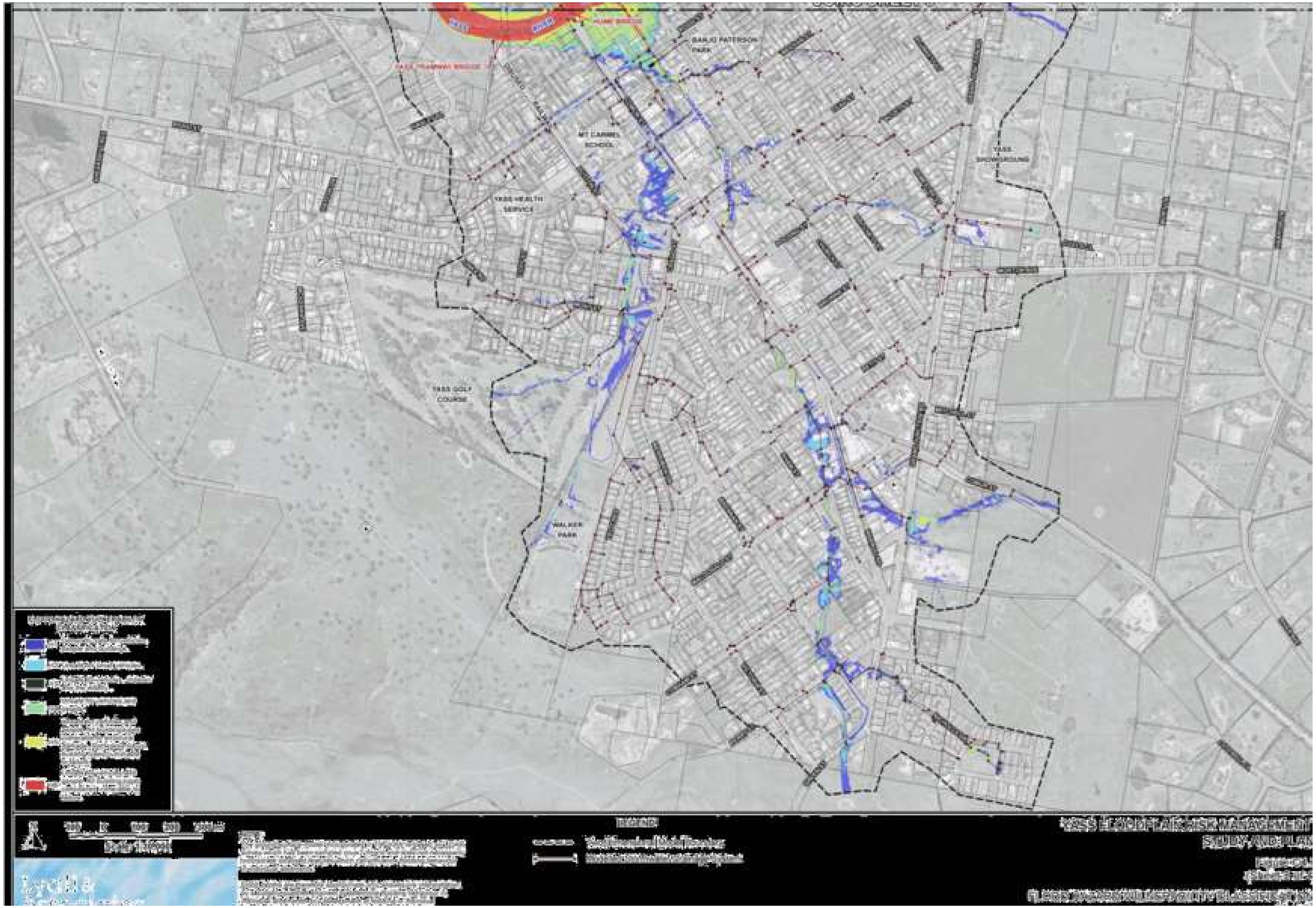
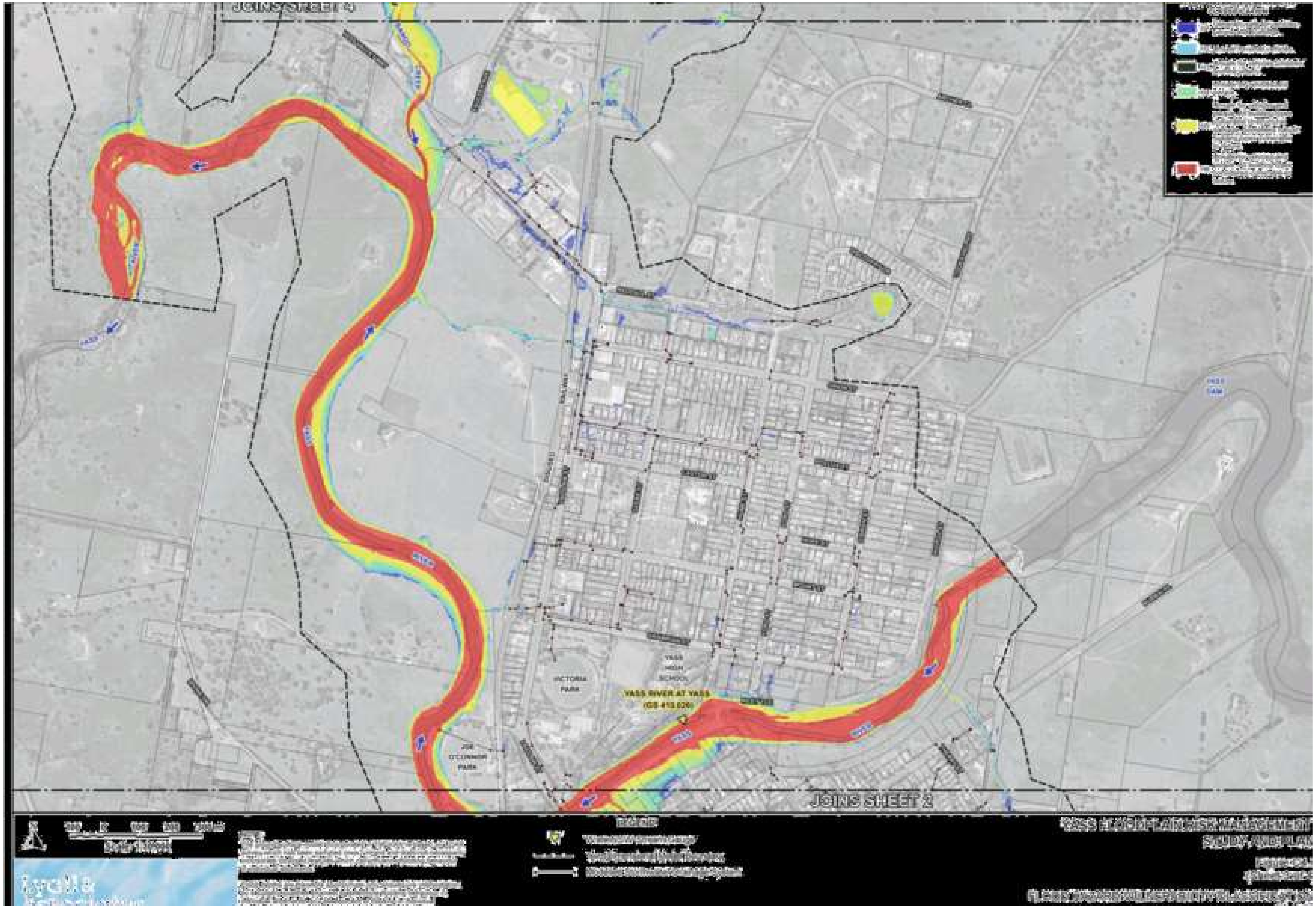
REFER SHEET 2
YASS RIVER AT YASS
YASS
GOLF COURSE


BANJO PATERSON PARK
MT CARMEL SCHOOL
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK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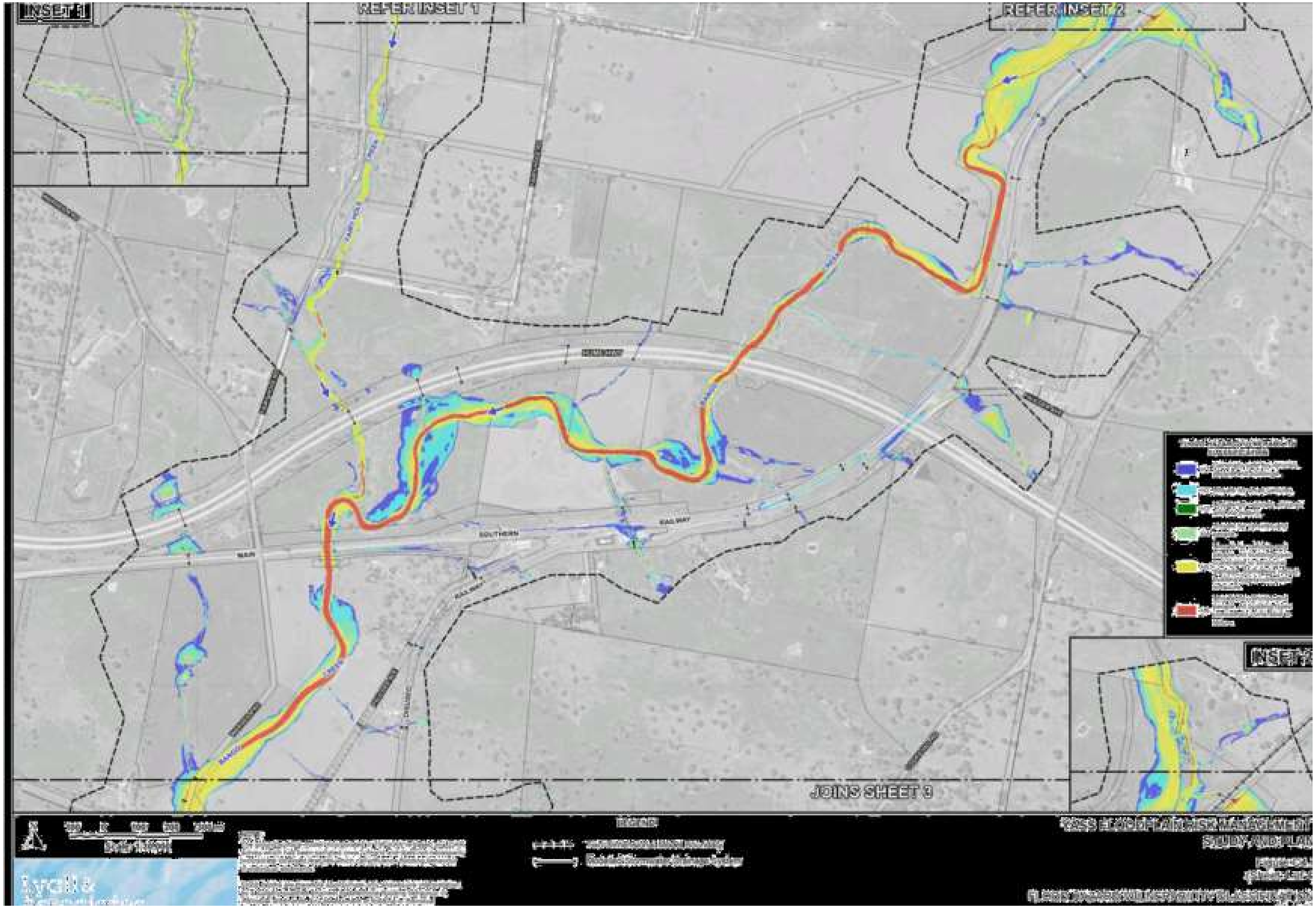
VICTORIA PARK
YASS HIGH SCHOOL
YASS RIVER AT YASS
JOE O'CONNOR PARK
JOINS SHEET 2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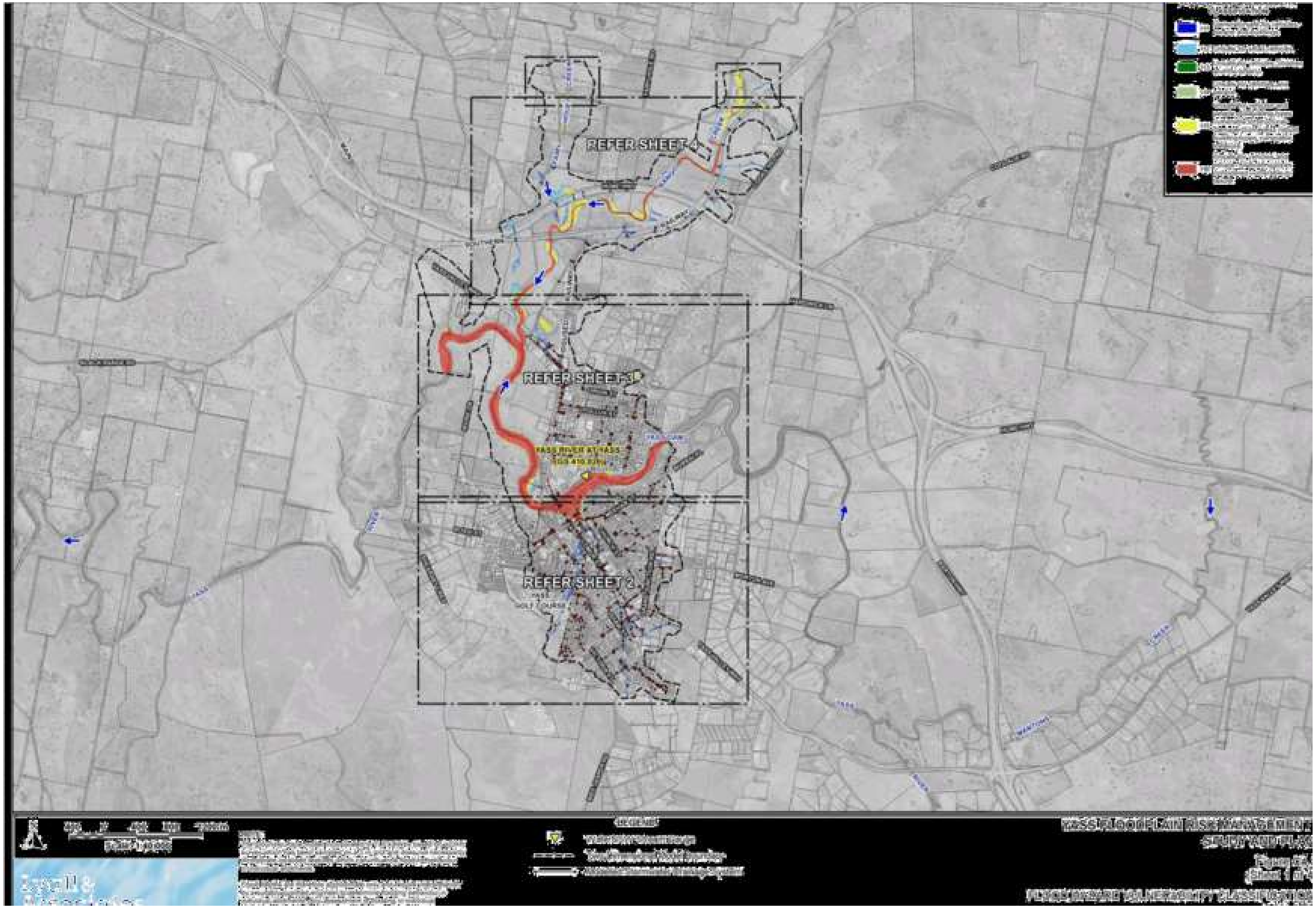
INSET 2
JOINS SHEET 3
SOUTHERN
RAILWAY
MAIN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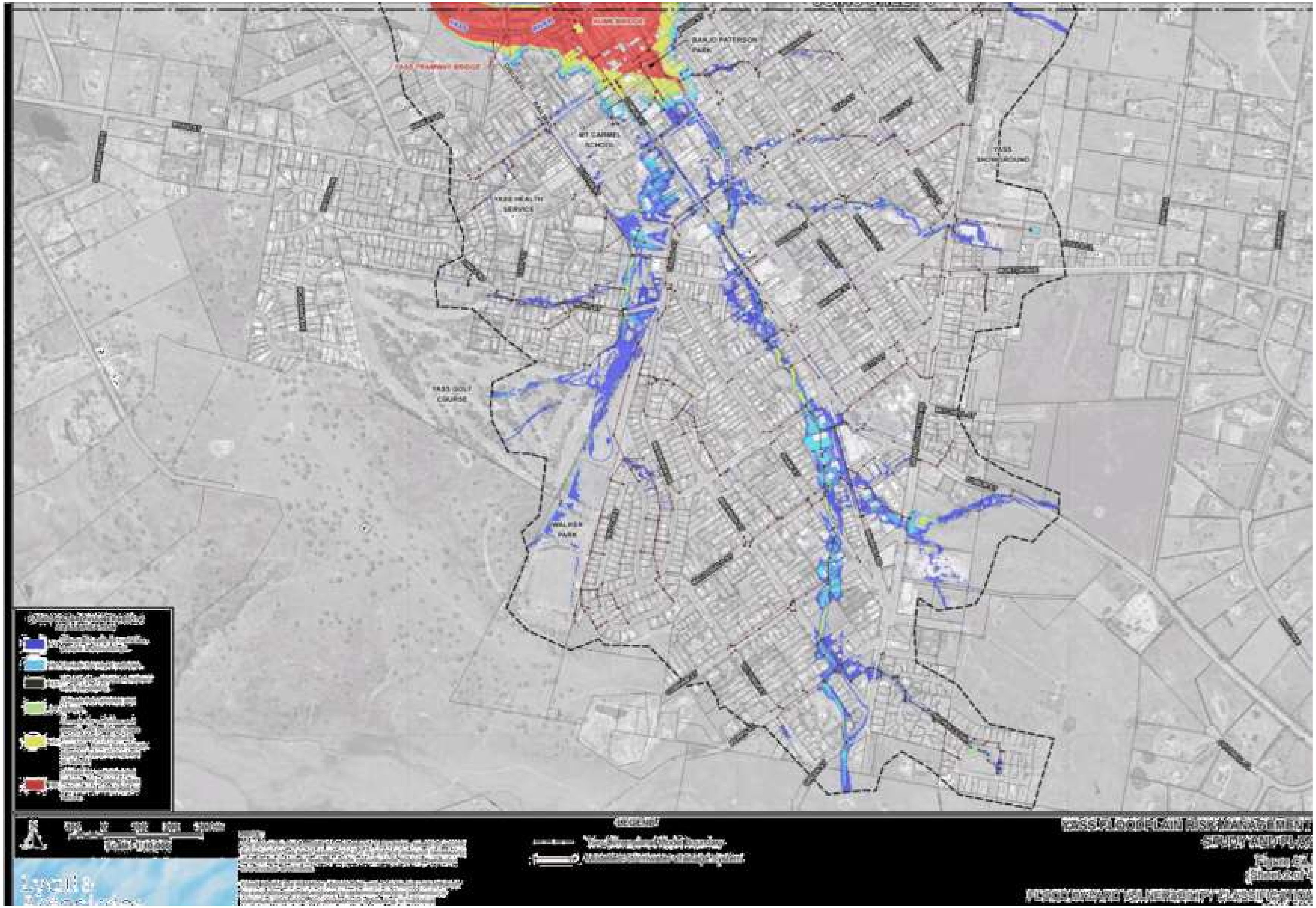
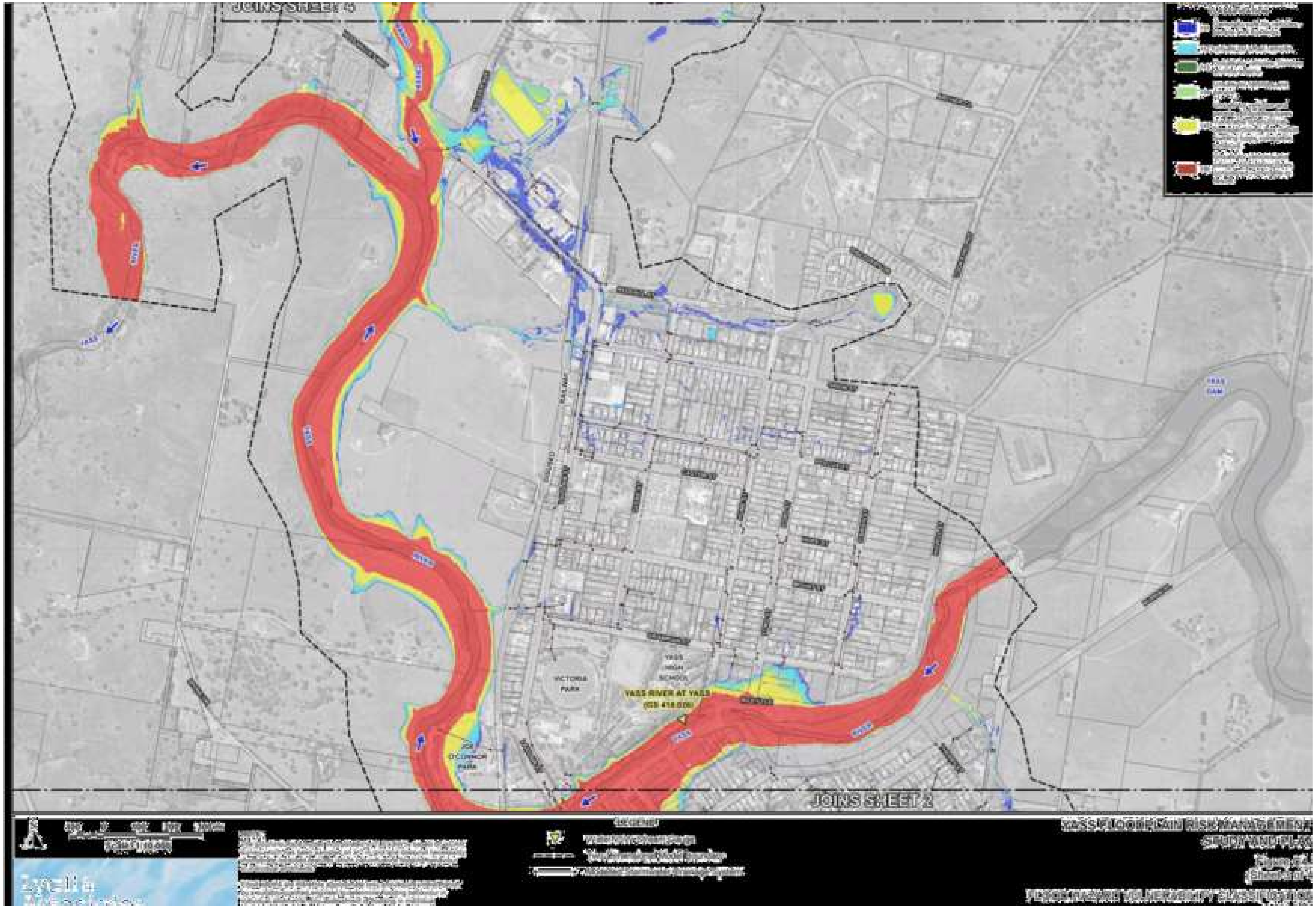
LEGEND


HUME BRIDGE
BANJO PATERSON PARK
MT CARMEL SCHOOL
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK
LEGEND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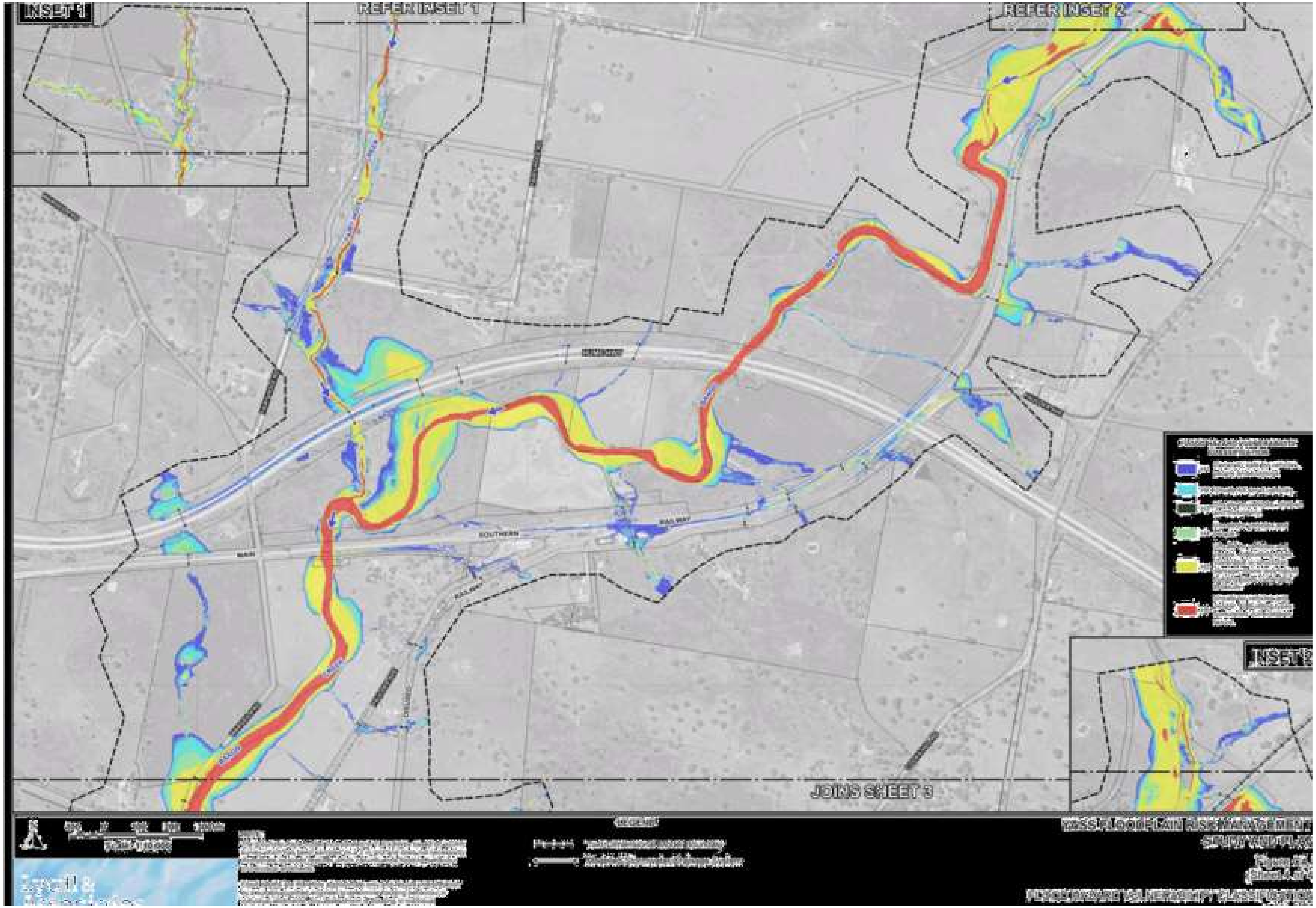
YASS RIVER AT YASS
VICTORIA PARK
YASS HIGH SCHOOL
LEGEND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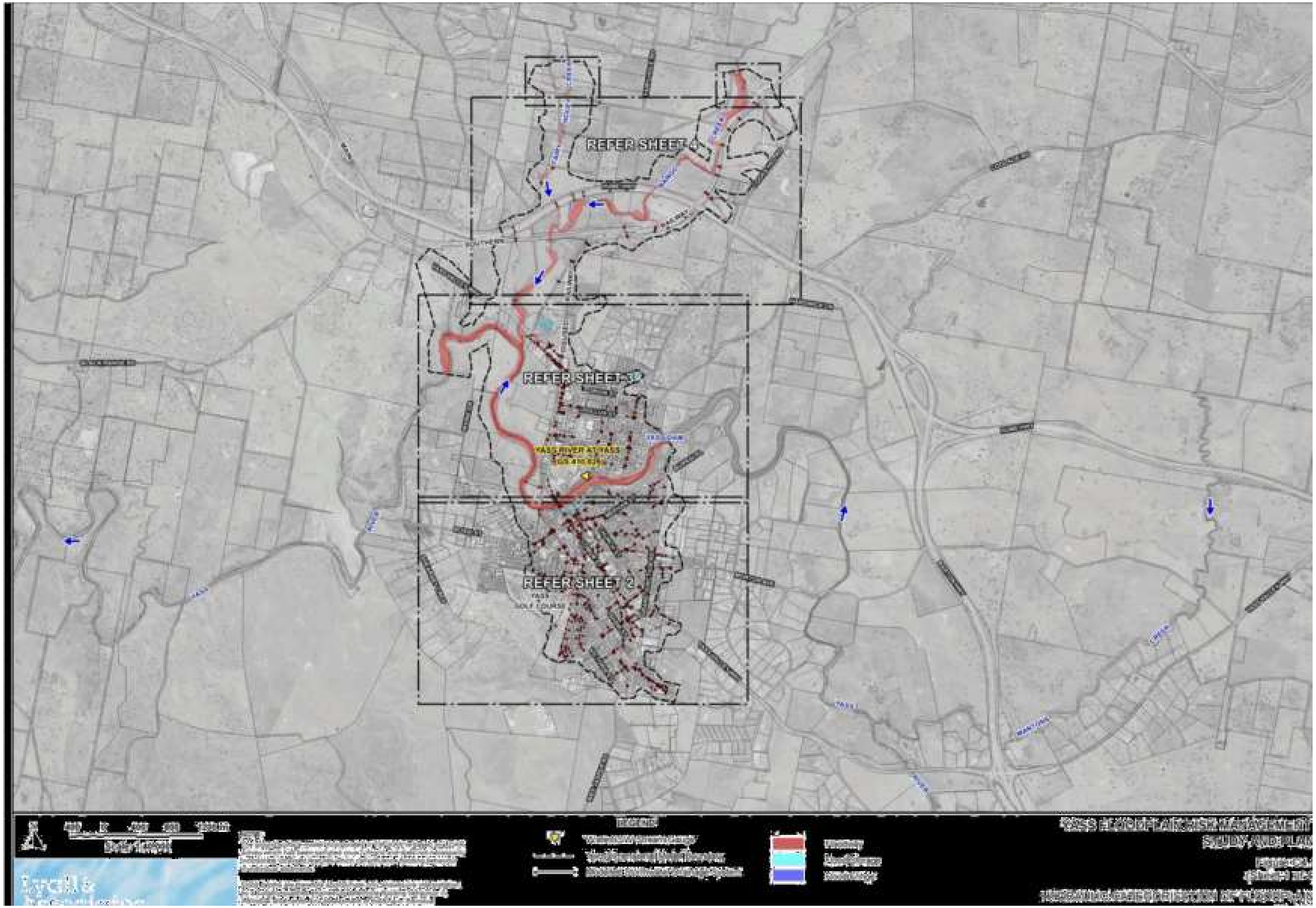
MAIN
RAILWAY
JOINS SHEET 3
INSET 2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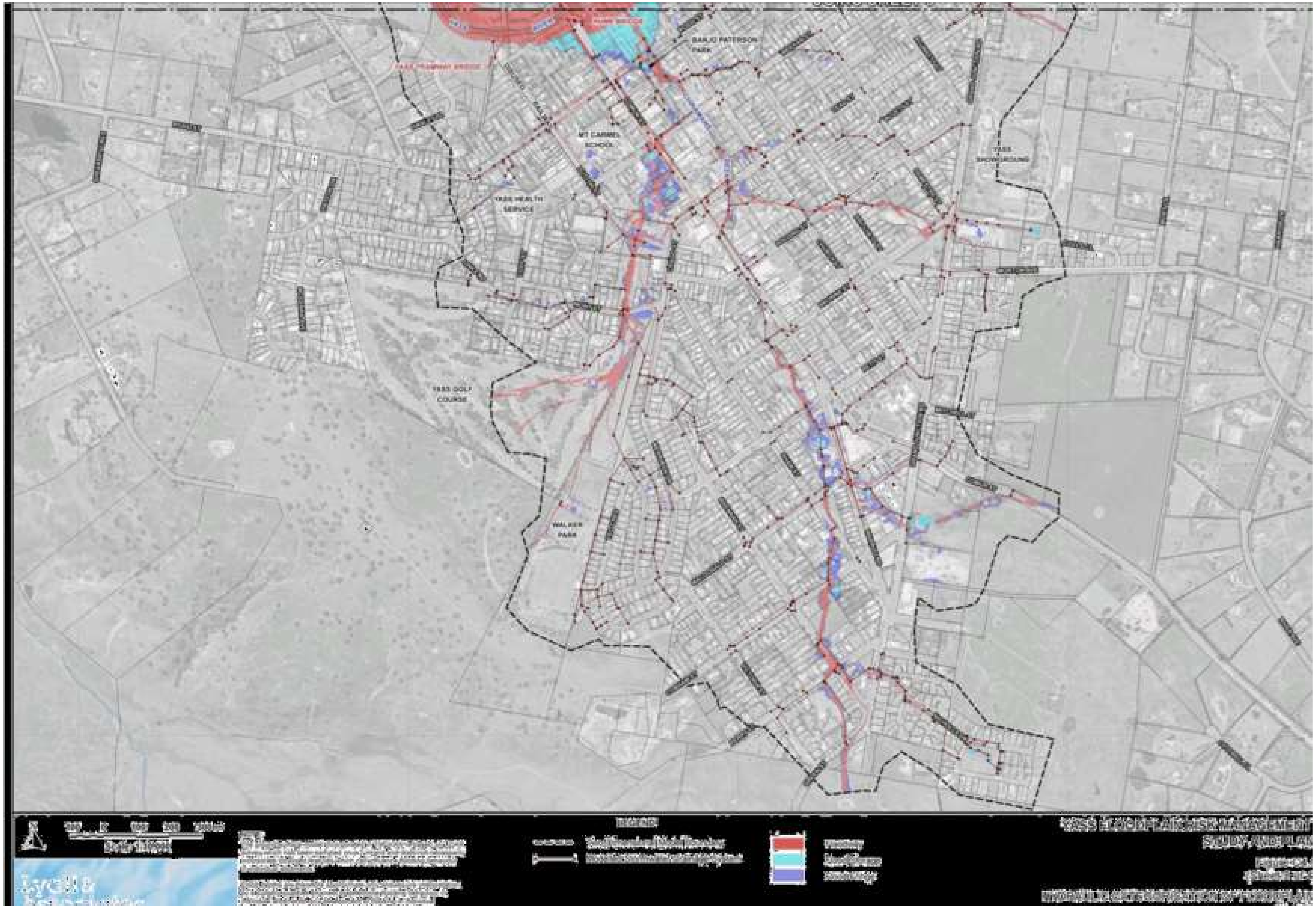
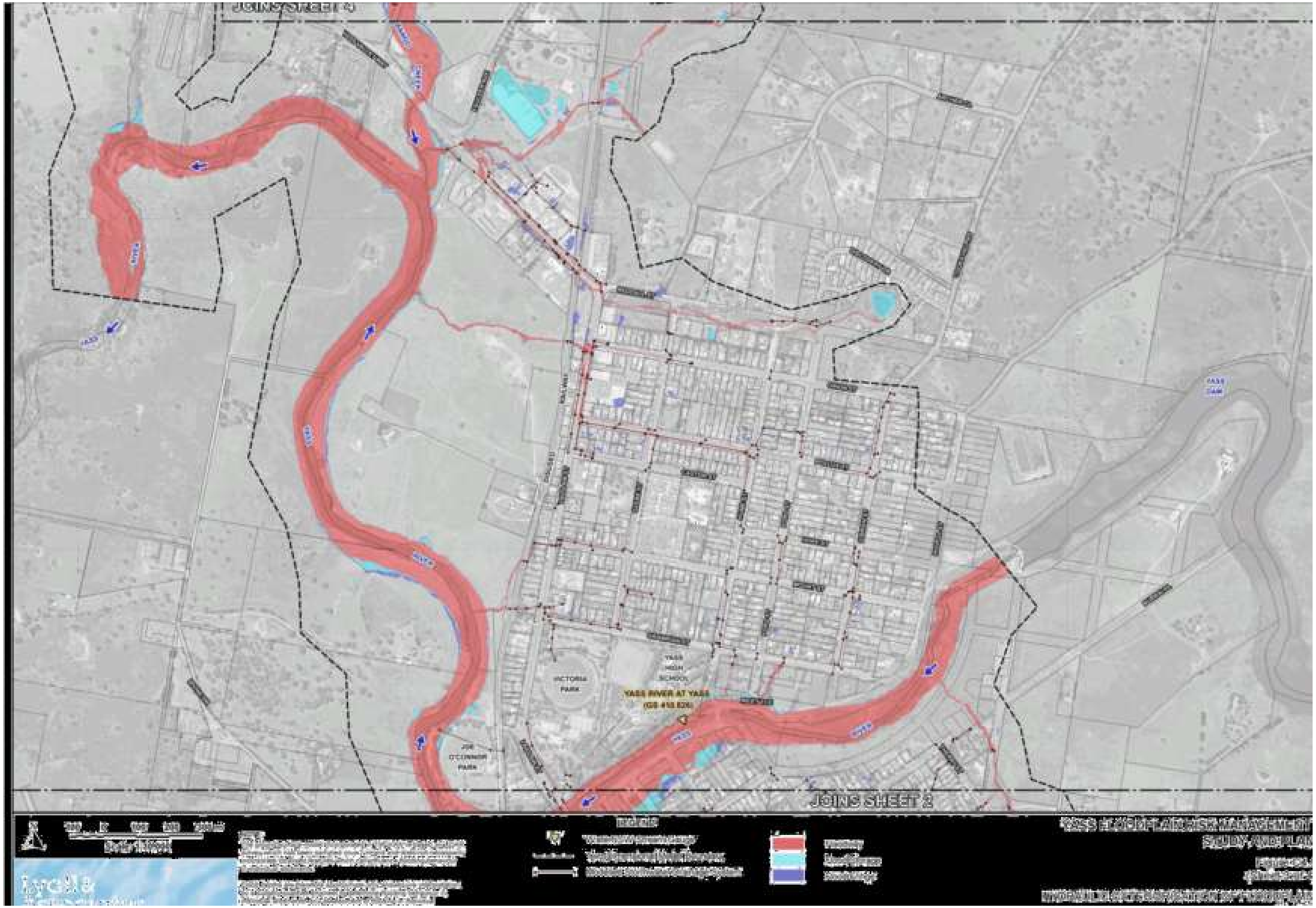
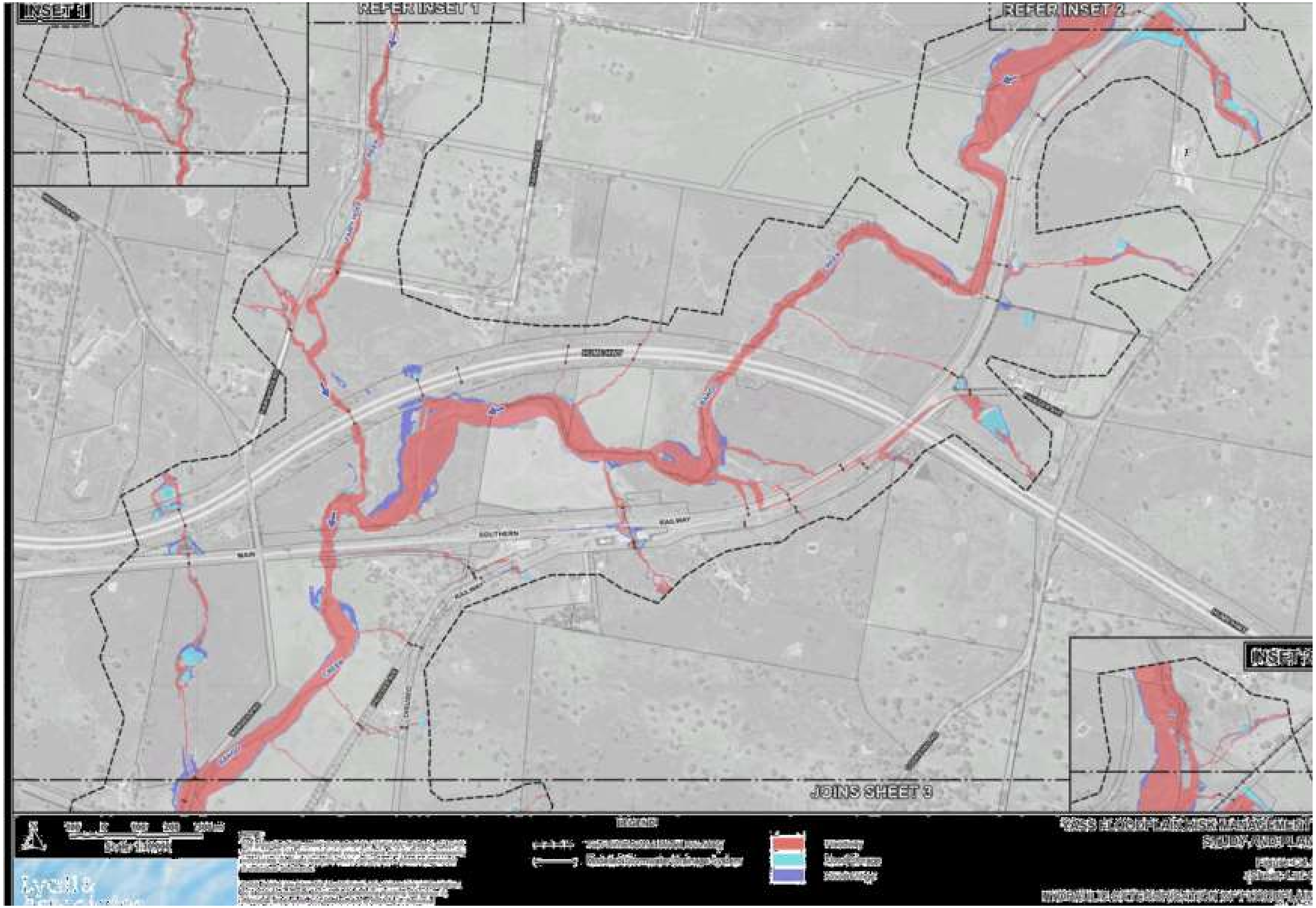
YASS RIVER AT YASS
REFER SHEET 2
YASS
GOLF COURSE


BANJO PATERSON PARK
MT CARMEL SCHOOL
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK


JOINS SHEET 2
VICTORIA PARK
YASS HIGH SCHOOL
YASS RIVER AT YASS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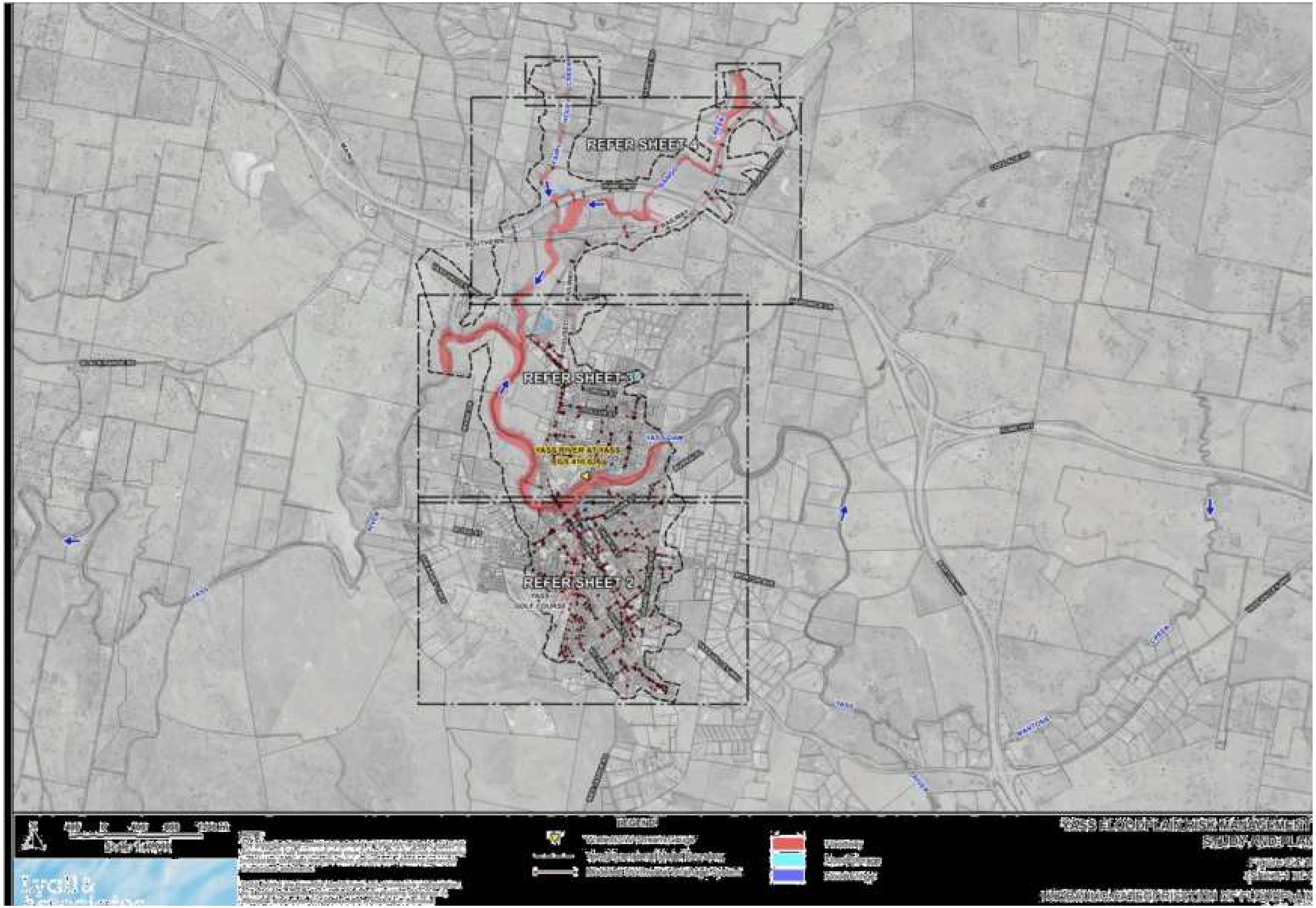
HUME HWY
SOUTHERN
RAILWAY
MAIN
JOINS SHEET 3
INSET 2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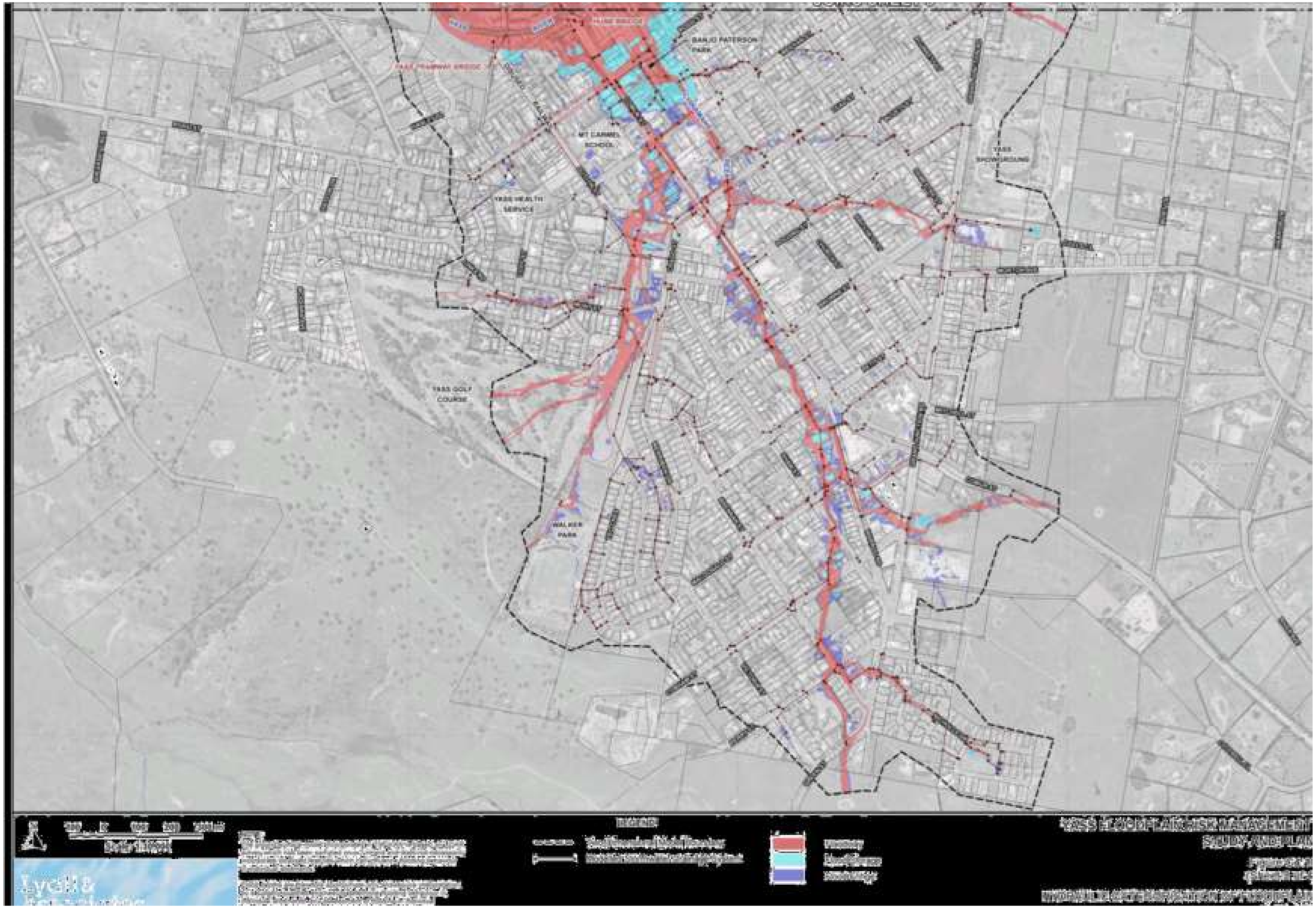
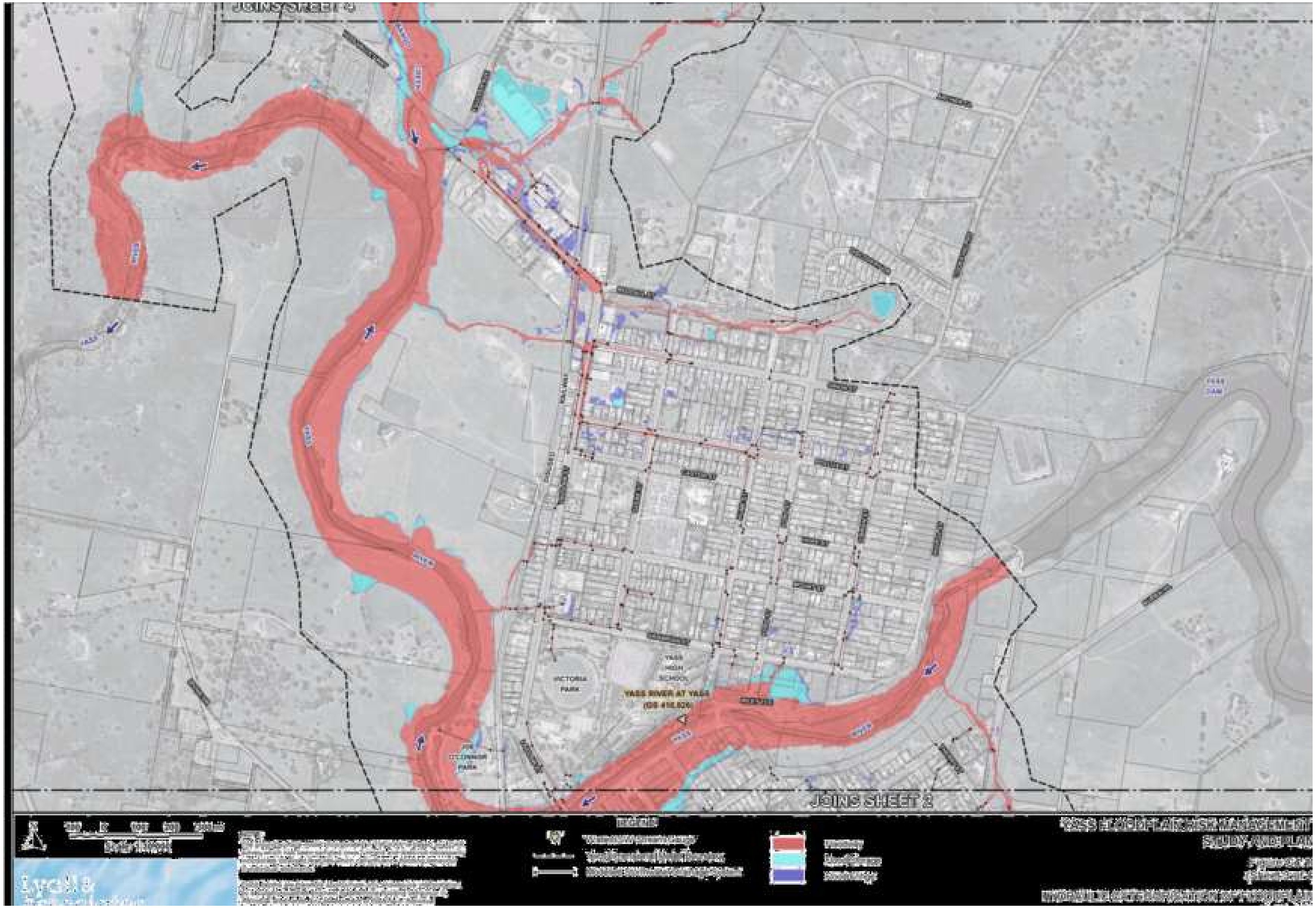

BANJO PATERSON PARK
MT CARMEL SCHOOL
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK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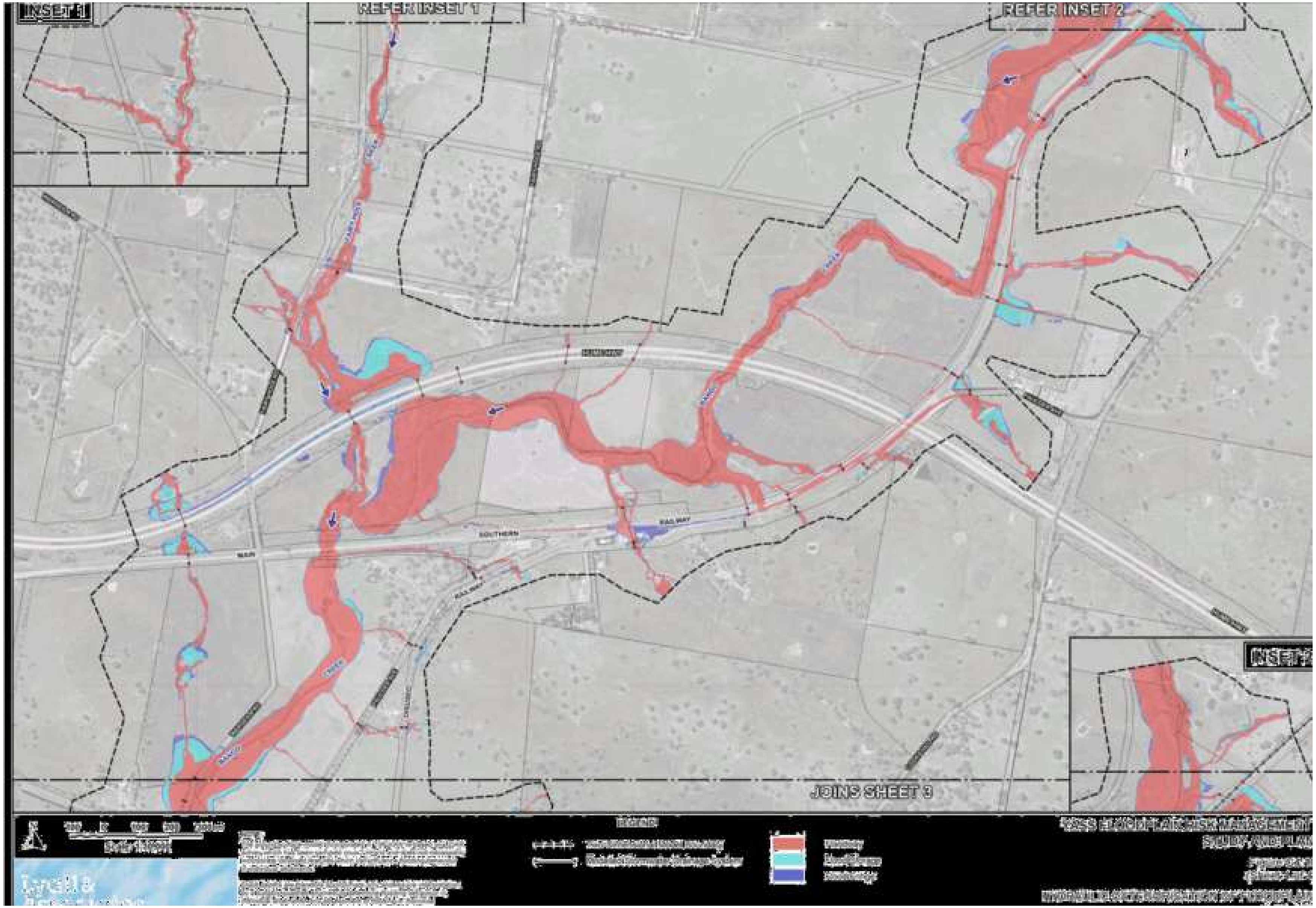
YASS HIGH SCHOOL
YASS RIVER AT YASS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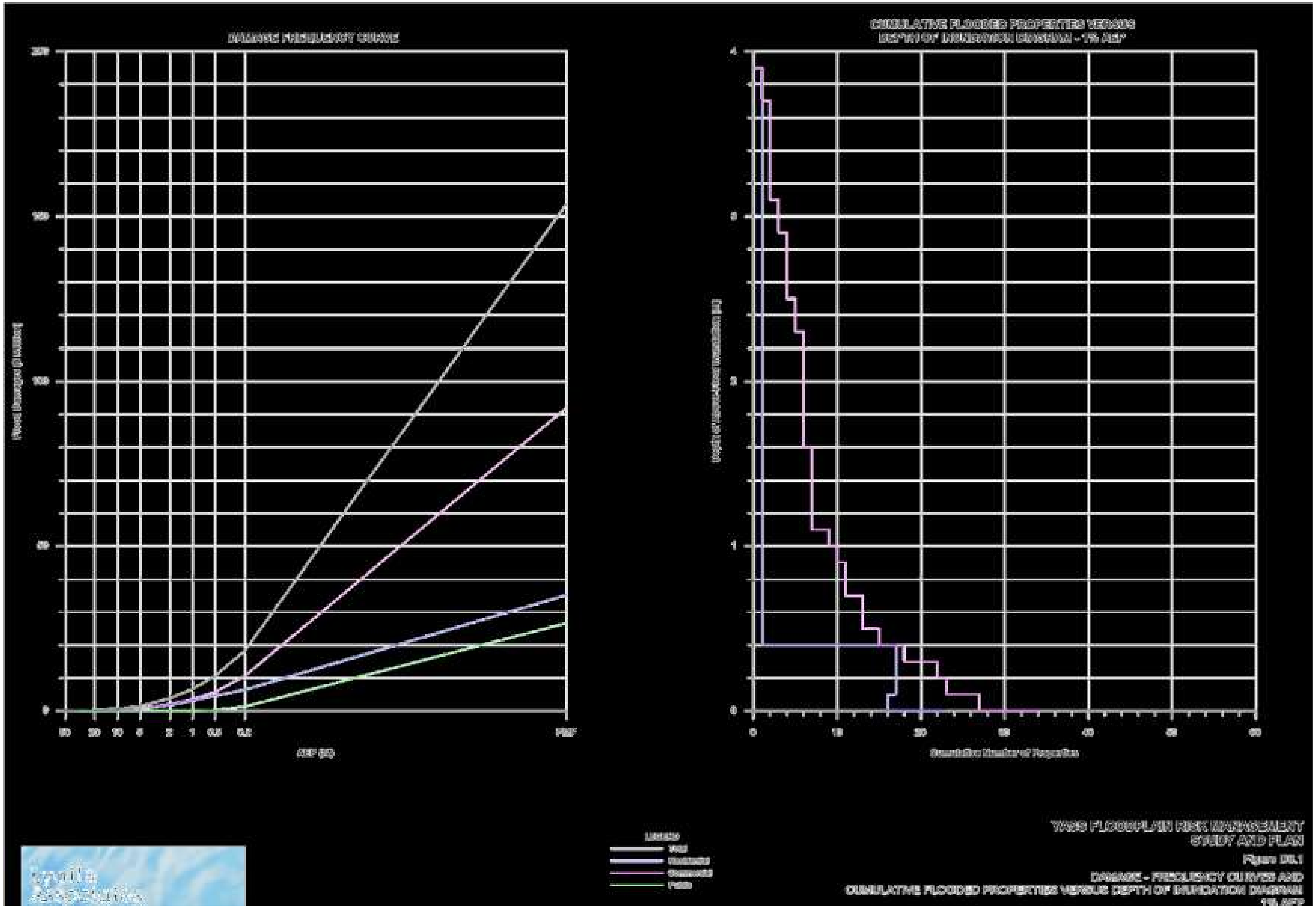
APPENDIX D

FLOOD DAMAGES

LIST OF FIGURES (APPENDIX D)


DAMAGE FREQUENCY CURVE
CUMULATIVE FLOODED PROPERTIES VERSUS
DEPTH OF INUNDATION DIAGRAM - 1% AEP
50
20
10
5
2
1
0.5
0.2
PMF
AEP (%)
0
10
20
30
40
50
60
LEGEND
YASS FLOODPLAIN RISK MANAGEMENT
STUDY AND PLAN
DAMAGE - FREQUENCY CURVES AND
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1% AEP

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SUGGESTED WORDING FOR INCLUSION IN YASS VALLEY DEVELOPMENT CONTROL PLAN

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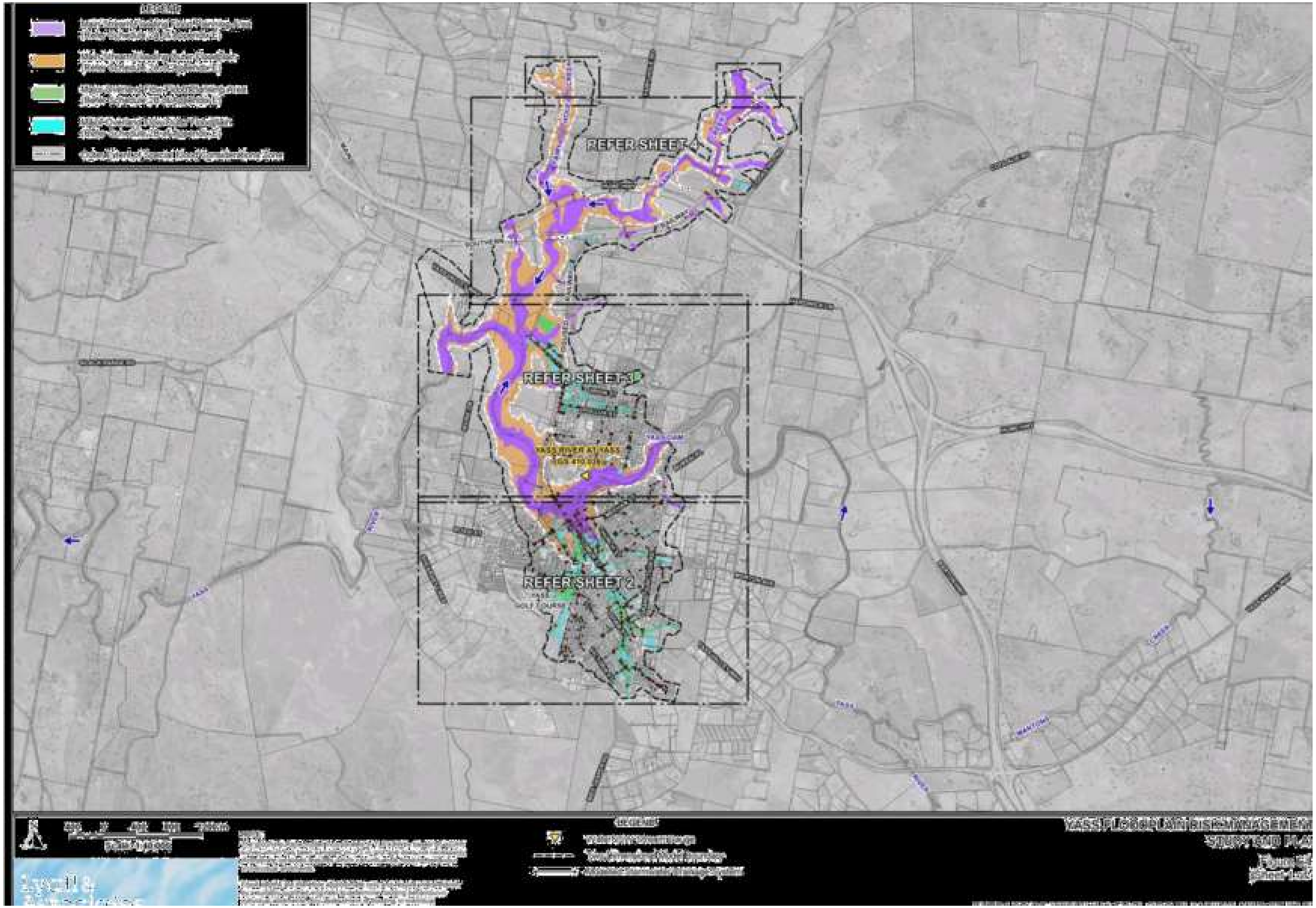
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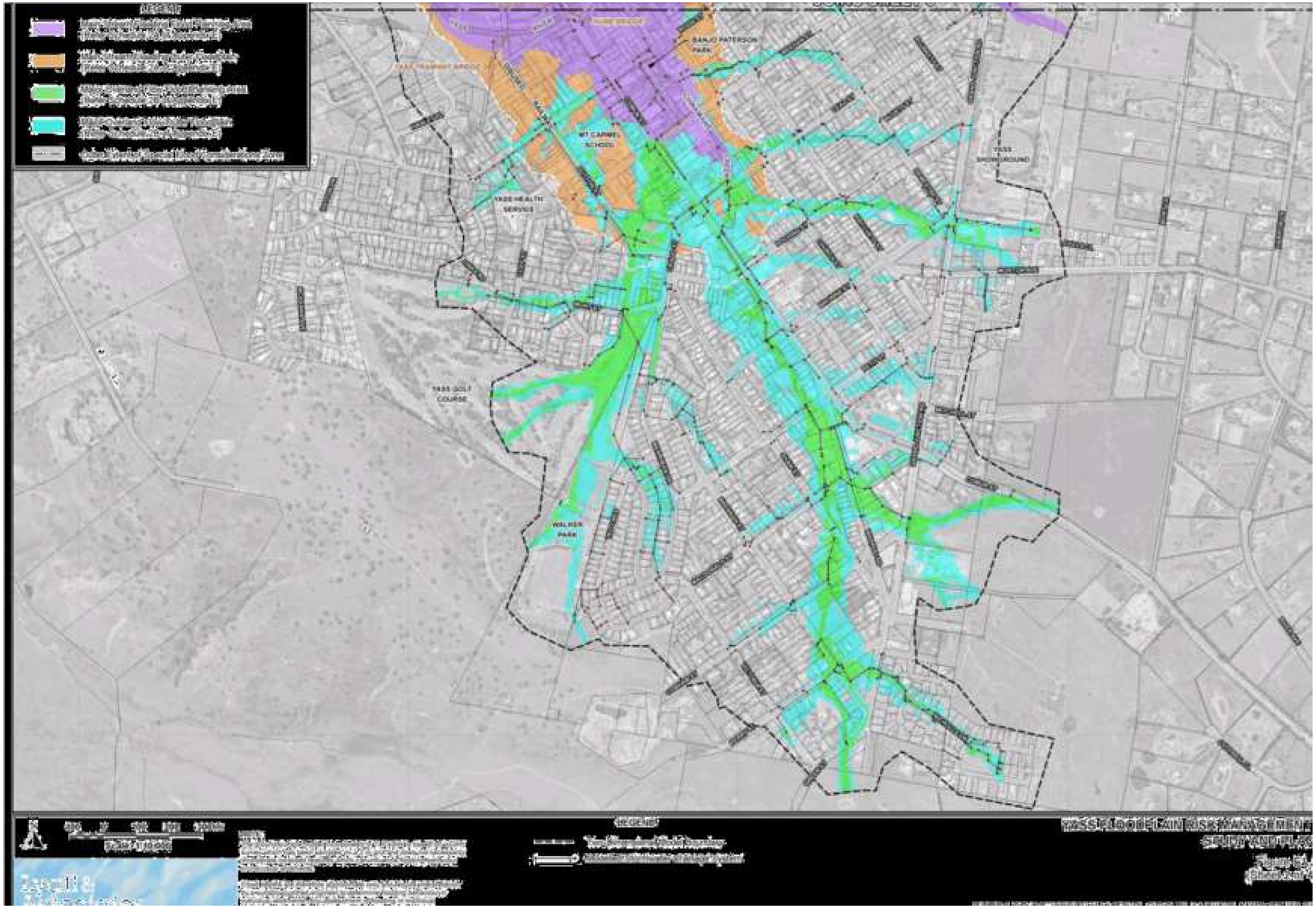
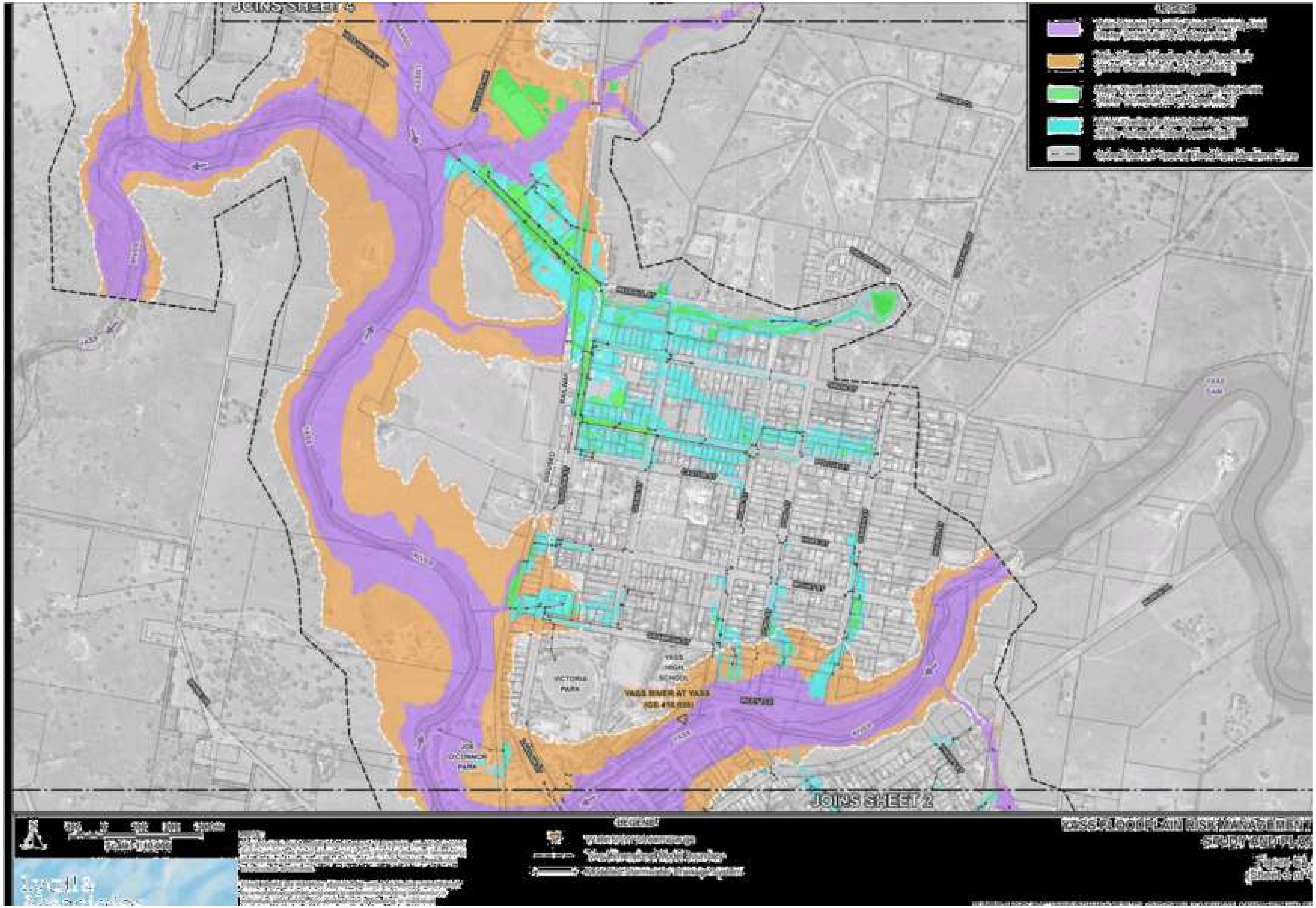

BANJO PATERSON PARK
MT CARMEL SCHOOL
YASS HEALTH SERVICE
YASS SHOWGROUND
YASS GOLF COURSE
WALKER PARK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YASS RIVER AT YASS
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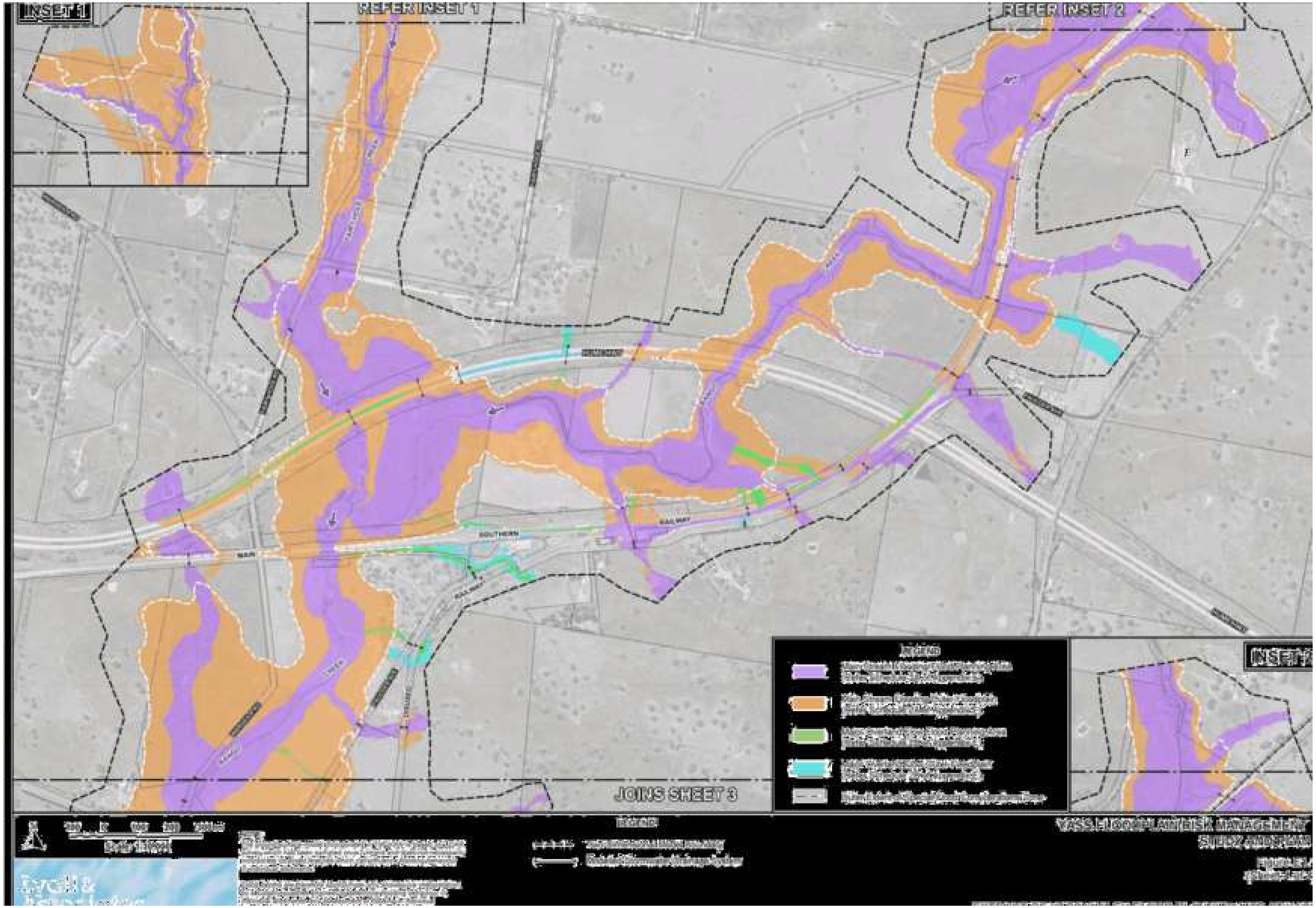
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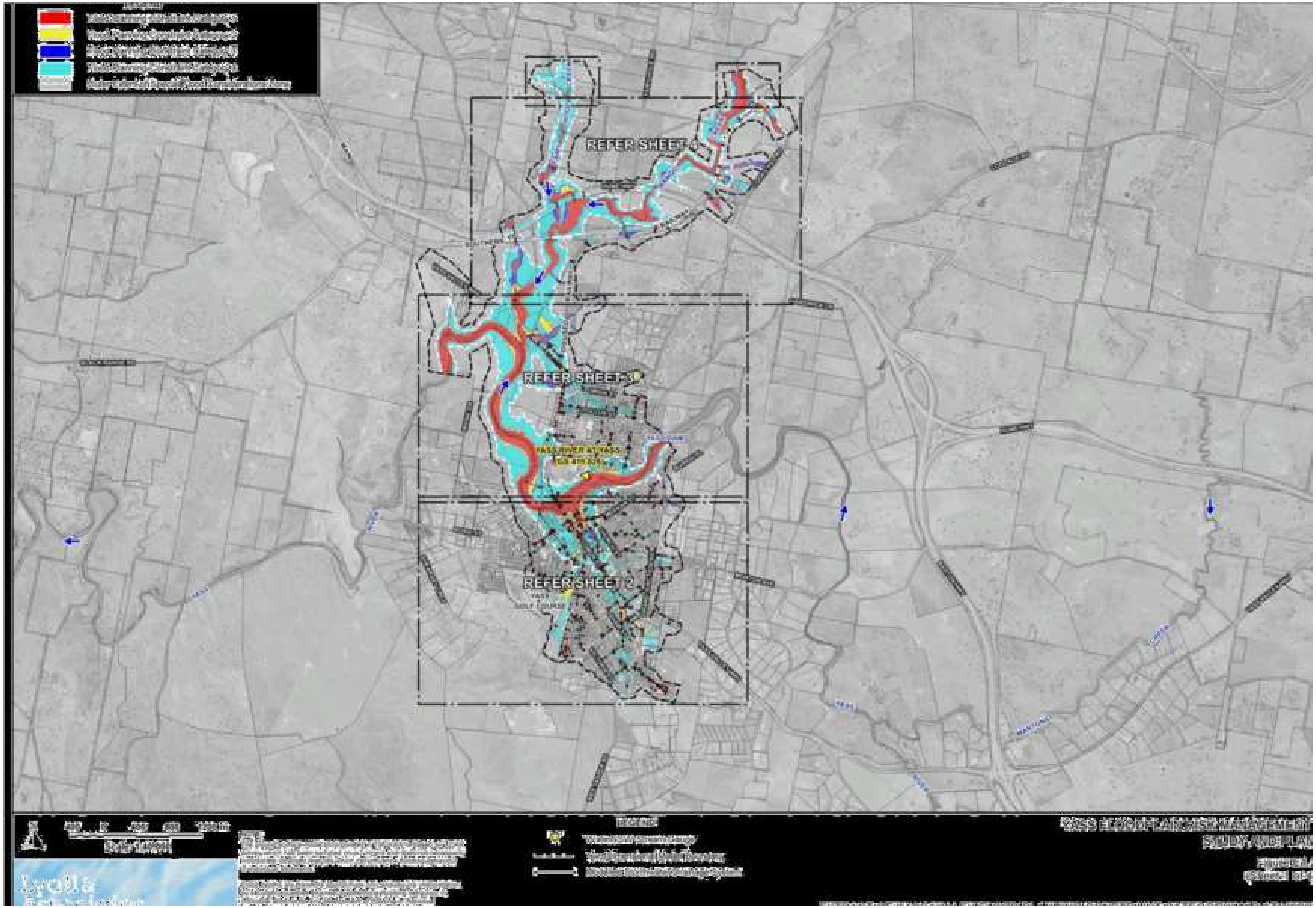
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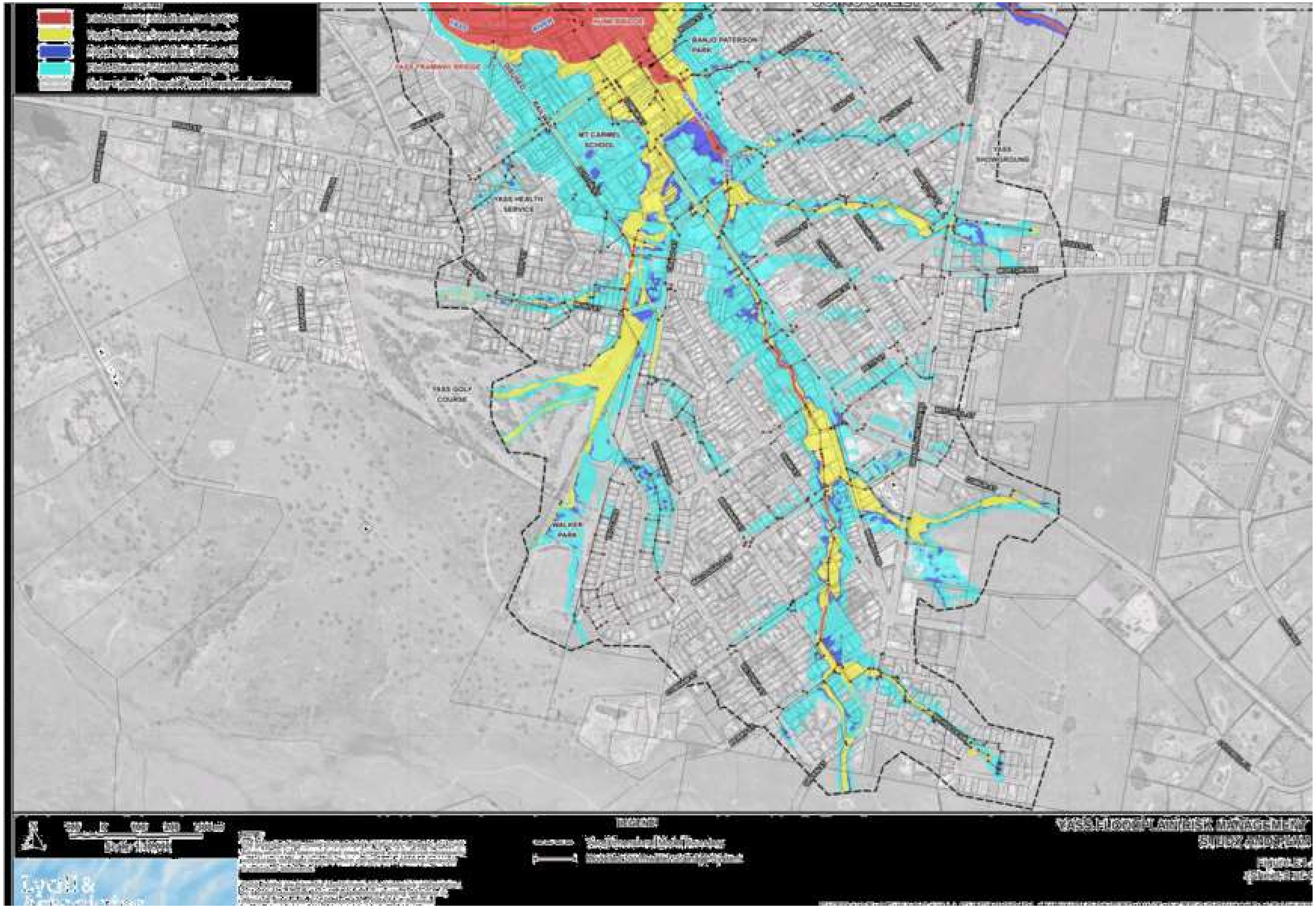
YASS RIVER AT YASS
YASS GOLF COURSE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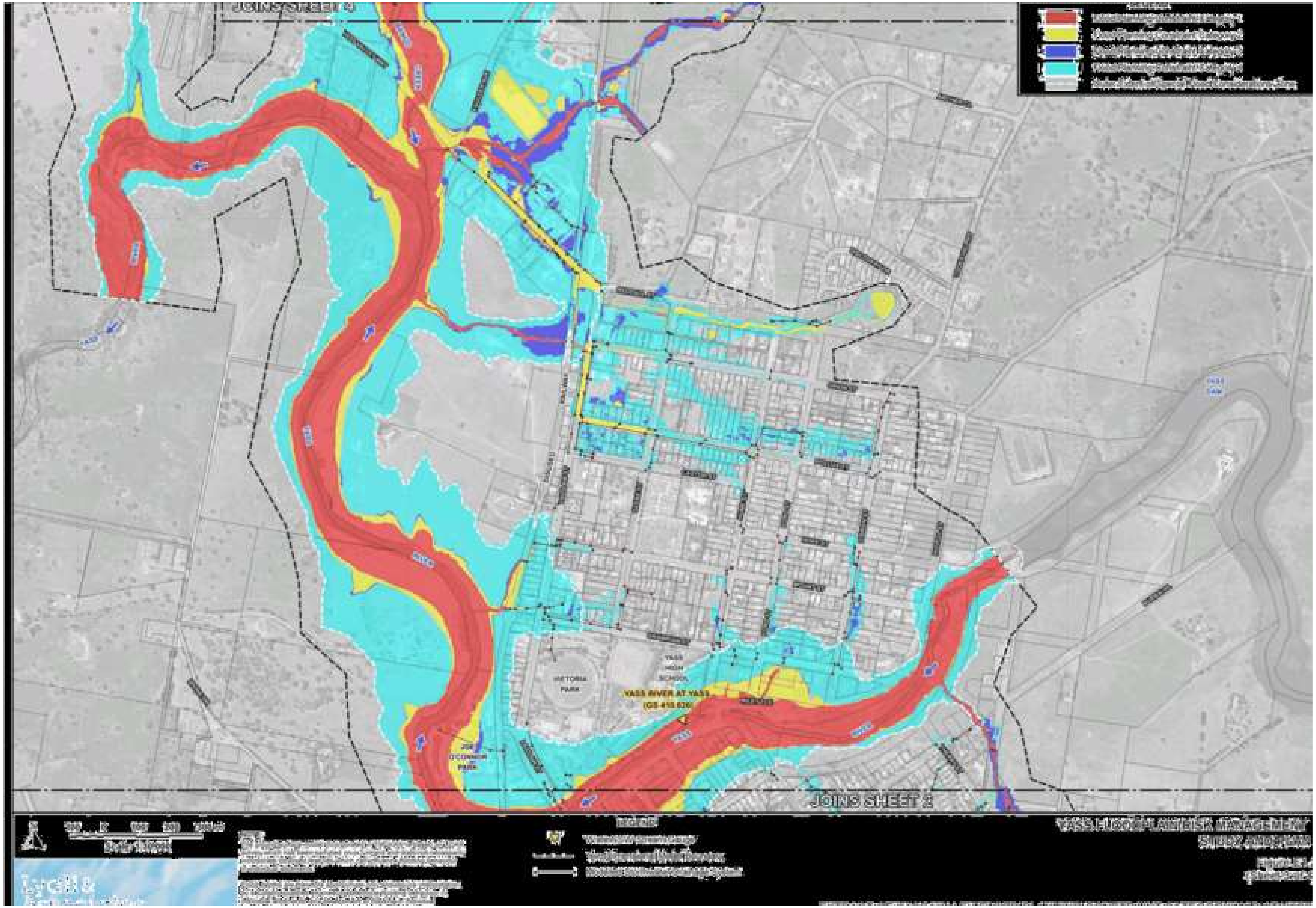
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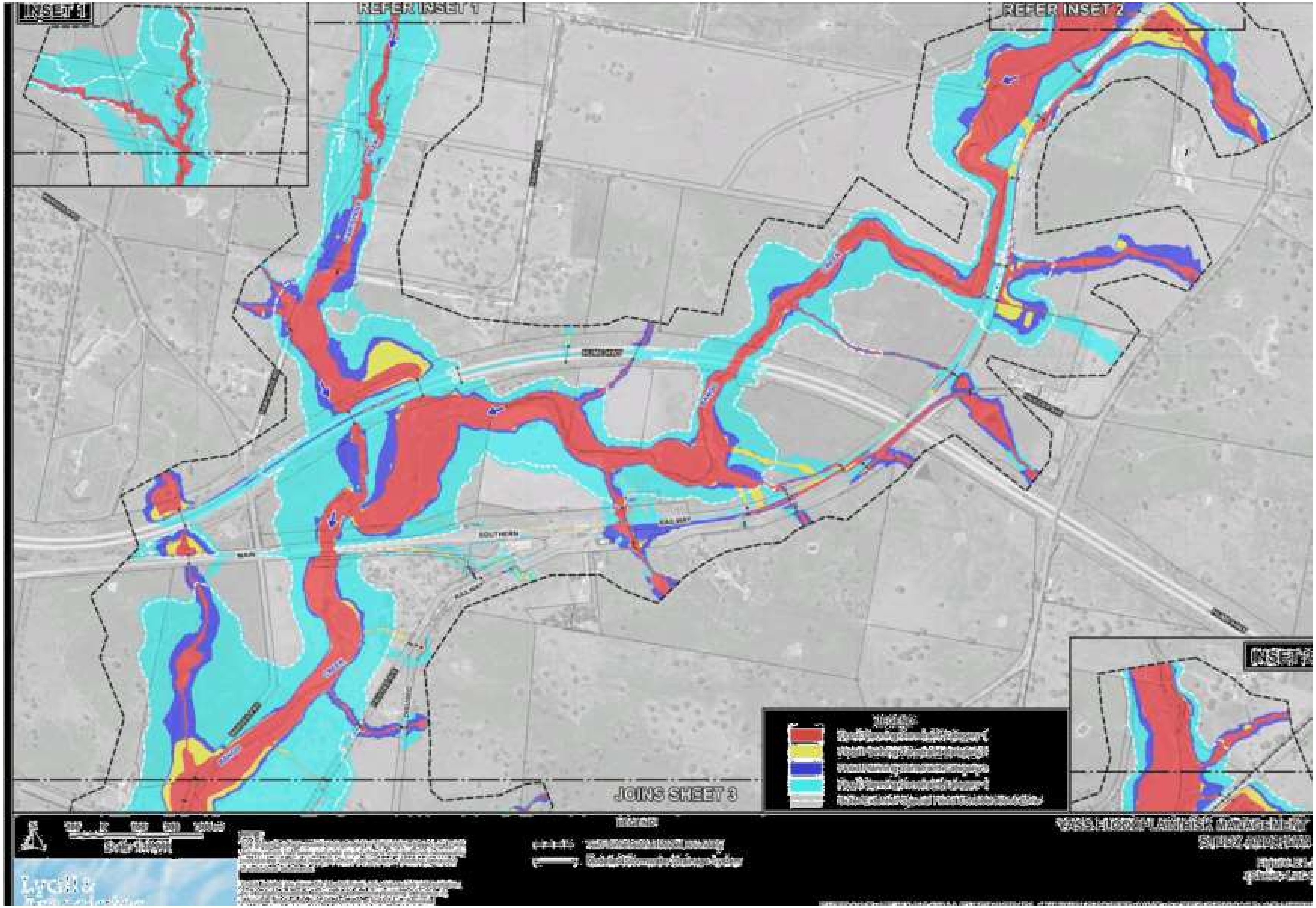
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YASS FLOODPLAIN RISK MANAGEMENT

YASS VALLEY COUNCIL

MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALONG FLOOD STUDY

AUGUST 2020

Job No: ES454 File: MBBBFS_V1_Report [Rev 1.3].doc	Date: August 2020 Rev No: 1.3	Principal: SAB Author: SAB/TDR

FOREWORD

The NSW State Government's Flood Prone Land Policy is directed at providing solutions to existing flooding problems in developed areas and to ensuring that new development is compatible with the flood hazard and does not create additional flooding problems in other areas.

Under the Policy, the management of flood liable land remains the responsibility of local government. The State subsidises flood mitigation works to alleviate existing problems and provides specialist technical advice to assist councils in the discharge of their floodplain management responsibilities.

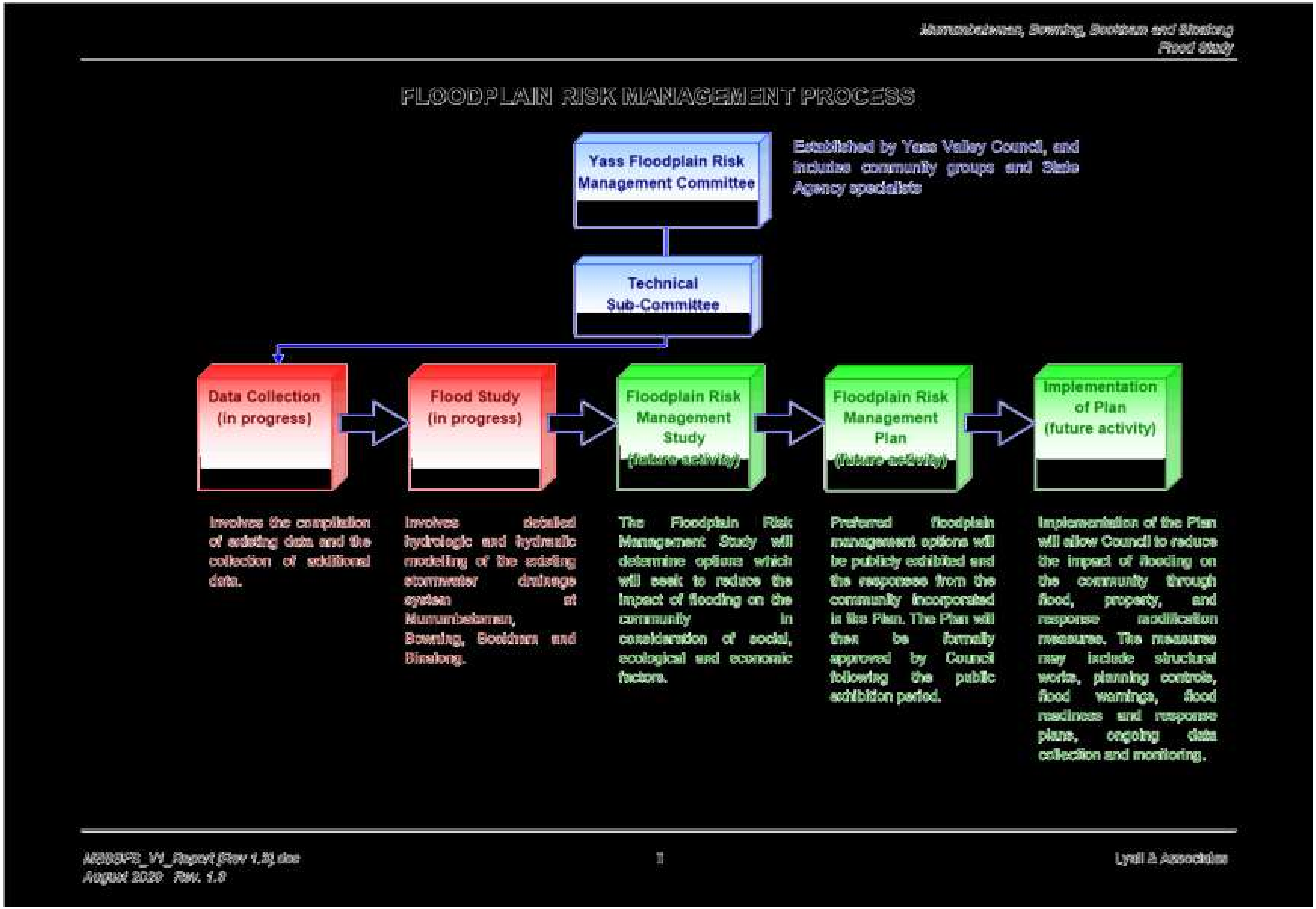
The Policy provides for technical and financial support by the Government through the following four sequential stages:

1.	Flood Study	Determines the nature and extent of flooding.
2.	Floodplain Risk Management Study	Evaluates management options for the floodplain in respect of both existing and proposed development.
3.	Floodplain Risk Management Plan	Involves formal adoption by Council of a plan of management for the floodplain.
4.	Implementation of the Plan	Construction of flood mitigation works to protect existing development. Use of Local Environmental Plans to ensure new development is compatible with the flood hazard. Improvements to flood emergency management measures.

The Murrumbateman, Bowning, Bookham and Binalong Flood Study is jointly funded by Yass Valley Council and the NSW Government, via the Department of Planning, Industry and Environment. The Flood Study constitutes the first and second stage of the Floodplain Risk Management process (refer over) for this area and has been prepared for Yass Valley Council to define flood behaviour under current conditions.

ACKNOWLEDGEMENT

Yass Valley Council has prepared this document with financial assistance from the NSW Government through its Floodplain Management Program. This document does not necessarily represent the opinions of the NSW Government or the Department of Planning, Industry and Environment.



FLOODPLAIN RISK MANAGEMENT PROCESS

Involves the compilation of existing data and the collection of additional data.

Involves detailed hydrologic and hydraulic modelling of the existing stormwater drainage system at Murrumbateman, Bowning, Bookham and Binalong.

The Floodplain Risk Management Study will determine options which will seek to reduce the impact of flooding on the community in consideration of social, ecological and economic factors.

Preferred floodplain management options will be publicly exhibited and the responses from the community incorporated in the Plan. The Plan will then be formally approved by Council following the public exhibition period.

Implementation of the Plan will allow Council to reduce the impact of flooding on the community through flood, property, and response modification measures. The measures may include structural works, planning controls, flood warnings, flood readiness and response plans, ongoing data collection and monitoring.

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NOTE ON FLOOD FREQUENCY

The frequency of floods is generally referred to in terms of their Annual Exceedance Probability (**AEP**) or Average Recurrence Interval (**ARI**). For example, for a flood magnitude having 5% AEP, there is a 5% probability that there will be floods of greater magnitude each year. As another example, for a flood having a 5 year ARI, there will be floods of equal or greater magnitude once in 5 years on average. The approximate correspondence between these two systems is:

Annual Exceedance Probability (AEP) (%)	Average Recurrence Interval (ARI) (years)
0.2	500
0.5	200
1	100
2	50
5	20
10	10
20	5

The report also refers to the Probable Maximum Flood (**PMF**). This flood occurs as a result of the Probable Maximum Precipitation (**PMP**). The PMP is the result of the optimum combination of the available moisture in the atmosphere and the efficiency of the storm mechanism as regards rainfall production. The PMP is used to estimate PMF discharges using a model which simulates the conversion of rainfall to runoff. The PMF is defined as the limiting value of floods that could reasonably be expected to occur. It is an extremely rare flood, generally considered to have a return period greater than 1 in 10^6 years.

NOTE ON QUOTED LEVEL OF ACCURACY

Peak flood levels have on occasion been quoted to more than one decimal place in the report in order to identify minor differences in values. For example, to demonstrate minor differences between peak heights reached by both historic and design floods and also minor differences in peak flood levels which will result from, for example, a partial blockage of hydraulic structures. It is not intended to infer a greater level of accuracy than is possible in hydrologic and hydraulic modelling.

ABBREVIATIONS

AEP	Annual Exceedance Probability (%)
AHD	Australian Height Datum
AMC	Antecedent Moisture Condition
ARF	Areal Reduction Factor
ARI	Average Recurrence Interval (years)
ARR	Australian Rainfall and Runoff (Geoscience Australia, 2019)
AWS	All Weather Station
BoM	Bureau of Meteorology
DEM	Digital Elevation Model
DPIE	Department of Planning, Industry and Environment
DTM	Digital Terrain Model
EY	Exceedances per Year
FDM	Floodplain Development Manual (NSW Government, 2005)
FPL	Flood Planning Level
FPA	Flood Planning Area
FRMS&P	Floodplain Risk Management Study and Plan
GDSM	Generalised Short Duration Method
GS	Gauging Station
Council	Yass Valley Council
IFD	Intensity-Frequency-Duration
LiDAR	Light Detecting and Ranging (type of aerial based survey)
NSW SES	New South Wales State Emergency Service
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
TUFLOW	A true two-dimensional hydrodynamic computer model which has been used to define flooding patterns as part of the present investigation.

Chapter 8 of the report contains definitions of flood-related terms used in the study.

SUMMARY

S.1 Study Objective

The study objective was to define the nature of both main stream flooding and major overland flow at the villages of Murrumbateman, Bowning, Bookham and Binalong for flood frequencies ranging between 20 and 0.2 per cent Annual Exceedance Probability (**AEP**), as well as for the Probable Maximum Flood (**PMF**).

The *Flood Study* is the source of present day flooding conditions and will be used as the basis for preparing the future *Floodplain Risk Management Study and Plan* (***FRMS&P***) which will assess options for flood mitigation and prepare a Plan of works and measures for managing the present and future flood risk in the four villages.

S.2 Background Information

The villages of Murrumbateman, Bowning, Bookham and Binalong lie within the headwaters of the Murrumbidgee River catchment and are located on the following major creek systems:

- McClungs Creek, Big Hill Creek and Gooda Creek at Murrumbateman.
- Bowning Creek at Bowning.
- Jugiong Creek and Bogolong Creek at Bookham.
- Balgalal Creek at Binalong.

The urbanised parts of the four villages are subject to main stream flooding as a result of floodwater which surcharges the above watercourses and their associated tributaries, as well as major overland flow which occurs as a result of local catchment runoff, as well as surcharges of the local stormwater drainage system during periods of heavy rain.

S.3 Study Method

The flood study involved the following activities:

- The forwarding of a *Community Newsletter and Questionnaire* to approximately 2090 residents and business owners at the four villages, 1140 of which reside in Murrumbateman, 230 in Bowning, 110 in Bookham and 610 in Binalong. The *Community Newsletter and Questionnaire*, a copy of which is contained in **Appendix A** of the report, introduced the study objectives and sought information on historic flood behaviour. Of those that responded, about one third noted that they had observed flooding in or adjacent to their property. Whilst one respondent provided information on flooding that occurred in "1998 or 1999", the majority of respondents identified more recent storm events that occurred on the following dates:

  - 22-23 September 2009
  - 13-15 February 2010
  - 27 February – 5 March 2012
  - 28 February – 1 March 2013
  - 17-18 September 2013
  - 25 January 2015
  - 4-6 June 2016
  - 20 June 2016
  - 22-23 July 2016
  - 31 August 2016
  - 21-22 September 2016

- The collection of flood data, details of which are set out in **Appendix B** of the report. Pluviographic rainfall data recorded by a series of Bureau of Meteorology operated rain gauges in the vicinity of the study catchments were obtained. A number of photographs were provided by respondents to the *Community Newsletter and Questionnaire* showing flood behaviour in Murrumbateman and Binalong, copies of which are contained in **Appendix C** of the report.
- The hydrologic modelling of the McClungs Creek and upper Big Hill Creek and Gooda Creek catchments at Murrumbateman, the Bowning Creek catchment at Bowning, the Jugiong Creek catchment at Bookham and the Balgalal Creek catchment at Binalong. The RAFTS sub-model in the DRAINS software was used to simulate the hydrologic response of the predominately rural parts of the study catchments, while the ILSAX sub-model in DRAINS was used to stimulate the hydrologic response of the urban parts of the four villages. The software generated discharge hydrographs resulting from historic and design storms.
- Application of the discharge hydrographs to hydraulic models comprising the main arms of the aforementioned creeks, their major tributaries and major overland flow paths. The TUFLOW two-dimensional modelling system was adopted for the hydraulic analysis.
- Presentation of study results as water surface profiles, as well as diagrams showing indicative extents and depths of inundation, flood hazard vulnerability and the hydraulic categorisation of the floodplain into floodway, flood storage and flood fringe areas.
- Sensitivity studies to assess the effects on model results resulting from variations in model parameters such as hydraulic roughness of the floodplain, the effects of a partial blockage of hydraulic structures, and the effects on flooding patterns resulting from future climate change.

After testing the models for the February 2010 and September 2016 storm events, design storm rainfalls ranging between 20 and 0.2% AEP were derived using procedures set out in the 2019 edition of *Australian Rainfall and Runoff* (Geoscience Australia, 2019) and applied to the hydrologic models to determine discharge hydrographs. The PMF was also modelled.

S.4 Design Flood Estimation

Figures 6.1 to **6.8** in **Appendices E**, **F**, **G** and **H** show the TUFLOW model results for the 20, 10, 5, 2, 1, 0.5 and 0.2 per cent AEP floods, together with the PMF at Murrumbateman, Bowning, Bookham and Binalong, respectively. These diagrams show the indicative extent and depth of inundation along the creeks and tributaries at the four villages, as well as along the major overland flow paths for the range of design flood events.

Water surface profiles along the major drainage lines at the four villages are shown on **Figure 6.9** in **Appendices E** to **H** for the modelled design floods events. **Figure 6.10** shows stage and discharge hydrographs at selected locations throughout the study areas, while **Table I1** in **Appendix I** sets out design peak flows and corresponding critical storm durations at the each location.

Flooding patterns derived by TUFLOW for the design storm events are described in **Chapter 6** of the report, with exhibits presented in **Volumes 2** and **3**.

S.5 Economic Impact of Flooding

At the 1% AEP level of flooding, 20 residential properties would be flood affected (i.e. floodwater on the allotment to a depth exceeding 100 mm) (13 at Murrumbateman, two at Bowning and five at Binalong), of which three would experience above-floor inundation (one each at Murrumbateman, Bowning and Binalong). No commercial/industrial and public buildings would experience above-floor inundation during a 1% AEP event. The total flood damages at the 1% AEP level of flooding are $0.23 Million at Murrumbateman, $0.16 Million at Binalong, $0.09 Million at Bowning and zero at Bookham.

The *"Present Worth Value"* of damages resulting from all floods up to the magnitude of the 1% AEP at Murrumbateman and Binalong are $0.04 Million and $0.02 Million, respectively. These values represent the amount of capital spending which would be justified if one or more flood mitigation schemes prevented flooding for all properties up to the 1% AEP event in the respective village.

The *Present Worth Value* of total damages at Bowning and Bookham for all flood events up to the 1% AEP flood is zero. As a result it is not possible to economically justify any works which are aimed at mitigating the impact of flooding on existing development up to the 1% AEP level in these two villages

Appendix J of the report contains further details on the economic impacts of flooding at the four villages.

S.6 Flood Hazard and Hydraulic Categorisation

Diagrams showing the flood hazard vulnerability classification for the 5, 1, and 0.2% AEP flood events, as well as the PMF are shown on **Figures 6.11**, **6.12**, **6.13** and **6.14** of **Appendices E** to **H**, respectively, while the hydraulic categorisation of the floodplain for the same four design flood events are shown on **Figures 6.15**, **6.16**, **6.17** and **6.18** of **Appendices E** to **H.**

The flood hazard vulnerability classification is dependent on the depth and velocity of flow in the channels and the floodplains. The floodplain has been divided into six hazard categories areas on the basis of these two variables based on the relationships set out in the publication entitled "*Managing the Floodplain: A Guide to Best practice in Flood Risk Management in Australia*" (Australian Institute for Disaster Resilience (**AIDR**), 2017).

The study found that at the 1% AEP level of flooding areas classified as either H5 or H6 are generally limited to the inbank areas of the major watercourses and local farm dams that are scattered through the study catchments, while the major overland flow paths which are located within urbanised areas are generally classified as either H1 or H2. The exception to the latter is in areas where floodwater ponds on the upstream side of road formations, where the resultant flooding is generally classified as either H3 or H4.

The hydraulic categorisation requires the assessment of the main flow paths. Those areas of the floodplain where a significant discharge of water occurs during floods are denoted Floodways and are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant re-distribution of flood flow or a significant increase in flood levels. The remainder of the floodplain is denoted *Flood Storage* or *Flood Fringe* areas.

As the hydraulic capacity of the creek channels is not large enough to convey the 1% AEP flow, a significant portion of the total flow in conveyed on the floodplain. As a result, areas which lie on the overbank area also function as a floodway during the 1% AEP flood event. Floodways are also generally present along the major overland flow paths, while flood storage areas are generally confined to the major ponding areas which are typically located on the upstream side of road formations and in local farm dams.

S.7 Flood Emergency Response Classification

Diagrams showing the flood emergency response for the 5, 1 and 0.2% AEP flood events, as well as the PMF based on the procedures set out in "*Managing the Floodplain: A Guide to Best practice in Flood Risk Management in Australia*" (Australian Institute for Disaster Resilience (**AIDR**), 2017) are presented on **Figures 6.19**, **6.20**, **6.21** and **6.22**, respectively of **Appendices E** to **H**. The flood emergency response classifications are based on whether or not the area is flooded during a PMF event, whether the area has an exit to flood-free land in a flood event and the consequence of flooding on the area.

S.8 Sensitivity Analyses

Analyses were undertaken to test the sensitivity of flood behaviour to:

a. An increase in hydraulic roughness. **Figure 6.23** of **Appendices E** to **H** shows the effects a 20 per cent increase in the adopted 'best estimate' hydraulic roughness values would have on flooding behaviour at the 1% AEP level of flooding.

b. A partial blockage of major hydraulic structures by debris. **Figure 6.24** of **Appendices E** to **H** shows the effects a partial blockage of both bridges and major culvert structures would have on flooding behaviour at the 1% AEP level of flooding.

c. The approach to design flood estimation set out in the 1987 and 2019 editions of *Australian Rainfall and Runoff*. **Figures 6.25** and **6.26** of **Appendices E** to **H** show the difference in the extent and depth of inundation based on the two approaches for the 5% and 1% AEP flood events, respectively.

d. Increases in rainfall intensity associated with future climate change. **Figures 6.27**, **6.28** and **6.29** of **Appendices E** to **H** show the effects a 10 and 30 per cent increase in design 1% AEP rainfall intensities would have on flooding behaviour.

The sensitivity analyses identified that:

- peak 1% AEP flood levels could be increased by up to 500 mm as a result of changes in hydraulic roughness;
- increases in peak 1% AEP flood levels of generally up to 500 mm would occur should certain hydraulic structures experience a partial blockage by debris during a major storm event, with the exception of Bookham where increases of up to 1.5 m could occur;
- peak flood levels derived using the procedures set out in the 2019 edition of *Australian Rainfall and Runoff* are generally about 50-100 mm lower than those derived using the earlier edition of the document; and
- an increase in the intensity of rainfall associated with future climate change has the potential to increase peak 1% AEP flood levels by a maximum of about 500 mm.

S.9 Interim Flood Planning Area and Levels

The Flood Planning Area (**FPA**) and Flood Planning Levels *(**FPLs**)* for main stream flooding at the four villages are shown on **Figure 6.30** of **Appendices E** to **H**. The FPA represents the area which will be subject to flood related development controls for main stream flooding and comprises the area lying within the extent of the 1% AEP flood plus an allowance of 500 mm for freeboard. Also shown on **Figure 6.30** are the individual allotments that are inundated by major overland flow to depths greater than 150 mm (refer yellow hatched allotments which have been denoted "Flood Control Lots").

Consideration will need to be given during the preparation of the future *FRMS&P* to the appropriateness of the adopted freeboard allowance of 500 mm for main stream flooding given the impact changes in hydraulic roughness and future increases in rainfall intensity could have on peak flood levels, especially in the case of Bookham. Consideration will also need to be given to the setting of an appropriate freeboard for areas subject to major overland flow given that the adopted value of 500 mm may be found to be too conservative. The adoption of an allotment based approach to the identification of individual properties subject to major overland flow related planning controls should also be considered.

In allotments that lie outside the extent of the FPA for main stream flooding where the depth of overland flow is greater than 150 mm (refer blue shaded area on **Figure 6.30**) it is recommended that a freeboard of 300 mm be applied to peak 1% AEP flood levels when setting the minimum floor level of future development. An assessment should also be undertaken by Council as part of any future Development Application to confirm that the proposed development will not form an obstruction to the passage of overland flow through the subject site.

1 INTRODUCTION

1.1 Study Background

This report presents the findings of an investigation of flooding at the villages of Murrumbateman, Bowning, Bookham and Binalong in the Yass Valley Council (**Council**) Local Government Area (**LGA**). The study has been commissioned by Council with financial and technical support from the NSW Government, via the Department of Planning, Industry and Environment (**DPIE**). **Figure 1.1** shows the extent of the study catchment at each of the four villages.

The study objective was to define flood behaviour in terms of flows, water levels and velocities for floods ranging between 20 and 0.2 per cent Annual Exceedance Probability (**AEP**), as well as for the Probable Maximum Flood (**PMF**). The investigation involved rainfall-runoff hydrologic modelling of the catchments to assess flows in the drainage systems of the study catchments, and application of these flows to a hydraulic model to assess peak water levels and flow velocities. The model results were interpreted to present a detailed picture of flooding under present day conditions.

The scope of the study included investigation of main stream flood behaviour along McClungs Creek, Big Hill Creek and Gooda Creek at Murrumbateman, Bowning Creek at Bowning, Jugiong Creek and its associated tributaries at Bookham and the Balgalal Creek and its associated tributaries at Binalong. The scope of the study also included the investigation of major overland flow which occurs during periods of heavy rain.

The study forms the first and second step in the floodplain risk management process for the four villages (refer process diagram presented in the Foreword), and is a precursor of the future *Floodplain Risk Management Study and Plan* (***FRMS&P***) which will consider measures which are aimed at reducing the existing, future and continuing flood risk in Murrumbateman, Bowning, Bookham and Binalong.

1.2 Community Consultation and Available Data

To assist with data collection and promotion of the study to the community, a *Community Newsletter and Questionnaire* was distributed by Council in November 2018 to residents and business owners in the four villages. A copy of the *Community Newsletter and Questionnaire* which was prepared by the Consultants is attached in **Appendix A** of this report.

Council advised that approximately 2090 *Community Newsletters and Questionnaires* were distributed to the residents and business owners in the four villages, 1140 of which reside in Murrumbateman, 230 in Bowning, 110 in Bookham and 610 in Binalong. A total of 48 responses were received by the closing date of submissions (a response rate of about 2 per cent), 29 from residents or business owners of Murrumbateman, five from Bowning, zero from Bookham and 14 from Binalong.

Of those that responded, about one third noted that they had observed flooding in or adjacent to their property. Whilst one respondent provided information on flooding that occurred in the 1998 or 1999, the majority of respondents identified more recent storm events that occurred on the following dates:

- 22-23 September 2009
- 13-15 February 2010
- 27 February – 5 March 2012
- 28 February – 1 March 2013
- 17-18 September 2013
- 25 January 2015
- 4-6 June 2016
- 20 June 2016
- 22-23 July 2016
- 31 August 2016
- 21-22 September 2016

A community forum was also held in Yass on the evening of 17 October 2019, during which time additional information on the September 2016 storm event at Murrumbateman was made available to the consultants.

Information on historic flooding patterns obtained from the responses assisted with "ground-truthing" the results of the hydraulic modelling.

Appendix B contains details of the data that were available for the present study, while **Appendix C** contains several photos which show historic flood behaviour in Murrumbateman during storms that occurred on 14 February 2010, 18 June 2016 and 21 September 2016, and in Binalong during storms that occurred on 14 February 2010, 24 January 2015, 31 August 2016 and 21 September 2016.

The draft Flood Study was placed on public exhibition over a four week period commencing 28 June 2020. Due to the COVID-19 situation in NSW, no public workshops were held during the public exhibition period. Rather a short pre-recorded Powerpoint presentation was posted on Council's web site which set out the aims and objectives of the study, as well as its key findings. No submissions were received by the closing date of submissions.

1.3 Previous Investigations

The following flooding investigations have been undertaken in the Yass Valley Council Local Government Area:

- *Yass Flood Study* (WMAwater (**WMA**), 2016a)
- *Sutton Flood Study* (WMA, 2016b)
- *Gundaroo Flood Study* (WMA, 2016c)
- *Sutton Floodplain Risk Management Study and Plan* (WMA, 2016d)
- *Gundaroo Floodplain Risk Management Study and Plan* (WMA, 2016e)
- *MR15 Barton Highway Duplication, Hall to Yass – Flood Impact Assessment Report* (J. Wyndham Prince, 2018)

1.4 Layout of Report

Chapter 2 contains background information including a brief description of the study catchments and their drainage systems, details of previous investigations, a brief history of flooding at the four villages and an analysis of the available rain gauge record.

Chapter 3 deals with the hydrology of the study catchments and describes the development and calibration of the hydrologic models that were used to generate discharge hydrographs for input to the hydraulic model.

Chapter 4 deals with the development and calibration of the TUFLOW hydraulic models which was used to analyse flood behaviour at the four villages.

Chapter 5 deals with the derivation of design discharge hydrographs, which involved the determination of design storm rainfall depths over the catchment for a range of storm durations and conversion of the rainfalls to discharge hydrographs.

Chapter 6 details the results of the hydraulic modelling of the design floods in the four villages. Results are presented as water surface profiles and plans showing indicative extents and depths of inundation for a range of design flood events up to the PMF. A summary of the economic impacts of flooding to existing development in the four village is presented in the chapter, along with a provisional assessment of flood hazard and hydraulic categorisation. (The assessment of flood hazard according to velocity and depth of floodwaters is necessarily *"provisional"*, pending a more detailed assessment which includes other flood related criteria, to be undertaken during the preparation of the future *FRMS&P*.)

Chapter 6 also details the results of various sensitivity studies undertaken using the TUFLOW model are also presented, including the effects changes in hydraulic roughness, a partial blockage of the hydraulic structures and potential increases in rainfall intensities due to future climate change will have on flooding behaviour. This chapter also deals with the selection of *Interim Flood Planning Levels* for the four villages.

Chapter 7 contains a list of references, whilst **Chapter 8** contains a list of flood-related terminology that is relevant to the scope of the study.

The following appendices are included in the report:

- **Appendix A**, which contains a copy of the *Community Newsletter and Questionnaires* that were distributed at the commencement of the study to residents and business owners in the four villages.
- **Appendix B**, which contains a list of data that were available for the present study.
- **Appendix C** contains photographs showing flood behaviour in Murrumbateman during storms that occurred on 14 February 2010, 18 June 2016 and 21 September 2016, and in Binalong during storms that occurred on 14 February 2010, 24 January 2015, 31 August 2016 and 21 September 2016.
- **Appendix D** contains a copy of the design input data that were extracted from the Australian Rainfall and Runoff (**ARR**) Data Hub for the four villages.
- **Appendix E** (bound is **Volume 2**) and Appendices **F**, **G** and **H** (bound in **Volume 3**), respectively contain figures showing flooding patterns at Murrumbateman, Bowning, Bookham and Binalong for the full range of design flood events.
- **Appendix I** contains a table showing the peak flows taken from the TUFLOW model for both historic and design storm events.
- **Appendix J** contains an assessment of the economic impacts of flooding to existing residential, commercial and industrial development, as well as public buildings in the four villages.

Figures referred in the main body of the report are bound separately in **Volume 2**.

2 BACKGROUND INFORMATION

2.1 Catchment Description

2.1.1. General

Figure 1.1 shows that the villages of Murrumbateman, Bowning, Bookham and Binalong lie within the headwaters of the Murrumbidgee River catchment, while **Figure 2.1** shows the layout of the following major creek and river systems in the vicinity of the four villages, as well as the extent of their contributing catchments:

- McClungs Creek, which drains the northern portion of Murrumbateman and joins Murrumbateman Creek immediately north of the village, before discharging to the Yass River about 15 km upstream of Yass.
- Big Hill Creek and Gooda Creek, both of which drain the southern portion of Murrumbateman and the latter which discharges to the Murrumbidgee River about 13 km upstream of Burrinjuck Dam.
- Bowning Creek, which drains in a southerly direction through Bowning where it discharges to the Yass River about 8 km upstream of Burrinjuck Dam.
- Bogolong Creek, which drains in a westerly direction to the north of Bookham and discharges where it discharges to Jugiong Creek.
- Balgalal Creek, which drains in a southerly direction through Binalong where it discharges to Jugiong Creek about 21 km downstream of its confluence with Bogolong Creek.
- Jugiong Creek, which drains to the west of Bookham and discharges to the Murrumbidgee River about 50 km downstream of its confluence with Balgalal Creek.

The following sections provides a brief description of each village and their drainage system.

2.1.2. Murrumbateman

The village of Murrumbateman has a population of about 1,730 people and is located on the catchment divide between the Yass River and the upper Murrumbidgee River. **Figure 2.2**, sheet 1 shows the extent of the 37 km^2 McClungs Creek catchment which drains in a northerly direction to Murrumbateman Creek. **Figure 2.2**, sheet 1 also shows the extent of the 10 km^2 and 12 km^2 catchments draining to Big Hill Creek and Gooda Creek in the vicinity of the village.

The portion of the McClungs Creek catchment that is located to the east of McIntosh Circuit drains to an unnamed watercourse that runs in a northerly direction on the eastern side of the Barton Highway (herein referred to as the **Unnamed Tributary**). The Unnamed Tributary joins McClungs Creek immediately upstream of its confluence with Murrumbateman Creek.

The topography at Murrumbateman is generally undulating in nature with several minor gullys discharging to the abovementioned creeks as shown on **Figure 2.2**. There are a large number of local farm dams along the minor gullys throughout the catchments.

The study catchments generally comprise rural pastoral land and large lot/low density residential allotments. The more highly urbanised part of the village is located in the area bounded by McClung Drive to the north, the Barton Highway to the east, South Street to the south and existing development and Keith Street to the west (herein denoted the **Village Centre**). There is a small pocket of commercial development located along Hercules Street in the vicinity of its intersection with the Barton Highway.

Figure 2.2 (sheets 2 to 8) show the layout of the existing stormwater drainage system at Murrumbateman. While the stormwater drainage system generally comprises roadside table drains with piped crossings at road intersections, there are two piped drainage lines that run through the Village Centre (refer sheet 4): one which controls runoff from the recently constructed Fairley Village and the other which drains the southern part of the Village Centre. The two piped drainage lines discharge to Unnamed Tributary on the eastern side of the Barton Highway.

Figure 2.2, sheet 3 shows the location of two existing detention basins, details of which are given in **Table 2.1**. The two basins are aimed at mitigating the impact that the subdivision of land for rural residential purposes would have otherwise had on flow in the receiving drainage lines.

TABLE 2.1
DETAILS OF EXISTING REGIONAL FLOOD DETENTION BASINS AT MURRUMBATEMAN

Basin ID	Basin Name	Year of Construction	Outlet Structure(2)		Spillway Elevation (m AHD)
			Dimensions (mm)	Invert Level (m AHD)	
B01	Carrington Park Detention Basin	2011	4 off 525 RCPs	587.98	590.50
B02	Merryville Estate Dam No. 1	1994	6 off 900 x 600 RCBCs	586.82	587.90

1. RCP = reinforced concrete pipe, RCBC = reinforced concrete box culvert.
2. Refer **Figure 2.2**, sheet 3 for location.

2.1.3. Bowning

The village of Bowning has a population of about 280 people and is centred on Bowning Creek. The village is bounded by the Main Southern Railway to the north, the Hume Highway to the south and rural land to its east and west. **Figure 2.3** (2 sheets) shows the extent of the 20.8 km^2 catchment which contributes to flow in Bowning Creek at Bowning Road. **Figure 2.3** also shows the extent of the 2.8 km^2 catchment which contributes to flow in a watercourse that runs in a westerly direction through the town (herein denoted the **Bowning Tributary**) and discharges to Bowning Creek immediately upstream of Bowning Road.

The headwaters of the Bowning Creek catchment are located about 7 km to the north of the village. The catchment is characterised by undulating pastoral land. Several minor gullys discharge to Bowning Creek in the vicinity of the village as shown on **Figure 2.3** (sheet 2).

Figure 2.3, sheet 2 shows the layout of the existing stormwater drainage system at Bowning. The stormwater drainage system generally comprises roadside table drains with piped crossings at road intersections. There are three major crossings of Bowning Creek: the Main Southern Railway bridge crossing, the low level Bowning Road bridge crossing and the dual Hume Highway Bridges. There is one bridge crossing of Bowning Tributary at Leake Street, the upgrade of which was recently completed by Council.

2.1.4. Bookham

The village of Bookham has a population of about 160 people and is located on the southern side of the Hume Highway about 25 km to the west of Yass. **Figure 2.4**, sheet 1 shows that Bookham is bounded by Jugiong Creek to its west, Bogolong Creek to its north and existing rural land to its east and west. Jugiong Creek, which drains in a northerly direction at Bookham has a catchment area of about 85.8 km^2 km at its confluence with Bogolong Creek, which drains in a westerly direction and has a total catchment area of about 79.9 km^2 at the same location.

Figure 2.4, sheet 2 shows the layout of the existing stormwater drainage system at Bookham. The stormwater drainage system generally comprises roadside table drains with piped crossings at road intersections. There is one major crossing of Bogolong Creek at Illalong Road. The Hume Highway bisects the study area in an east-west direction and spans the natural low points in the floodplain causing local catchment runoff from the catchments that are located to its south to pond on its upstream (southern) side. There are a series of pipe culverts through the highway embankment that discharge local catchment runoff to Bogolong Creek.

2.1.5. Binalong

The village of Binalong, which has a population of about 330 people, is located on the southern (left) bank of Balgalal Creek. **Figure 2.5** (4 sheets) shows that Balgalal Creek generally runs in a southerly direction and has a catchment area of about 39.7 km^2 at Armours Road. The creek then flows in a westerly direction through the village to a location about 0.5 km downstream of Burley Griffin Way where it joins Bobbara Gully and continues in a southerly direction, discharging to Jugiong Creek a further 13 km to the south. Bobbara Gully has a total catchment area of 4.8 km^2 at its confluence with Balgalal Creek.

Figure 2.5 shows the extent of a 2.7 km^2 catchment that contributes to flow in a watercourse that runs in a northerly direction through the village (herein denoted the **Balgalal Tributary**) and discharges to Balgalal Creek west of Fitzroy Street. Several other minor gullys discharge to Balgalal Creek in the vicinity of the village.

The urbanised part of Binalong are located in the area bounded by Manning Street to the west, Balgalal Creek to the north, the Main Southern Railway to the east and the Mylora Street road reserve to the south. There is a small pocket of commercial development located in the vicinity of the intersection of Fitzroy Street and Queen Street.

Figure 2.5, sheets 2, 3 and 4 show the layout of the existing stormwater drainage system at Binalong. The stormwater drainage system generally comprises roadside table drains with piped crossings at road intersections. There are two major crossings of Balgalal Creek in the study area: a low-level crossing at Armours Road and an elevated road crossing that spans the 350 m wide floodplain at Burley Griffin Way.

2.2 Flood History and Analysis of Historic Rainfall

2.2.1. General

Respondents to the *Community Newsletter and Questionnaire* identified a number of notably intense storm events that have been experienced at Murrumbateman and Binalong, the dates of which are given in **Section 1.2** of the report. No information was provided about historic flooding patterns at Bowning and Bookham. A number of respondents also provided photographic evidence (refer **Appendix C**), as well as descriptions of the patterns of overland flow in the vicinity of their properties.

Figure 2.6 (4 sheets) shows design versus historic intensity-frequency-duration (**IFD**) curves for seven nearby Bureau of Meteorology (**BoM**) operated All Weather Station (**AWS**) rain gauges for the abovementioned bursts of rainfall, while **Table 2.2** at the end of this chapter gives the approximate AEP of the recorded rainfall for durations ranging between 1 and 12 hours. **Figure 1.1** shows that the BoM operated pluviographic rainfall gauges lie between 40 and 150 km from Murrumbateman and between 60 and 100 km from Binalong.

Figure 2.6 and **Table 2.2** show that the majority of the storms identified by the respondents to the *Community Questionnaire* were less intense than a storm that occurs once every year on average (i.e. less than 1 Exceedance per Year (**EY**)), with the exception of the 27 February – 5 March 2012 and 4 – 6 June 2016 storm which were equivalent to a design storm event with an AEP of about 5 per cent.

Based on the availability of historic flood data, the storm events that occurred on 14 February 2010 and 21 September 2016 were selected for use in calibrating the hydrologic and hydraulic models that were developed as part of the present study. **Figure 2.7** shows the cumulative rainfall that was recorded at the nearby rain gauges for these two events, while **Table 2.3** and **2.4** at the end of this chapter show a comparison of the recorded daily rainfall depths at Murrumbateman and Binalong, respectively, and those recorded at the BoM operated pluviographic rainfall gauges that were in operations at the time of the event.

2.2.2. February 2010 Storm Event

Murrumbateman

Based on photographic evidence provided by respondents to the *Community Questionnaire*, flooding occurred at Murrumbateman between 12:30 and 15:00 hours on 14 February 2010. **Plates C2.1** to **C2.8** in **Appendix C** show overland flow through the rear of a number of properties that are located in Broughton Close in the Ambleside Estate.

Table 2.3 shows that the recorded rainfall depths at the Murrumbateman (McIntosh Circuit) gauge (about 95.0 mm) are similar to that which fell at the Canberra Airport AWS (about 99.0 mm) which is located about 40 km south of Murrumbateman. **Table 2.2** and **Figure 2.6**, sheet 1 show that this event was less intense than a storm that occurs once every year on average (i.e. less than 1 EY).

Based on the rainfall recorded at the Canberra Airport AWS, flooding occurred after 58.2 mm of rain fell between 09:00 hours on 13 February 2010 and 09:00 hours on 14 February 2010, in addition to a further 33.4 mm which fell between 09:00 and 15:00 hours on 14 February 2010.

One respondent to the *Community Questionnaire* noted that the flooding occurred after 164 mm of rain had fallen,[1] which is about 1.7 times that which was recorded at the nearby rain gauges.

Binalong

Table 2.4 shows that the recorded rainfall depths at Binalong are similar to that which fell at the Canberra Airport AWS which is located about 88 km south-east of Binalong. **Table 2.2** and **Figure 2.6**, sheet 1 show that based on the rainfall recorded at the Canberra Airport AWS, this event was less intense than a storm that occurs once every year on average (i.e. less than 1 EY).

Plates C1.1 and **C1.2** in **Appendix C** show that the Balgalal Tributary was running full on the upstream side of Monteagle Street at about 11:00 hours on 14 February 2010, while **Figure 2.7** shows that the flooding occurred following significant rainfall over the preceding 36 hours.

[1] The respondent did not provide any information regarding the period over time over which the rain fell.

2.2.3. September 2016 Storm Event

Murrumbateman

Photographic evidence provided by respondents the *Community Questionnaire* showed that flooding on 21 September 2016 occurred in the eastern parts of Murrumbateman at around 13:00 hours in the vicinity of the Ambleside Estate. Anecdotal and video evidence provided by residents at the community forum indicated that the flood peak occurred at about 07:30 hours in the western parts of Murrumbateman in the vicinity of the McClungs Creek crossing of Merryville Drive.

Plates C7.1 and **C7.2** in **Appendix C** show the presence of major overland flow in the Dundoos and Ambleside Estates to the north-east of the intersection of Murrumbateman Road and Elrington Close, while **Plate C7.3** shows that the culverts under Murrumbateman Road were half full at the time of the photography.

Table 2.3 shows that the recorded rainfall depths at Murrumbateman are similar to that which fell at the Canberra Airport AWS which is located about 40 km south of Murrumbateman. **Table 2.2** and **Figure 2.6**, sheet 1 show that this event was less intense than a storm that occurs once every year on average (i.e. less than 1 EY).

Figure 2.7 shows that based on the rainfall recorded at the Canberra Airport AWS, the flooding occurred as a result of rain which commenced to fall at 06:00 hours on 21 September 2016.

Binalong

Plates B6.2 to **C6.3** in **Appendix C** show that the banks of Balgalal Creek was overtopping at the northern end of Stephens Street at about 15:00 hours on 21 September 2016. Residents of Binalong provided anecdotal evidence that floodwater from Balgalal Creek inundated the rear of residential properties that are located on the northern side of Queen Street. They also indicated that floodwater inundated the Burley Griffin Way crossing of Balgalal Creek, resulting in its temporarily closure by the local New South Wales State Emergency Service (**NSW SES**) unit.

Table 2.4 shows that the recorded rainfall depths at Binalong are similar to that which fell at the Canberra Airport AWS which is located about 59 km north-west of Binalong. **Table 2.2** and **Figure 2.6**, sheet 3 show that this event was less intense than a storm that occurs once every year on average (i.e. less than 1 EY).

TABLE 2.2
APPROXIMATE AEPs OF RECORDED RAINFALL FOR HISTORIC STORM EVENTS(1)
(% AEP)

Storm Event	Rain Gauge(2)	Storm Duration (hours)					
		1	2	3	6	9	12
22-25 September 2009	Canberra Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Mount Ginini AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Tuggeranong (Isabella Plains) AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
13-15 February 2010	Canberra Airport	<1 EY	<1 EY	<1 EY	1 EY	50	20-50
	Mount Ginini AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Tuggeranong (Isabella Plains) AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
27 February - 6 March 2012	Canberra Airport	<1 EY	<1 EY	<1 EY	50	20	20
	Goulburn Airport AWS	<1 EY	<1 EY	<1 EY	1 EY	50	20
	Mount Ginini AWS	<1 EY	50	50	20	20	10
	Temora Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Tuggeranong (Isabella Plains) AWS	50	50	1 EY	20	20	10
	Young Airport	50	10	5	5	5	5
	Burrinjuck Dam	50	20	20	5	5	5
28 February - 1 March 2013	Canberra Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Goulburn Airport AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Mount Ginini AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Temora Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Tuggeranong (Isabella Plains) AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Young Airport	1 EY	50	50	50	50	20

Refer over for footnote to table

TABLE 2.2 (Cont'd)
APPROXIMATE AEPs OF RECORDED RAINFALL FOR HISTORIC STORM EVENTS[1]
(% AEP)

Storm Event	Rain Gauge[2]	Storm Duration (hours)					
		1	2	3	6	9	12
17-18 September 2016	Canberra Airport	<1 EY	<1 EY	<1 EY	50	60	50
	Goulburn Airport AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Mount Ginini AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	1 EY
	Temora Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Tuggeranong (Isabella Plains) AWS	<1 EY	<1 EY	<1 EY	50	60	20
	Young Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
25 January 2015	Canberra Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Goulburn Airport AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Mount Ginini AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Temora Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Tuggeranong (Isabella Plains) AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Young Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
4-6 June 2016	Canberra Airport	<1 EY	<1 EY	<1 EY	50	20	10
	Goulburn Airport AWS	<1 EY	1 EY	60	20	10	10
	Mount Ginini AWS	<1 EY	<1 EY	60	20	20	20
	Temora Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Tuggeranong (Isabella Plains) AWS	<1 EY	1 EY	60	20	10	5
	Young Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY

Refer over for footnote to table

TABLE 2.2 (Cont'd)
APPROXIMATE AEPs OF RECORDED RAINFALL FOR HISTORIC STORM EVENTS[1]
(% AEP)

Storm Event	Rain Gauge[2]	Storm Duration (hours)					
		1	2	3	6	9	12
17-18 June 2016	Canberra Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Goulburn Airport AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Mount Ginini AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Temora Airport	<1 EY	<1 EY	1 EY	1 EY	<1 EY	<1 EY
	Tuggeranong (Isabella Plains) AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Young Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
22-23 July 2016	Canberra Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Goulburn Airport AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Mount Ginini AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Temora Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Tuggeranong (Isabella Plains) AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Young Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
21-22 September 2016	Canberra Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Goulburn Airport AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Mount Ginini AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Temora Airport	<1 EY	<1 EY	<1 EY	<1 EY	50	50
	Tuggeranong (Isabella Plains) AWS	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY
	Young Airport	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY	<1 EY

1. Unless otherwise noted, storm frequency is given as % AEP.
2. Refer Figure 1.1 for location.

TABLE 2.3
RECORDED DAILY RAINFALL TOTALS RELEVANT TO MURRUMBATEMAN
FOR HISTORIC STORM EVENTS

Historic Storm	Rainday	Daily Rainfall Total[1,2] (mm)						
		Murrumbateman (McIntosh Circuit) (GS 70344) [0 km]	Canberra Airport (GS 70351) [40 km]	Goulburn Airport AWS (70330) [65 km]	Mount Ginini AWS (GS 70349) [68 km]	Temora Airport (GS 73151) [150 km]	Tuggeranong (Isabella Plains) (GS 70339) [49 km]	Young Airport (GS 73138) [108 km]
February 2010	13	3.4	12	Not in operation	1	Not in operation	20.2	Not in operation
	14	58.2	54.6		28.4		23	
	15	33.4	32.4		21.4		28.4	
September 2018	21	12.8	6.8	4	6	28.4	8.8	17.9
	22	24	24.2	18.4	13.6	32.8	20.2	30.6

1. Number in [ ] indicates the distance between the gauge and Murrumbateman.
2. Refer Figure 1.1 for gauge location.

TABLE 2.4
RECORDED DAILY RAINFALL TOTALS RELEVANT TO BINALONG
FOR HISTORIC STORM EVENTS

Historic Storm	Rainday	Daily Rainfall Total[1,2] (mm)							
		Binalong Post Office (GS 73005) [0 km]	Kangiara (Laverstock) (GS 73023) [16 km]	Canberra Airport (GS 70351) [88 km]	Goulburn Airport AWS (GS 70330) [101 km]	Mount Ginini AWS (GS 70349) [97 km]	Temora Airport (GS 73151) [106 km]	Tuggeranong (Isabella Plains) (GS 70339) [93 km]	Young Airport (GS 73138) [59 km]
February 2010	13	0	8.4	12	Not in operation	1	Not in operation	20.2	Not in operation
	14	81[3]	67	54.6		28.4		23	
	15		Not in operation	32.4		21.4		26.4	
September 2016	21	Not in operation	7.8	6.8	4	6	28.4	6.6	17.8
	22		32.2	24.2	19.4	13.8	32.8	20.2	30.6

1. Number in [ ] indicates the distance between the gauge and Binalong.
2. Refer Figure 1.1 for gauge location.
3. Two-day rainfall total over 14-15 February 2010.

3 HYDROLOGIC MODEL DEVELOPMENT AND CALIBRATION

3.1 Hydrologic Modelling Approach

The present study required the use of a hydrologic model which is capable of representing the rainfall-runoff processes that occur within both the rural and urbanised parts of the study catchments. For hydrologic modelling, the practical choice is between the models known as ILSAX, RAFTS, RORB and WBNM. Whilst there is little to choose technically between these models, ILSAX has been developed primarily for use in modelling the passage of a flood wave through urban catchments, whilst RAFTS, RORB and WBNM have been widely used in the preparation of rural flood studies.

Both the ILSAX and RAFTS modelling approaches which are built into the DRAINS software were used to generate discharge hydrographs from urban and rural areas, respectively, as this combined approach was considered to provide a more accurate representation of the rainfall runoff process in the study catchments. The discharge hydrographs generated by ILSAX and RAFTS were applied to the TUFLOW hydraulic model as either point or distributed inflow sources (refer **Section 4.4** of this report for further details).

3.2 Hydrologic Model Layout

Figures 3.1, **3.2**, **3.3** and **3.4** show the layout of the hydrologic models that were developed for the Murrumbateman (**Murrumbateman Hydrologic Model**), Bowning (**Bowning Hydrologic Model**), Bookham (**Bookham Hydrologic Model**) and Binalong (**Binalong Hydrologic Model**) catchments, respectively.

As the primary function of the hydrologic model was to generate discharge hydrographs for input to the TUFLOW hydraulic model, individual reaches linking the various sub-catchments were generally not incorporated in the model. However, the outlets of the sub-catchments in the upper reaches of the study catchments at Bowning, Bookham and Binalong were linked and the lag times between each assumed to be equal to the distance along the main drainage line divided by an assumed flow velocity of 2 m/s. A small number of sub-catchments in the headwaters of the Unnamed Tributary and Gooda Creek catchments at Murrumbateman were also linked assuming a flow velocity of 0.5 m/s. Both assumed flow velocities were derived from preliminary runs of the TUFLOW model.

Careful consideration was given to the definition of the sub-catchments which comprise the hydrologic models to ensure peak flows throughout the drainage system would be properly routed through the TUFLOW model. In addition to using the LiDAR-based contour data, the location of inlet pits and headwalls were also taken into consideration when deriving the boundaries of the various sub-catchments.

Percentages of impervious area were assessed using Council's aerial photography and cadastral boundary data. Sub-catchment slopes used for input to the hydrologic models were derived using the vectored average slope approach for the relatively large sub-catchments that exist in the headwaters of the study catchments, whilst the average sub-catchment slope computed via a region inspection in the QGIS software was used for all remaining catchments of the hydrologic models. Digital Elevation Models (**DEMs**) derived from the available Light Detecting and Ranging (**LiDAR**) survey data were used as the basis for computing the slope for both methods.

3.3 Hydrologic Model Testing

3.3.1. General

Historic flood data suitable for use in the model calibration process is limited to photographic and anecdotal evidence of flooding patterns at Murrumbateman and Binalong for the storms that occurred in February 2010 and September 2016. As discussed in **Section 2.2**, the storm events for which flood data were available are generally equivalent to a 1 EY design storm event. There is no historic flood data available at Bowning and Bookham.

As there were no historic data on storm flows anywhere in the four villages, the procedure adopted for the calibration of the hydrologic models involved an iterative process sometimes referred to as "tuning". This process involved the generation of discharge hydrographs for the historic storm events using a starting set of hydrologic model parameters. The discharge hydrographs were then input to the TUFLOW hydraulic model, which was then run with an initial set of hydraulic roughness parameters and the resulting flooding patterns compared with the photographic and anecdotal evidence.

Several iterations of this process were required, whereby changes were made to the rainfall multipliers and hydrologic model parameters, after which the resulting adjusted discharge hydrographs were input to the hydraulic model until a good fit with recorded data was achieved (refer **Chapter 4** for further details).

3.3.2. Hydrologic Model Parameters

A Manning's n value of 0.04 was applied to the typically rural sub-catchments which are located in the headwaters of the study catchments and were modelled using the RAFTS sub-model. The initial and continuing loss rates, as well as the Bx factors that were used to derive discharge hydrographs which, when applied to the TUFLOW model, gave a good match with the historic flood data are set out in **Table 3.1** over.

The ILSAX hydrologic model requires information on the soil type and losses to be applied to storm rainfall to determine the depth of excess rainfall. Infiltration losses are of two types: initial loss arising from water which is held in depressions which must be filled before runoff commences, and a continuing loss rate which depends on the type of soil and the duration of the storm event. ILSAX also requires information on flow path characteristics in order to compute the time of travel of the flood wave through the sub-catchments.

The following ILSAX model parameters were found to give a good fit to historic flood data:

Soil and Rainfall Loss Parameters

- Soil Type = 3.0
- AMC = 3.0
- Paved area depression storage = 2.0 mm
- Grassed area depression storage = 10.0 mm

Travel Time Parameters

- Paved flow path roughness = 0.02
- Grassed flow path roughness = 0.07

TABLE 3.1
ADOPTED RAFTS MODEL PARAMETERS
HISTORIC STORM EVENTS

Historic Storm Event	Village	Pluviographic Rainfall Station		Rainfall Depth at Village			Adopted Rainfall Multiplier	Initial Loss (mm)		Continuing Loss (mm/hr)		Bx Factor
		Location	Rainfall Total[4] (mm)	Source	Rainfall Total (mm)	Rainfall Multiplier		Impervious Area	Pervious Area	Impervious Area	Pervious Area	
February 2010	Murrumbateman	Canberra Airport AWS	99.0	Resident (Respondent Y97)	168.0	1.7	1.7	2	15	0	1.5	0.8
	Binalong	Canberra Airport AWS	87.0	Binalong Post Office	81.0	0.9	0.9	2	15	0	4	0.8
September 2016	Murrumbateman	Canberra Airport AWS	31.0	Murrumbateman (McIntosh Circuit)	38.6	1.2[1]	1.7[1]	2	0	0	1.5	0.8
	Binalong	Young Airport AWS	48.4	Binalong Post Office	N/A[2]	N/A	2[3]	2	0	0	1.7	0.8

1. It was not possible to achieve a good match between the observed and modelled flood behaviour using a multiple of 1.2.
2. The BoM operated Binalong Post Office was not operational during the September 2016 storm event.
3. A rainfall multiplier of two was required in order to achieve a match between the observed and modelled flood behaviour.
4. Refer Table 2.5 for the depth of rain which fell on consecutive rain days.

3.3.3. Application of Historic Rainfall to the Hydrologic Model

Continuous rainfall recorded at the two BoM operated AWS rain gauges set out in **Table 3.1** were used as input to the Murrumbateman and Binalong Hydrologic Models. **Table 3.1** also sets out the rainfall multipliers that needed to be applied to the rainfall recorded at the nearby AWS gauges in order to achieve a good match with the photographic and anecdotal evidence of flooding patterns.

While it was possible to achieve a good match between observed and modelled flooding patterns at Murrumbateman for the February 2010 storm event using a continuing loss value of 1.5 mm/hr, a higher value of 4.0 mm/hr was required to obtain a reasonable match with the observed flooding patterns at Binalong.

Initial loss values of zero were required in order to obtain a good match with observed flooding patterns for the September 2016 storm event at Murrumbateman and Binalong. Based on the information provided by respondents to the *Community Questionnaire*, the storm event occurred following a particularly wet three month period which would have resulted in a saturated catchment at the time of the burst. While initial losses of zero are lower than those typically expected in NSW, it was not possible to replicate the observed flooding patterns for the September 2016 storm event using the initial loss values for pervious areas similar to those that provided a good match for the February 2010 storm event (i.e. 15 mm).

While **Table 2.3** shows that the total rainfall depth recorded on the raindays of 21-22 September 2016 at Murrumbateman (36.8 mm) was similar to that recorded at Canberra Airport AWS (31.0 mm), the Canberra Airport AWS rainfall needed to be factored up by a multiple of 1.7 in order to obtain a good match between the observed and modelled flooding patterns. It is possible that the temporal distribution of rainfall across the two raindays at Canberra Airport AWS is not representative of that which fell at Murrumbateman, with the likelihood being that the rain fell over a shorter period, thereby generating higher flows in the drainage system.

As shown in **Table 2.4**, the Binalong Post Office daily rainfall gauge was not in operation at the time of the September 2016 storm event. While the total two-day rainfall depth at the Kangiara (Laverstock) rain gauge (40.0 mm), which is the closest operational rain gauge to Binalong during the event, was comparable to that recorded 59 km away at the Young Airport AWS (48.4 mm), **Table 3.1** shows that the Young Airport AWS rainfall needed to be factored up by a multiple of 2.0 in order to obtain a good match between the observed and modelled flooding patterns. Again, the need to apply a multiplication factor to the recorded rainfall in order to achieve a reasonable fit with the recorded data likely lies in differences in its temporal variability between the village and the gauge site.

3.3.4. Results of Model Testing

The discharge hydrographs generated by the hydrologic models, when applied to the TUFLOW hydraulic model, gave reasonable correspondence with observed flood behaviour. The ILSAX and RAFTS hydrologic model parameters set out in this chapter were therefore adopted for design flood estimation purposes.

4 HYDRAULIC MODEL DEVELOPMENT AND CALIBRATION

4.1 General

The present study required the use of a hydraulic model that is capable of analysing the time varying effects of flow in the creeks and the two-dimensional nature of flow on both the floodplain and in the steeper parts of the four villages that are subject to overland flow. The TUFLOW modelling software was adopted as it is one of only a few commercially available hydraulic models which contain all the required features.

This chapter deals with the development and calibration of the TUFLOW models that were then used to define the behaviour of both main stream flooding and major overland flow in the four villages for a range of design storm events (refer **Chapter 6** for further details).

4.2 The TUFLOW Modelling Approach

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 extent, depth, velocity and distribution of flow.

TUFLOW solves the equations of flow at each point of a rectangular grid system which represent overland flow on the floodplain and along streets. The choice of grid point spacing depends on the need to accurately represent features on the floodplain which influence hydraulic behaviour and flow patterns (e.g. buildings, streets, changes in channel and floodplain dimensions, hydraulic structures which influence flow patterns, hydraulic roughness etc.).

Piped drainage and channel systems can be modelled as one-dimensional elements embedded in the larger two-dimensional domain, which typically represents the wider floodplain. Flows are able to move between the one and two-dimensional elements of the model, depending on the capacity characteristics of the drainage system being modelled.

The TUFLOW models developed as part of the present study will allow for the future assessment of potential flood management measures, such as detention storage, increased channel and floodway dimensions, augmentation of culverts and bridge crossing dimensions, diversion banks and levee systems.

4.3 TUFLOW Model Setup

4.3.1. Model Structure

The layout of the TUFLOW models that were developed for Murrumbateman (**Murrumbateman TUFLOW Model**), Bowning (**Bowning TUFLOW Model**), Bookham (**Bookham TUFLOW Model**) and Binalong (**Binalong TUFLOW Model**) are shown on **Figures 4.1**, **4.2**, **4.3** and **4.4**, respectively. Within the "urbanised" areas of each village, the model comprises the pit and pipe drainage system, while the inbank, out-of-bank and shallow "overland" flow areas are modelled by the rectangular grid.

The following sections provide further details of the model development.

4.3.2. Two-dimensional Model Domain

An important consideration of two-dimensional modelling is how best to represent the roads, fences, buildings and other features 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 influences the way in which these features are represented in the model.

A grid spacing of 3 m 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 investigation. Ground surface elevations for model grid points were initially assigned using the LiDAR derived DEMs for each village.

Ridge and gully lines were added to the TUFLOW model where the grid spacing was considered too coarse to accurately represent important topographic features which influence the passage of overland flow. The elevations for these ridge and gully lines were determined from inspection of LiDAR survey or site-based measurements.

Gully lines were also used to represent the major creeks and watercourses in the four villages. The use of gully lines ensured that positive drainage was achieved along the full length of these watercourses, and thus avoided creation of artificial ponding areas as artefacts of the 'bumpy' nature of the underlying LiDAR survey data.

The footprints of individual buildings located in the two-dimensional model domain were digitised and assigned a high hydraulic roughness value relative to the more hydraulically efficient roads and flow paths through allotments. This accounted for their blocking effect on flow while maintaining a correct estimate of floodplain storage in the model.

It was not practicable to model the individual fences surrounding the many allotments in the four villages. For the purpose of the present study, it was assumed that there would be sufficient openings in the fences to allow water to enter the properties, whether as flow under or through fences and via openings at driveways. Individual allotments where development is present were digitised and assigned a high hydraulic roughness value (although not as high as for individual buildings) to account for the reduction in conveyance capacity which will result from obstructive fences, such as Colorbond or brick, and other obstructions stored on these properties.

4.3.3. One-dimensional Model Elements

Survey data provided by Diverse Property Solutions were used as the primary source of details of the piped drainage system which were incorporated into the TUFLOW models. These data were supplemented with detailed design drawings and field measurements (refer **Appendix B** for more detail). **Table 4.1** over the page summarises the pit and pipe data that were incorporated into the TUFLOW models.

Several types of pits are identified on **Figures 4.1** to **4.4** including junction pits which have a closed lid and inlet pits which are capable of accepting overland flow. Council's asset database contained reasonably detailed information in regard to inlet pit types and dimensions, however, when information was missing, inlet pit capacity relationships were incorporated in the TUFLOW models based on a visual inspection of the existing stormwater drainage system.

TABLE 4.1
SUMMARY OF MODELLED DRAINAGE STRUCTURES

TUFLOW Model	Pipes		Box Culverts		Bridges	Inlet Pits / Headwalls	Junction Pits
	No.	Length (m)	No.	Length (m)	No.	No.	No.
Murrumbateman	396	8,580	63	930	0	694	22
Bowning	52	990	4	45	5	612	0
Bookham	31	980	4	145	1	66	0
Binalong	92	1470	7	105	5	196	0

Pit losses throughout the various piped drainage networks were modelled using the Engelhund approach in TUFLOW. This approach provides an automatic method for determining time-varying energy loss coefficients at pipe junctions that are recalculated each time step based on a range of variables including the inlet/outlet flow distribution, the depth of water within the pit, expansion and contraction of flow through the pit, and the horizontal deflection and vertical drop across the pit.

4.3.4. Model Parameters

The main physical parameter for TUFLOW is the hydraulic roughness. Hydraulic roughness is required for each of the various types of surfaces comprising the overland flow paths, as well as in-bank areas of the creeks. In addition to the energy lost by bed friction, obstructions to flow also dissipate energy by forcing water to change direction and velocity and by forming eddies. Hydraulic modelling traditionally represents all of these effects via the surface roughness parameter known as "Manning's n". Flow in the piped system also requires an estimate of hydraulic roughness.

Manning's n values along the channel and immediate overbank areas along the modelled length of creeks were varied, with the values in **Table 4.2** over the page providing reasonable correspondence between recorded and modelled flood levels.

The adoption of a value of 0.02 for the surfaces of roads, along with an adequate description of their widths and centreline/kerb elevations, allowed an accurate assessment of their conveyance capacity to be made. Similarly, the high value of roughness adopted for buildings recognised that these structures will completely block the flow but are capable of storing water when flooded.

Figure 4.5 is a typical example of flow patterns derived from the above roughness values. This example applies to the 1% AEP design storm event and shows flooding patterns in the Village Centre at Murrumbateman. The left hand side of the figure shows the roads and inter-allotment areas, as well as the outlines of buildings, which have all been assigned different hydraulic roughness values in the model. The right hand side shows the resulting flow paths in the form of scaled velocity vectors and the depths of inundation. The buildings with their high values of hydraulic roughness block the passage of flow, although the model recognises that they store floodwater when inundated and therefore correctly accounts for flood storage.[2] Similar information to that shown on **Figure 4.5** may be presented at any location within the model domain (which are shown on **Figures 4.1** to **4.4**) and will be of assistance to Council in assessing individual flooding problems in the floodplain.

TABLE 4.2
BEST ESTIMATE HYDRAULIC ROUGHNESS VALUES

Surface Treatment	Manning's n Value
Concrete piped elements	0.015
Asphalt or concrete road surface	0.02
Creeks	0.03
Overbank area, including grass and lawns	0.045
Moderately vegetated areas	0.08
Allotments (between buildings)	0.1
Buildings	10

4.4 Model Boundary Conditions

The locations where sub-catchment inflow hydrographs were applied to the TUFLOW model are shown on **Figures 4.1** to **4.4**. These comprise both point-source inflows at selected locations around the perimeter of the two-dimensional model domain, as well as internal to the model (for example, at the location of surface inlet pits) and as distributed inflows via "Rain Boundaries".

The Rain Boundaries act to "inject" flow into the 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 extent of each Rain Boundary has been trimmed to the outlet of the catchment in order to reduce the over-attenuation of runoff from the catchment.

The downstream boundaries of the model comprised "free discharge" outlets, where TUFLOW derived normal depth calculations were used to define hydraulic conditions at the outlet.

4.5 Hydraulic Model Calibration

4.5.1. General

As previously mentioned, the Murrumbateman and Binalong hydrologic and hydraulic models were tested for storms that occurred in February 2010 and September 2016 using the available rain gauge data. The calibrated Murrumbateman and Binalong TUFLOW Models were run using discharge hydrographs that were generated by the corresponding Murrumbateman and Binalong Hydrologic Models, parameters for which are set out in **Section 3.3**.

[2] Note that the depth grid has been trimmed to the building polygons as based on previous experience, residents tend to interpret the figure as showing the depth of above-floor inundation, when in fact it is showing the depth of above-ground inundation over the footprint of the building. The same approach has been adopted for presenting the results for the various design flood events, details of which are contained in **Chapter 6**.

4.5.2. Results of Model Testing

Figures 4.6 and **4.7** show the TUFLOW model results for the February 2010 storm, at Murrumbateman and Binalong, respectively, while **Figures 4.8** and **4.9** show similar information at the two villages for the September 2016 storm. Also shown on the figures is the plan location of the respondents who observed flooding in or adjacent to their property during the two storm events.

Tables 4.3 and **4.4** at the end of this chapter summarise the comments that were made by respondents to the *Community Questionnaire* in relation to the flooding that they observed during the February 2010 and September 2016 storm events at Murrumbateman and Binalong, respectively.

In general, the model was able to reproduce the flood levels which were approximated from the photographs provided by respondents to the *Community Newsletter and Questionnaire* to within 100 mm. However, it was not always possible to reproduce the timing of the flooding at all locations as the available pluviographic rainfall data that were taken from gauges that were located more than 30 km away from the two villages don't appear to be representative of the rainfall that fell at the villages.

4.5.3. Summary

Based on the findings of the model testing process, the Murrumbateman and Binalong hydrologic and hydraulic models were considered to give satisfactory correspondence with the available historic flood data. As such, the hydraulic model parameters set out in **Sections 4.3** and **4.4**, and in particular the hydraulic roughness values set out in **Table 4.2,** were considered appropriate for use in defining flood behaviour in the four villages over the full range of design flood events. Further discussion and presentation of hydrologic model parameters that were adopted for design flood estimation purposes is provided in **Section 5.3**.

TABLE 4.3
SUMMARY OF QUESTIONNAIRE RESPONSES RELATED TO OBSERVED FLOOD BEHAVIOUR AT MURRUMBATEMAN

Response Identifier [A]	Flood Event [B]	Observed Flood Behaviour/ Other Comment [C]	Model Verification Comments [D]
Y37[5]	13 – 15 February 2010	◦ 184 mm of rainfall resulted in flooding that inundated three quarters of a property that is located on Broughton Circuit. Floodwater was "over knee-deep" (greater than about 500 mm deep) at its deepest point (refer Plates C2.1 – C2.3 in Appendix C). ◦ Water flowed in westerly direction along southern boundary of a property that is located on Broughton Circuit to depth of about 300 mm. (refer Plates C2.4, C2.5 and C2.6 in Appendix C).	◦ The TUFLOW model shows approximately three quarters of the rear of the property inundated to a maximum depth of about 400 mm (i.e. about 100 mm lower than is estimated at the time the photograph was taken). ◦ The TUFLOW model shows floodwater flowing in a westerly direction along the southern boundary of the property to a maximum depth of about 400 mm (i.e. about 100 mm higher than is estimated at the time the photograph was taken).
Y66[6]	21 – 22 September 2016	◦ Floodwater flowed through paddock in vicinity of driveway of a property that is located on South Street to a depth of approximately 18 inches (about 450 mm). The driveway on the property was washed away.	◦ TUFLOW model shows ponding to a depth of about 180 mm against the driveway (i.e. about 270 mm lower than the estimated depth of overland flow). It is possible that the localised rainfall over the 6.5 ha catchment contributing to overland flow at this location was more severe than that recorded at closest rain gauges.
Y67[6]		◦ Floodwater broke the left bank of the watercourse immediately downstream of Murrumbateman Road. Plates C7.1 and C7.2 contained in Appendix C show the approximate extent of floodwater. ◦ Plate C7.3 contained in Appendix C shows the 5 off 1600 mm diameter pipes beneath Murrumbateman Road are approximately half-full at the time that the photo was taken. The downstream invert of the pipes is about RL 587.75 m AHD based on survey data. Therefore the peak flood level at this location is about RL 588.50 m AHD.	◦ The TUFLOW model results give a good match with the flood extents shown on Plates C7.1 and C7.2 contained in Appendix C. ◦ The modelled peak flood level immediately downstream of the Murrumbateman Road culverts is RL 588.60 m AHD (i.e. about 100 mm higher than is estimated at the time the photograph was taken)..
Y68[6]		◦ Floodwater in McClungs Creek was at the point of overtopping the banks on the southern (upstream) side of Merryville Drive. ◦ Flood peaked at about 07:00 hours on 21 September 2016.	◦ The TUFLOW model shows McClungs Creek running full. ◦ The flood peak occurs at 09:30 hours on 21 September 2016 in the TUFLOW model (i.e. 2.5 hours before the observed flood peak).

5. Refer Figure 4.3 for cross reference to Response Identifier.
6. Refer Figure 4.3 for cross reference to Response Identifier.

TABLE 4.4
SUMMARY OF QUESTIONNAIRE RESPONSES RELATED TO OBSERVED FLOOD BEHAVIOUR AT BINALONG

Response Identifier [A]	Flood Event [B]	Observed Flood Behaviour/ Other Comment [C]	Model Verification Comments [D]
Y41[1]	13 – 15 February 2010	▫ Floodwater in Balgalal Tributary was almost overtopping the banks on the upstream (southern) side of Monteagle Street (refer Plates F1.1 and F1.2 in Appendix F). The top of the bank is set at an elevation of about RL 485.00 m AHD. ▫ Flood peaked at about 11:00 hours on 14 February 2010.	▫ The peak flood level is about RL 484.95 m AHD in the TUFLOW model results (i.e. about 50 mm lower than is estimated at the time the photograph was taken). ▫ The flood peak occurs at 11:30 hours on 14 February 2010 in the TUFLOW model (i.e. 30 minutes after the observed flood peak).
Y55[2]	21 – 22 September 2016	▫ Floodwater overtops the banks of Balgalal Creek at the northern end of Stephens Street at about 15:00 hours on 21 September 2016 (refer Plates G8.2 and G8.3 in Appendix G). The top of the bank is set at an elevation of about RL 459.70 m AHD.	▫ The flood peak occurs at 21:00 hours on 21 September 2016 in the TUFLOW model (i.e. 6 hours after the observed flood peak). ▫ The peak flood level is about RL 459.80 m AHD in the TUFLOW model results (i.e. about 100 mm higher than is estimated at the time the photograph was taken).
Y42[2]		▫ Floodwater originating from Balgalal Creek inundated gated entrance to back paddock in a property that is located on Queen Street. ▫ Floodwater in Balgalal Creek overtopped Burley Griffin Way.	▫ TUFLOW model shows gated entrance to the back paddock inundated to a depth of about 350 mm. ▫ TUFLOW model shows overtopping of Burley Griffin Way to depths less than 100 mm.

1. Refer Figure 4.7 for cross reference to Response Identifier.
2. Refer Figure 4.8 for cross reference to Response Identifier.

5 DERIVATION OF DESIGN FLOOD HYDROGRAPHS

5.1 Design Storms

5.1.1. Rainfall Intensity

The procedures used to obtain temporally and spatially accurate and consistent Intensity-Frequency-Duration (**IFD**) design rainfall curves for the assessment of local catchment flooding at the four villages are presented in the 2019 edition of *Australian Rainfall and Runoff* (**ARR 2019**) (GA, 2019). Design storms for frequencies of 20, 10, 5, 2, 1, 0.5 and 0.2% AEP were derived for storm durations ranging between 30 minutes and seven days. The IFD dataset was downloaded from the BoM's *2016 Rainfall IFD Data System*.

5.1.2. Areal Reduction Factors

The rainfalls derived using the processes outlined in ARR 2019 are applicable strictly to a point. In the case of a catchment of over tens of square kilometres area, it is not realistic to assume that the same rainfall intensity can be maintained. An Areal Reduction Factor (**ARF**) is typically applied to obtain an intensity that is applicable over the entire catchment.

While ARFs ranging between 0.95 and 1.0 are applicable on the main arms of the watercourses that run through Bowning, Bookham and Binalong, a good match was achieved between the flows derived by the hydrologic models that were developed as part of the present study and those derived by the Regional Flood Frequency Estimation (**RFFE**) Model, the procedures for which are set out in ARR 2019 using a single value of 1.0. As the purpose of the study was to also define the nature of major overland flow which is typically associated with smaller catchments, where point rainfall is more applicable, a global ARF value of 1.0 was adopted for design flood estimation purposes.

5.1.3. Temporal Patterns

ARR 2019 prescribes the analysis of an ensemble of 10 temporal patterns per storm duration for various zones in Australia. These patterns are used in the conversion of a design rainfall depth with a specific AEP into a design flood of the same frequency. The patterns may be used for AEPs down to 0.2 per cent where the design rainfall data is extrapolated for storm events with an AEP less than 1 per cent.

The temporal pattern ensembles that are applicable to Frequent (more frequent than 14.4% AEP), Intermediate (between 3.2 and 14.4% AEP) and Rare (rarer than 3.2% AEP) storm events were obtained from the ARR Data Hub[3], while those for the very rare events were taken from the BoMs update of *Bulletin 53* (BoM, 2003). A copy of the data extracted from the ARR Data Hub for the four villages is contained in **Appendix D**.

5.1.4. Probable Maximum Precipitation

Estimates of Probable Maximum Precipitation (**PMP**) were made using the Generalised Short Duration Method (**GSDM**) as described in the BoM, 2003. This method is appropriate for estimating extreme rainfall depths for catchments up to 1000 km^2 in area and storm durations up to 3 hours.

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

[3] It is noted that the temporal pattern data set for the *Murray Basin* region is suitable for use at all four villages.

- 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 *Bulletin 53* (BoM, 2003), which is based on pluviographic traces recorded in major Australian storms.

Figures 3.1 to **3.4** show the location and orientation of the PMP ellipses which were used to derive the rainfall estimates for each individual sub-catchment at the four villages. Note that three orientations of the PMP ellipses were adopted at Murrumbateman in order to more accurately define the upper limit of flooding in the village.

5.2 Design Rainfall Losses

The initial and continuing loss values to be applied in flood hydrograph estimation were derive using the NSW jurisdictional specific procedures set out in the ARR Data Hub. The continuing loss values that were adopted for design flood estimation purposes are shown in **Table 5.1**, while a copy of the raw ARR Data Hub data, which includes the Probability Neutral Burst Initial Loss values that were adopted for design flood estimation purposes, is contained in **Appendix D**.

TABLE 5.1
ADOPTED CONTINUING LOSS VALUES

Village	Continuing Loss[1] (mm/hr)
Murrumbateman	1.5
Bowning	1.8
Bookham	1.6
Binalong	1.7

1. Derived by multiplying the raw continuing loss value taken from the ARR Data Hub by a multiple of 0.4.

5.3 Derivation of Design Discharges

The Murrumbateman, Bowning, Bookham and Binalong Hydrologic Models were run with the design rainfall data set out in **Sections 5.1** and **5.2**, as well as the hydrologic parameters set out in **Section 3.3.2** in order to obtain design discharge hydrographs for input to their respective TUFLOW Models.

Table 5.2 shows a comparison of design peak flow estimates derived from the Bowning, Bookham and Binalong Hydrologic Models compared to those derived by the RFFE Model[4], while **Figures 3.2**, **3.3** and **3.4** show the location at which the comparisons were made. The peak flow comparison was undertaken for catchments that fit the following criteria:

[4] Note that a similar comparison was not undertaken at Murrumbateman as the RFFE Model is not considered suitable to derive design peak flow estimates for catchments with total catchments areas of less than 0.5 km^2 or greater than 1,000 km^2.

- The total catchment area was greater than 0.5 km^2 and less than 1,000 km^2.
- The shape factor[5] and catchment area is comparable to those of the '*Nearby Catchments*' that are relied upon as part of the RFFE Model.[6]

Table 5.2 shows the hydrologic models developed as part of the present investigation generally provide a good match to the RFFE Model for flood events with an AEP of less than 5 per cent, but provide and overestimate for more frequent flood events.

The storm duration of 30-60 minutes was generally found to be critical for maximising peak flows for individual sub-catchments where the catchment area is less than 60 ha, with the critical storm duration generally increasing with an increase in catchment area. Peak PMF flow rates for individual sub-catchments computed by the hydrologic models for the critical 15 minute PMP storm duration were generally between 9.9 and 11.7 times greater than the corresponding 1% AEP flow rates, with an upper and lower limit of 20.7 and 6.5, respectively. These values lie within the range of expected multiples for a small urban catchment.

TABLE 5.2
COMPARISON OF DESIGN PEAK FLOW ESTIMATES
AT BOWNING, BOOKHAM AND BINALONG

Village	Identifier	AEP (%)	RFFE Derived Peak Flow (m^3/s)	Model Derived Peak Flow (m^3/s)	Discussion
Bowning(1)	Bow_RFFE1 (Catchment Area = 17.6 km^2)	20	33.5	35.1	RFFE gives higher design peak flow estimates than the *Nearby Catchments* of a similar size and is therefore considered to overestimate the design peak flow.
		10	50.1	44.5	
		5	70.5	58.5	
		2	104	77.6	
		1	136	96.9	
	Bow_RFFE2 (Catchment Area = 1.1 km^2)	20	5.3	4.6	Bow_RFFE2 catchment area is significantly smaller than the *Nearby Catchments*. RFFE estimates are therefore extrapolated from larger catchments and may have a lower level of accuracy.
		10	8.0	8.3	
		5	11.3	10.6	
		2	16.8	11.7	
		1	21.8	13.4	

Refer over for footnotes to table.

[5] Defined as the shortest distance between catchment outlet and centroid divided by the square root of catchment area (GA, 2016).

[6] *Nearby Catchments* are the 15 gauged catchments that are in close proximity to the study catchment and have been relied upon by the RFFE Model to estimate design peak flows at a given location.

TABLE 5.2 (Cont'd)
COMPARISON OF DESIGN PEAK FLOW ESTIMATES AT BOWNING, BOOKHAM AND BINALONG

Village	Identifier	AEP (%)	RFFE Derived Peak Flow (m^3/s)	Model Derived Peak Flow (m^3/s)	Discussion
Bookham[(2)]	Bow_RFFE1 (Catchment Area = 85.7 km^2)	20	63.8	121	RFFE derived flows appear to be influenced by outlier data from *Nearby Catchments*. Modelled peak flow estimates are well within the upper and lower confidence limits.
		10	95.7	174	
		5	134	218	
		2	199	281	
		1	258	351	
	Bow_RFFE2 (Catchment Area = 37.6 km^2)	20	22	52.3	Achieves a good match between modelled and RFFE derived design peak flows.
		10	45.9	79.9	
		5	68.4	101	
		2	95.5	140	
		1	140	168	
	Bow_RFFE3 (Catchment Area = 24.4 km^2)	20	23.1	40.3	Achieves a good match between modelled and RFFE derived design peak flows.
		10	34.6	57.5	
		5	48.5	76.8	
		2	71.5	97	
		1	93	118	
Binalong[(3)]	Bin_RFFE1 (Catchment Area = 33.4 km^2)	20	30.4	43.2	Shape Factor matches that of *Nearby Catchments*. Considered to be a good fit with the RFFE Model.
		10	46.5	58.2	
		5	66.6	73.9	
		2	100	104	
		1	132	124	
	Bin_RFFE2 (Catchment Area = 3.0 km^2)	20	7.0	12.7	Catchment area is more than 7 km^2 less than the *Nearby Catchment*. However, results still provide a good match with the RFFE Model.
		10	10.7	18.4	
		5	15.3	23.3	
		2	23.1	27	
		1	30.5	32.7	
	Bin_RFFE3 (Catchment Area = 1.7km^2)	20	4.2	6.8	Catchment area is more than 8 km^2 less than the *Nearby Catchment*. However, results still provide a good match with the RFFE Model.
		10	6.4	10	
		5	9.2	12.6	
		2	14	15.5	
		1	18.5	18.1	

1. Refer **Figure 3.2** for location of peak flow comparison at Bowning.
2. Refer **Figure 3.3** for location of peak flow comparison at Bookham.
3. Refer **Figure 3.4** for location of peak flow comparison at Binalong.

6 HYDRAULIC MODELLING OF DESIGN STORM EVENTS

6.1 Presentation and Discussion of Results

6.1.1. Water Surface Profiles and Extents of Inundation

The results of the hydraulic modelling of design storm events at the four villages are presented in separate Appendices: Murrumbateman in **Appendix E**, Bowning in **Appendix F**, Bookham in **Appendix G** and Binalong in **Appendix H**. Any reference to a figure number in this chapter refers to the corresponding figure in **Appendices E** to **H**.

Figures 6.1 to **6.8** in **Appendices E** to **H** show the TUFLOW model results for the 20, 10, 5, 2, 1, 0.5 and 0.2 per cent AEP floods, together with the PMF. These diagrams show the indicative extent and depth of inundation along the creeks and tributaries at the four villages, as well as along the major overland flow paths for the range of design flood events.

Water surface profiles along the major drainage lines at the four villages are shown on **Figure 6.9** in **Appendices E** to **H** for the modelled design floods events. **Figure 6.10** shows stage and discharge hydrographs at selected locations throughout the four study areas, while **Table I1** in **Appendix I** sets out peak design flows and corresponding critical storm durations at each location.

In order to create realistic results which remove most of the anomalies caused by inaccuracies in the LiDAR survey data (refer below for details), a filter was applied to remove depths of inundation over the natural surface less than 100 mm. This has the effect of removing the very shallow depths which are more prone to be artefacts of the model, but at the same time giving a reasonable representation of the various overland flow paths. The depth grids shown on the figures have also been trimmed to the building polygons, as experience has shown that property owners incorrectly associate depths of above-ground inundation at the location of buildings with depths of above-floor inundation.

6.1.2. Accuracy of Hydraulic Modelling

The accuracy of results depends on the precision of the numerical finite difference procedure used to solve the partial differential equations of flow, which is also influenced by the time step used for routing the floodwave through the system and the grid spacing adopted for describing the natural surface levels in the floodplain. Channels are described by cross-sections normal to the direction of flow, so their spacing also has a bearing on the accuracy of the results. The results are also heavily dependent on the size of the two-dimensional grid, as well as the accuracy of the LiDAR survey data which has a design accuracy based on 95% of points within +/- 150 mm.

Given the uncertainties in the LiDAR survey data and the definition of features affecting the passage of flow, maintenance of a depth of flow of at least 200 mm is required for the definition of a "continuous" flow path in the areas subject to shallow overland flow. Lesser modelled depths of inundation may be influenced by the above factors and therefore may be spurious, especially where that inundation occurs at isolated locations and is not part of a continuous flow path. In areas where the depth of inundation is greater than the 200 mm threshold and the flow path is continuous, the likely accuracy of the hydraulic modelling in deriving peak flood levels is considered to be between 100 and 150 mm.

Use of the flood study results when applying flood related controls to development proposals should be undertaken with the above limitations in mind. Proposals should be assessed with the benefit of a site survey to be supplied by applicants in order to allow any inconsistencies in results to be identified and given consideration. This comment is especially appropriate in the areas subject to shallow overland flow, where the inaccuracies in the LiDAR survey data or obstructions to flow would have a proportionally greater influence on the computed water surface levels than in the deeper flooded main stream areas.

Minimum floor levels for residential and commercial developments should be based on the 1% AEP flood level plus appropriate freeboard (this planning level is defined as the *"Flood Planning Level"* (**FPL**)), to cater for uncertainties such as wave action, effects of flood debris conveyed in the overland flow stream and precision of modelling. Note that a freeboard of 500 mm has been adopted for defining an interim set of FPLs (**Interim FPLs**) along the main drainage paths in the four villages pending the completion of the future *FRMS&P*. Derivation of an interim Flood Planning Area (**Interim FPA**) based on the Interim FPLs is presented in **Section 6.7**.

The sensitivity studies and discussion presented in **Section 6.5** provide guidance on the suitability of the recommended allowance for freeboard under present day climatic conditions.

In accordance with DPIE recommendations (DECC, 2007), sensitivity studies have also been carried out to assess the impacts of future climate change on flood behaviour (refer **Section 6.5**). Increases in flood levels due to future increases in rainfall intensities may influence the selection of FPLs. However, final selection of FPLs is a matter for more detailed consideration during the preparation of the future *FRMS&P*.

6.1.3. Description of Flood Behaviour

Murrumbateman

Figures E6.1 to **E6.8** in **Appendix E** show the TUFLOW model results at Murrumbateman for the assessed design flood events, while **Table I1** in **Appendix I** sets out design peak flows at selected locations throughout the village.
The key features of flooding in the McClungs Creek catchment are as follows:

- In Merryville Estate which is located in the headwaters of the McClungs Creek catchment, floodwater surcharges the road reserve at the following locations:
  - Merryville Drive in the vicinity of Merryville Estate Basin No. 1 (refer location of Peak Flow Location (**PFL**) MUR_01 on sheet 2 of **Appendix E** figures) in a 1% AEP event;
  - Merryville Drive at its intersection with Suffolk Avenue (refer PFL MUR_02 on sheet 2) in a 20% AEP event; and
  - Isabel Drive at a location about 250 m east of its intersection with Merryville Drive (refer PFL MUR_03 on sheet 2) in a 20% AEP event.
- The culvert beneath Merryville Drive in the vicinity of Carrington Park (refer PFL MUR_04 on sheet 2) will surcharge in events that occur more frequently than the 20% AEP. Floodwater that surcharges the culvert flows in a westerly direction along a channel that runs parallel to Merryville Drive on its southern side and discharges to McClungs Creek. Floodwater commences to surcharge the aforementioned channel and sheet flow in a northerly direction across Merryville Dive in a 5% AEP event.

- McClungs Creek commences to surcharge Merryville Drive in the vicinity of Carrington Park (refer PFL MUR_05 on sheet 2) in a 2% AEP storm event, while the Barton Highway crossing of the creek (refer PFL MUR_06 on sheet 1) will remain flood free until the 0.2 % AEP event.
- The Carrington Park Detention Basin (refer sheet 2) commences to surcharge in a 0.2% AEP event.

The key features of flooding in the Unnamed Tributary catchment are as follows:

- Murrumbateman Road will commence to overtop in a 2% AEP event at the following locations;
  - at a location about 400 m east of its intersection with Patemans Lane (refer PFL MUR_07 on sheet 5); and
  - in the vicinity of its intersection with Elrington Close (refer PFL MUR_08 on sheet 5).
- Floodwater commences to surcharge the low point in Ambleside Avenue in Ambleside Estate (refer PFL MUR_09 on sheet 3) in a 20% AEP event, resulting in the isolation of the existing dwellings that are located in the vicinity of Broughton Circuit.
- The culvert beneath the Barton Highway that is located about 600 m south of its intersection with Murrumbateman Road (refer PFL MUR_10 on sheet 3) will surcharge in a 20% AEP event and flow in a northerly direction along a channel that runs parallel to the highway on its western side and discharges a culvert that runs beneath the Barton Highway a further 200 m to the north (refer PFL MUR_11 on sheet 3). Floodwater commences to surcharge the Barton Highway at this location in a 2% AEP event.
- Floodwater commences to surcharge the low point in Dundoos Drive in Dundoos Estate (refer PFL MUR_12 on sheet 3) in a 10% AEP event, isolating the existing dwellings that are located in the estate.
- Floodwater commences to surcharge Murrumbateman Road in the vicinity of its intersection with the Barton Highway (refer PFL MUR_13 on sheet 3) in a 2% AEP event. Floodwater also surcharges the left (western) bank of the Unamed Tributary about 100 m to the north of Murrumbateman Road and inundates the Barton Highway at its intersection with South Street in a storm of this intensity.
- Floodwater surcharges the Hillview Drive crossing of the Unamed Tributary (refer PFL MUR_15 on sheet 1) in a 2% AEP event.
- Floodwater commences to surcharge the right (eastern) bank of the Unnamed Tributary and inundate the Murrumbateman Recreation Ground (refer sheet 3) in a 2% AEP event. The water supply bore and pumping station that is located in the vicinity of the Murrumbateman Recreation Ground will commence to become inundated in a 1% AEP event.
- Depths of overland flow through the Village Centre would exceed 300 mm in a 1% AEP event at the flowing locations:
  - through existing development that is bounded by West Street to the west, Hercules Street to the north, Rose Street to the east and South Street to the south; and
  - adjacent to the pedestrian footpath that is located along the southern boundary of Fairley Village between William Street and Camp Street.

The key features of flooding in the Gooda Creek catchment are as follows:

- Floodwater commences to surcharge Goldfields Lane (refer PFL MUR_09 on sheet 7) in events that occur more frequently than 20% AEP.
- Floodwater commences to surcharge the Barton Highway at a location about 100 m north of the Gooda Creek crossing (refer PFL MUR_17 on sheet 6) in a 5% AEP event.
- Floodwater commences to surcharge the Barton Highway at a location about 230 m south of its intersection with Valencia Drive (refer PFL MUR_18 on sheet 6) in a 10% AEP event.

The key feature of flooding in the Big Hill Creek catchment is that Dog Trap Road will be inundated over a distance of about 250 m to the north of the Big Hill Creek crossing in a 20% AEP event. This section of road will be inundated to depths greater than 800 mm in a 1% AEP event.

Peak PMF flow rates in the drainage lines at Murrumbateman are about 14-18 times the corresponding peak 1% AEP flow rates. This is a result of a combination of the reduced effect that temporary floodplain storage has on the attenuation of flows during extreme flood events and the fact that the rainfall excess in the PMP event is up to 12 times the 1% AEP excess for equivalent storm durations.

Bowning

Figures F6.1 to **F6.8** in **Appendix F** show the TUFLOW model results at Bowning for the assessed design flood events. **Table I1** in **Appendix I** sets out design peak flows at selected locations throughout the village.

The key features of main stream flooding in Bowning are as follows:

- As shown on **Figure F6.10**, water levels in Bowning Creek and Bowning Tributary generally commence to rise within an hour of the onset of heavy rain and typically rise to their peak within 2-5 hours. The height to which water levels reach relative to adjacent road and bridge deck levels is also shown on **Figure F6.10**.
- Floodwater is generally contained within the inbank area of Bowning Creek in a 20% AEP event with the exception of the following locations:
    - in the ponding area that is located immediately upstream of the Bowning Road crossing;
    - between Bowning Road and the Hume Highway; and
    - along the 650 m reach of Bowning Creek immediately downstream of the Hume Highway.
- Floodwater that surcharges the eastern (left) bank of Bowning Creek immediately downstream of Bowning Road cuts off access to the existing residential development that is located about 180 m to the south of its intersection with Playfair Street.
- Floodwater commences to surcharge Bowning Road (refer PFL BOW_02) in a 0.5% AEP event. The Main Southern Railway (refer PFL BOW_01) and Hume Highway (refer PFL BOW_03) will remain flood free in a 0.2% AEP event, but will be inundated in a PMF event.

- The two residential properties that are located on the south-western side of the intersection of Bowning Road and Playfair Street will become isolated in a 0.2% AEP event.
- Floodwater is generally contained within the inbank area of Bowning Tributary during storms up to 2% AEP in intensity with the exception of the following locations:
  - in the vicinity of Montem Street (refer PFL BOW_05) where floodwater surcharges the existing culverts in a 10% AEP event and inundates the road to depths of less than 100 mm. Floodwater that surcharges the existing culverts at this location commences to isolate the existing residential property that is located on the northern (right) bank of the tributary in a 5% AEP event; and
  - in the vicinity of Leake Street (refer PFL BOW_04) where floodwater that surcharges the eastern (right) bank of Bowning Tributary inundates the road in a 20% AEP event.
- Peak PMF flow rates in Bowning Creek and Bowning Tributary are about 10-13 times the corresponding peak 1% AEP flow rates. This is a result of the PMP rainfall excess being about 10-12 times the corresponding rainfall excess in a 1% AEP event.

The key features of major overland flow in Bowning are as follows:

- While depths of overland flow along existing flow paths are generally less than 300 mm for storms up to 10% AEP in intensity, they would exceed 300 mm at the following locations in a 1% AEP event:
  - on the western (right) bank of Bowning Creek in line with the projection of Juno Street;
  - between Red Hill Road and Bowning Creek on its western (right) bank at a location about 250 m upstream of the Main Southern Railway;
  - on the western side of Cossack Street between the Hume Highway and Bowning Creek;
  - on the eastern (right) and western (left) bank of Bowning Creek downstream of the Hume Highway; and
  - between Walls Junction Road and Bowning Tributary to the east of the Bowning Railway Station.
- Floodwater ponds to depths greater than 300 mm in a 1% AEP event at the following trapped low points:
  - on the northern side of the Main Southern Railway to the east of Montem Street; and
  - on the northern side of Bogolong Street at a location about 70 m west of its intersection with Bowning Road.
- Floodwater ponds to lesser depths in a 1% AEP event at the trapped low point that is located on the western side of Bowning Road between Airy Street and Red Hill Road.

Bookham

Figures G6.1 to **G6. 8** in **Appendix G** show the TUFLOW model results at Bookham for the assessed design flood events, while **Table I1** in **Appendix I** sets out design peak flows at selected locations throughout the village.

The key features of main stream flooding in Bookham are as follows:

- As shown on **Figure G6.10**, water levels in Bogolong Creek and Middletons Creek generally commence to rise within an hour of the onset of heavy rain and typically rise to their peak within 2-5 hours. The height to which water levels reach relative to adjacent road and bridge deck levels is also shown on **Figure G6.10**.
- The Bogolong Creek floodplain narrows from a width of 200 m at its confluence with Stony Creek to a width of about 70 m along a 600 m reach of the watercourse adjacent to the Bookham Recreational Ground. The floodplain then widens to about 160 m downstream of the recreation ground before narrowing to about 60 m immediately upstream of Illalong Road.
- Floodwater commences to surcharge the banks of Bogolong Creek during storms that are more frequent than 20% AEP. The overbank areas of the Bogolong Creek floodplain are generally inundated to depths greater than 1 m in a 1% AEP event. The flow velocity is about 0.8-1.2 m/s on the overbank area of Bogolong Creek and exceeds 2 m/s in the inbank area during a storm of this intensity.
- **Figure G6.10** shows that access across Bogolong Creek at Illalong Road (refer PFL BO0_01) will be cut in a 0.2% AEP event, while floodwater will commence to surcharge the Fagan Drive crossing of Middletons Creek (refer PFL BOO_02) in a 2% AEP event.
- **Table I1** in **Appendix I** shows that the peak PMF flows in Bogolong Creek and Middletons Creek are about 9-10 times the corresponding peak 1% AEP flow rates. This is a result of the PMP rainfall excess being about 7-11 times the corresponding rainfall excess in a 1% AEP event.

Heavy rainfall that falls on the catchment that is located to the south of the village generates shallow sheet flow (of generally less than 100 mm in depth) through existing development that is located on Drummond Street and Fagan Drive. This overland flow then ponds in the trapped low point that is located on the southern side of the Hume Highway, reaching a maximum depth of about 1.5 m in a 1% AEP event.

Binalong

Figures H6.1 to **H6.8** in **Appendix H** show the TUFLOW model results at Binalong for the assessed design flood events, while **Table I1** in **Appendix I** sets out design peak flows at selected locations throughout the village.

The key features of main stream flooding in Binalong are as follows:

- As shown on **Figure G6.10**, water levels in Balgalal Creek generally commence to rise about 2 hours after the onset of heavy rain and typically rise to their peak after about 4 hours, while the water levels in Balgalal Tributary generally commence to rise within one hour of the onset of heavy rain and typically rise to their peak within two hours. The height to which water levels reach relative to adjacent road and bridge deck levels is also shown on **Figure G6.10**.
- The Balgalal Creek floodplain is between 90-180 m wide where it flow pasts the urbanised parts of Binalong between Armours Road and a location about 200 m upstream of Burley Griffin Way, after which it widens to about 200-300 m. The floodplain then constricts to about 70 m wide at a location about 400 m downstream of Garryowen Road.
- Floodwater commences to surcharge the banks of Balgalal Creek during storms that are more frequent than 20% AEP. Floodwater commences to inundate the rear of the residential allotments that are located on the northern side of Queen Street in a 10% AEP event.

- The low level crossings of Balgalal Creek at Armours Road (refer PFL BIN_02 on sheet 1) and Stephen Street (refer PFL BIN_03 on sheet 2) are submerged during freshes in the creek, which isolates the rural residential properties that are located on the right (northern) bank of the creek.
- Garryowen Road (refer PFL BIN_05 on sheet 2) is submerged to depths of about 400 mm in a 20% AEP event, while floodwater commences to surcharge Burley Griffin Way at a location approximately 100 m north of the creek crossing (refer PFL BIN_04 on sheet 2) in a 10% AEP event.
- Floodwater commences to surcharge the Main Southern Railway (refer PFL BIN_01 on sheet 1) immediately to the south of the bridge crossing of Balgalal Creek in a 1% AEP event.
- Floodwater is generally contained within the inbank area of Balgalal Tributary in a 20% AEP event with the exception of the following locations:
  - in the vicinity of Richmond Street (refer PFL BIN_07 on sheet 2) where floodwater surcharges the left (southern) bank of the tributary and overtops the road by about 500 mm; and
  - upstream of Monteagle Street (refer PFL BIN_09 on sheet 2) where floodwater surcharges the left (western) bank of the creek and isolates residential development that is located on the southern side of the road. Monteagle Street is inundated to a depth of about 200 mm in an event of this intensity.
- Floodwater in Balgalal Tributary commences to surcharge Wellington Street (refer PFL BIN_08 on sheet 2) and Queen Street (refer PFL BIN_10 on sheet 2) in a 2% AEP event, which prevents access between the urbanised parts of Binalong that are located on each side of the watercourse.
- Peak PMF flow rates in Balgalal Creek and Balgalal Tributary respectively are about 12-14 and 9-10 times the corresponding peak 1% AEP flow rates. This is a result of the PMP rainfall excess being up to 13 times the corresponding rainfall excess in a 1% AEP event.

The key features of major overland flow in Binalong are as follows:

- While depths of overland flow through the urbanised parts of the village are generally less than 300 mm for storms up to 1% AEP in intensity, they would exceed that depth at the following locations in a 20% AEP event:
  - along the flow path that runs in a northerly direction through residential development that is located between Balgalal Creek and the intersection of Stephens Street and Wellington Street;
  - on the southern side of Stephens Street in the vicinity of its intersection with Beckham Street;
  - on the eastern side of the Main Southern Railway at a location about 450 m south of the Binalong Railway Station;
  - on the eastern side of Fitzroy Street at a location about 400 m south of its intersection with Wellington Street; and
  - along the flow path that runs in a northerly direction between the Binalong Railway Station and Balgalal Creek on the eastern side of Fitzroy Street.
- Depths of overland flow along the abovementioned flow paths generally exceed 1 m during a 1% AEP event at locations where floodwater ponds on the upstream side of the elevated road/rail crossings.

6.2 Economic Impacts of Flooding

Table 6.1 sets out the number of properties that are flood affected in the four villages and the estimated damages which would occur for storm events of varying AEP.

At the 1% AEP level of flooding only three dwellings would experience above-floor inundation in the four villages; one each at Murrumbateman, Bowning and Binalong, while no dwellings are inundated above-floor level at Bookham. No commercial/industrial or public buildings would be above-floor inundated in a storm of this intensity.

During a PMF event, 47 individual dwellings would experience above-floor inundation in Murrumbateman, 27 in Bowning, 19 in Binalong and two in Bookham. During a storm of this intensity, six commercial/industrial buildings (two each at Murrumbateman and Bookham and one each at Bowning and Binalong) and eight public buildings (four at Murrumbateman, two at Bookham and one each at Bowning and Binalong) would be inundated above-floor level.

The *"Present Worth Value"* of damages resulting from all floods up to the magnitude of the 1% AEP at Murrumbateman and Binalong is $0.04 Million and $0.02 Million, respectively. These values represent the amount of capital spending which would be justified if one or more flood mitigation schemes prevented flooding for all properties up to the 1% AEP event in the respective village.

The *Present Worth Value* of total damages at Bowning and Bookham for all flood events up to the 1% AEP flood is zero. As a result it is not possible to economically justify any works which are aimed at mitigating the impact of flooding on existing development up to the 1% AEP level in these two villages.

Appendix J of this report contains further details on the economic assessment that was undertaken as part of the present study.

TABLE 6.1
SUMMARY OF FLOOD DAMAGES

Village	Design Flood Event (% AEP)	Number of Properties						Total Damage ($ Million)
		Residential		Commercial/ Industrial		Public		
		Flood Affected	Flood Above Floor Level	Flood Affected	Flood Above Floor Level	Flood Affected	Flood Above Floor Level	
Murrumbateman	5	5	0	0	0	0	0	0.08
	10	8	0	0	0	0	0	0.13
	20	9	0	0	0	0	0	0.14
	50	12	0	0	0	0	0	0.19
	100	13	1	0	0	0	0	0.23
	200	15	1	0	0	0	0	0.26
	500	19	3	0	0	1	0	0.41
	PMF	94	47	4	2	5	4	5.67

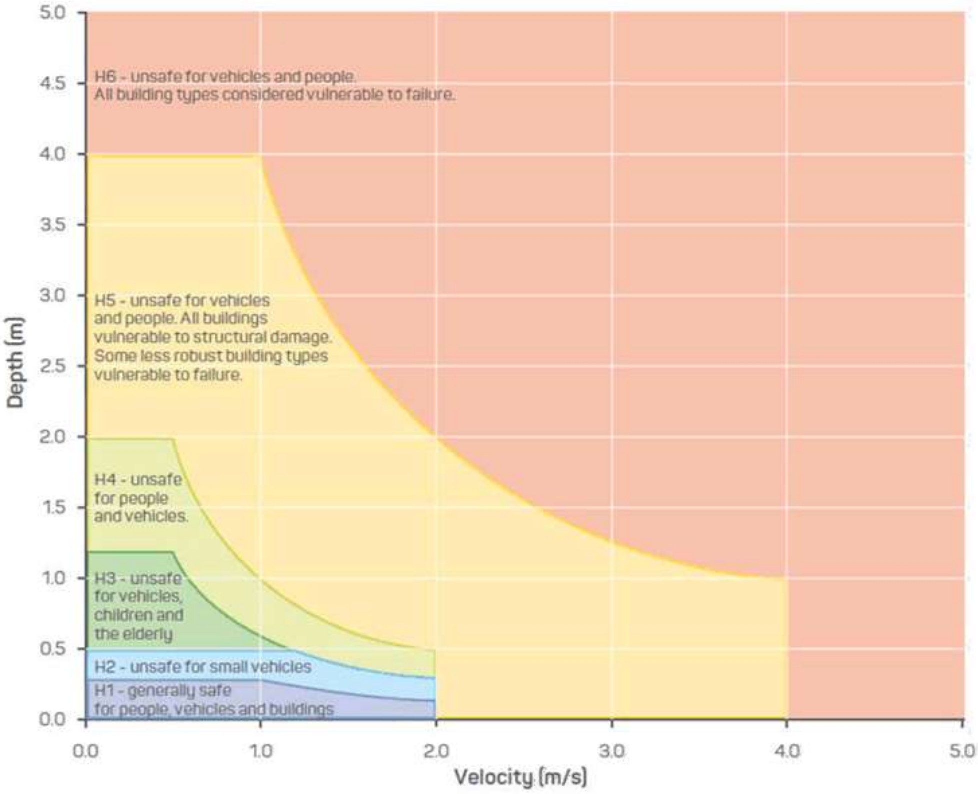
TABLE6.1 (Cont'd)
SUMMARY OF FLOOD DAMAGES

Village	Design Flood Event (% AEP)	Number of Properties						Total Damage ($ Million)
		Residential		Commercial/ Industrial		Public		
		Flood Affected	Flood Above Floor Level	Flood Affected	Flood Above Floor Level	Flood Affected	Flood Above Floor Level	
Bowning	5	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0
	20	1	0	0	0	0	0	0.02
	50	2	1	0	0	0	0	0.05
	100	2	1	0	0	0	0	0.09
	200	3	1	0	0	0	0	0.11
	500	5	2	0	0	0	0	0.21
	PMF	32	27	1	1	2	1	3.62
Bookham	5	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0
	20	0	0	0	0	0	0	0
	50	0	0	0	0	0	0	0
	100	0	0	0	0	0	0	0
	200	0	0	0	0	0	0	0
	500	0	0	0	0	0	0	0
	PMF	3	2	2	2	2	2	0.67
Binalong	5	2	0	0	0	0	0	0.03
	10	3	1	0	0	0	0	0.07
	20	4	1	0	0	0	0	0.13
	50	5	1	0	0	0	0	0.14
	100	6	1	0	0	0	0	0.16
	200	8	1	0	0	0	0	0.2
	500	8	1	0	0	0	0	0.2
	PMF	33	19	1	1	1	1	2.52

6.3 Flood Hazard Zones and Floodways

6.3.1. Flood Hazard Vulnerability Classification

Flood hazard categories may be assigned to flood affected areas in accordance with the definitions contained in the publication entitled "*Managing the Floodplain: A Guide to Best practice in Flood Risk Management in Australia*" (Australian Institute for Disaster Resilience (**AIDR**), 2017). Flood prone areas may be classified into six hazard categories based on the depth of inundation and flow velocity that relate to the vulnerability of the community when interacting with floodwater as shown in the following illustration which has been taken from AIDR, 2017:



Flood Hazard Vulnerability Classification diagrams for the 5, 1 and 0.2% AEP flood events, as well as PMF based on the procedures set out in AIDR, 2017 are presented on **Figures 6.11**, **6.12**, **6.13** and **6.14**, respectively of **Appendices E** to **H**.

It was found that areas classified as H5 and H6 are generally limited to the inbank areas of the major watercourses and local farm dams that are scattered through the study catchments in a 1% AEP event.

The flooding that is experienced at the road crossings that are inundated in a 1% AEP event (refer **Sections 6.1.3** to **6.1.6** for locations) falls within the H1 category with the following exceptions:

Murrumbateman

- H2 at Ambleside Avenue (refer PFL MUR_09 on sheet 3);
- H2 at Murrumbateman Road (refer PFL MUR_13 on sheet 3);
- H2 at Hillview Drive (refer PFL MUR_15 on sheet 1);
- H5 at Goldfields Lane (refer PFL MUR_16 on sheet 7);

Bowning

- H2 at Montem Street (refer PFL BOW_05);
- H2 at Leake Street (refer PFL BOW_04);

Binalong

- H6 at Armours Road (refer PFL BIN_02 on sheet 1);
- H2 at Burley Griffin Way (refer PFL BIN_04 on sheet 2);
- H5 at Garryowen Road (refer PFL BIN_05 on sheet 2);
- H5 at Monteagle Street (refer PFL BOW_09 on sheet 2);

The overland flow paths in the urbanised parts of the four villages are generally classified as either H1 or H2 in a 1% AEP event, except in the areas where floodwater ponds on the upstream side of roads where it is generally classified as either H3 or H4.

For the PMF event, the width of the H5 and H6 hazard zones increases significantly, mainly along the main arms of the creeks and their major tributaries. The hazard category along the majority of the remaining drainage lines increases to between H3 and H5 during a storm event of this intensity.

6.3.2. Hydraulic Categorisation of the Floodplain

According to the *FDM*, the floodplain may be subdivided into the following three hydraulic categories:

- Floodways;
- Flood storage; and
- Flood fringe.

Floodways are those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with obvious naturally defined channels. Floodways are the areas that, even if only partially blocked, would cause a significant re-distribution of flow, or a significant increase in flood level which may in turn adversely affect other areas. They are often, but not necessarily, areas with deeper flow or areas where higher velocities occur.

Flood storage areas are those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. If the capacity of a flood storage area is substantially reduced by, for example, the construction of levees or by landfill, flood levels in nearby areas may rise and the peak discharge downstream may be increased. Substantial reduction of the capacity of a flood storage area can also cause a significant redistribution of flood flows.

Flood fringe is the remaining area of land affected by flooding, after floodway and flood storage areas have been defined. Development in flood fringe areas would not have any significant effect on the pattern of flood flows and/or flood levels.

Floodplain Risk Management Guideline No. 2 Floodway Definition, offers guidance in relation to two alternative procedures for identifying floodways. They are:

- **Approach A**. Using a *qualitative approach* which is based on the judgement of an experienced hydraulic engineer. In assessing whether or not the area under consideration was a floodway, the qualitative approach would need to consider; whether obstruction would divert water to other existing flow paths; or would have a significant impact on upstream flood levels during major flood events; or would adversely re-direct flows towards existing development.
- **Approach B**. Using the hydraulic model, in this case TUFLOW, to define the floodway based on *quantitative experiments* where flows are restricted or the conveyance capacity of the flow path reduced, until there was a significant effect on upstream flood levels and/or a diversion of flows to existing or new flow paths.

One quantitative experimental procedure commonly used is to progressively encroach across either floodplain towards the channel until the designated flood level has increased by a significant amount (for example 0.1 m) above the existing (un-encroached) flood levels. This indicates the limits of the hydraulic floodway since any further encroachment will intrude into that part of the floodplain necessary for the free flow of flood waters – that is, into the floodway.

The *quantitative assessment* associated with **Approach B** is technically difficult to implement. Restricting the flow to achieve the 0.1 m increase in flood levels can result in contradictory results, especially in unsteady flow modelling, with the restriction actually causing reductions in computed levels in some areas due to changes in the distribution of flows along the main drainage line.

Accordingly the *qualitative approach* associated with **Approach A** was adopted, together with consideration of the portion of the floodplain which conveys approximately 80% of the total flow and also the findings of *Howells et al, 2004* who defined the floodway based on velocity of flow and depth. Howells et al suggested the following criteria for defining those areas which operate as a "floodway" in a 1% AEP event:

- Velocity x Depth greater than 0.25 m^2/s **and** Velocity greater than 0.25 m/s; or
- Velocity greater than 1 m/s.

Flood storage areas are identified as those areas which do not operate as floodways in a 1% AEP event but where the depth of inundation exceeds 400 mm. The remainder of the flood affected area was classified as flood fringe.

Figures 6.15, **6.16** and **6.17** in **Appendices E** to **H** shows the division of the floodplain into floodway, flood storage and flood fringe areas for the 5, 1 and 0.2% AEP storm events, respectively, while Figure 6.18 in **Appendices E** to **H** shows the hydraulic categorisation of the floodplain for the PMF.

As the hydraulic capacity of the creek channels is not large enough to convey the 1% AEP flow, a significant portion of the total flow in conveyed on the floodplain. As a result, areas which lie on the overbank area also function as a floodway during the 1% AEP flood event. Floodways are also generally present along the major overland flow paths described in **Sections 6.1.3** to **6.1.6**.

Flood storage areas are confined to the major ponding areas which are located on the upstream side of the roads, as well as in the local farm dams that have been constructed to capture runoff in several parts of the four villages.

6.4 Flood Emergency Response Classification

Flood emergency response categories may be assigned to flood affected areas in accordance with the definitions contained in AIDR, 2017. The flood emergency response classifications are based on whether or not the area is flooded during a PMF event, whether the area has an exit to flood-free land in a flood event and the consequence of flooding on the area. This information will assist NSW SES in emergency management planning during flood events.

Flood Emergency Response Classification diagrams for the 5, 1 and 0.2% AEP flood events, as well as the PMF based on the procedures set out in AIDR, 2017 are presented on **Figures 6.19**, **6.20**, **6.21** and **6.22**, respectively of **Appendices E** to **H**.

6.5 Sensitivity Studies

6.5.1. General

The sensitivity of the hydraulic model was tested to variations in model parameters such as hydraulic roughness and the partial blockage of the major hydraulic structures by woody debris. The main purpose of these studies was to give some guidance on:

a) the freeboard to be adopted when setting minimum floor levels of development in flood prone areas, pending the completion of the future *FRMS&P*; and

b) areas where additional flood related planning controls should be implemented due to the development of new hazardous flow paths.

6.5.2. Sensitivity to Hydraulic Roughness

Figure 6.23 in **Appendices E** to **H** shows the difference in peak flood levels (i.e. the "afflux") for the 1% AEP flood event resulting from an assumed 20% increase in hydraulic roughness (compared to the values given in **Table 4.2**).

The typical increase in peak flood level in the areas subject to main stream flooding are generally in the range 20 to 100 mm, with increases of up to 200 mm at Murrumbateman, Bowning and Binalong and in the range 100 to 500 mm at Bookham.

Increases in peak flood levels along the tributary arms of the watercourses at the four villages and in areas subject to major overland flow are generally in the range 10 to 50 mm, with increases in the range 50 to 100 mm present in isolated locations. The increase in assumed hydraulic roughness in the upper reaches of the study catchments at Murrumbateman and Binalong has had an attenuating effect on the peak flow, resulting in minor reductions in peak flood levels in in the lower reaches.

6.5.3. Sensitivity to Partial Blockage

The mechanism and geometrical characteristics of blockages in hydraulic structures and piped drainage systems are difficult to quantify due to a lack of recorded data and would no doubt be different for each system and also vary with flood events. Realistic scenarios would be limited to waterway openings becoming partially blocked during a flood event (no quantitative data are available on instances of blockage of the drainage systems which may have occurred during historic flood events).

A blockage assessment was undertaken for the four villages based on the procedures set out in ARR 2019. A blockage factor of 50% was found to be applicable for the minor piped drainage lines within the urbanised parts of the villages, while blockage factors of up to 50% were found to be applicable for the culvert / bridge crossing of the major watercourses. Based on this finding, a constant blockage factor of 50 per cent was applied to all hydraulic structures in the study area for the purpose of the sensitivity analysis.

Figure 6.24 in **Appendices E** to **H** shows the afflux for a 1% AEP storm[7] resulting from a 50 per cent blockage. This represents a case which is well beyond a blockage scenario which could reasonably be expected to occur and is presented for illustrative purposes.

The effects of blockage are greatest immediately upstream of hydraulic structures and in several locations results in a redistribution of flood flows across the floodplain. While peak flood levels would increase by up to 500 mm immediately upstream of culvert and bridge crossings on the main creeks and their tributaries, and up to 200 mm along the major overland flow paths, the extent of inundation would not increase significantly in these areas. Greater increases in peak flood level and also the extent of inundation occur at Bookham where the blockage of the Middletons Creek culverts beneath the Hume Highway increases peak flood levels to its south by up to 1.5 m.[8]

6.5.4. Differences in Design Flood Estimation – ARR 1987 versus ARR 2019

For comparison purposes, design flood modelling was undertaken for the 5% and 1% AEP design storm events based on the procedures set out in the 1987 edition of *Australian Rainfall and Runoff* (**ARR 1987**) (The Institution of Engineers Australia, 1987).

Figures 6.25 and **6.26** of **Appendices E** to **H** show the difference in the extent and depth of inundation resulting on the application of the procedures set out in ARR 1987 and ARR 2019 for the 5 and 1% AEP events, respectively. Note that a positive afflux indicates that the modelled peak flood levels derived using the procedures set out in ARR 2019 are higher than those derived using ARR 1987.

In general, peak flood levels derived using the procedures set out in ARR 2019 are about 50-100 mm lower than those derived using the ARR 1987 approach to design flood estimation with the following exceptions:

- isolated pockets of larger reductions in peak flood level occur at all villages in ponding areas that are located on the upstream side of road crossings;
- isolated pockets of increases in peak flood level that are present in a small number of local farm dams; and
- the peak flow in Stony Creek at Bookham is increased by about 6% in a 5% AEP event which increases peak flood levels along Bogolong Creek by about 30 mm. The peak flow in Stony is also increased by about 15% in a 1% AEP event, but this doesn't result in increases in peak flood level along Bogolong Creek as the timing of the peak flows in the two creek systems do not coincide in larger flood events.

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[7] Note that the sensitivity analyses were undertaken for a single storm duration and temporal pattern that was found to be critical for maximising peak flood levels on the major watercourses at each village.

[8] The blockage factor applied to the twin 1.8 m diameter pipes beneath the Hume Highway at Middletons Creek is sensitive to the adopted L_{10} value. An L_{10} value that is larger than the culvert diameter (> 1.8 m) results in a blockage factor of 50 per cent, while an L_{10} value slightly smaller than the diameter (< 1.8 m) gives a blockage factor of 10 per cent. As there is no guidance in ARR 2019 regarding the L_{10} values that is suitable for application in rural areas, the conservatively high blockage factor of 50% was adopted for the purpose of undertaking the sensitivity analysis.

6.6 Climate Change Sensitivity Analysis

6.6.1. General

At the present flood study stage, the principal issue regarding climate change is the potential increase in flood levels and extents of inundation throughout the four villages. In addition it is necessary to assess whether the patterns of flow will be altered by new floodways being developed for key design events, or whether the provisional flood hazard will be increased.

DPIE recommends that its guideline *Practical Considerations of Climate Change, 2007* be used as the basis for examining climate change induced increases in rainfall intensities in projects undertaken under the State Floodplain Management Program and NSWG, 2005. The guideline recommends that until more work is completed in relation to the climate change impacts on rainfall intensities, sensitivity analyses should be undertaken based on increases in rainfall intensities ranging between 10 and 30 per cent. On current projections the increase in rainfalls within the service life of developments or flood management measures is likely to be around 10 per cent, with the higher value of 30 per cent representing an upper limit. Under present day climatic conditions, increasing the 1% AEP design rainfall intensities by 10 per cent would produce a 0.5% AEP flood; and increasing those rainfalls by 30 per cent would produce a 0.2% AEP event.

The impacts of climate change and associated effects on the viability of floodplain risk management options and development decisions may be significant and will need to be taken into account in the future *FRMS&P* for the four villages using site specific data.

At the present flood study stage, the principal issue regarding climate change is the potential increase in flood levels throughout the four villages. In addition, it is necessary to assess whether the patterns of flow will be altered by new floodways being developed for key design events, or whether the provisional flood hazard will be increased.

In the *FRMS&P* it will be necessary to consider the impact of climate change on flood damages to existing development. Consideration will also be given both to setting floor levels for future development and in the formulation of works and measures aimed at mitigating adverse effects expected within the service life of development.

Mitigating measures which could be considered in the *FRMS&P* include the implementation of structural works such as levees and channel improvements, improved flood warning and emergency management procedures and education of the population as to the nature of the flood risk.

6.6.2. Sensitivity to Increased Rainfall Intensities

As mentioned, the investigations undertaken at the flood study stage are mainly seen as sensitivity studies pending more detailed consideration in the *FRMS&P*. For the purposes of the present study, the design rainfalls for 0.5 and 0.2 per cent AEP events were adopted as being analogous to flooding which could be expected should present day 1% AEP rainfall intensities increase by 10 and 30 per cent, respectively.

Figure 6.27 in **Appendices E** to **H** shows the afflux resulting from a 10 per cent increase in 1% AEP rainfall intensities. The increase in peak flood levels along the creeks and their tributaries varies between 50 to 300 mm at Murrumbateman, Bowning and Binalong, with increases of up to 500 mm in Bookham. Increases in peak flood levels in the range 10 to 50 mm are shown to occur along major overland flow paths.

Figure 6.28 in **Appendices E** to **H** shows the afflux for a 30 per cent increase in 1% AEP rainfall intensities. Peak flood levels along the creeks and their tributaries increase by up to 500 mm at Murrumbateman, Bowning and Binalong, with increases of over 1 m shown to occur in Bookham. Increases in peak flood levels in the range 20 to 200 mm are shown to occur along major overland flow paths.

Figure 6.29 in **Appendices E** to **H** shows the increase in the extent of land affected by floodwater should 1% AEP rainfall intensities increase by 10 or 30 per cent. The extent of land that is affected by floodwater increases significantly at the following locations:

- in the lower reaches of McClungs Creek at Murrumbateman (refer sheet 1);
- along the Unnamed Tributary and the watercourse that drains Dundoos Estate in the vicinity of the Murrumbateman Recreation Ground at Murrumbateman (refer sheet 3);
- on the left (eastern) bank of Big Hill Creek in the vicinity of Dog Trap Road at Murrumbateman (refer sheet 4);
- along a 1 km reach Gooda Creek in the vicinity of Goldfields Lane at Murrumbateman (refer sheet 7);
- on the both banks of Bowning Creek between the Main Southern Railway and the Hume Highway at Bowning; and
- on the upstream (southern) side of the Hume Highway crossing of Middletons Creek at Bookham.

Consideration will need to be given to the identified changes that occur in flood behaviour during the preparation of the future *FRMS&P*.

6.7 Selection of Interim Flood Planning Levels

After consideration of the TUFLOW results and the findings of sensitivity studies outlined in **Sections 6.5** and **6.6**, the following criteria were adopted for defining the Interim FPA:

- in areas subject to main stream flooding the extent of the FPA was defined as land lying below the peak 1% AEP flood level plus a freeboard allowance of 500 mm; and
- in areas subject to major overland flow the extent of the FPA was define as land inundated to a depth greater than 100 mm.

Figure 6.30 in **Appendices E** to **H** show the extent of the Interim FPA in the four villages.

In areas that lie within the extent of the Interim FPA it is recommended that a freeboard of 500 mm be applied to peak 1% AEP flood levels when setting the minimum floor level of future development. An assessment should also be undertaken by Council as part of any future Development Application to confirm that the proposed development will not form an obstruction to the passage of overland flow through the subject site.

Consideration will need to be given during the preparation of the future *FRMS&P* to the appropriateness of the adopted freeboard allowance of 500 mm given the impact changes in hydraulic roughness and future increases in rainfall intensity could have on peak flood levels, especially in the case of Bookham. Consideration will also need to be given to the setting of an appropriate freeboard for areas subject to major overland flow given that the adopted value of 500 mm may be found to be too conservative.

Figure 6.30 in **Appendices E** to **H** also shows the extent of the *Outer Floodplain*, which is the area which lies between the FPA and the extent of the PMF. It is recommended that Council consider precluding critical, sensitive and vulnerable type development such as hospitals with emergency facilities, emergency services facilities, utilities, community evacuation centres, aged care homes, seniors housing, group homes, boarding houses, hostels, caravan parks, schools and childcare facilities in this area.

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8 FLOOD-RELATED TERMINOLOGY

Note: For an expanded list of flood-related terminology, refer to glossary contained within the Floodplain Development Manual, NSW Government, 2005).

TERM	DEFINITION
Afflux	Increase in water level resulting from a change in conditions. The change may relate to the watercourse, floodplain, flow rate, tailwater level etc.
Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 50 m^3/s has an AEP of 5%, it means that there is a 5% chance (that is one-in-20 chance) of a 50 m^3/s or larger events occurring in any one year (see average recurrence interval).
Australian Height Datum (AHD)	A common national surface level datum approximately corresponding to mean sea level.
Average Recurrence Interval (ARI)	The average period in years between the occurrence of a flood of a particular magnitude or greater. In a long period of say 1,000 years, a flood equivalent to or greater than a 100 year ARI event would occur 10 times. The 100 year ARI flood has a 1% chance (i.e. a one-in-100 chance) of occurrence in any one year (see annual exceedance probability).
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
Discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving (e.g. metres per second [m/s]).
Flood fringe area	The remaining area of flood prone land after floodway and flood storage areas have been defined.
Flood Planning Area (FPA)	The area of land inundated at the Flood Planning Level.
Flood Planning Level (FPL)	A combination of flood level and freeboard selected for planning purposes, as determined in floodplain risk management studies and incorporated in floodplain risk management plans.
Flood prone land	Land susceptible to flooding by the Probable Maximum Flood. Note that the flood prone land is synonymous with flood liable land.
Flood storage area	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
Floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event (i.e. flood prone land).

TERM	DEFINITION
Floodplain Risk Management Plan	A management plan developed in accordance with the principles and guidelines in the *Floodplain Development Manual, 2005*. Usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.
Floodway area	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
Freeboard	A factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. It is usually expressed as the difference in height between the adopted Flood Planning Level and the peak height of the flood used to determine the flood planning level. Freeboard provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the floodplain, such and wave action, localised hydraulic behaviour and impacts that are specific event related, such as levee and embankment settlement, and other effects such as "greenhouse" and climate change. Freeboard is included in the flood planning level.
High hazard	Where land in the event of a 1% AEP flood is subject to a combination of flood water velocities and depths greater than the following combinations: 2 metres per second with shallow depth of flood water depths greater than 0.8 metres in depth with low velocity. Damage to structures is possible and wading would be unsafe for able bodied adults.
Low hazard	Where land may be affected by floodway or flood storage subject to a combination of floodwater velocities less than 2 metres per second with shallow depth or flood water depths less than 0.8 metres with low velocity. Nuisance damage to structures is possible and able bodied adults would have little difficulty wading.
Main stream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
Mathematical/computer models	The mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.
Merit approach	The merit approach weighs social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well-being of the State's rivers and floodplains.
Major overland flow	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.
Peak discharge	The maximum discharge occurring during a flood event.

TERM	DEFINITION
Peak flood level	The maximum water level occurring during a flood event.
Probable Maximum Flood (PMF)	The largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land (i.e. the floodplain). The extent, nature and potential consequences of flooding associated with events up to and including the PMF should be addressed in a floodplain risk management study.
Probability	A statistical measure of the expected chance of flooding (see annual exceedance probability).
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
Runoff	The amount of rainfall which actually ends up as stream flow, also known as rainfall excess.
Stage	Equivalent to water level (both measured with reference to a specified datum).

APPENDIX A
COMMUNITY NEWSLETTER AND QUESTIONNAIRE

MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALONG FLOOD STUDIES

Community Newsletter

Yass Valley Council has engaged consultants to undertake flood studies for the villages of Murrumbateman, Bowning, Bookham and Binalong which will define mainstream flooding patterns along McClungs and Big Hill Creek (Murrumbateman), Bowning Creek (Bowning), Bogolong Creek (Booham) and Balgalal Creek and Bobbara Gully (Binalong). The study will also define areas that are subject to major overland flow which occurs as a result of surcharge of the local stormwater drainage system. Please see the back of this page for the approximate extent of the study areas.

The study is being undertaken by Council with funding assistance from the NSW Office of Environment and Heritage which aims to build community resilience towards flooding through informing better planning of development, emergency management and community awareness. Council has established a Floodplain Risk Management Committee which is comprised of relevant council members, state government agencies and community representatives.

The *Flood Study* is an important first step in the floodplain risk management process for this area and will be managed by Council according to the NSW Government's Flood Prone Lands Policy. Following the completion of the *Flood Study*, a Floodplain Risk Management Study and Plan will also be completed which will include further consultation on management options.

The various stages of the *Flood Study* will be as follows:

- Survey along the creeks and collection of data on historic flooding.
- Preparation of computer models of the creeks and floodplain to determine flooding and drainage patterns, flood levels, flow velocities and depths of inundation.
- Preparation of a *Flood Study* report which will document the findings of the investigation. The draft *Flood Study* report will be placed on public exhibition following completion of the investigation seeking community feedback on its findings

An important first step in the preparation of a *Flood Study* is to identify the availability of information on historic flooding in the village. The attached **questionnaire** has been provided to residents and business owners to assist the consultants in gathering this important information. The questionnaire may also be completed online via Council's website (https://www.surveymonkey.com/r/MBBBFloodStudy). All information provided will remain confidential and for use in this study only. Please return the completed questionnaire in the reply paid envelope provided by **Friday 31 August 2018**.

Contact: Yass Valley Council

Joseph Cleary | Design Engineer
Phone: (02) 6226 1477
Email: Council@yass.nsw.gov.au

yass valley council
the country the people

MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALONG FLOOD STUDIES

Community Questionnaire

This questionnaire is part of the *Murrumbateman, Bowning, Bookham and Binalong Flood Studies*, which is currently being prepared by Yass Valley Council with the financial and technical support of the NSW Office of Environment & Heritage. Your responses to the questionnaire will help us determine the flood issues that are important to you.

Please return your completed questionnaire in the reply paid envelope provided by **Friday 31 August 2018**. No postage stamp is required. If you have misplaced the supplied envelope or wish to send an additional submission the address is:

Lyall & Associates Consulting Water Engineers
Reply Paid 85163
NORTH SYDNEY NSW 2060

Alternatively, the questionnaire can be completed online via the following link:

https://www.surveymonkey.com/r/MBBBFloodStudy

1. What village do you live in?

____

2. Your details:

Name (Optional):______________________________

Address:______________________________

Phone Number (Optional):______________________________

Email (Optional): ______________________________

3. Please tick as appropriate:

- ☐ I am a resident
- ☐ I am a business owner
- ☐ Other (please specify ____________________)

4. How long have you been at this address?

- ☐ 1 year to 5 years
- ☐ 5 years to 20 years
- ☐ More than 20 years (__________ years)

5. What is your property?

- ☐ House
- ☐ Villa/Townhouse
- ☐ Unit/Flat/Apartment
- ☐ Vacant land
- ☐ Industrial unit in larger complex
- ☐ Stand alone warehouse or factory
- ☐ Shop
- ☐ Community building
- ☐ Other (____)

6. Has your property ever been inundated by floodwaters in the past?

[ ] Yes [ ] No

7. If you answered yes to Question 6, when did it occur and which part(s) of your property was affected?

(Please provide a short description such as: duration of flooding, source of water, flow directions, etc. Refer example below.)

	Location	Date / Time / Description
[✓]	**EXAMPLE ONLY** Driveway	8 March 2012 @ 2 pm – driveway flooded from direction of street, continued for 10 – 15 minutes. Floodwaters continued through property down northern side of house.
[ ]	Driveway	
[ ]	Water level below floor level in building	
[ ]	Water level above floor level in building	
[ ]	Garage	
[ ]	Front yard	
[ ]	Backyard	
[ ]	Shed	
[ ]	Other (please specify)	

8. If flooding affected your property in the past, what damages occurred as a result?

____

____

____

9. Are you aware of any other flooding problems in the study area? (The attached map may be useful to mark the location of any problem areas).

____

____

____

10. Please provide dates of historic flooding, even if it is only the year in which the event occurred. Rank the floods from the most severe to the least severe.

1. ___________ 2. ___________ 3. ___________ 4.___________

11. For the floods you have listed, do you have any records of the height the floodwaters reached? For example, a flood mark on a building, shed, fence, light pole, etc.

[ ] Yes [ ] No

12. If you answered yes to Question 11, please provide a short description of the location of the flood mark(s), maximum depth of flooding, source and or direction of water, etc. Refer example below.

	Location	Maximum Depth (m)	Description
[✓]	**EXAMPLE ONLY** Residential	0.3 m	8 March 2012, just after 2 pm - depth of floodwaters along northern side of house reached 0.3 m adjacent to front steps.
[ ]	Residential		
[ ]	Commercial		
[ ]	Park		
[ ]	Road/ Footpath		
[ ]	Other (please specify)		

13. Do you have any photos, videos or other evidence of the flood marks that you have identified?

[ ] Yes [ ] No

14. If you answered yes to Question 13, could you please provide as much detail as possible, including whether you would be willing to provide Council with electronic copies of any photos/videos?

You may wish to email any flood data that you have directly to Council (refer email address provided at the bottom of the attached Community Newsletter).

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15. Do you have any information on bridge or pipe blockage or the inundation of local roads due to surcharge of the existing drainage system?

[ ] Yes [ ] No

16. If you answered yes to Question 15, could you please identify the location? Could you also comment on the nature of the blockage and/or the duration and depth of the flooding in the local road network?

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17. Do you wish Council to contact you so you can provide further information? Please make sure you have provided your contact details in Question 1

[ ] Yes [ ] No

18. Please write any additional comments here:

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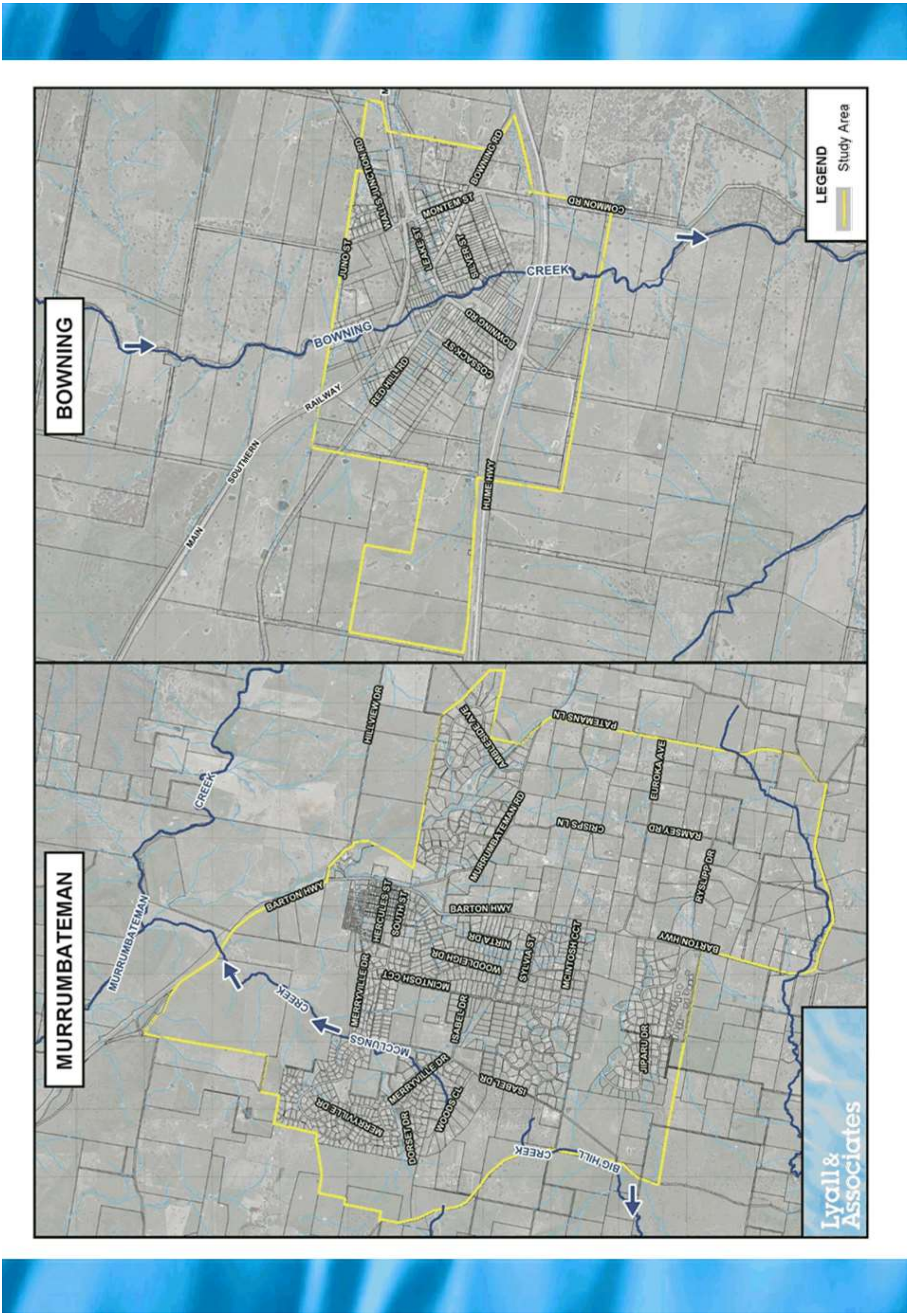
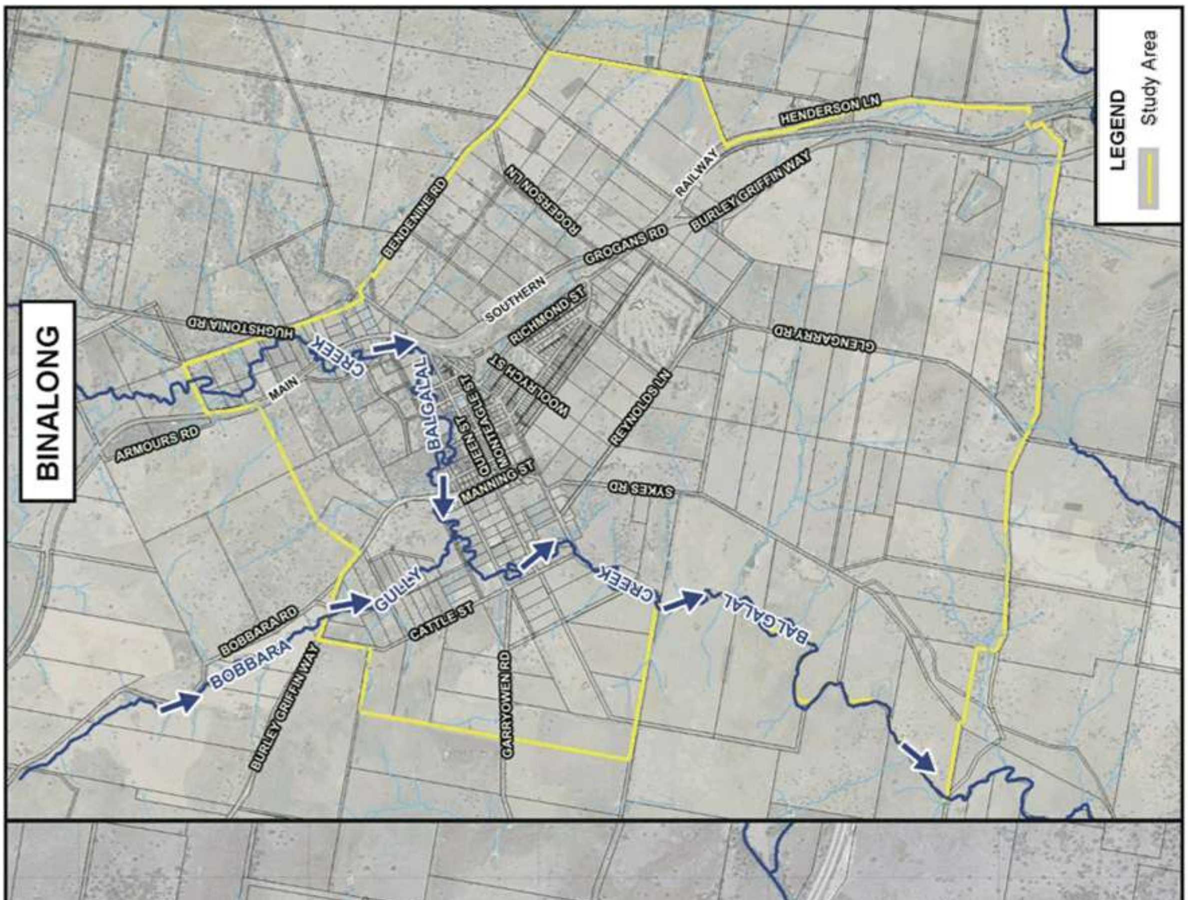

LEGEND
Study Area
BOWNING
BOWNING
CREEK
WALLS JUNCTION RD
JUNO ST
LEAKE ST
MONTEM ST
SILVER ST
BOWNING RD
COMMON RD
BOWNING RD
COSSACK ST
RED HILL RD
MAIN SOUTHERN RAILWAY
HUME HWY
MURRUMBATEMAN
MURRUMBATEMAN
CREEK
MCCLUNGS
CREEK
BIG HILL
CREEK
HILLVIEW DR
AMBLESIDE AVE
PATEMANS LN
EUROKA AVE
CRISPS LN
RAMSEY RD
RYSLIPP DR
MURRUMBATEMAN RD
BARTON HWY
BARTON HWY
BARTON HWY
HERCULES ST
SOUTH ST
NIRTA DR
WOODLEIGH DR
SYLVIA ST
MCINTOSH CCT
MCINTOSH CCT
MERRYVILLE DR
ISABEL DR
ISABEL DR
JIPARU DR
MERRYVILLE DR
MERRYVILLE DR
DORSET DR
WOODS CL
Lyall & Associates


BINALONG
BOOKHAM
LEGEND
Study Area
HENDERSON LN
RAILWAY
BURLEY GRIFFIN WAY
GROGANS RD
SOUTHERN
ROGERSON LN
BENDENINE RD
HUGHSTONIA RD
RICHMOND ST
GLENCARRY RD
CREEK
BALGALAL
MAIN
WOOLRYCH ST
QUEEN ST
MONTEAGLE ST
MANNING ST
REYNOLDS LN
ARMOURS RD
SYKES RD
GULLY
CATTLE ST
BOBBARA RD
BOBBARA
GARRYOWEN RD
MIDDLETONS
FAGAN DR
DRUMMOND ST
ILLALONG RD
BOGOLONG
JUGIONG
CHILDOWLA RD
HUME HWY
Lyall & Associates

APPENDIX B
DETAILS OF AVAILABLE DATA

B1. COLLECTION OF MISCELLANEOUS DATA

B1.1 Previous Reports

The following studies have previously been undertaken in the vicinity of the four villages:

- *Yass Flood Study* (WMA, 2016a)
- *Sutton Flood Study* (WMA, 2016b)
- *Gundaroo Flood Study* (WMA, 2016c)
- *Sutton Floodplain Risk Management Study and Plan* (WMA, 2016d)
- *Gundaroo Floodplain Risk Management Study and Plan* (WMA, 2016e)
- *MR15 Barton Highway Duplication, Hall to Yass – Flood Impact Assessment Report* (J. Wyndham Prince, 2018)

B1.2 Airborne Laser Scanning Survey

Table B2.1 sets out the details of the five sets of LiDAR survey data that cover the four villages. The data comprising each set were captured in accordance with the International Committee on Surveying and Mapping guidelines for digital elevation data with a 95% confidence interval on horizontal accuracy of ±800 mm and a vertical accuracy of ±150 mm.

TABLE B2.1
LiDAR SURVEY DATA SPECIFICATIONS

Data Set	Date of Capture	Data Provider
MurrumbatemanTown1212	December 2012	Lands and Property Information
BowningTown0313	March 2013	
BinalongTown201411	November 2014	
GDA94_MGA_Zone55_Murrumbateman_LIDAR_1808(1)	August 2018	AVMap Aerial Mapping & Surveying
GDA94_MGA_Zone55_Bookham_LIDAR_1808	August 2018	

1. "GDA94_MGA_Zone55_Murrumbateman_LIDAR_1808" data set covers a 1 km^2 area in the vicinity of the Fairley Village sub-division which has been constructed since the "MurrumbatemanTown1212" data set was captured in December 2012.

B1.3 Existing Stormwater Network

Figures 2.2, **2.3**, **2.4** and **2.5** of the Main Report show the plan location of the existing stormwater network at Murrumbateman, Bowning, Bookham and Binalong, respectively. Details of the stormwater network were taken from the following sources:

- **Councils Stormwater Asset Database**

  At the commencement of the study, Council provided a copy of its then current stormwater pit and pipe database in MAPINFO format. The database was generally limited to pipe and culvert dimensions, pipe invert levels and pit type in the vicinity of Fairley Village at Murrumbateman. Council's stormwater asset database also included the approximate alignment on the piped drainage system in the area that is bounded by Fairley Village to the north, the Barton Highway to the east, South Street to the south and West Street to the west.

The database did not contain details of the piped drainage system at Bowning, Bookham and Binalong.

➢ **Detailed Design Drawings**

At the commencement of the study, Council provided a hard-copy set of Work-As-Executed plans of the stormwater drainage network associated within the following residential subdivisions at Murrumbateman:

- Merryville Estate
- Jiparu Estate
- Carrington Park
- Meryville Park
- Dundoos Estate
- Ambleside Estate

The database was generally limited to pipe and culvert dimensions and alignments.

➢ **Road Asset Management System**

NSW Roads and Maritime Services (**Roads and Maritime**) South West Region provided details of the culvert and bridge crossings along the Barton Highway (Murrumbateman), the Hume Highway (Bowning and Bookham) and Burley Griffin Way (Binalong). The data were limited to culvert dimensions and alignment. Roads and Maritime also provided Work-As-Executed plans for the bridge structures on the aforementioned roads.

➢ **Structure Survey**

Diverse Property Solutions was engaged to undertake survey of the stormwater network that was not included in the available databases. Pipe and box culvert structure survey was provided as tabulations of location (coordinates set out in the MGA co-ordinate system), elevation, size and number of barrels in an Excel spreadsheet. Where the structure was a bridge, a sketch was provided showing its key dimensions. A photographic record of each structure was compiled by the surveyor.

B1.4 Floor Level Survey

A drive-by estimate of floor heights above natural surface level was undertaken by Lyall & Associates during field inspections in June 2018. The elevations of building floors were derived by adding the drive-by estimate of the above-ground floor height to the natural surface elevation determined from the available LiDAR survey data.

B1.5 Historic Rainfall Data

Rainfall data were available at five AWS and two pluviographic rain gauges, all of which are operated by BoM. **Figure 1.1** of the Main Report shows the plan location of the abovementioned gauges, while **Table B1.2** at the end of this Appendix sets out the details of the rain gauges, as well as the historic storm events for which rainfall data were available.

B1.6 Photographic Record

A number of photographs were provided by respondents to the *Community Newsletter and Questionnaire* showing flooding behaviour in in Murrumbateman during storms that occurred on 14 February 2010, 18 June 2016 and 21 September 2016, and in Binalong during storms that occurred on 14 February 2010, 24 January 2015, 31 August 2016 and 21 September 2016.

TABLE B1.2
SUMMARY OF AVAILABLE RAIN GAUGE DATA[1]

Gauge Number	Gauge Name	Storm Event										
		22-23 September 2009	13-15 February 2010	27 February - 5 March 2012	28 February - 1 March 2013	17-18 September 2013	25 January 2015	4-6 June 2016	20 June 2016	22-23 July 2016	31 August 2016	21-22 September 2016
70351	Canberra Airport	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
70330	Goulburn Airport AWS	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
70349	Mount Ginini AWS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
73151	Temora Airport	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
70339	Tuggeranong (Isabella Plains) AWS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
73138	Young Airport	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
73007	Burrinjuck Dam	No	No	Yes	No	No	No	No	No	No	No	No

1. Refer Figure 1.1 for location.

APPENDIX C
PHOTOGRAPHS SHOWING HISTORIC FLOOD BEHAVIOUR IN MURRUMBATEMAN AND BINALONG

BINALONG – 14 FEBRUARY 2010

(Source: Beverley Pollard)

Plate C1.1 – (Photo taken at 11:00 hrs) Floodwater in channel on upstream (southern) side of Monteagle Street.

Plate C1.2 – (Photo taken at 11:00 hrs) Looking south from road reserve along channel adjacent to No. 2 Monteagle Street.

MURRUMBATEMAN – 14 FEBRUARY 2010

(Source: Simone Clark)

Plate C2.1 – (Photo taken at 12:39 hrs) Looking south-west across floodwater in the rear of No. 20 Broughton Circuit.

Plate C2.2 – (Photo taken at 12:38 hrs) Looking south from across floodwater in the rear of No. 20 Broughton Circuit.

Plate C2.3 – (Photo taken at 12:37 hrs) Looking south-east across floodwater in the rear of No. 20 Broughton Circuit.

Plate C2.4 – (Photo taken at 14:45 hrs) Looking north-west along boundary between Nos. 20 and 22 Broughton Circuit.

Plate C2.5 – (Photo taken at 14:27 hrs) Looking north-east from southern boundary of No. 20 Broughton Circuit.

Plate C2.6 – (Photo taken at 14:43 hrs) Looking north-west along boundary between Nos. 20 and 22 Broughton Circuit.

<table>
<tr><th colspan="2">MURRUMBATEMAN – 14 FEBRUARY 2010
(Source: Simone Clark)</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Plate C2.7 – (Photo taken at 14:48 hrs) Looking west along boundary between Nos. 20 and 22 Broughton Circuit.</td><td>Plate C2.8 – (Photo taken at 14:45 hrs) Photo showing approximate depth of overland flow along boundary between Nos. 20 and 22 Broughton Circuit.</td></tr>
</table>

BINALONG – 24 JANUARY 2015

(Source: Beverley Pollard)

Plate C3.1 – (Photo taken at 15:09 hrs) Looking north along channel adjacent to No. 2 Monteagle Street.

MURRUMBATEMAN – 18 JUNE 2016

(Source: Steve Hein)

Plate C4.1 – (Photo taken at 10:21 hrs) Looking north-west at McClungs Creek in the rear of No. 2 Woods Close.

Plate C4.2 – (Photo taken at 10:31 hrs) Runoff flowing into existing dam at the rear of No. 2 Woods Close.

Plate C4.3 – (Photo taken on 23 Jul 10:17 hrs) Looking west across existing dam at the rear of No. 2 Woods Close. Normal dam line marked in photograph.

Plate C4.4 – (Photo taken on 22 July 17:47 hrs) Looking south-east across existing dam at the rear of No. 2 Woods Close. Normal dam line marked in photograph.

BINALONG – 31 AUGUST 2016

(Source: Beverley Pollard)

Plate C5.1 – (Photo taken at 11:26 hrs) Looking west along channel at rear of No. 2 Monteagle Street.

Plate C5.2 – (Photo taken at 11:27 hrs) Looking west across channel adjacent to No. 2 Monteagle Street.

Plate C5.3 – (Photo taken at 11:28 hrs) Looking west across channel adjacent to No. 2 Monteagle Street.

BINALONG – 21 SEPTEMBER 2016

(Source: Luke McAlary)

Plate C6.1 – (Photo taken at 11:42 hrs) Looking north-east along Balgalal Creek from No. 32 Queen Street.

Plate C6.2 – (Photo taken at 14:57 hrs) Looking north across Balgalal Creek from northern end of Stephens Street.

Plate C6.3 – (Photo taken at 14:59 hrs) Looking north across Balgalal Creek from northern end of Stephens Street.

Plate C6.4 – (Photo taken at 15:12 hrs) Looking north along channel that runs parallel to Richmond Street between Monteagle Street and Queen Street.

MURRUMBATEMAN – 21 SEPTEMBER 2016

Plate C7.1 – (Photo taken at 12:50 hrs) Looking south-east from Elrington Close toward Murrumbateman Road. *(Source: Bob Evans)*

Plate C7.2 – (Photo taken at 12:50 hrs) Looking south-east from Elrington Close toward Murrumbateman Road. *(Source: Bob Evans)*

Plate C7.3 – (Photo taken at 12:50 hrs) Looking south-east from Elrington Close toward Murrumbateman Road. *(Source: Bob Evans)*

Plate C7.4 – (Photo taken at 17:15 hrs) Greenwood Road Crossing of Murrumbateman Creek. *(Source: Dennis Hogan)*

Plate C7.5 – (Photo taken at 17:30 hrs) Keirs Road Crossing of Murrumbateman Creek. *(Source: Dennis Hogan)*

Plate C7.6 – (Photo taken at 17:30 hrs) Keirs Road Crossing of Murrumbateman Creek. *(Source: Dennis Hogan)*

APPENDIX D
DESIGN INPUT DATA FROM ARR DATA HUB

ATTENTION: This site was updated recently, changing some of the functionality. Please see the changelog (./changelog) for further information.

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	149.025
Latitude	-34.975
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

Data

River Region

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

Layer Info

Time Accessed	23 July 2019 04:02PM
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
SE Coast	0.06	0.361	0.0	0.317	8.11e-05	0.651	0.0	0.0	0.0

Layer Info

Time Accessed	23 July 2019 04:02PM
Version	2016_v1

Short Duration ARF

$$ARF = Min\left[1, 1 - 0.287\left(Area^{0.265} - 0.439\log_{10}(Duration)\right).Duration^{-0.36} + 2.26 \times 10^{-5} \times Area^{0.226}.Duration^{0.125}\left(0.3 + \log_{10}(AEP)\right) + 0.0141 \times Area^{0.213} \times 10^{-0.021\frac{(Duration-180)^2}{1440}}\left(0.3 + \log_{10}(AEP)\right)\right]$$

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	22208.0
Storm Initial Losses (mm)	27.0
Storm Continuing Losses (mm/h)	3.7

Layer Info

Time Accessed	23 July 2019 04:02PM
Version	2016_v1

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

code	MB
Label	Murray Basin

Layer Info

Time Accessed	23 July 2019 04:02PM
Version	2016_v2

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

code	MB
arealabel	Murray Basin

Layer Info

Time Accessed	23 July 2019 04:02PM
Version	2016_v2

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-34.975&longitude=149.025&sdmin=true&sdhr
to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	23 July 2019 04:02PM

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)	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)	0.2 (0.005)	0.4 (0.008)
120 (2.0)	0.3 (0.012)	0.2 (0.006)	0.1 (0.003)	0.1 (0.001)	0.3 (0.005)	0.4 (0.008)
180 (3.0)	0.1 (0.005)	0.9 (0.026)	1.4 (0.035)	1.9 (0.041)	0.8 (0.015)	0.0 (0.000)
360 (6.0)	0.8 (0.024)	0.5 (0.011)	0.2 (0.005)	0.0 (0.000)	0.3 (0.005)	0.5 (0.007)
720 (12.0)	0.2 (0.004)	1.4 (0.026)	2.3 (0.034)	3.1 (0.039)	5.6 (0.059)	7.5 (0.069)
1080 (18.0)	0.0 (0.000)	0.7 (0.011)	1.2 (0.015)	1.6 (0.018)	7.0 (0.064)	11.1 (0.087)
1440 (24.0)	0.0 (0.000)	0.2 (0.003)	0.3 (0.004)	0.4 (0.004)	2.8 (0.023)	4.6 (0.033)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.6 (0.004)	1.0 (0.007)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.1 (0.001)	0.2 (0.001)
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	23 July 2019 04:02PM
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	23 July 2019 04:02PM
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 (0.000)	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	23 July 2019 04:02PM
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)	10.1 (0.575)	9.3 (0.394)	8.8 (0.317)	8.3 (0.261)	10.1 (0.271)	11.4 (0.275)
90 (1.5)	8.6 (0.430)	8.1 (0.302)	7.8 (0.246)	7.5 (0.206)	10.2 (0.238)	12.2 (0.255)
120 (2.0)	11.8 (0.541)	9.7 (0.328)	8.2 (0.237)	6.8 (0.171)	10.3 (0.217)	12.8 (0.242)
180 (3.0)	10.0 (0.400)	12.4 (0.370)	14.0 (0.354)	15.6 (0.339)	12.7 (0.232)	10.6 (0.171)
360 (6.0)	7.6 (0.238)	9.2 (0.215)	10.2 (0.281)	11.3 (0.189)	20.6 (0.287)	27.7 (0.336)
720 (12.0)	7.3 (0.179)	11.1 (0.202)	13.6 (0.206)	16.0 (0.206)	29.9 (0.315)	40.3 (0.369)
1080 (18.0)	4.4 (0.092)	8.2 (0.129)	10.7 (0.140)	13.2 (0.146)	27.6 (0.250)	38.4 (0.302)
1440 (24.0)	0.2 (0.003)	3.6 (0.051)	5.8 (0.069)	8.0 (0.080)	14.8 (0.122)	19.9 (0.143)
2160 (36.0)	0.0 (0.000)	1.3 (0.016)	2.1 (0.022)	2.9 (0.026)	7.8 (0.057)	11.5 (0.074)
2880 (48.0)	0.0 (0.000)	1.3 (0.014)	2.1 (0.020)	2.9 (0.024)	5.8 (0.040)	8.0 (0.048)
4320 (72.0)	0.0 (0.000)	0.1 (0.001)	0.1 (0.001)	0.2 (0.001)	0.4 (0.002)	0.5 (0.003)

Layer Info

Time Accessed	23 July 2019 04:02PM
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)	24.5 (1.401)	21.1 (0.896)	18.8 (0.680)	16.6 (0.524)	22.8 (0.613)	27.4 (0.662)
90 (1.5)	16.7 (0.838)	18.9 (0.705)	20.3 (0.644)	21.7 (0.598)	21.8 (0.511)	21.9 (0.459)
120 (2.0)	22.5 (1.027)	22.9 (0.778)	23.1 (0.667)	23.4 (0.585)	28.9 (0.612)	33.1 (0.624)
180 (3.0)	19.9 (0.795)	22.9 (0.681)	24.8 (0.625)	26.7 (0.581)	24.2 (0.442)	22.4 (0.362)
360 (6.0)	18.2 (0.570)	24.7 (0.577)	28.9 (0.569)	33.1 (0.556)	51.6 (0.718)	65.5 (0.797)
720 (12.0)	19.6 (0.477)	31.9 (0.579)	40.0 (0.607)	47.8 (0.616)	67.7 (0.715)	82.7 (0.757)
1080 (18.0)	14.4 (0.304)	21.2 (0.333)	25.8 (0.337)	30.1 (0.333)	56.5 (0.513)	76.3 (0.601)
1440 (24.0)	6.0 (0.114)	16.4 (0.234)	23.4 (0.277)	30.0 (0.301)	36.6 (0.301)	41.5 (0.298)
2160 (36.0)	6.5 (0.110)	10.2 (0.128)	12.7 (0.132)	15.0 (0.133)	23.7 (0.173)	30.2 (0.194)
2880 (48.0)	1.3 (0.020)	8.3 (0.095)	12.9 (0.124)	17.3 (0.142)	23.2 (0.158)	27.5 (0.166)
4320 (72.0)	3.5 (0.049)	6.7 (0.070)	8.8 (0.078)	10.9 (0.082)	12.2 (0.077)	13.2 (0.074)

Layer Info

Time Accessed	23 July 2019 04:02PM
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	23 July 2019 04:02PM
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	20	10	5	2	1
60 (1.0)	17.7	11.9	10.8	11.0	10.6	9.4
90 (1.5)	20.2	13.7	10.2	12.3	11.5	10.7
120 (2.0)	20.8	12.8	11.9	12.4	11.5	9.7
180 (3.0)	21.0	13.4	10.1	12.6	12.8	12.1
360 (6.0)	21.4	14.9	14.2	14.6	13.2	7.6
720 (12.0)	21.4	14.9	14.5	14.5	11.4	6.9
1080 (18.0)	22.9	17.6	17.2	18.0	13.2	7.0
1440 (24.0)	25.5	20.1	18.4	20.4	17.6	9.5
2160 (36.0)	26.0	21.4	22.1	24.4	20.2	14.0
2880 (48.0)	27.3	22.3	22.5	24.9	20.9	14.3
4320 (72.0)	27.1	23.2	24.7	27.3	24.1	19.8

Layer Info

Time Accessed	23 July 2019 04:02PM
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/7a1e482b-50d7-43e9-9e77-6e3a17e7ce8e.txt)

Download JSON (downloads/ab3b9977-e1f1-4a35-8c18-23b700f3dda7.json)

Generating PDF... (downloads/b047daa2-6454-479c-8065-9da7ca96c813.pdf)

ATTENTION: This site was updated recently, changing some of the functionality. Please see the changelog (./changelog) for further information.

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	148.81
Latitude	-34.746
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

Data

River Region

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

Layer Info

Time Accessed	05 August 2019 03:34PM
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	05 August 2019 03:34PM
Version	2016_v1

Short Duration ARF

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

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	4511.0
Storm Initial Losses (mm)	30.0
Storm Continuing Losses (mm/h)	4.5

Layer Info

Time Accessed	05 August 2019 03:34PM
Version	2016_v1

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

code	MB
Label	Murray Basin

Layer Info

Time Accessed	05 August 2019 03:34PM
Version	2016_v2

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

code	MB
arealabel	Murray Basin

Layer Info

Time Accessed	05 August 2019 03:34PM
Version	2016_v2

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-34.748&longitude=148.81&sdmin=true&sdhr= to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	05 August 2019 03:34PM

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)	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)	0.1 (0.007)	0.1 (0.003)	0.0 (0.001)	0.0 (0.000)	0.1 (0.002)	0.1 (0.003)
120 (2.0)	0.1 (0.004)	0.1 (0.004)	0.1 (0.004)	0.1 (0.004)	0.3 (0.007)	0.4 (0.008)
180 (3.0)	4.0 (0.164)	2.8 (0.085)	2.0 (0.051)	1.2 (0.026)	0.6 (0.012)	0.2 (0.003)
360 (6.0)	0.6 (0.018)	0.5 (0.011)	0.4 (0.008)	0.3 (0.006)	0.6 (0.008)	0.8 (0.010)
720 (12.0)	0.0 (0.000)	1.6 (0.028)	2.6 (0.039)	3.6 (0.047)	7.5 (0.081)	10.5 (0.099)
1080 (18.0)	0.0 (0.000)	0.6 (0.009)	1.0 (0.013)	1.3 (0.015)	5.6 (0.052)	8.8 (0.072)
1440 (24.0)	0.0 (0.000)	0.3 (0.004)	0.5 (0.006)	0.6 (0.007)	1.9 (0.016)	2.9 (0.022)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.3 (0.002)	0.5 (0.004)
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	05 August 2019 03:34PM
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	05 August 2019 03:34PM
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 (0.000)	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	05 August 2019 03:34PM
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)	6.8 (0.412)	5.3 (0.240)	4.3 (0.165)	3.3 (0.111)	5.9 (0.169)	7.9 (0.202)
90 (1.5)	7.1 (0.375)	6.2 (0.245)	5.6 (0.188)	5.1 (0.147)	9.8 (0.240)	13.3 (0.291)
120 (2.0)	12.3 (0.582)	12.7 (0.449)	12.9 (0.388)	13.2 (0.343)	13.2 (0.291)	13.3 (0.260)
180 (3.0)	16.0 (0.657)	15.1 (0.460)	14.4 (0.373)	13.8 (0.308)	11.7 (0.220)	10.2 (0.168)
360 (6.0)	9.1 (0.287)	11.5 (0.269)	13.1 (0.258)	14.6 (0.247)	20.4 (0.288)	24.8 (0.307)
720 (12.0)	3.7 (0.089)	10.0 (0.181)	14.2 (0.215)	18.3 (0.236)	30.3 (0.324)	39.3 (0.370)
1080 (18.0)	1.9 (0.040)	6.6 (0.103)	9.7 (0.127)	12.7 (0.142)	21.4 (0.198)	27.8 (0.228)
1440 (24.0)	0.9 (0.017)	4.5 (0.064)	6.9 (0.083)	9.3 (0.094)	11.2 (0.096)	12.7 (0.096)
2160 (36.0)	0.3 (0.005)	2.0 (0.025)	3.1 (0.033)	4.1 (0.037)	6.8 (0.052)	8.8 (0.060)
2880 (48.0)	0.0 (0.000)	0.2 (0.002)	0.3 (0.003)	0.5 (0.004)	4.0 (0.029)	6.6 (0.043)
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	05 August 2019 03:34PM
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)	16.9 (1.021)	20.9 (0.947)	23.5 (0.908)	26.0 (0.875)	26.0 (0.742)	25.9 (0.661)
90 (1.5)	15.3 (0.805)	17.3 (0.680)	18.6 (0.621)	19.8 (0.575)	21.7 (0.532)	23.0 (0.504)
120 (2.0)	22.1 (1.046)	25.6 (0.907)	27.9 (0.840)	30.2 (0.786)	28.5 (0.628)	27.3 (0.534)
180 (3.0)	40.4 (1.659)	34.5 (1.054)	30.6 (0.790)	26.8 (0.598)	25.7 (0.481)	24.8 (0.411)
360 (6.0)	18.4 (0.583)	25.3 (0.593)	29.6 (0.588)	34.2 (0.579)	47.4 (0.667)	57.2 (0.709)
720 (12.0)	19.0 (0.464)	33.2 (0.598)	42.6 (0.642)	51.6 (0.664)	67.1 (0.718)	78.7 (0.740)
1080 (18.0)	14.6 (0.309)	21.5 (0.337)	26.1 (0.341)	30.5 (0.340)	48.6 (0.451)	62.1 (0.508)
1440 (24.0)	11.8 (0.228)	19.2 (0.274)	24.1 (0.287)	28.8 (0.293)	30.6 (0.260)	31.9 (0.240)
2160 (36.0)	9.4 (0.161)	14.0 (0.178)	17.1 (0.182)	20.1 (0.182)	21.4 (0.164)	22.5 (0.153)
2880 (48.0)	1.2 (0.019)	5.4 (0.063)	8.1 (0.081)	10.8 (0.092)	21.0 (0.152)	28.6 (0.185)
4320 (72.0)	1.0 (0.014)	5.0 (0.054)	7.6 (0.070)	10.2 (0.080)	10.4 (0.070)	10.5 (0.064)

Layer Info

Time Accessed	05 August 2019 03:34PM
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%)**
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Layer Info

Time Accessed	05 August 2019 03:34PM
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	20	10	5	2	1
60 (1.0)	16.8	14.4	12.1	11.5	11.4	10.0
90 (1.5)	19.2	15.3	13.4	13.1	12.6	11.5
120 (2.0)	21.2	13.5	11.8	11.7	11.7	11.3
180 (3.0)	20.5	11.5	11.3	12.7	13.1	12.3
360 (6.0)	23.8	16.2	14.8	15.2	13.1	9.0
720 (12.0)	24.5	17.2	15.7	15.2	12.7	6.3
1080 (18.0)	25.7	20.2	18.0	19.3	15.6	10.2
1440 (24.0)	26.9	21.4	20.7	22.0	19.3	14.0
2160 (36.0)	28.0	22.9	23.5	25.3	23.0	15.6
2880 (48.0)	30.1	25.2	26.4	27.6	24.2	16.6
4320 (72.0)	30.5	25.7	27.1	28.8	25.3	22.2

Layer Info

Time Accessed	05 August 2019 03:34PM
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/10b5b875-7022-46cf-ab46-628ce5765403.txt)

Download JSON (downloads/65f48c3f-6290-49eb-a957-62ab84289243.json)

Generating PDF... (downloads/39f2d2da-33f2-4628-b9d1-ccaa8452f123.pdf)

ATTENTION: This site was updated recently, changing some of the functionality. Please see the changelog (./changelog) for further information

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	148.649
Latitude	-34.854
Selected Regions (clear)	
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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

Data

River Region

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

Layer Info

Time Accessed	16 August 2019 01:32PM
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	16 August 2019 01:32PM
Version	2016_v1

Short Duration ARF

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

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	18727.0
Storm Initial Losses (mm)	31.0
Storm Continuing Losses (mm/h)	4.1

Layer Info

Time Accessed	16 August 2019 01:32PM
Version	2016_v1

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

code	MB
Label	Murray Basin

Layer Info

Time Accessed	16 August 2019 01:32PM
Version	2016_v2

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

code	MB
arealabel	Murray Basin

Layer Info

Time Accessed	16 August 2019 01:32PM
Version	2016_v2

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-34.854014&longitude=148.648668&sdmin=tr to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	16 August 2019 01:32PM

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)	1.1 (0.059)	0.6 (0.026)	0.3 (0.012)	0.1 (0.002)	0.0 (0.001)	0.0 (0.000)
90 (1.5)	1.6 (0.075)	1.1 (0.040)	0.8 (0.024)	0.5 (0.013)	0.6 (0.014)	0.7 (0.014)
120 (2.0)	1.3 (0.058)	0.9 (0.029)	0.6 (0.016)	0.3 (0.007)	0.3 (0.006)	0.2 (0.004)
180 (3.0)	2.1 (0.081)	1.8 (0.050)	1.5 (0.037)	1.3 (0.027)	0.6 (0.011)	0.1 (0.002)
360 (6.0)	3.1 (0.091)	1.9 (0.041)	1.1 (0.026)	0.3 (0.005)	0.7 (0.010)	1.1 (0.012)
720 (12.0)	0.4 (0.009)	1.8 (0.030)	2.7 (0.038)	3.6 (0.043)	7.6 (0.076)	10.6 (0.093)
1080 (18.0)	0.0 (0.000)	1.1 (0.016)	1.8 (0.022)	2.5 (0.026)	7.4 (0.064)	11.1 (0.085)
1440 (24.0)	0.0 (0.000)	0.4 (0.005)	0.7 (0.008)	1.0 (0.009)	3.6 (0.028)	5.5 (0.038)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.2 (0.002)	0.4 (0.002)
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	16 August 2019 01:32PM
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	16 August 2019 01:32PM
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 (0.000)	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)	0.2 (0.002)	0.3 (0.003)
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	16 August 2019 01:32PM
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)	10.1 (0.565)	9.8 (0.410)	9.6 (0.341)	9.4 (0.291)	10.4 (0.271)	11.2 (0.259)
90 (1.5)	12.6 (0.610)	11.6 (0.419)	10.9 (0.335)	10.3 (0.273)	12.7 (0.285)	14.5 (0.289)
120 (2.0)	12.7 (0.555)	11.9 (0.388)	11.4 (0.314)	10.8 (0.259)	10.1 (0.203)	9.5 (0.169)
180 (3.0)	11.5 (0.434)	13.6 (0.383)	15.0 (0.357)	16.3 (0.335)	14.1 (0.243)	12.5 (0.190)
360 (6.0)	14.9 (0.436)	14.7 (0.320)	14.5 (0.266)	14.4 (0.226)	22.2 (0.291)	28.1 (0.323)
720 (12.0)	9.5 (0.215)	13.0 (0.219)	15.4 (0.216)	17.6 (0.211)	30.8 (0.308)	40.7 (0.357)
1080 (18.0)	2.3 (0.044)	6.9 (0.100)	9.9 (0.121)	12.9 (0.133)	25.4 (0.219)	34.7 (0.264)
1440 (24.0)	0.9 (0.016)	4.5 (0.059)	6.9 (0.076)	9.2 (0.086)	16.0 (0.126)	21.0 (0.146)
2160 (36.0)	0.0 (0.000)	1.7 (0.020)	2.9 (0.028)	4.0 (0.033)	7.7 (0.054)	10.5 (0.065)
2880 (48.0)	0.0 (0.000)	1.5 (0.016)	2.4 (0.022)	3.4 (0.026)	6.0 (0.039)	8.0 (0.046)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.1 (0.001)	0.1 (0.001)	0.2 (0.001)	0.3 (0.002)

Layer Info

Time Accessed	16 August 2019 01:32PM
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)	24.6 (1.371)	22.2 (0.928)	20.7 (0.734)	19.2 (0.591)	21.9 (0.570)	23.9 (0.555)
90 (1.5)	24.9 (1.205)	25.5 (0.923)	25.9 (0.795)	26.3 (0.700)	29.3 (0.657)	31.6 (0.628)
120 (2.0)	33.1 (1.446)	31.2 (1.019)	30.0 (0.829)	28.8 (0.689)	32.2 (0.648)	34.7 (0.620)
180 (3.0)	20.7 (0.783)	24.9 (0.703)	27.7 (0.661)	30.4 (0.625)	31.2 (0.537)	31.8 (0.484)
360 (6.0)	27.1 (0.794)	32.2 (0.701)	35.5 (0.651)	38.8 (0.609)	56.7 (0.741)	70.1 (0.805)
720 (12.0)	25.2 (0.572)	33.0 (0.555)	38.2 (0.537)	43.2 (0.518)	68.1 (0.680)	86.9 (0.761)
1080 (18.0)	16.9 (0.329)	23.0 (0.333)	27.1 (0.328)	31.0 (0.321)	53.5 (0.463)	70.5 (0.536)
1440 (24.0)	11.0 (0.195)	17.4 (0.228)	21.6 (0.238)	25.7 (0.241)	35.2 (0.277)	42.3 (0.295)
2160 (36.0)	11.3 (0.175)	13.8 (0.159)	15.4 (0.149)	17.0 (0.141)	22.2 (0.156)	26.1 (0.163)
2880 (48.0)	3.2 (0.045)	11.2 (0.119)	16.5 (0.148)	21.6 (0.166)	24.4 (0.159)	26.5 (0.155)
4320 (72.0)	3.2 (0.042)	7.0 (0.067)	9.4 (0.076)	11.8 (0.083)	9.2 (0.055)	7.3 (0.039)

Layer Info

Time Accessed	16 August 2019 01:32PM
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	16 August 2019 01:32PM
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	20	10	5	2	1
60 (1.0)	18.1	13.2	11.6	11.7	12.1	11.5
90 (1.5)	20.9	13.4	11.9	12.2	12.0	11.3
120 (2.0)	22.8	12.6	12.1	12.9	12.8	11.1
180 (3.0)	23.6	14.9	13.4	13.9	13.9	12.2
360 (6.0)	21.8	15.4	14.3	15.3	13.7	8.6
720 (12.0)	23.5	17.1	16.2	16.6	13.8	6.7
1080 (18.0)	26.3	20.6	19.5	20.4	15.4	8.2
1440 (24.0)	27.9	22.4	22.5	23.5	18.4	12.2
2160 (36.0)	28.7	23.9	24.7	27.0	24.5	16.0
2880 (48.0)	30.6	25.1	25.1	27.4	24.4	16.9
4320 (72.0)	31.0	26.3	27.8	29.9	27.5	23.6

Layer Info

Time Accessed	16 August 2019 01:32PM
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/67ddea33-7b6f-45f2-a5b5-373efdb06d90.txt)

Download JSON (downloads/b0e304be-244c-42f9-8ead-e414a49567cf.json)

Generating PDF... (downloads/05adcb9e-ff9b-4822-ad6f-f02702baea50.pdf)

ATTENTION: This site was updated recently, changing some of the functionality. Please see the changelog (./changelog) for further information

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	148.641
Latitude	-34.658
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

Data

River Region

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

Layer Info

Time Accessed	11 July 2019 02:47PM
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	11 July 2019 02:47PM
Version	2016_v1

Short Duration ARF

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

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	16012.0
Storm Initial Losses (mm)	31.0
Storm Continuing Losses (mm/h)	4.2

Layer Info

Time Accessed	11 July 2019 02:47PM
Version	2016_v1

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

code	MB
Label	Murray Basin

Layer Info

Time Accessed	11 July 2019 02:47PM
Version	2016_v2

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

code	MB
arealabel	Murray Basin

Layer Info

Time Accessed	11 July 2019 02:47PM
Version	2016_v2

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-34.658&longitude=148.641&sdmin=true&sdhr
to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	11 July 2019 02:47PM

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)	1.0 (0.058)	0.6 (0.025)	0.3 (0.010)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
90 (1.5)	1.1 (0.058)	0.7 (0.025)	0.3 (0.011)	0.0 (0.001)	0.4 (0.009)	0.7 (0.013)
120 (2.0)	0.8 (0.035)	0.5 (0.016)	0.3 (0.008)	0.1 (0.002)	0.2 (0.005)	0.3 (0.006)
180 (3.0)	2.1 (0.082)	1.6 (0.048)	1.3 (0.033)	1.1 (0.023)	0.5 (0.008)	0.0 (0.000)
360 (6.0)	2.6 (0.079)	1.5 (0.035)	0.8 (0.016)	0.2 (0.003)	0.5 (0.007)	0.8 (0.010)
720 (12.0)	0.0 (0.001)	0.9 (0.017)	1.5 (0.023)	2.1 (0.027)	6.5 (0.073)	9.8 (0.098)
1080 (18.0)	0.0 (0.000)	0.5 (0.008)	0.9 (0.012)	1.2 (0.014)	4.5 (0.044)	6.9 (0.060)
1440 (24.0)	0.0 (0.000)	0.4 (0.005)	0.6 (0.007)	0.8 (0.009)	1.6 (0.015)	2.2 (0.018)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.1 (0.001)	0.2 (0.001)
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	11 July 2019 02:47PM
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	11 July 2019 02:47PM
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 (0.000)	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	11 July 2019 02:47PM
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)	12.8 (0.737)	10.1 (0.437)	8.4 (0.367)	6.7 (0.213)	9.1 (0.245)	11.0 (0.262)
90 (1.5)	10.6 (0.531)	9.6 (0.359)	8.9 (0.284)	8.3 (0.229)	10.9 (0.254)	12.9 (0.267)
120 (2.0)	11.9 (0.540)	9.6 (0.325)	8.1 (0.232)	6.6 (0.165)	9.6 (0.202)	11.8 (0.221)
180 (3.0)	12.4 (0.492)	13.0 (0.382)	13.3 (0.333)	13.7 (0.295)	10.4 (0.190)	8.0 (0.130)
360 (6.0)	12.9 (0.399)	12.4 (0.286)	12.1 (0.236)	11.8 (0.199)	18.8 (0.267)	24.1 (0.304)
720 (12.0)	6.1 (0.146)	9.7 (0.174)	12.0 (0.183)	14.3 (0.189)	25.5 (0.284)	34.0 (0.336)
1080 (18.0)	3.1 (0.065)	6.9 (0.108)	9.4 (0.125)	11.8 (0.136)	18.9 (0.185)	24.2 (0.211)
1440 (24.0)	0.4 (0.007)	3.7 (0.053)	6.0 (0.073)	8.1 (0.086)	11.5 (0.104)	14.1 (0.113)
2160 (36.0)	0.0 (0.000)	1.8 (0.023)	3.0 (0.033)	4.2 (0.040)	5.5 (0.044)	6.4 (0.046)
2880 (48.0)	0.0 (0.000)	0.7 (0.008)	1.1 (0.011)	1.5 (0.013)	3.7 (0.028)	5.4 (0.036)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.1 (0.001)	0.1 (0.001)	0.1 (0.001)	0.2 (0.001)

Layer Info

Time Accessed	11 July 2019 02:47PM
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)	23.9 (1.378)	21.0 (0.905)	19.1 (0.698)	17.3 (0.547)	22.0 (0.590)	25.6 (0.611)
90 (1.5)	20.3 (1.018)	21.5 (0.805)	22.3 (0.768)	23.1 (0.635)	25.7 (0.598)	27.7 (0.574)
120 (2.0)	28.7 (1.308)	27.2 (0.925)	26.2 (0.755)	25.3 (0.630)	29.7 (0.625)	33.0 (0.617)
180 (3.0)	24.5 (0.968)	24.6 (0.726)	24.7 (0.617)	24.8 (0.536)	23.1 (0.421)	21.9 (0.354)
360 (6.0)	21.9 (0.676)	26.0 (0.600)	28.8 (0.561)	31.4 (0.530)	49.2 (0.698)	62.6 (0.788)
720 (12.0)	18.8 (0.453)	28.4 (0.512)	34.8 (0.531)	41.0 (0.540)	61.5 (0.685)	76.9 (0.762)
1080 (18.0)	15.4 (0.323)	21.1 (0.332)	25.0 (0.332)	28.6 (0.330)	44.9 (0.439)	57.1 (0.498)
1440 (24.0)	8.4 (0.162)	14.7 (0.211)	18.8 (0.229)	22.8 (0.241)	27.8 (0.250)	31.6 (0.254)
2160 (36.0)	5.8 (0.099)	12.0 (0.153)	16.0 (0.174)	19.9 (0.189)	19.3 (0.156)	18.8 (0.136)
2880 (48.0)	2.2 (0.035)	7.0 (0.084)	10.2 (0.104)	13.3 (0.117)	20.2 (0.152)	25.3 (0.172)
4320 (72.0)	0.7 (0.011)	5.8 (0.063)	9.1 (0.084)	12.3 (0.100)	10.3 (0.072)	8.8 (0.055)

Layer Info

Time Accessed	11 July 2019 02:47PM
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	11 July 2019 02:47PM
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	20	10	5	2	1
60 (1.0)	17.5	13.5	11.6	11.7	12.5	12.0
90 (1.5)	20.1	14.4	12.9	13.0	12.2	12.1
120 (2.0)	22.1	13.8	12.7	13.2	12.6	11.8
180 (3.0)	23.8	14.5	13.4	14.4	14.3	13.9
360 (6.0)	23.7	16.2	15.1	15.7	13.0	9.7
720 (12.0)	25.8	18.6	16.8	16.6	12.6	7.4
1080 (18.0)	27.0	20.8	18.9	19.3	15.5	10.0
1440 (24.0)	29.0	23.0	22.2	22.3	19.3	13.3
2160 (36.0)	30.1	24.7	24.2	25.2	22.9	18.7
2880 (48.0)	31.2	25.9	26.0	27.1	23.6	18.2
4320 (72.0)	31.9	26.8	27.1	27.8	25.9	22.9

Layer Info

Time Accessed	11 July 2019 02:47PM
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/0d39b1b1-95ed-49cb-bd91-7120ee5b350a.txt)

Download JSON (downloads/23280114-a173-454b-b062-079049022512.json)

Generating PDF... (downloads/7444cfb6-be03-4488-9a57-fb4a533d6785.pdf)

APPENDIX I
DESIGN PEAK FLOWS

TABLE 11
DESIGN PEAK FLOWS[1]

Peak Flow Location Identifier[1]	Village	Tributary/ Catchment	Location	20% AEP Peak Flow (m^3/s)	20% AEP Critical Storm Duration[2] (minutes)	20% AEP Critical Storm Burst[3]	10% AEP Peak Flow (m^3/s)	10% AEP Critical Storm Duration[2] (minutes)	10% AEP Critical Storm Burst[3]	5% AEP Peak Flow (m^3/s)	5% AEP Critical Storm Duration[2] (minutes)	5% AEP Critical Storm Burst[3]	2% AEP Peak Flow (m^3/s)	2% AEP Critical Storm Duration[2] (minutes)	2% AEP Critical Storm Burst[3]	1% AEP Peak Flow (m^3/s)	1% AEP Critical Storm Duration[2] (minutes)	1% AEP Critical Storm Burst[3]	0.5% AEP Peak Flow (m^3/s)	0.5% AEP Critical Storm Duration[2] (minutes)	0.5% AEP Critical Storm Burst[3]	0.2% AEP Peak Flow (m^3/s)	0.2% AEP Critical Storm Duration[2] (minutes)	0.2% AEP Critical Storm Burst[3]	PMF Peak Flow (m^3/s)	PMF Critical Storm Duration[2] (minutes)
[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]	[K]	[L]	[M]	[N]	[O]	[P]	[Q]	[R]	[S]	[T]	[U]	[V]	[W]	[X]	[Y]	[Z]	[AA]
MUR_01	Murrumbateman	McClung Creek	Merryville Drive	2.6	540	2	4.6	540	2	6.6	540	2	7.7	180	9	19.8	180	1	14.6	180	9	18.8	180	7	170.8	60
MUR_02			Merryville Drive	1.9	180	8	2.1	120	8	2.7	120	8	3.6	90	1	6.0	270	1	6.6	270	9	7.9	270	6	-	-
MUR_03			Initial Drive	2.0	180	9	2.6	120	9	4.3	120	9	3.6	360	8	4.6	270	1	7.1	270	1	8.7	270	2	-	-
MUR_04			Merryville Drive	2.5	180	8	4.0	120	8	4.1	120	9	3.6	180	6	6.1	270	1	8.7	270	1	10.1	270	1	-	-
MUR_05			Merryville Drive	3.2	270	4	11.6	540	2	16.2	540	2	20.4	180	8	33.2	180	1	40.9	180	2	60.3	180	9	200.8	60
MUR_06			Barton Highway	10.0	180	9	30.6	540	2	60.4	540	2	80.3	180	1	80.6	180	1	84.1	180	9	80.3	180	9	804.8	90
MUR_07		Unnamed Tributary	Murrumbateman Road	3.4	180	9	3.5	120	8	4.6	120	8	6.0	90	1	8.1	270	6	10.6	270	2	12.8	270	2	-	-
MUR_08			Murrumbateman Road	9.9	270	4	14.9	540	2	19.7	540	2	30.3	180	1	30.3	180	8	40.7	180	3	50.8	180	7	600.8	60
MUR_09			Adelaide Avenue	3.6	180	9	12.4	120	8	16.6	120	4	21.0	90	1	27.8	270	1	30.7	270	1	40.0	270	2	-	-
MUR_10			Barton Highway	4.3	270	4	9.0	540	2	6.0	540	2	10.9	180	8	19.7	180	8	18.0	180	1	21.8	180	9	-	-
MUR_11			Barton Highway	1.2	180	9	1.6	120	8	2.0	120	8	2.9	180	8	4.1	180	2	5.6	180	9	8.0	180	6	-	-
MUR_12			Donovan Drive	0.8	270	4	1.4	120	8	2.2	120	8	2.7	90	8	3.5	270	1	4.8	270	1	5.8	270	1	60.0	30
MUR_13			Murrumbateman Road	3.5	180	9	12.9	540	2	16.2	180	1	21.0	180	9	27.1	180	1	34.0	180	9	44.9	180	8	110.8	90
MUR_14			Barton Highway	0.7	180	8	12.9	540	2	13.6	180	1	22.4	180	8	30.7	180	9	34.0	180	9	44.7	180	6	-	-
MUR_15			Hillview Drive	24.2	270	4	42.7	540	2	56.0	540	2	74.4	180	8	87.2	270	6	120.8	180	8	620.0	180	9	-	-
MUR_16		Sheltie Creek	Goldfields Lane	11.0	180	9	18.0	120	8	28.0	120	9	30.9	180	9	60.7	90	9	40.4	270	1	62.4	270	1	-	-
MUR_17			Barton Highway	12.4	540	7	17.0	180	1	22.5	180	1	30.6	180	3	42.5	120	8	34.8	120	8	38.8	270	1	-	-
MUR_18			Barton Highway	1.6	180	6	8.4	120	9	6.8	60	7	7.8	90	1	16.0	270	2	16.1	270	2	16.7	270	2	130.8	30

Refer over for footnotes of Table.

TABLE 11 (Cont'd)
DESIGN PEAK FLOWS[1]

Peak Flow Location Identifier[2]	Village	Tributary	Location	20% AEP Peak Flow (m³/s)	20% AEP Critical Storm Duration[3] (minutes)	20% AEP Critical Storm Burst[4]	10% AEP Peak Flow (m³/s)	10% AEP Critical Storm Duration[3] (minutes)	10% AEP Critical Storm Burst[4]	5% AEP Peak Flow (m³/s)	5% AEP Critical Storm Duration[3] (minutes)	5% AEP Critical Storm Burst[4]	2% AEP Peak Flow (m³/s)	2% AEP Critical Storm Duration[3] (minutes)	2% AEP Critical Storm Burst[4]	1% AEP Peak Flow (m³/s)	1% AEP Critical Storm Duration[3] (minutes)	1% AEP Critical Storm Burst[4]	0.5% AEP Peak Flow (m³/s)	0.5% AEP Critical Storm Duration[3] (minutes)	0.5% AEP Critical Storm Burst[4]	0.2% AEP Peak Flow (m³/s)	0.2% AEP Critical Storm Duration[3] (minutes)	0.2% AEP Critical Storm Burst[4]	PMF Peak Flow (m³/s)	PMF Critical Storm Duration[3] (minutes)
[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]	[K]	[L]	[M]	[N]	[O]	[P]	[Q]	[R]	[S]	[T]	[U]	[V]	[W]	[X]	[Y]	[Z]	[AA]
BOW_01	Bowning	Bowning Creek	Main Western Railway	35.8	180	8	49.6	720	8	65.1	120	8	85.8	180	8	102	360	6	119	360	6	145	360	5	1026	90
BOW_02			Bowning Road	61.1	180	8	82.4	120	8	108.6	120	6	184	180	8	128	180	8	140	360	6	170	360	6	-	-
BOW_03			Hume Highway	61.1	180	9	82.7	120	8	110.8	120	6	184	180	9	122	180	9	140	360	6	170	360	6	1526	120
BOW_04		Bowning Tributary	Leake Street	8.4	180	8	11.7	120	8	18.8	120	2	24.2	270	1	27.1	270	6	30.7	270	5	58.8	270	6	222	30
BOW_05			[illegible] Street	8.6	180	9	11.7	120	9	18.6	120	2	24.4	270	1	28.6	270	6	30.2	270	5	58.6	270	6	265	30
BOO_01	Bookham	[illegible] Creek	Binalong Road	134.0	720	10	161.9	720	1	260.0	720	2	305.6	360	7	504.0	270	6	408.8	270	6	408.0	270	6	9100	180
BOO_02		[illegible] Creek	Hume Highway	10.4	180	6	14.7	120	9	16.0	120	8	21.9	180	8	26.9	360	2	30.6	360	2	35.8	360	2	282	90
BIN_01	Binalong	Balgalal Creek	Main South Railway	57.6	270	4	69.8	720	1	102	720	1	181	180	9	135	180	9	136	270	6	216	180	6	-	-
BIN_02			[illegible] Road	57.9	270	4	89.8	720	1	102	720	2	181	180	8	138	180	8	135	270	5	216	270	6	2120	120
BIN_03			[illegible] Street	64.6	270	4	96.8	720	1	114	720	2	156	180	9	184	180	6	210	180	10	252	180	8	2940	120
BIN_04			Burley Griffin Way	64.6	270	4	92.8	720	1	114	720	2	189	360	7	185	180	6	219	180	6	254	180	6	-	-
BIN_05			[illegible] Road	14.7	360	4	26.6	540	3	122	540	2	177	360	7	259	270	7	395	180	6	299	180	6	2970	120
BIN_06		Balgalal Tributary	Fitzroy Street	6.0	180	9	6.9	120	8	10.3	60	9	12.5	90	1	14.2	270	1	17.1	270	0	18.8	270	2	120.8	60
BIN_07			Richmond Street	7.9	180	6	11.1	120	9	18.2	90	9	14.8	90	1	22.6	270	1	26.9	270	1	64.8	270	2	199.8	60
BIN_08			Wellington Street	8.8	180	6	11.8	120	8	16.9	120	9	14.1	90	1	22.8	270	1	27.2	270	1	66.8	270	1	214.8	60
BIN_09			[illegible] Street	8.4	180	6	11.8	120	9	16.8	120	8	14.4	90	1	26.8	90	8	27.8	270	1	66.8	270	1	217.8	60
BIN_10			Queen Street	8.8	180	8	11.6	120	8	16.8	120	9	14.4	90	1	26.4	90	8	27.8	270	1	66.8	270	1	-	-

1. Peak flows less than 100m³/s have been quoted to one decimal place in order to show minor differences.
2. Refer to relevant figures in Volume 2 for location of Flow Location Identifiers.
3. Relates to storm duration that is critical for maximising the peak flood level at each location, not necessarily the peak flow.
4. Relates to temporal pattern that is critical for maximising the peak flood level at each location, not necessarily the peak flow.

APPENDIX J

FLOOD DAMAGES

TABLE OF CONTENTS

J1. INTRODUCTION AND SCOPE

J1.1 Introduction

Damages from flooding belong to two categories:

- **Tangible Damages**
- **Intangible Damages**

Tangible damages are defined as those to which monetary values may be assigned, and may be subdivided into direct and indirect damages. Direct damages are those caused by physical contact of floodwater with damageable property. They include damages to commercial and residential building structures and contents as well as damages to infrastructure services such as electricity and water supply. Indirect damages result from the interruption of community activities, including traffic flows, trade, industrial production, costs to relief agencies, evacuation of people and contents and clean up after the flood.

Generally, tangible damages are estimated in dollar values using survey procedures, interpretation of data from actual floods and research of government files.

The various factors included in the **intangible damage** category may be significant. However, these effects are difficult to quantify due to lack of data and the absence of an accepted method. Such factors may include:

- inconvenience
- isolation
- disruption of family and social activities
- anxiety, pain and suffering, trauma
- physical ill-health
- psychological ill-health.

J1.2 Scope of Investigation

In the following sections, tangible damages to residential, commercial and industrial properties, and public buildings have been estimated resulting from flooding at the four villages. Intangible damages have not been quantified. The threshold floods at which damages may commence to infrastructure and community assets have also been estimated, mainly from site inspection and interpretation of flood level data. However, there are no data available to allow a quantitative assessment of damages to be made to this category.

J1.3 Terminology

Definitions of the terms used in this Appendix are presented in **Section J8** which also summarises the value of Tangible Flood Damages.

J2. DESCRIPTION OF APPROACH

The damage caused by a flood to a particular property is a function of the depth of flooding above floor level and the value of the property and its contents. The warning time available for residents to take action to lift property above floor level also influences damages actually experienced. A spreadsheet model which has been developed by DPIE for estimating residential damages and an in-house spreadsheet model which has been developed for previous investigations of this nature for estimating commercial, industrial and public building damages were used to estimate damages on a property by property basis according to the type of development, the location of the property and the depth of inundation.

Using the results of the hydraulic modelling, a peak flood elevation was derived for each event at each property. The property flood levels were input to the spreadsheet model which also contained property characteristics and depth-damage relationships. The depth of flooding was computed as the difference between the interpolated flood level and the floor elevation at each property. The elevations of building floors were assessed by adding the height of floor above a representative natural surface within the allotment (as estimated by visual inspection) to the natural surface elevation determined from LiDAR survey. The type of structure and potential for property damage were also assessed during the visual inspection.

The depth-damage curves for residential damages were determined using procedures described in *"Floodplain Management Guideline No 4. Residential Flood Damage Calculation"*, *2007* published by DECC. Damage curves for other categories of development (commercial and industrial, public buildings) were derived from previous floodplain management investigations.

It should be understood that this approach is not intended to identify individual properties liable to flood damages and the values of damages in individual properties, even though it appears to be capable of doing so. The reason for this caveat lies in the various assumptions used in the procedure, the main ones being:

- the assumption that computed water levels and topographic data used to define flood extents are exact and without any error;
- the assumption that the water levels as computed by the hydraulic model are not subject to localised influences;
- the estimation of property floor levels by visual inspection rather than by formal field survey;
- the use of "average" stage-damage relationships, rather than a unique relationship for each property;
- the uncertainties associated with assessing appropriate factors to convert *potential damages* to *actual flood damages* experienced for each property after residents have taken action to mitigate damages to contents.

The consequence of these assumptions is that some individual properties may be inappropriately classified as flood liable, while others may be excluded. Nevertheless, when applied over a broad area these effects would tend to cancel, and the resulting estimates of overall damages, would be expected to be reasonably accurate.

For the above reasons, the information contained in the spreadsheets used to prepare the estimates of flood damages for the catchments should not be used to provide information on the depths of above-floor inundation of individual properties.

J3. SOURCES OF DATA

J3.1 General

To estimate *Average Annual Flood Damages* for a specific area it is necessary to estimate the damages for several floods of different magnitudes, i.e. of different frequencies, and then to integrate the area beneath the damage – frequency curve over the whole range of frequencies. To do this it is necessary to have data on the damages sustained by all types of property over the likely range of inundation. There are several ways of doing this:

- The ideal way would be to conduct specific damage surveys in the aftermath of a range of floods, preferably immediately after each. An example approaching this ideal is the case of Nyngan where surveys were conducted in May 1990 following the disastrous flood of a month earlier (DWR, 1990). This approach is not possible at the four villages as specific damage surveys have not been conducted following the historic flood events.

- The second best way is for experienced loss adjusters to conduct a survey to estimate likely losses that would arise due to various depths of inundation. This approach is used from time to time, but it can add significantly to the cost of a floodplain management study (LMJ, 1985). It was not used for the present investigation.

- The third way is to use generalised data such as that published by CRES (Centre for Resource & Economic Studies, Canberra) and used in the Floodplain Management Study for Forbes (SKM, 1994). These kinds of data are considered to be suitable for generalised studies, such as broad regional studies. They are not considered to be suitable for use in specific areas, unless none of the other approaches can be satisfactorily applied.

- The fourth way is to adapt or transpose data from other flood liable areas. This was the approach used for the present study. As mentioned, the *DECC Guideline No 4, 2007* procedure was adopted for the assessment of residential damages. The approach was based on data collected following major flooding in Katherine in 1998, with adjustments to account for changes in values due to inflation, and after taking into account the nature of development and flooding patterns in the study area. The data collected during site inspection in the flood liable areas assisted in providing the necessary adjustments. Commercial and industrial damages were assessed via reference to recent floodplain management investigations of a similar nature to the present study (L&A, 2019).

J3.2 Property Data

The properties were divided into three categories: residential, commercial/industrial and public buildings.

For residential properties, the data used in the damages estimation included:

- the location/address of each property
- an assessment of the type of structure
- representative natural surface level of the allotment
- floor level of the residence

For commercial/industrial properties, the Property Survey obtained information regarding:

- the location of each property
- the nature of each enterprise
- an estimation of the floor area
- natural surface level
- floor level

The property descriptions were used to classify the commercial and public developments into categories (i.e. high, medium or low value properties) which relate to the magnitude of likely flood damages.

The total number of residential properties, commercial / industrial and public buildings at the four villages is shown in **Table J3.1**.

TABLE J3.1
NUMBER OF PROPERTIES INCLUDED IN DAMAGES DATABASE

Development Type	Number of Properties			
	Murrumbateman	Bowning	Bookham	Binalong
Residential	147	46	7	45
Commercial / Industrial	9	1	2	2
Public	5	2	3	1
Total	**161**	**49**	**12**	**48**

J3.3 Flood Levels Used in the Analysis

Damages were computed for the design flood levels determined from the hydraulic models that were developed as part of the present investigation. The design levels assume that the drainage system is operating at optimum capacity. They do not allow for any increase in levels resulting from wave action, debris build-ups in the channels which may cause a partial blockage of bridges and which may result in conversions of flow from the supercritical to the subcritical flow regime, as well as other local hydraulic effects. These factors are usually taken into account by adding a factor of safety (freeboard) to the "nominal" flood level when assessing the "level of protection" against flooding of a particular property. Freeboard could also include an allowance for the future effects of climate change.

J4. RESIDENTIAL DAMAGES

J4.1 Damage Functions

The procedures identified in *DECCW Guideline No 4, 2007* allow for the preparation of a depth versus damage relationship which incorporates structural damage to the building, damage to internals and contents, external damages and clean-up costs. In addition, there is the facility for including allowance for accommodation costs and loss of rent. Separate curves are computed for three residential categories:

- Single storey slab on ground construction
- Single storey elevated floor
- Two storey residence

The level of flood awareness and available warning time are taken into account by factors which are used to reduce "potential" damages to contents to "actual" damages. "Potential" damages represent losses likely to be experienced if no action were taken by residents to mitigate impacts. A reduction in the potential damages to "actual" damages is usually made to allow for property evacuation and raising valuables above floor level, which would reduce the damages actually experienced. The ability of residents to take action to reduce flood losses is mainly limited to reductions in damages to contents, as damages to the structure and clean-up costs are not usually capable of significant mitigation.

The reduction in damages to contents is site specific, being dependent on a number of factors related to the time of rise of floodwaters, the recent flood history and flood awareness of residents and emergency planning by the various Government Agencies (BoM and NSW SES).

Flooding in the four villages is "flash flooding" in nature, with surcharge of the watercourses and various drainage lines occurring less than one hour after the onset of flood producing rain. Consequently, there would be very limited time in advance of a flood event in which to warn residents located along the various flow paths and for them to take action to mitigate flood losses.

Provided adequate warning were available, house contents may be raised above floor level to about 0.9 m, which corresponds with the height of a typical table/bench height. The spreadsheet provides two factors for assessing damages to contents, one for above and one for below the typical bench height. The reduction in damages is also dependent on the likely duration of inundation of contents, which would be limited to no more than an hour for most flooded properties. **Table J4.1** over sets out the parameters and resulting factors that were adopted for converting potential to actual damages in areas subject to both main stream flooding and major overland flow.

Table J4.2 over shows total flood damages estimated for the three classes of residential property using the procedures identified in *Guideline No. 4*, for typical depths of above-floor inundation of 0.3 m and 1.0 m. A typical ground floor area of 240 m^2 was adopted for the assessment. The values in **Table J4.2** allow for damages to buildings and contents, as well as external damages and provision for alternative accommodation.

TABLE J4.1
DAMAGE ADJUSTMENT FACTORS/PARAMETERS FOR RESIDENTIAL DEVELOPMENT AT THE FOUR VILLAGES

Property Damage	Parameter/Factor	Adopted Value
Building	Typical Duration of Immersion (hours)	2
	Building Damage Repair Limitation Factor	0.85
	Total Building Adjustment Factor	1.60
Contents	Contents Damage Repair Limitation Factor	0.75
	Level of Flood Awareness	Low
	Effective Warning Time	0
	Typical Table/Bench Height (TTBH) (m)	0.9
	Total Contents Adjustment Factor (Above-Floor Depth <= TTBH)	1.37
	Total Contents Adjustment Factor (Above-Floor Depth > TTBH)	1.37

1. Maximum value permitted in damages spreadsheet.

TABLE J4.2
DAMAGES TO RESIDENTIAL PROPERTIES

Type of Residential Construction	0.3 m Depth of Inundation Above Floor Level	1.0 m Depth of Inundation Above Floor Level
Single Storey Slab on Ground	$68,074	$92,761
Single Storey High Set	$74,801	$102,386
Double Storey	$47,652	$64,933

Note: These values allow for damages to buildings and contents, as well as external damages and provision for alternative accommodation.

J4.2 Total Residential Damages

Table J4.3 over summarises residential damages for the range of floods at the four villages. The damage estimates were carried out for floods between the 20% AEP and the PMF, which were modelled hydraulically as part of the present study.

At the 1% AEP level of flooding only three dwellings would experience above-floor inundation in the four villages; one each at Murrumbateman, Bowning and Binalong, while no dwellings are inundated above-floor level at Bookham. During a PMF event, 47 individual dwellings would experience above-floor inundation in Murrumbateman, 27 in Bowning, 19 in Binalong and two in Bookham.

TABLE J4.3
RESIDENTIAL FLOOD DAMAGES

Design Flood Event (%AEP)	Murrumbateman			Bowning			Bookham			Binalong		
	No of Allotments Flood Affected	No of Dwellings Flooded Above Floor Level	Damages $ Million	No of Allotments Flood Affected	No of Dwellings Flooded Above Floor Level	Damages $ Million	No of Allotments Flood Affected	No of Dwellings Flooded Above Floor Level	Damages $ Million	No of Allotments Flood Affected	No of Dwellings Flooded Above Floor Level	Damages $ Million
20	4	0	0.05	0	0	0	0	0	0	2	0	0.05
10	8	0	0.10	0	0	0	0	0	0	3	1	0.07
5	8	0	0.14	1	0	0.02	0	0	0	4	1	0.10
2	12	0	0.19	2	1	0.05	0	0	0	5	1	0.14
1	18	1	0.23	2	1	0.05	0	0	0	6	1	0.15
0.5	15	1	0.28	5	1	0.11	0	0	0	8	1	0.20
0.2	19	3	0.41	6	2	0.21	0	0	0	8	1	0.20
PMF	94	47	4.60	38	27	5.11	3	2	0.38	50	10	2.22

J5. COMMERCIAL AND INDUSTRIAL DAMAGES

J5.1 Direct Commercial and Industrial Damages

The method used to calculate damages requires each property to be categorised in terms of the following:

- damage category;
- floor area; and
- floor elevation.

The damage category assigned to each enterprise may vary between "low", "medium" or "high", depending on the nature of the enterprise and the likely effects of flooding. Damages also depend on the floor area.

It has recently been recognised following the 1998 flood in Katherine that previous investigations using stage damage curves contained in proprietary software tend to seriously underestimate true damage costs (*DECC Guideline No 4, 2007*). DPIE are currently researching appropriate damage functions which could be adopted in the estimation of commercial and industrial categories as they have already done with residential damages. However, these data were not available for the four villages study.

On the basis of previous investigations the following typical damage rates are considered appropriate for potential external and internal damages and clean-up costs for both commercial and industrial properties. They are indexed to a depth of inundation of 2 metres. At floor level and 1.2 m inundation, zero and 70% of these values respectively were assumed to occur:

Low value enterprise	$280/m^2	(e.g. Commercial: small shops, cafes, joinery, public halls. Industrial: auto workshop with concrete floor and minimal goods at floor level, Council or Government Depots, storage areas.)
Medium value enterprise	$420/m^2	(e.g. Commercial: food shops, hardware, banks, professional offices, retail enterprises, with furniture/fixtures at floor level which would suffer damage if inundated. Industrial: warehouses, equipment hire.)
High value enterprise	$650/m^2	(e.g. Commercial : electrical shops, clothing stores, bookshops, newsagents, restaurants, schools, showrooms and retailers with goods and furniture, or other high value items at ground or lower floor level. Industrial: service stations, vehicle showrooms, smash repairs.)

The factor for converting potential to actual damages depends on a range of variables such as the available warning time, flood awareness and the depth of inundation. Given sufficient warning time a well prepared business will be able to temporarily lift property above floor level. However, unless property is actually moved to flood free areas, floods which result in a large depth of inundation, will cause considerable damage to stock and contents.

For the four villages study, the above potential damages were converted to actual damages using a multiplier which ranged between 0.5 and 0.8 depending on the depth of inundation above the floor. At relatively shallow depths it would be expected that owners may be able to take significant action to mitigate damages, even when allowing for the flash flooding nature of inundation. Consequently, a multiplier of 0.5 was adopted to convert potential to actual damages for depths of inundation up to 1.2 m, and a multiplier of 0.8 for greater depths.

J5.2 Indirect Commercial and Industrial Damages

Indirect commercial and industrial damages comprise costs of removal of goods and storage, loss of trading profit and loss of business confidence.

Disruption to trade takes the following forms:

- The loss through isolation at the time of the flood when water is in the business premises or separating clients and customers. The total loss of trade is influenced by the opportunity for trade to divert to an alternative source. There may be significant local loss but due to the trade transfer this may be considerably reduced at the regional or state level.
- In the case of major flooding, a downturn in business can occur within the flood affected region due to the cancellation of contracts and loss of business confidence. This is in addition to the actual loss of trading caused by closure of the business by flooding.

Loss of trading profit is a difficult value to assess and the magnitude of damages can vary depending on whether the assessment is made at the local, regional or national level. Differences between regional and national economic effects arise because of transfers between the sectors, such as taxes, and subsidies such as flood relief returned to the region.

Some investigations have lumped this loss with indirect damages and have adopted total damage as a percentage of the direct damage. In other cases, loss of profit has been related to the gross margin of the business, i.e. turnover less average wages. The former approach has been adopted in this present study. Indirect damages have been taken as 50% of direct actual damages. A clean-up cost of $15/m^2 of floor area of each flooded property was also included.

J5.3 Total Commercial and Industrial Damages

Table J5.1 over summarises estimated commercial and industrial damages in the four villages. No commercial or industrial buildings would experience above-floor inundation in a 1% AEP event, while six buildings (two each at Murrumbateman and Bookham and one each at Bowning and Binalong) would be above-floor inundated during a PMF event.

TABLE J5.1
COMMERCIAL / INDUSTRIAL FLOOD DAMAGES

Design Flood Event (%AEP)	Murrumbateman			Bowning			Bookham			Binalong		
	No of Allotments Flood Affected	No of Dwellings Flooded Above Floor Level	Damages $ Million	No of Allotments Flood Affected	No of Dwellings Flooded Above Floor Level	Damages $ Million	No of Allotments Flood Affected	No of Dwellings Flooded Above Floor Level	Damages $ Million	No of Allotments Flood Affected	No of Dwellings Flooded Above Floor Level	Damages $ Million
20	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0
0.5	0	0	0	0	0	0	0	0	0	0	0	0
0.2	0	0	0	0	0	0	0	0	0	0	0	0
PMF	4	2	0.88	1	1	0.47	2	2	0.35	1	1	0.27

J6. DAMAGES TO PUBLIC BUILDINGS

J6.1 Direct Damages – Public Buildings

Included under this heading are government buildings, churches, swimming pools and parks. Damages were estimated individually on an areal basis according to the perceived value of the property. Potential internal damages were indexed to a depth of above floor inundation of 2 m as shown below. At floor level and 1.2 m depth of inundation, zero and 70% of these values respectively were assumed to occur.

Low value	\$280/m^2	
Medium value	\$420/m^2	(eg. council buildings, SES HQ, fire station)
High value	\$650/m^2	(eg. schools)

These values were obtained from the Nyngan Study (DWR, 1990) as well as commercial data presented in the Forbes Water Studies report (WS, 1992). External and structural damages were taken as 4 and 10% of internal damages respectively.

J6.2 Indirect Damages – Public Buildings

A value of \$15/m^2 was adopted for the clean-up of each property. This value is based on results presented in the Nyngan Study and adjusted for inflation. Total "welfare and disaster" relief costs were assessed as 50% of the actual direct costs.

J6.3 Total Damages – Public Buildings

Table J6.1 over summarises estimated damages to public buildings in the four villages. No public buildings would experience above-floor inundation in a 1% AEP event, while eight buildings (four at Murrumbateman, two at Bookham and one each at Bowning and Binalong) would be above-floor inundated during a PMF event.

TABLE [illegible]
PUBLIC FLOOD DAMAGES

Design Flood Event (%AEP)	Murrumbateman			Bowning			Bookham			Binalong		
	No of Allotments Flood Affected	No of Dwellings Flooded Above Floor Level	Damages $ Million	No of Allotments Flood Affected	No of Dwellings Flooded Above Floor Level	Damages $ Million	No of Allotments Flood Affected	No of Dwellings Flooded Above Floor Level	Damages $ Million	No of Allotments Flood Affected	No of Dwellings Flooded Above Floor Level	Damages $ Million
20	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0
0.5	0	0	0	0	0	0	0	0	0	0	0	0
0.2	1	0	0	0	0	0	0	0	0	0	0	0
PMF	5	4	0.10	2	1	0.04	2	2	0.14	1	1	0.03

J7. DAMAGES TO INFRASTRUCTURE AND COMMUNITY ASSETS

No data are available on damages experienced to infrastructure and community assets during historic flood events. However, a qualitative matrix of the effects of flooding on important assets around the four villages is presented in **Table J7.1**.

TABLE J7.1
QUALITATIVE EFFECTS OF FLOODING ON INFRASTRUCTURE AND COMMUNITY ASSETS IN THE FOUR VILLAGES

Village	Damage Sector	Design Flood Event (% AEP)							
		20%	10%	5%	2%	1%	0.5%	0.2%	PMF
Murrumbateman	Roads	X	X	X	X	X	X	X	X
	Parks and Gardens	O	O	O	X	X	X	X	X
	Sewage Pumping Station	O	O	O	O	O	O	O	X
	Water Supply	O	O	O	O	X	X	X	X
Bowning	Roads	O	X	X	X	X	X	X	X
	Parks and Gardens	O	O	O	O	O	O	X	X
	Water Supply	O	O	O	O	O	O	O	O
Bookham	Roads	O	O	O	X	X	X	X	X
	Parks and Gardens	O	O	O	O	O	O	O	X
Binalong	Roads	X	X	X	X	X	X	X	X
	Parks and Gardens	O	O	O	O	O	O	O	X
	Water Supply	O	O	O	O	O	O	O	O

Notes: O = No significant damages likely to be incurred.
X = Some damages likely to be incurred.

J8. SUMMARY OF TANGIBLE DAMAGES

J8.1 Tangible Damages

Floods have been computed for a range of flood frequencies from 20% AEP up to the PMF. For the purposes of assessing damages, the 50% AEP was adopted as the "threshold" flood at which damages commence in the drainage system. From **Table J8.1** over, significant flood damages at the four villages are limited to the PMF event, with about $0.23 Million of damages being incurred at the 1% AEP level of flooding at Murrumbateman, $0.16 Million at Binalong and $0.09 Million at Bowning. No flood damages are incurred at Bookham during a 1% AEP storm event.

J8.2 Definition of Terms

Average Annual Damages (also termed "expected damages") are determined by integrating the area under the damage-frequency curve. They represent the time stream of annual damages, which would be expected to occur on a year by year basis over a long duration.

Using an appropriate discount rate, average annual damages may be expressed as an equivalent "*Present Worth Value*" of damages and used in the economic analysis of potential flood management measures.

A flood management scheme which has a design 1% AEP level of protection, by definition, will eliminate damages up to this level of flooding. If the scheme has no mitigating effect on larger floods then these damages represent the benefits of the scheme expressed on an average annual basis and converted to the *Present Worth Value* via the discount rate.

Using the procedures outlined in *Guideline No. 4*, as well as current NSW Treasury guidelines, economic analyses were carried out assuming a 50 year economic life for projects and discount rates of 7% pa. (best estimate) and 11% and 4% pa. (sensitivity analyses).

J8.3 Average Annual Damages

The average annual damages for all flood events up to the PMF are shown below in **Table J8.2**. Note that values have been quoted to two decimal places to highlight the relatively small recurring damages.

J8.4 Present Worth of Damages

The *Present Worth Value* of damages likely to be experienced for all flood events up to the 1% AEP and PMF, for a 50 year economic life and discount rates of 4, 7 and 11 per cent are shown in **Table J8.3** over.

For a discount rate of 7% pa, the *Present Worth Value* of total damages for all flood events up to the 1% AEP flood at Murrumbateman and Binalong are $0.04 Million and $0.02 Million, respectively. Therefore one or more schemes costing up to these amounts could be economically justified if they eliminated damages in the two villages for all flood events up to this level. While schemes costing more than this value would have a benefit/cost ratio less than 1, they may still be justified according to a multi-objective approach which considers other criteria in addition to economic feasibility.

The *Present Worth Value* of total damages at Bowning and Bookham for all flood events up to the 1% AEP flood is zero. As a result it is not possible to economically justify any mitigation works which are aimed at reducing the impact of flooding on existing development up to the 1% AEP level in these two villages.

TABLE J0.1
TOTAL FLOOD DAMAGES
$ MILLION

Design Flood Event (%AEP)	Murrumbateman				Bowning				Bookham				Binalong			
	Residential	Commercial/ Industrial	Public	Total	Residential	Commercial/ Industrial	Public	Total	Residential	Commercial/ Industrial	Public	Total	Residential	Commercial/ Industrial	Public	Total
20	0.08	0	0	0.08	0	0	0	0	0	0	0	0	0.05	0	0	0.08
10	0.13	0	0	0.13	0	0	0	0	0	0	0	0	0.07	0	0	0.07
5	0.14	0	0	0.14	0.02	0	0	0.02	0	0	0	0	0.15	0	0	0.12
2	0.19	0	0	0.19	0.05	0	0	0.05	0	0	0	0	0.14	0	0	0.14
1	0.25	0	0	0.25	0.09	0	0	0.09	0	0	0	0	0.16	0	0	0.16
0.5	0.29	0	0	0.29	0.11	0	0	0.11	0	0	0	0	0.2	0	0	0.2
0.2	0.41	0	0	0.41	0.21	0	0	0.21	0	0	0	0	0.2	0	0	0.2
PMF	4.88	0.69	0.13	5.70	1.11	0.47	0.04	1.62	0.38	0.35	0.14	0.87	2.22	0.27	0.08	2.58

TABLE J0.2
AVERAGE ANNUAL DAMAGES
$ MILLION

Design Flood Event (%AEP)	Murrumbateman				Bowning				Bookham				Binalong			
	Residential	Commercial/ Industrial	Public	Total	Residential	Commercial/ Industrial	Public	Total	Residential	Commercial/ Industrial	Public	Total	Residential	Commercial/ Industrial	Public	Total
20	0.01	0	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0
10	0.02	0	0	0.02	0	0	0	0	0	0	0	0	0.01	0	0	0.01
5	0.03	0	0	0.03	0	0	0	0	0	0	0	0	0.01	0	0	0.01
2	0.03	0	0	0.03	0	0	0	0	0	0	0	0	0.02	0	0	0.02
1	0.04	0	0	0.04	0	0	0	0	0	0	0	0	0.02	0	0	0.02
0.5	0.04	0	0	0.04	0	0	0	0	0	0	0	0	0.02	0	0	0.02
0.2	0.04	0	0	0.04	0	0	0	0	0	0	0	0	0.02	0	0	0.02
PMF	0.04	0	0	0.04	0.01	0	0	0.01	0	0	0	0	0.02	0	0	0.02

TABLE J8.3
PRESENT WORTH VALUE OF DAMAGES
$ MILLION

Village	Discount Rate (%)	Nominal Flood Level Case	
		All Floods up to 1% AEP	All Floods up to PMF
Murrumbateman	4	0.9	0.9
	7	0.6	0.6
	11	0.4	0.4
Bowning	4	0	0.2
	7	0	0.1
	11	0	0.1
Bookham	4	0	0
	7	0	0
	11	0	0
Binalong	4	0.4	0.4
	7	0.3	0.3
	11	0.2	0.2

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YASS VALLEY COUNCIL

MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALONG FLOOD STUDY

AUGUST 2020

VOLUME 2 – MAIN REPORT AND APPENDIX E FIGURES

Job No: ES454 File: MBBBFS_V2_Figures_[Rev 1.3].docx	Date: August 2020 Rev No: 1.3	Principal: SAB Author: SAB/TDR

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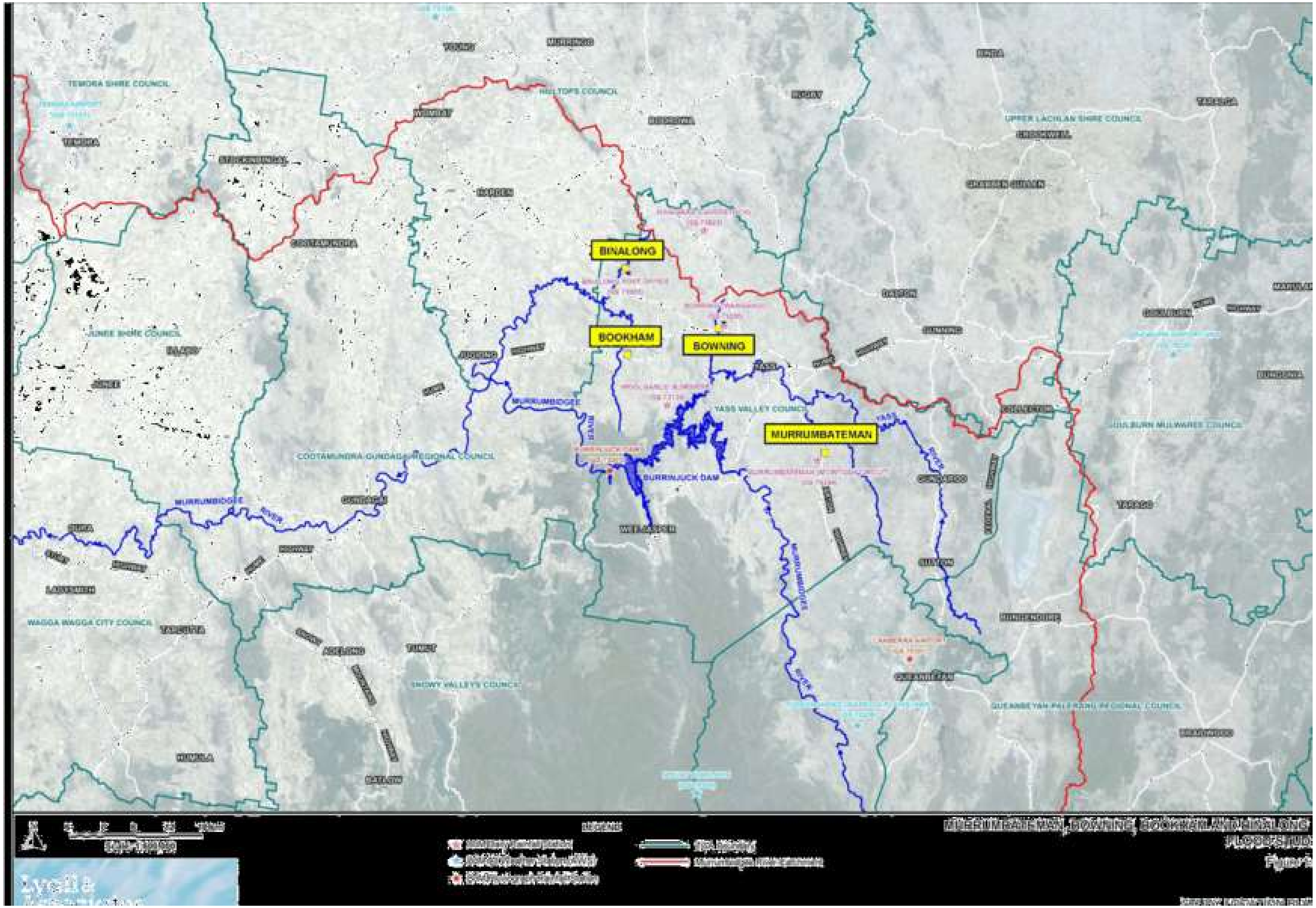
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COOTAMUNDRA-GUNDAGAI REGIONAL COUNCIL
WAGGA WAGGA CITY COUNCIL
SNOWY VALLEYS COUNCIL
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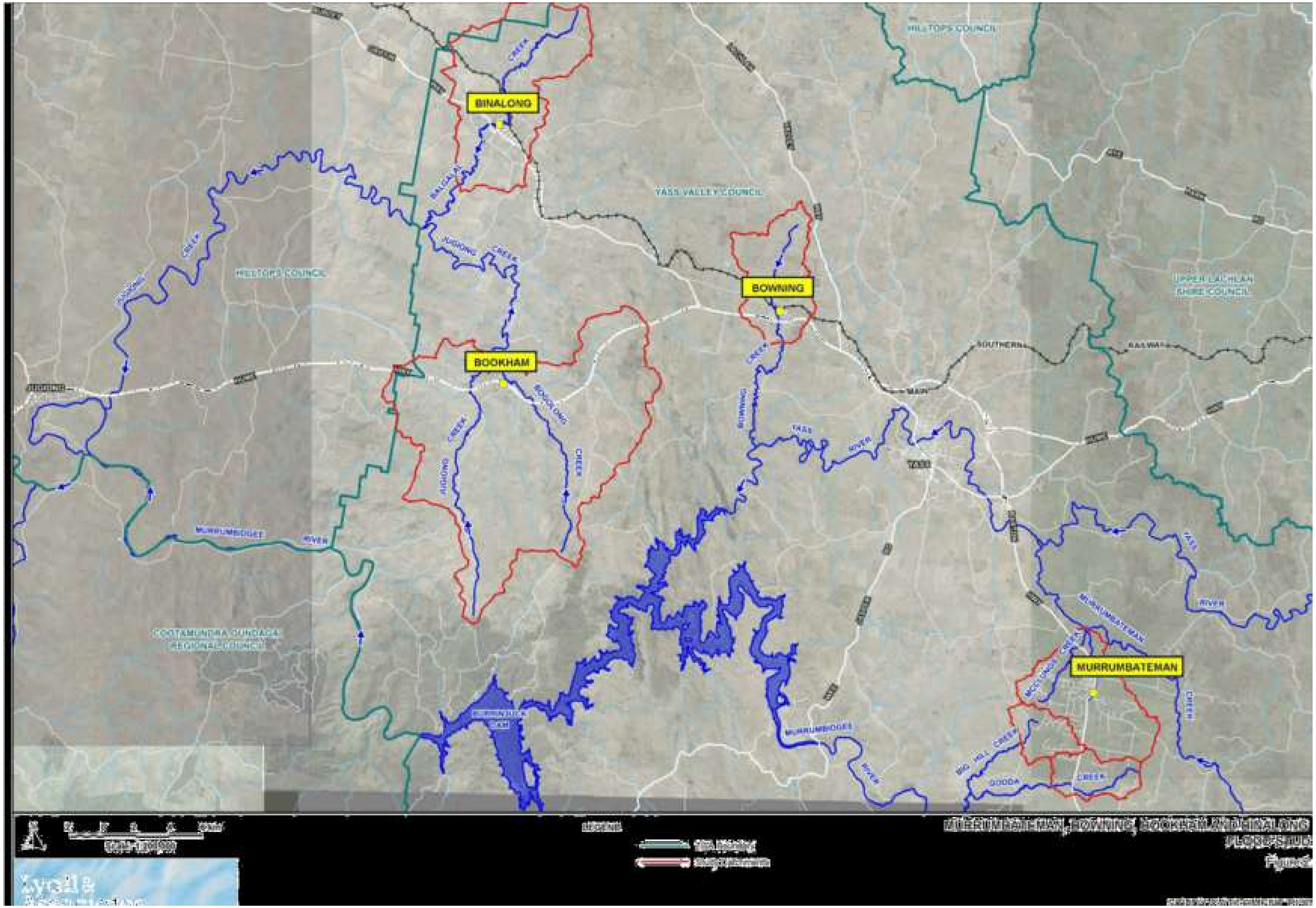
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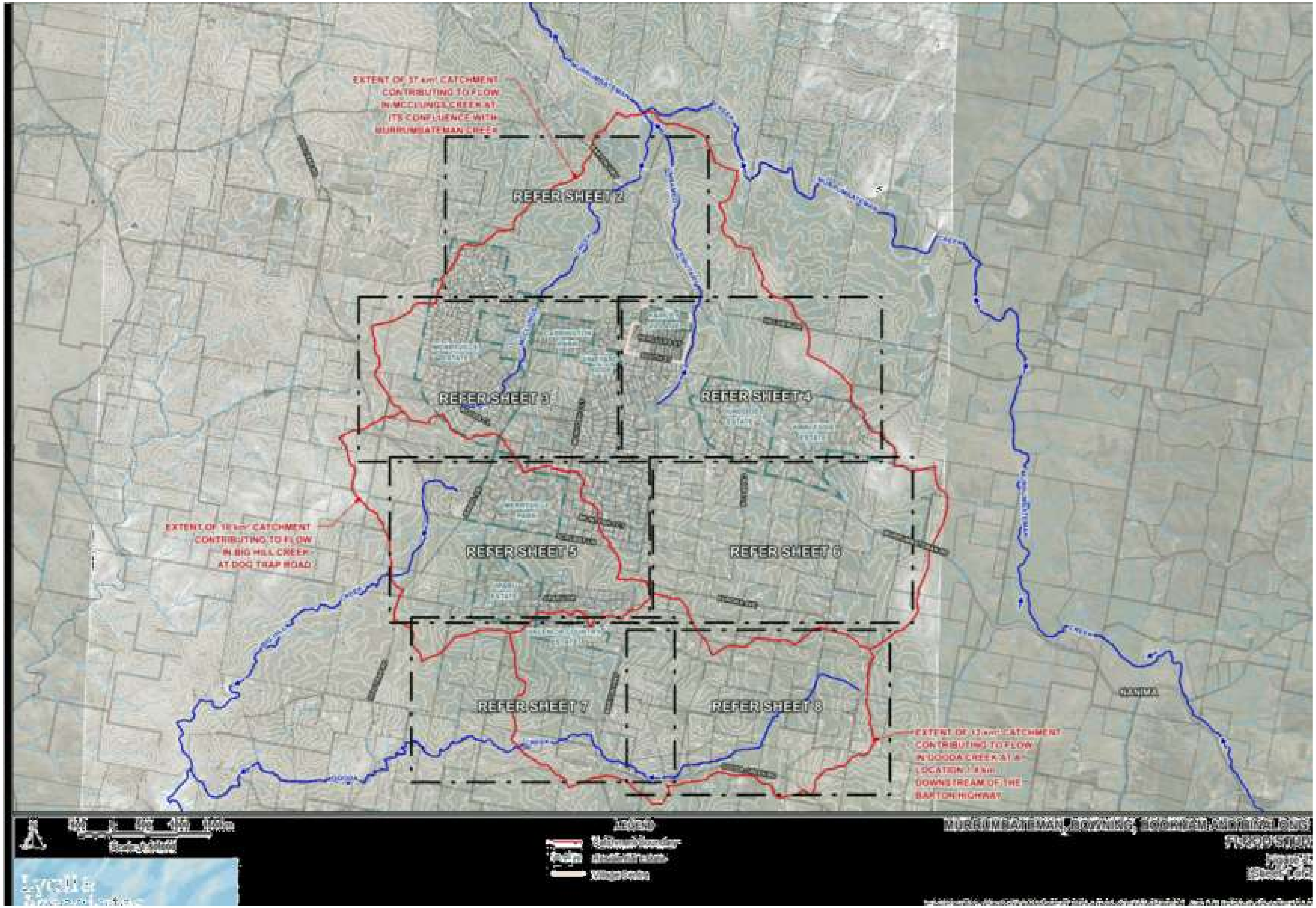
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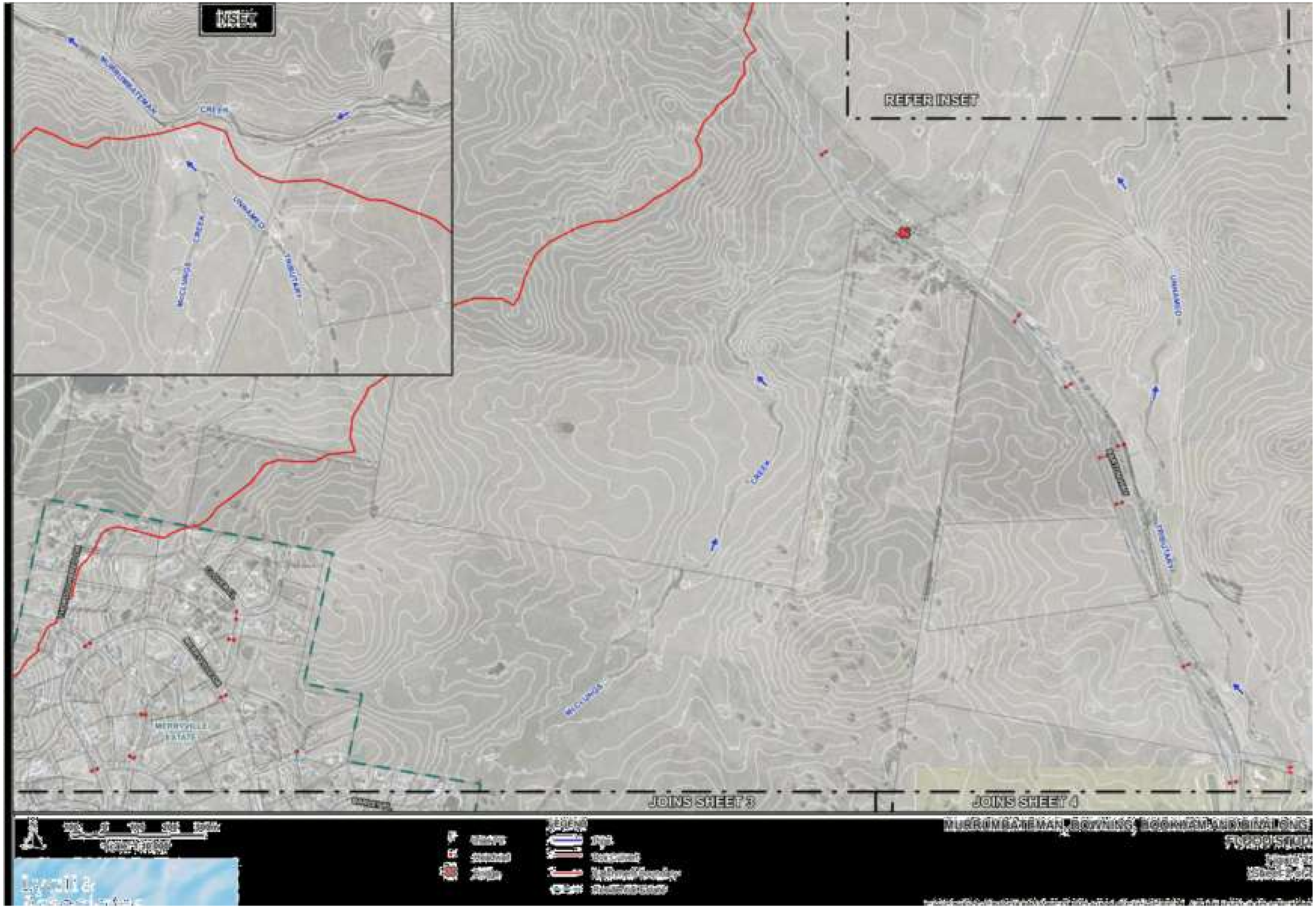
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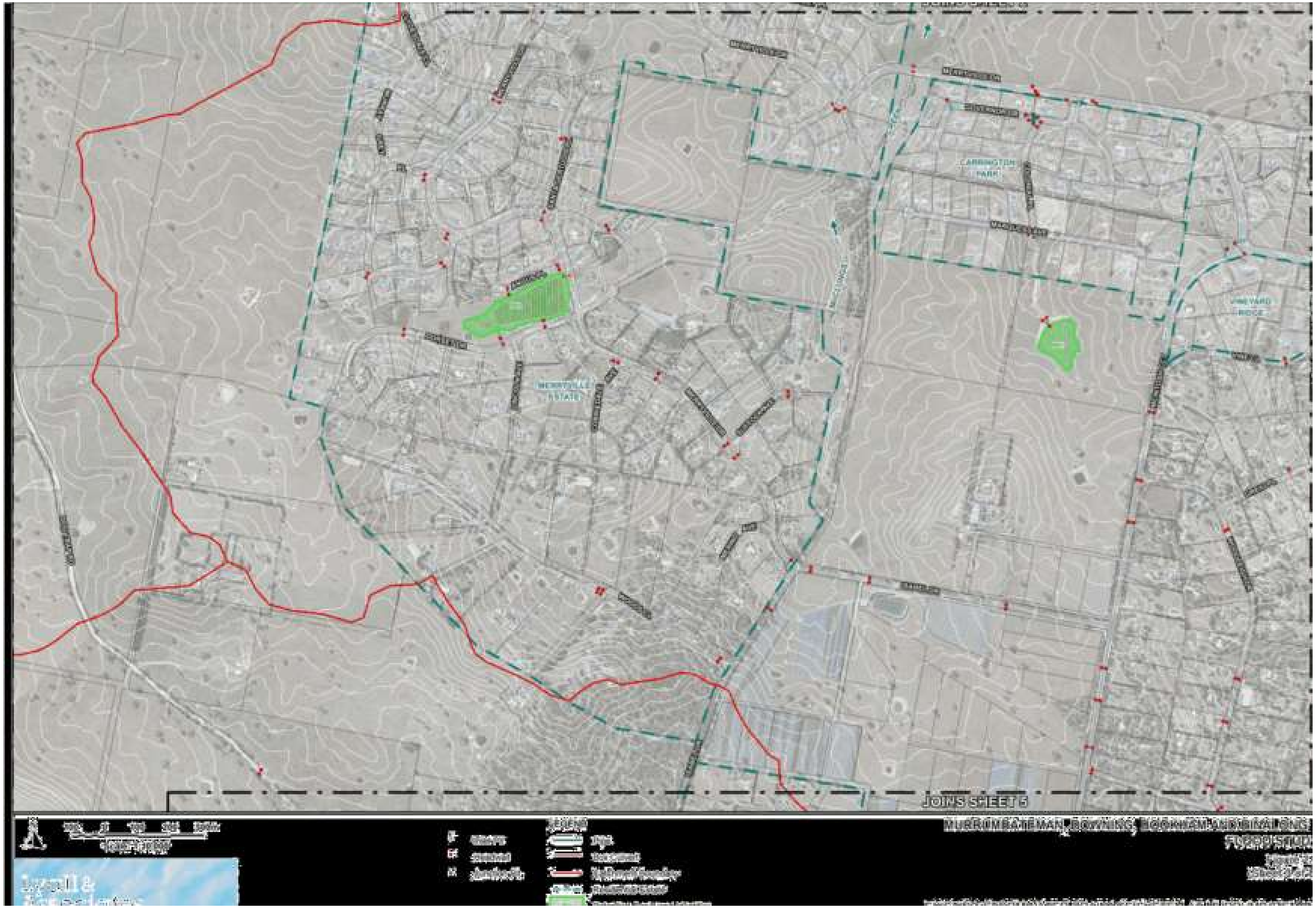
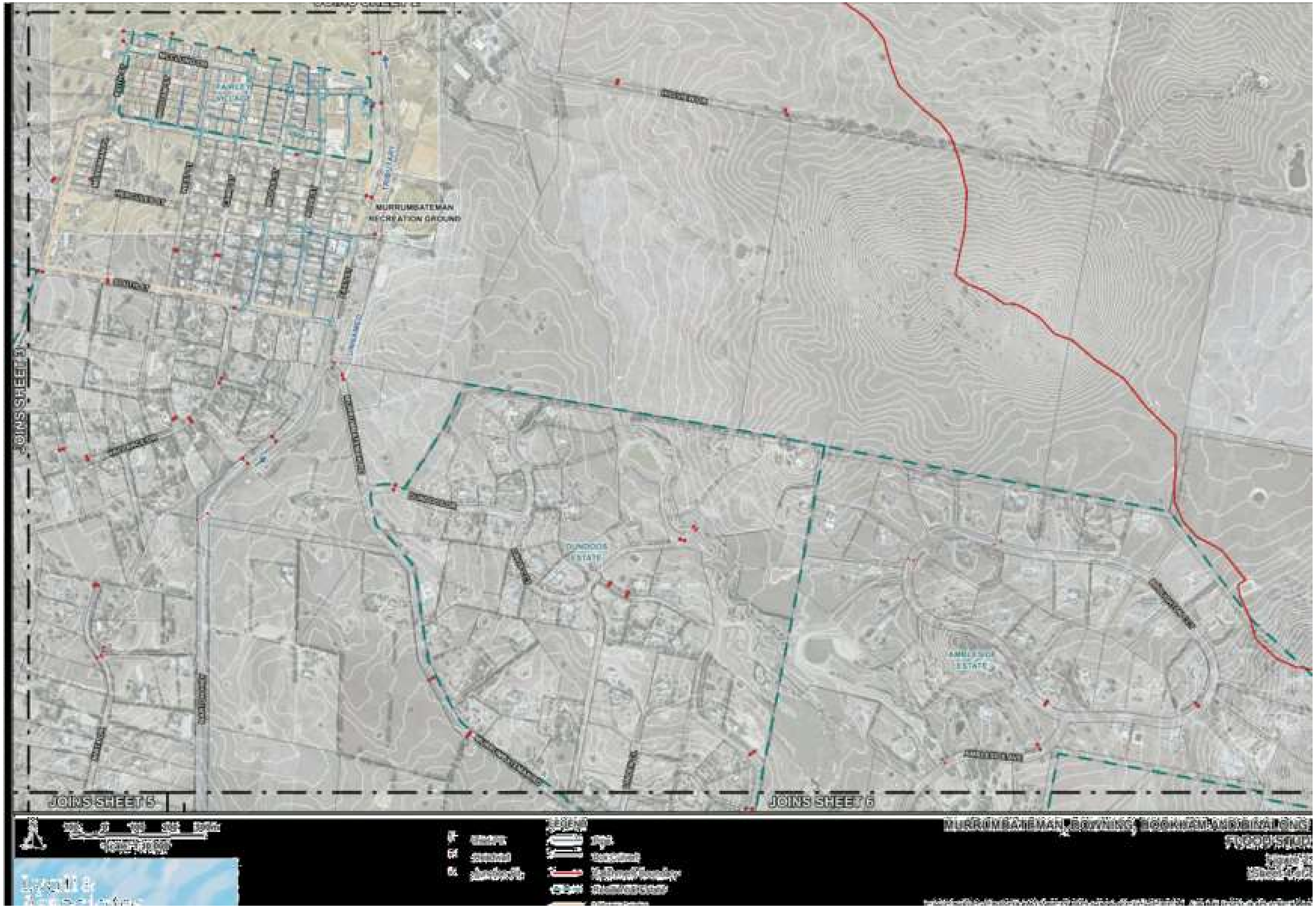
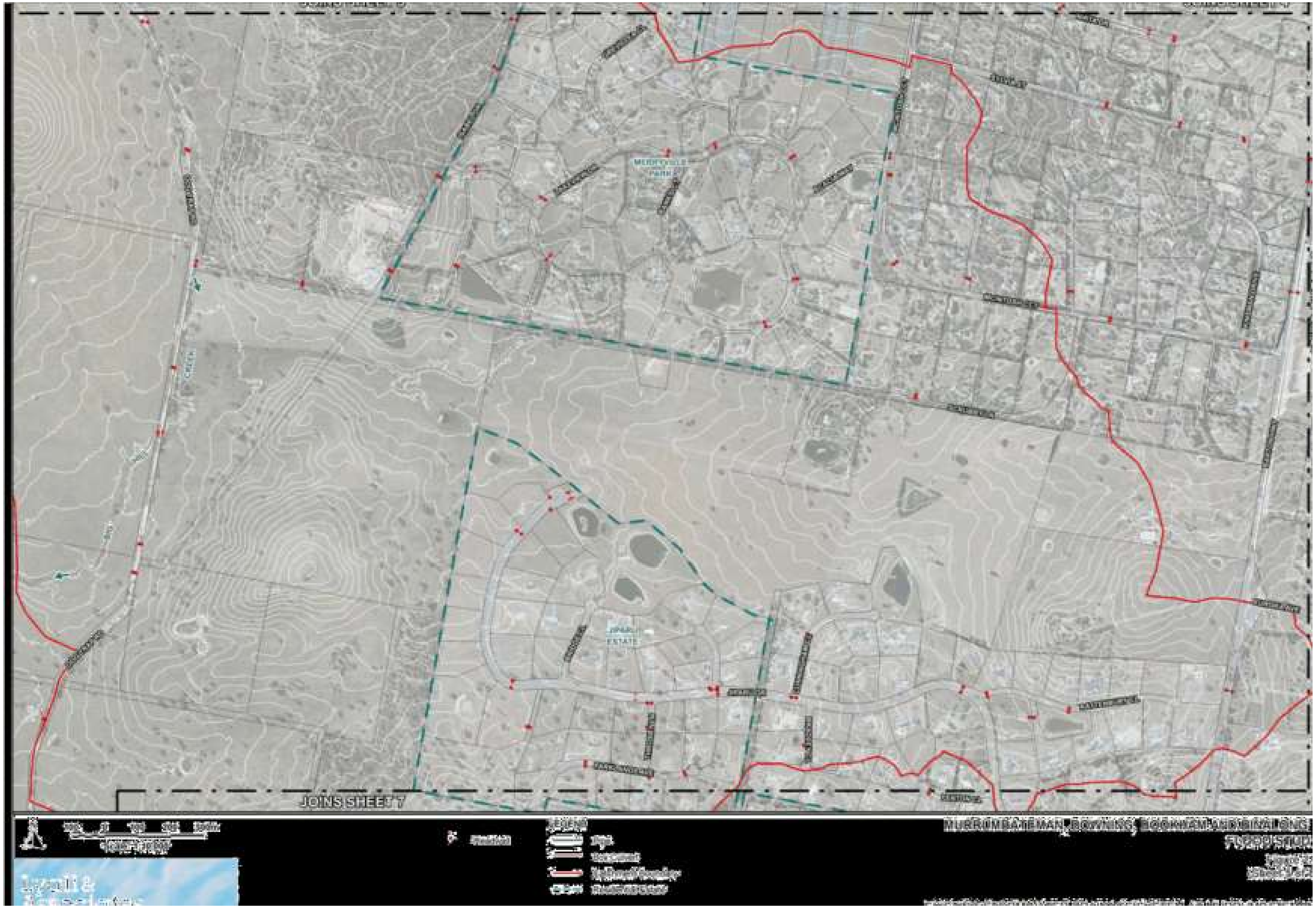
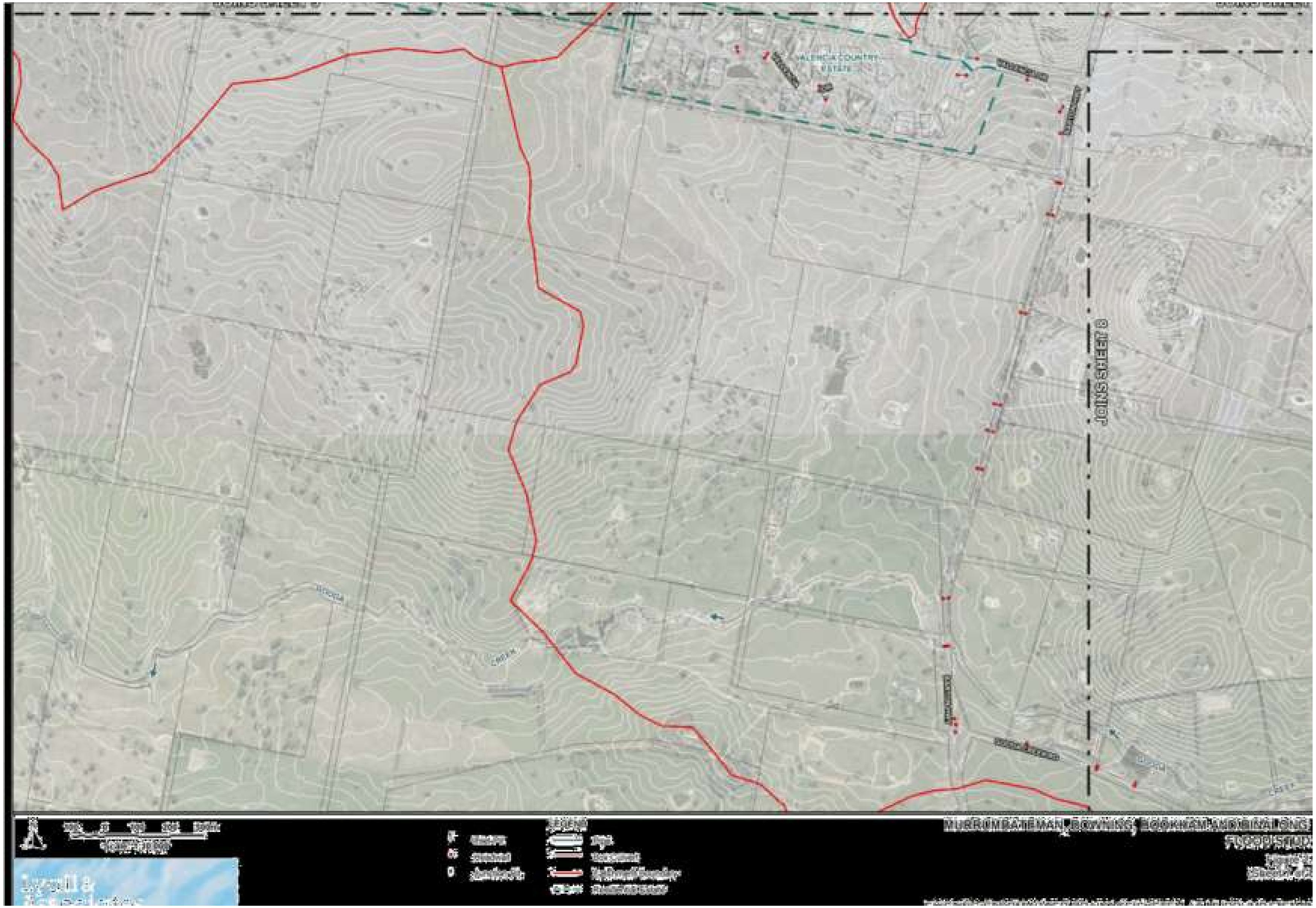
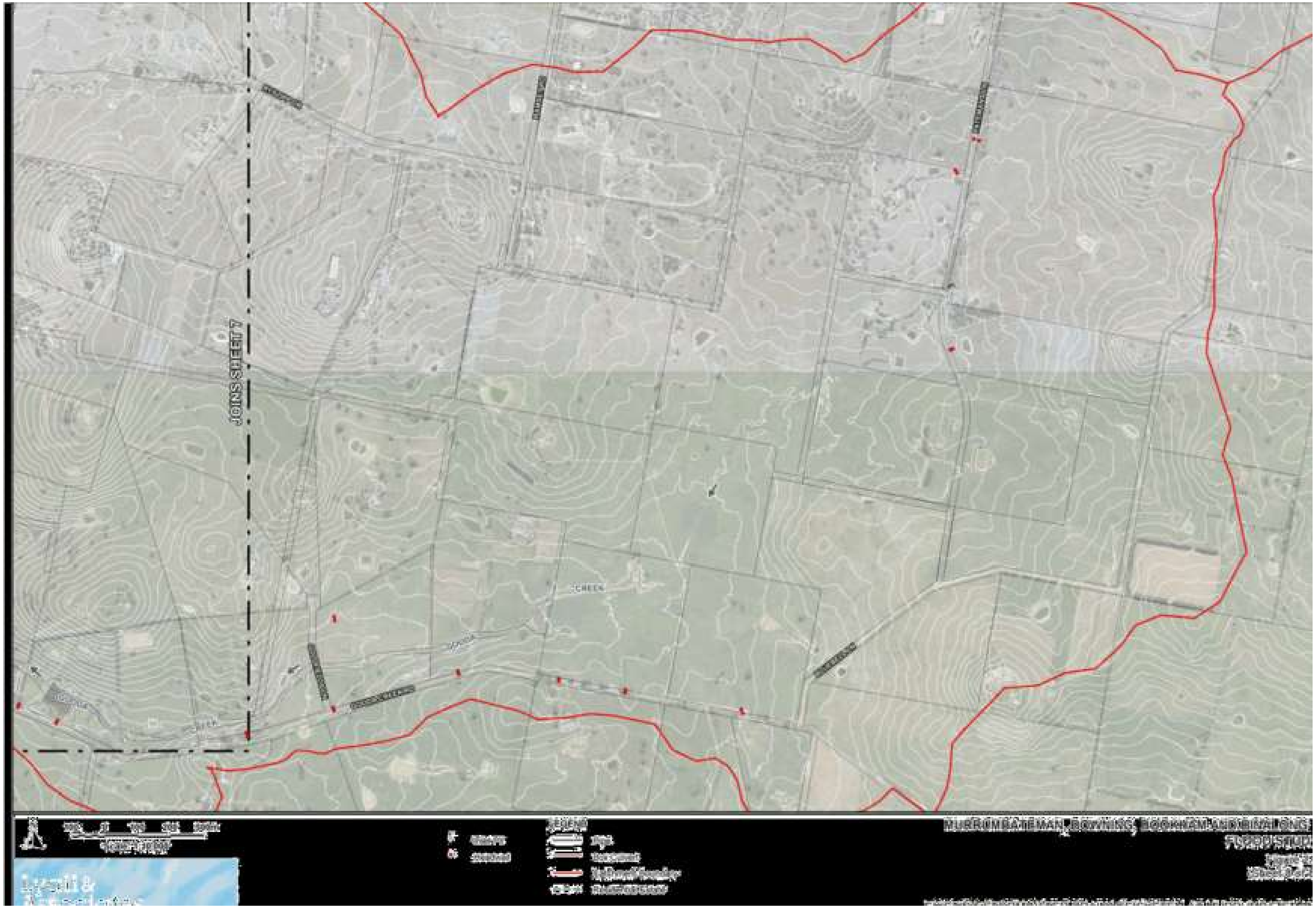


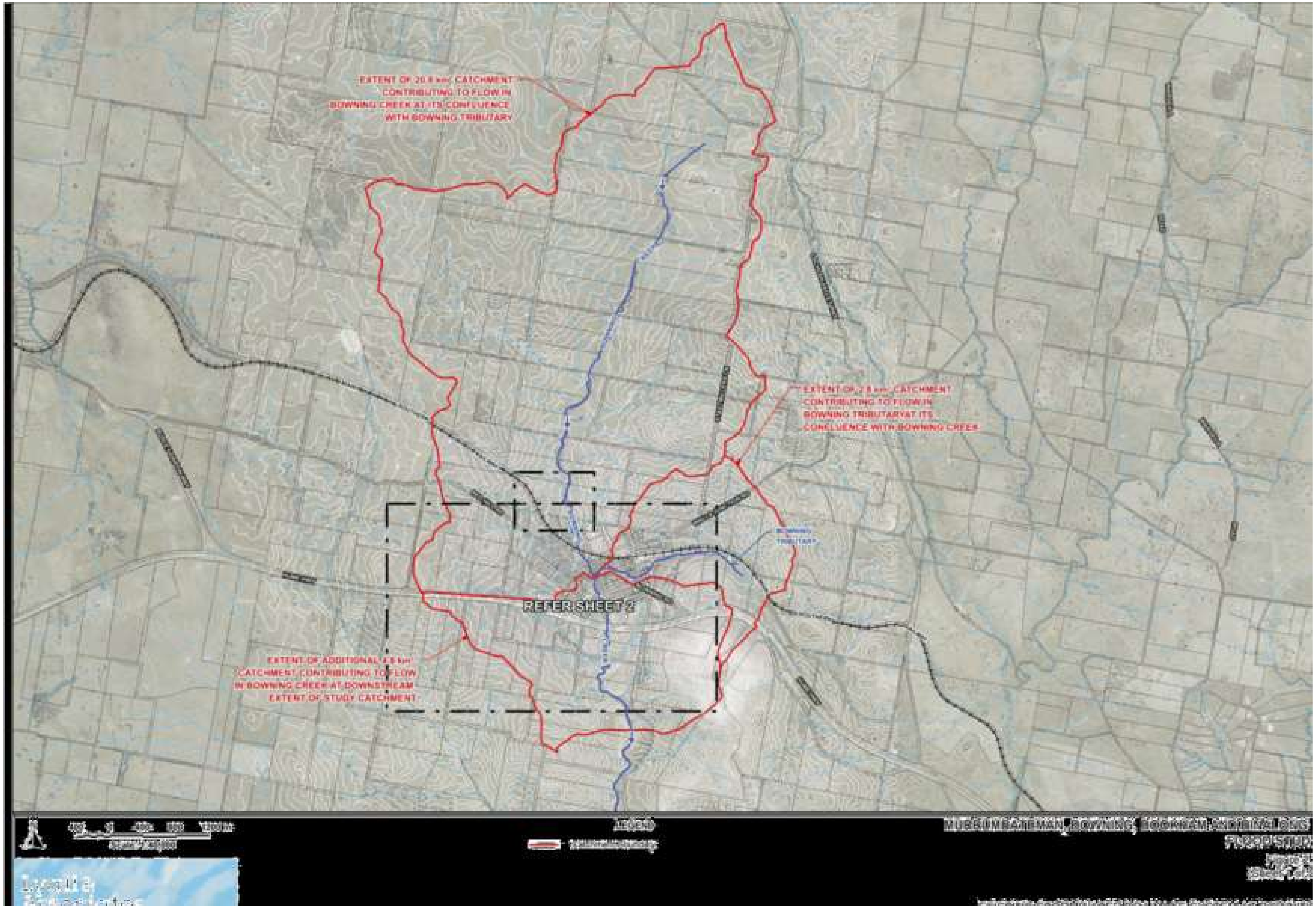

MURRUMBATEMAN
RECREATION GROUND
JOINS SHEET 5
JOINS SHEET 6


JOINS SHEET 7


JOINS SHEET 5
JOINS SHEET 7
AMBLESIDE ESTATE


VALENCIA COUNTRY ESTATE
JOINS SHEET 8
CREEK


JOINS SHEET 7
CREEK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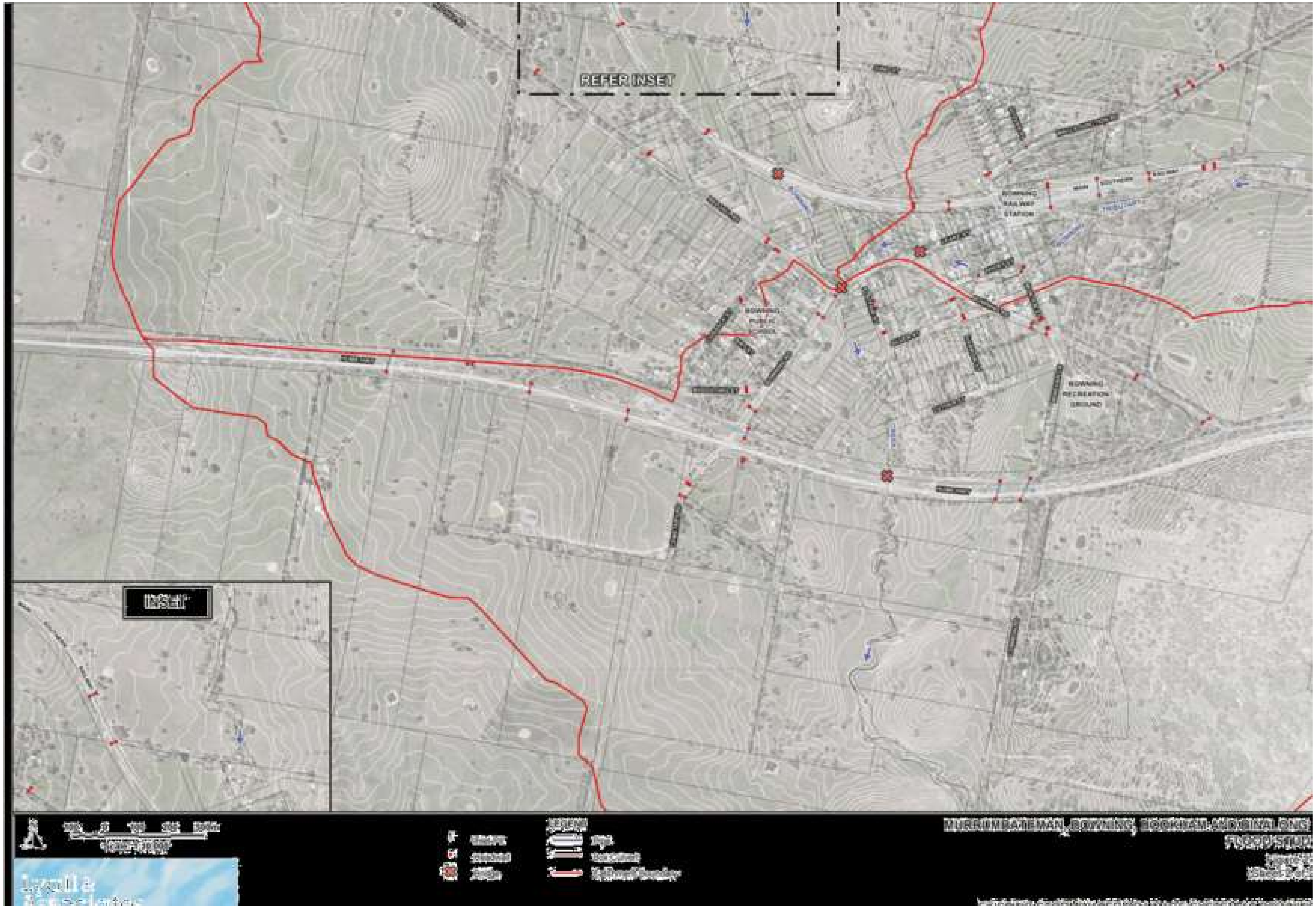
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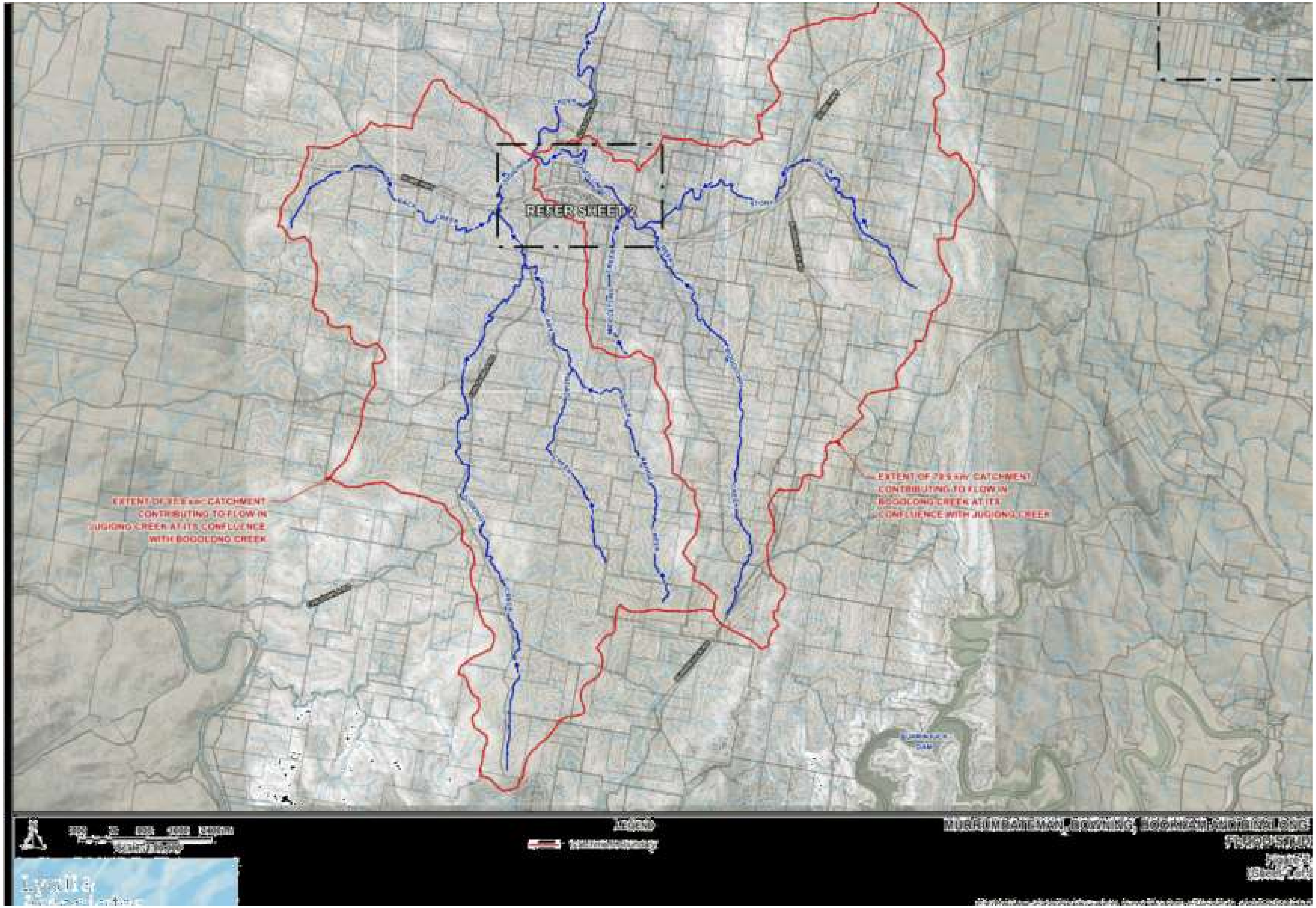
INSET
BOWNING RAILWAY STATION
BOWNING PUBLIC SCHOOL
BOWNING RECREATION GROUND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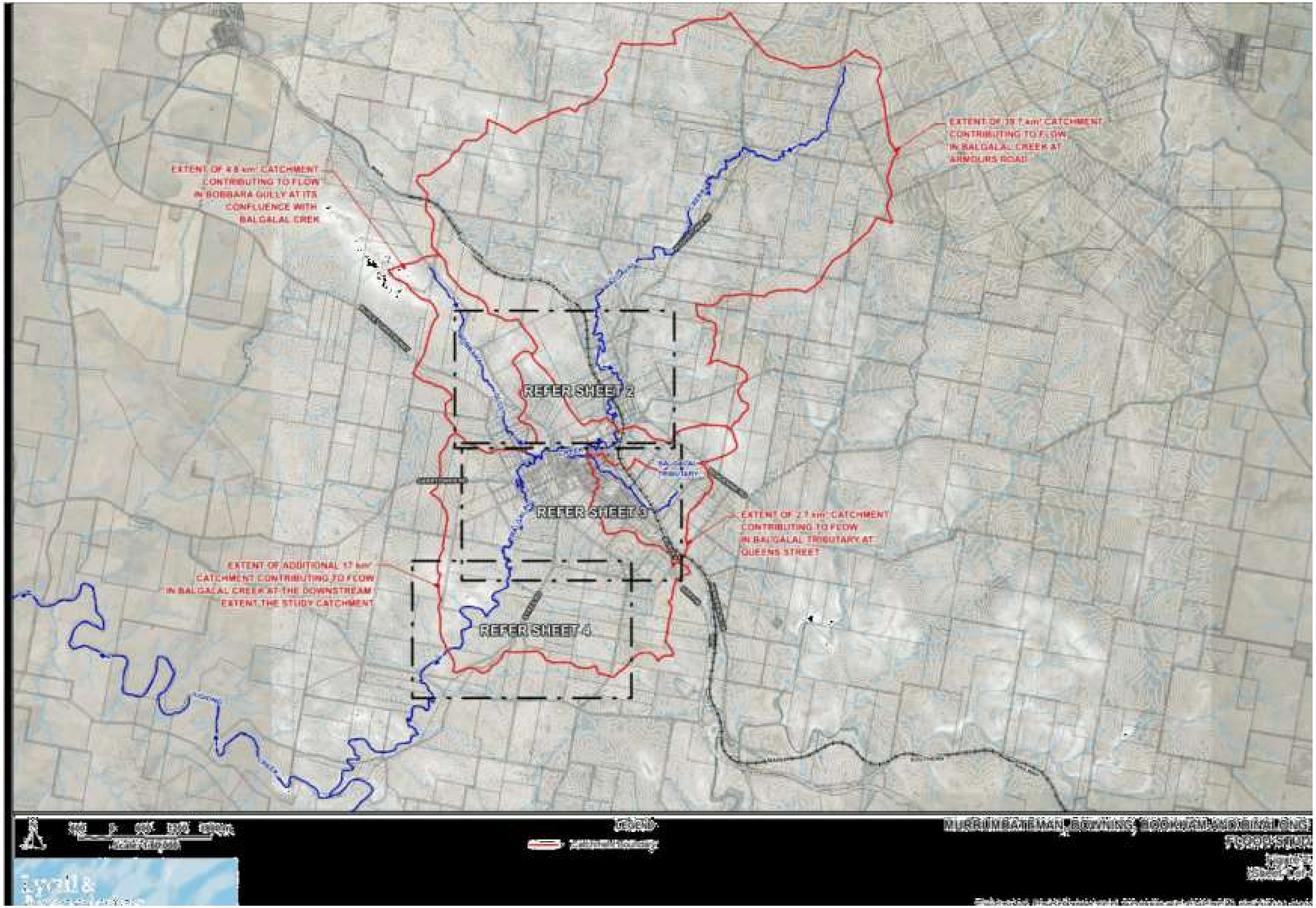
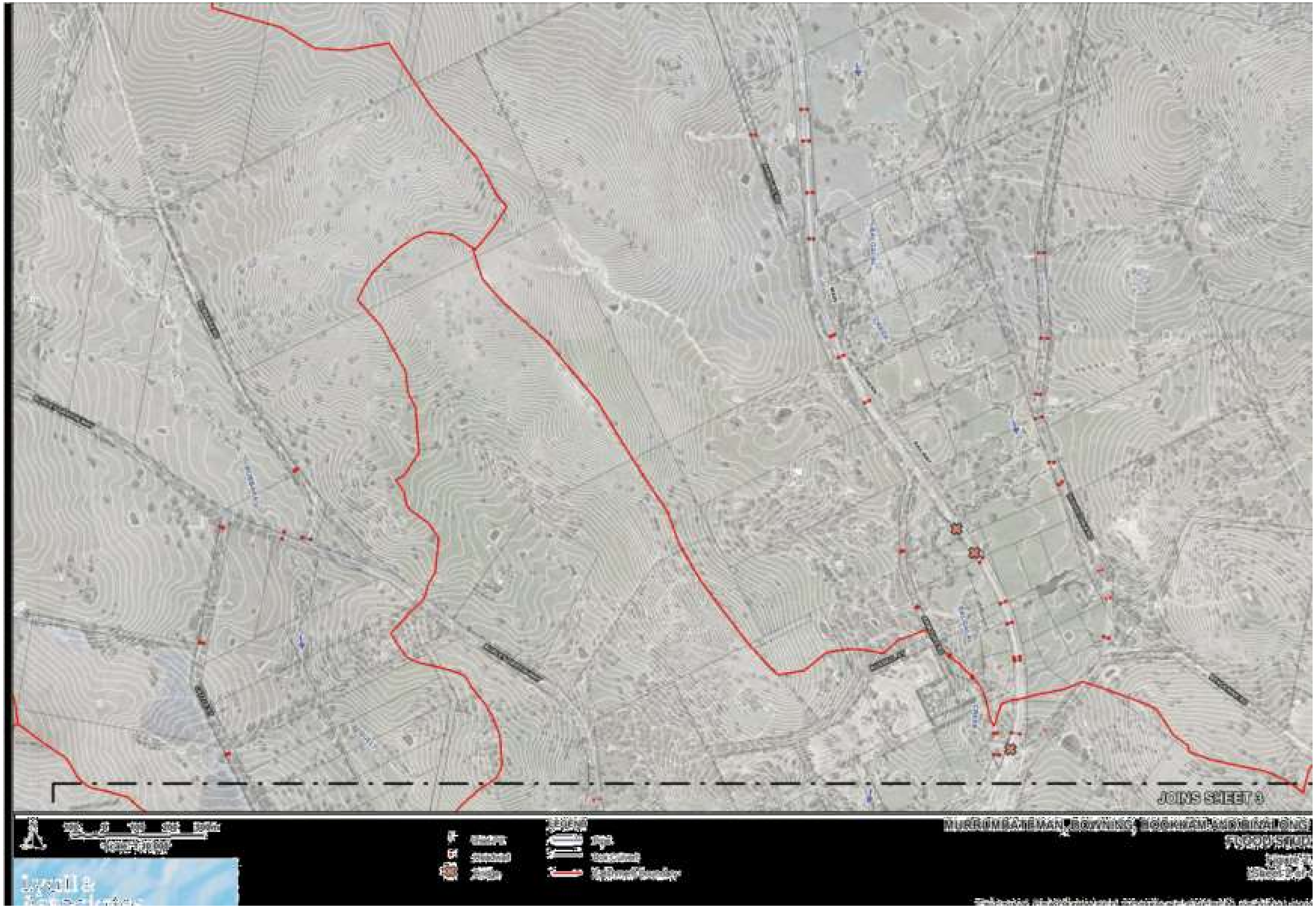
CONTRIBUTING TO FLOW IN
JUGIONG CREEK AT ITS CONFLUENCE
WITH BOGOLONG CREEK
CONTRIBUTING TO FLOW IN
BOGOLONG CREEK AT ITS
CONFLUENCE WITH JUGIONG CREEK

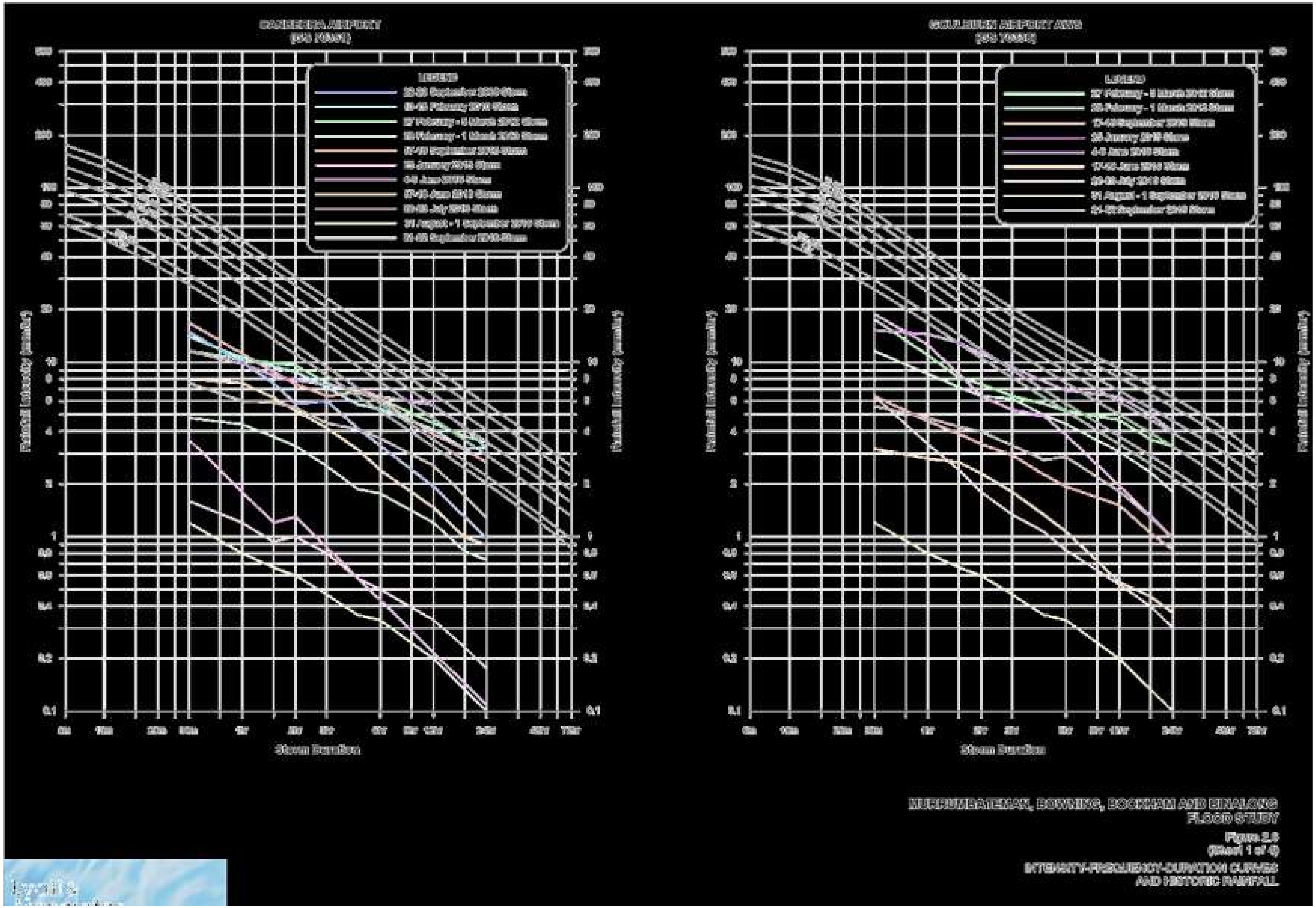

REFER INSET
BOOKHAM
RECREATION
GROUND
INSET

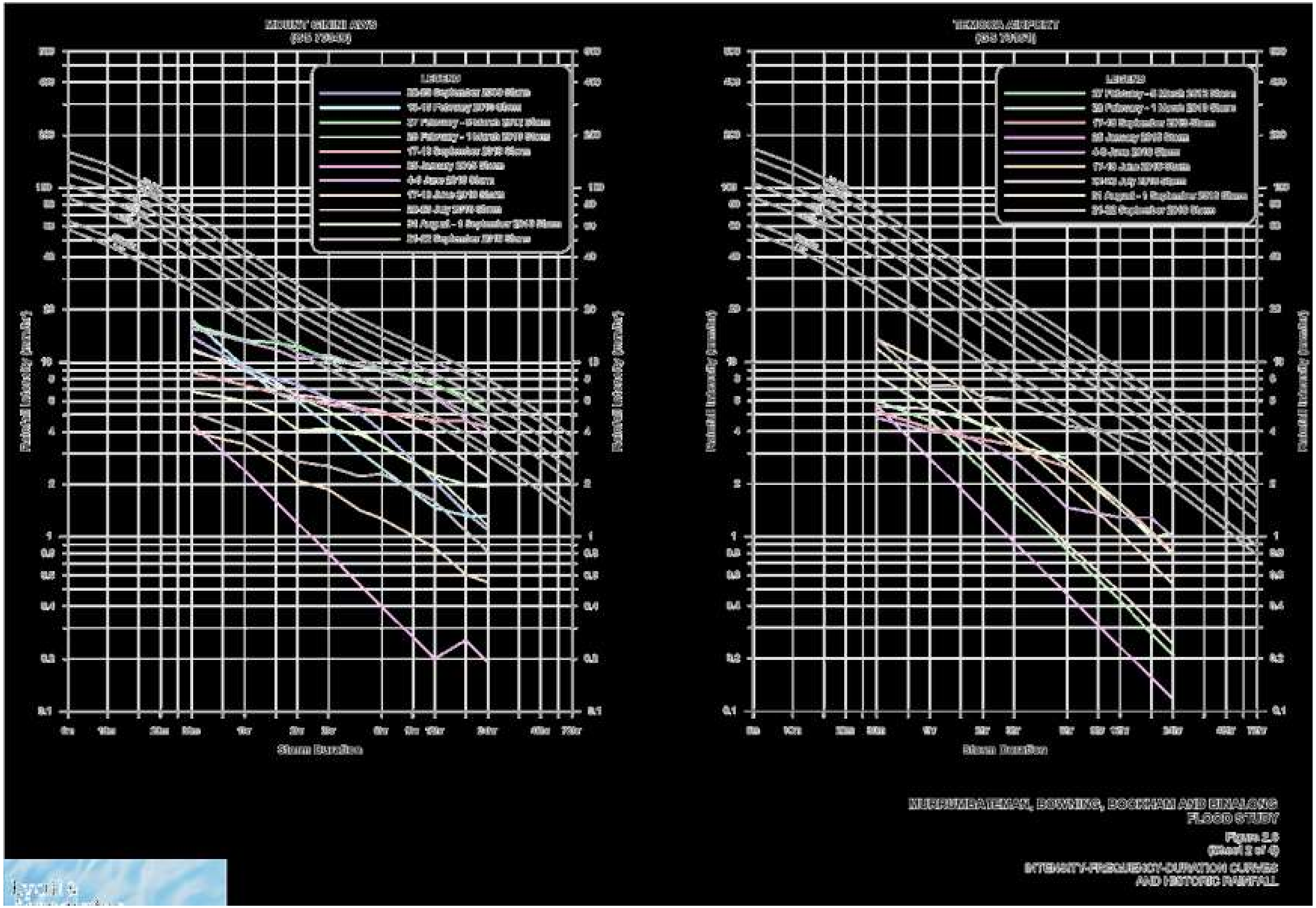

EXTENT OF 4.8 km² CATCHMENT
CONTRIBUTING TO FLOW
IN BOBBARA GULLY AT ITS
CONFLUENCE WITH
BALGALAL CREK
EXTENT OF 39.7 km² CATCHMENT
CONTRIBUTING TO FLOW
IN BALGALAL CREEK AT
ARMOURS ROAD
REFER SHEET 2
REFER SHEET 3
REFER SHEET 4
EXTENT OF 2.7 km² CATCHMENT
CONTRIBUTING TO FLOW
IN BALGALAL TRIBUTARY AT
QUEENS STREET
EXTENT OF ADDITIONAL 17 km²
CATCHMENT CONTRIBUTING TO FLOW
IN BALGALAL CREEK AT THE DOWNSTREAM
EXTENT THE STUDY CATCHMENT

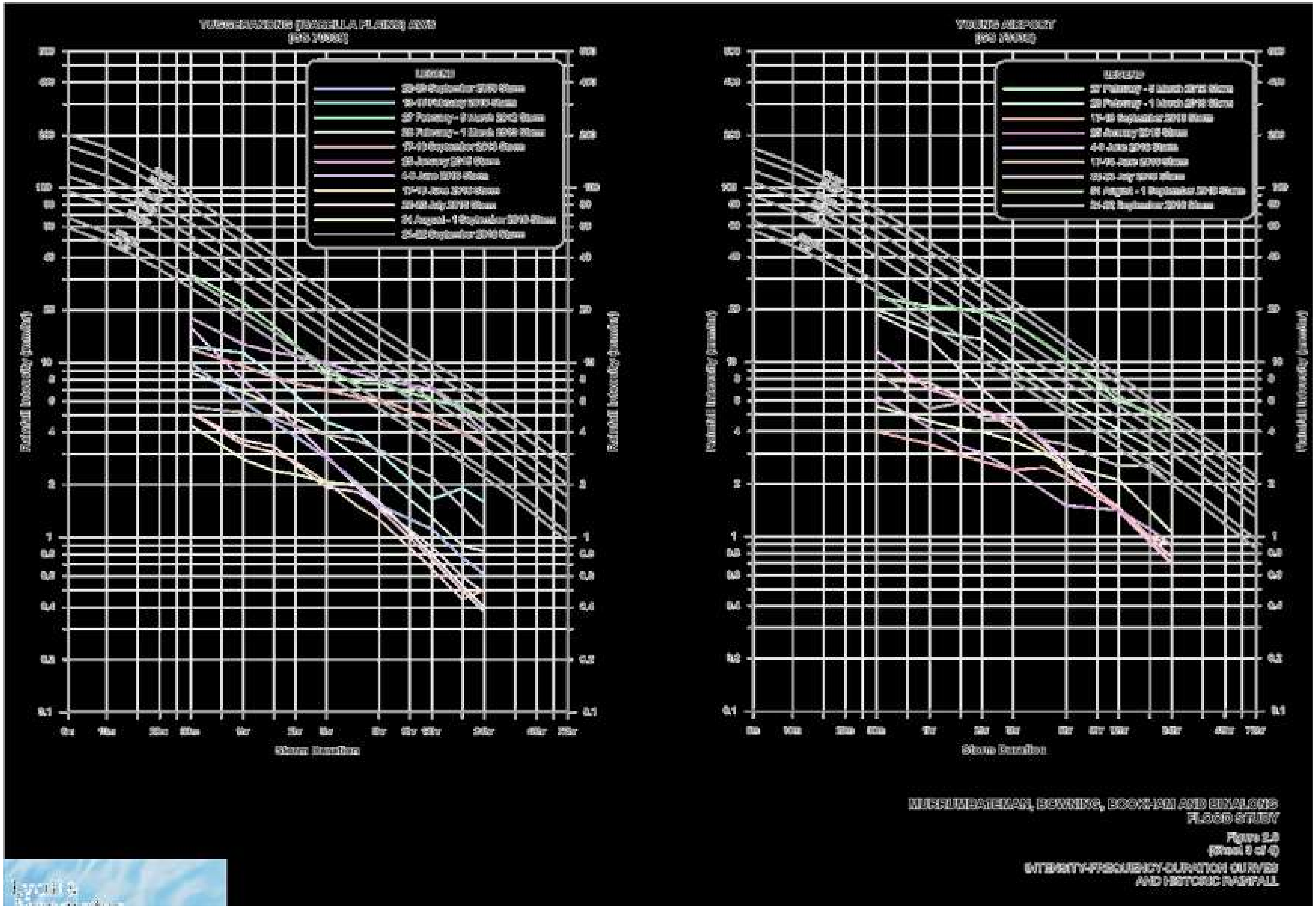

JOINS SHEET 3

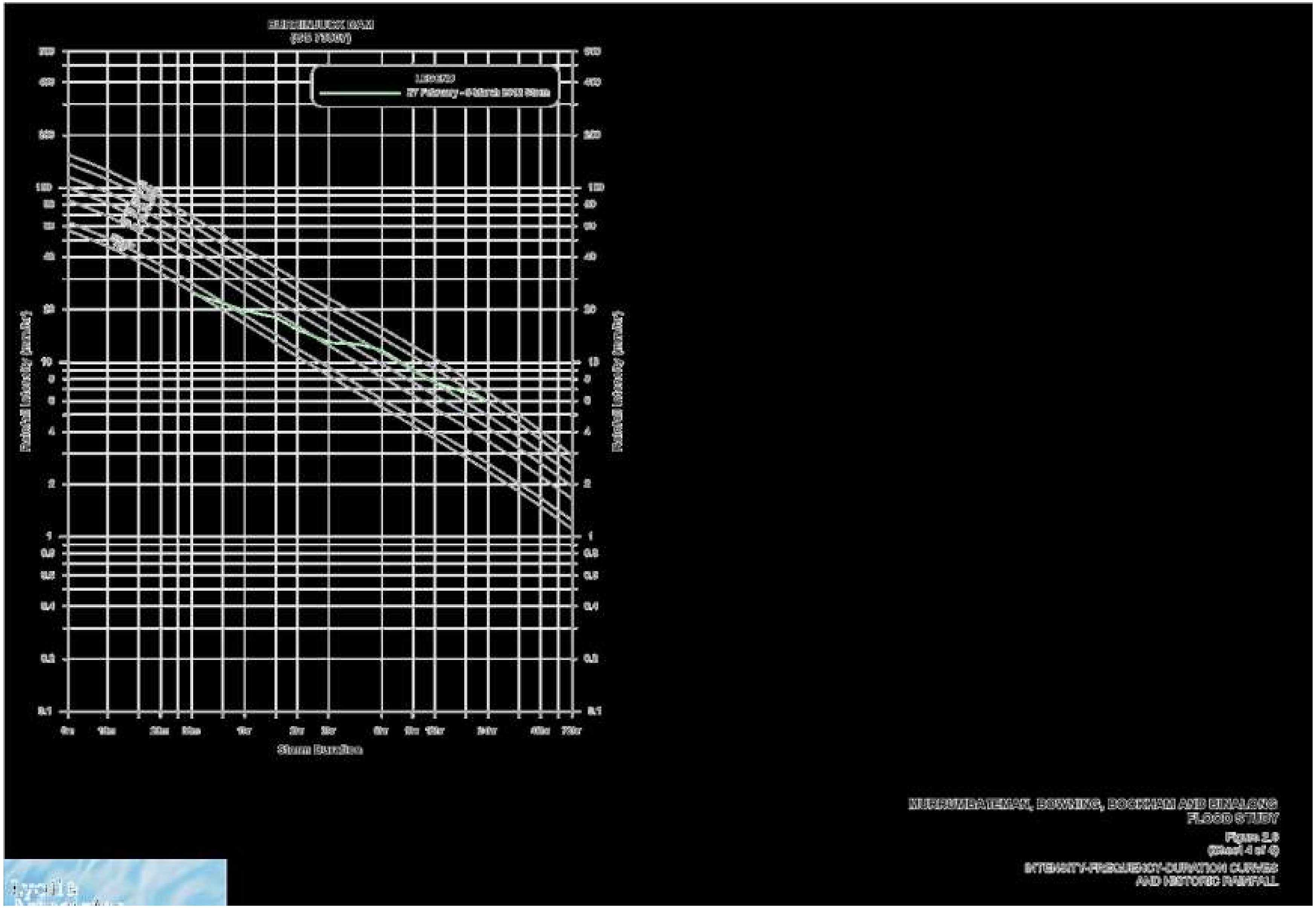

JOINS SHEET 2
JOINS SHEET 4

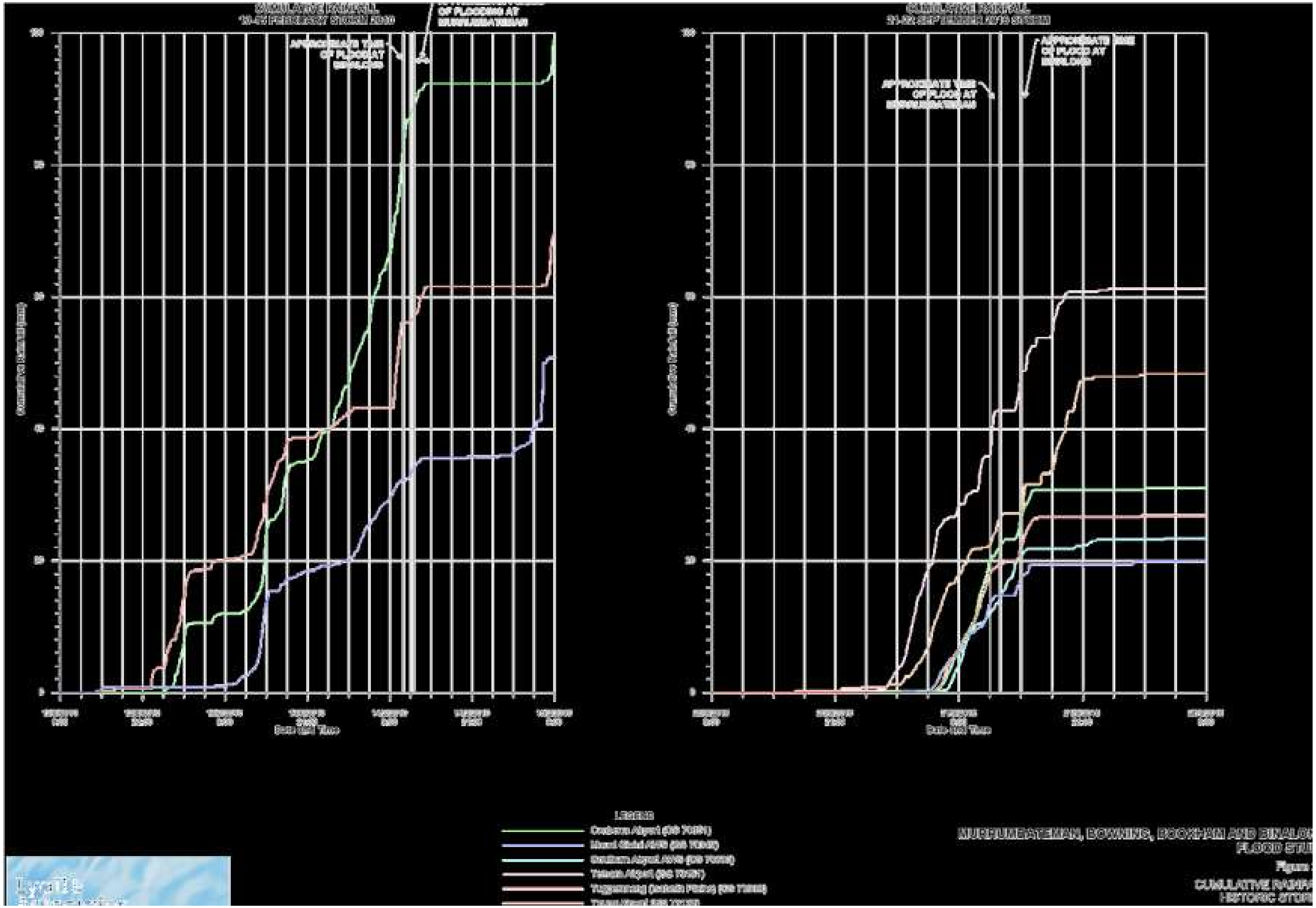

JOINS SHEET 3

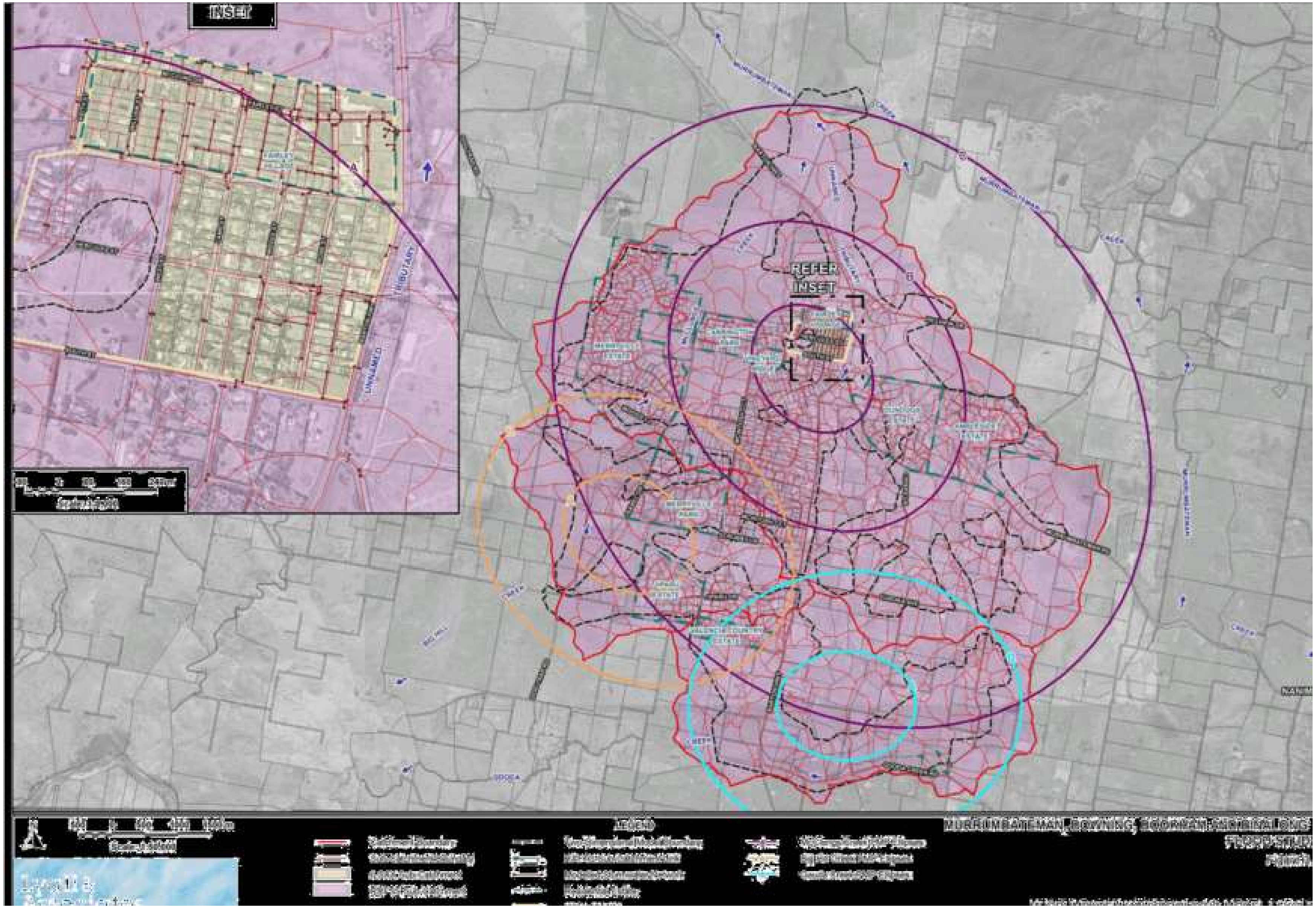

CANBERRA AIRPORT
GOULBURN AIRPORT AWS
LEGEND
Storm Duration
MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALONG FLOOD STUDY
Figure 2.6
(Sheet 1 of 4)
INTENSITY-FREQUENCY-DURATION CURVES AND HISTORIC RAINFALL

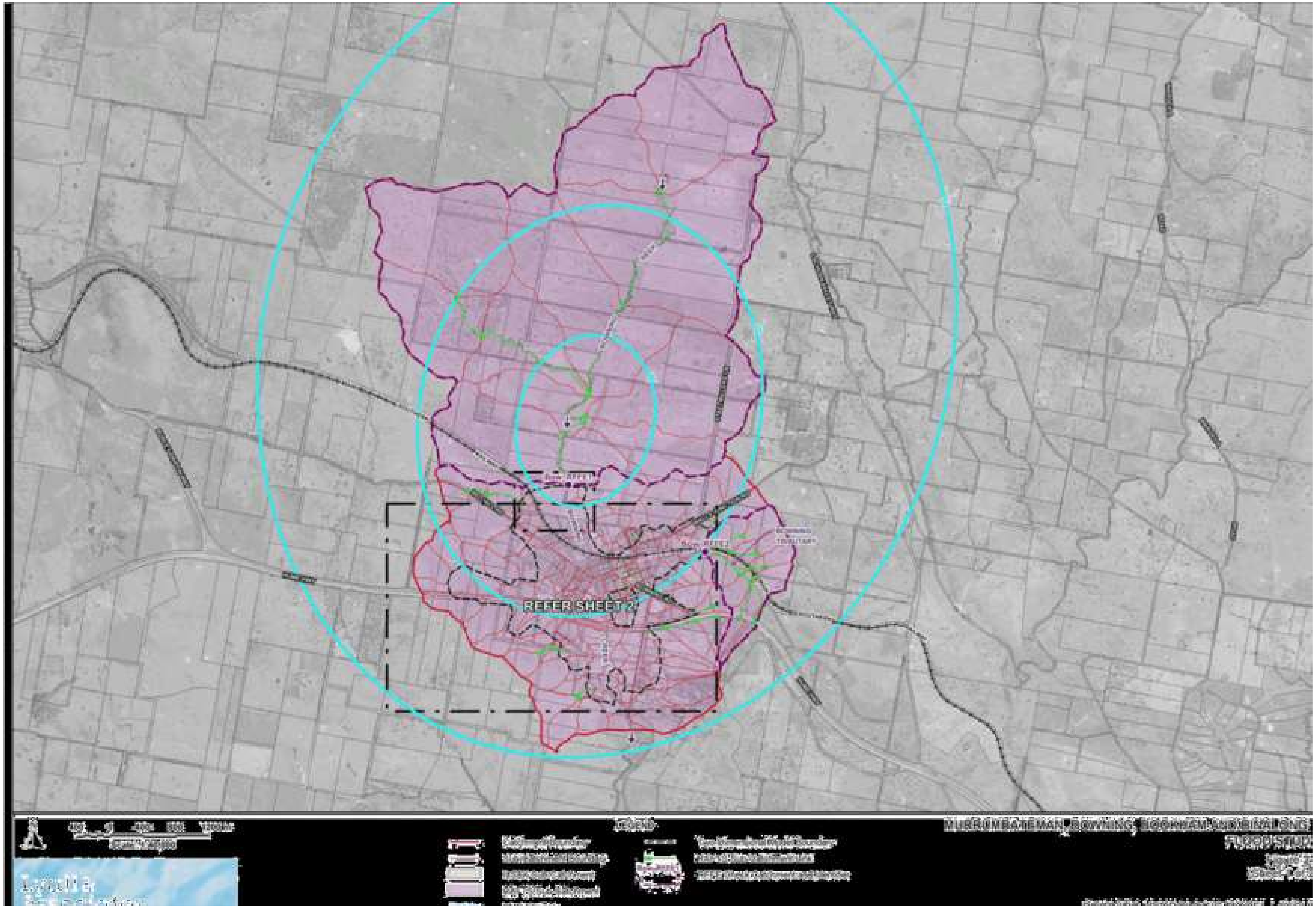



MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALONG
FLOOD STUDY
INTENSITY-FREQUENCY-DURATION CURVES
AND HISTORIC RAINFALL


MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALONG
FLOOD STUDY
INTENSITY-FREQUENCY-DURATION CURVES
AND HISTORIC RAINFALL


MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALO
CUMULATIVE RAINFA
HISTORIC STOR


INSET
REFER
INSET
UNNAMED
TRIBUTARY
MURRUMBATEMAN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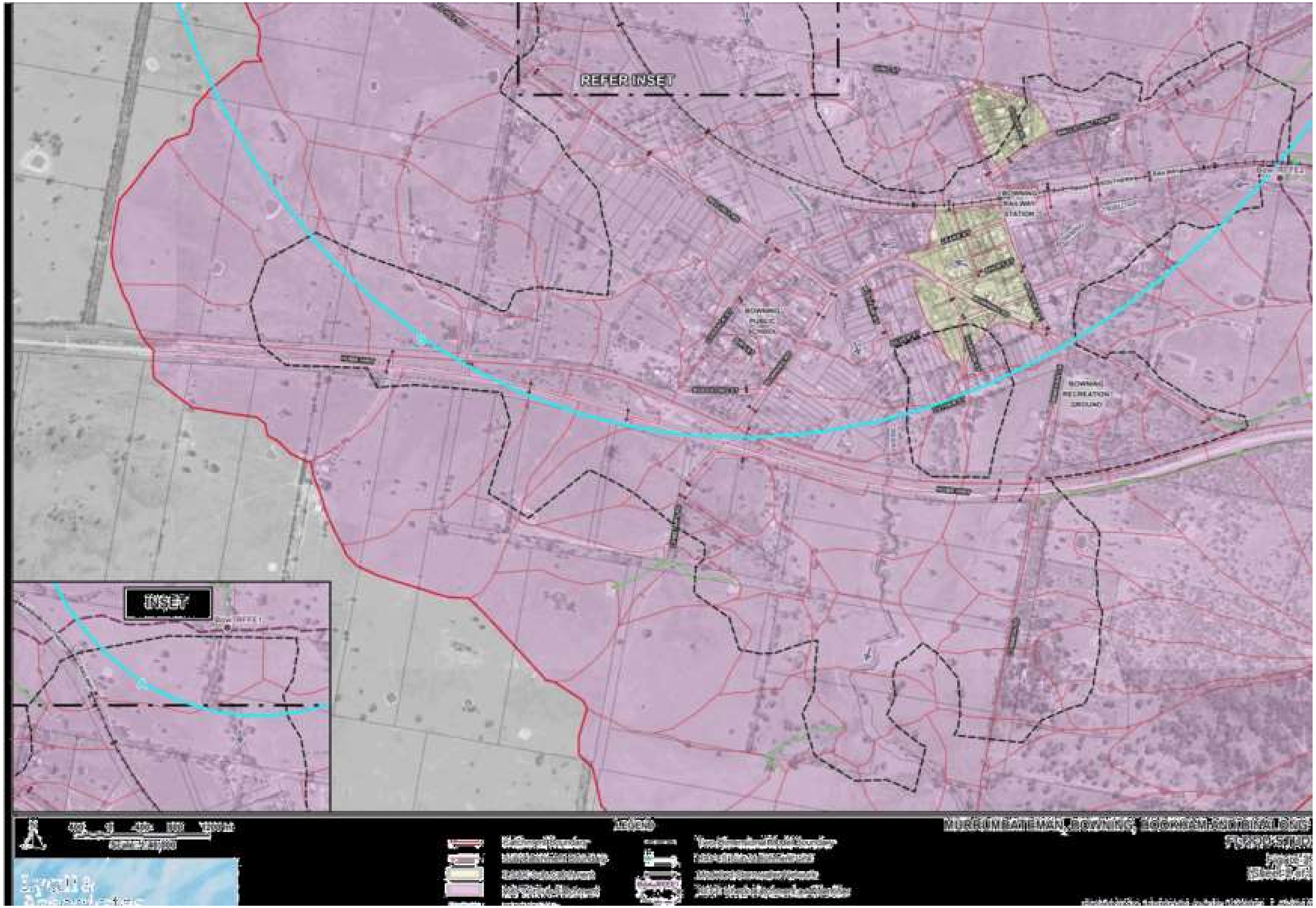
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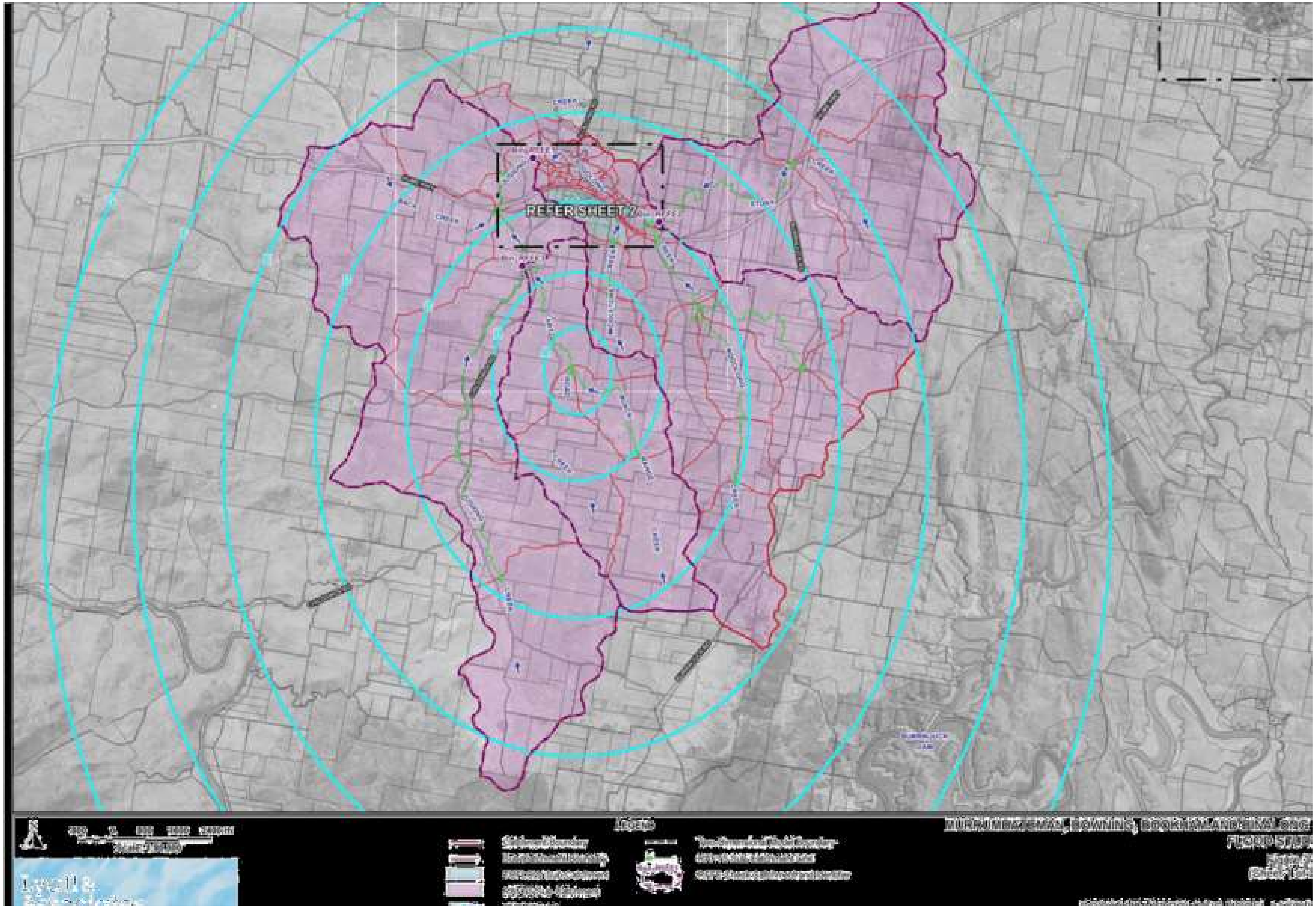
INSET
BOWNING RAILWAY STATION
BOWNING PUBLIC SCHOOL
BOWNING RECREATION GROUND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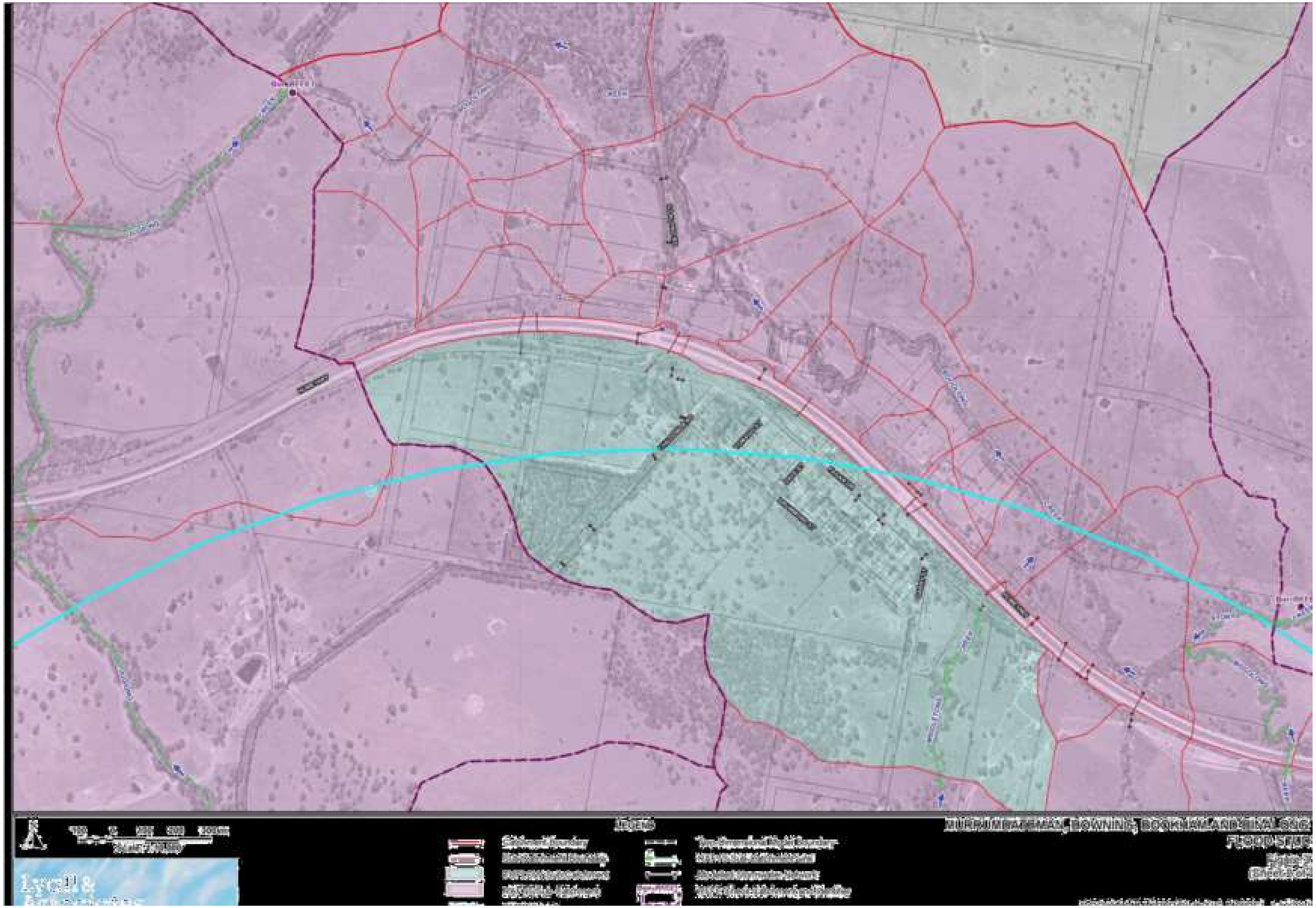

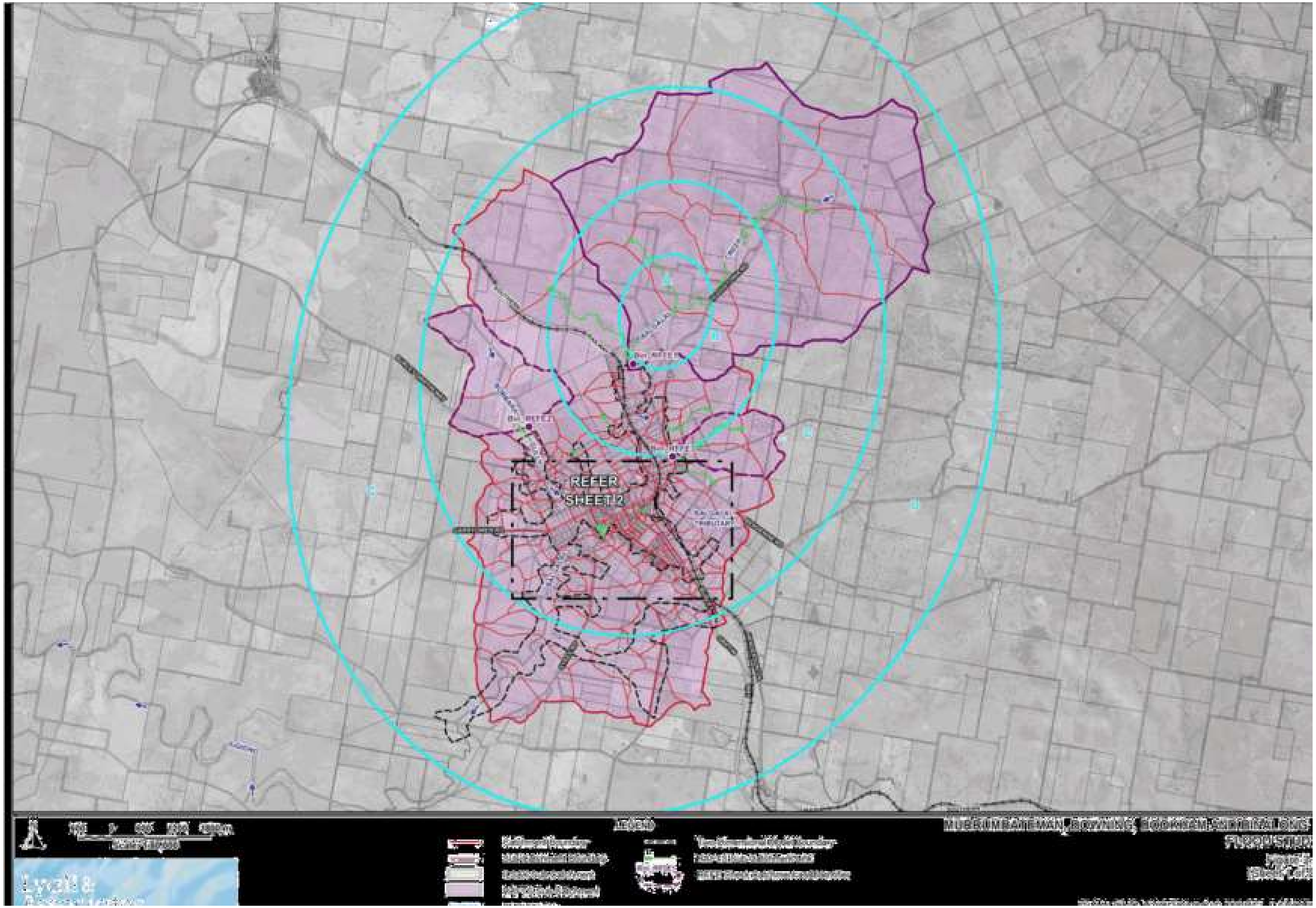
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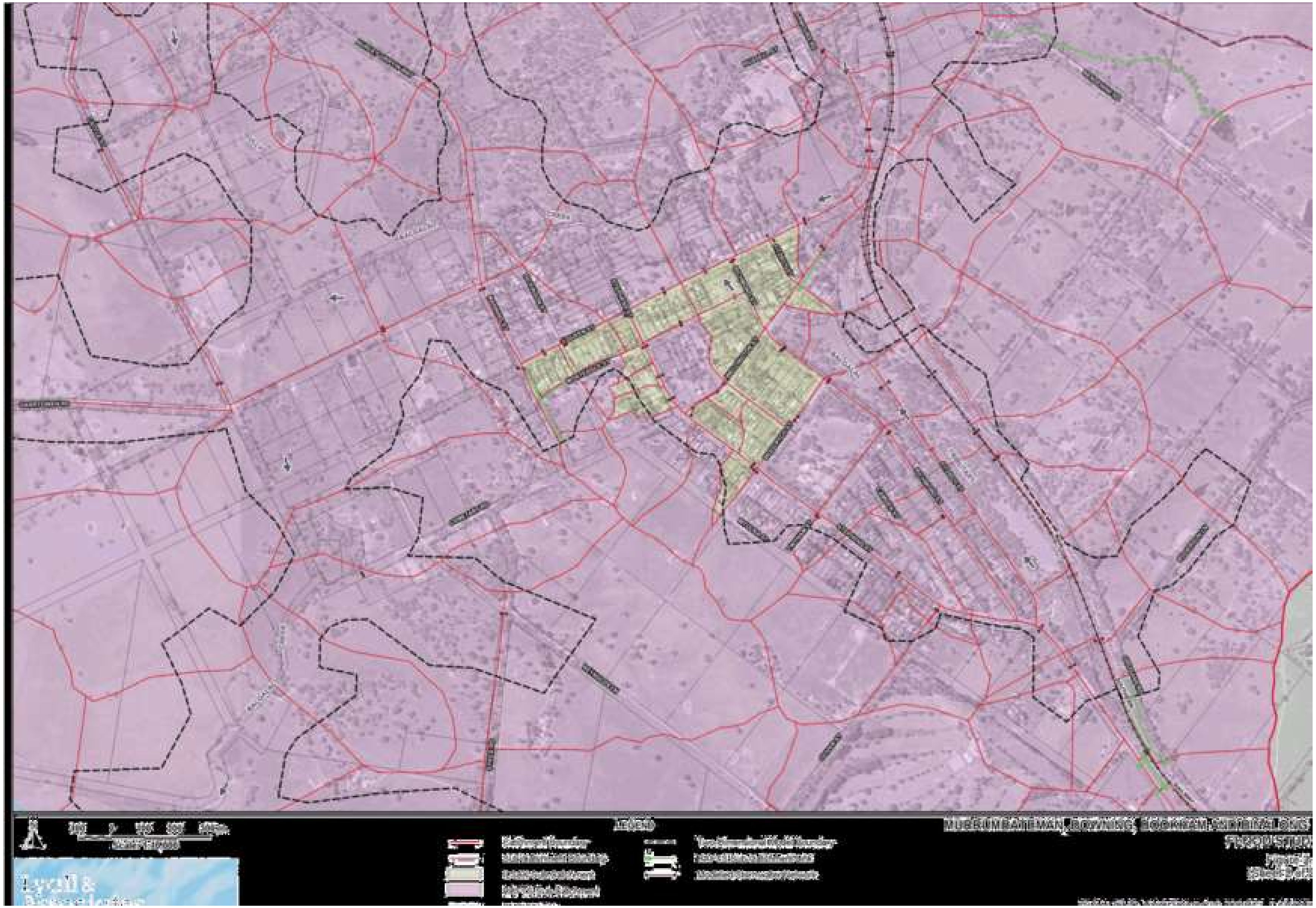
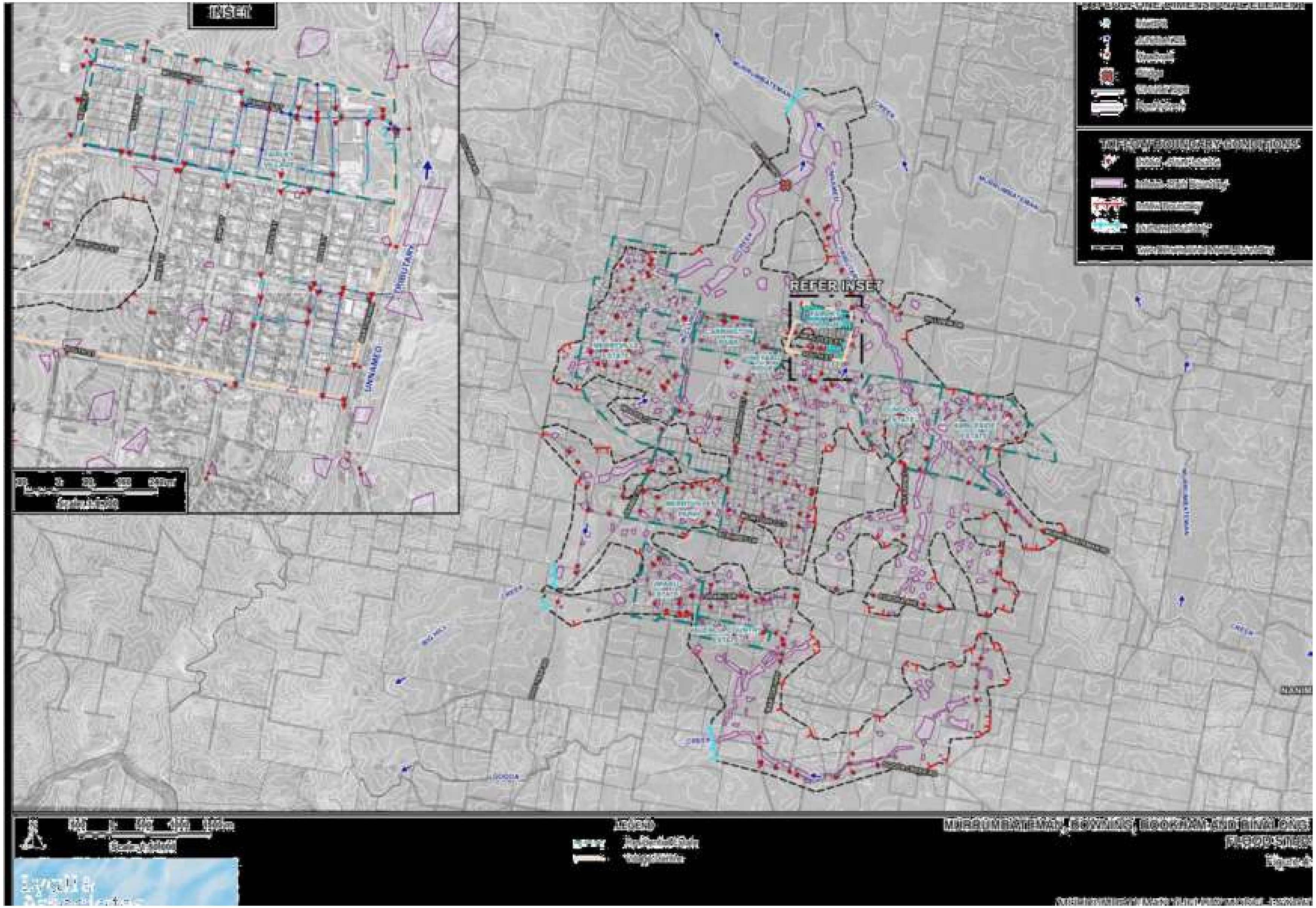
SHEET 2

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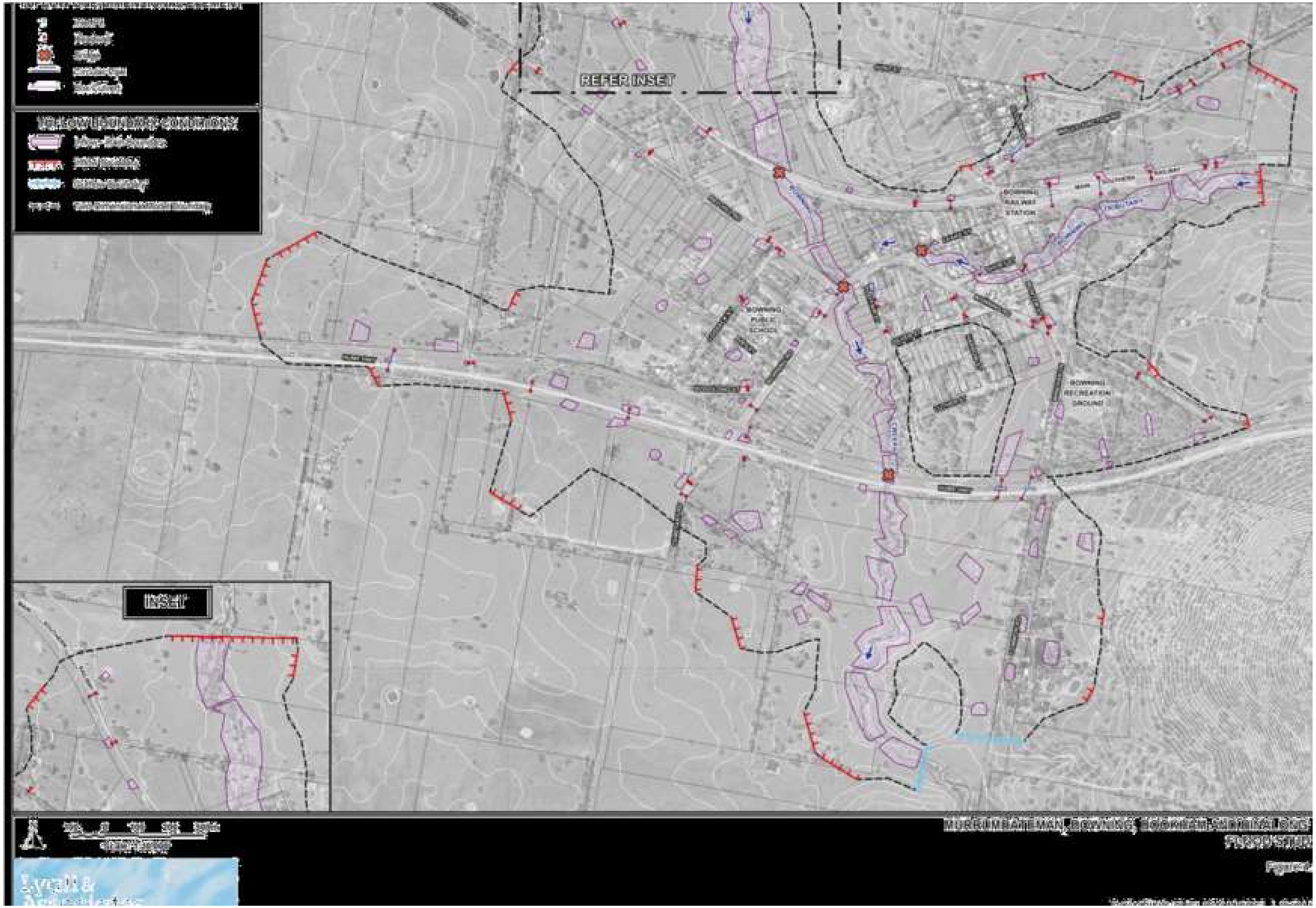
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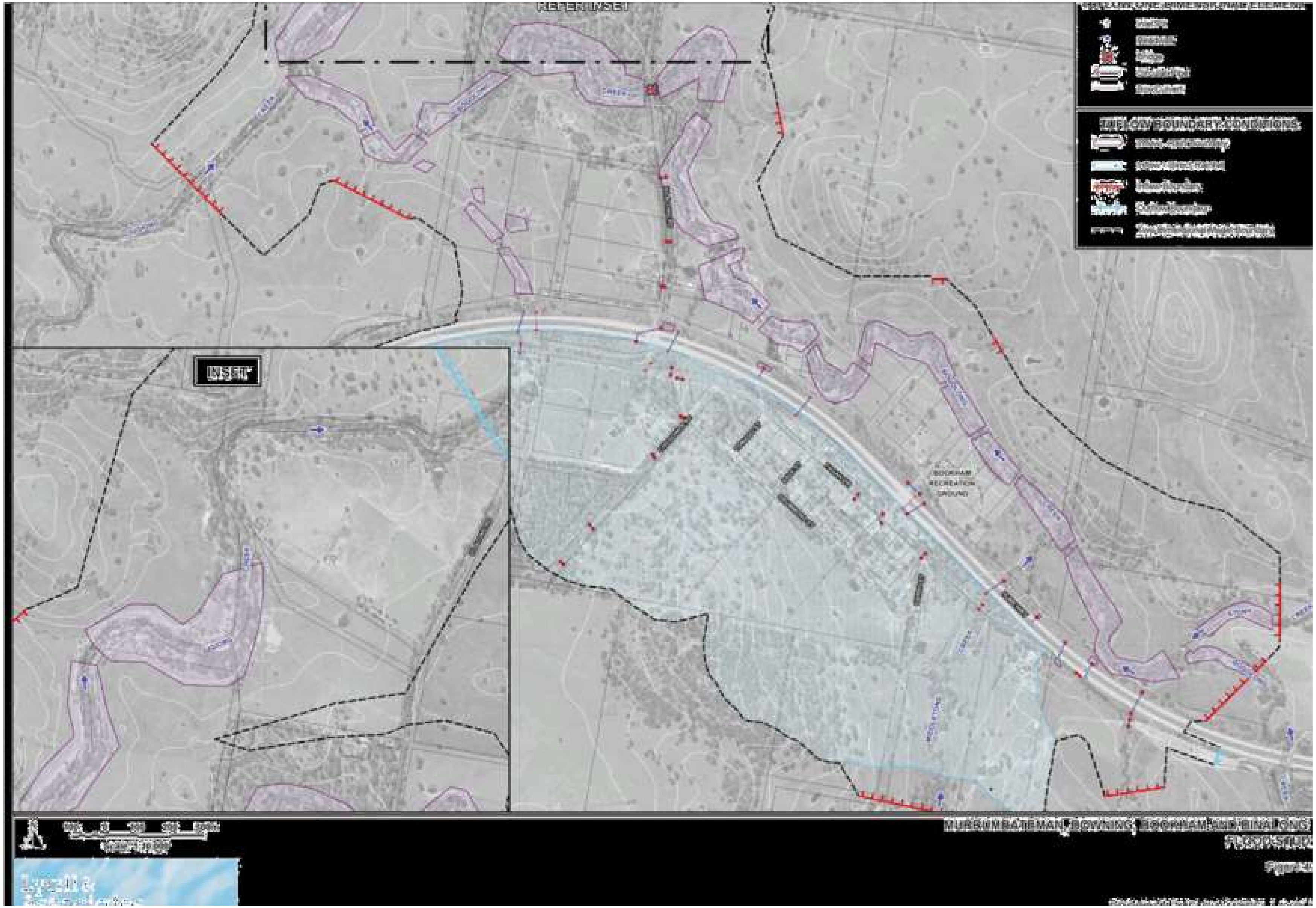
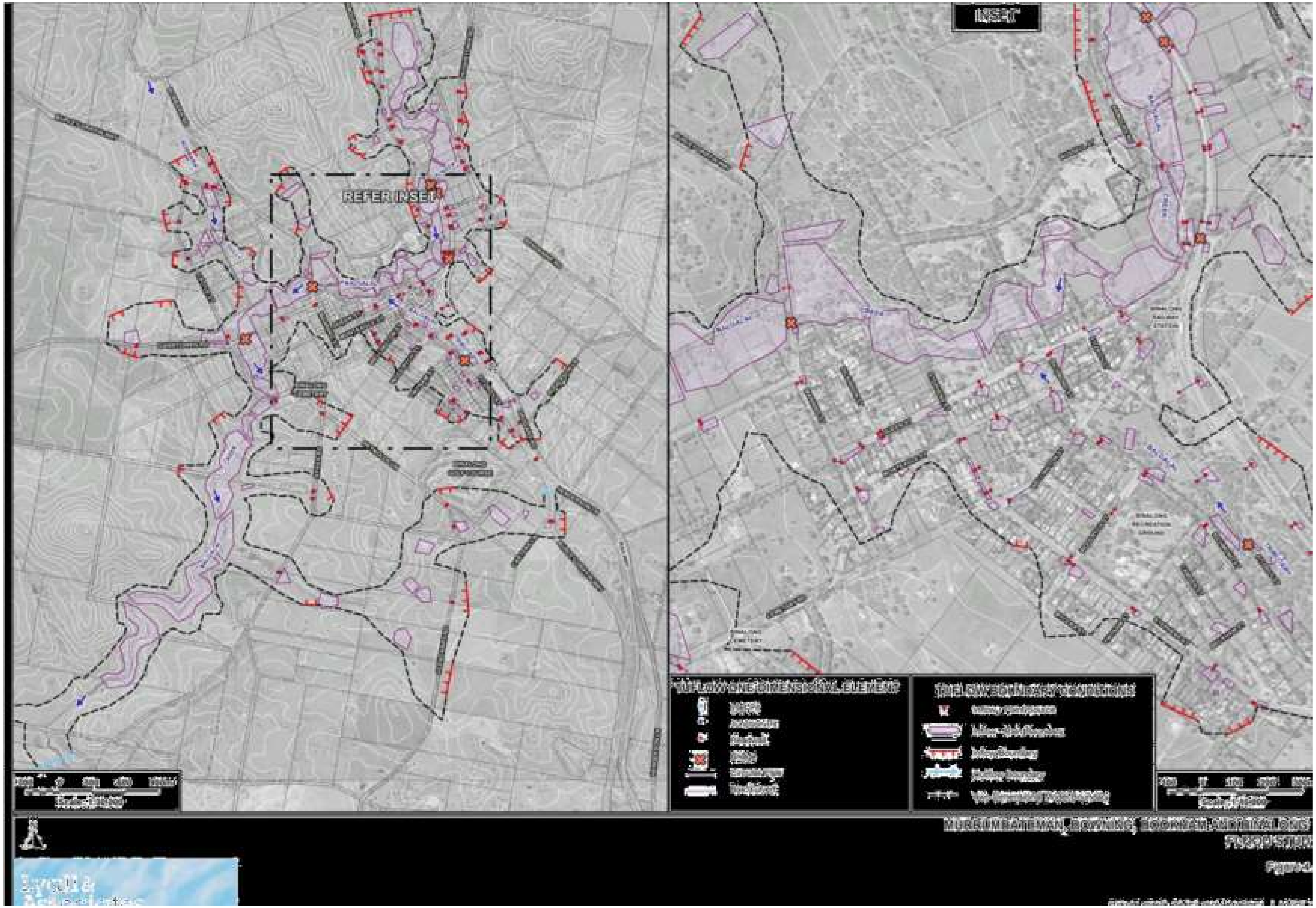
BOWNING RAILWAY STATION
BOWNING PUBLIC SCHOOL
BOWNING RECREATION GROUND
INSET


INSET
BOOKHAM
RECREATION
GROUND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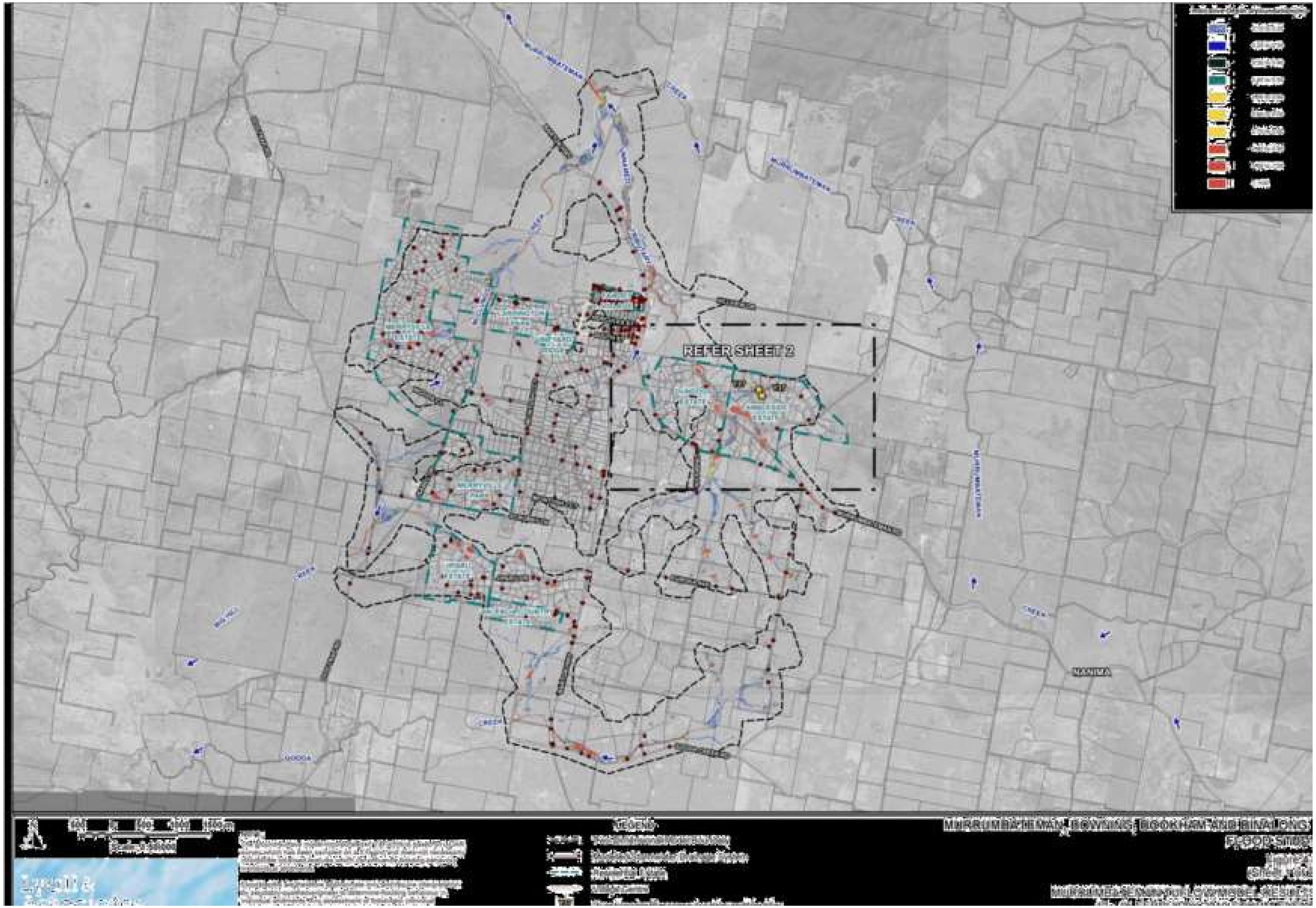
INSET


FAIRLEY
VILLAGE
WEST ST
CAMP ST
MIDDLE ST
ROSE ST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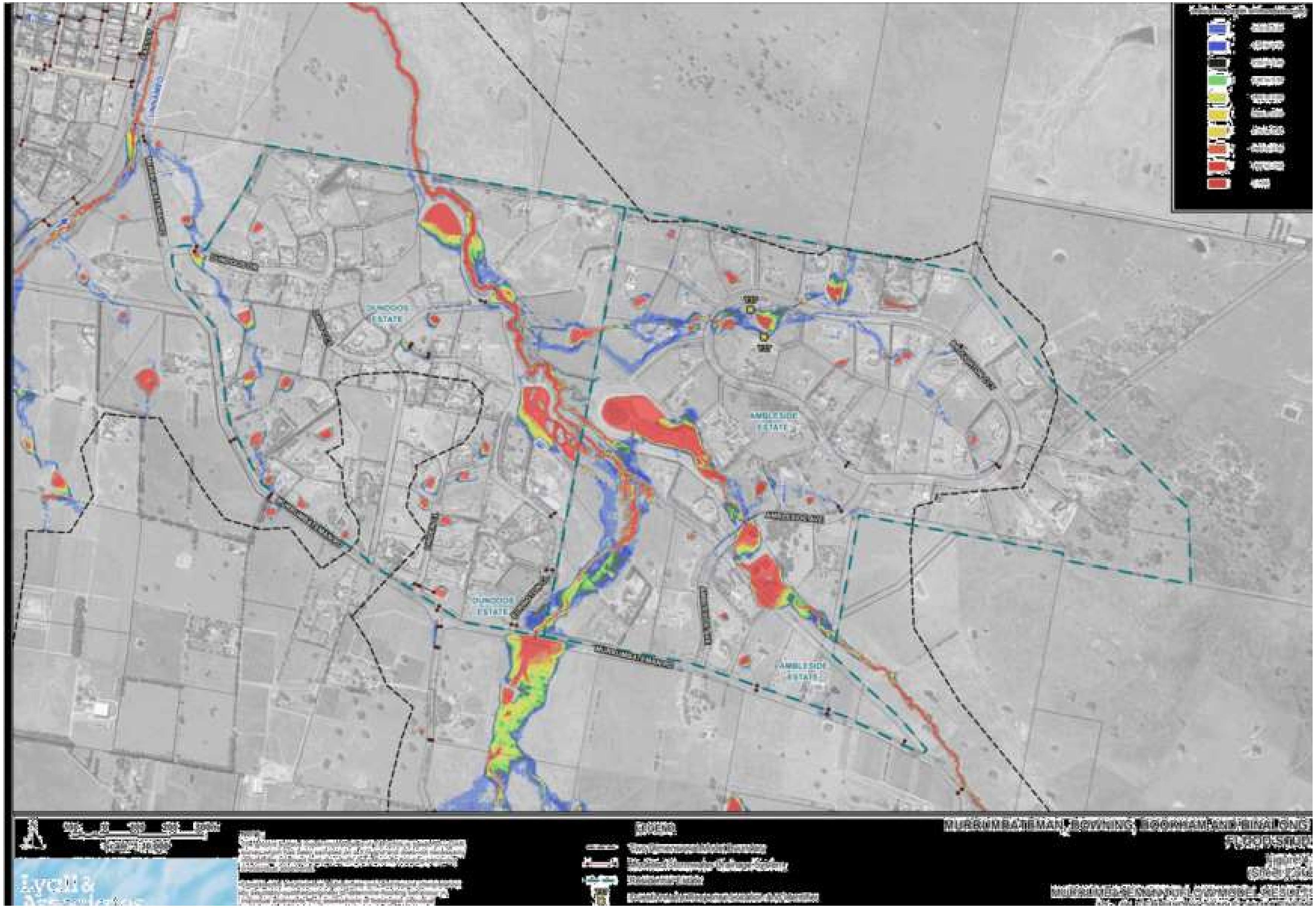
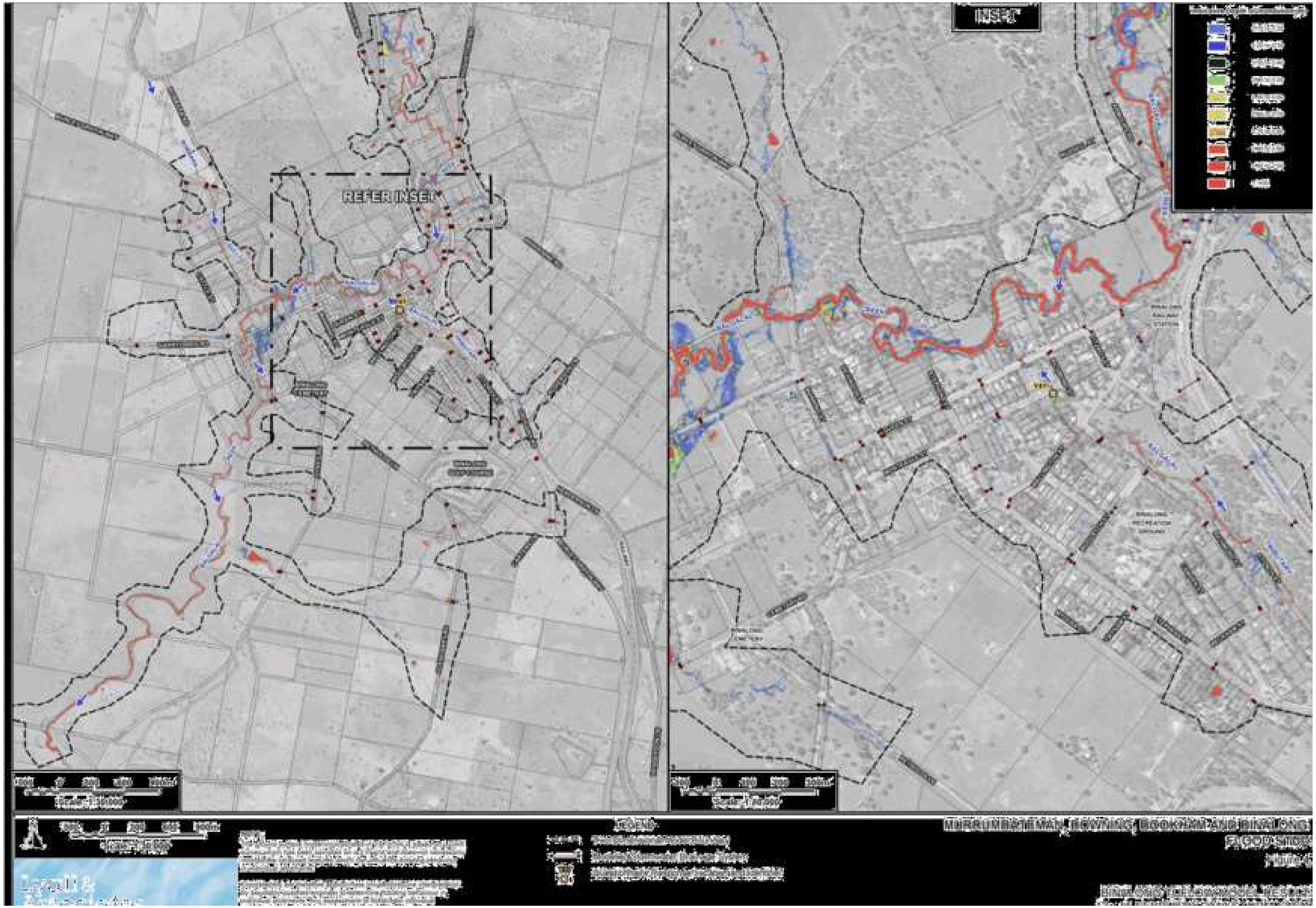

DUNDOOS ESTATE
AMBLESIDE ESTATE
DUNDOOS ESTATE
AMBLESIDE ESTATE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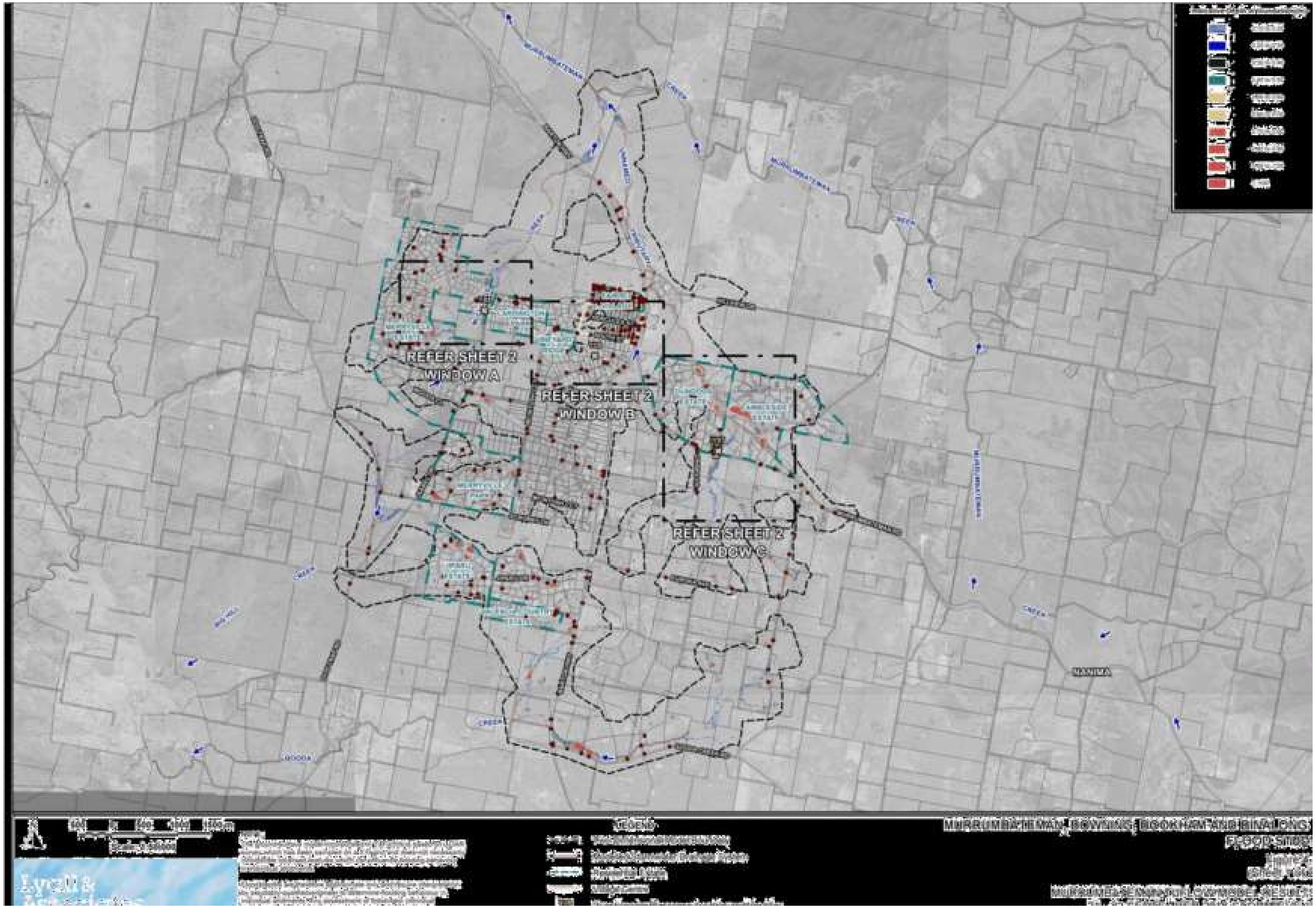
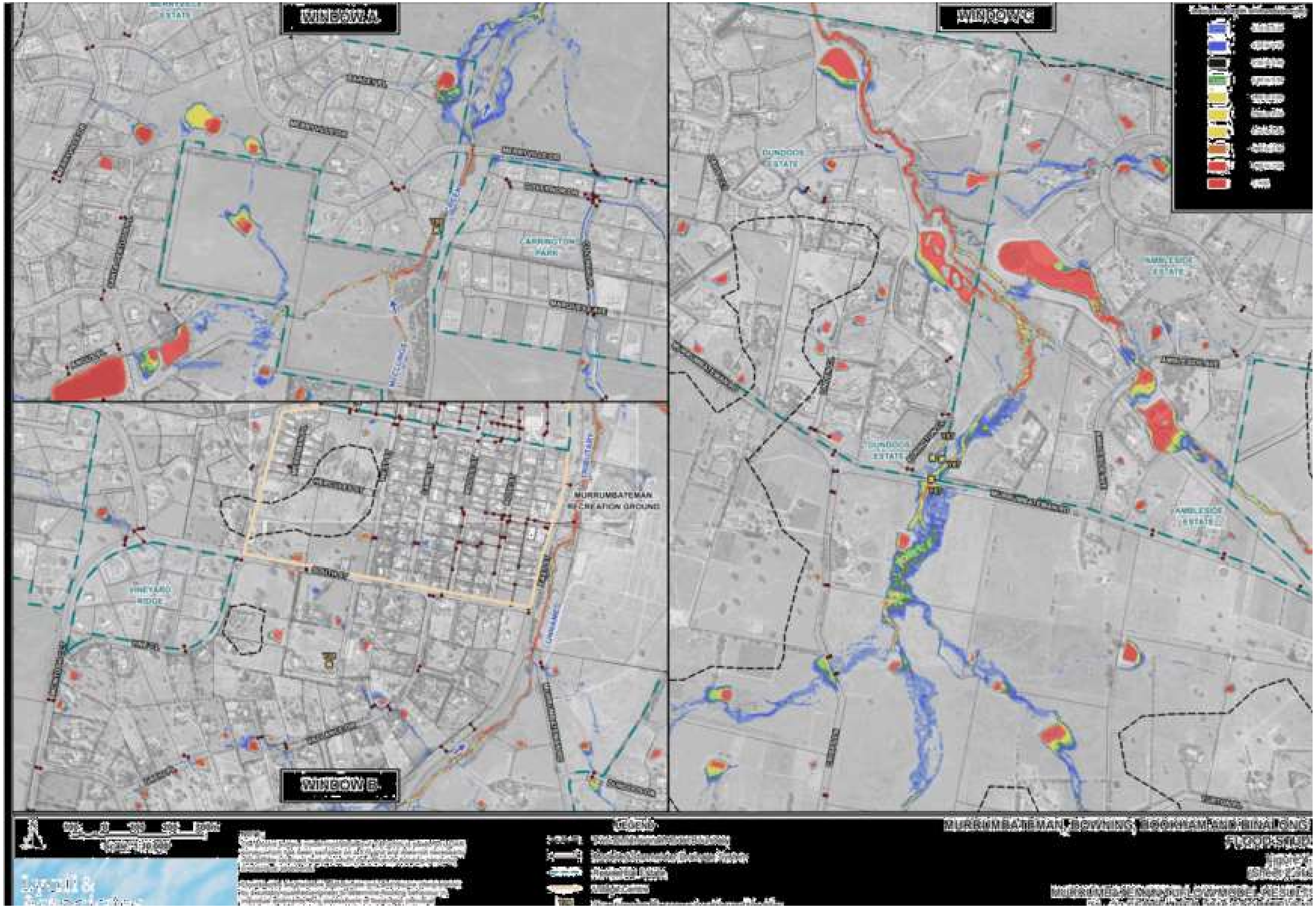
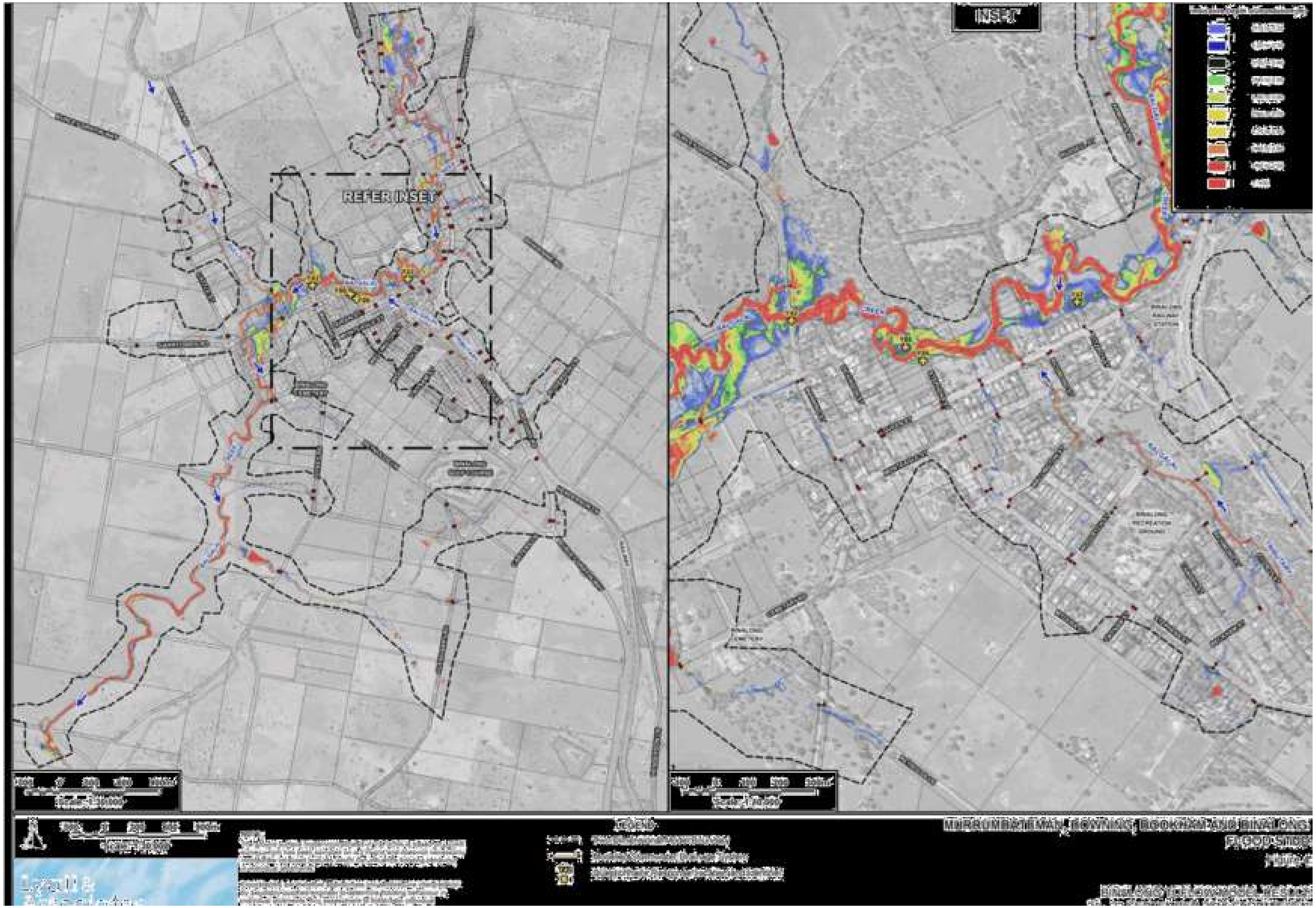

REFER SHEET 2
WINDOW A
REFER SHEET 2
WINDOW B
REFER SHEET 2
WINDOW C
NANIMA


WINDOW B
MURRUMBATEMAN
RECREATION GROUND
CARRINGTON
PARK
VINEYARD
RIDGE
DUNDOOS
ESTATE
AMBLESIDE
ESTATE
LEGEND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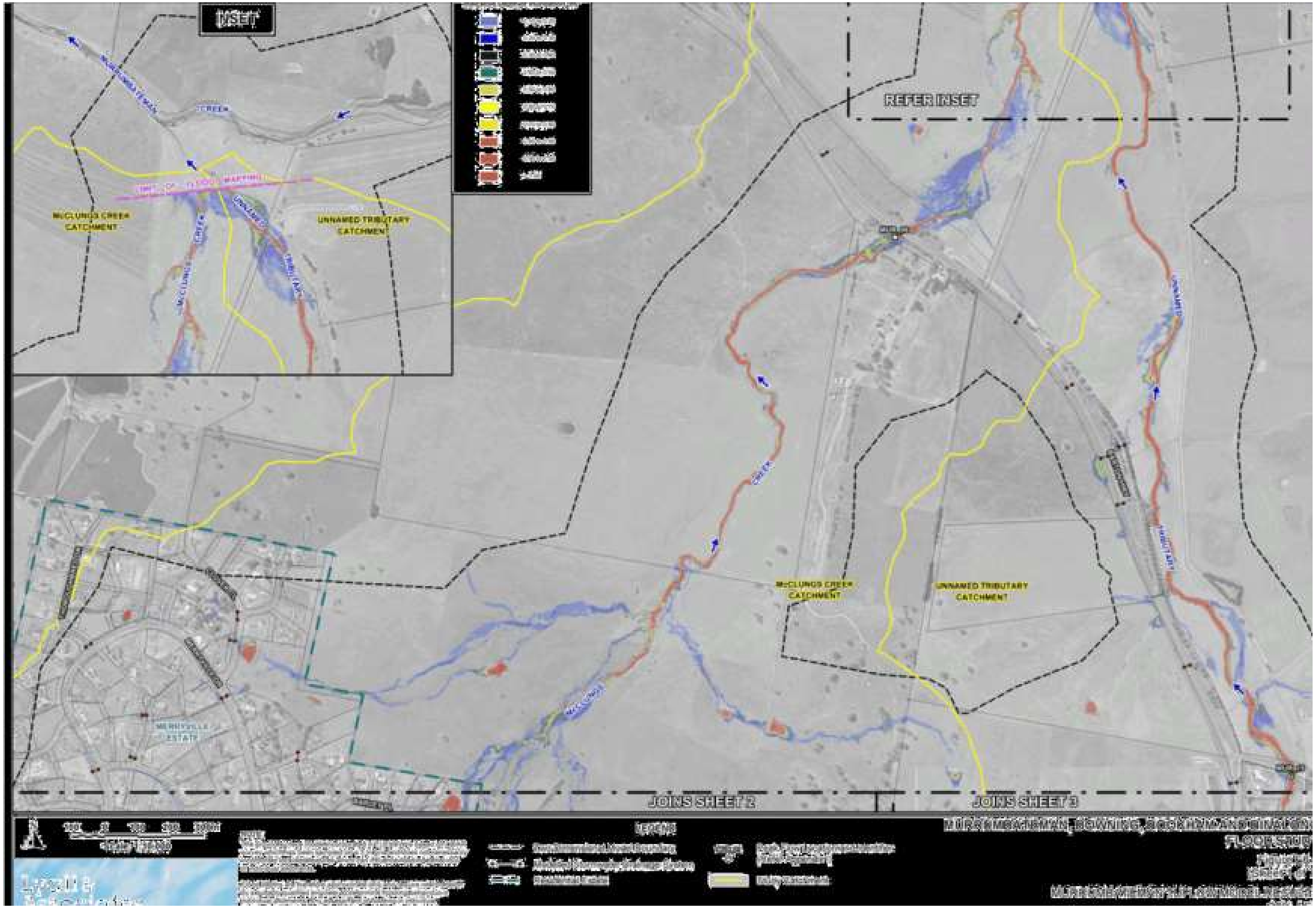
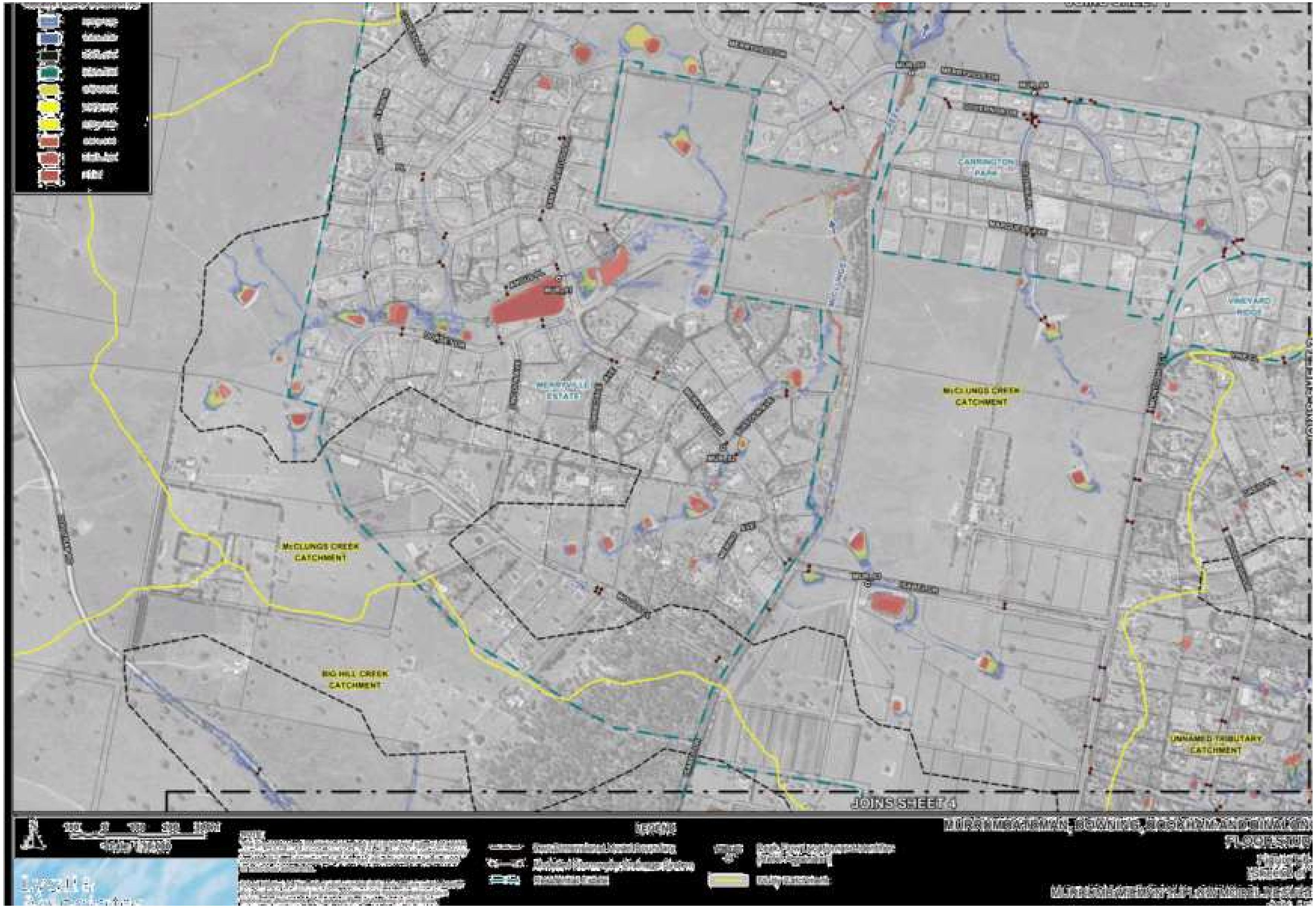
INSET

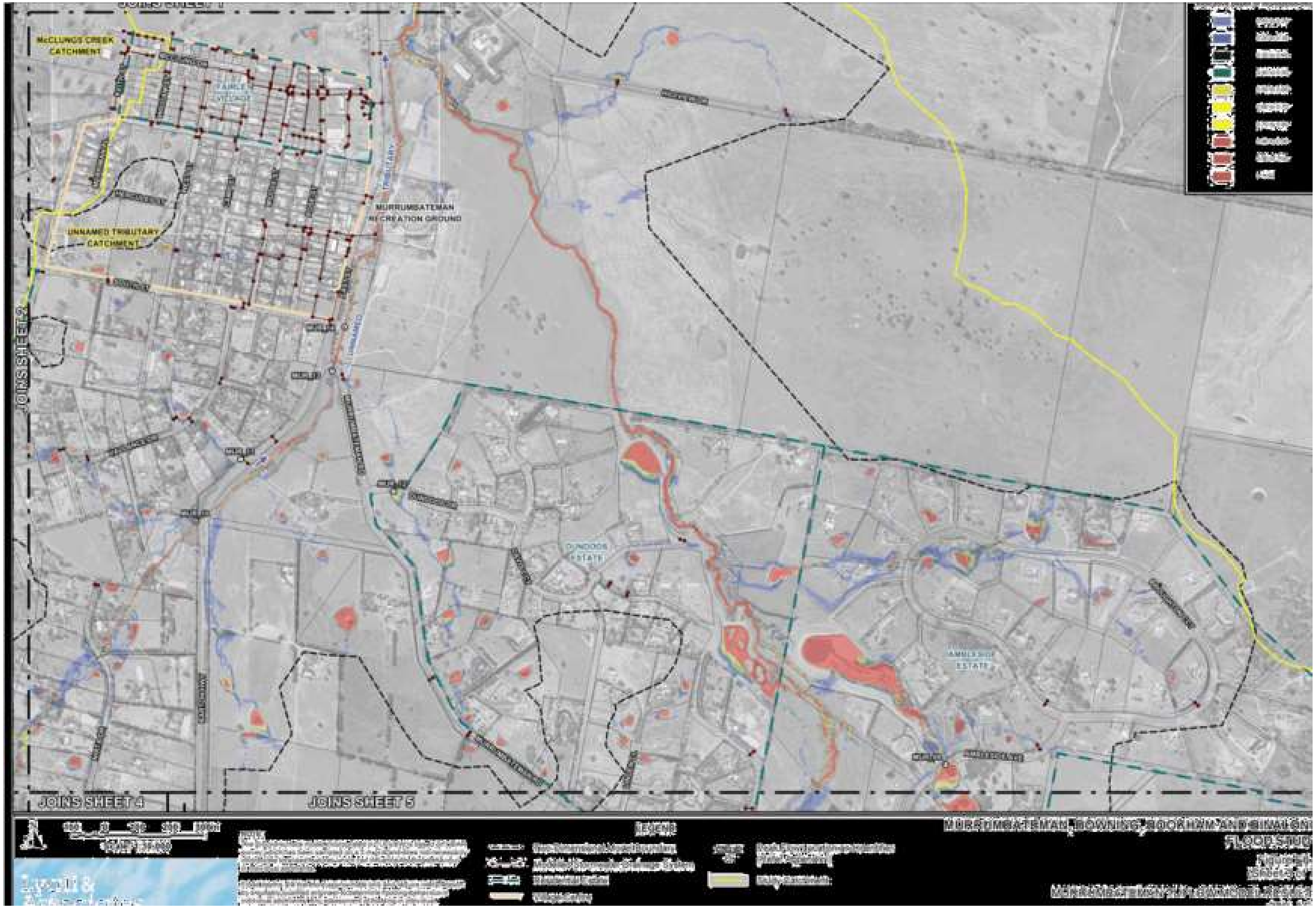
APPENDIX E

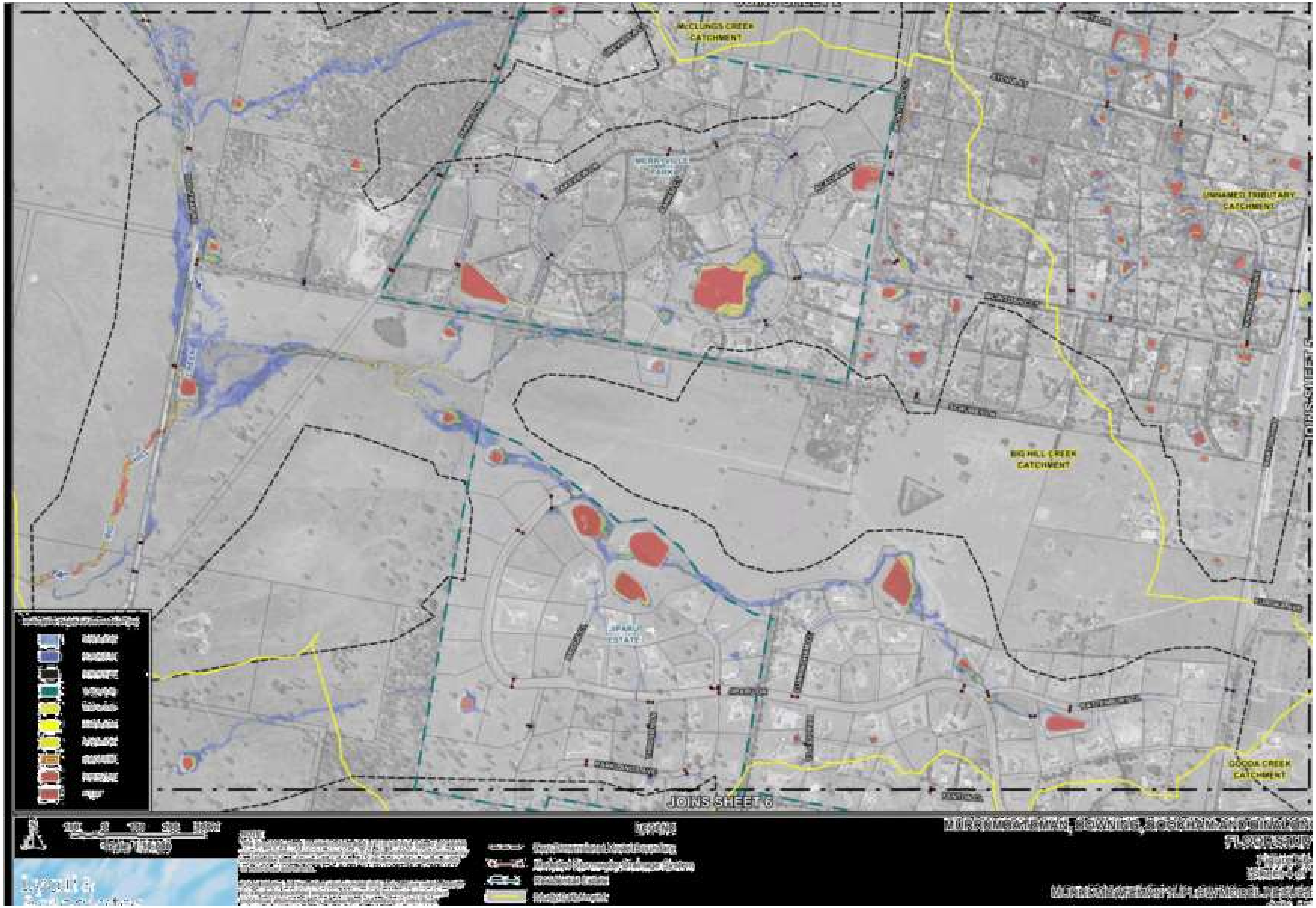
HYDRAULIC MODELLING OF DESIGN FLOODS AT MURRUMBATEMAN

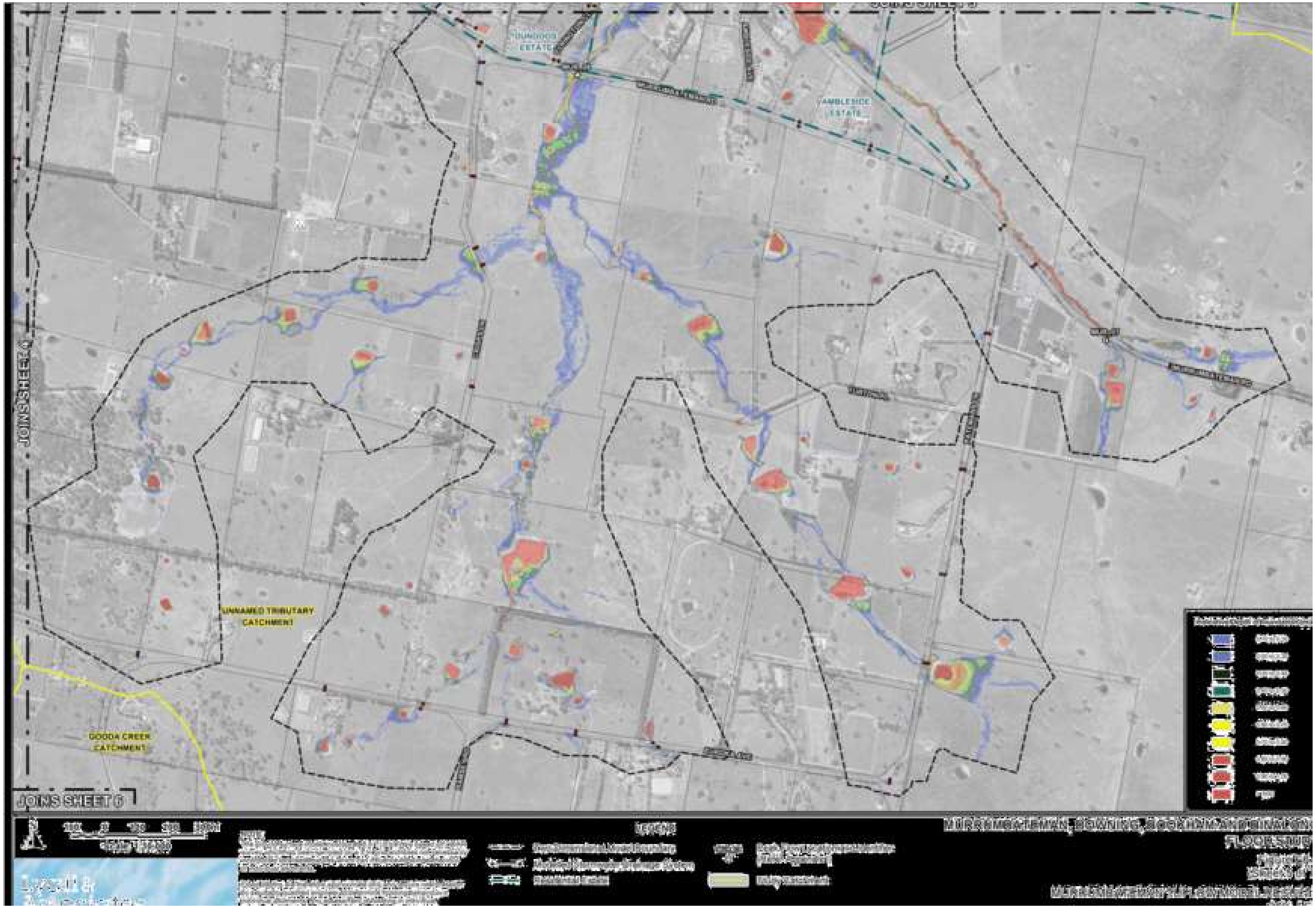
LIST OF FIGURES (APPENDIX E)

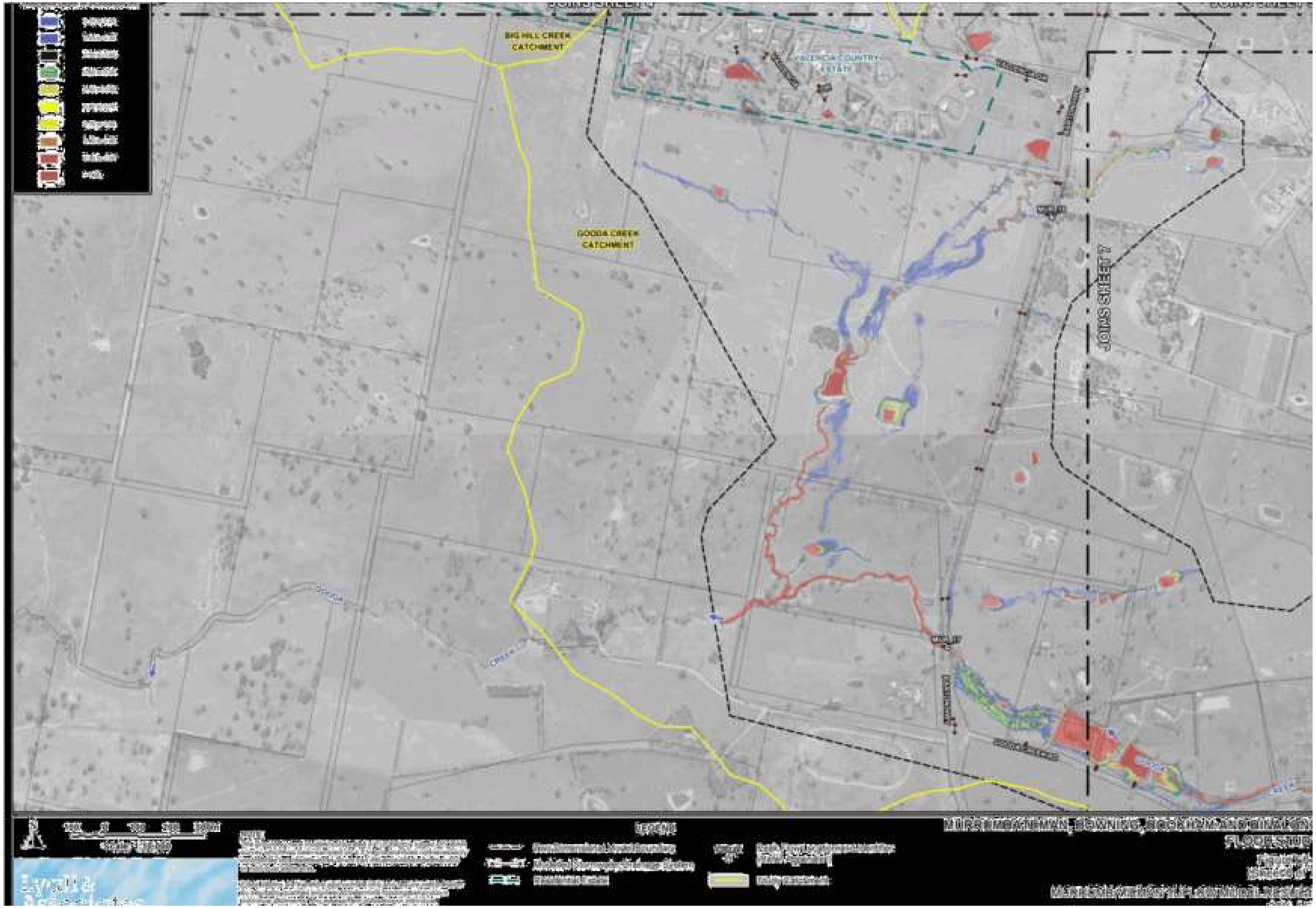

INSET
REFER INSET
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
LIMIT OF FLOOD MAPPING
CREEK
UNNAMED TRIBUTARY
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3
LEGEND

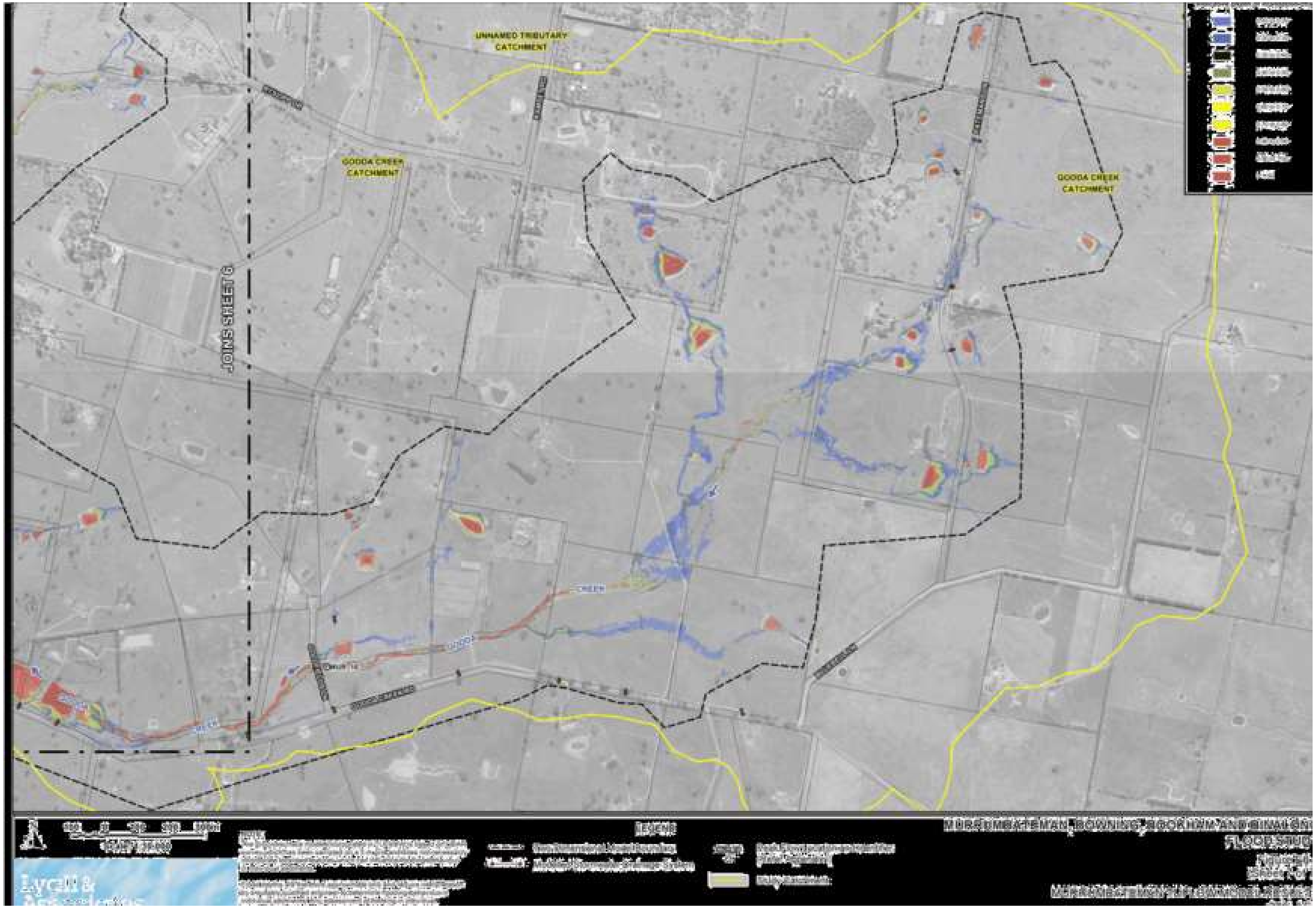

CARRINGTON PARK
VINEYARD RIDGE
MERRYVILLE ESTATE
McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4
LEGEND

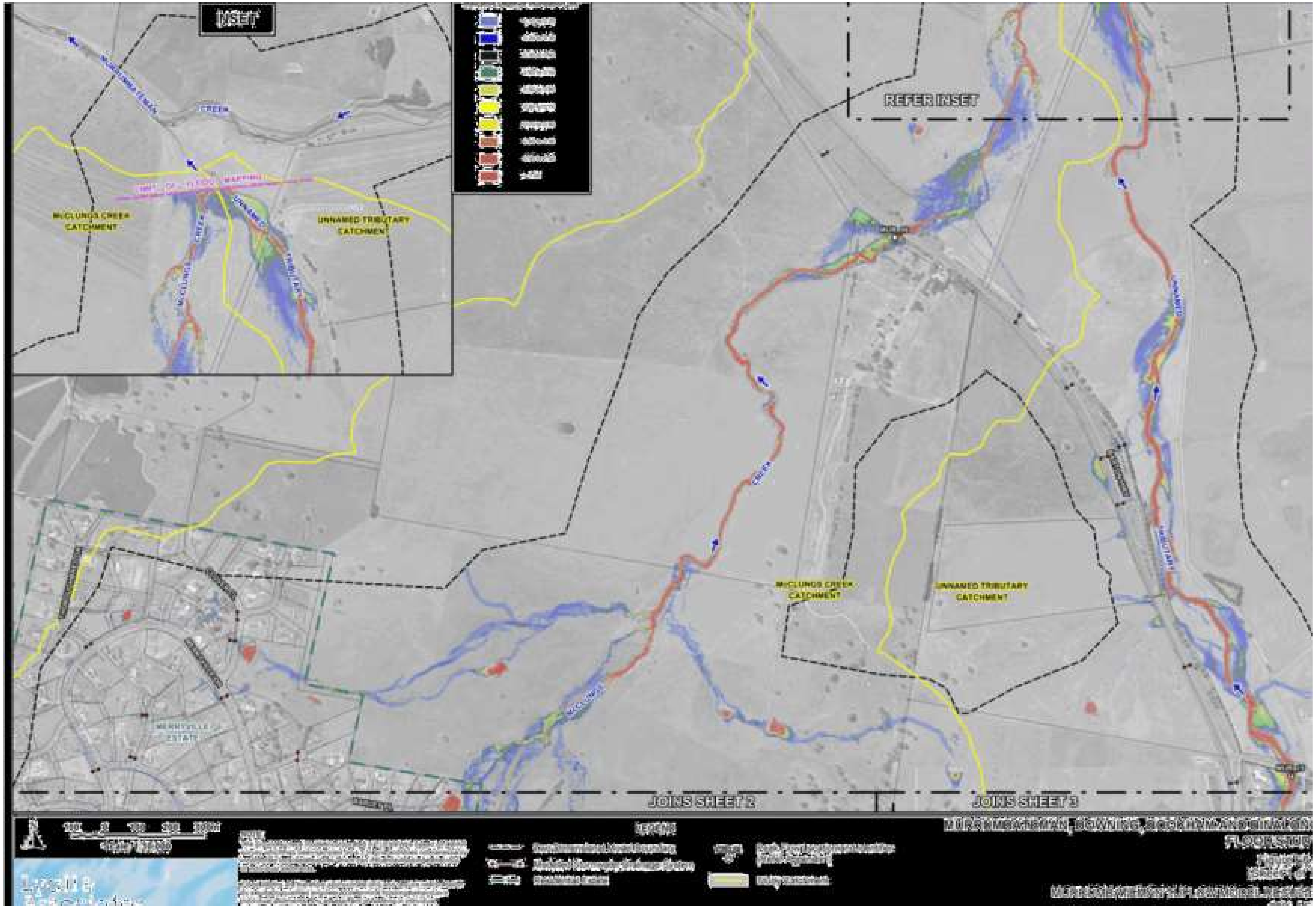

McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
TRIBUTARY
UNNAMED
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5
LEGEND

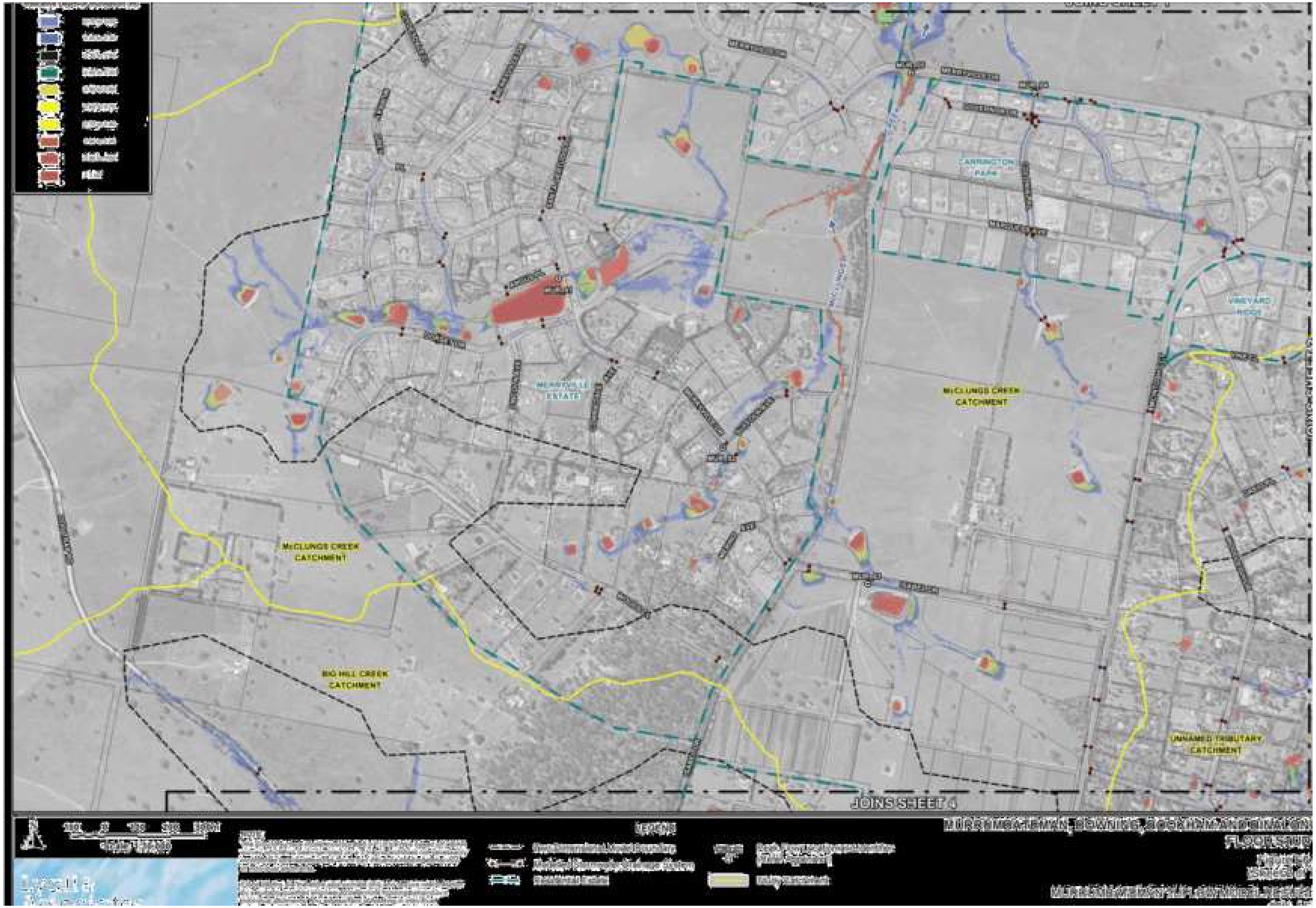

McCLUNGS CREEK CATCHMENT
MERRYVILLE PARK
UNNAMED TRIBUTARY CATCHMENT
BIG HILL CREEK CATCHMENT
JIPARU ESTATE
GOODA CREEK CATCHMENT
JOINS SHEET 6
JOINS SHEET 5
LEGEND

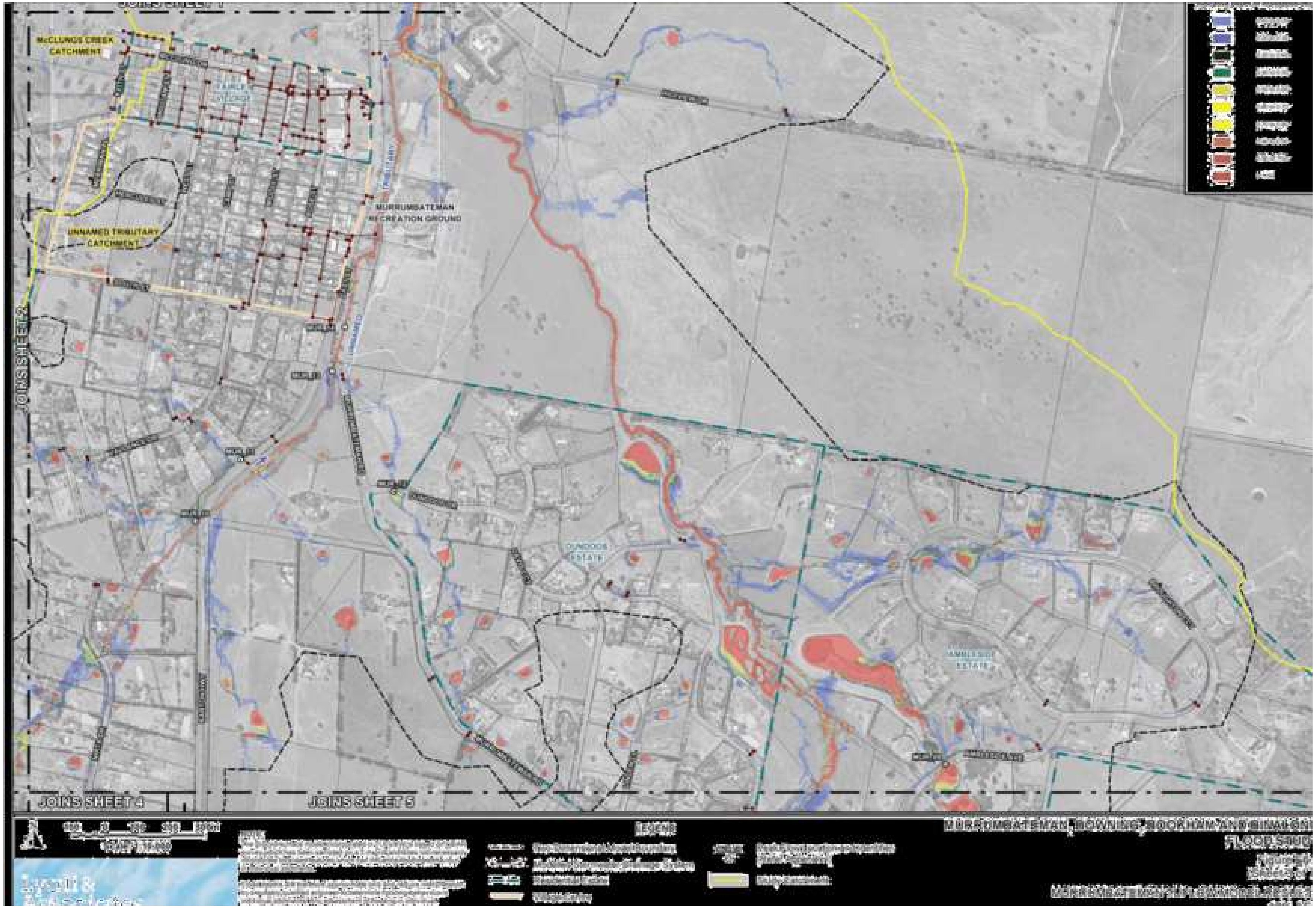

AMBLESIDE ESTATE
JOINS SHEET 4
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
LEGEND

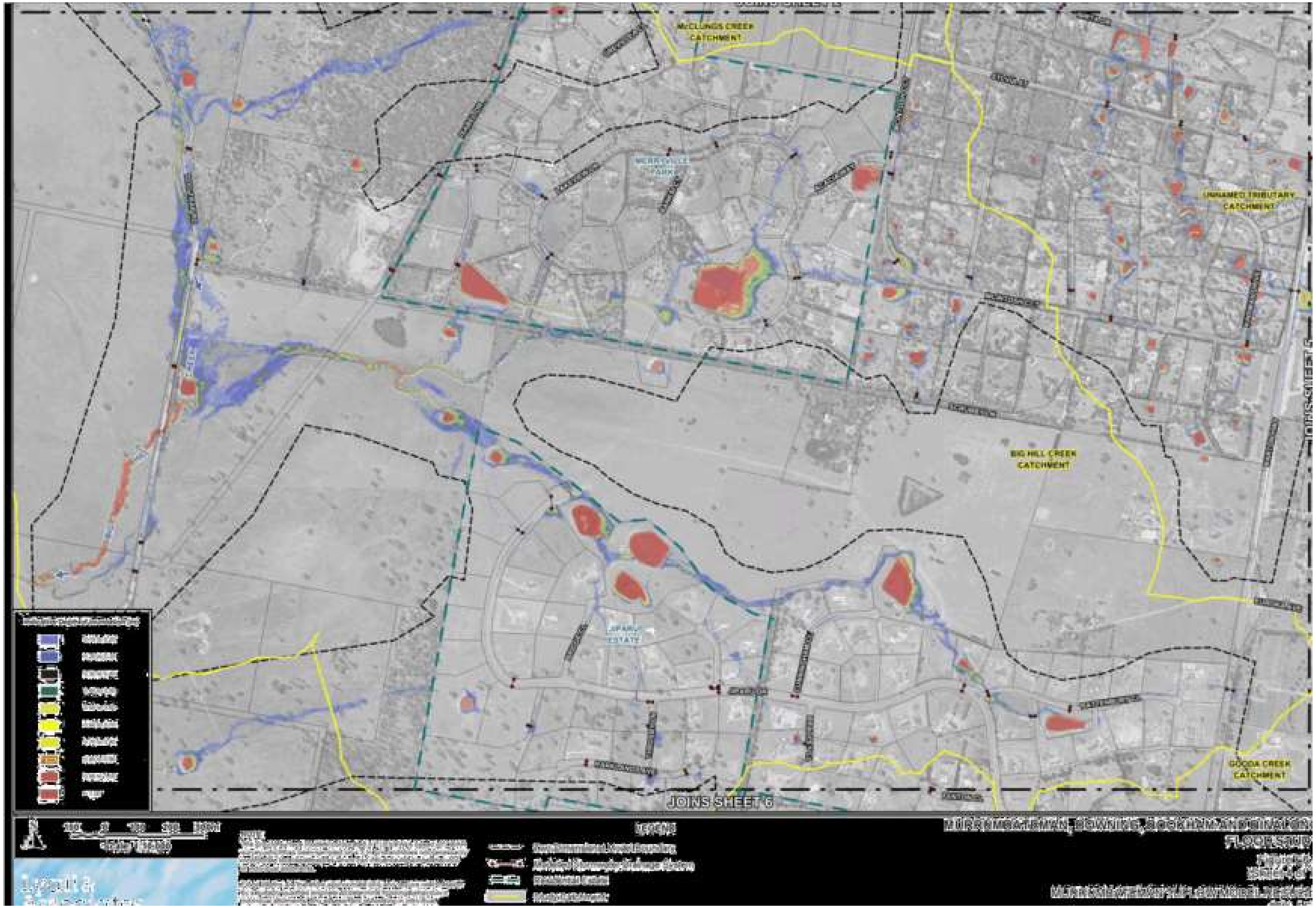

BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 7
LEGEND


UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
CREEK


INSET
REFER INSET
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3
LEGEND


CARRINGTON PARK
VINEYARD RIDGE
MERRYVILLE ESTATE
McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4
LEGEND


McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5
LEGEND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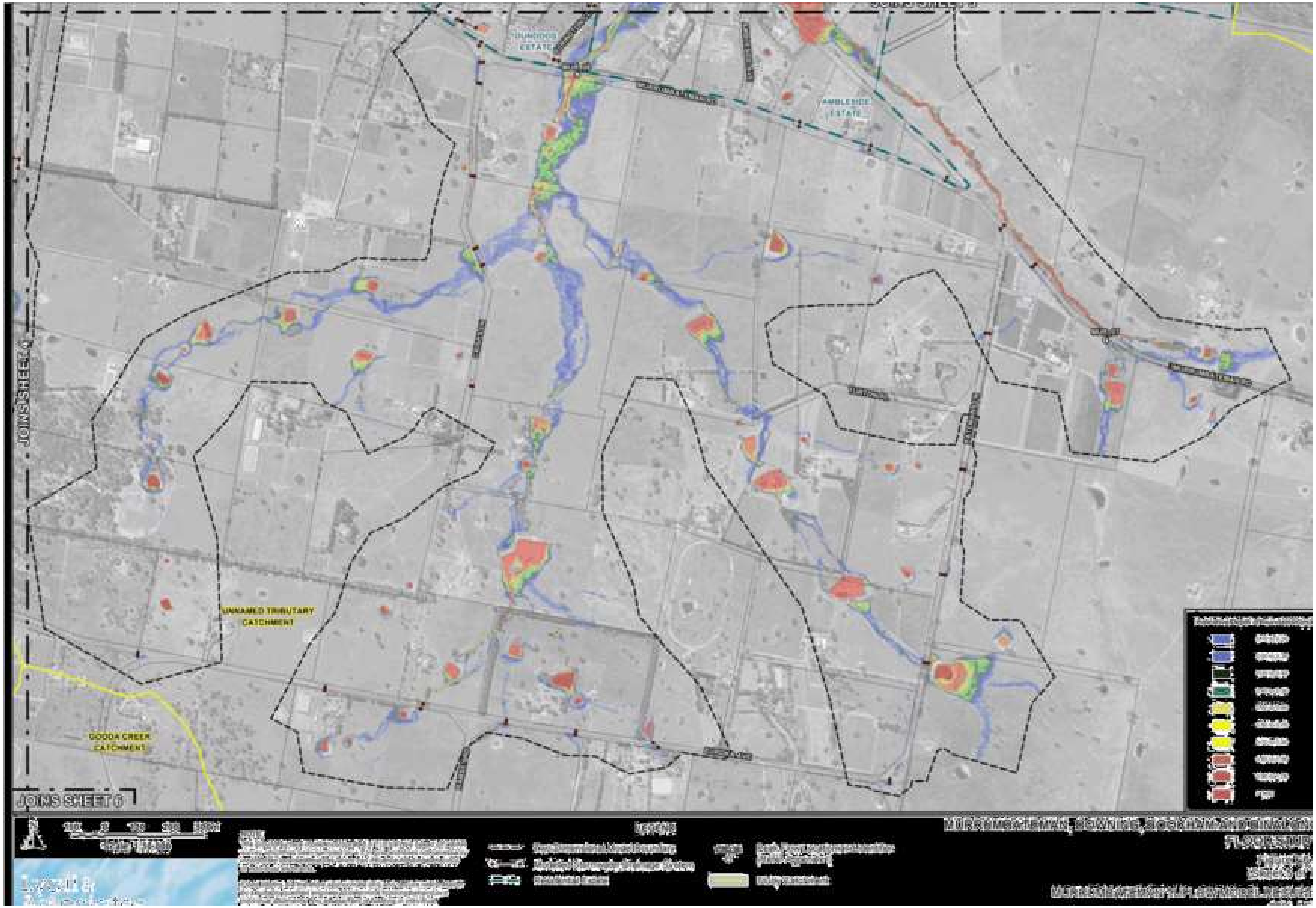
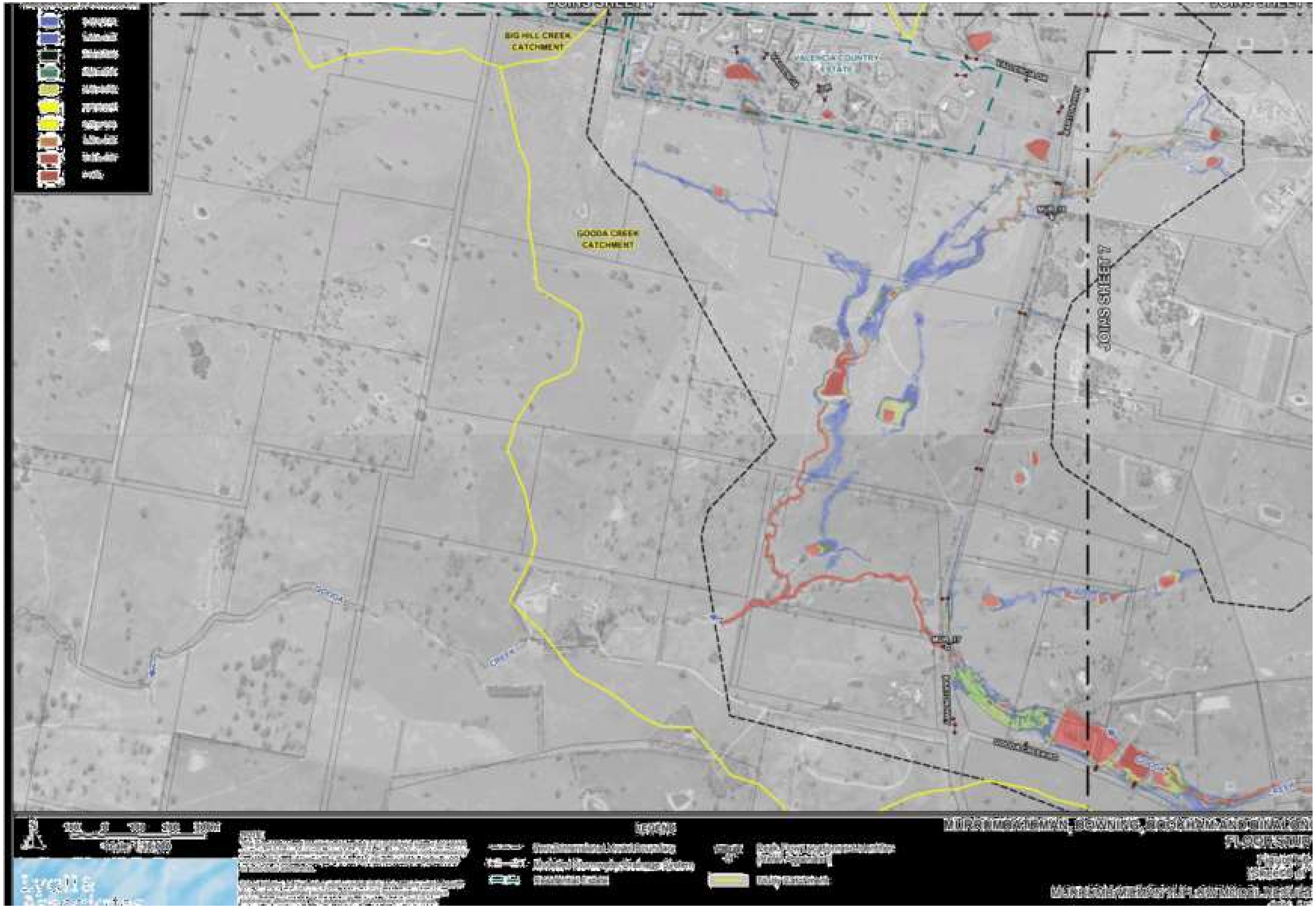
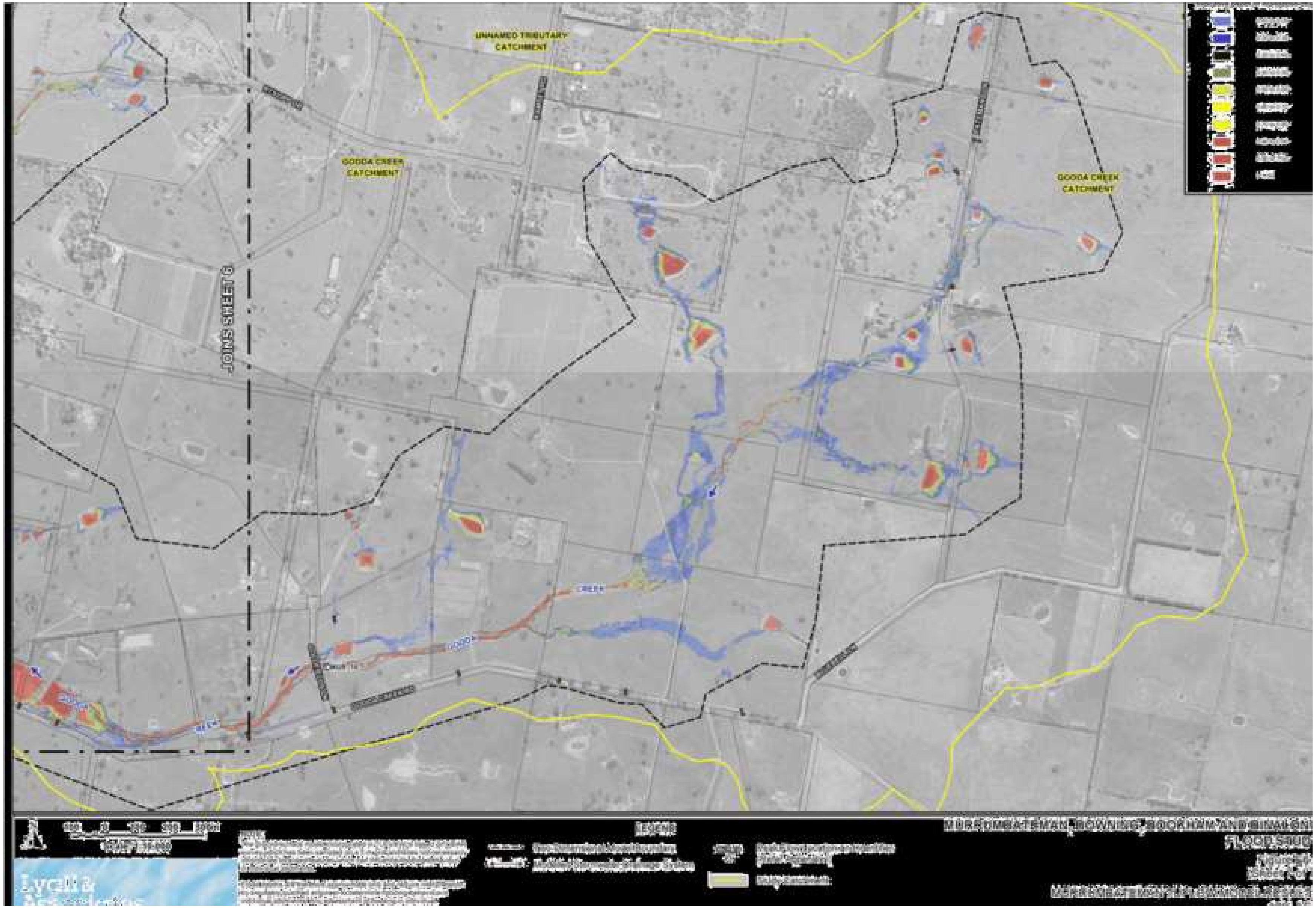
UNNAMED TRIBUTARY CATCHMENT
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
JOINS SHEET 5


DUNDOOS ESTATE
AMBLESIDE ESTATE
JOINS SHEET 4
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
LEGEND


BIG HILL CREEK
CATCHMENT
GOODA CREEK
CATCHMENT
JOINS SHEET 7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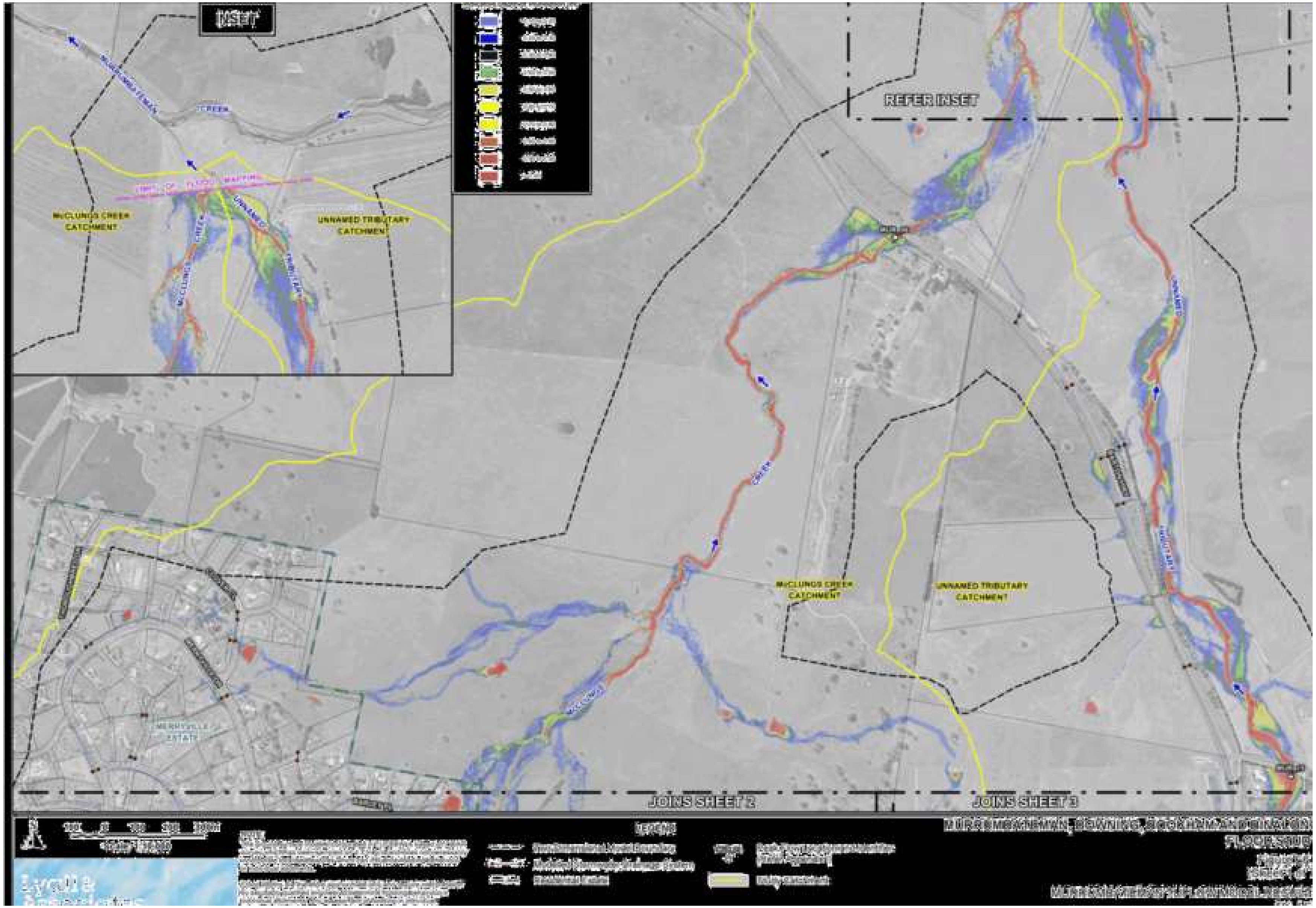
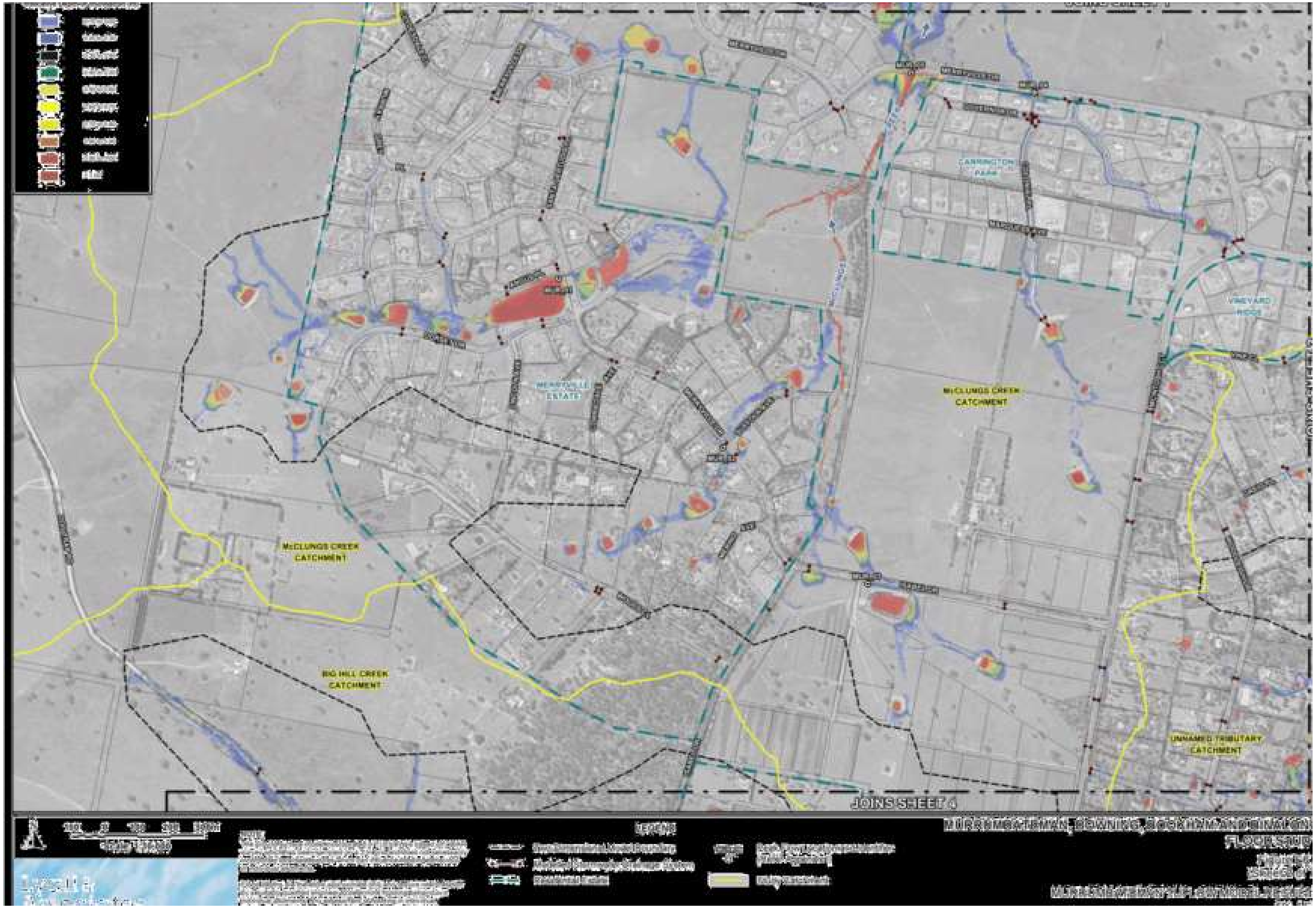
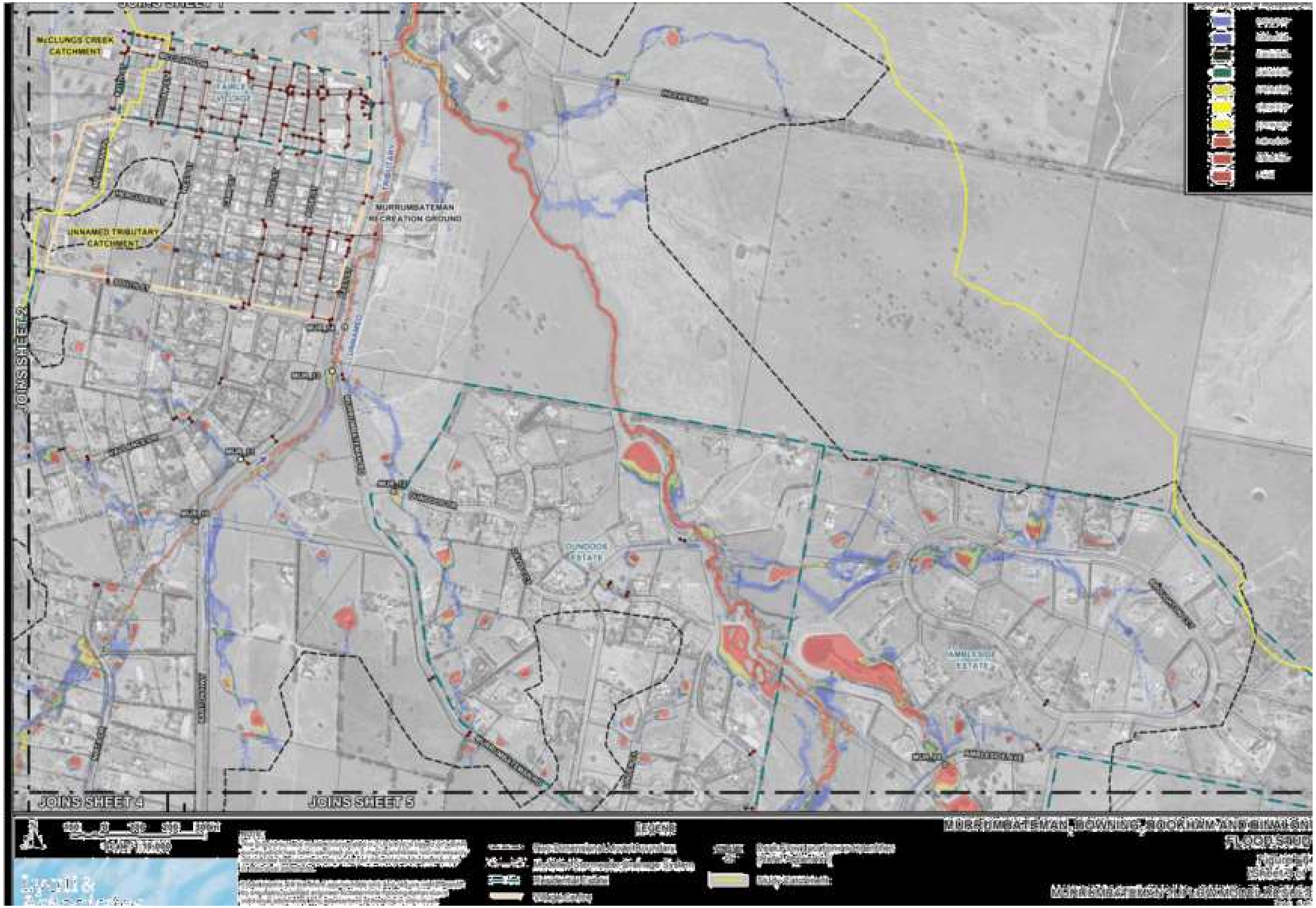
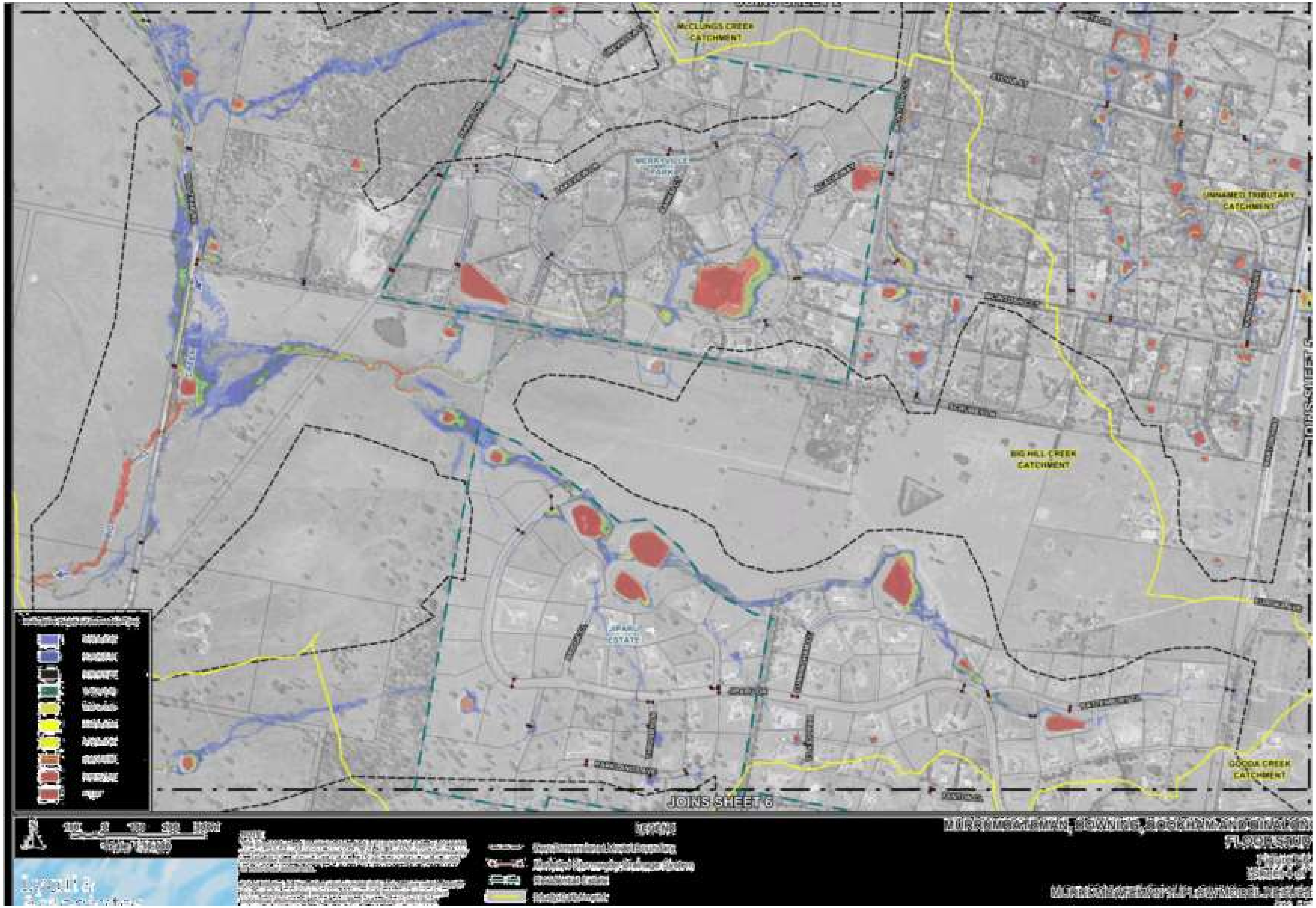
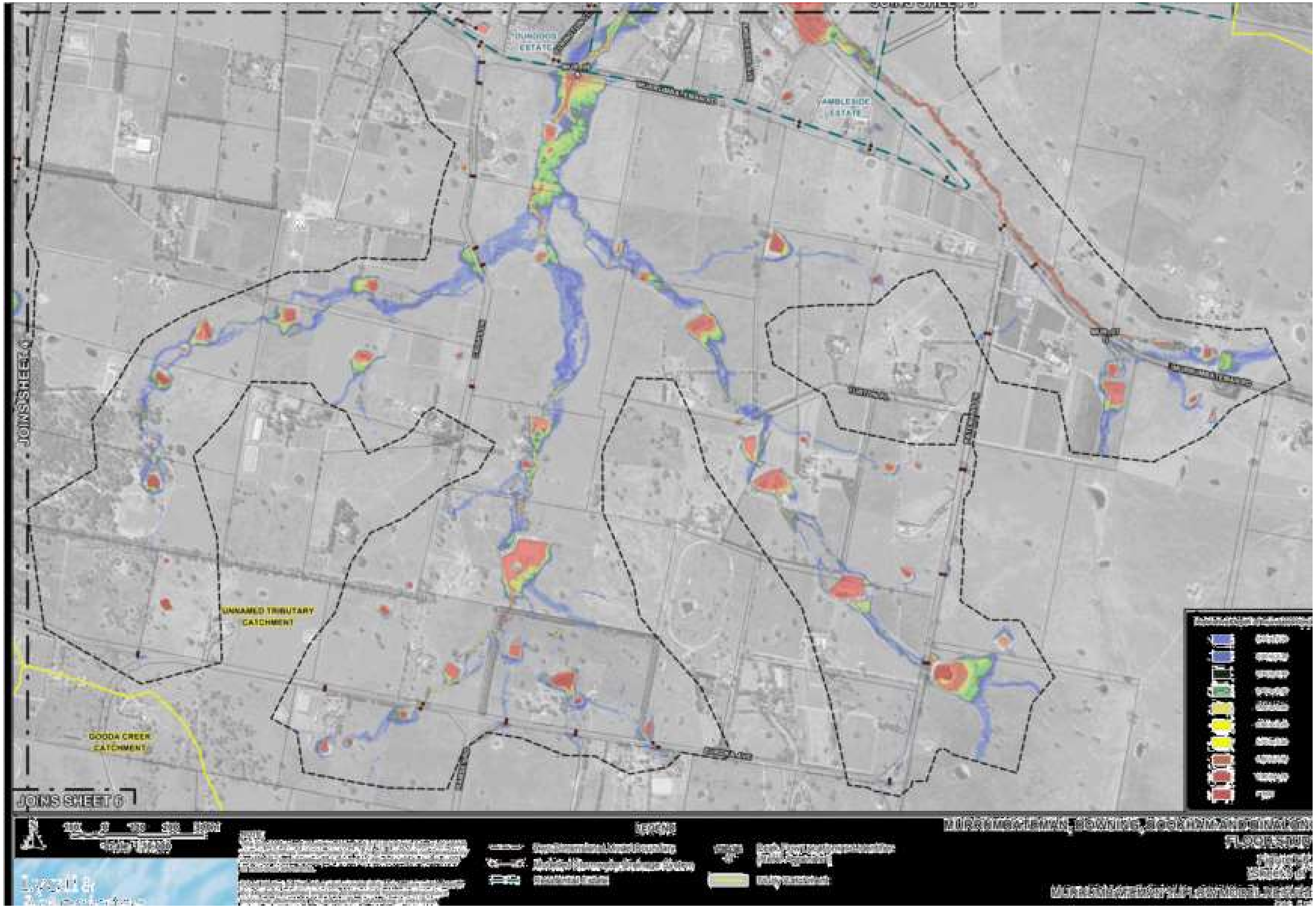
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
CREEK
GOODA
LEGEND

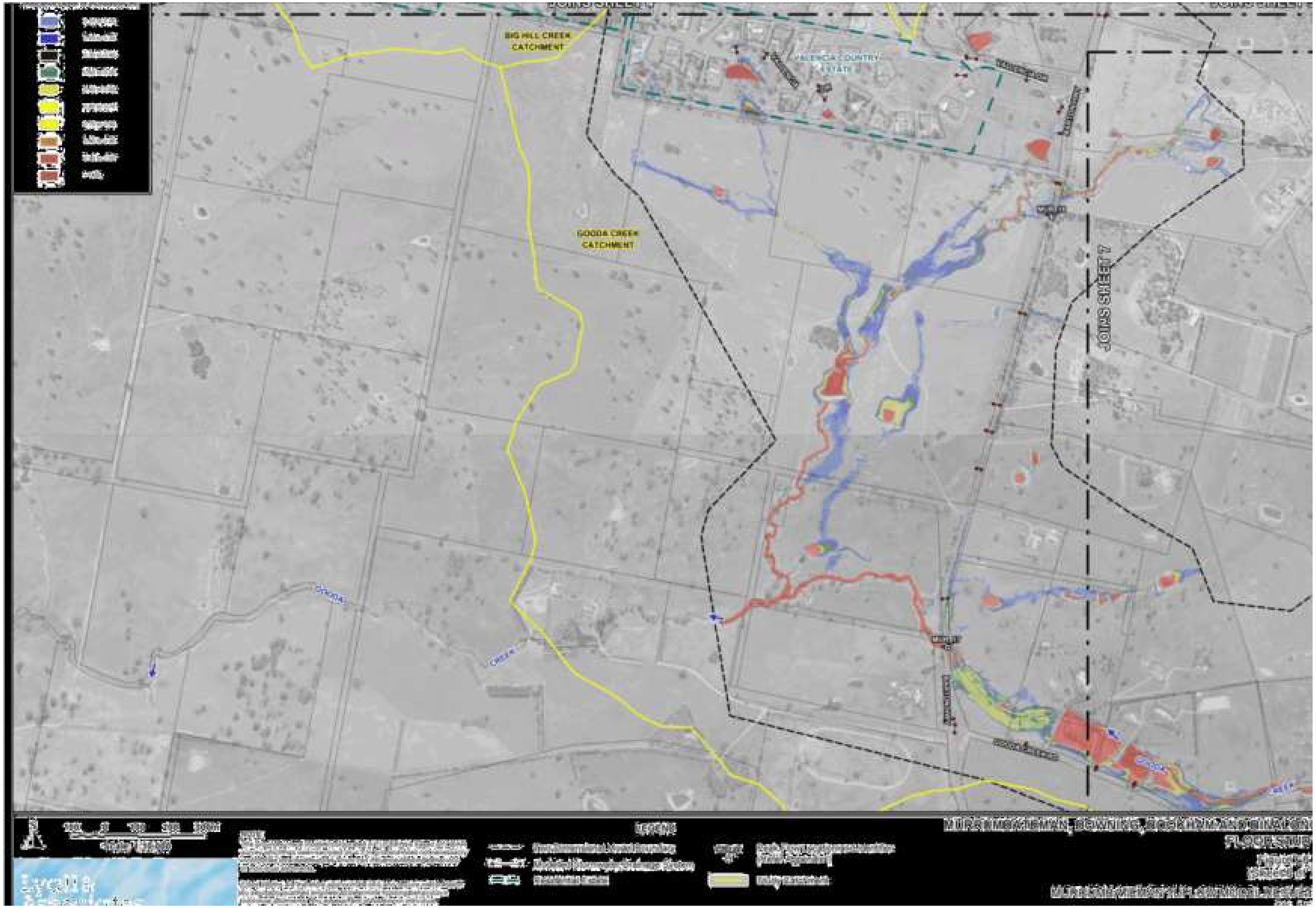

INSET
REFER INSET
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
LIMIT OF FLOOD MAPPING
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3
LEGEND
FLOOD STUDY

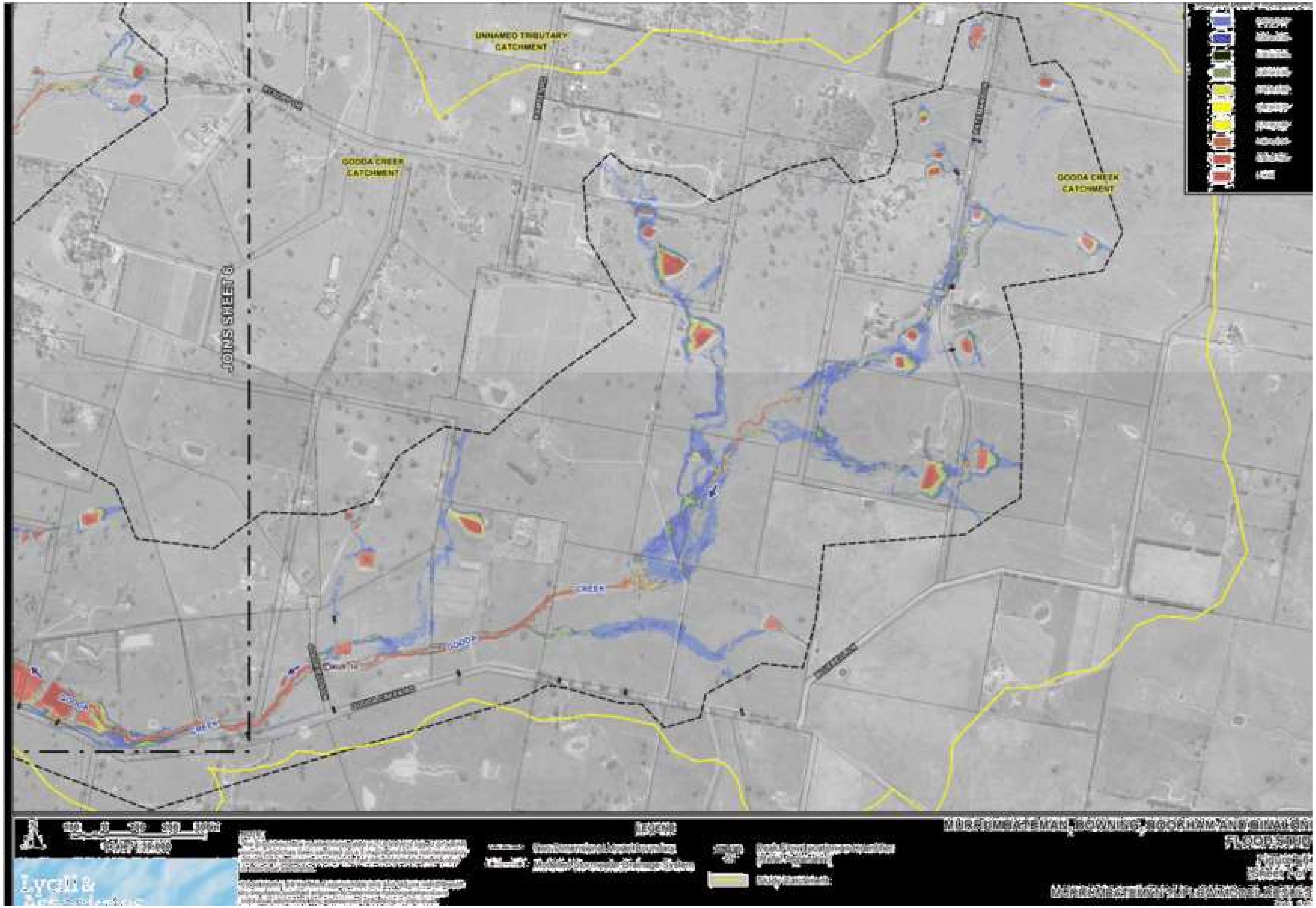

CARRINGTON PARK
VINEYARD RIDGE
MERRYVILLE ESTATE
McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4
LEGEND

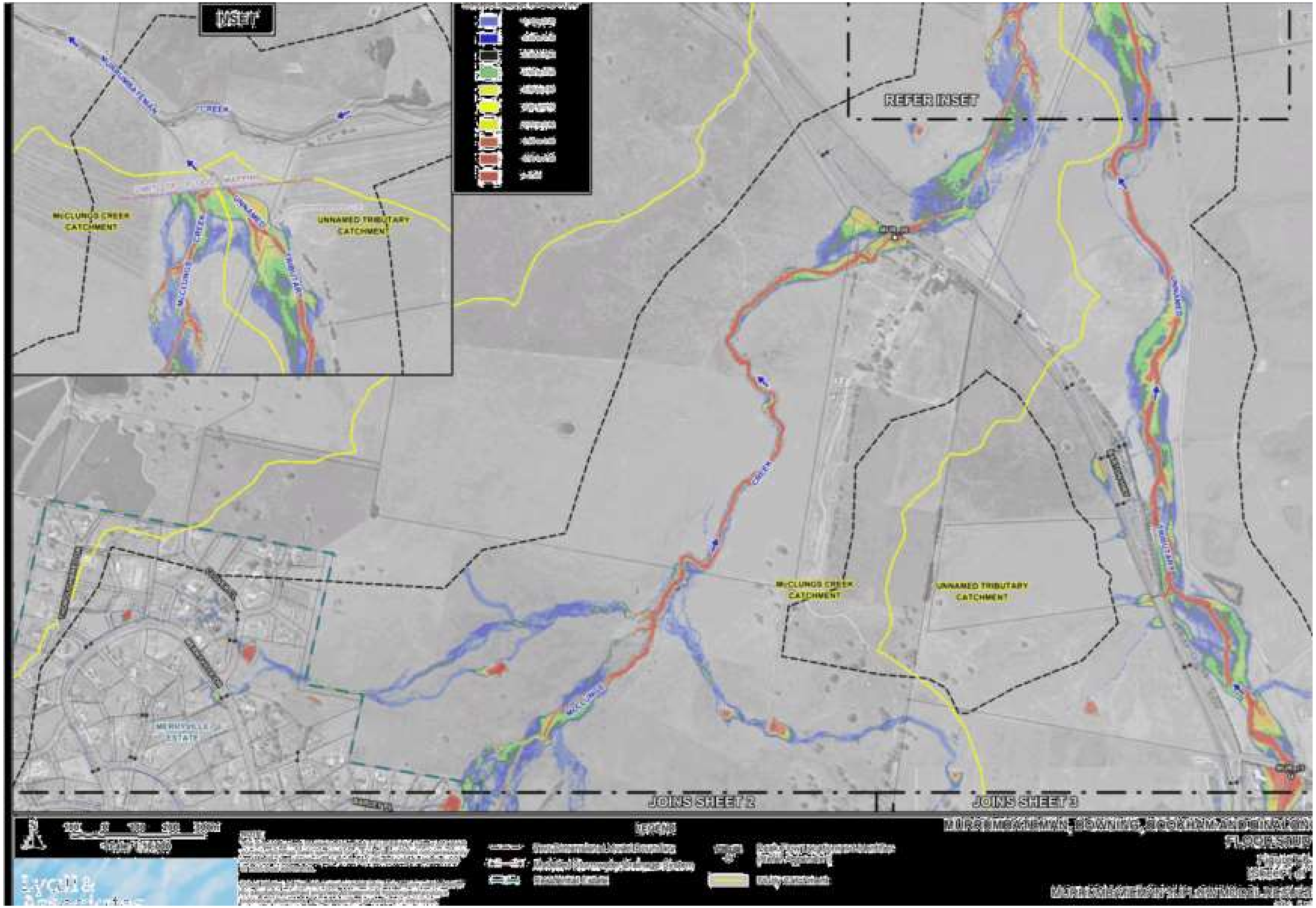

McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5
LEGEND

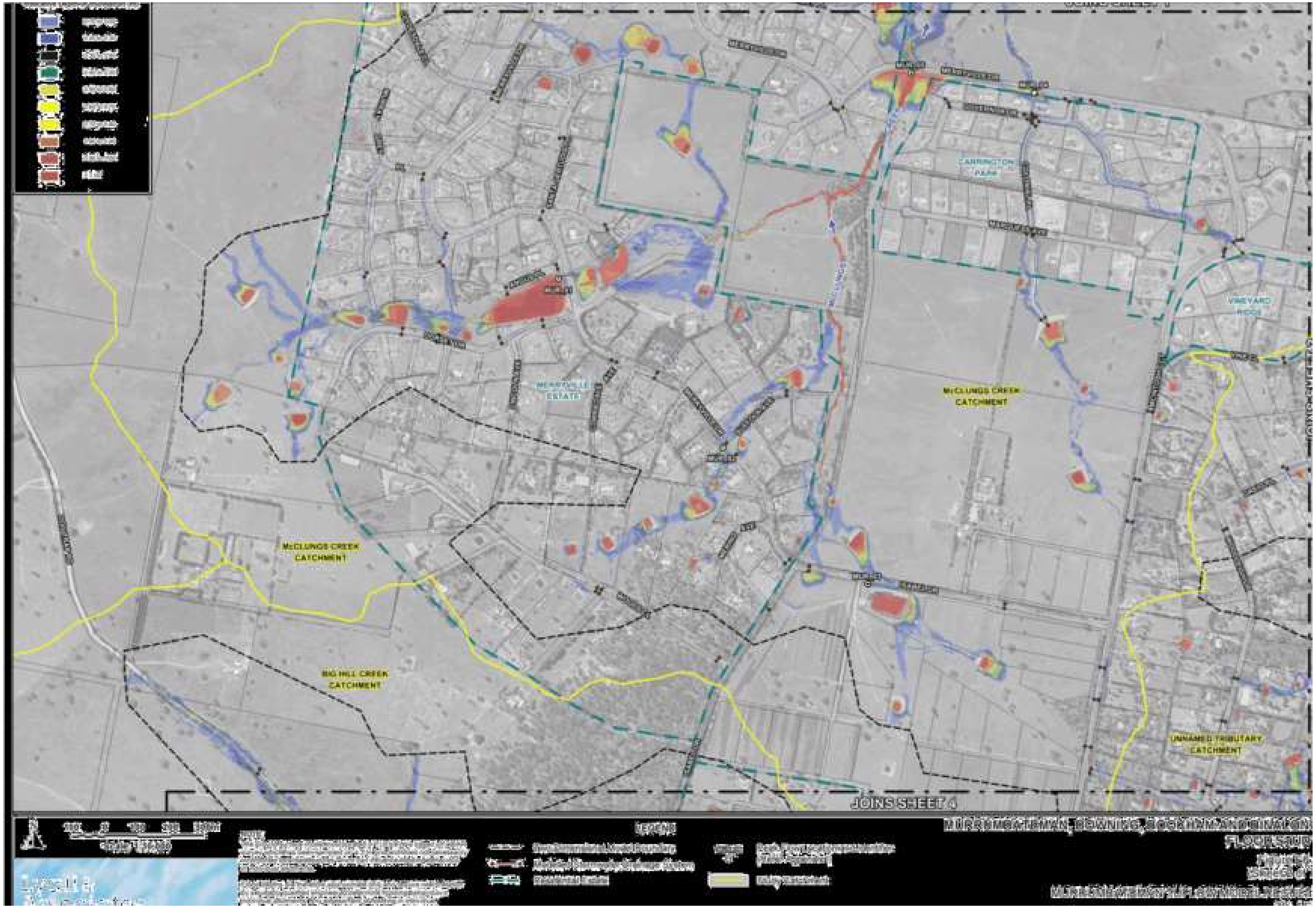

McCLUNGS CREEK
CATCHMENT
MERRYVILLE
PARK
UNNAMED TRIBUTARY
CATCHMENT
BIG HILL CREEK
CATCHMENT
JIPARU
ESTATE
GOODA CREEK
CATCHMENT
JOINS SHEET 6
JOINS SHEET 5
LEGEND

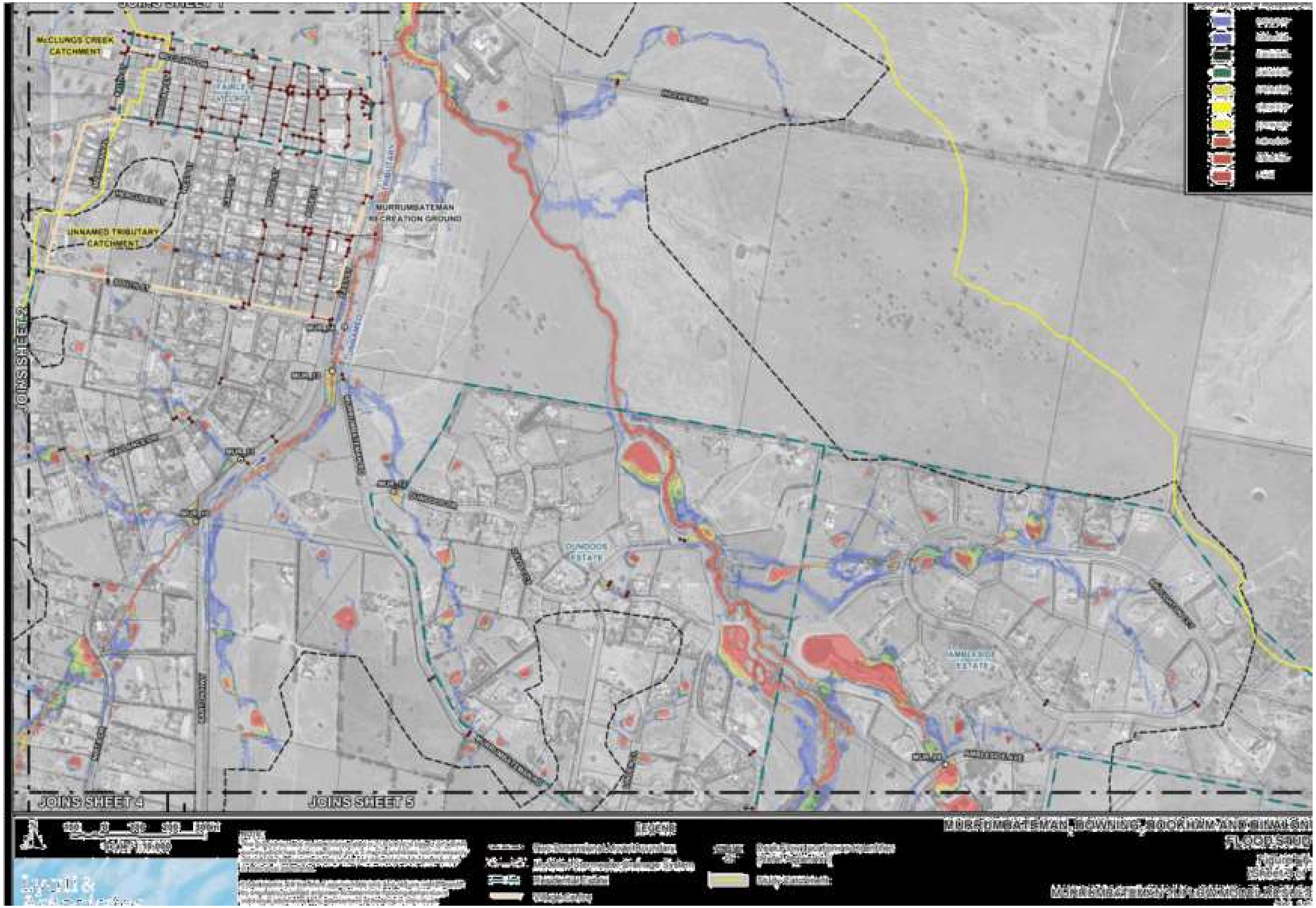

AMBLESIDE ESTATE
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 4
JOINS SHEET 6
LEGEND

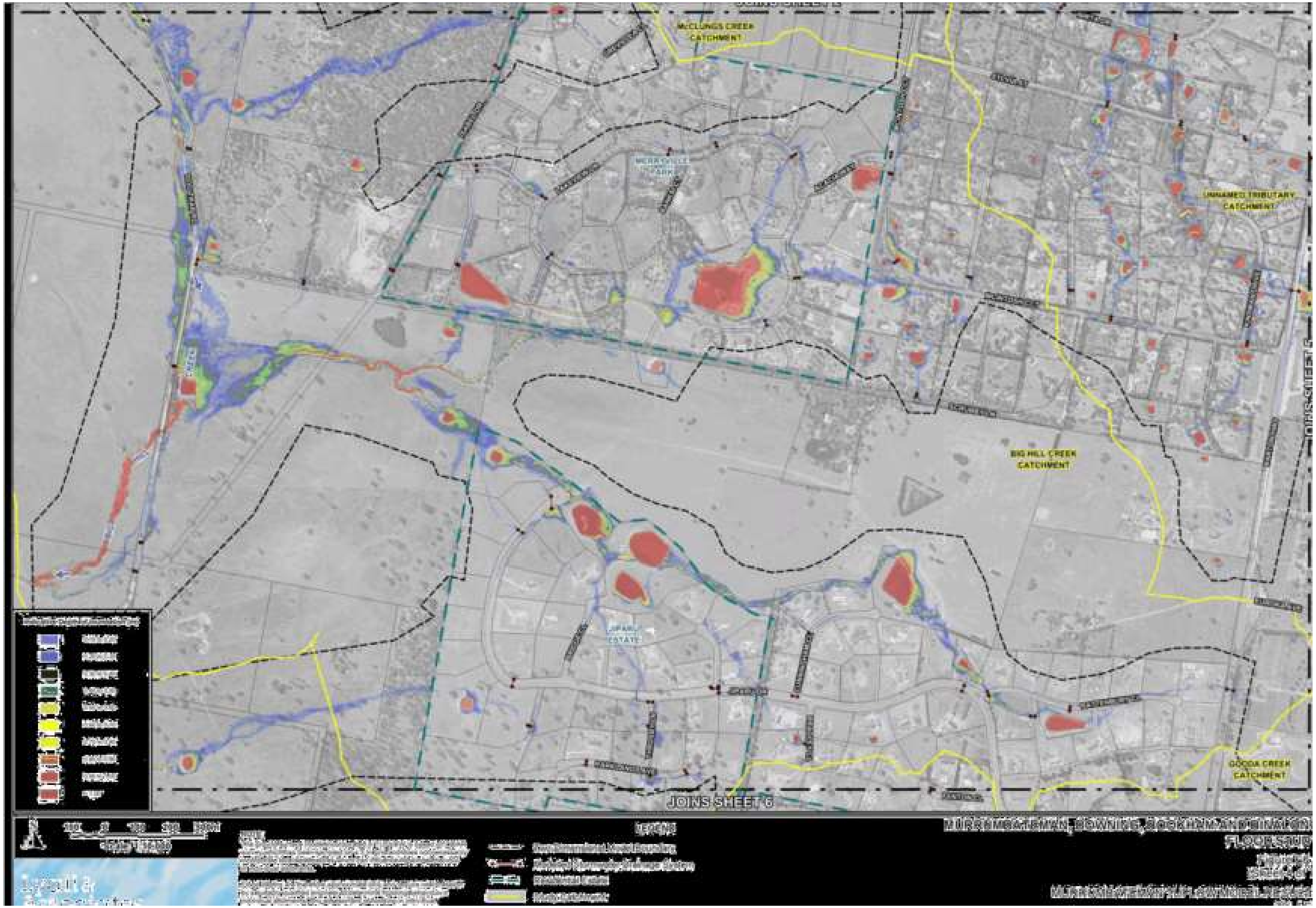

BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 7
LEGEND

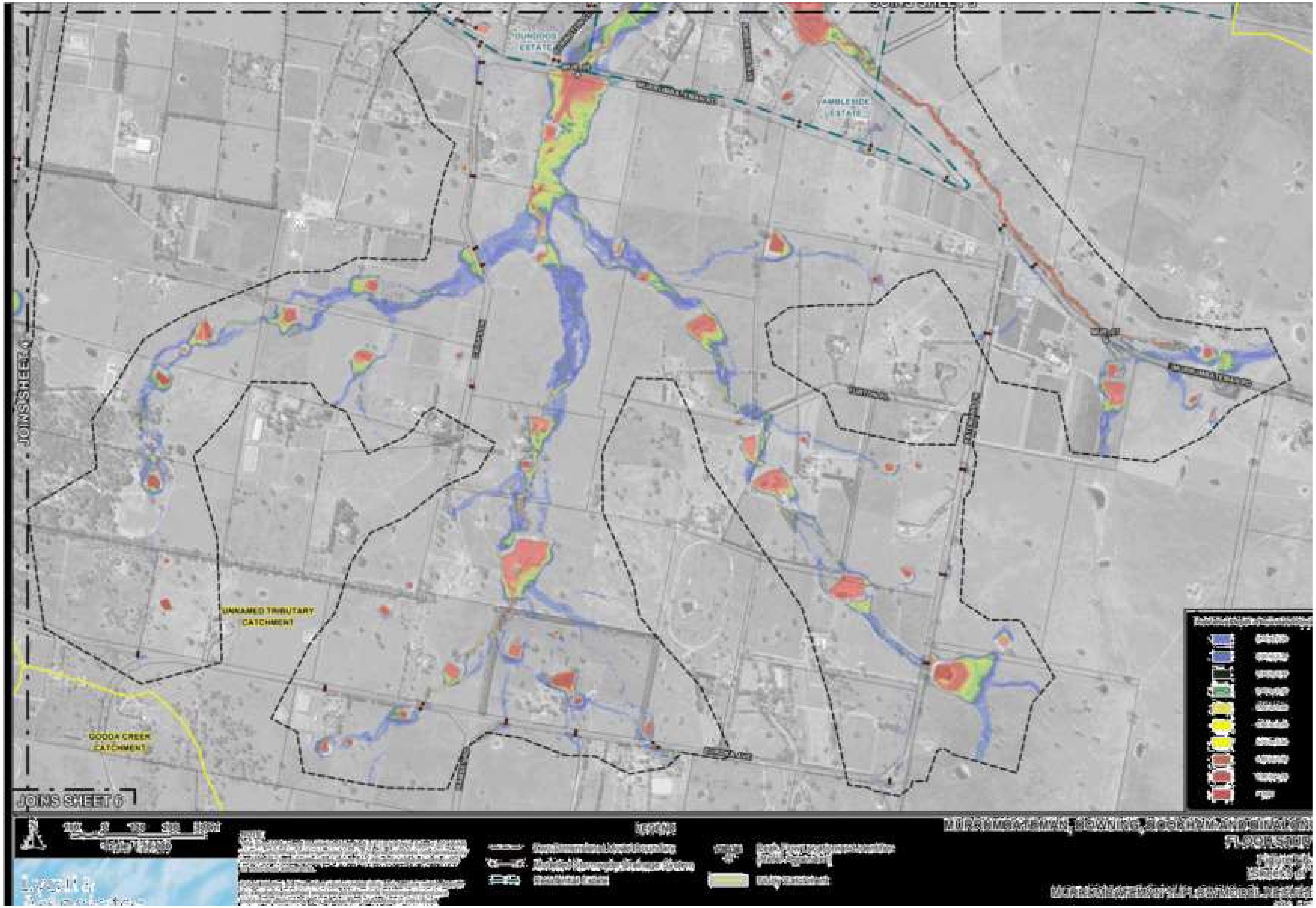

UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
GOODA
CREEK
GOODA
CREEK

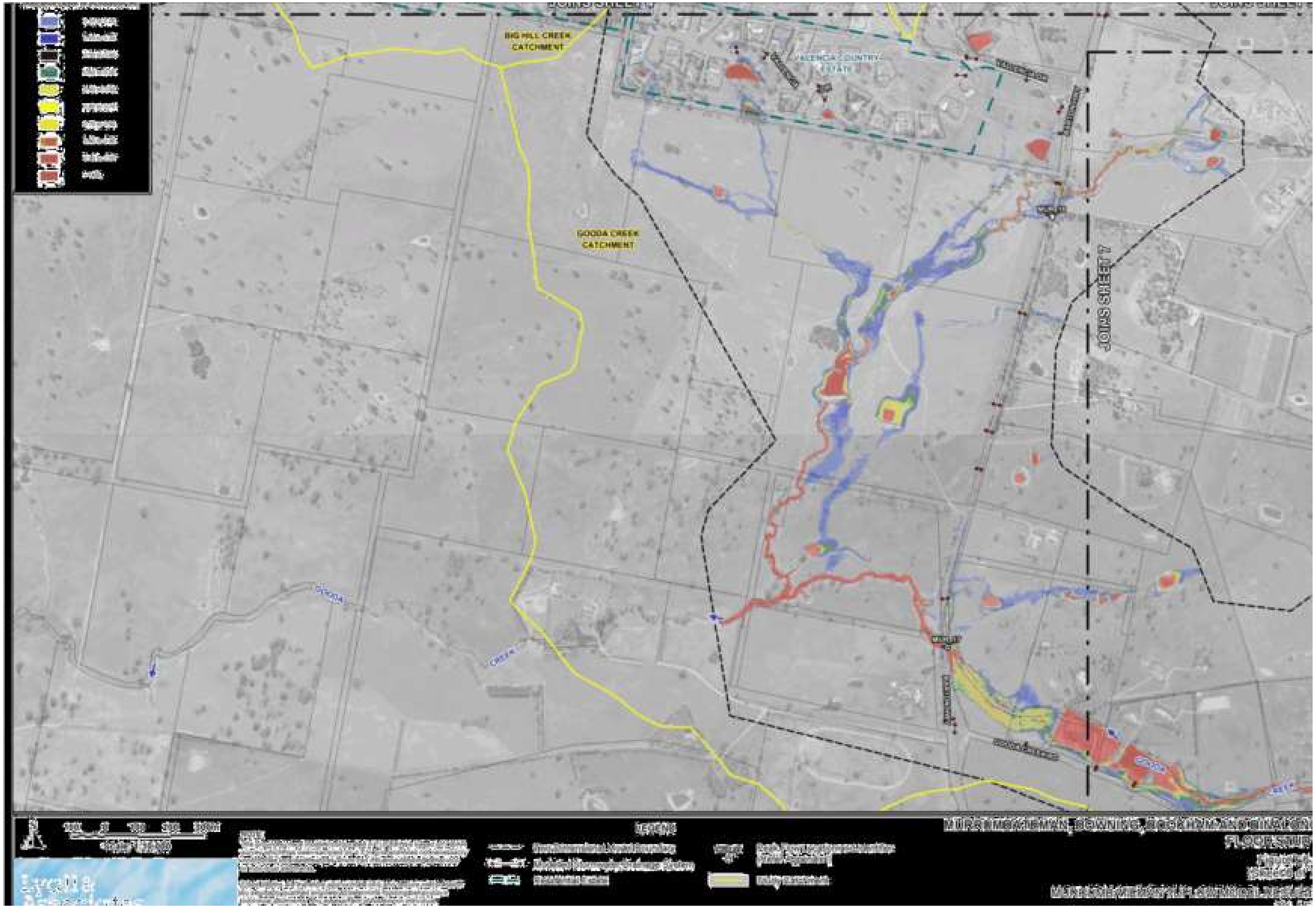

INSET
REFER INSET
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3
LEGEND

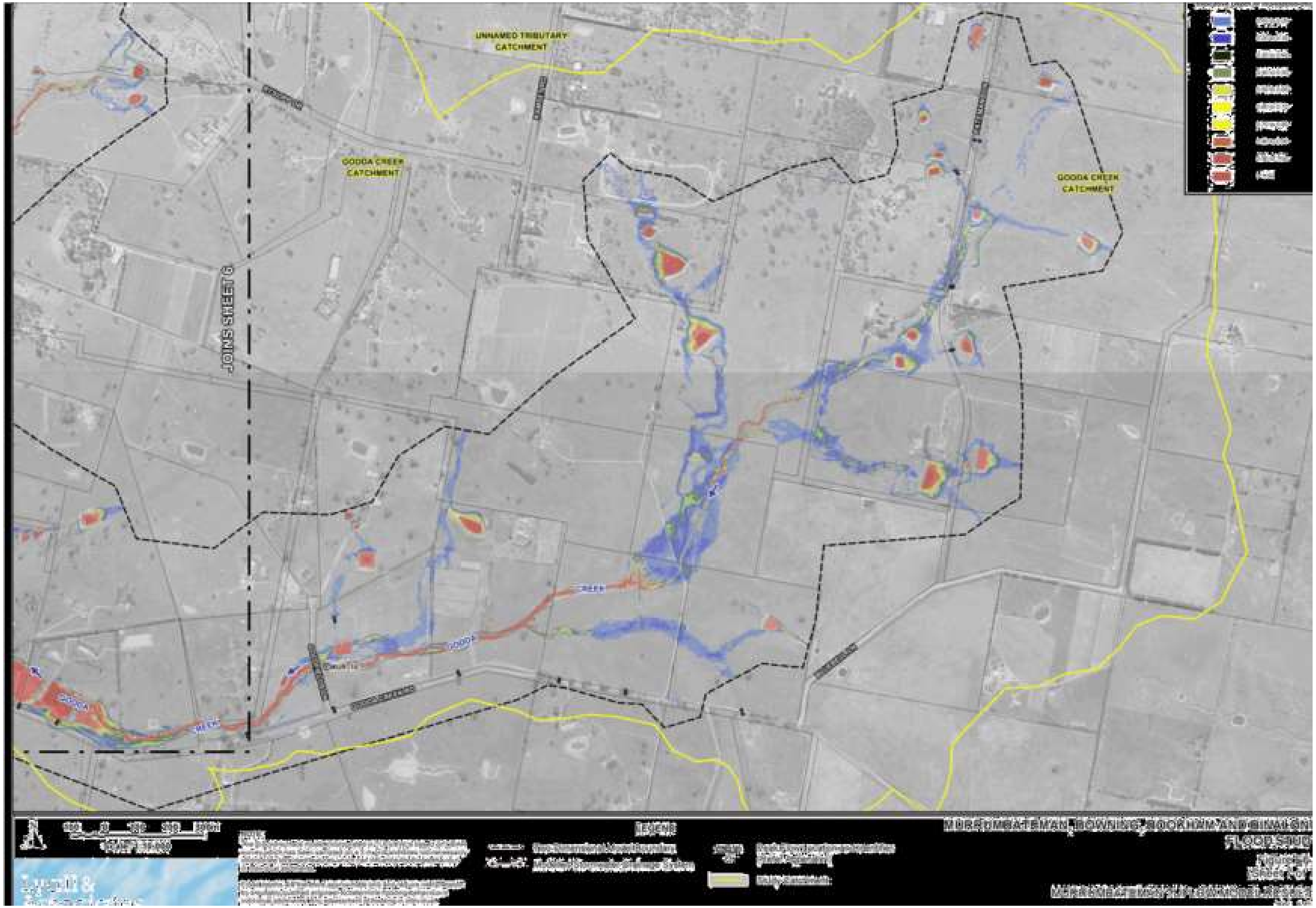

CARRINGTON PARK
VINEYARD RIDGE
MERRYVILLE ESTATE
McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4
LEGEND

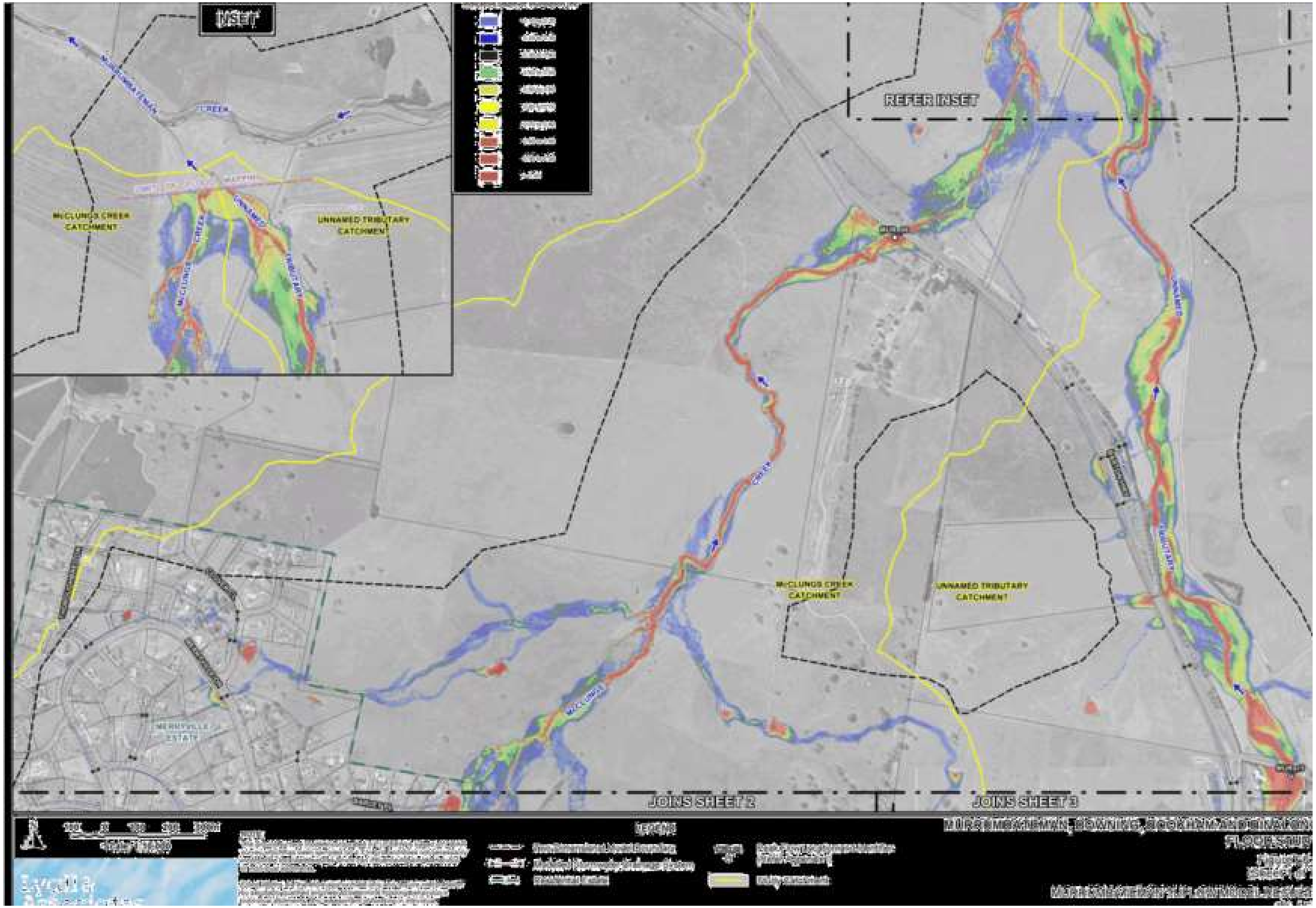

McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5
LEGEND

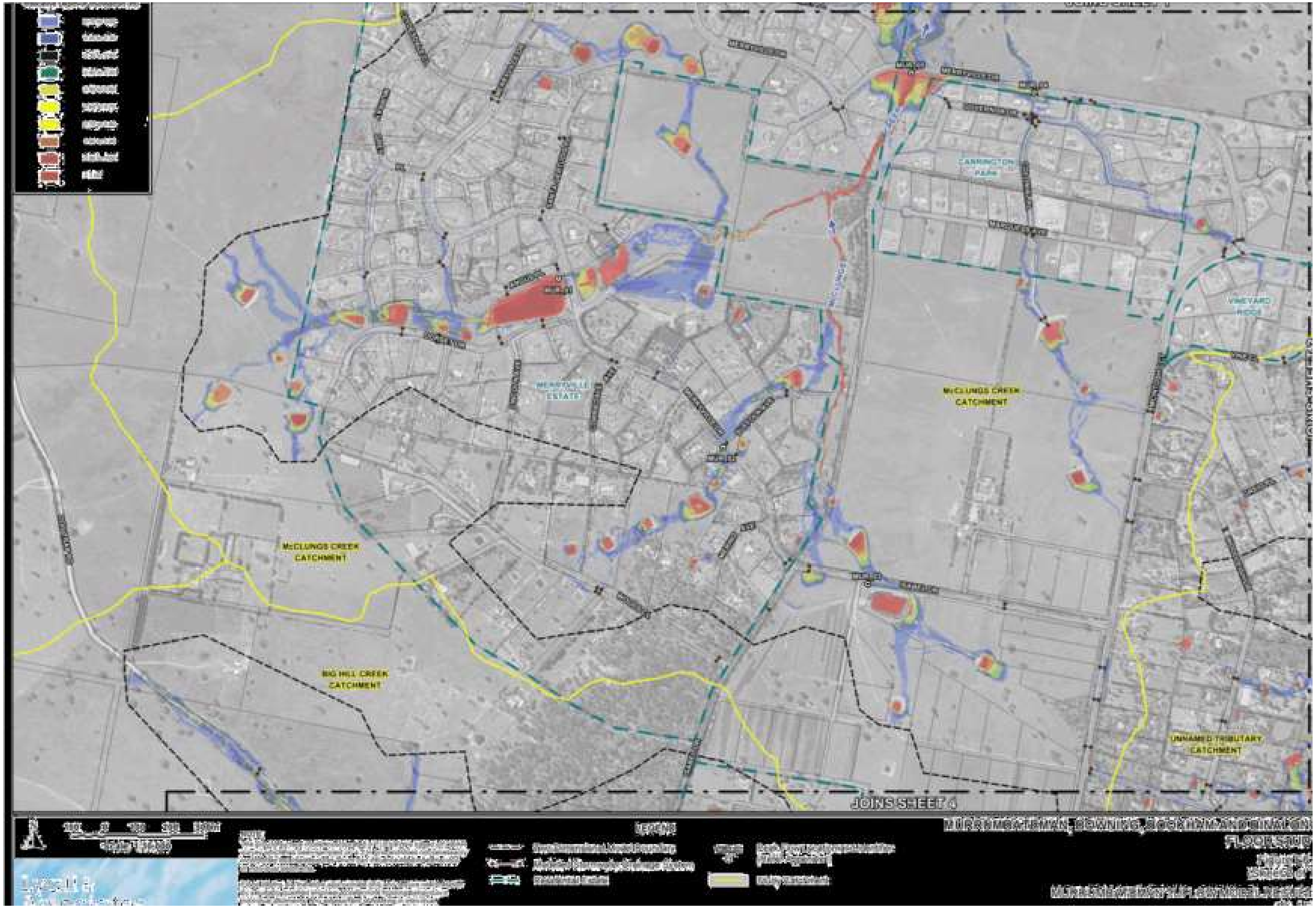

McCLUNGS CREEK
CATCHMENT
UNNAMED TRIBUTARY
CATCHMENT
BIG HILL CREEK
CATCHMENT
GOODA CREEK
CATCHMENT
JOINS SHEET 6
JOINS SHEET 5
LEGEND

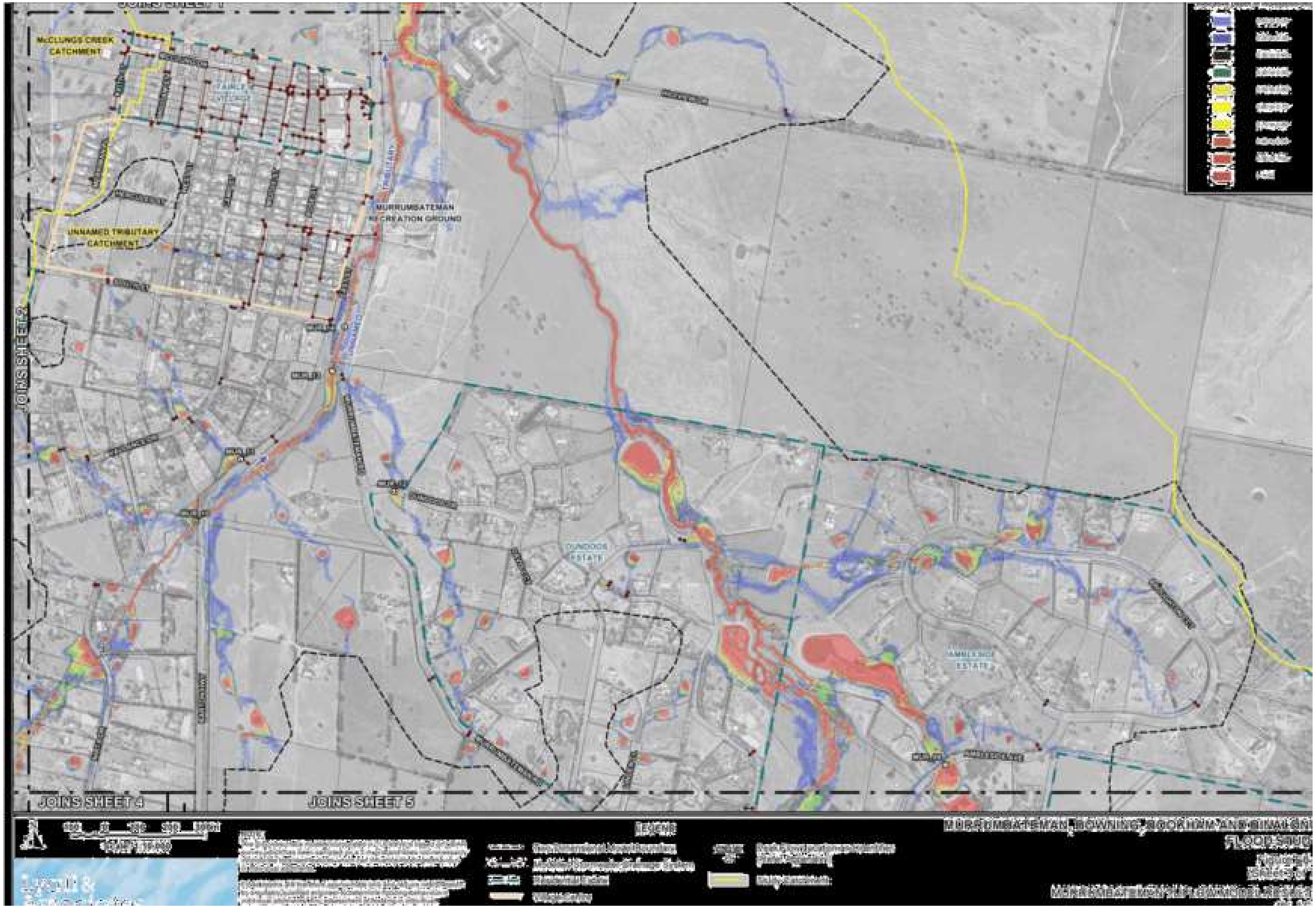

AMBLESIDE ESTATE
JOINS SHEET 4
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6

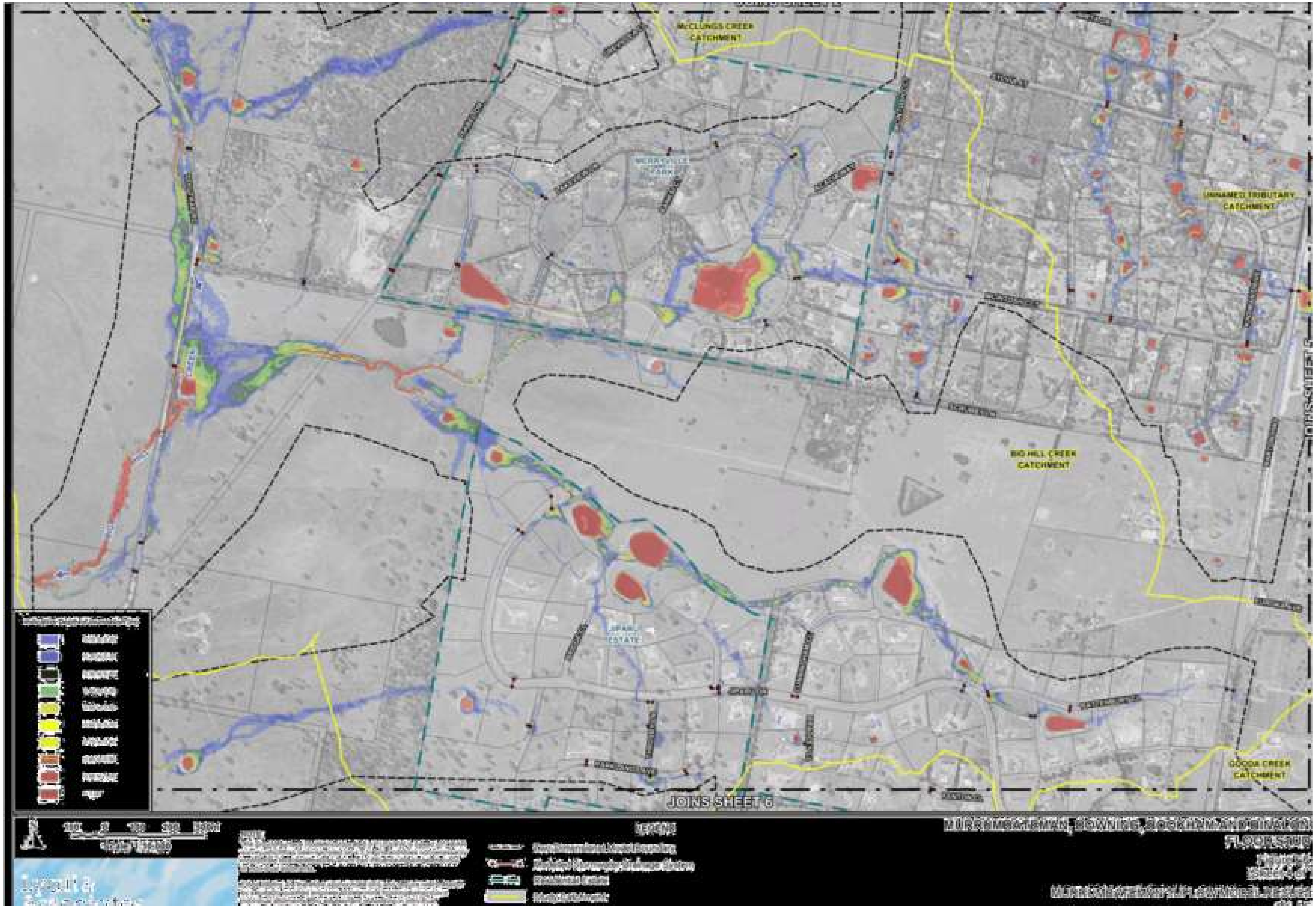

BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
VALENCIA COUNTRY ESTATE
GOODA
CREEK
JOUS SHEET 7
LEGEND

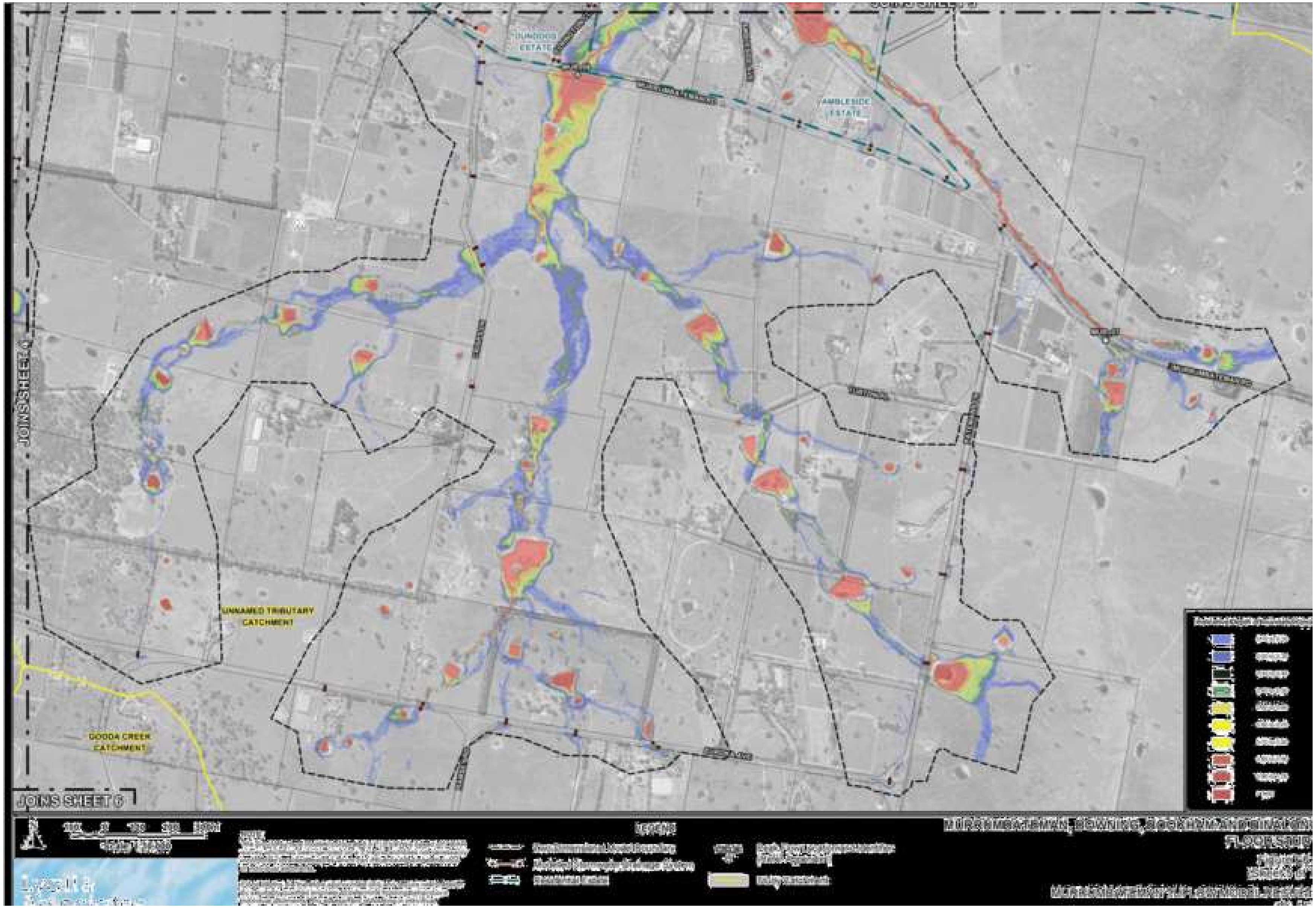

UNNAMED TRIBUTARY
CATCHMENT
GOODA CREEK
CATCHMENT
GOODA CREEK
CATCHMENT
JOINS SHEET 6
GOODA
CREEK
GOODA
CREEK
LEGEND

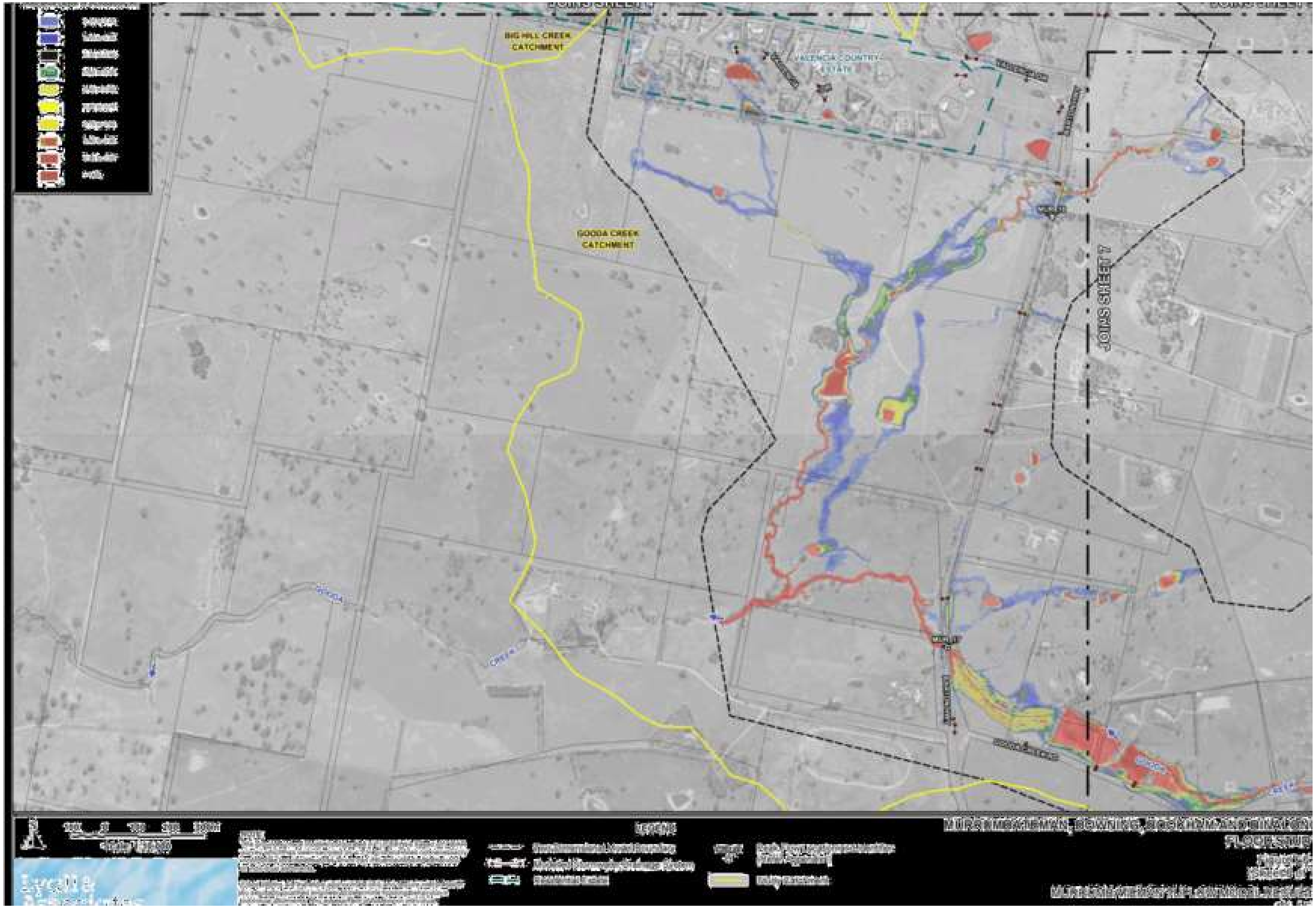

INSET
REFER INSET
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3
LEGEND

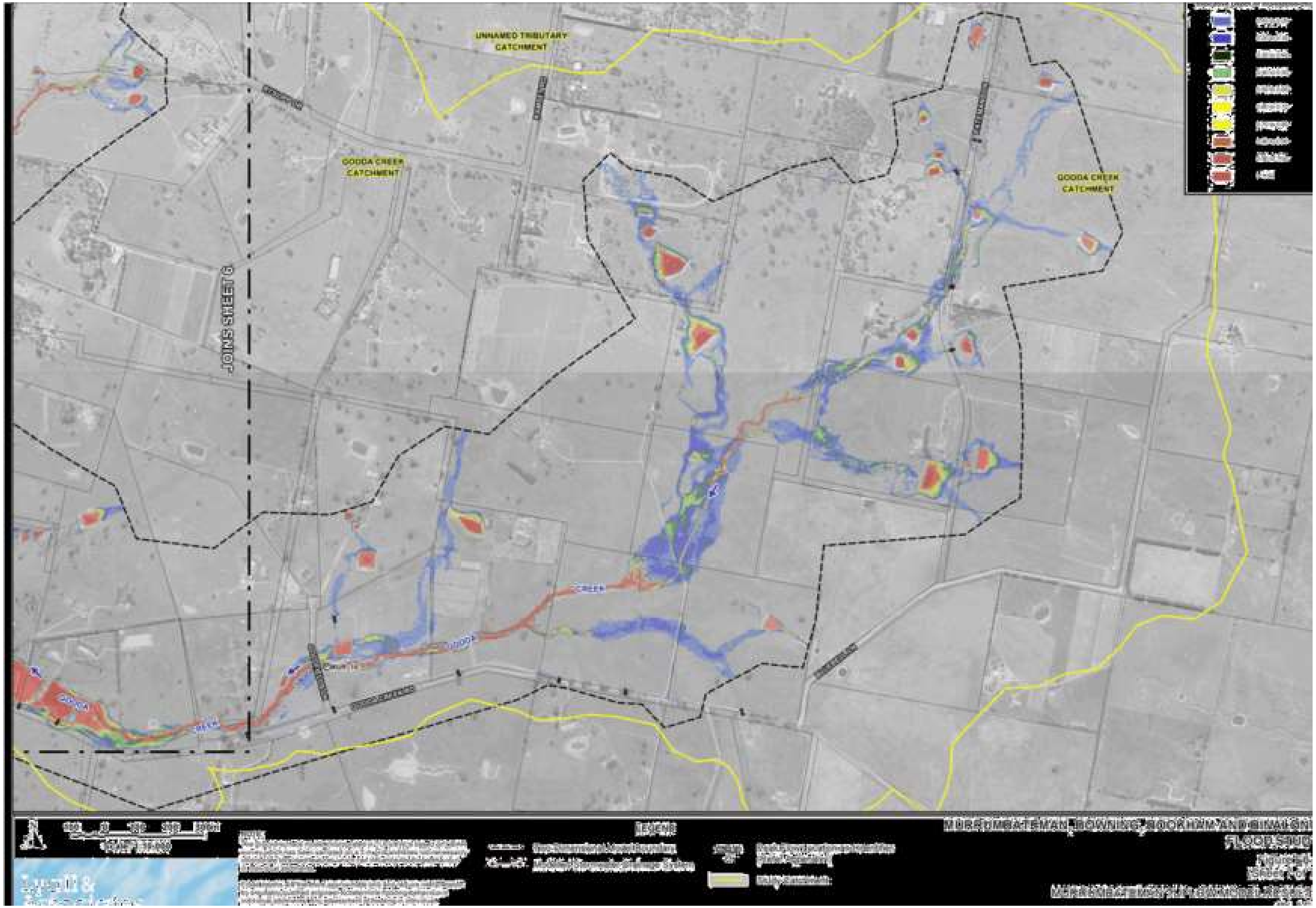

McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
CARRINGTON PARK
VINEYARD RIDGE
JOINS SHEET 4
LEGEND

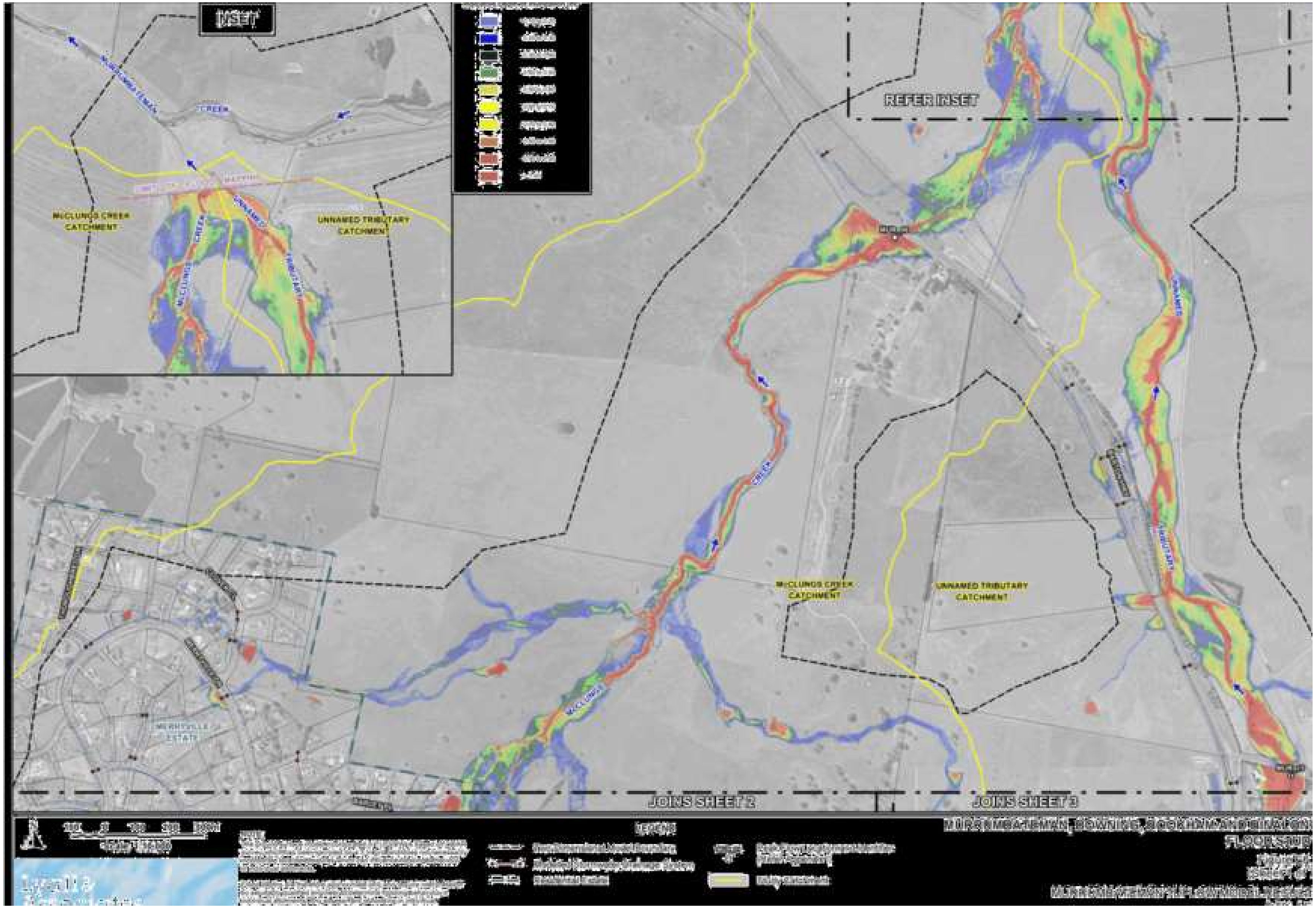

McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
DUNDOOS ESTATE
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5
LEGEND

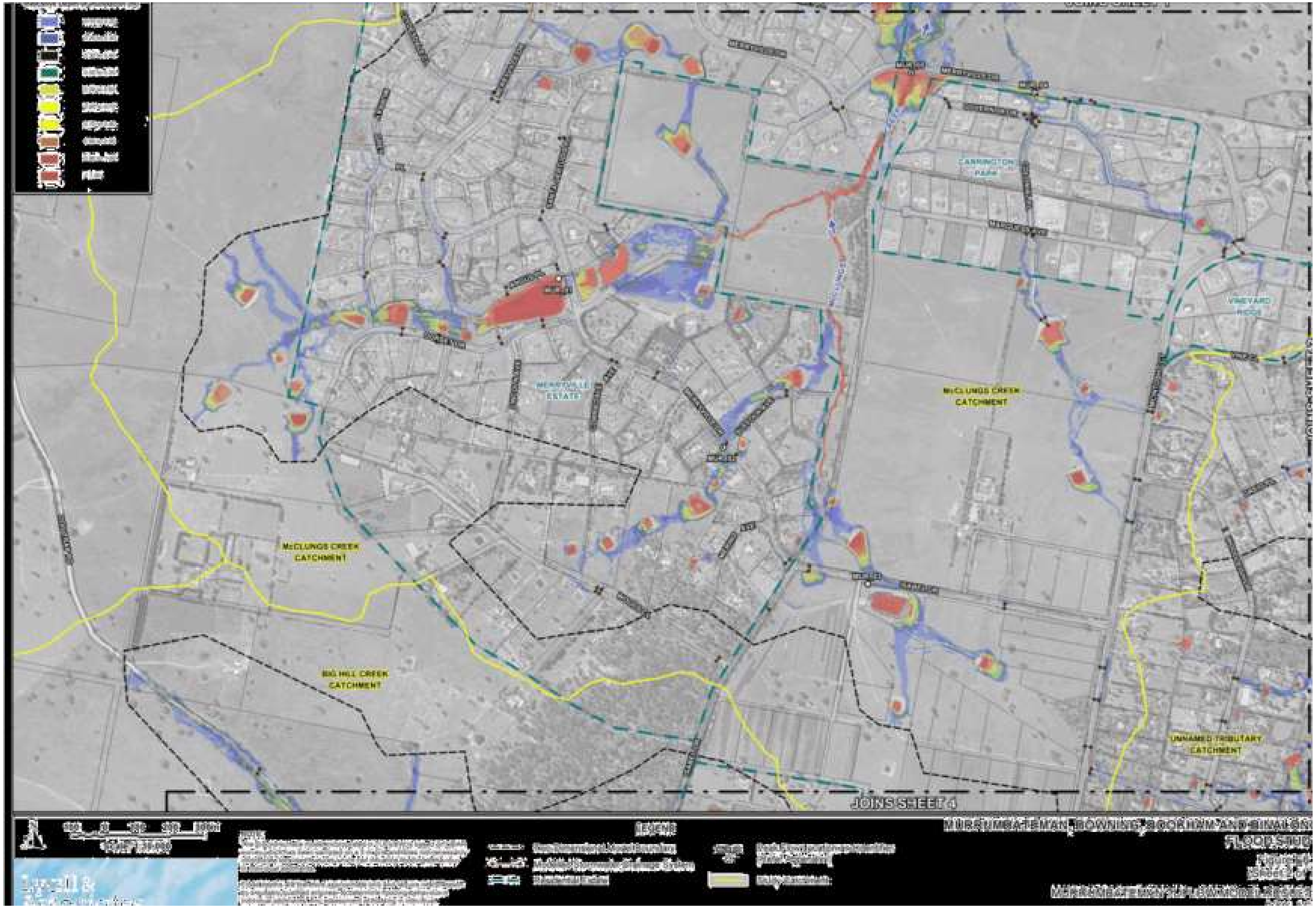

McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
JOINS SHEET 5
LEGEND

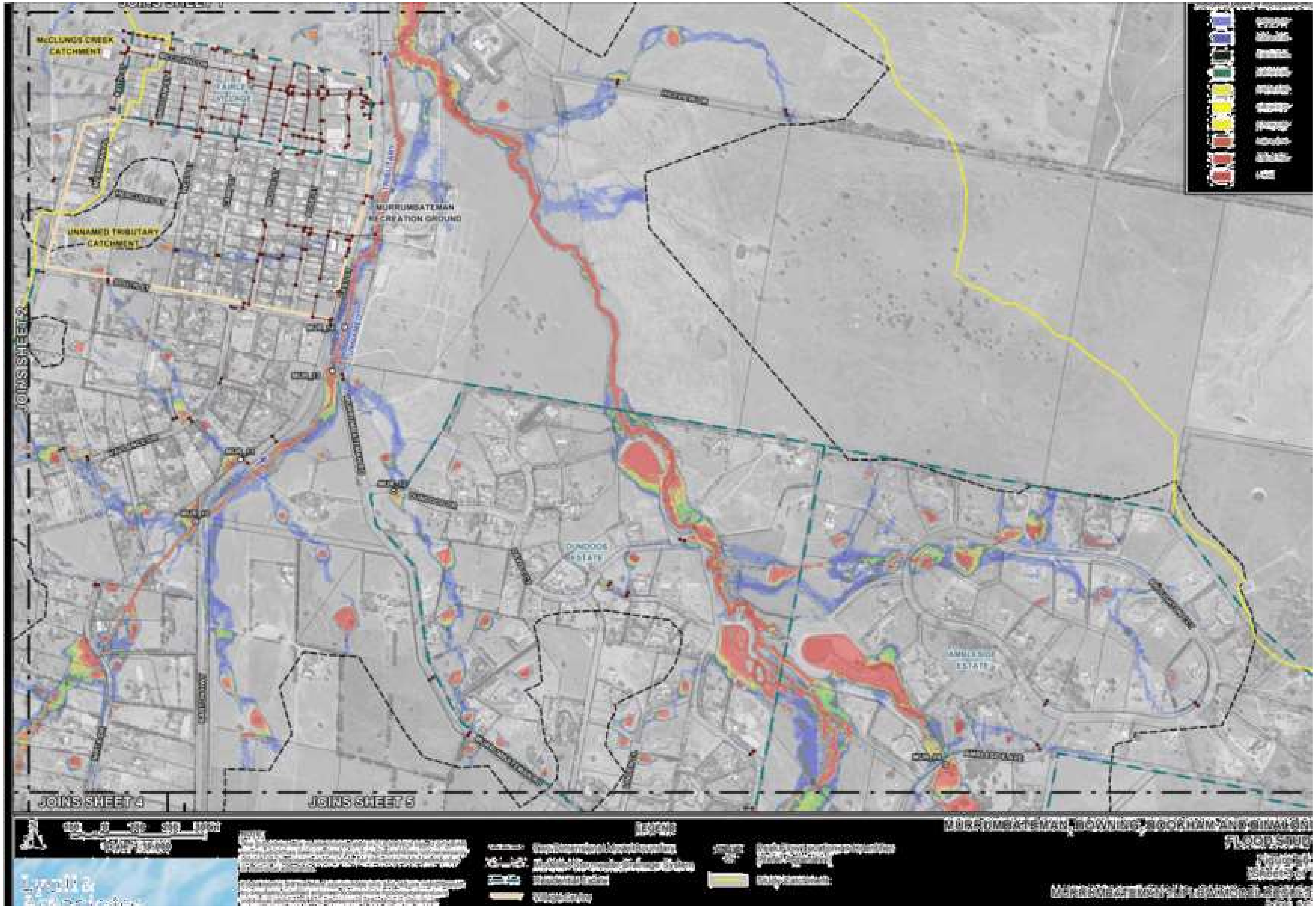

AMBLESIDE ESTATE
JOINS SHEET 4
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
LEGEND

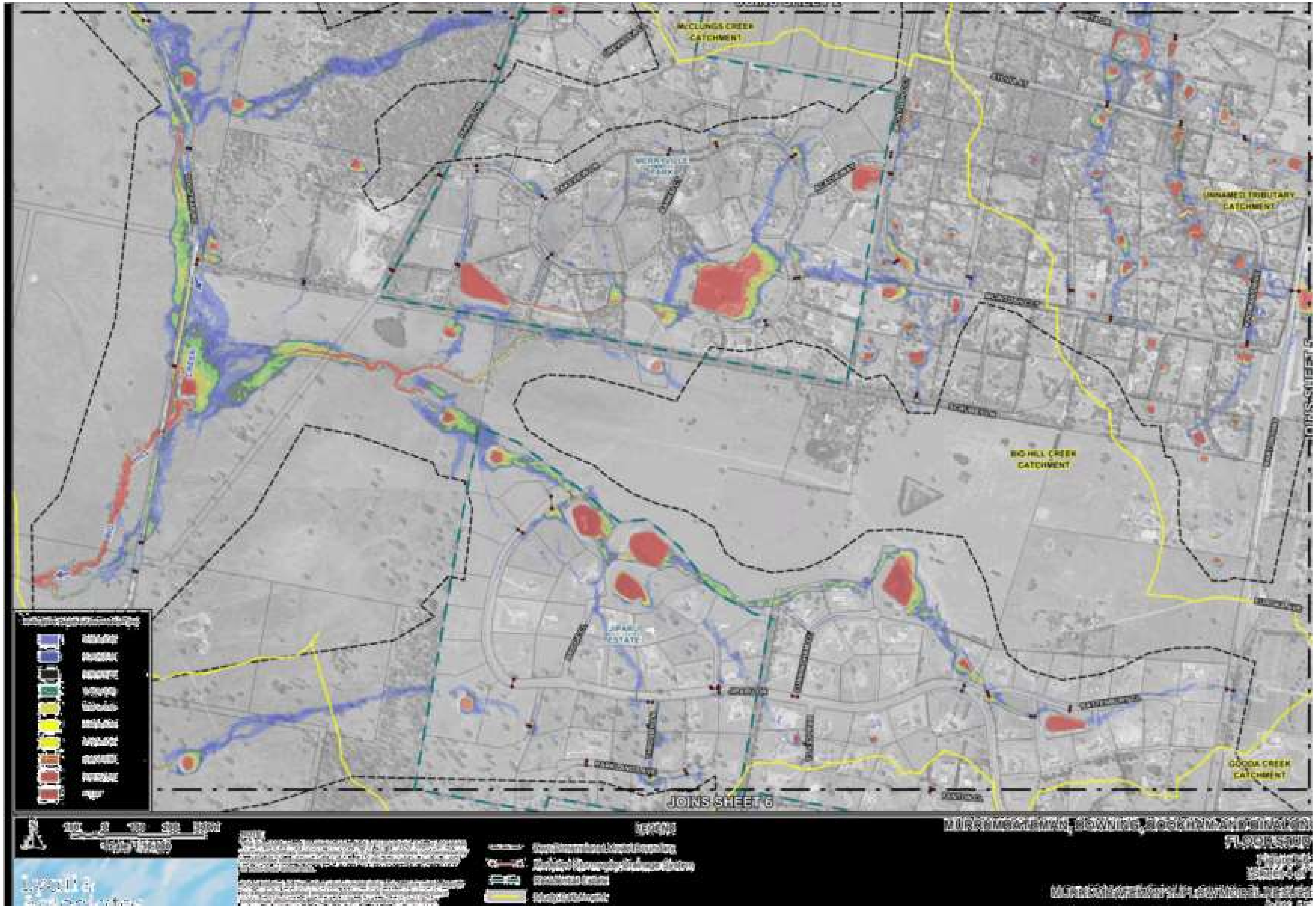

BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 7
LEGEND

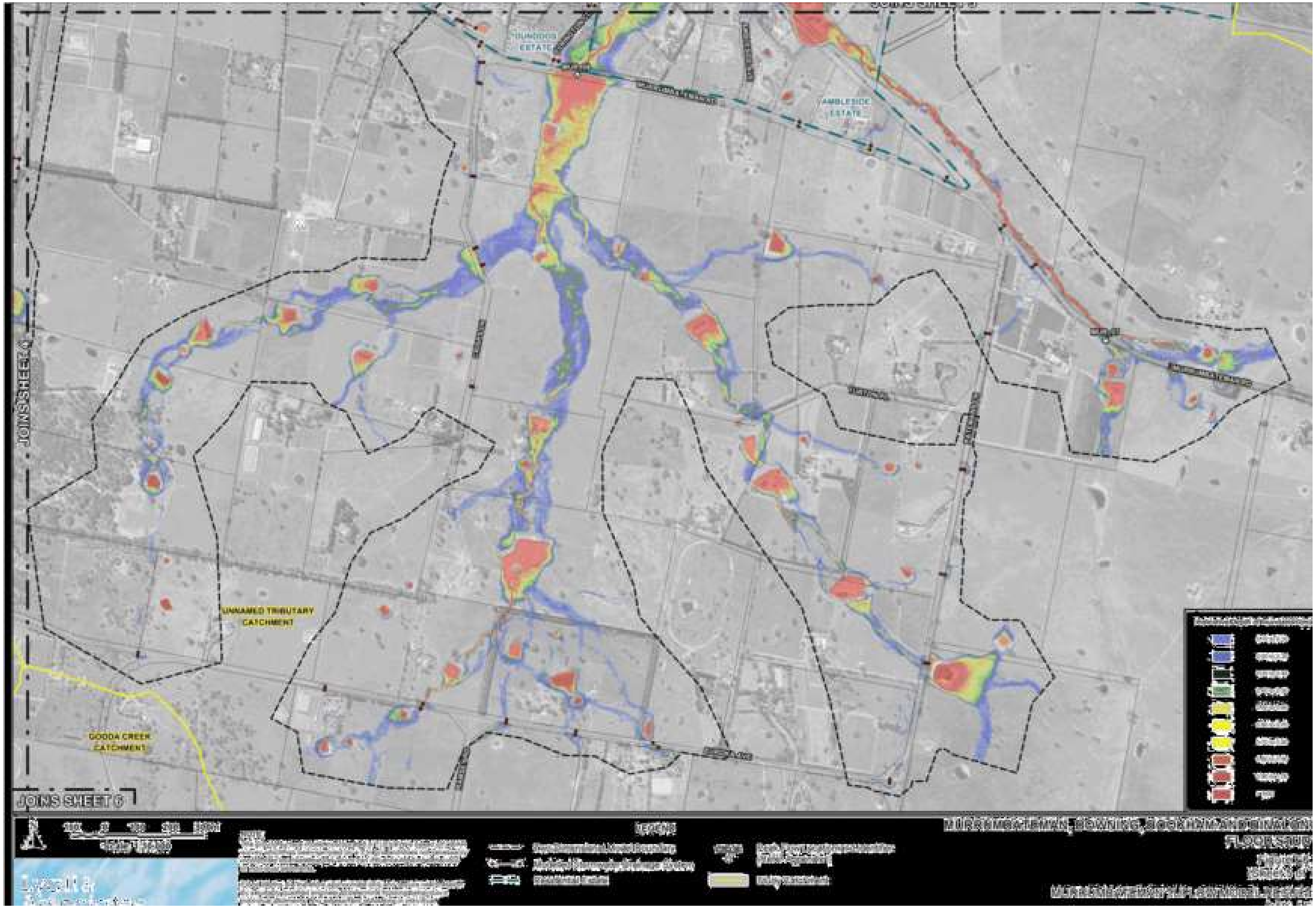

UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
GOODA
CREEK

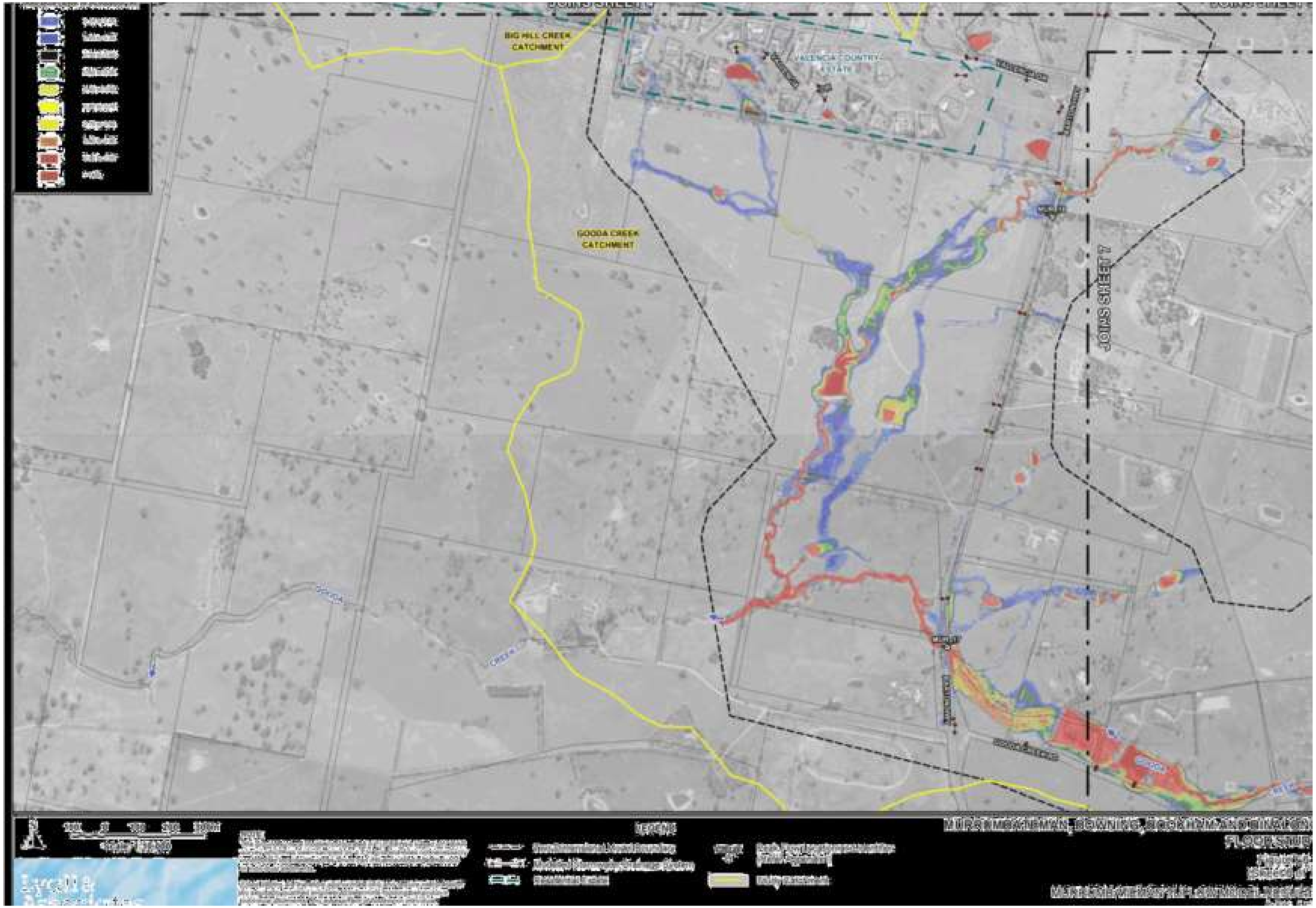

INSET
REFER INSET
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 2
JOINS SHEET 3
LEGEND

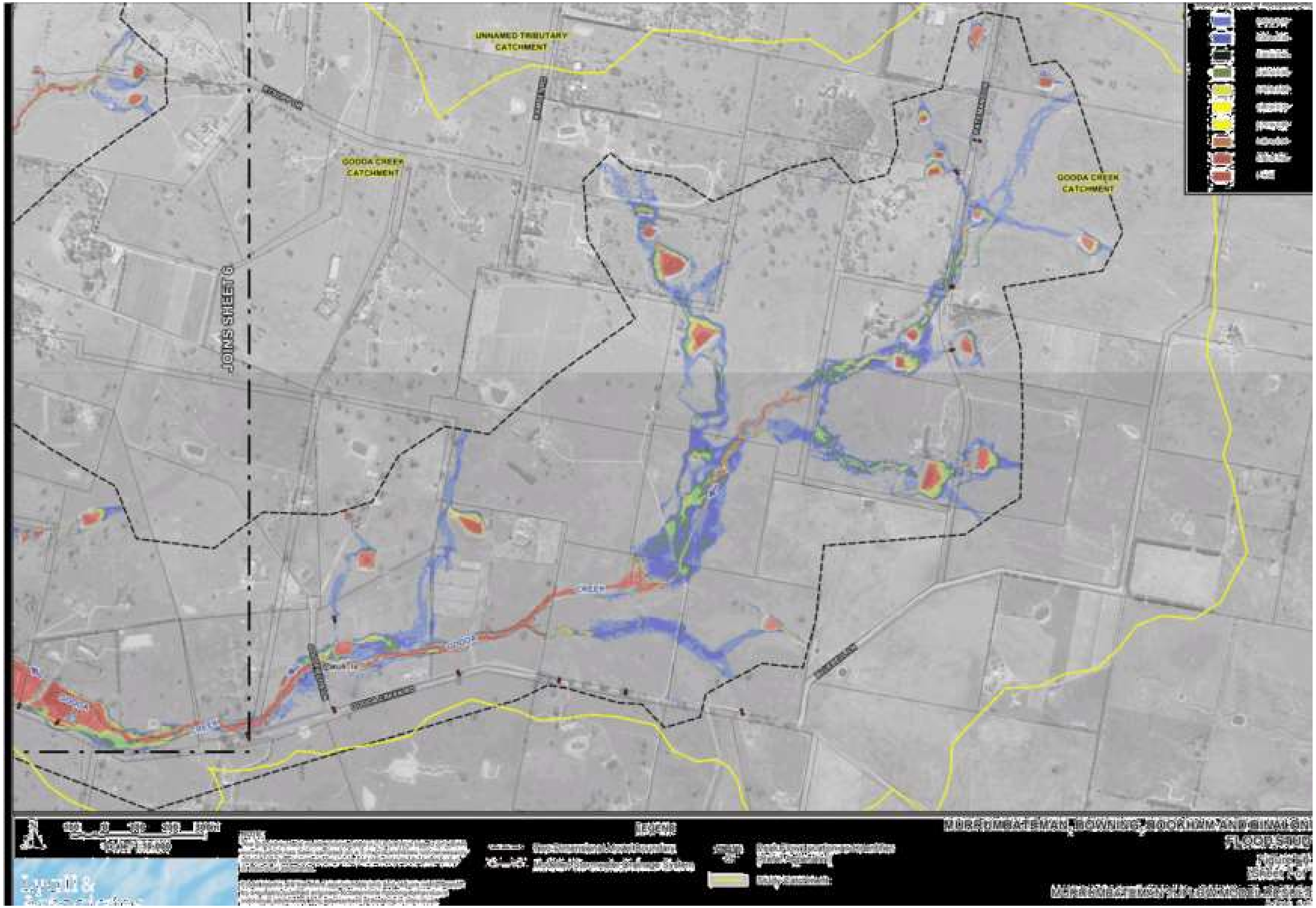

CARRINGTON PARK
VINEYARD RIDGE
MERRYVILLE ESTATE
McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4
LEGEND

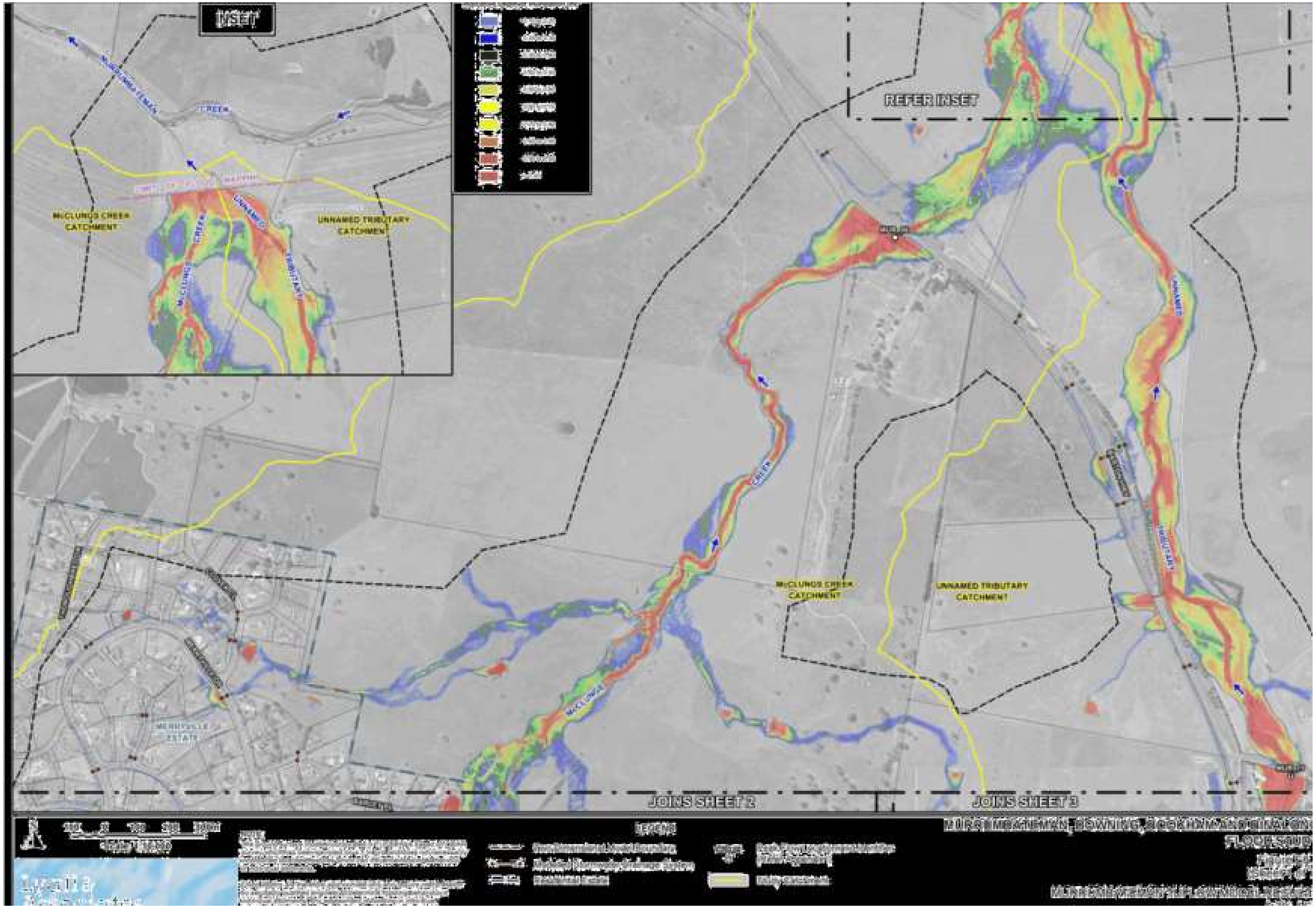

McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5
LEGEND

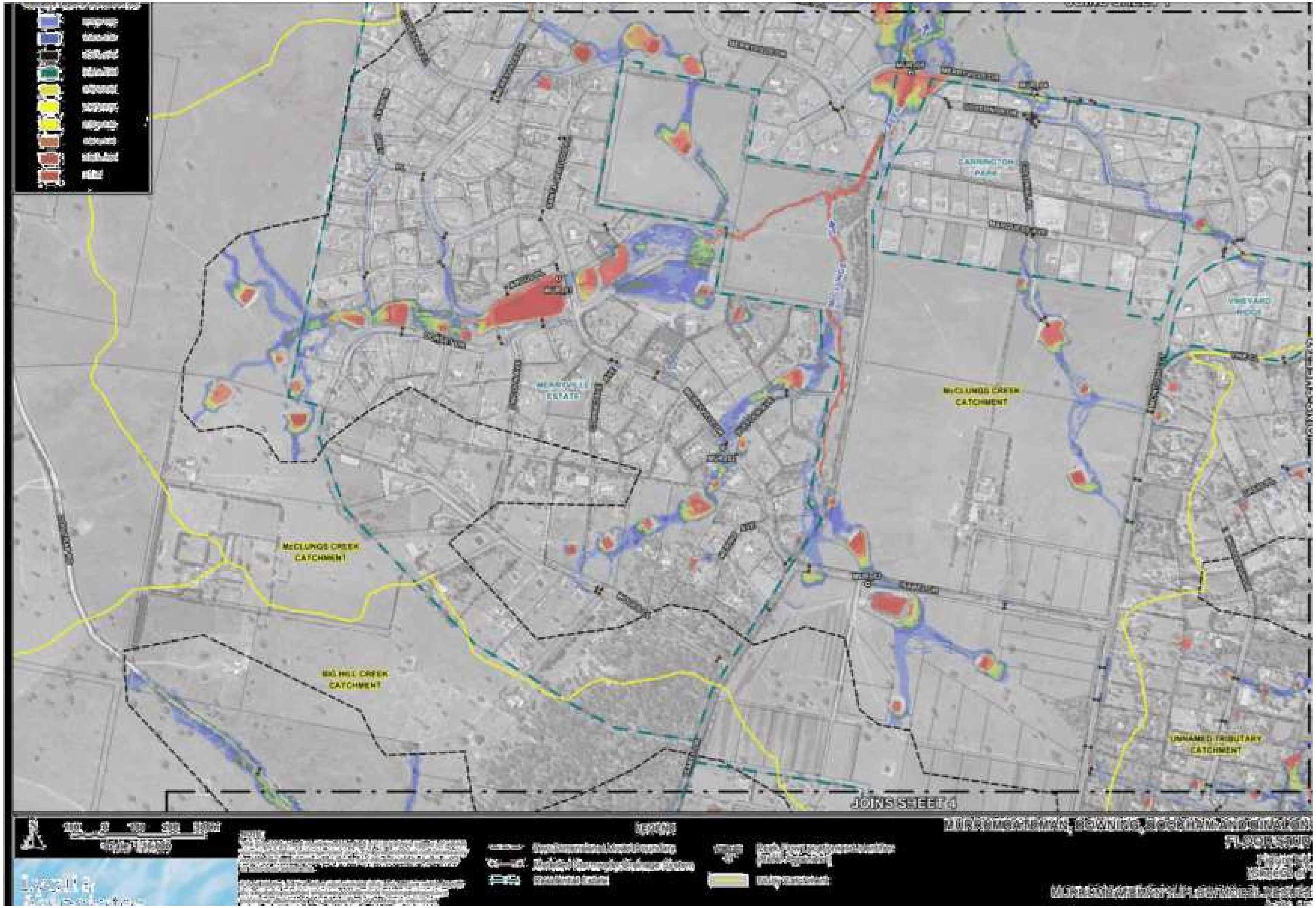

McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 5
JOINS SHEET 6
LEGEND

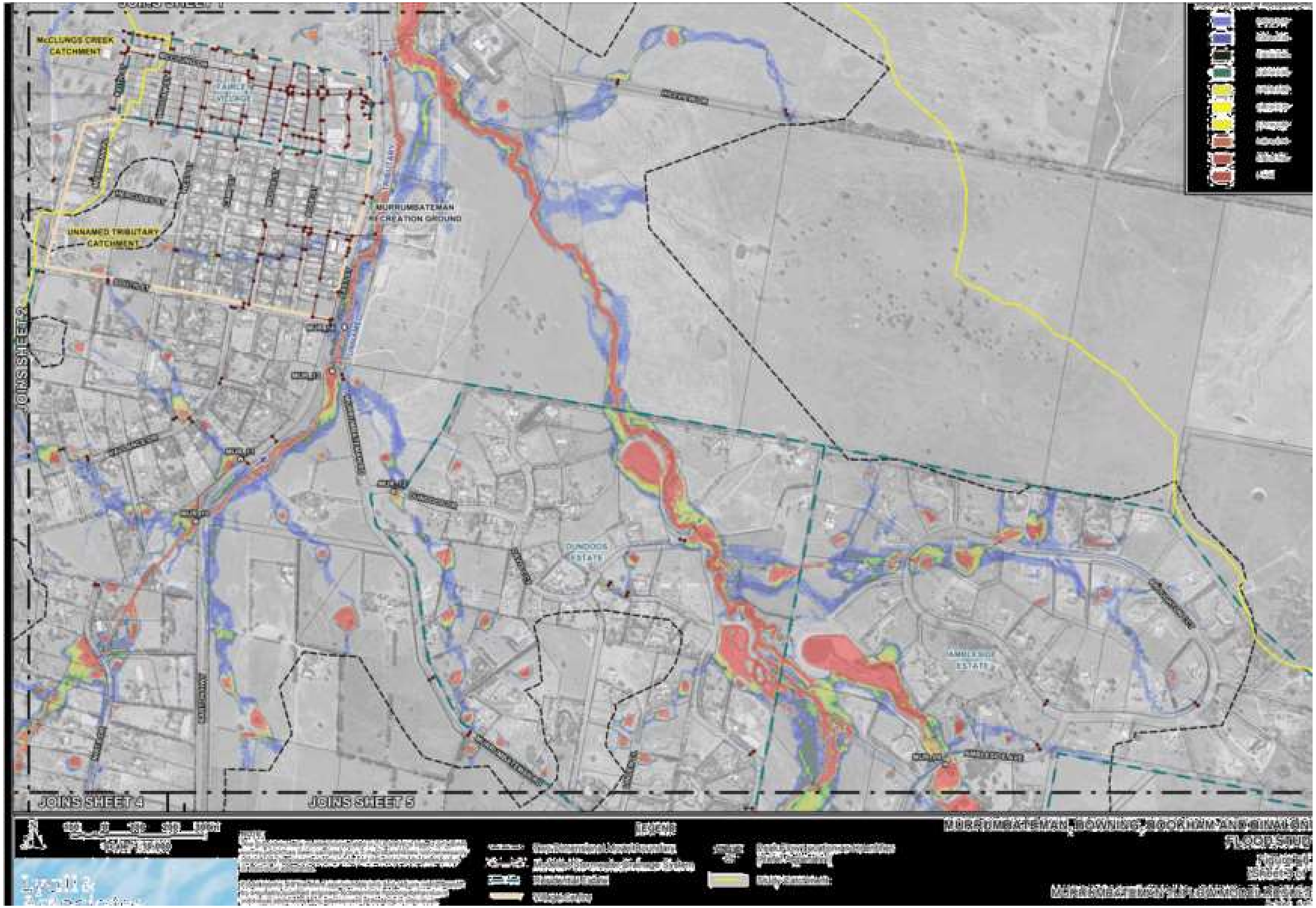

AMBLESIDE ESTATE
JOINS SHEET 4
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
LEGEND

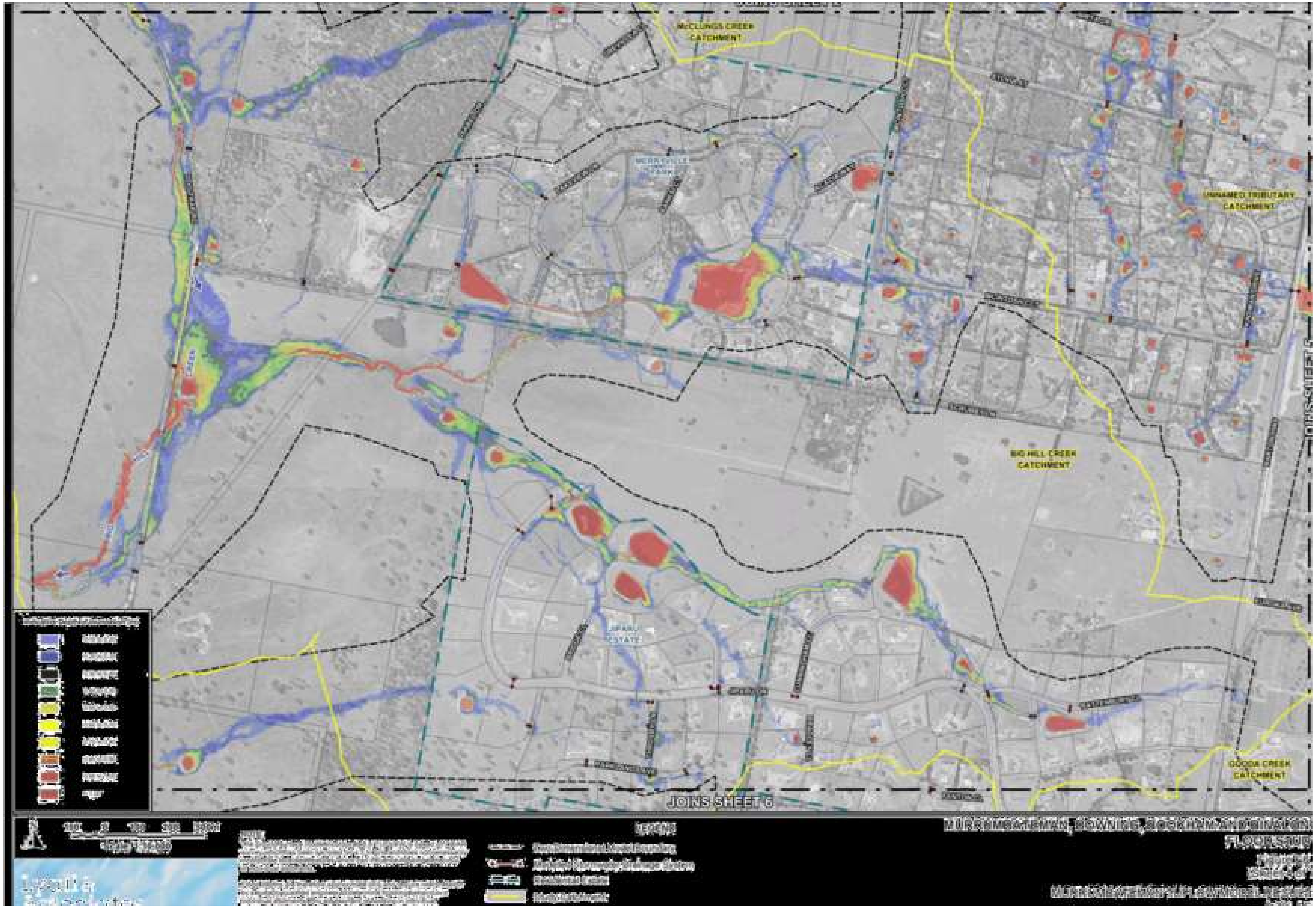

BIG HILL CREEK
CATCHMENT
VALENCIA COUNTRY
ESTATE
GOODA CREEK
CATCHMENT
JOINS SHEET 7
LEGEND

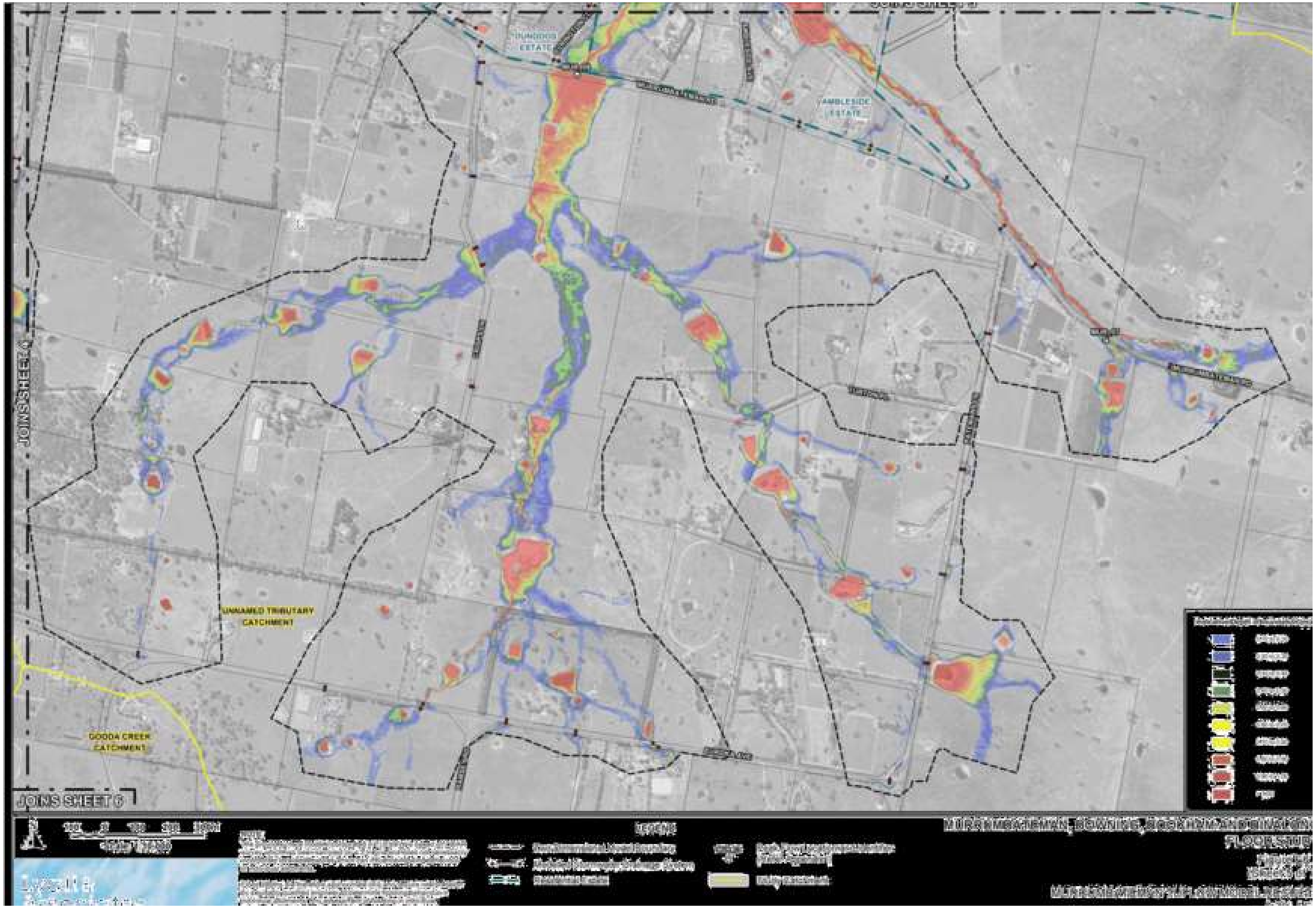

UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
LEGEND

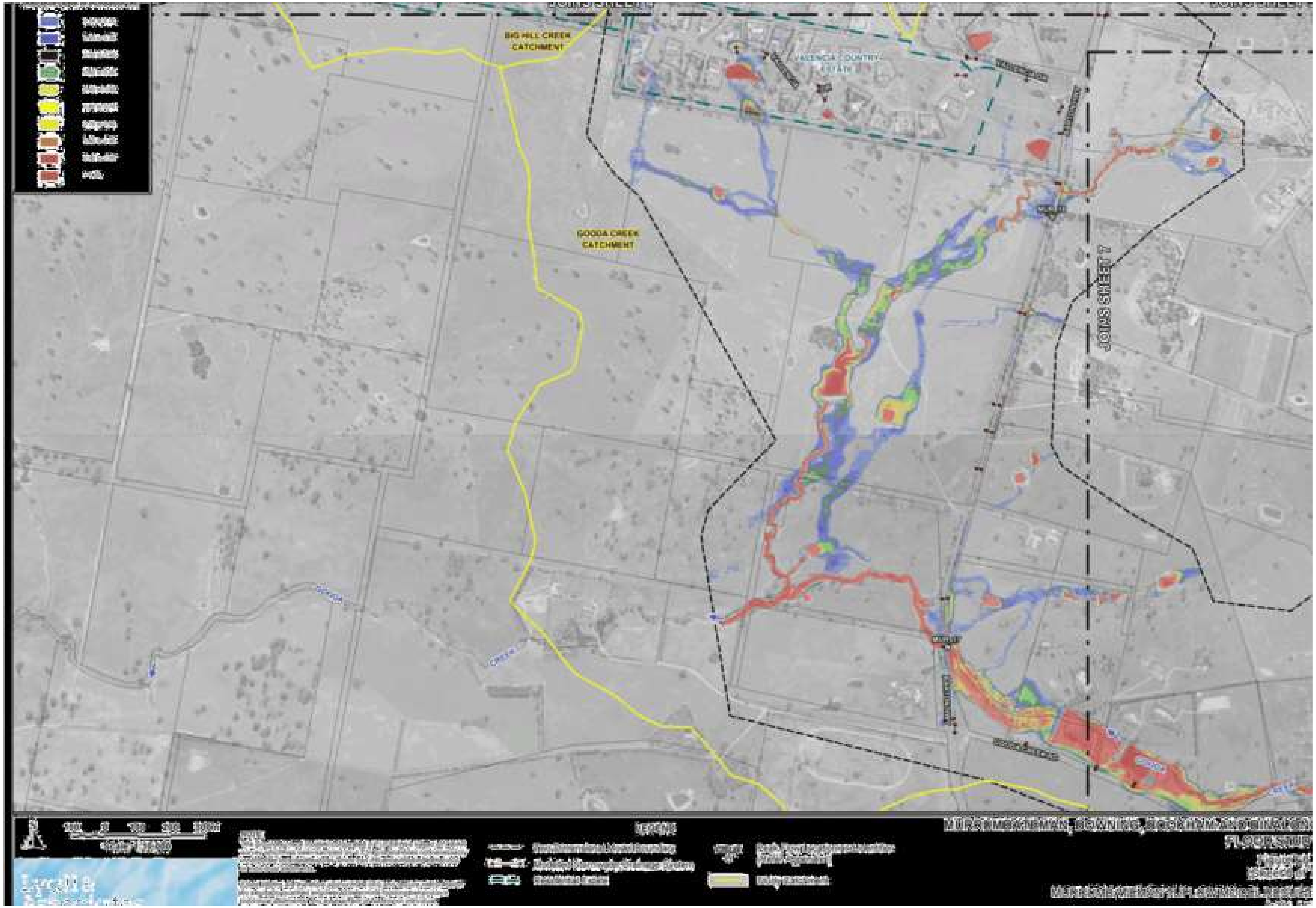

INSET
REFER INSET
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 2
JOINS SHEET 3
LEGEND

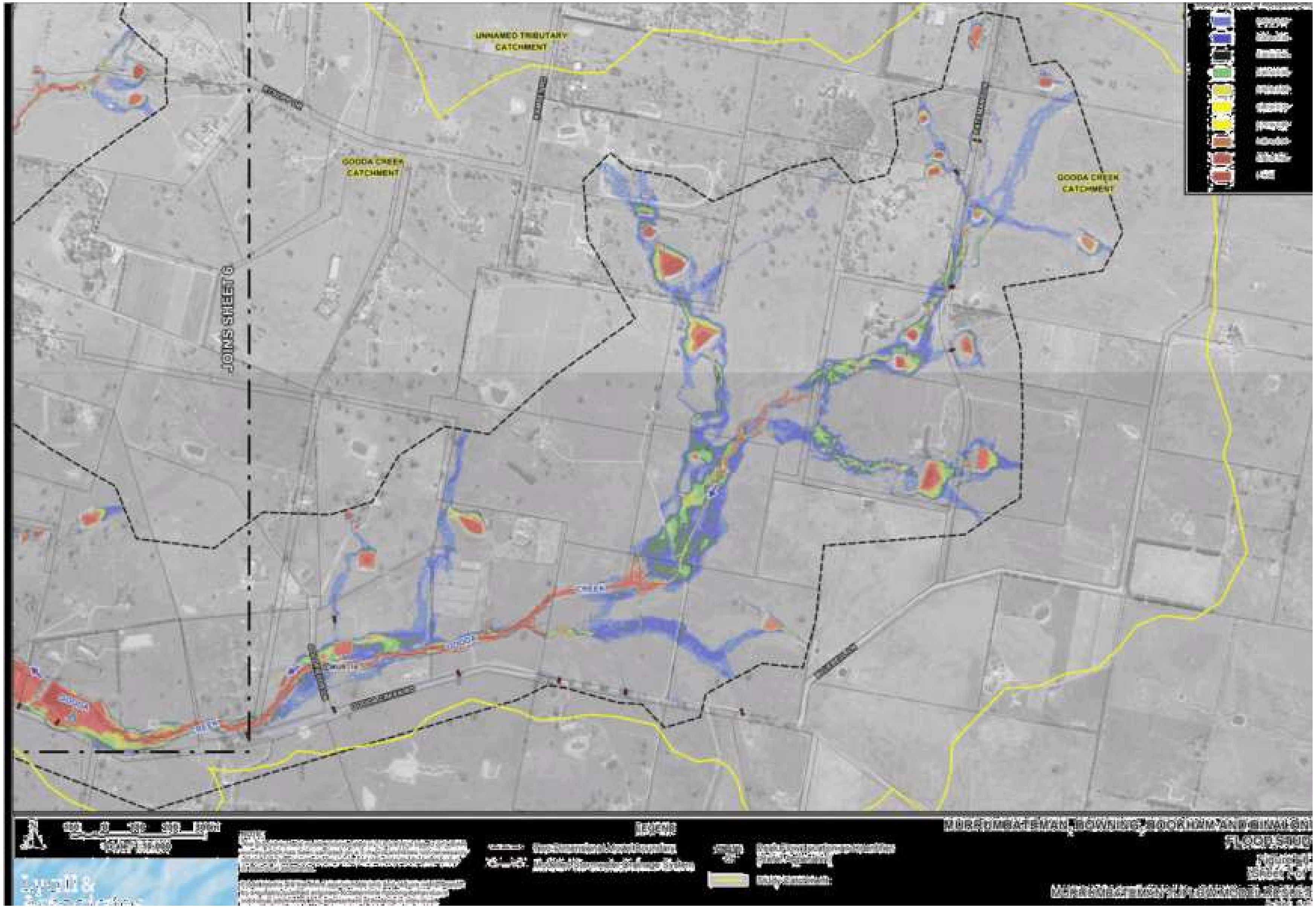

CARRINGTON PARK
VINEYARD RIDGE
MERRYVILLE ESTATE
McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4
LEGEND

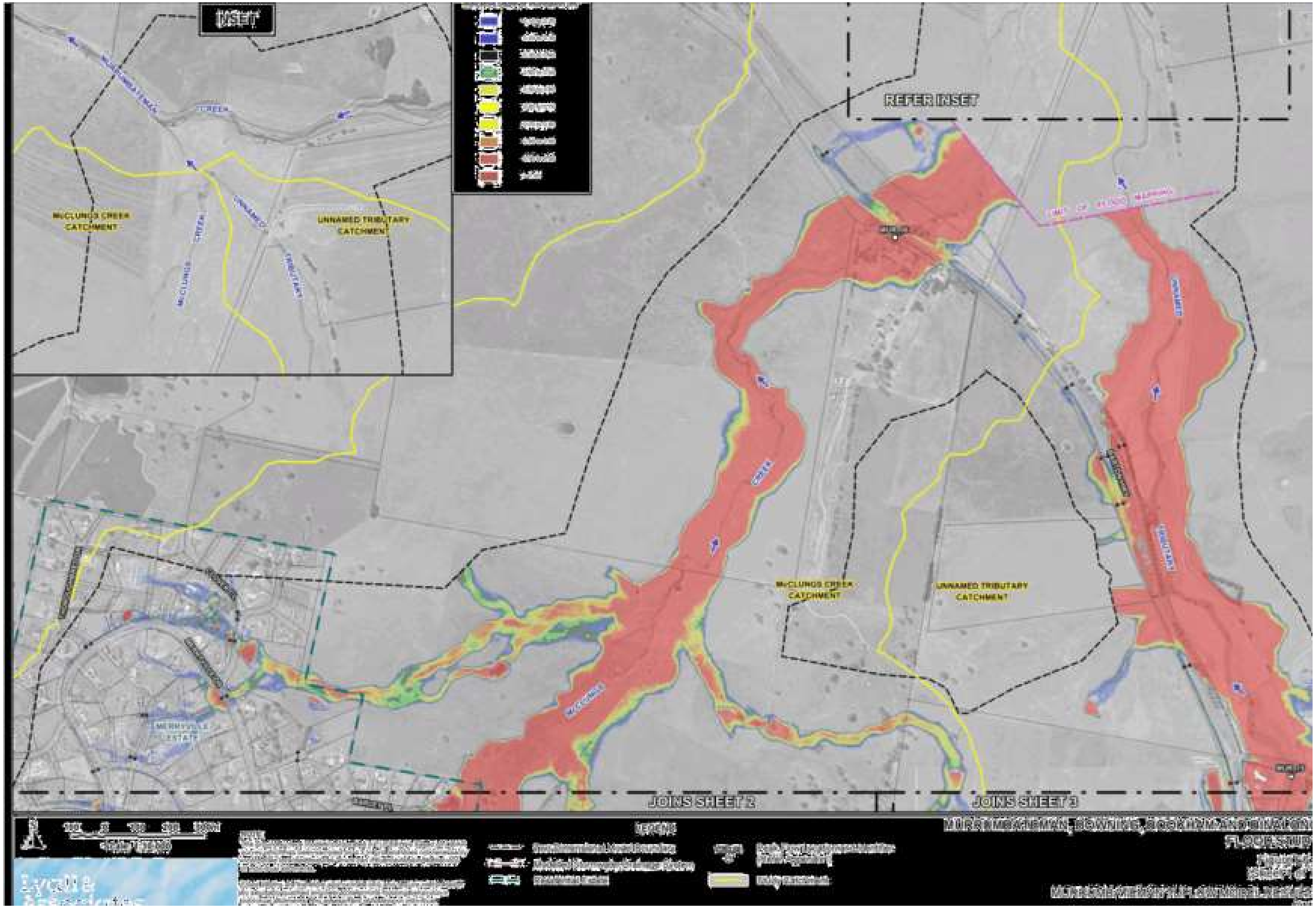

McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5

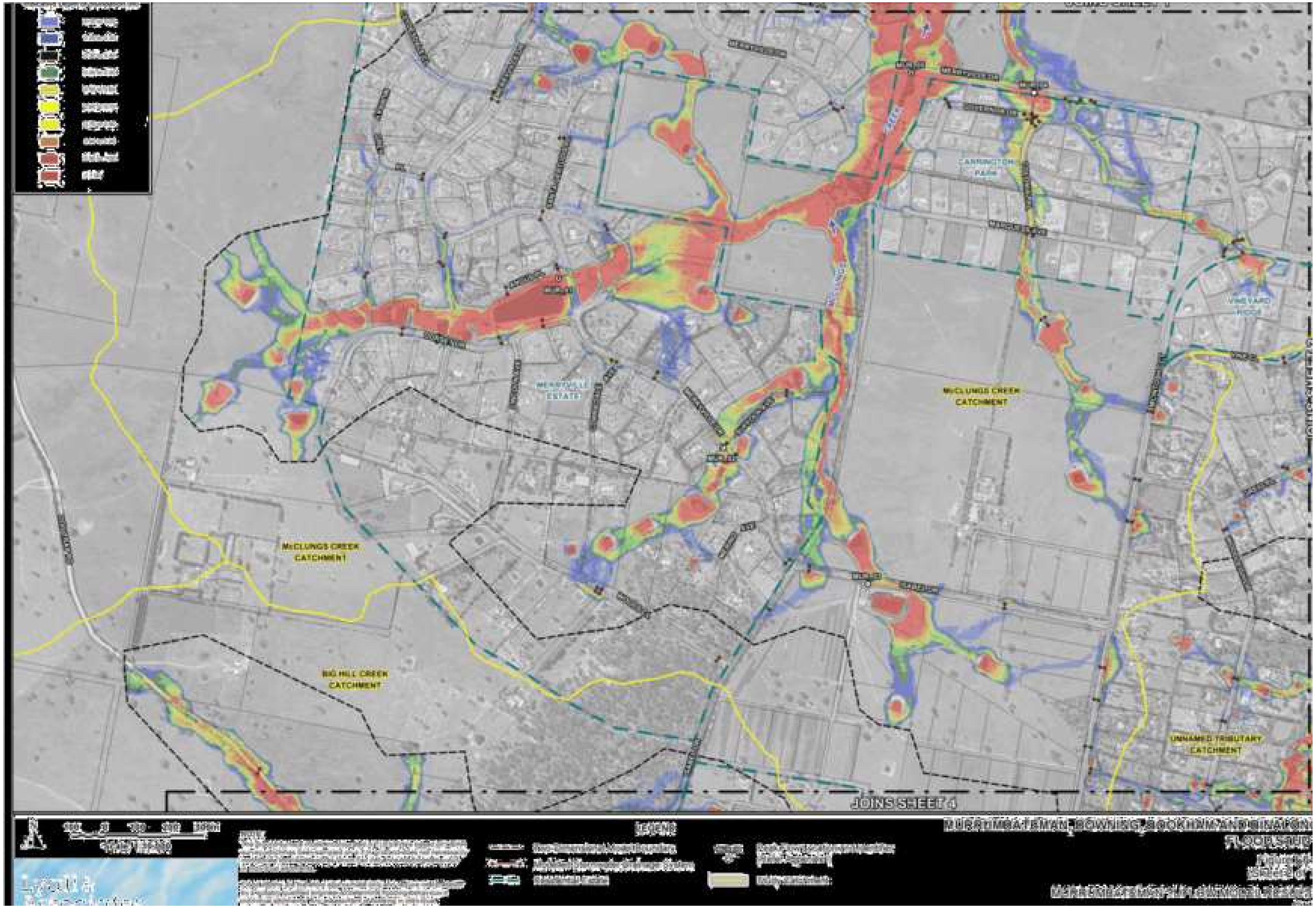

McCLUNGS CREEK
CATCHMENT
MERRIVILLE
PARK
UNNAMED TRIBUTARY
CATCHMENT
BIG HILL CREEK
CATCHMENT
JIPARU
ESTATE
GOODA CREEK
CATCHMENT
JOINS SHEET 6
JOINS SHEET 5
LEGEND

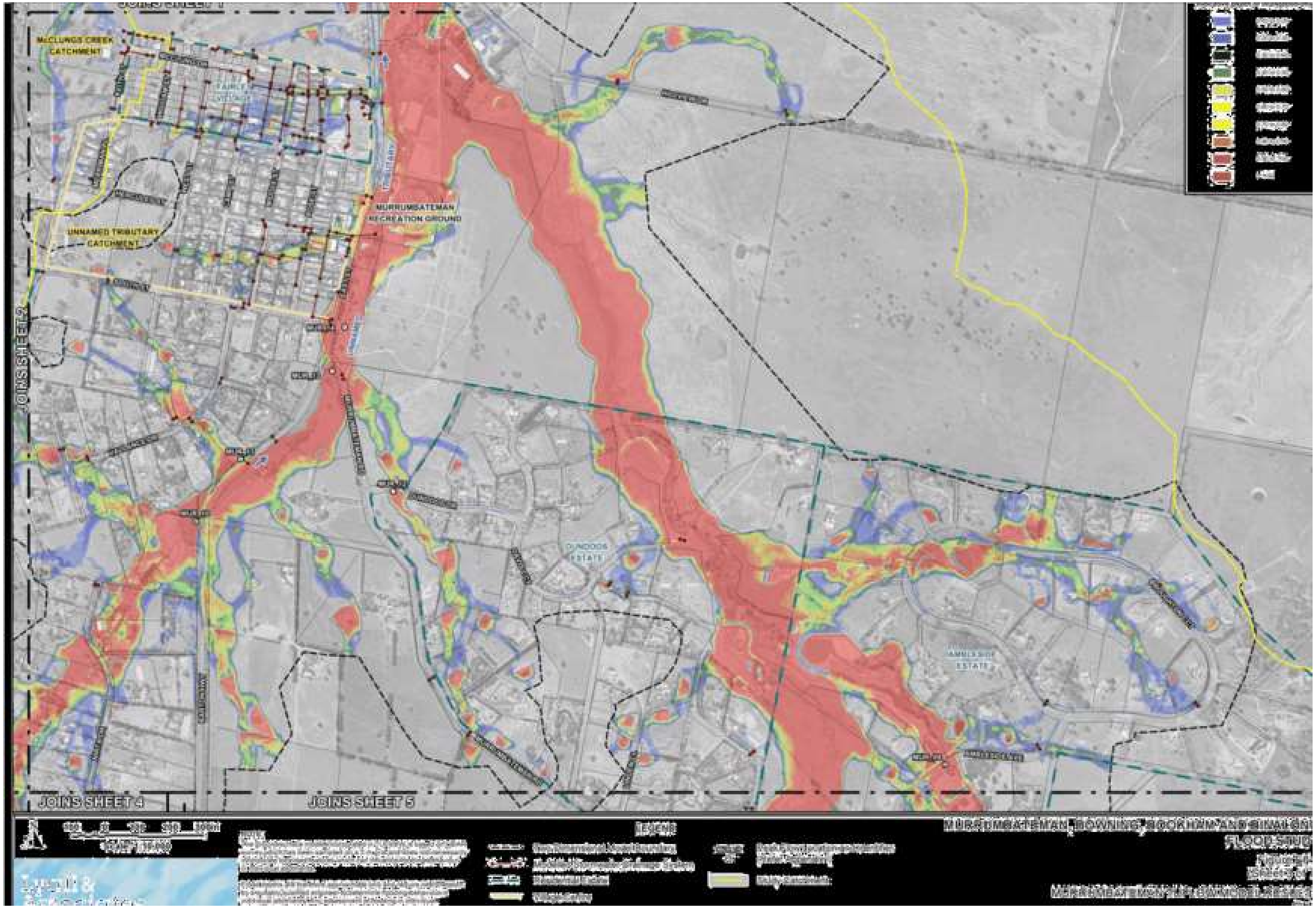

AMBLESIDE ESTATE
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 4
JOINS SHEET 6
LEGEND

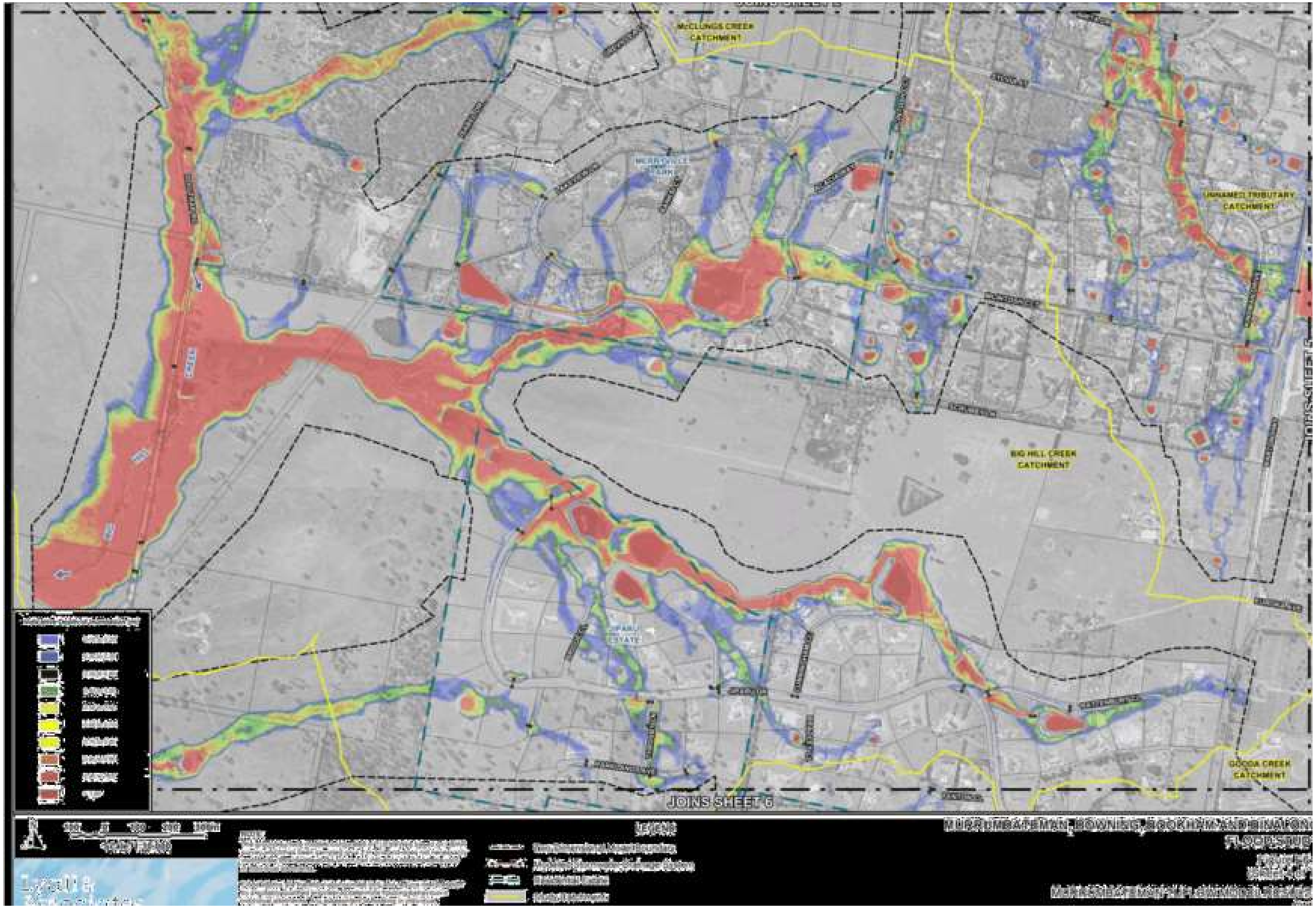

BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
VALENCIA COUNTRY ESTATE
JOINS SHEET 7

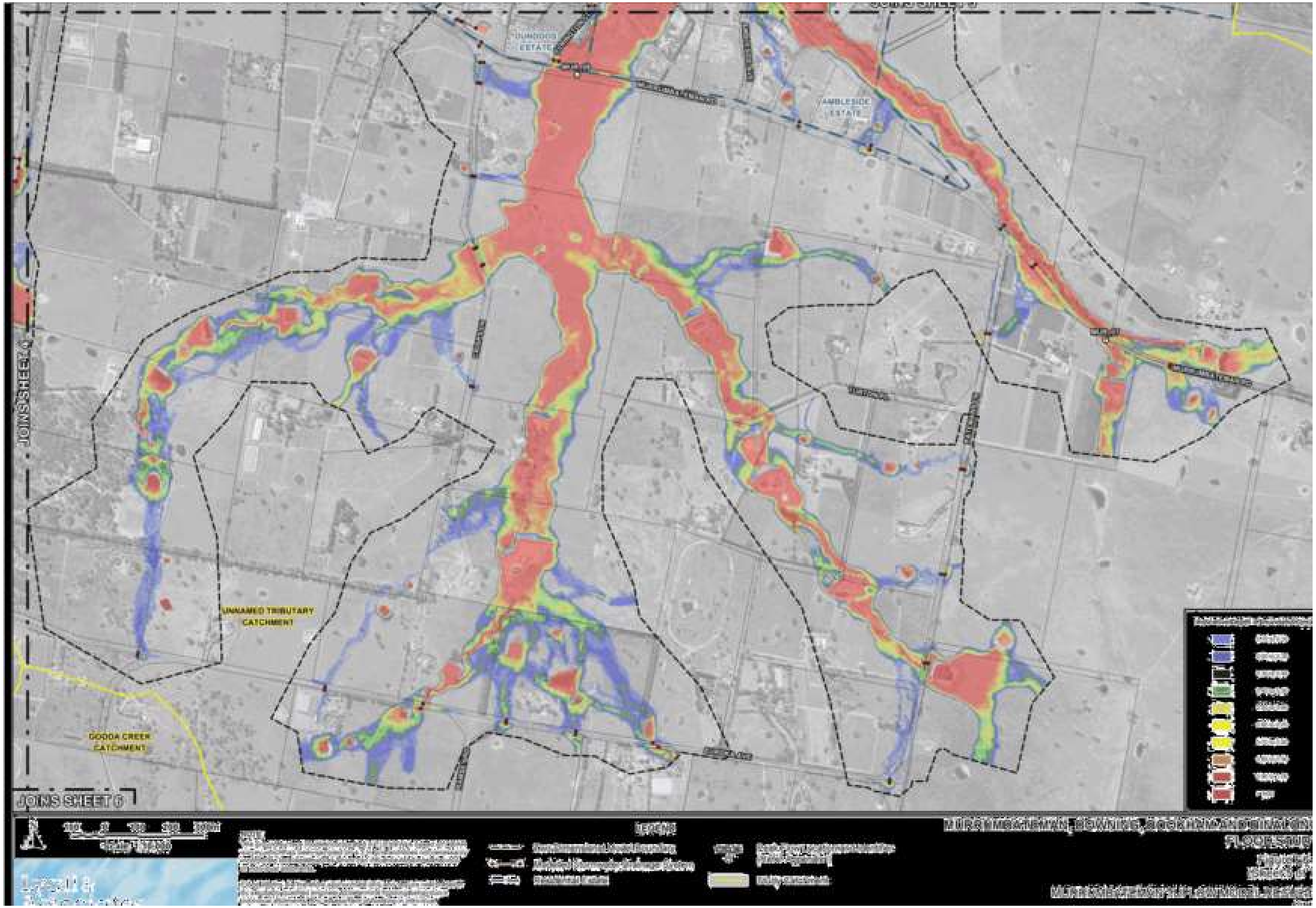

UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6

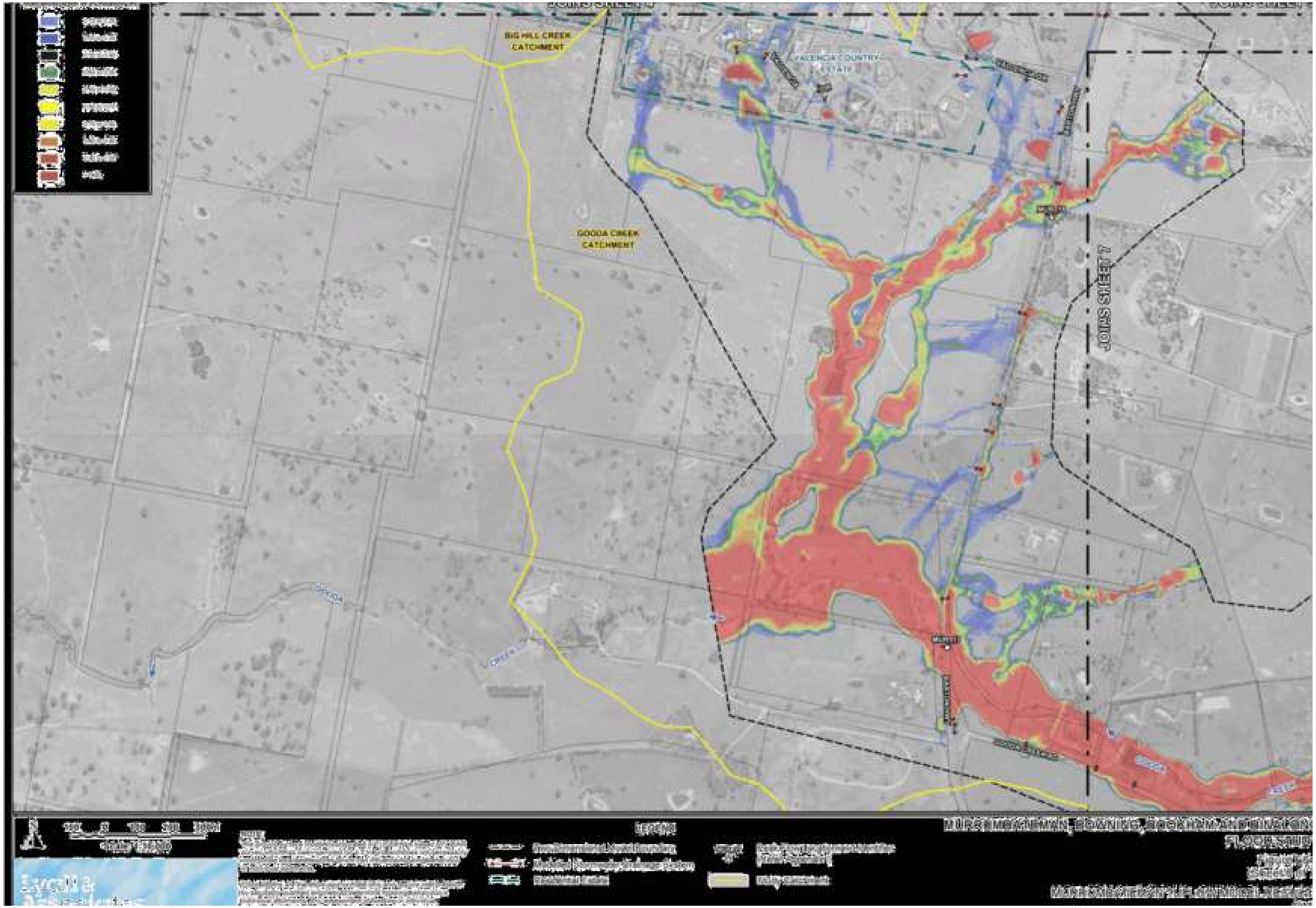

INSET
REFER INSET
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3
LEGEND

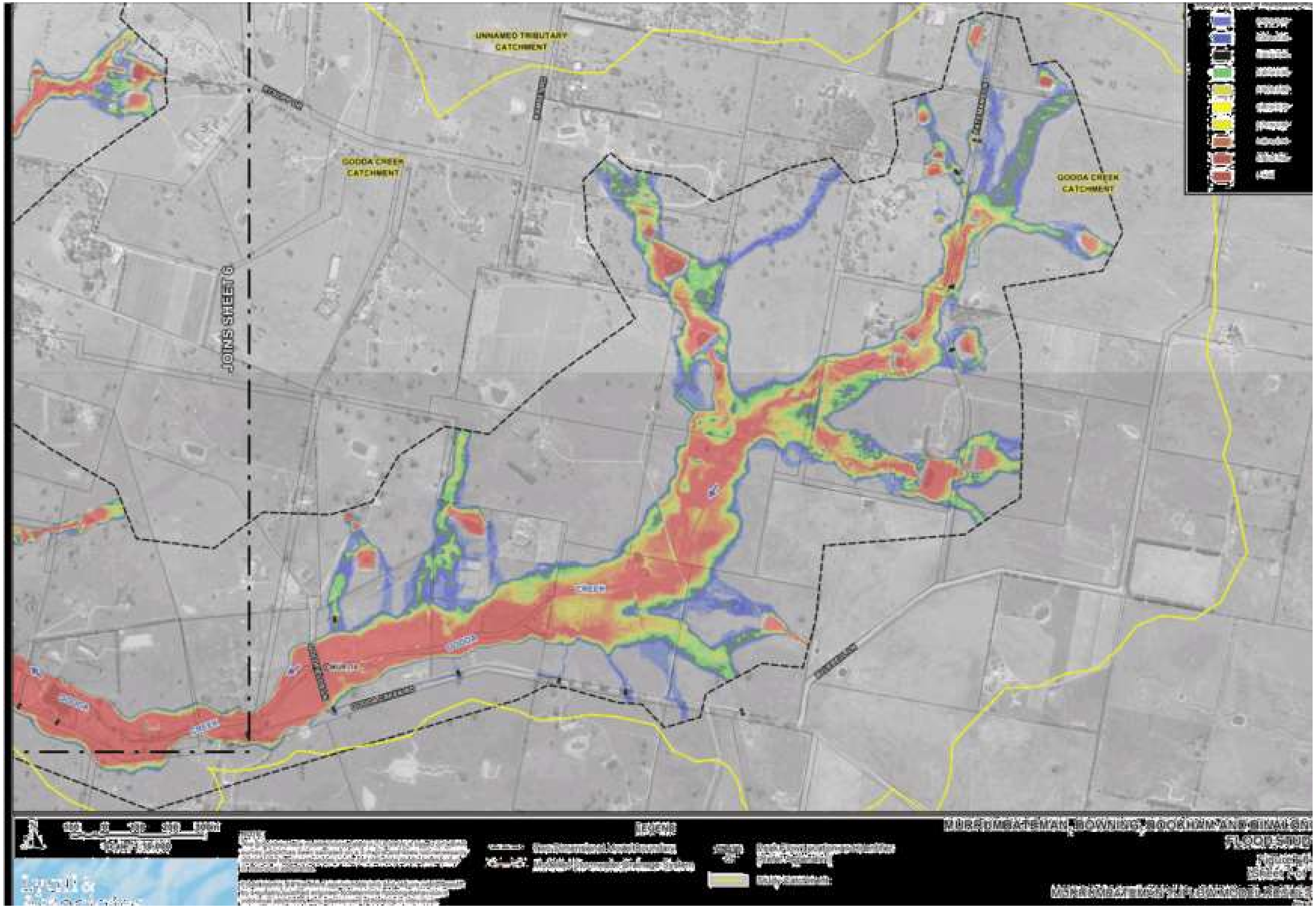

McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
CARRINGTON PARK
VINEYARD RIDGE
JOINS SHEET 4
LEGEND

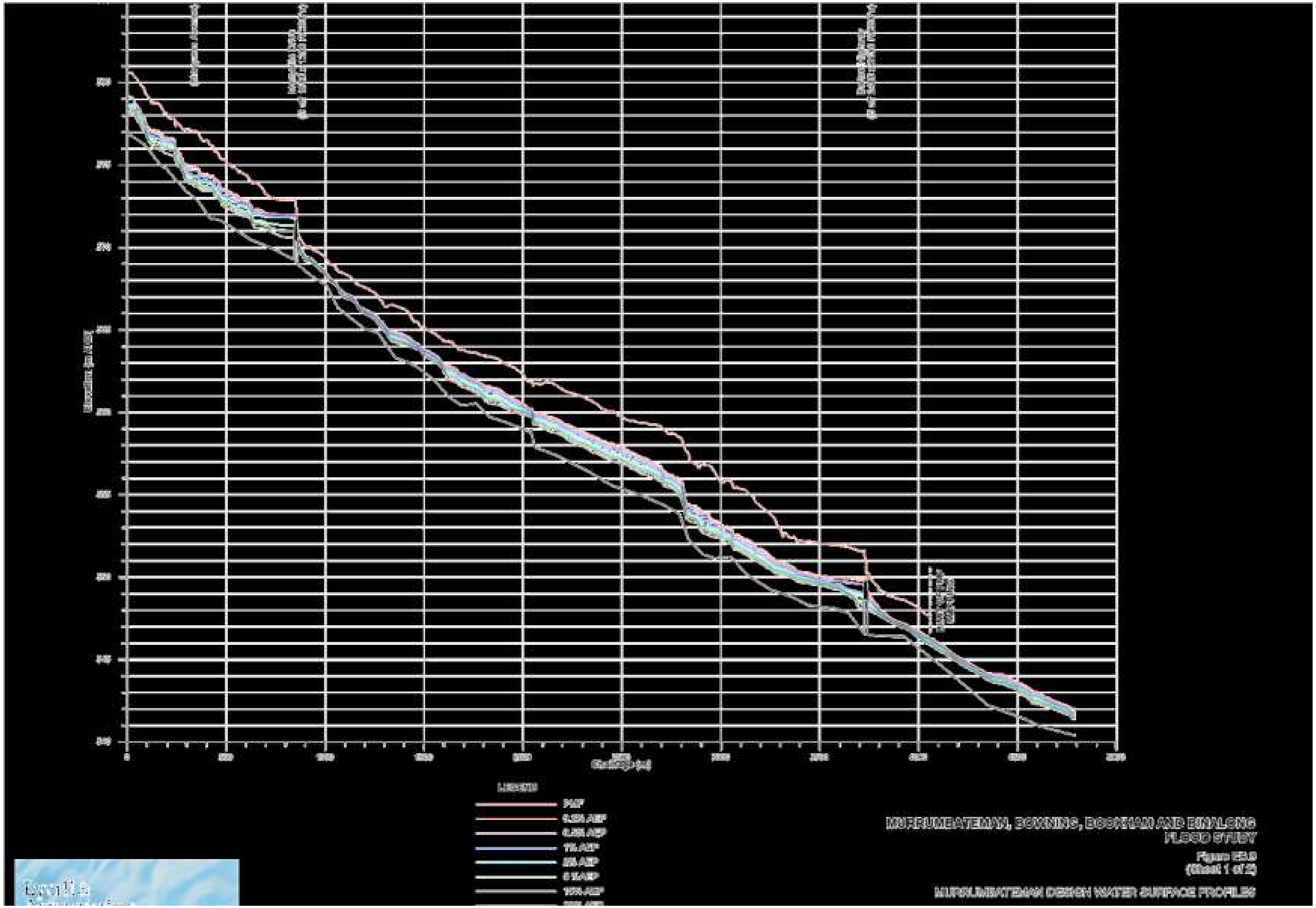

McCLUNGS CREEK
CATCHMENT
MURRUMBATEMAN
RECREATION GROUND
UNNAMED TRIBUTARY
CATCHMENT
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5
LEGEND

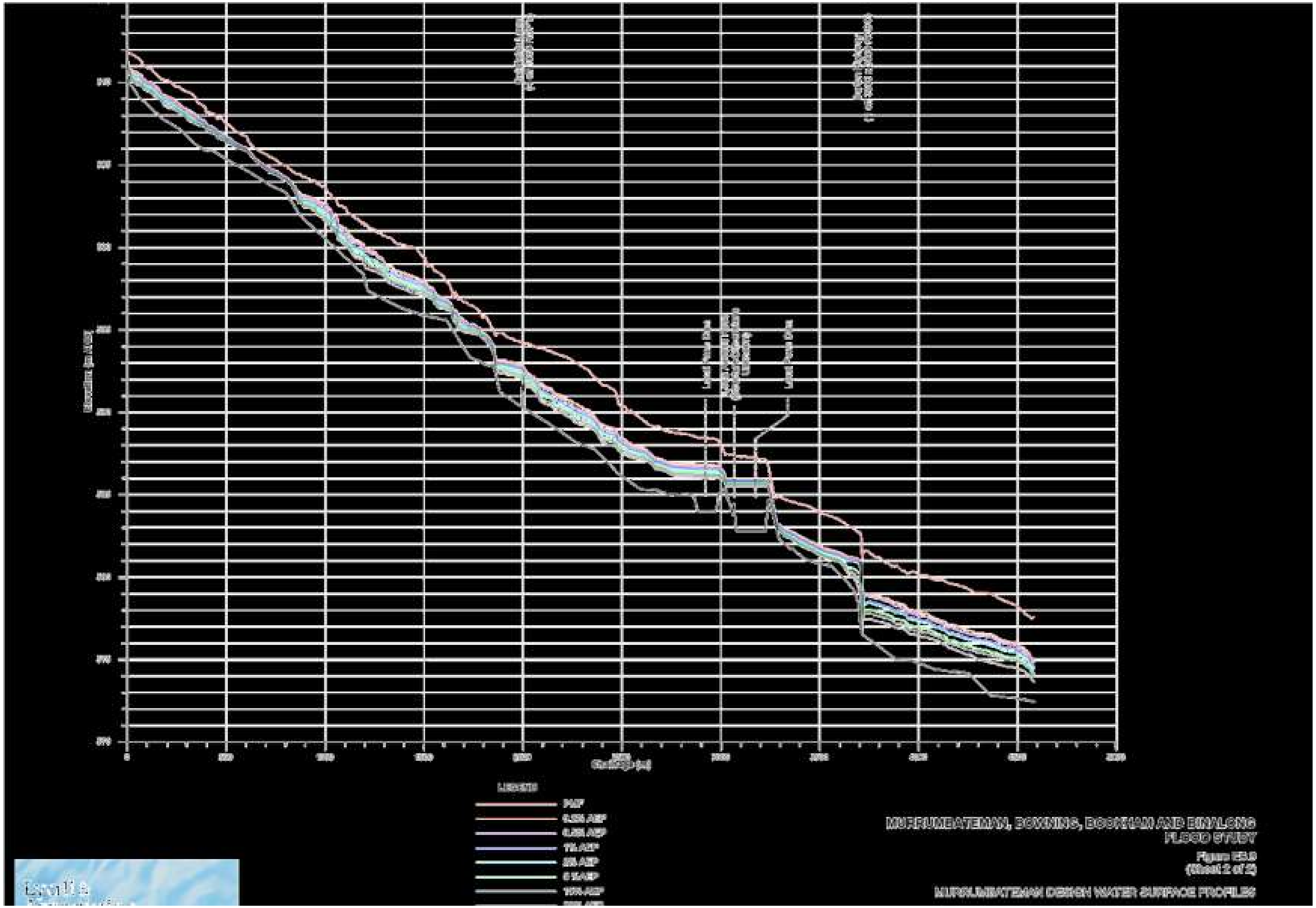

McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6

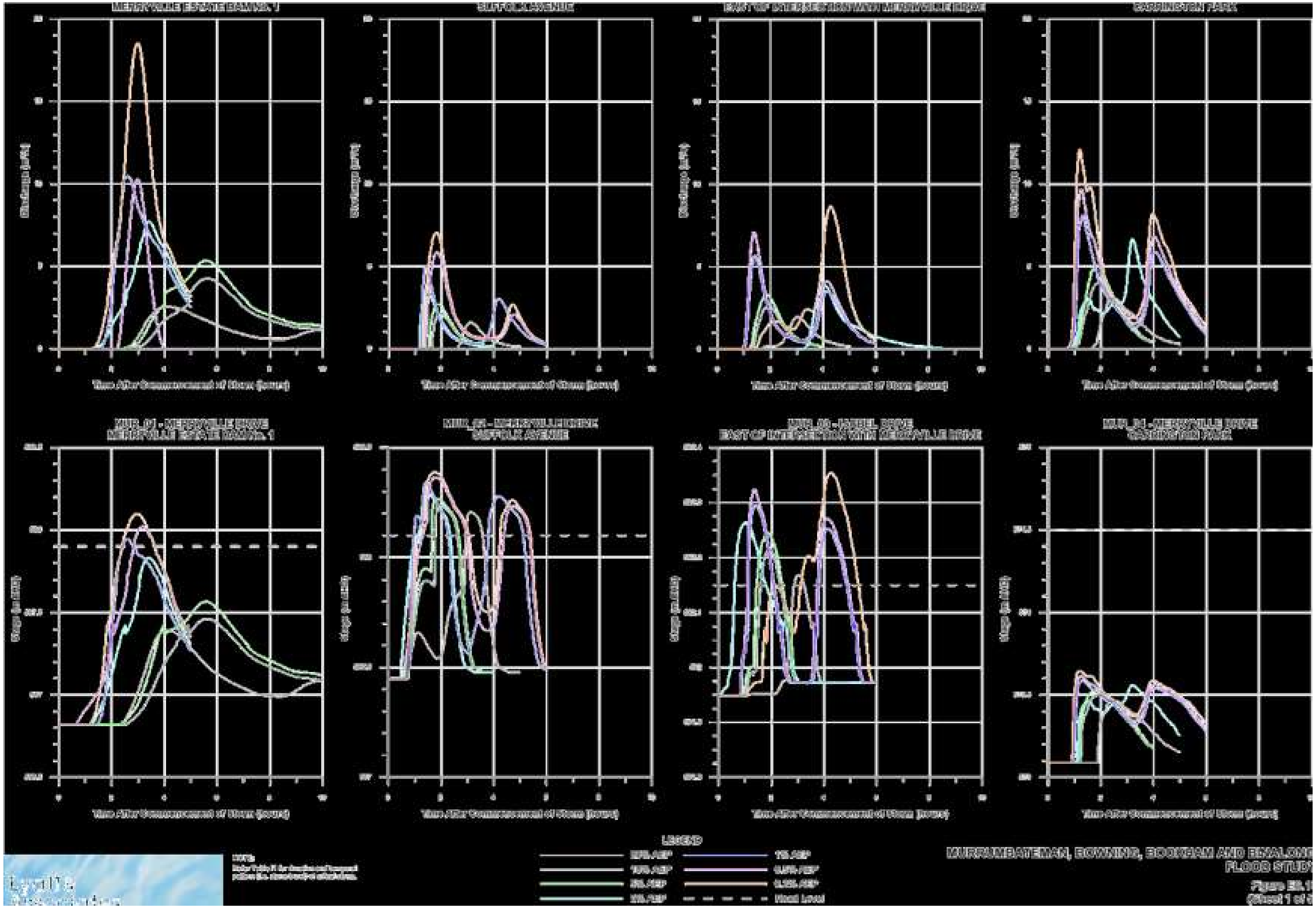

AMBLESIDE ESTATE
JOINS SHEET 4
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
LEGEND

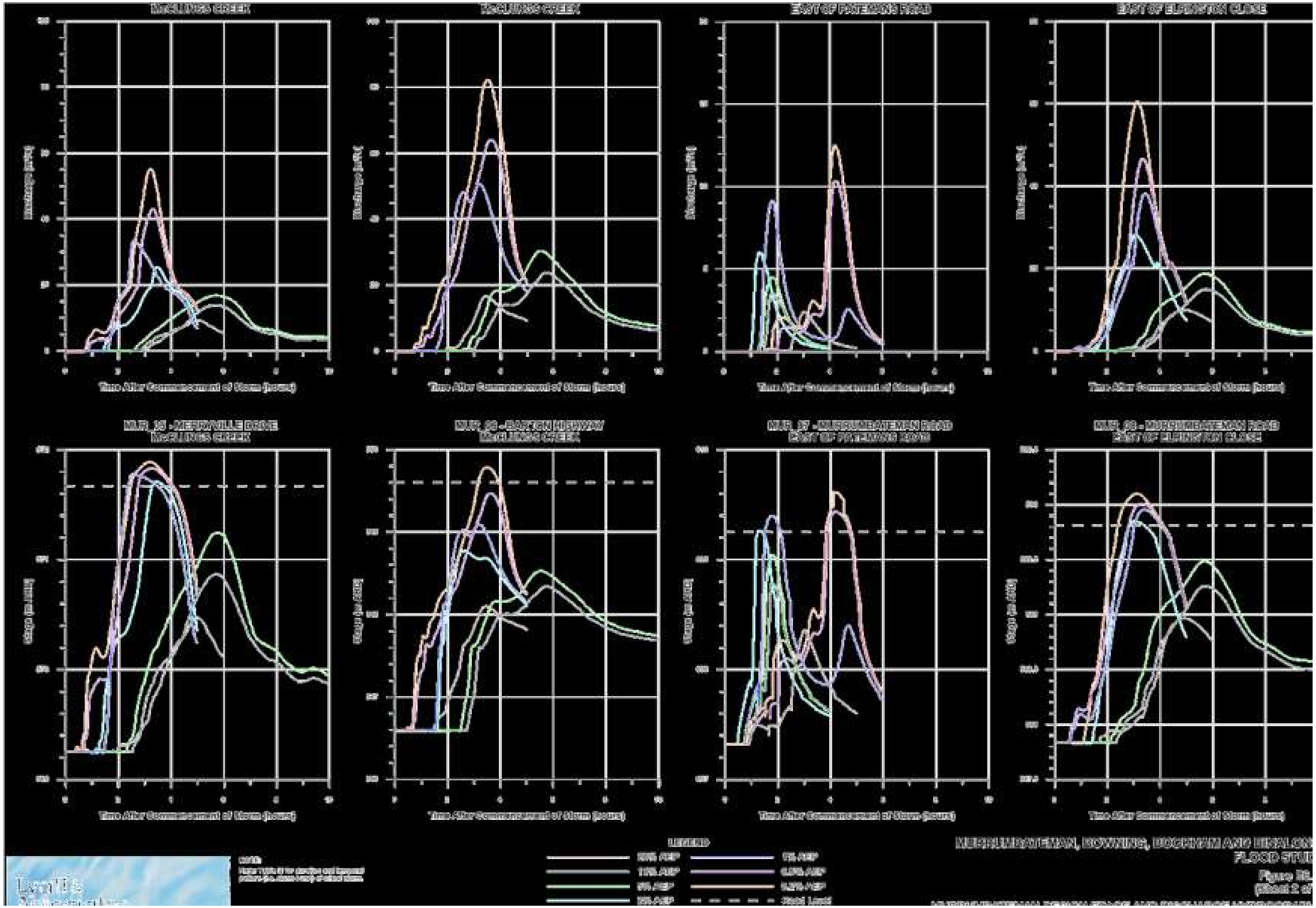

BIG HILL CREEK
CATCHMENT
GOODA CREEK
CATCHMENT
JOINS SHEET 7
LEGEND

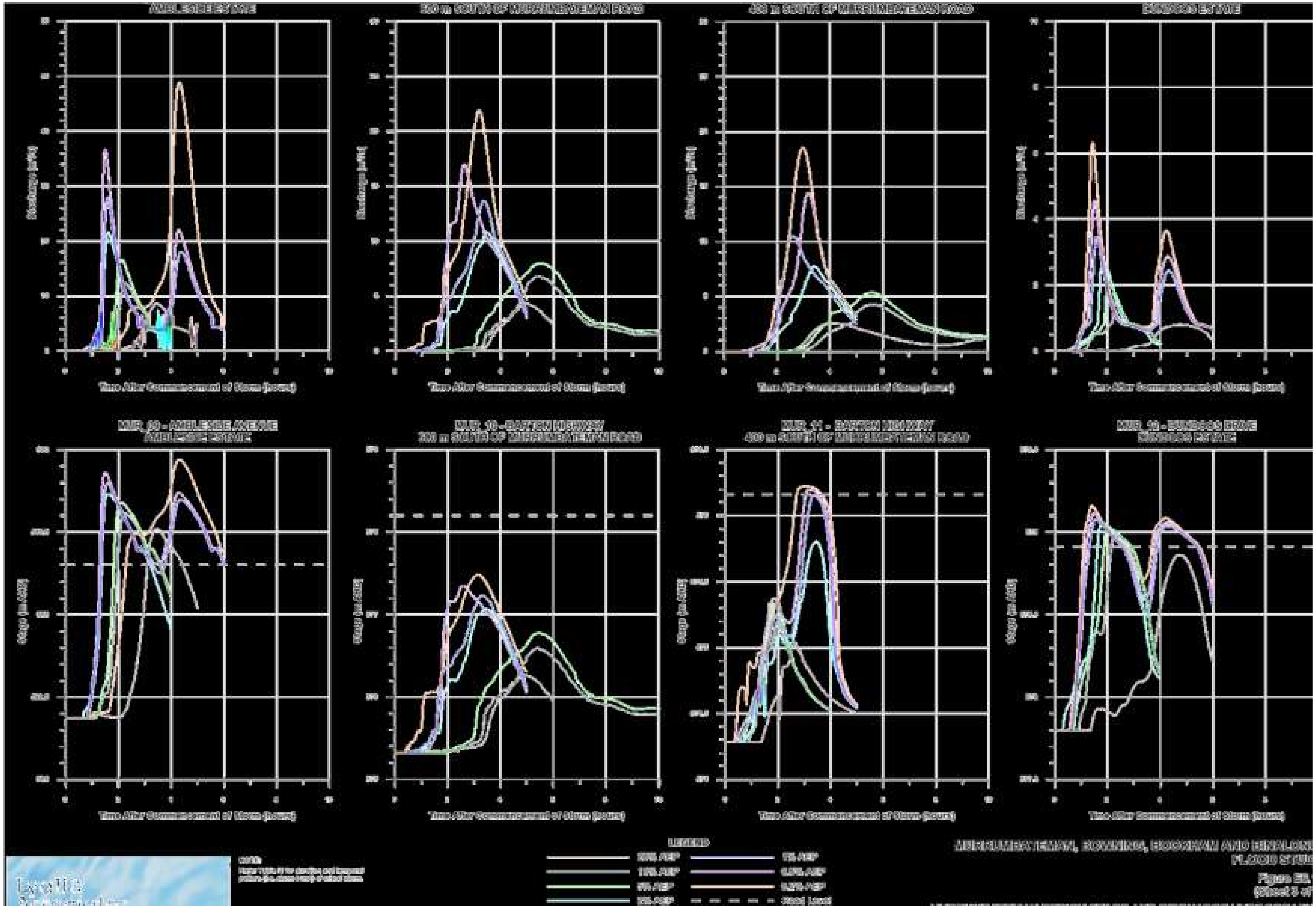

UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
GOODA
CREEK
LEGEND

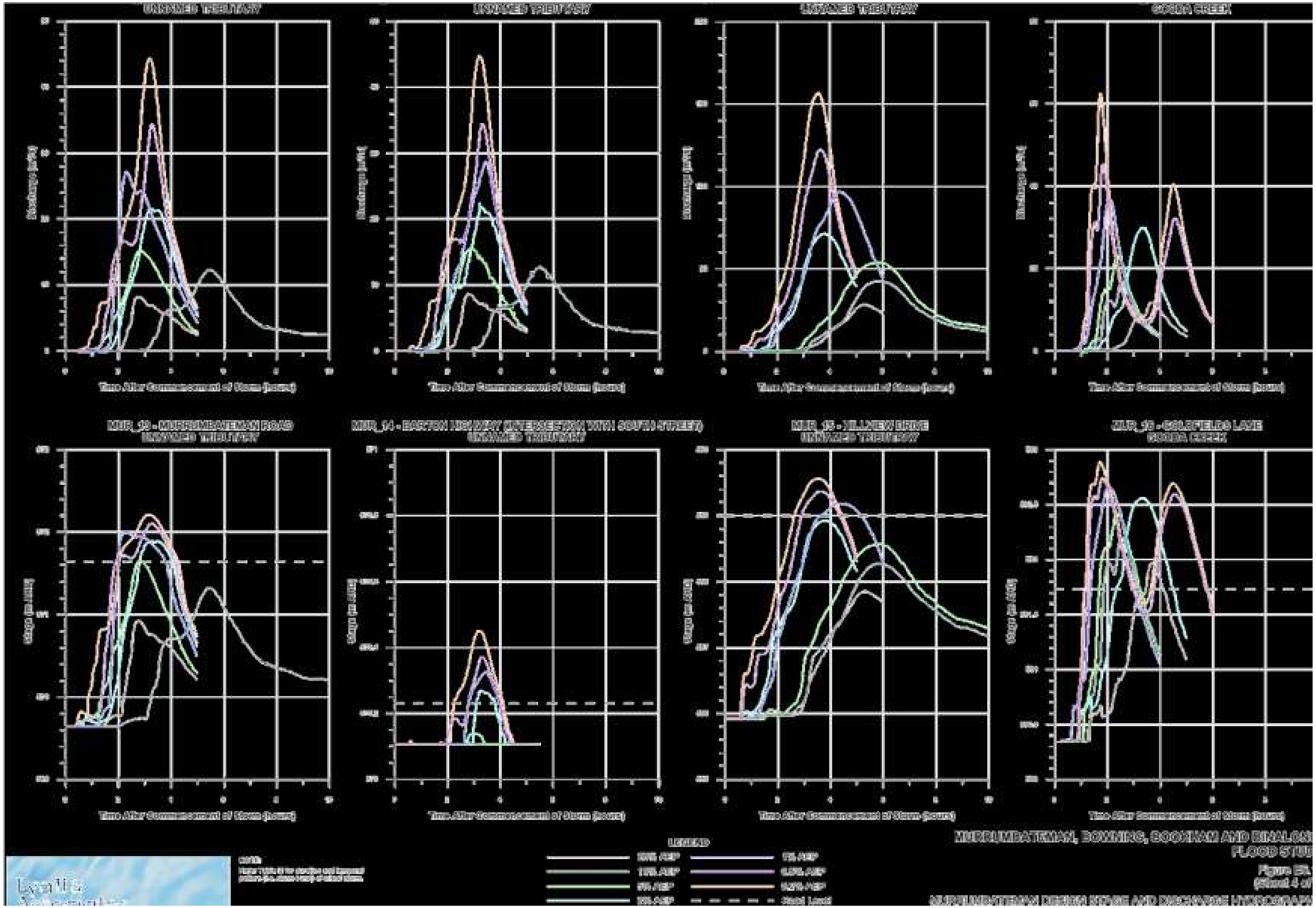

MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALONG
FLOOD STUDY
MURRUMBATEMAN DESIGN WATER SURFACE PROFILES

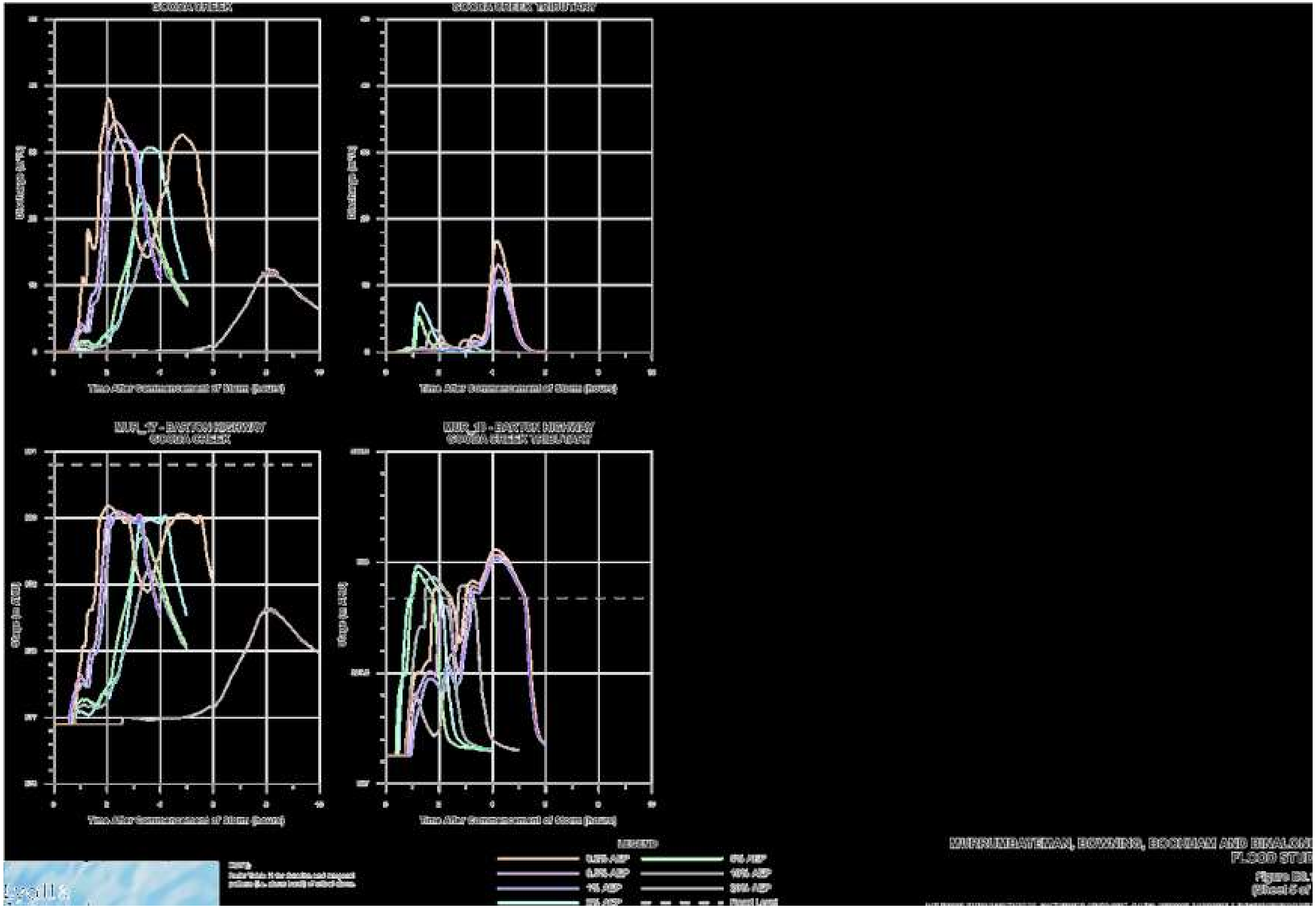

PMF
1% AEP
5% AEP
MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALONG
FLOOD STUDY
MURRUMBATEMAN DESIGN WATER SURFACE PROFILES

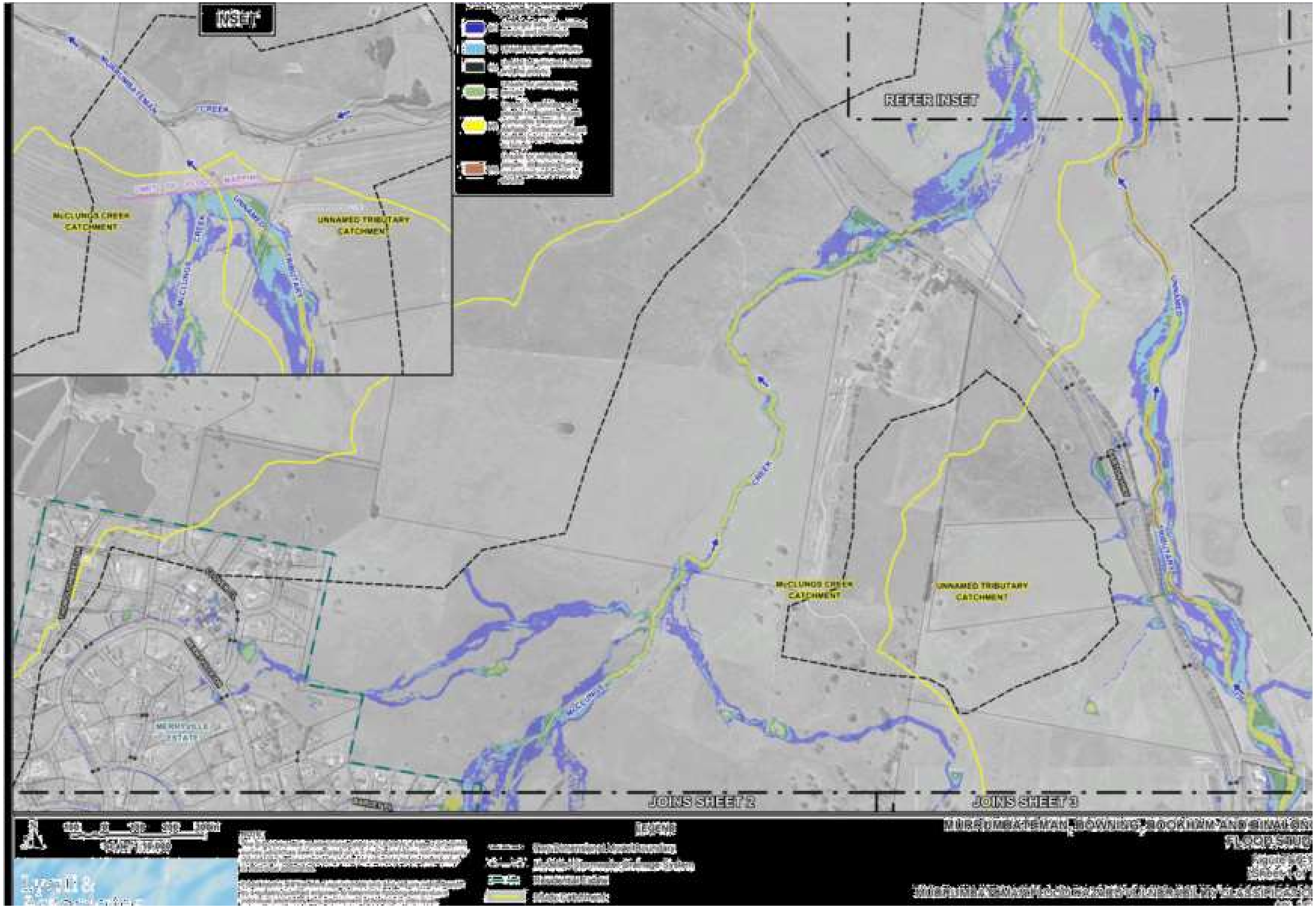


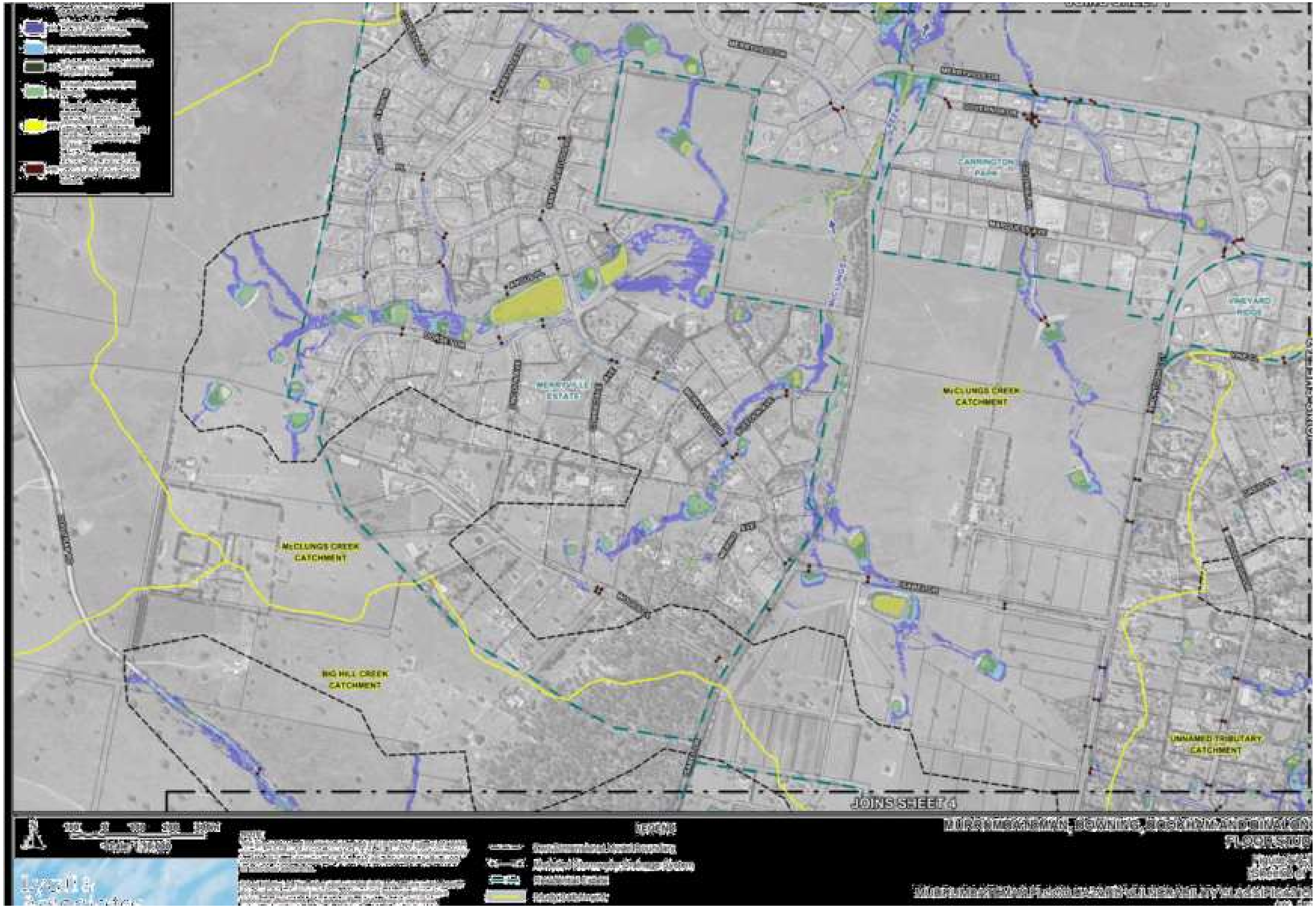


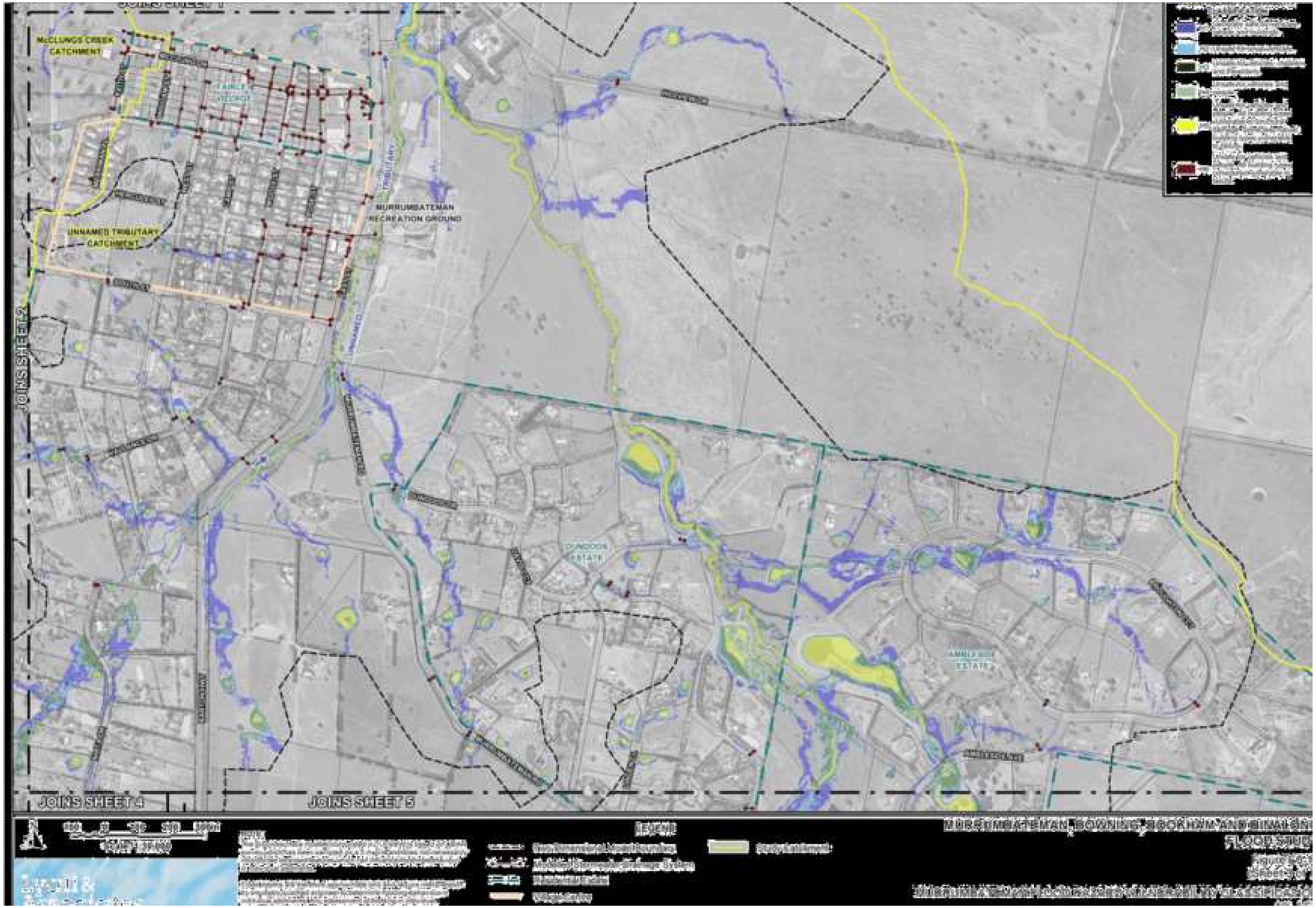


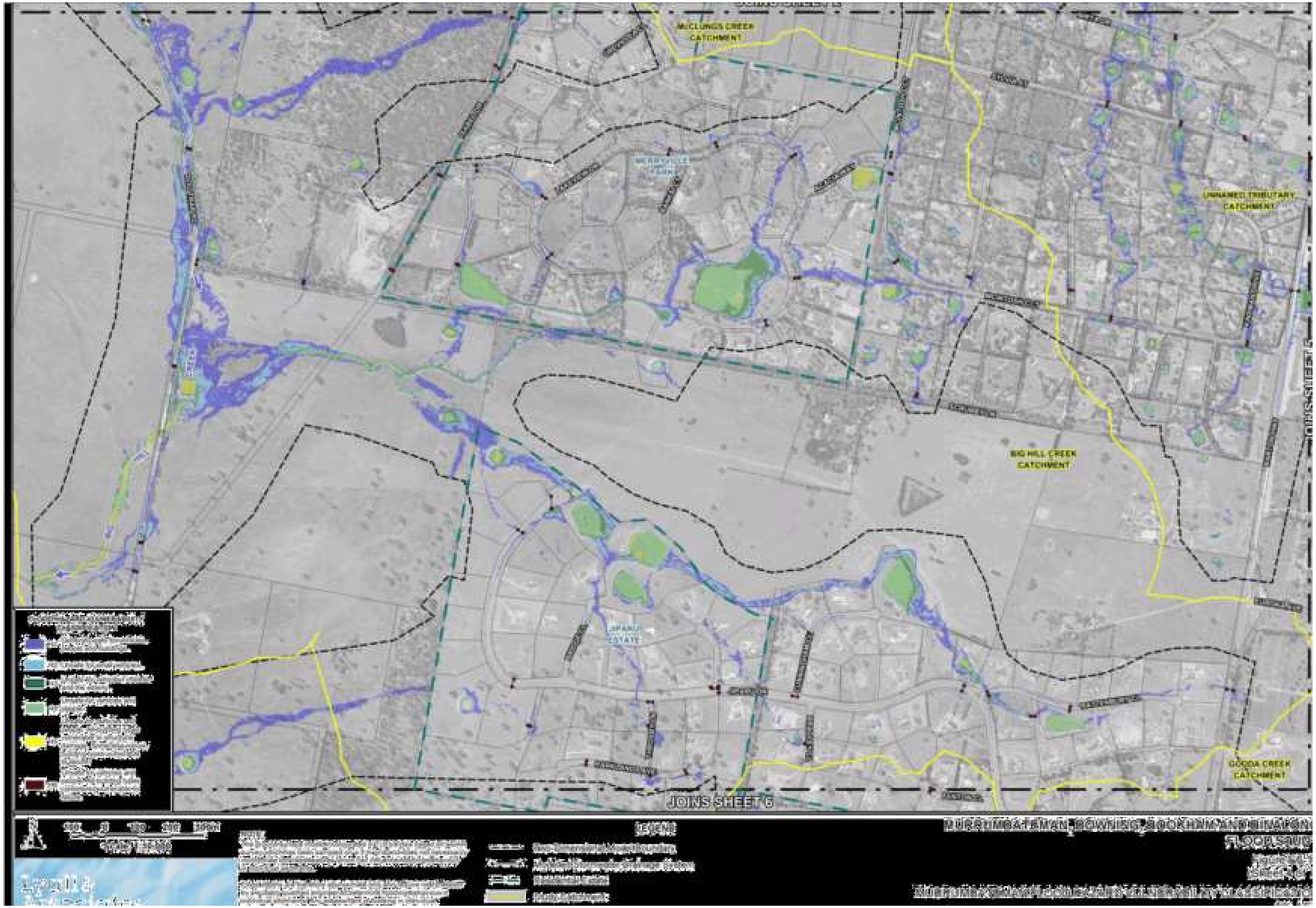

UNNAMED TRIBUTARY
UNNAMED TRIBUTARY
UNNAMED TRIBUTARY
GOODA CREEK
MUR_13 - MURRUMBATEMAN ROAD
UNNAMED TRIBUTARY
MUR_14 - BARTON HIGHWAY (INTERSECTION WITH SOUTH STREET)
UNNAMED TRIBUTARY
MUR_15 - HILLVIEW DRIVE
UNNAMED TRIBUTARY
MUR_16 - GOLDFIELDS LANE
GOODA CREEK
Time After Commencement of Storm (hours)
LEGEND

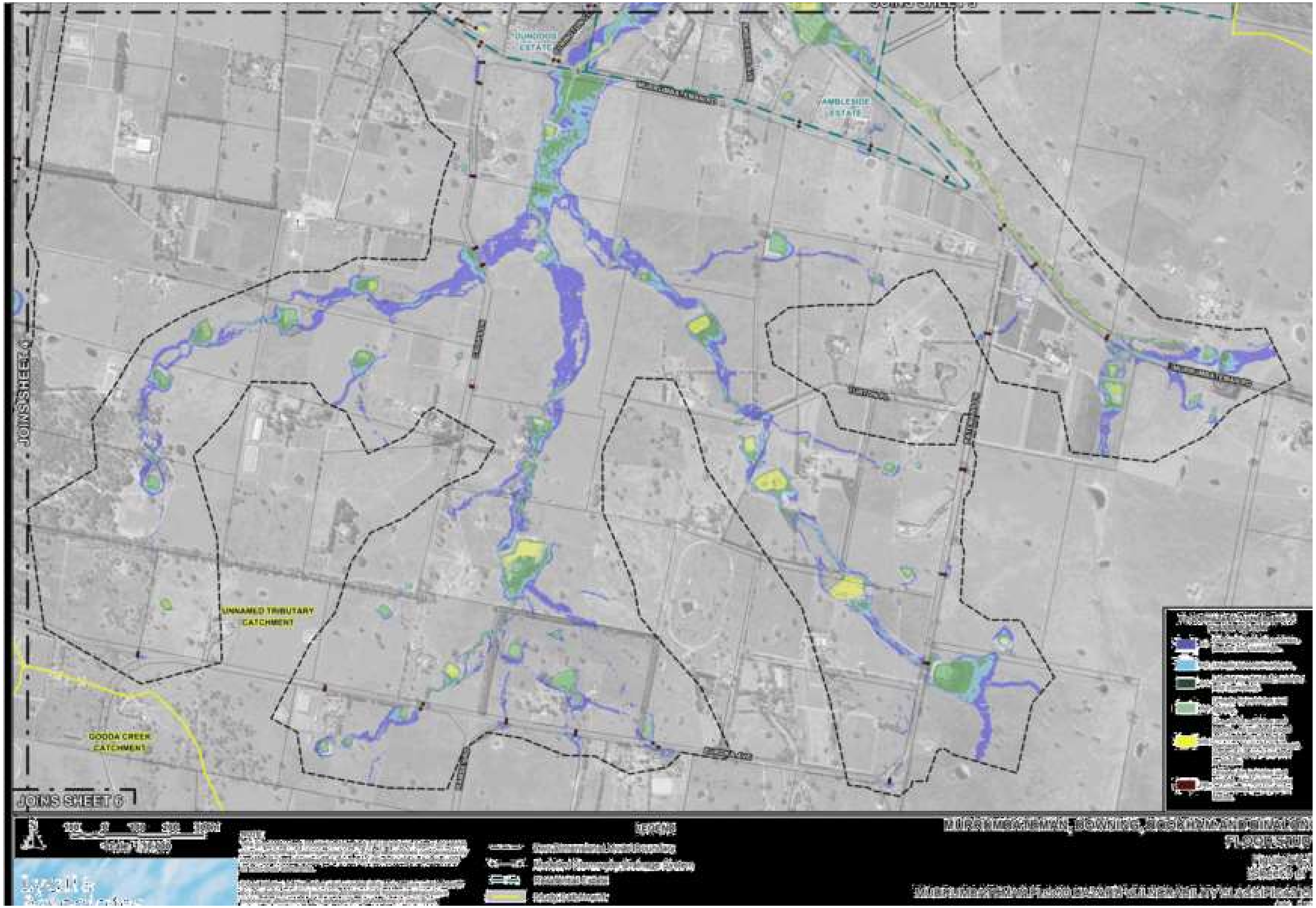


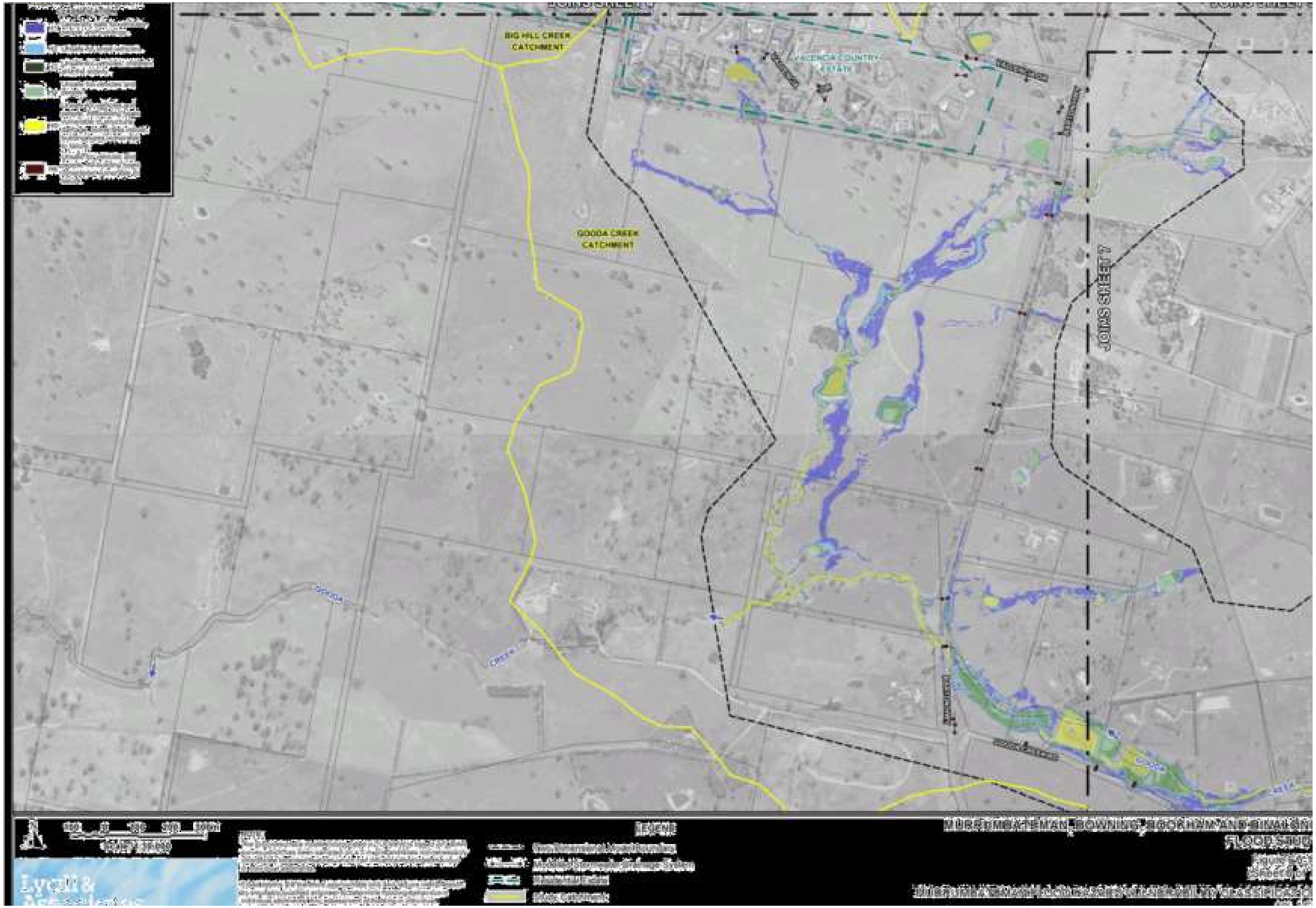

INSET
REFER INSET
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
CREEK
UNNAMED
TRIBUTARY
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3
LEGEND

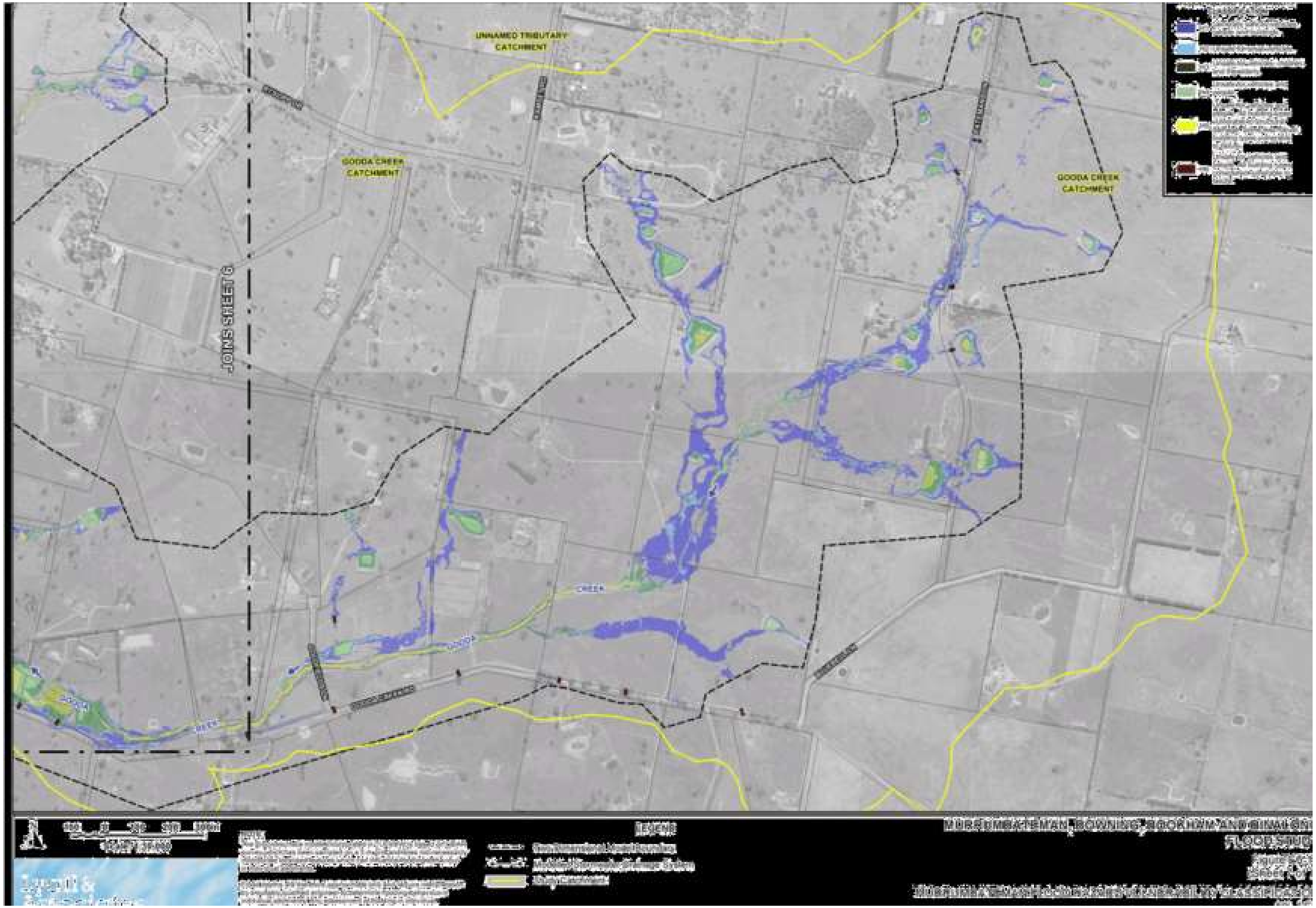

CARRINGTON PARK
VINEYARD RIDGE
MERRYVILLE ESTATE
McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4
LEGEND

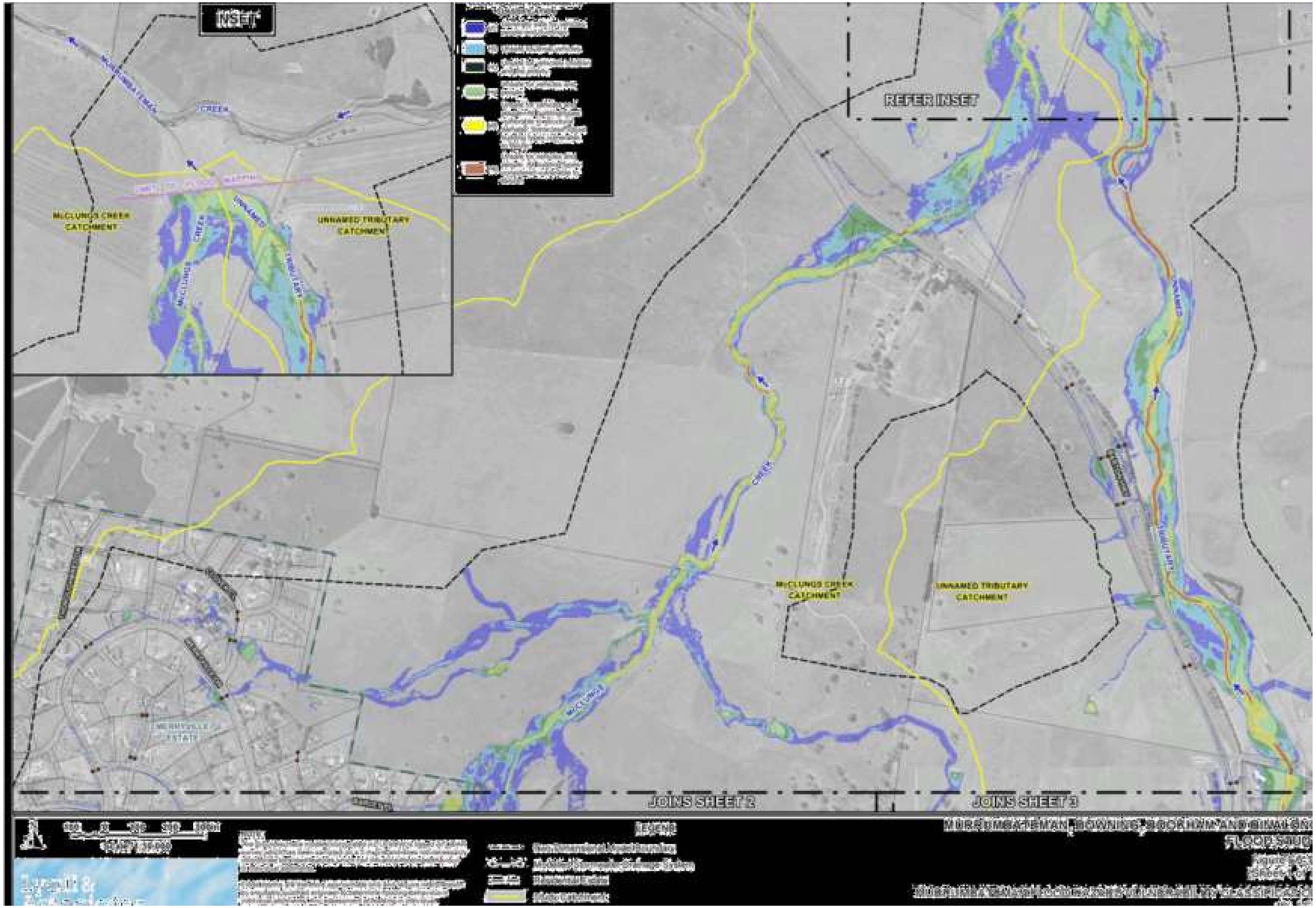

McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5
LEGEND

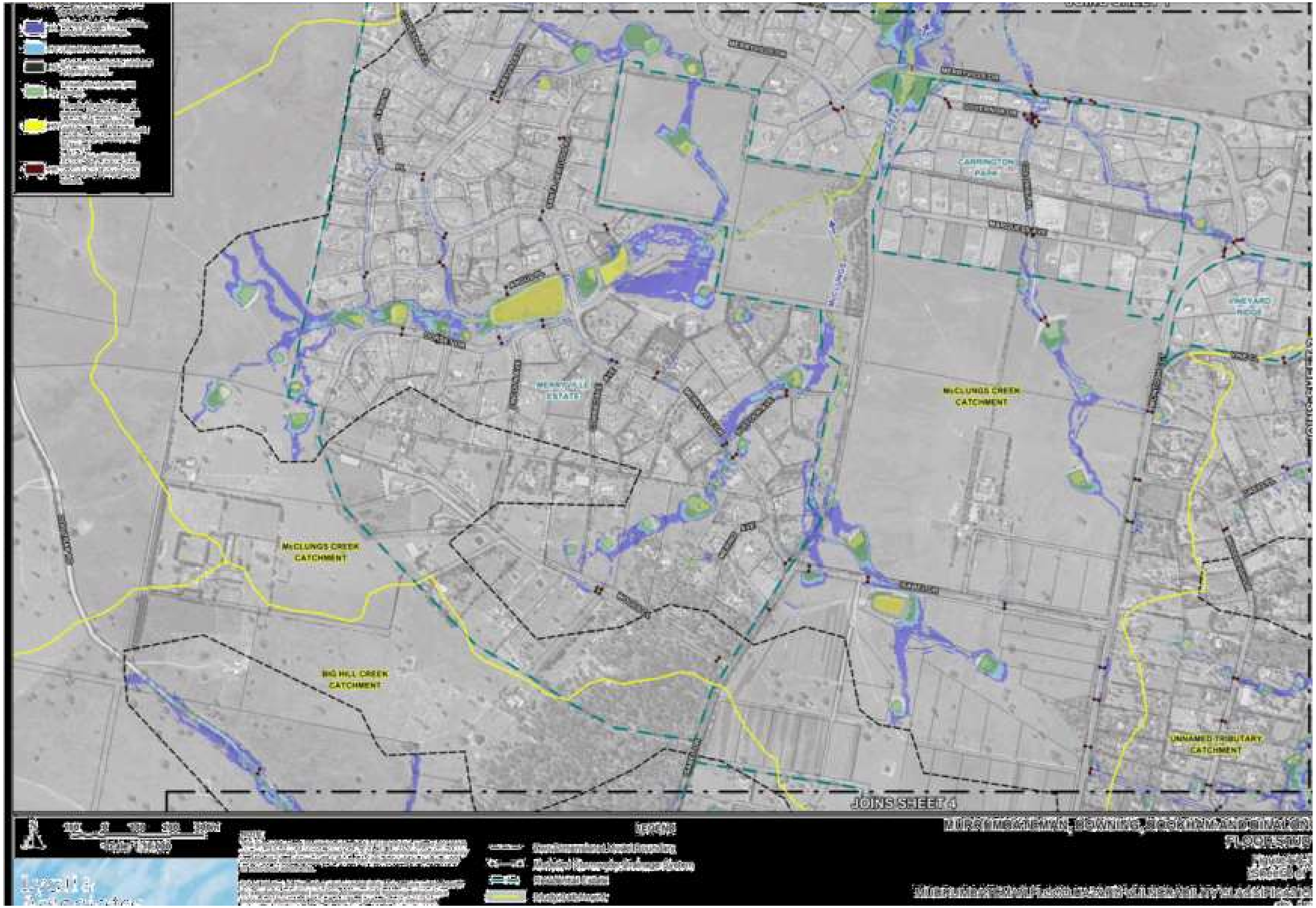

McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 5
JOINS SHEET 6
LEGEND

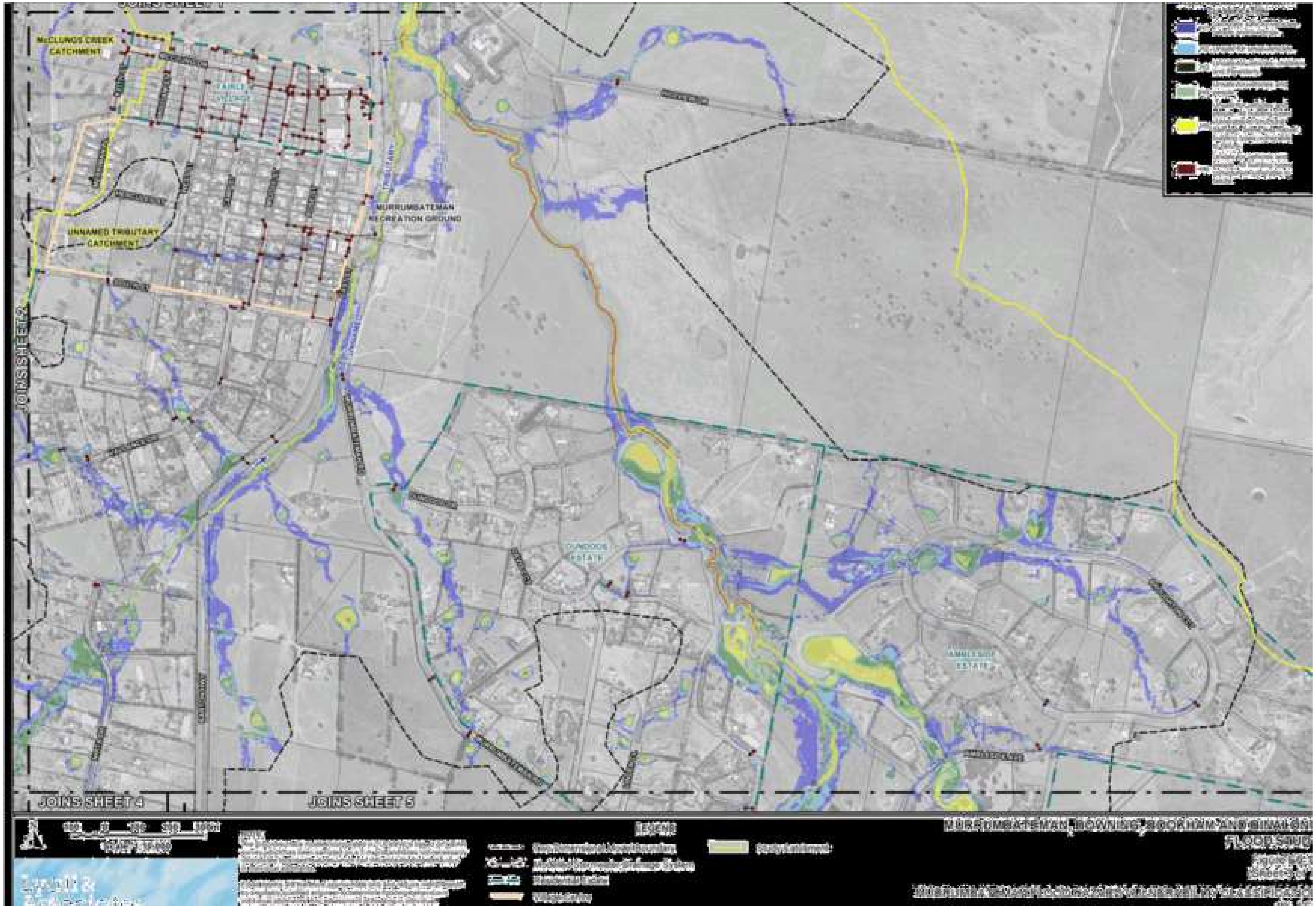

DUNGOOS ESTATE
AMBLESIDE ESTATE
JOINS SHEET 4
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
LEGEND

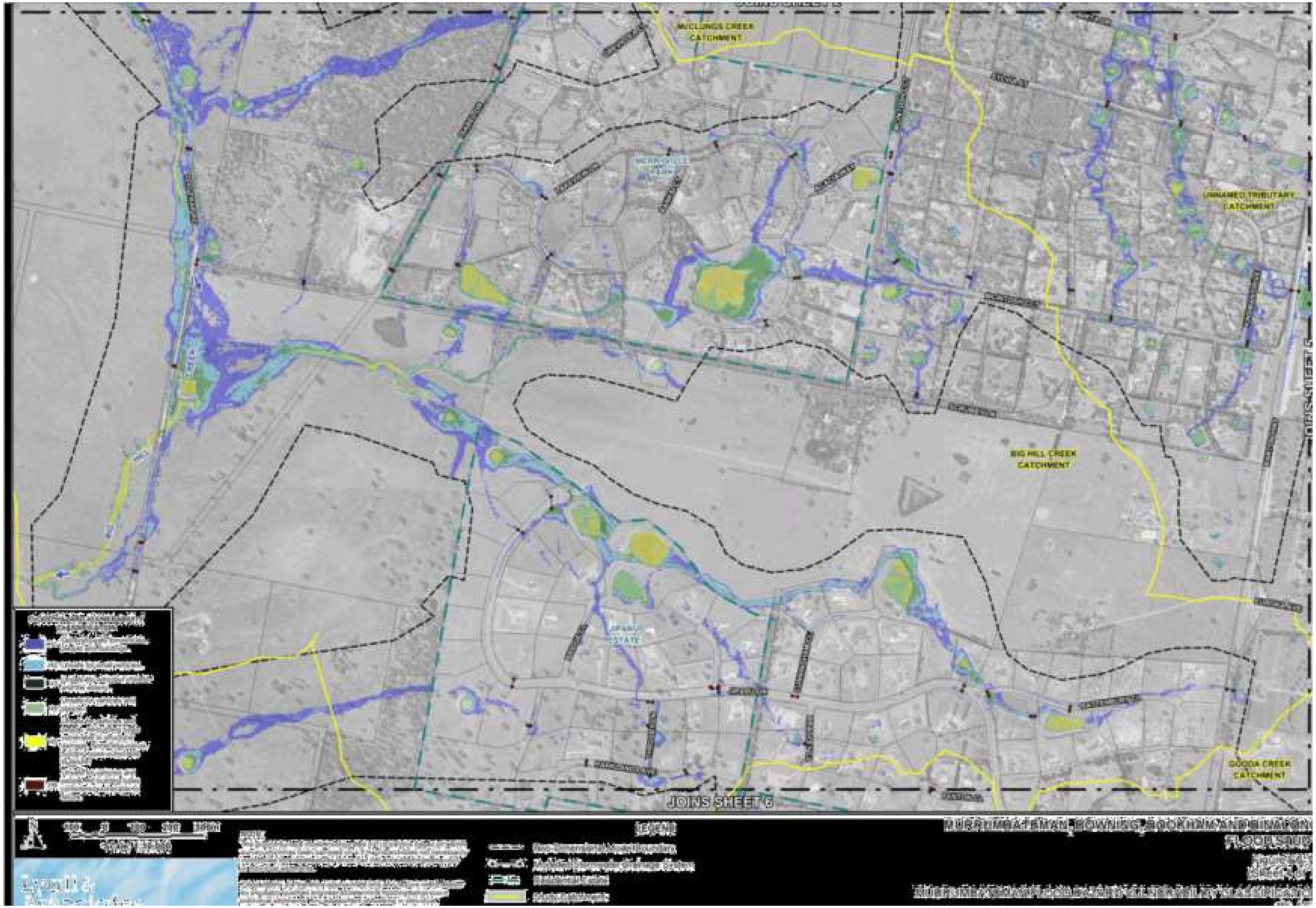

BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 7
GOODA
CREEK

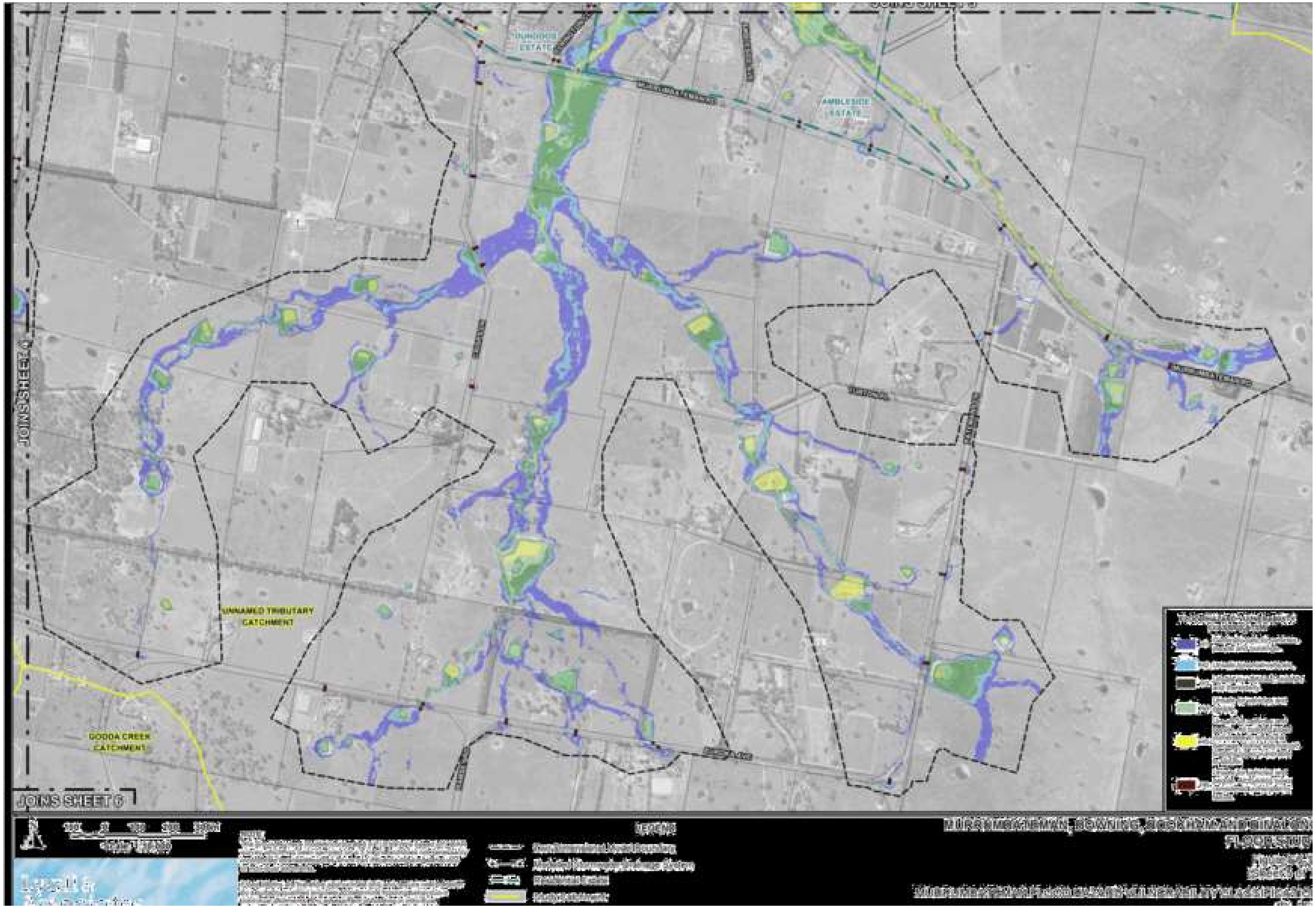

UNNAMED TRIBUTARY
CATCHMENT
GOODA CREEK
CATCHMENT
JOINS SHEET 6
GOODA CREEK
CATCHMENT
CREEK
GOODA
LEGEND


INSET
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
REFER INSET
JOINS SHEET 2
JOINS SHEET 3
LEGEND


CARRINGTON PARK
VINEYARD RIDGE
MERRYVILLE ESTATE
McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4
LEGEND


McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5
LEGEND


MCCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
JOINS SHEET 5
LEGEND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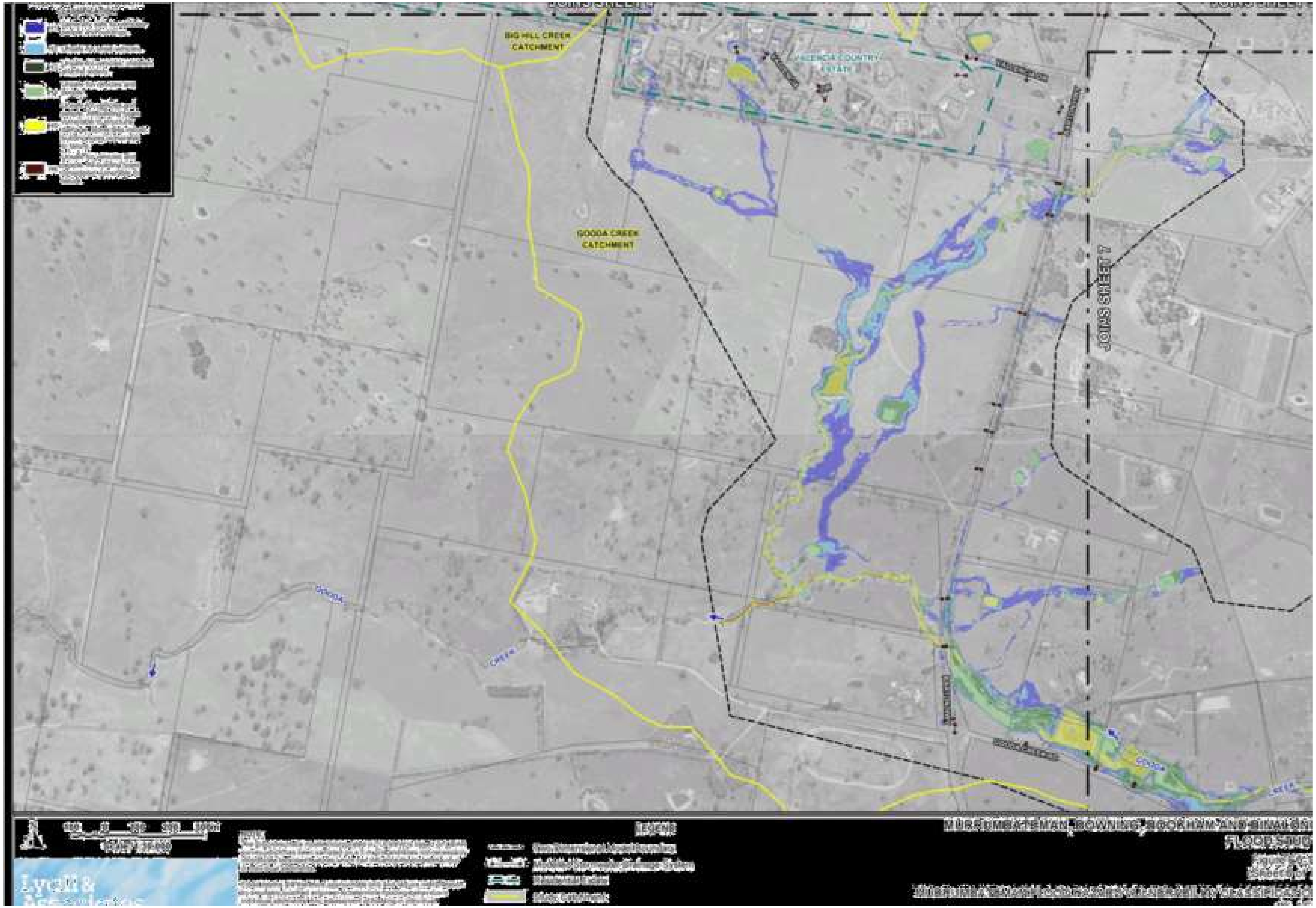
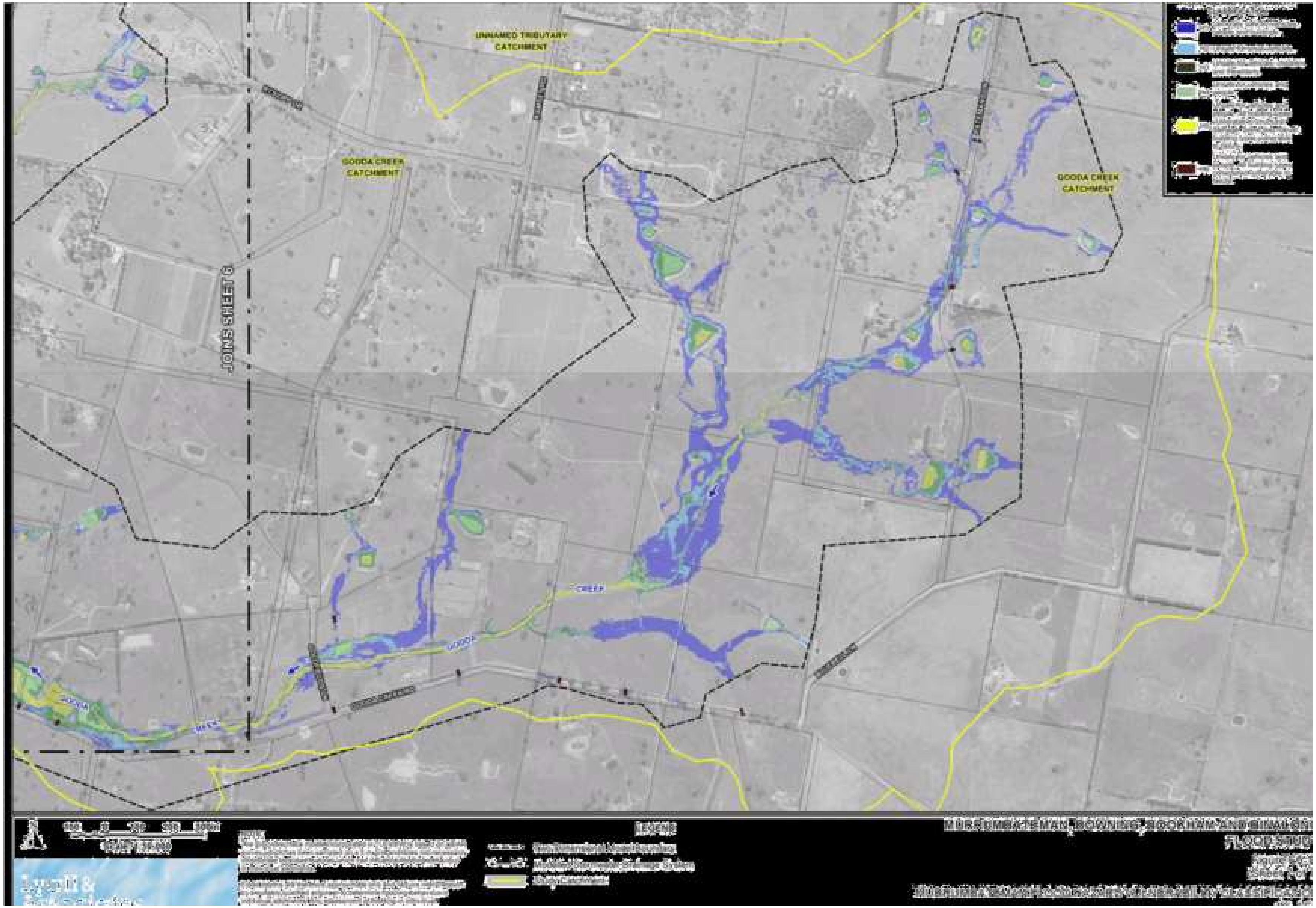
AMBLESIDE ESTATE
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 4
JOINS SHEET 6
LEGEND
FLOOD STUDY


BIG HILL CREEK
CATCHMENT
GOODA CREEK
CATCHMENT
JOINS SHEET 7
GOODA
CREEK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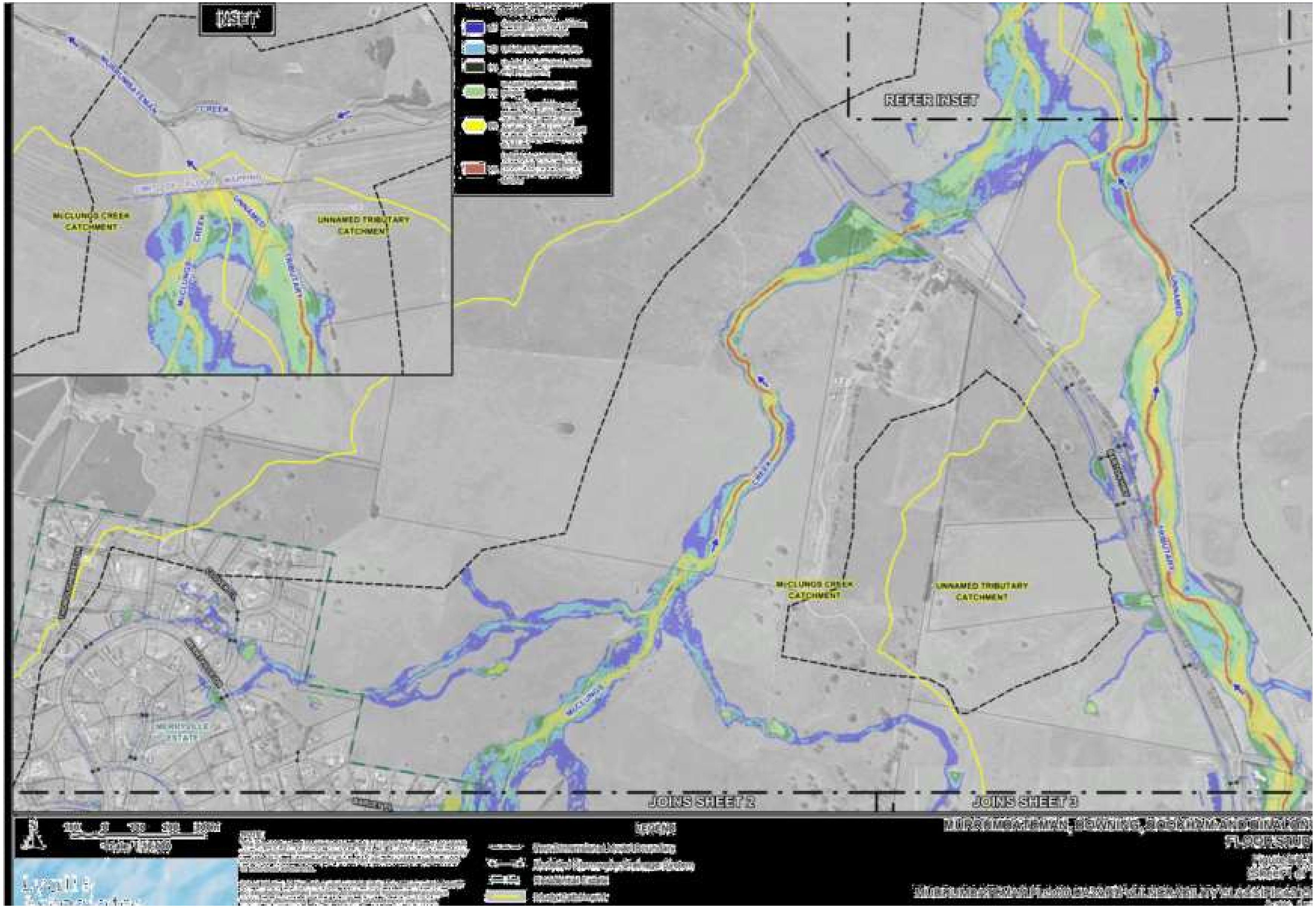
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
GOODA
CREEK
LEGEND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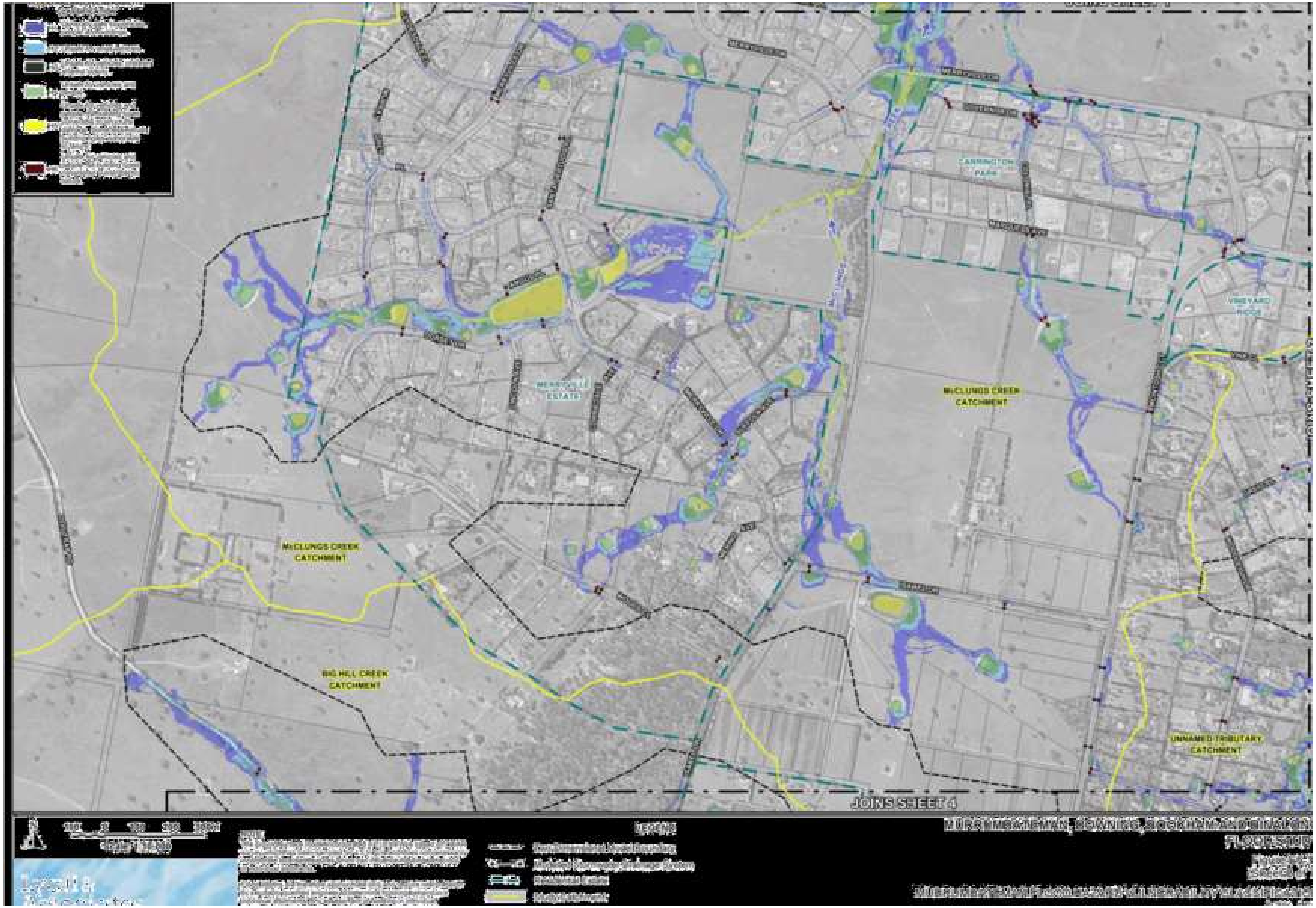
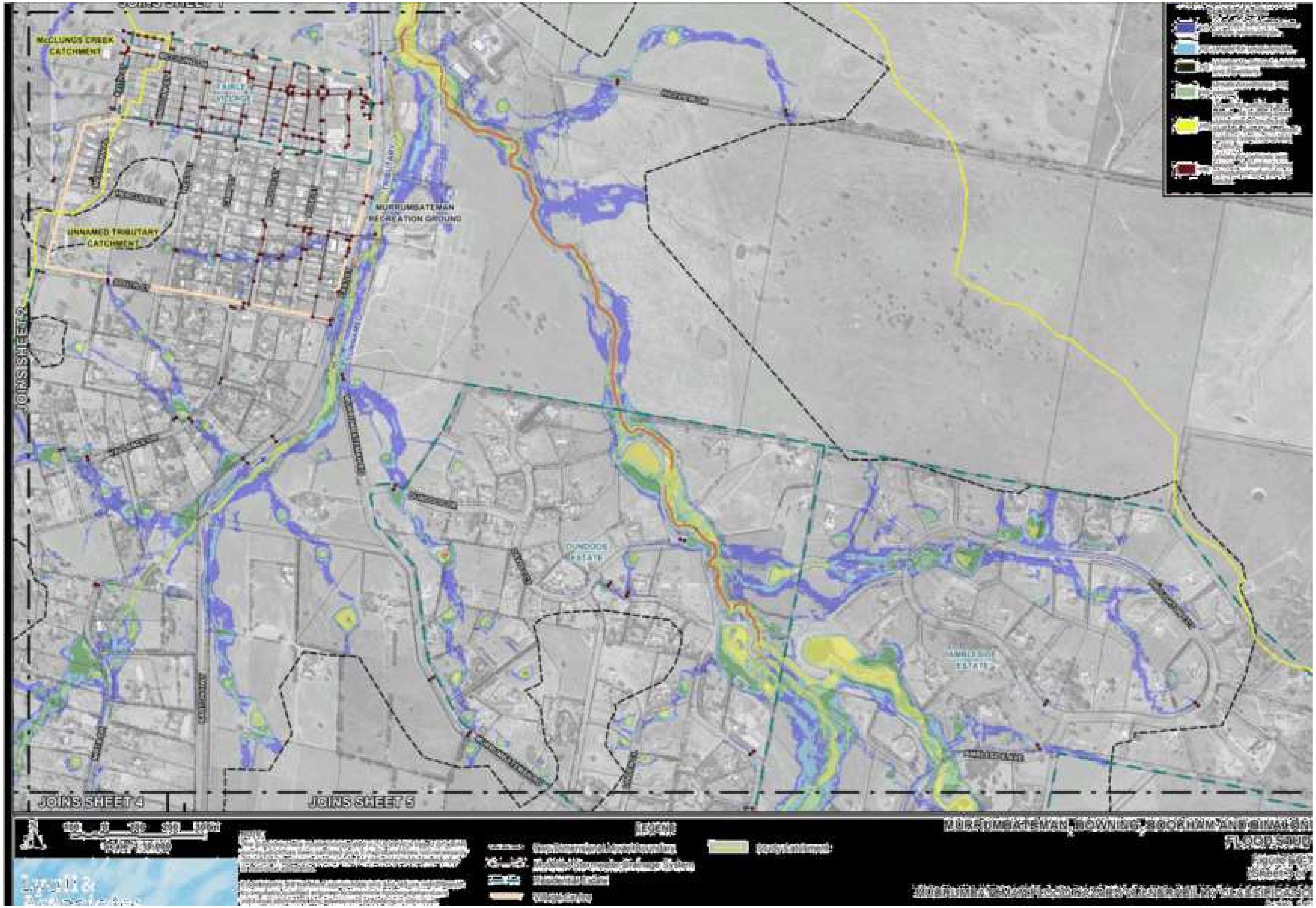
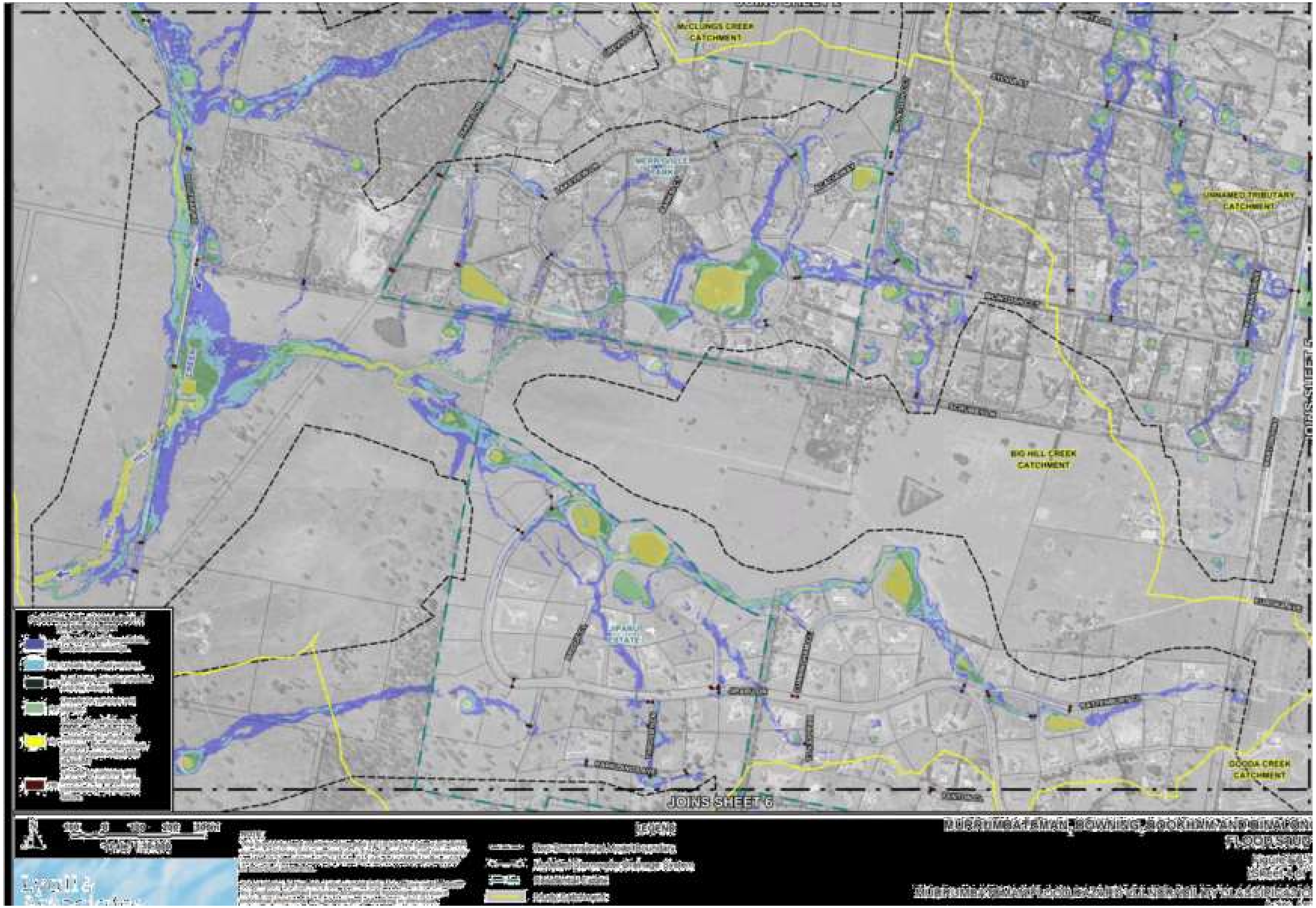
UNNAMED TRIBUTARY CATCHMENT
REFER INSET
JOINS SHEET 2
JOINS SHEET 3
LEGEND


McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MERRYVILLE ESTATE
CARRINGTON PARK
VINEYARD RIDGE
JOINS SHEET 4
LEGEND


McCLUNGS CREEK
CATCHMENT
MURRUMBATEMAN
RECREATION GROUND
UNNAMED TRIBUTARY
CATCHMENT
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5
LEGEND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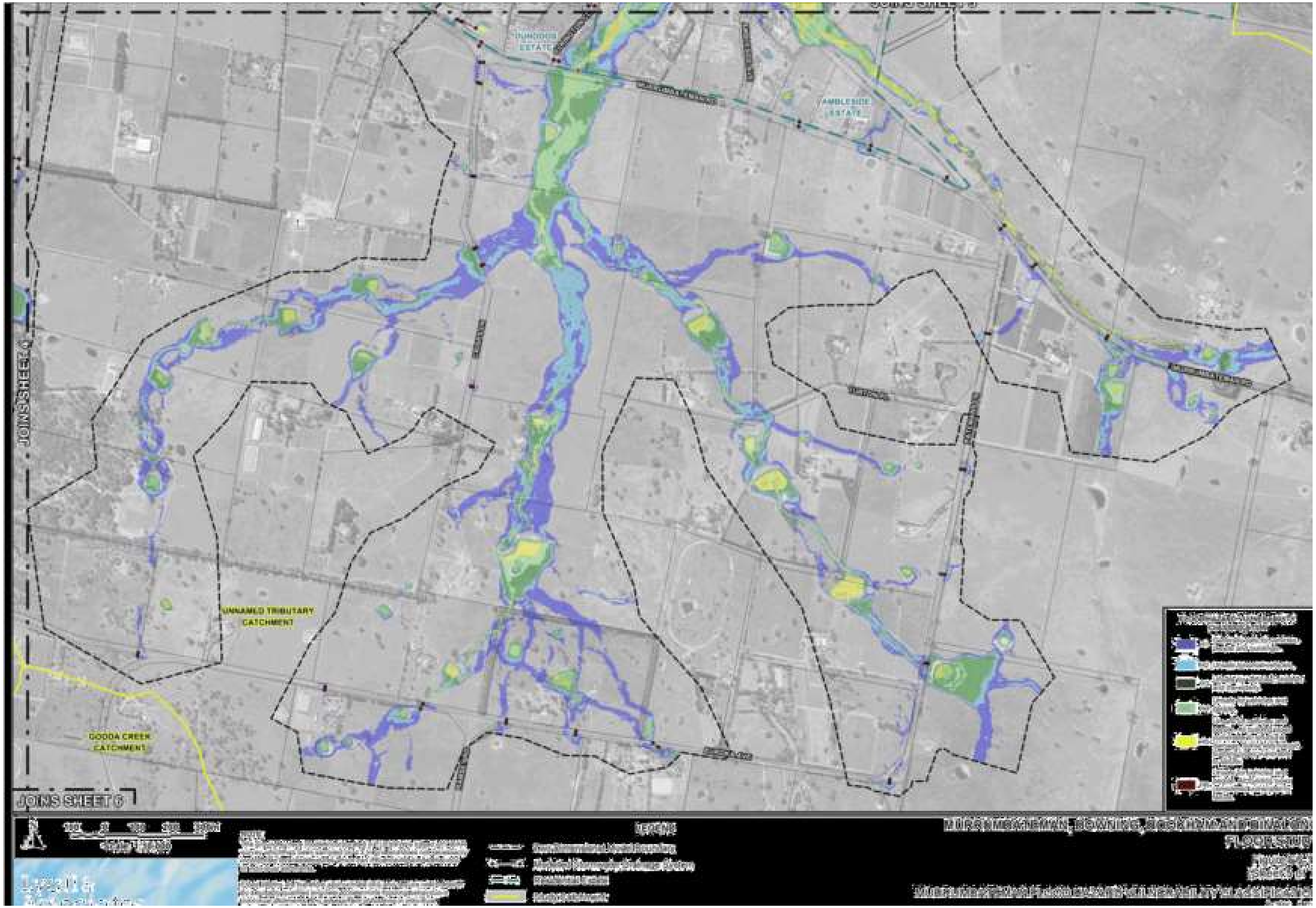
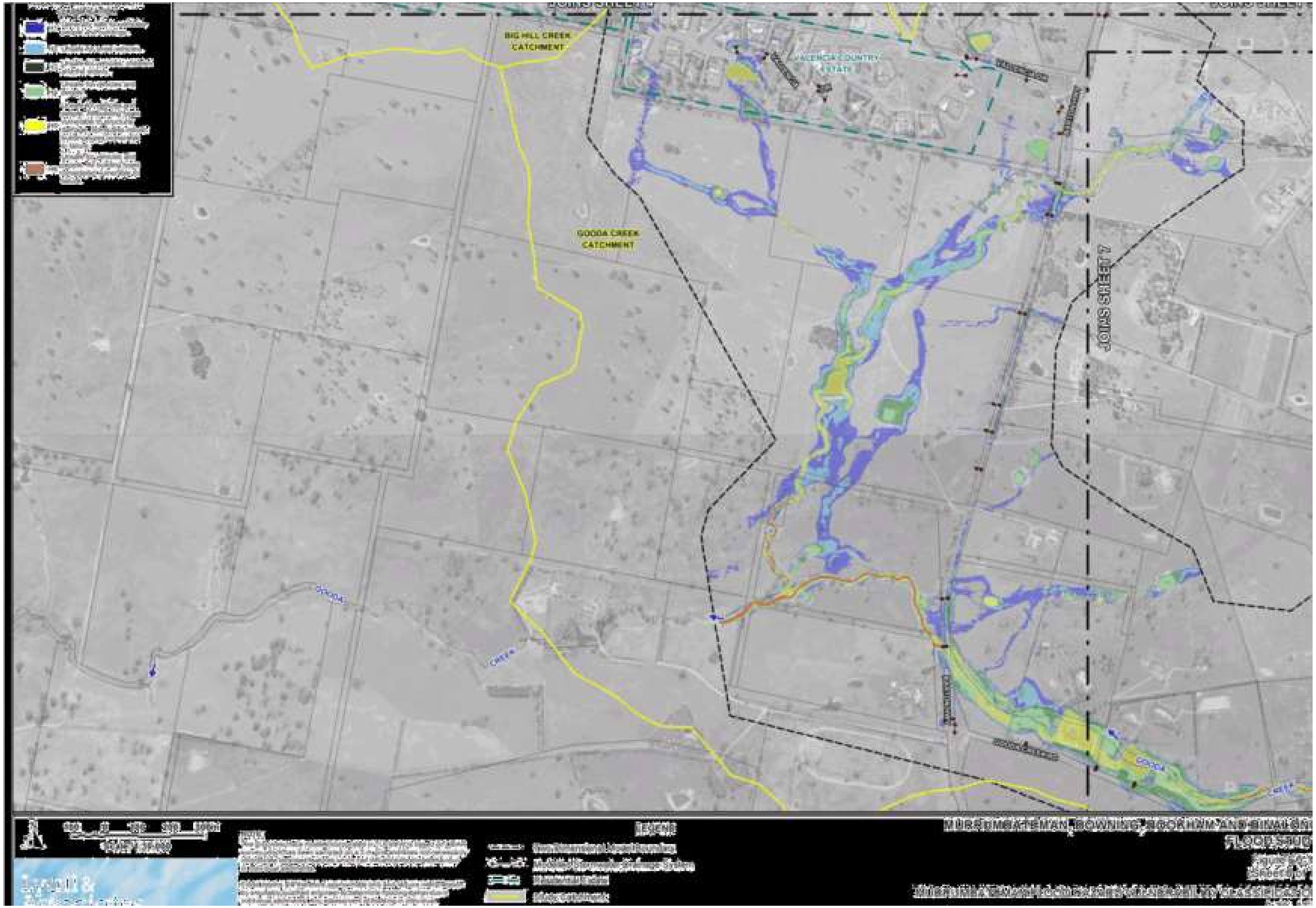
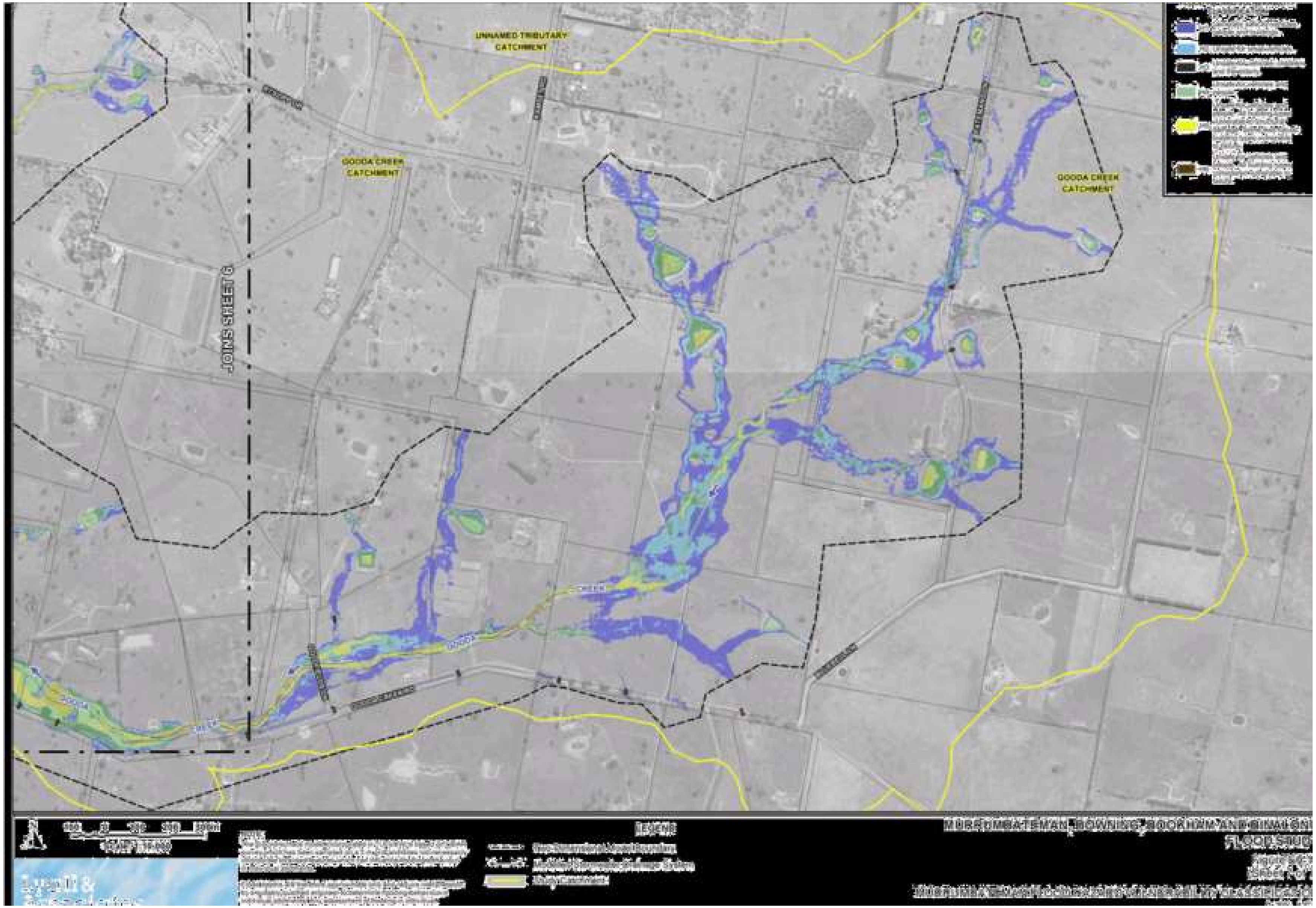
CATCHMENT
UNNAMED TRIBUTARY
CATCHMENT
BIG HILL CREEK
CATCHMENT
GOODA CREEK
CATCHMENT
JOINS SHEET 6
JOINS SHEET 5
LEGEND


DUNGOOS ESTATE
AMBLESIDE ESTATE
JOINS SHEET 4
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
LEGEND


BIG HILL CREEK
CATCHMENT
VALENCIA COUNTRY
ESTATE
GOODA CREEK
CATCHMENT
JOINS SHEET 7
GOODA
CREEK
LEGEND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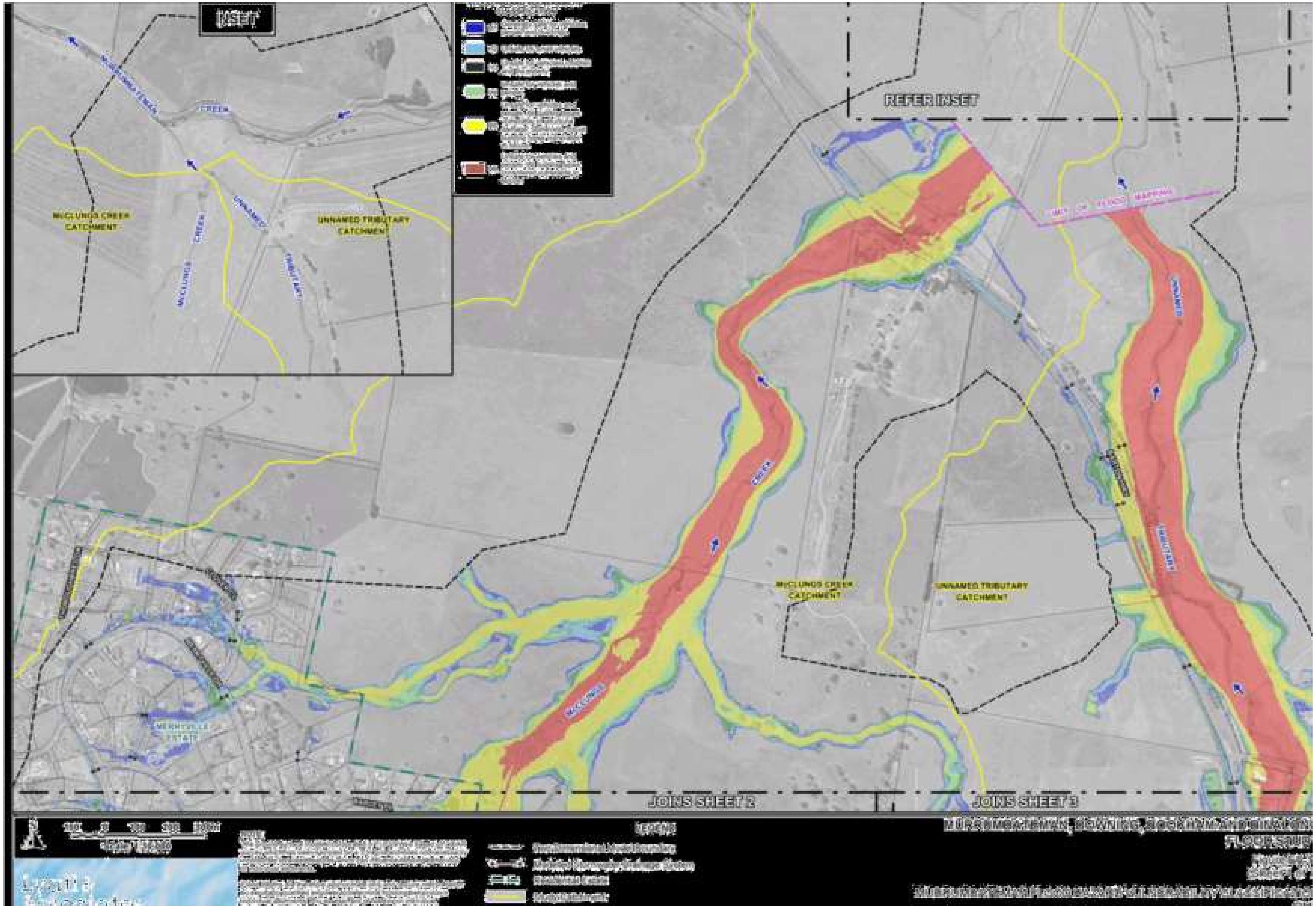
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6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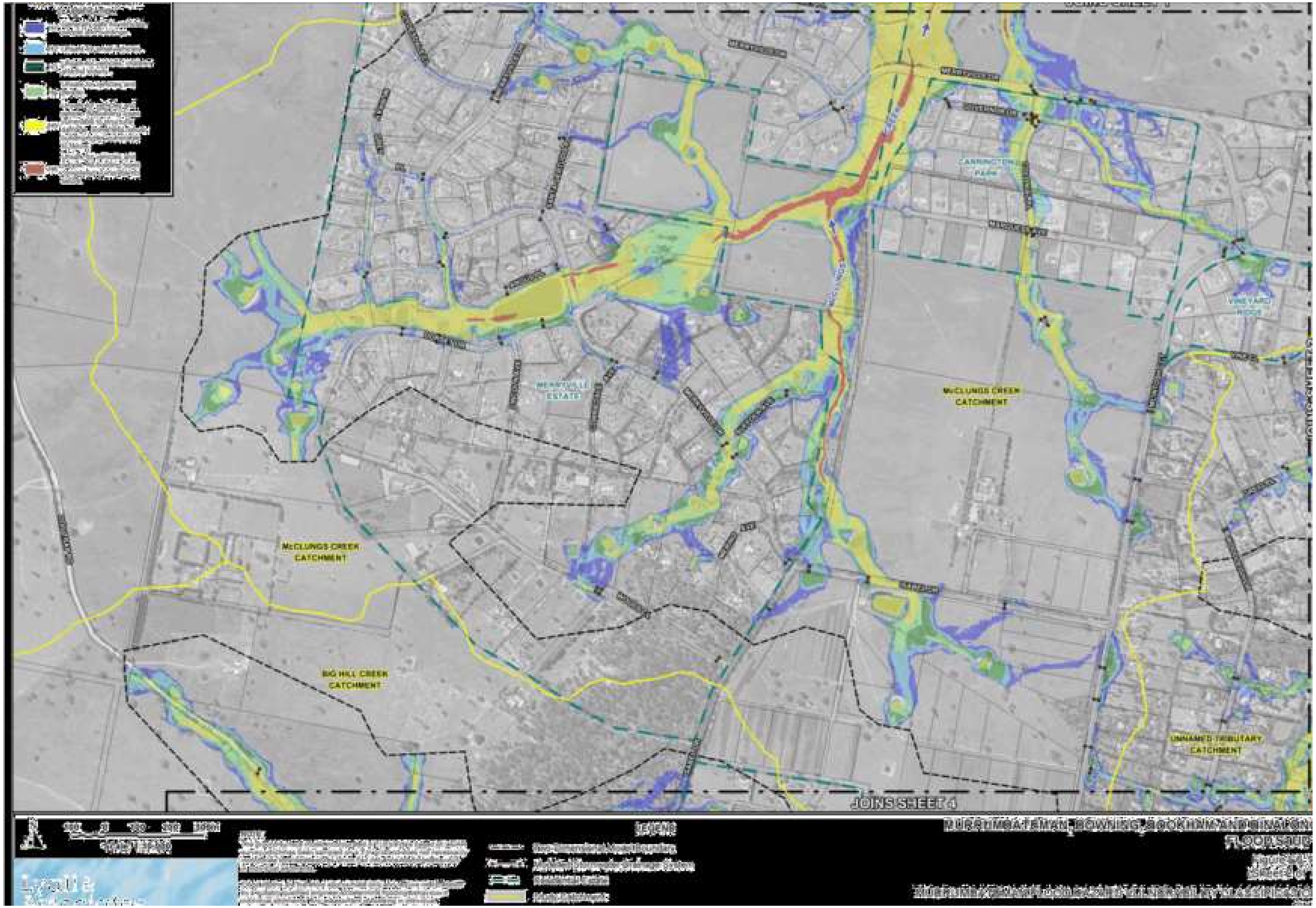
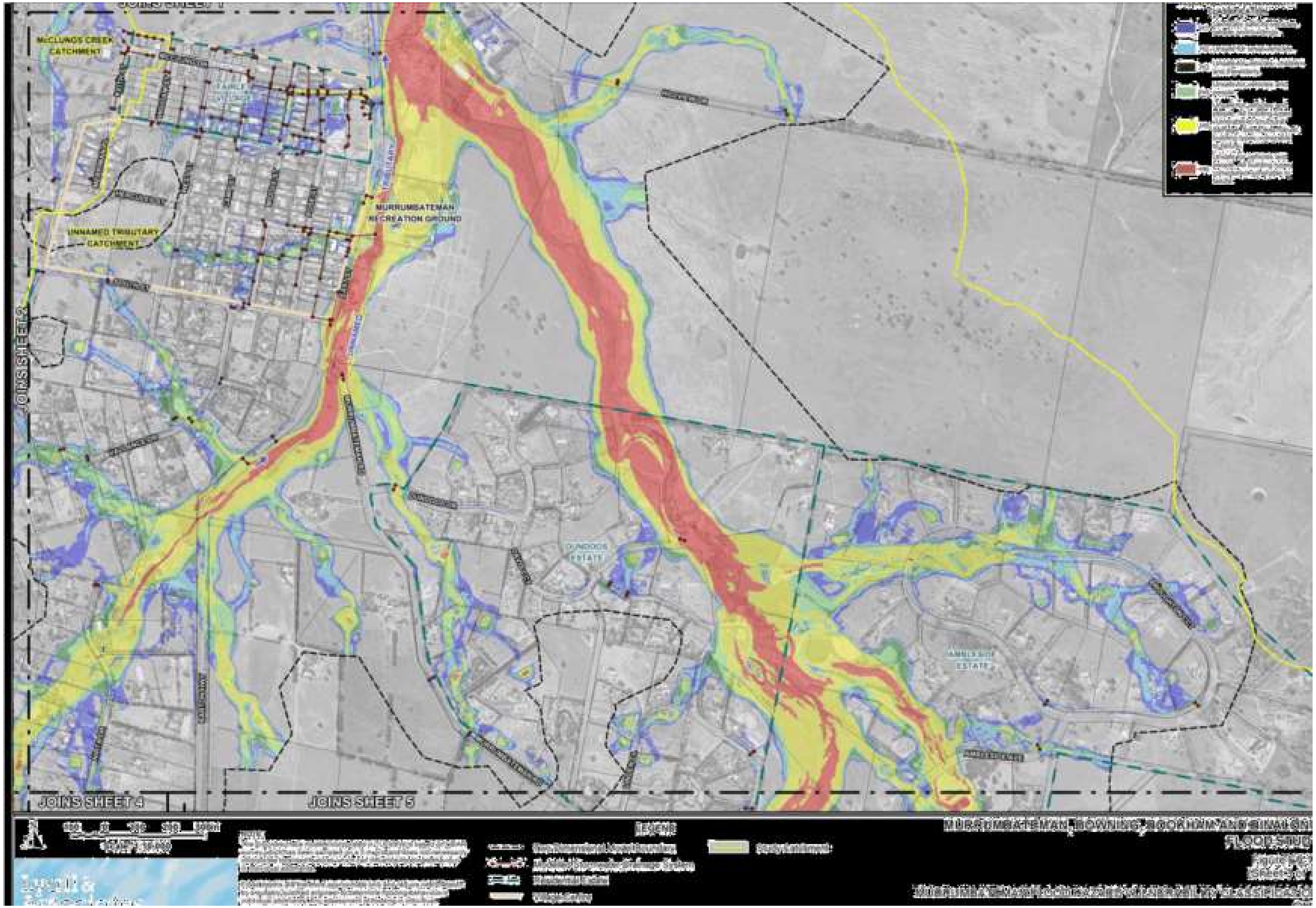
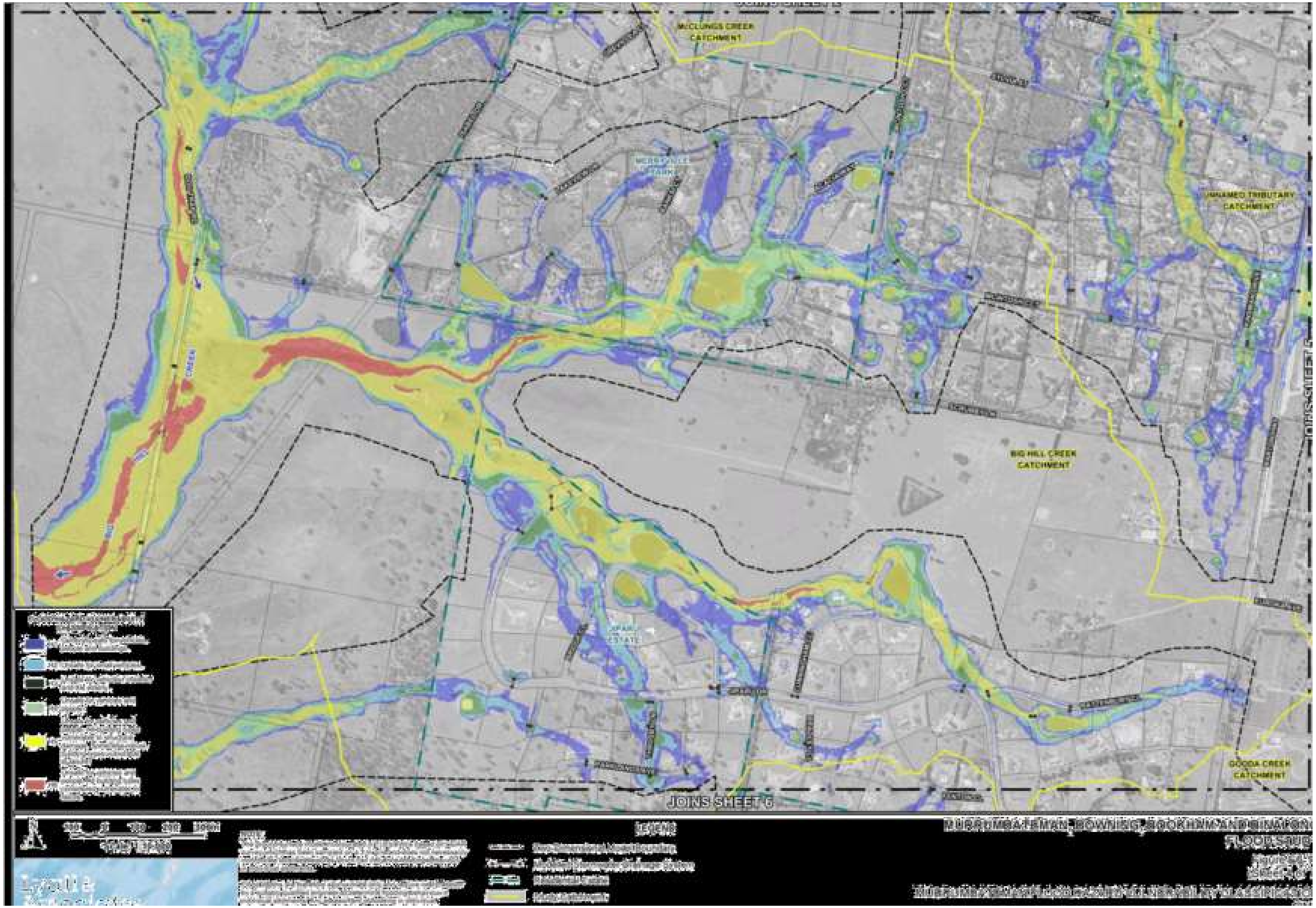
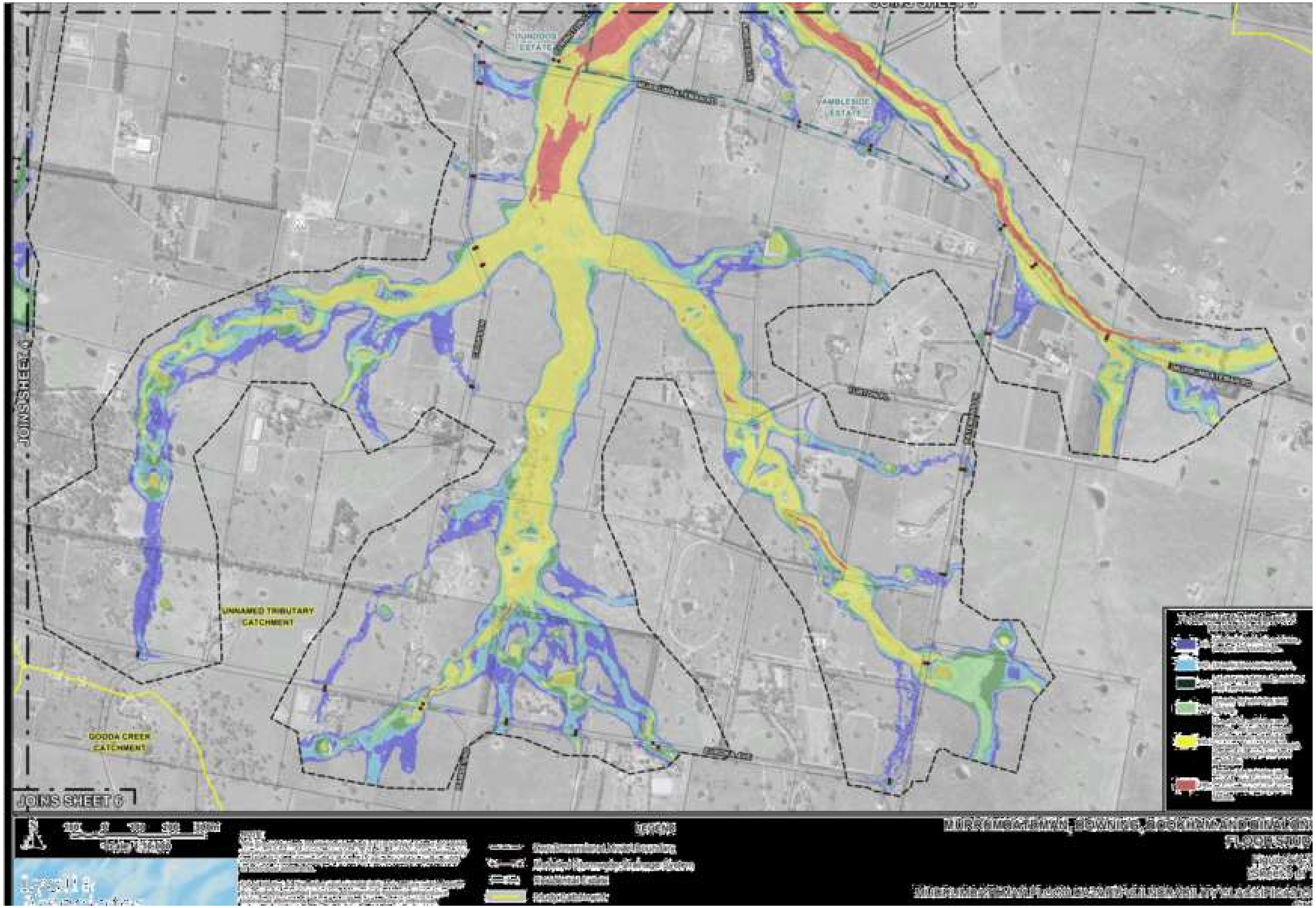
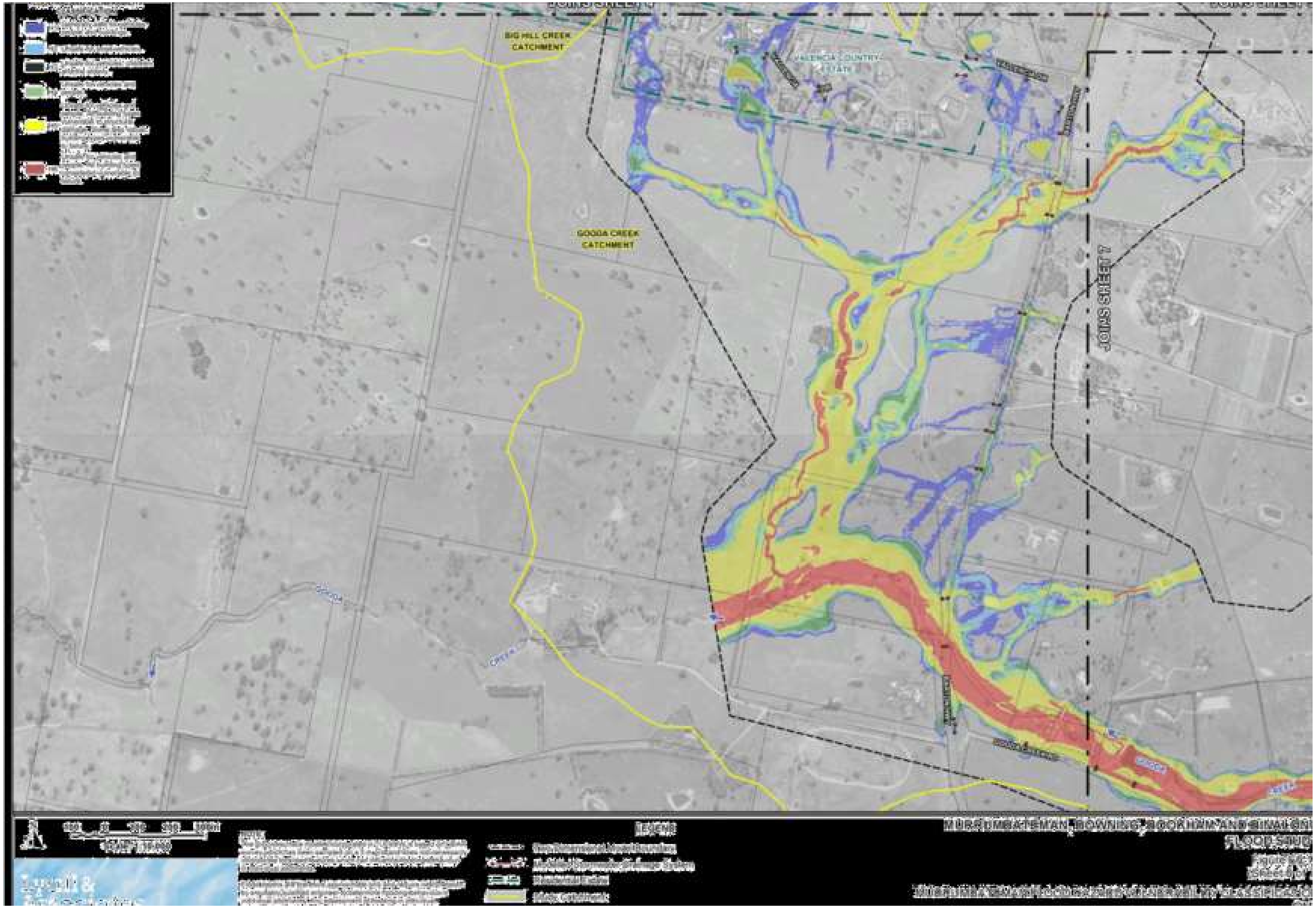
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3
LEGEND

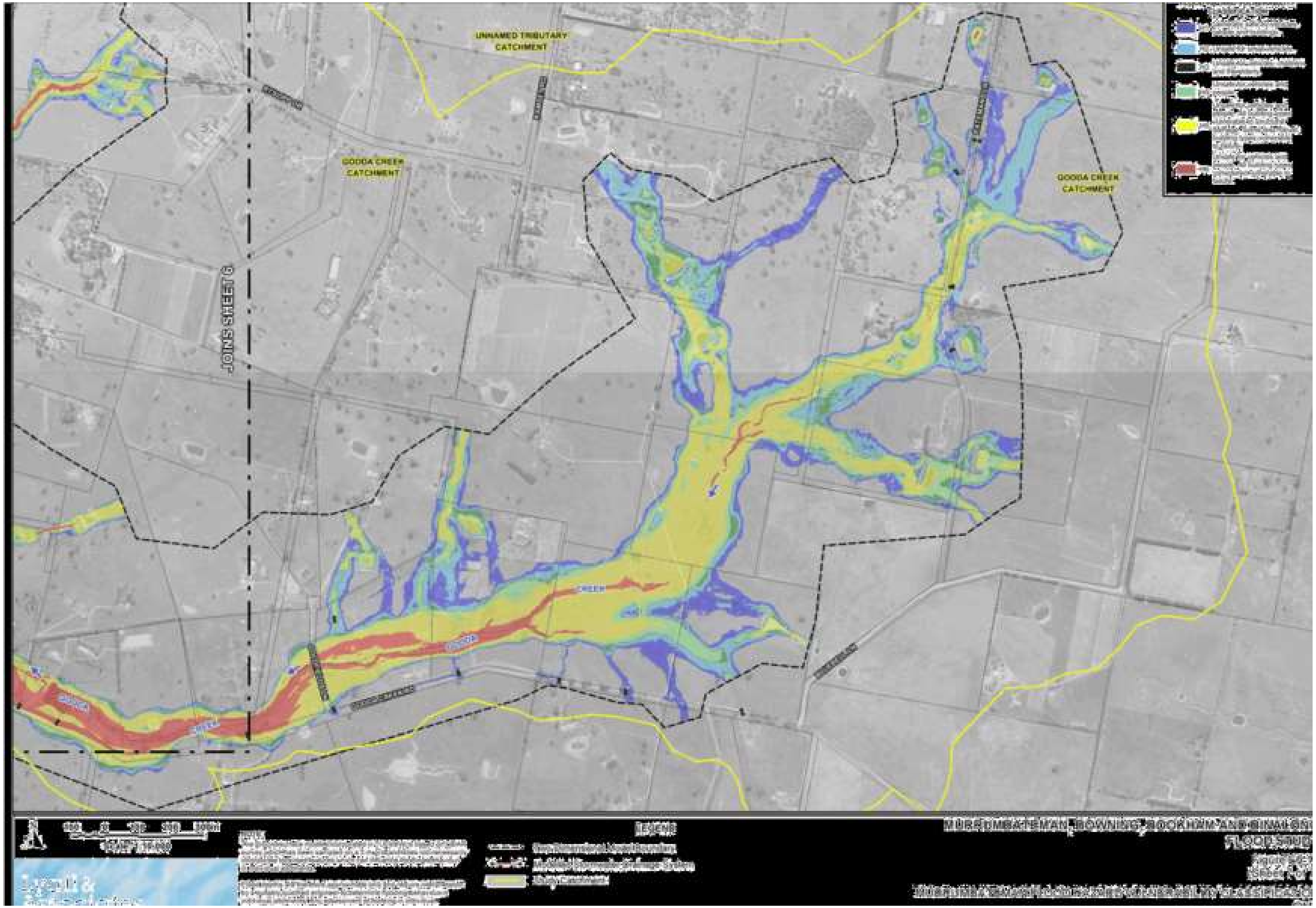

CARRINGTON PARK
VINEYARD RIDGE
McCLUNGS CREEK CATCHMENT
MERRYVILLE ESTATE
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4
LEGEND

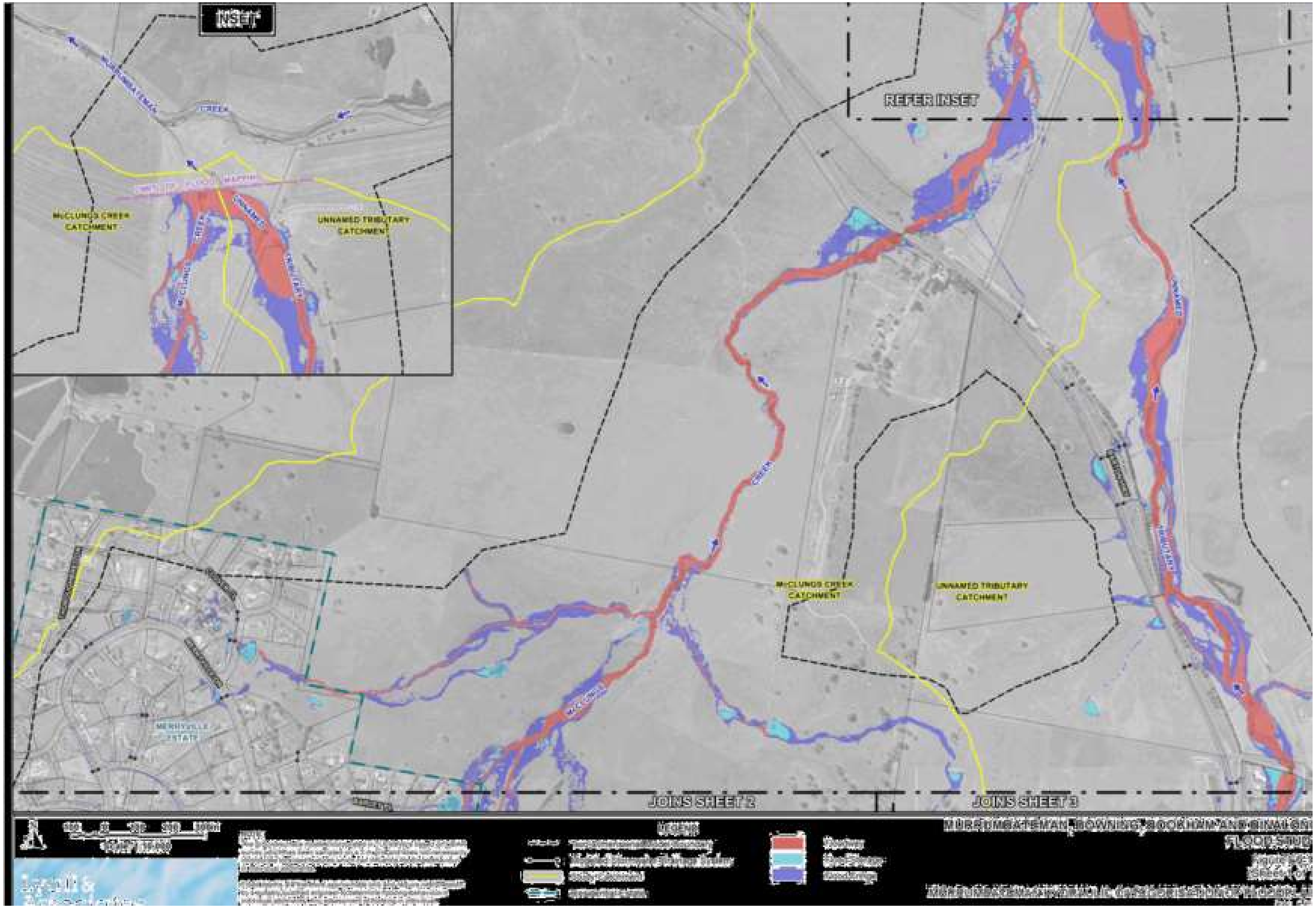

McCLUNGS CREEK CATCHMENT
MURRUMBATEMAN RECREATION GROUND
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5
DUNGOOS ESTATE
LEGEND

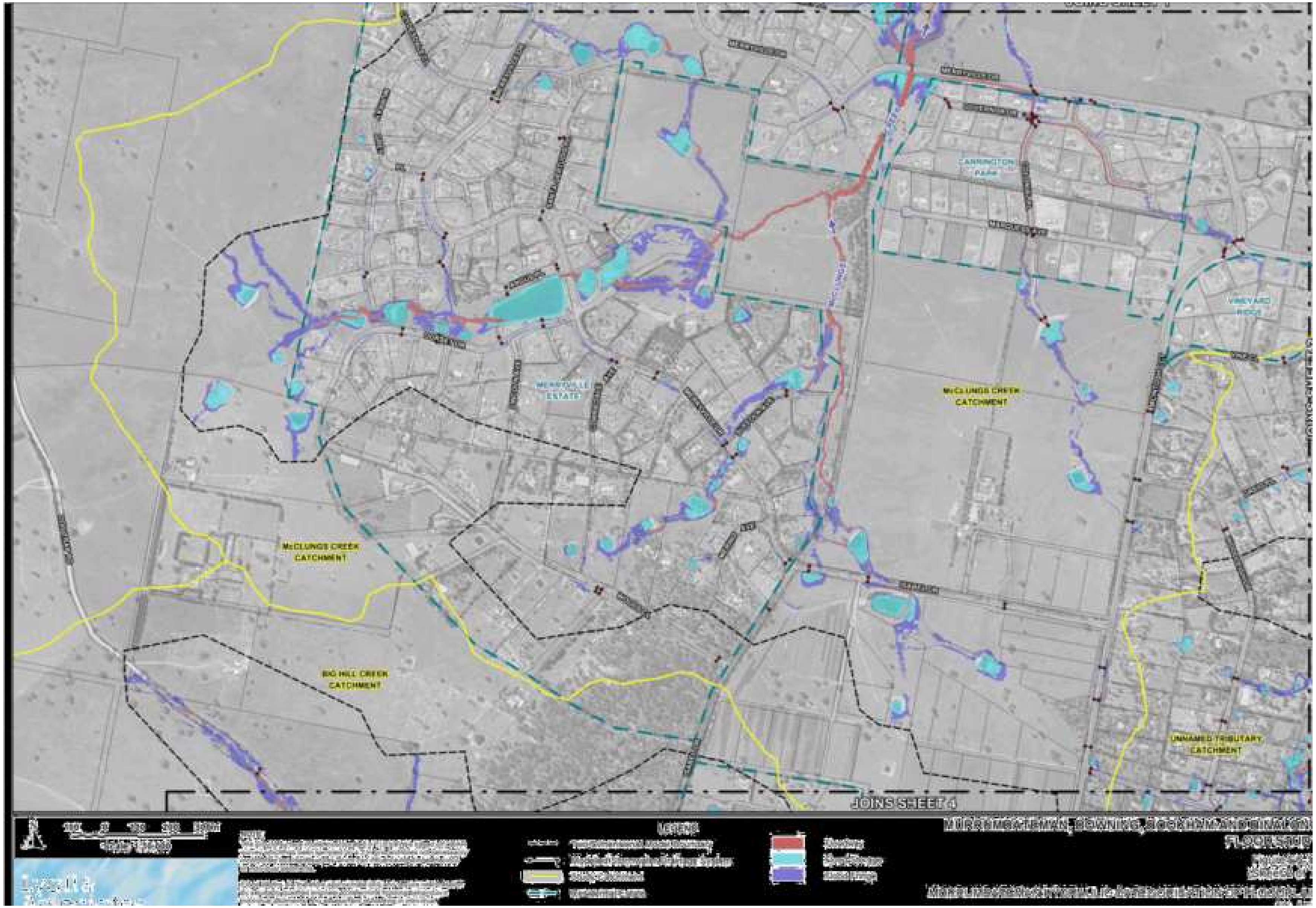

M'CLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
JOINS SHEET 5

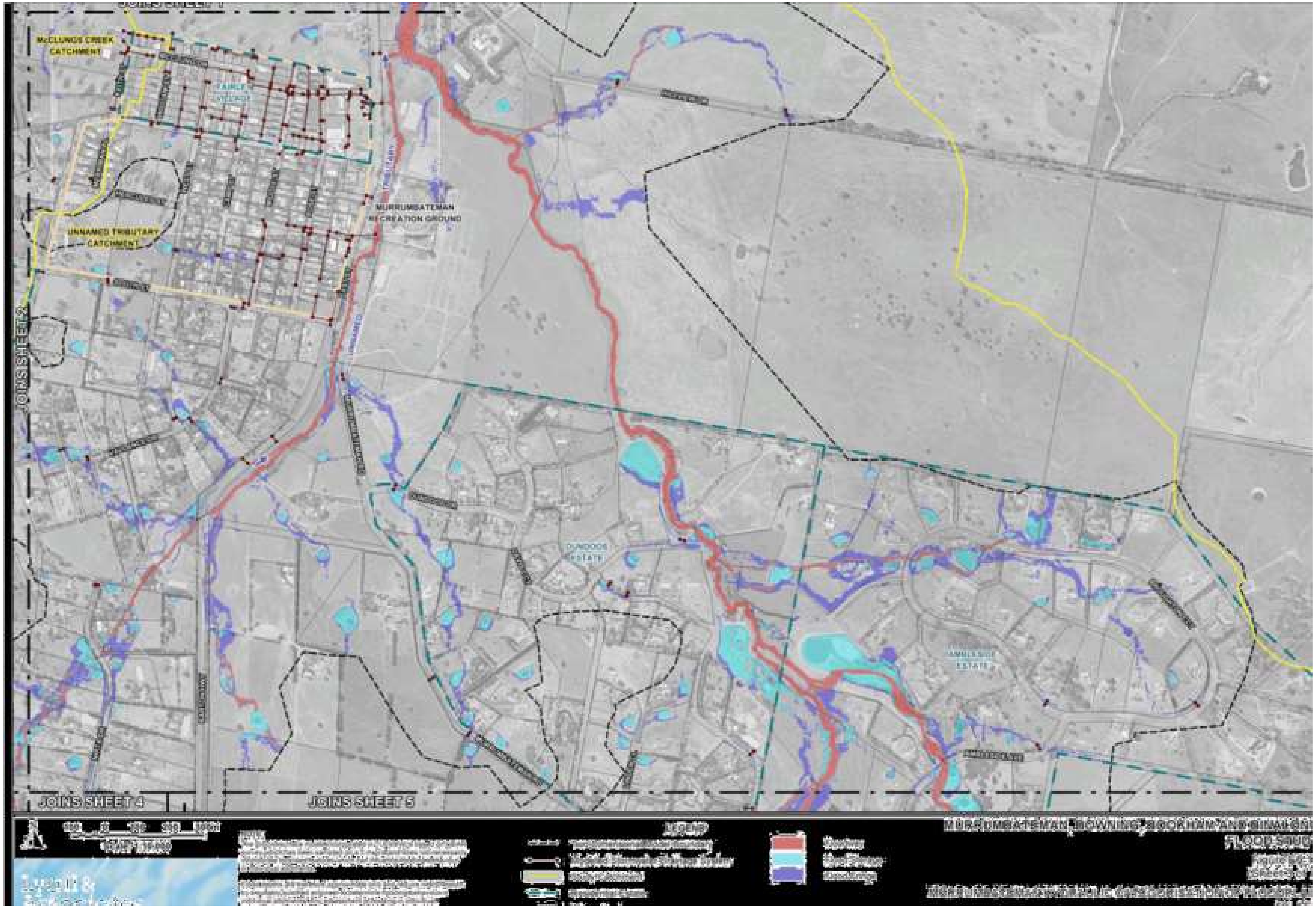

AMBLESIDE ESTATE
JOINS SHEET 4
UNNAMED TRIBUTARY CATCHMENT

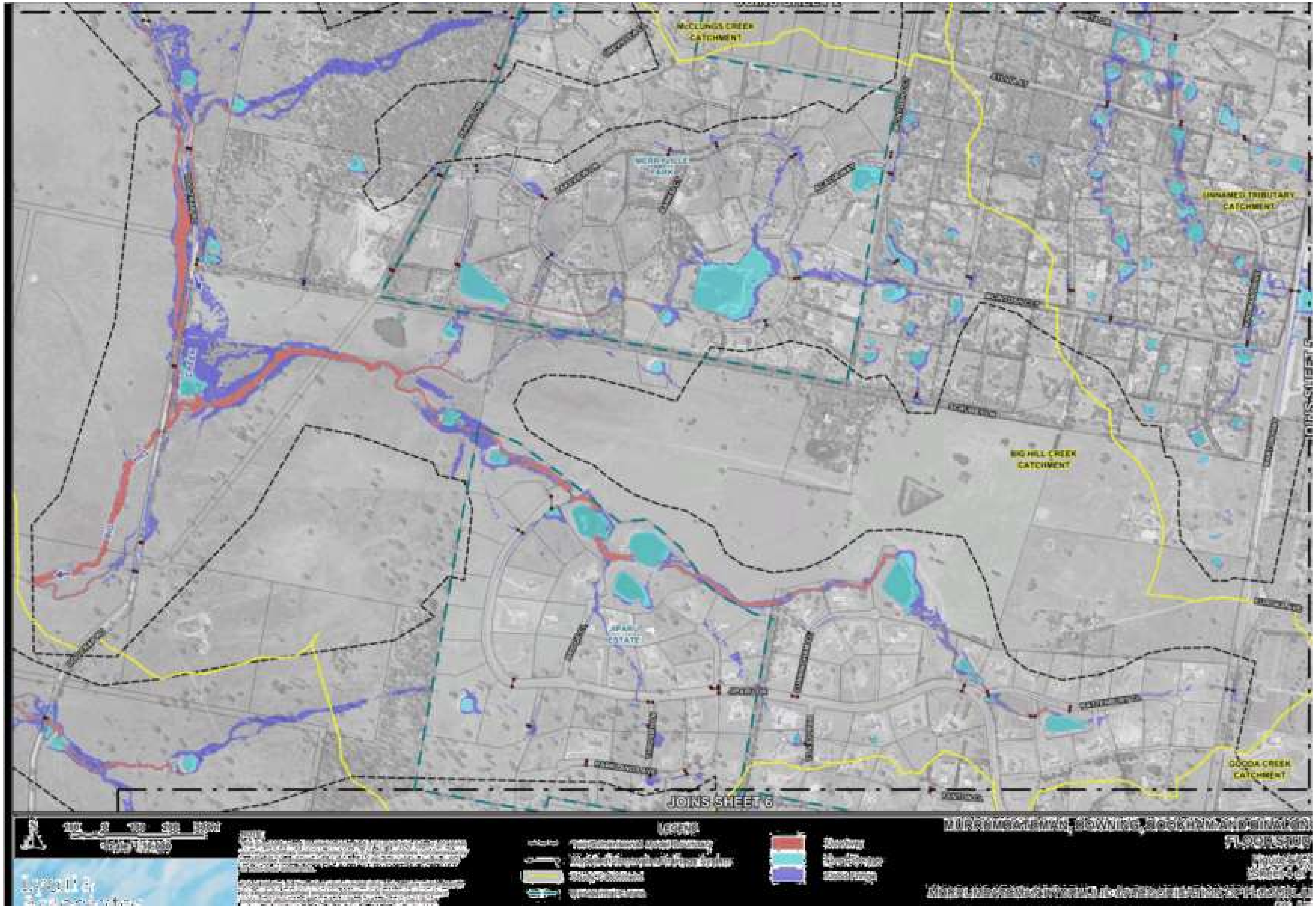

BIG HILL CREEK
CATCHMENT
GOODA CREEK
CATCHMENT


UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
GOODA
CREEK
LEGEND


INSET
REFER INSET
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 2
JOINS SHEET 3


McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MERRYVILLE ESTATE
CANNINGTON PARK
VINEYARD RIDGE
JOINS SHEET 4
LEGEND


McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5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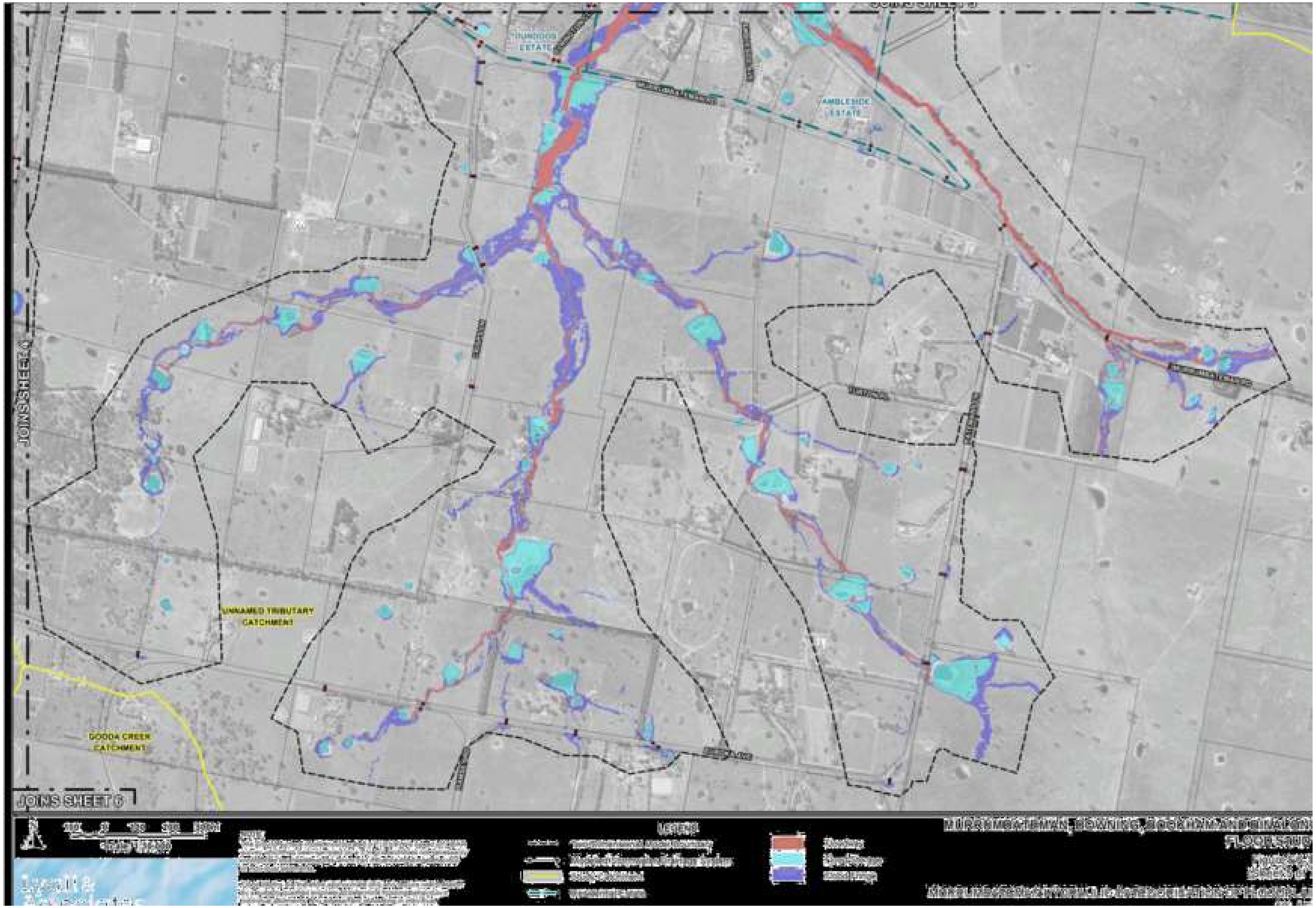
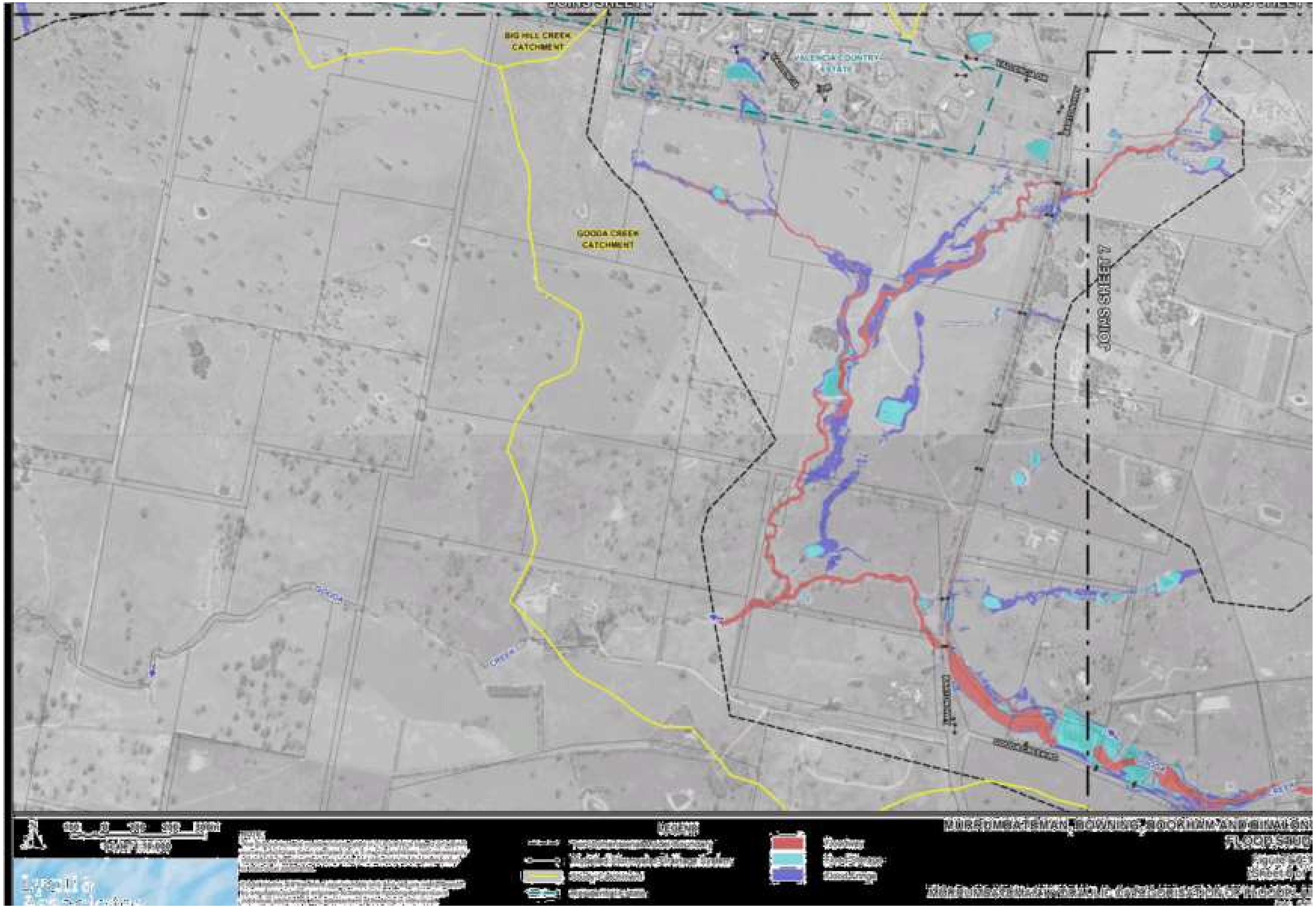
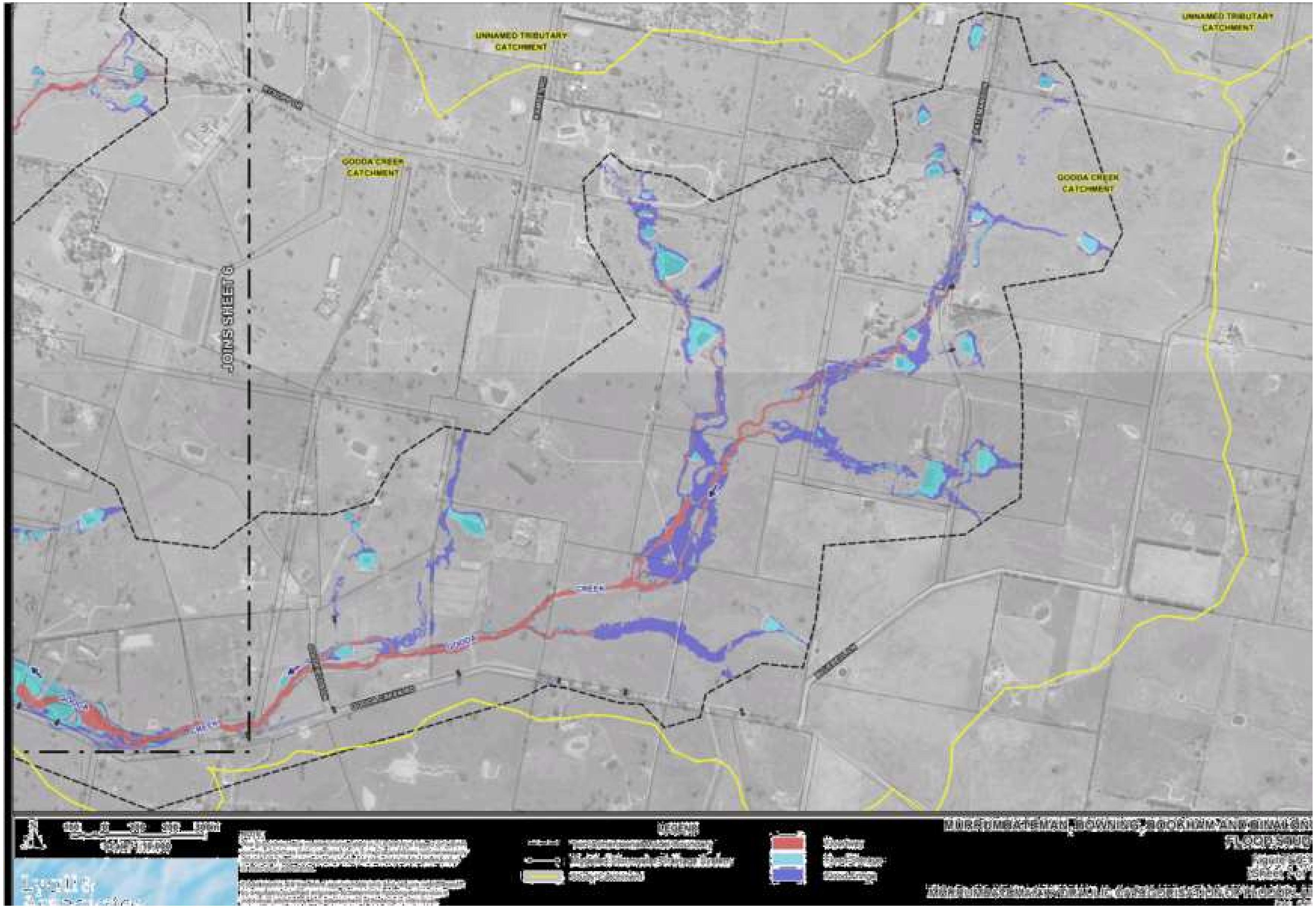
UNNAMED TRIBUTARY CATCHMENT
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
JOINS SHEET 5
LEGEND


AMBLESIDE ESTATE
JOINS SHEET 4
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
LEGEND


BIG HILL CREEK
CATCHMENT
GOODA CREEK
CATCHMENT
JOINS SHEET 7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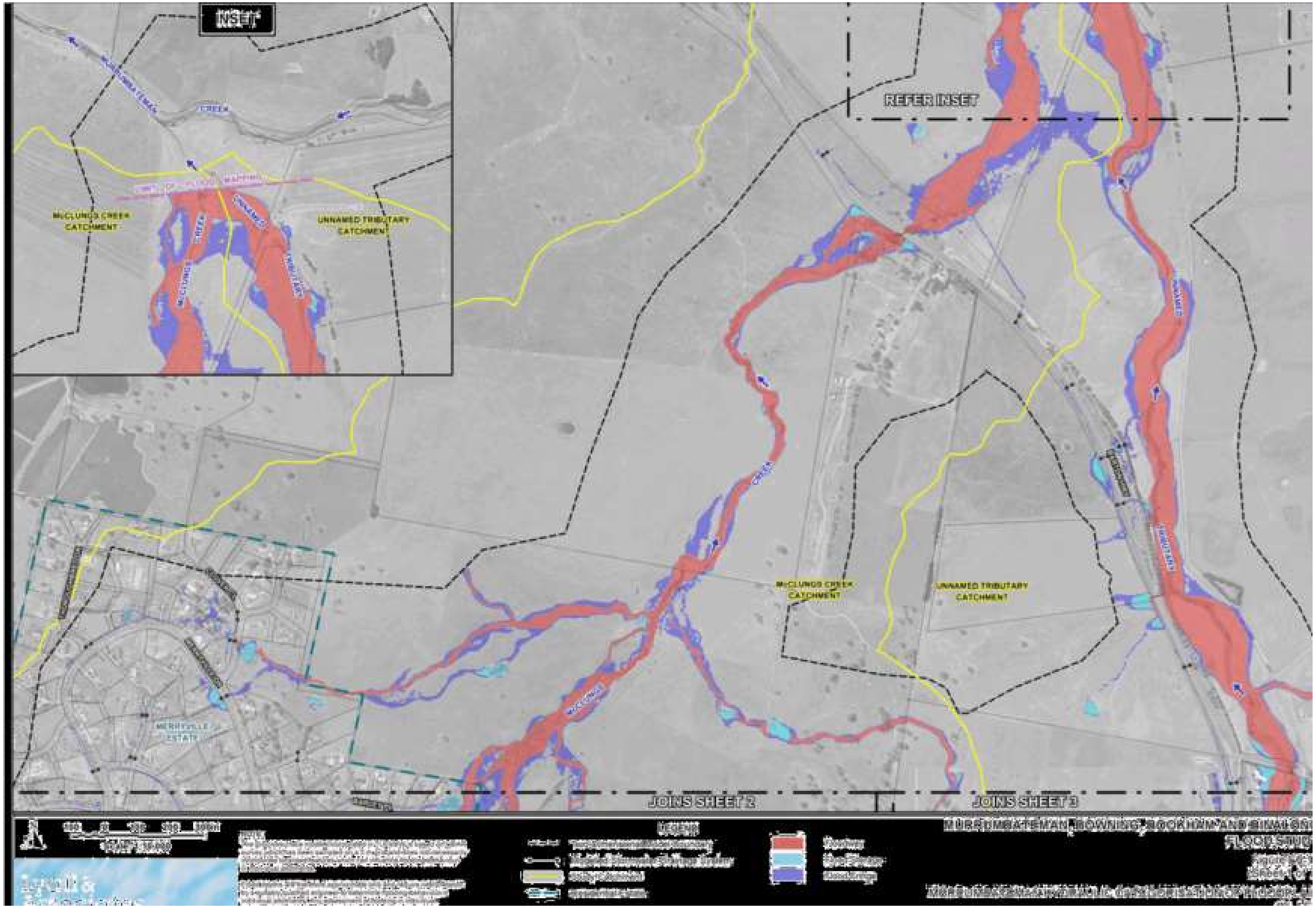
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
CREEK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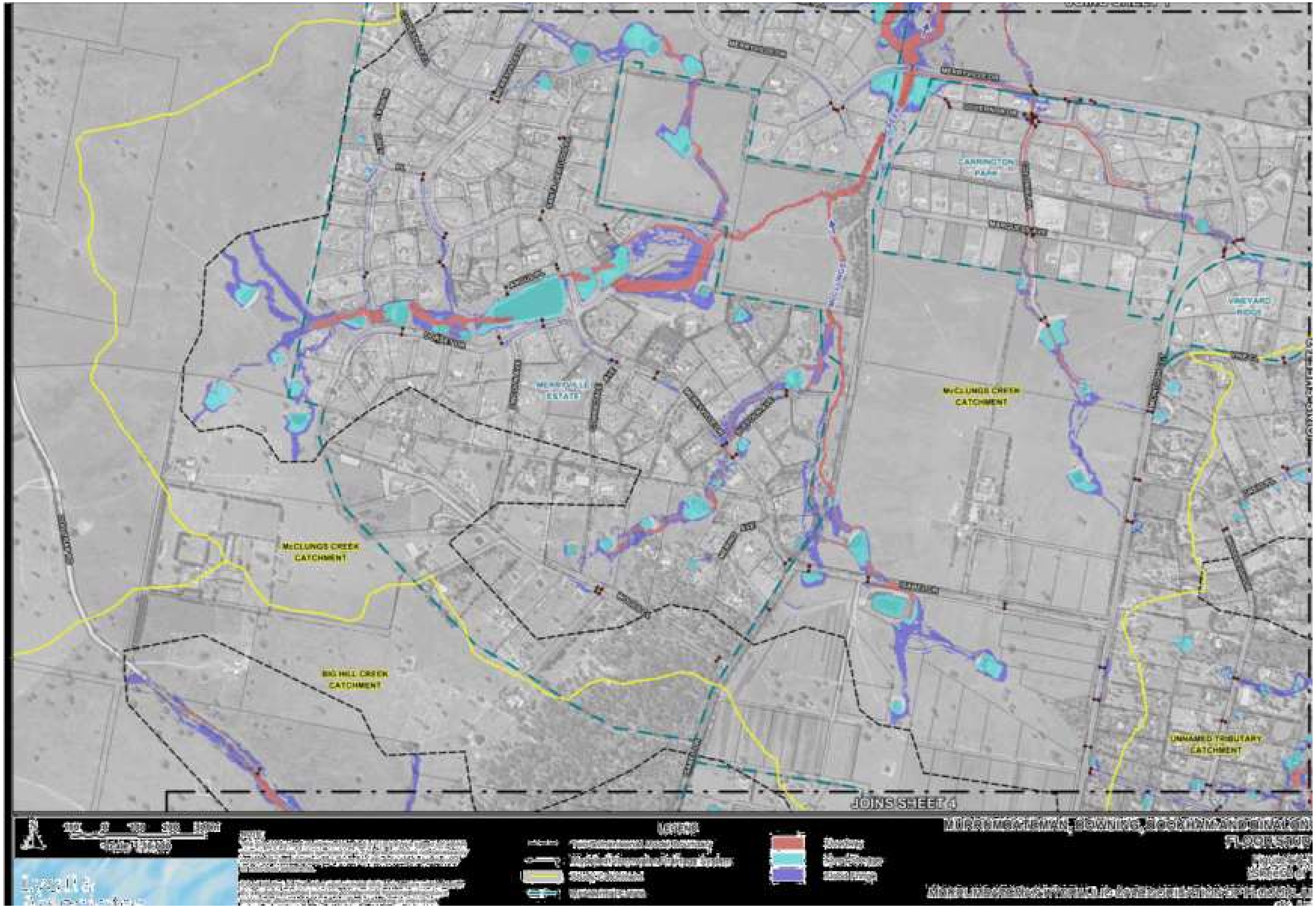
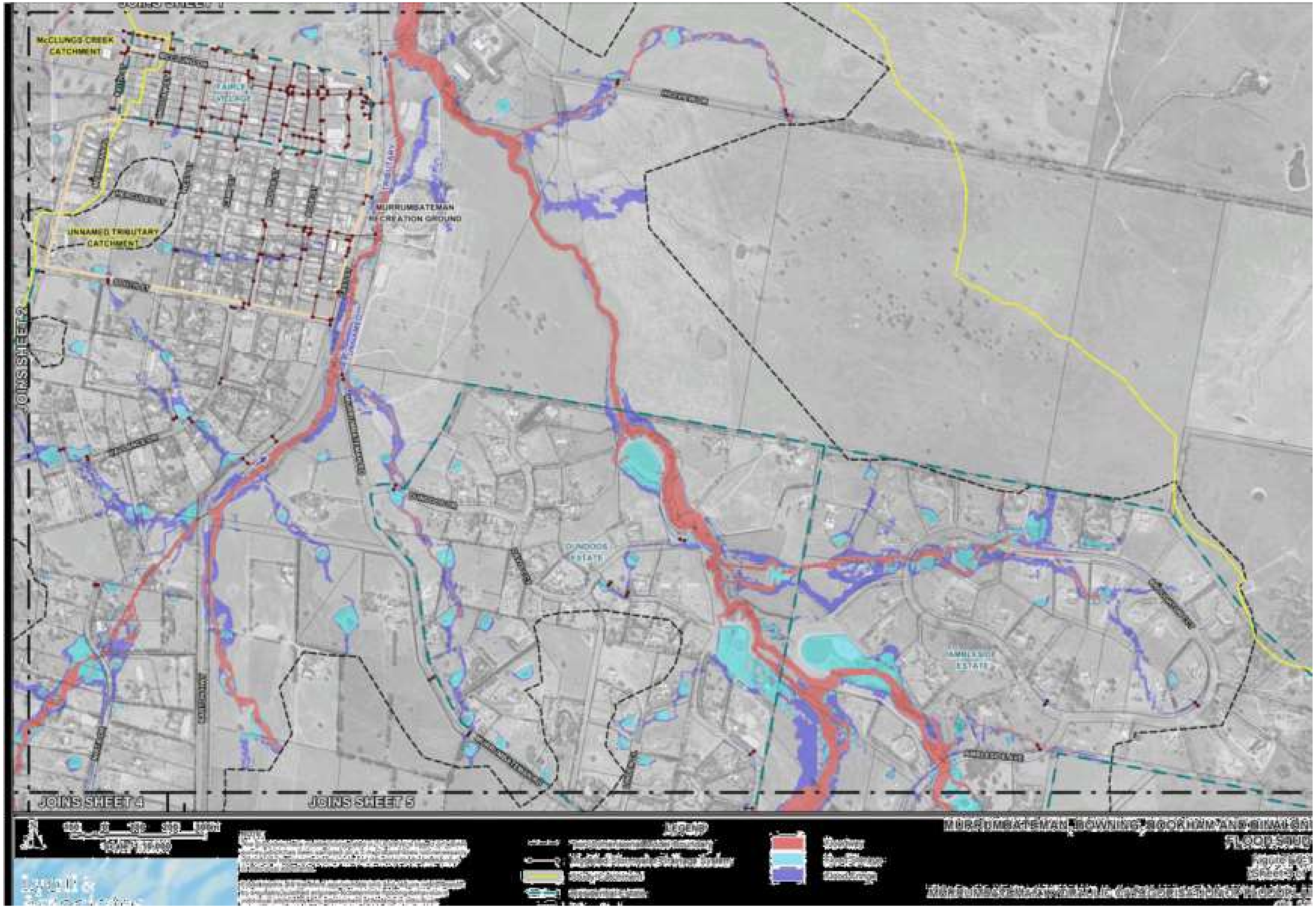
UNNAMED TRIBUTARY CATCHMENT
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3


CARRINGTON PARK
VINEYARD RIDGE
MERRYVILLE ESTATE
McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4
LEGEND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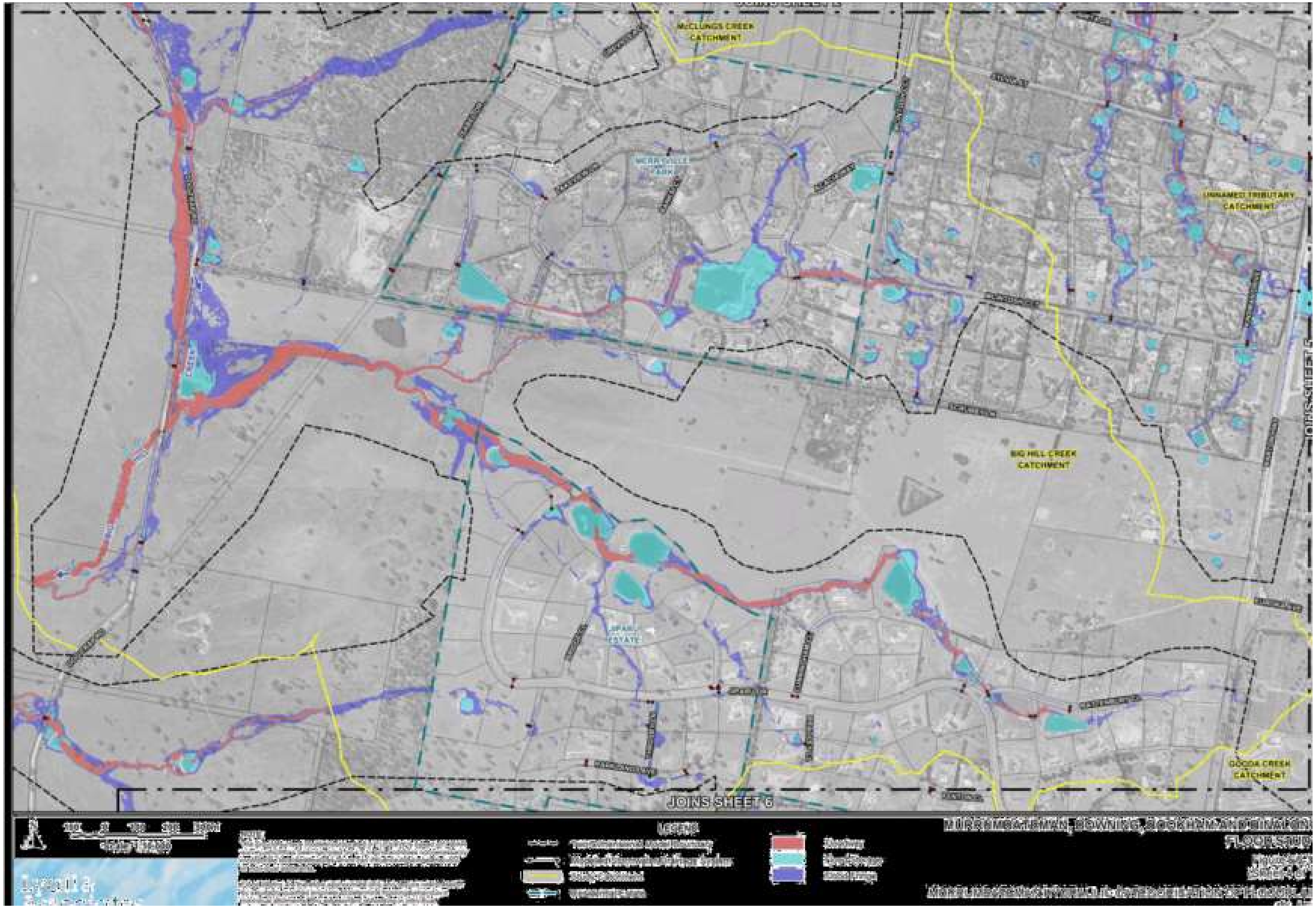
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5
LEGEND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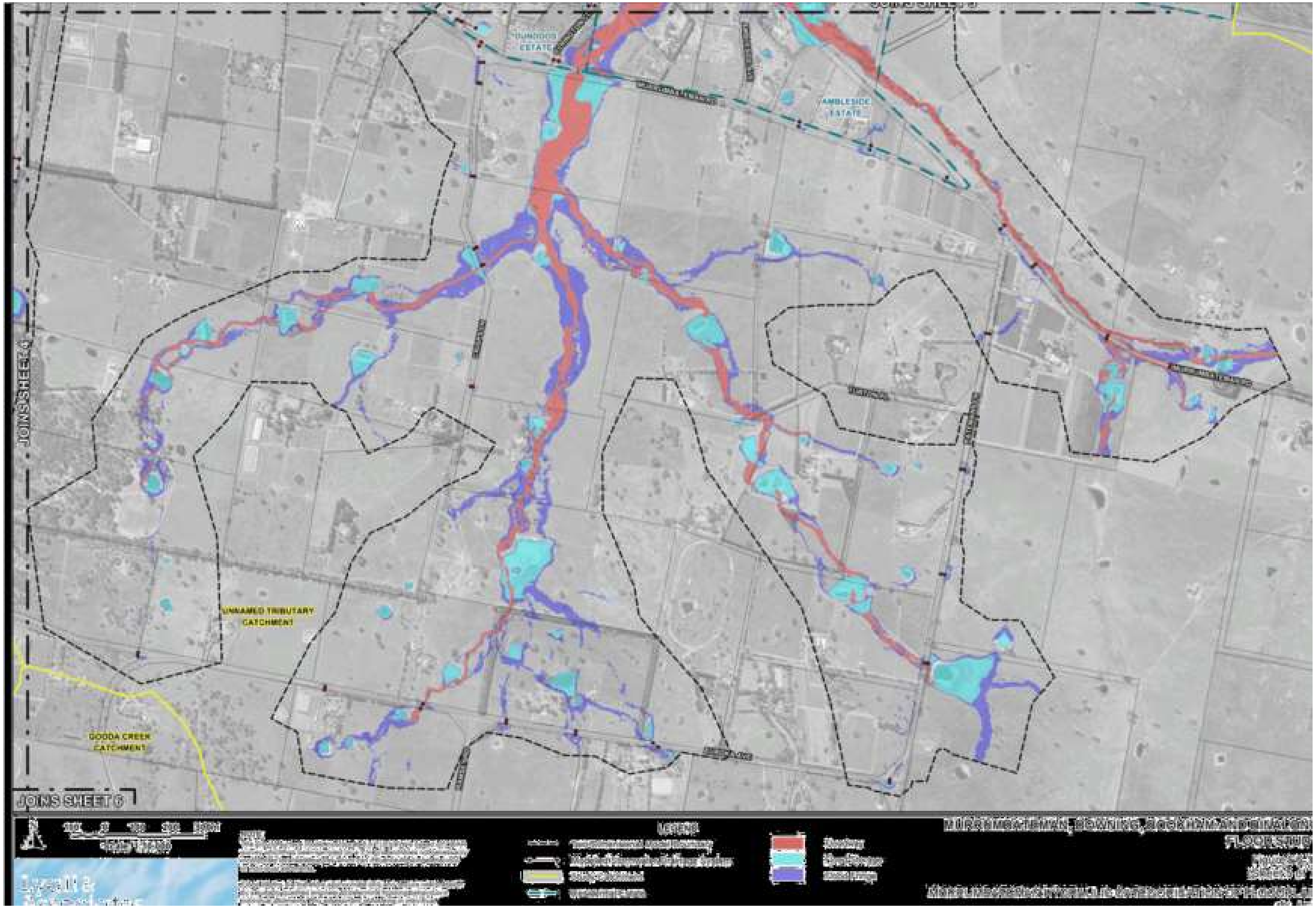
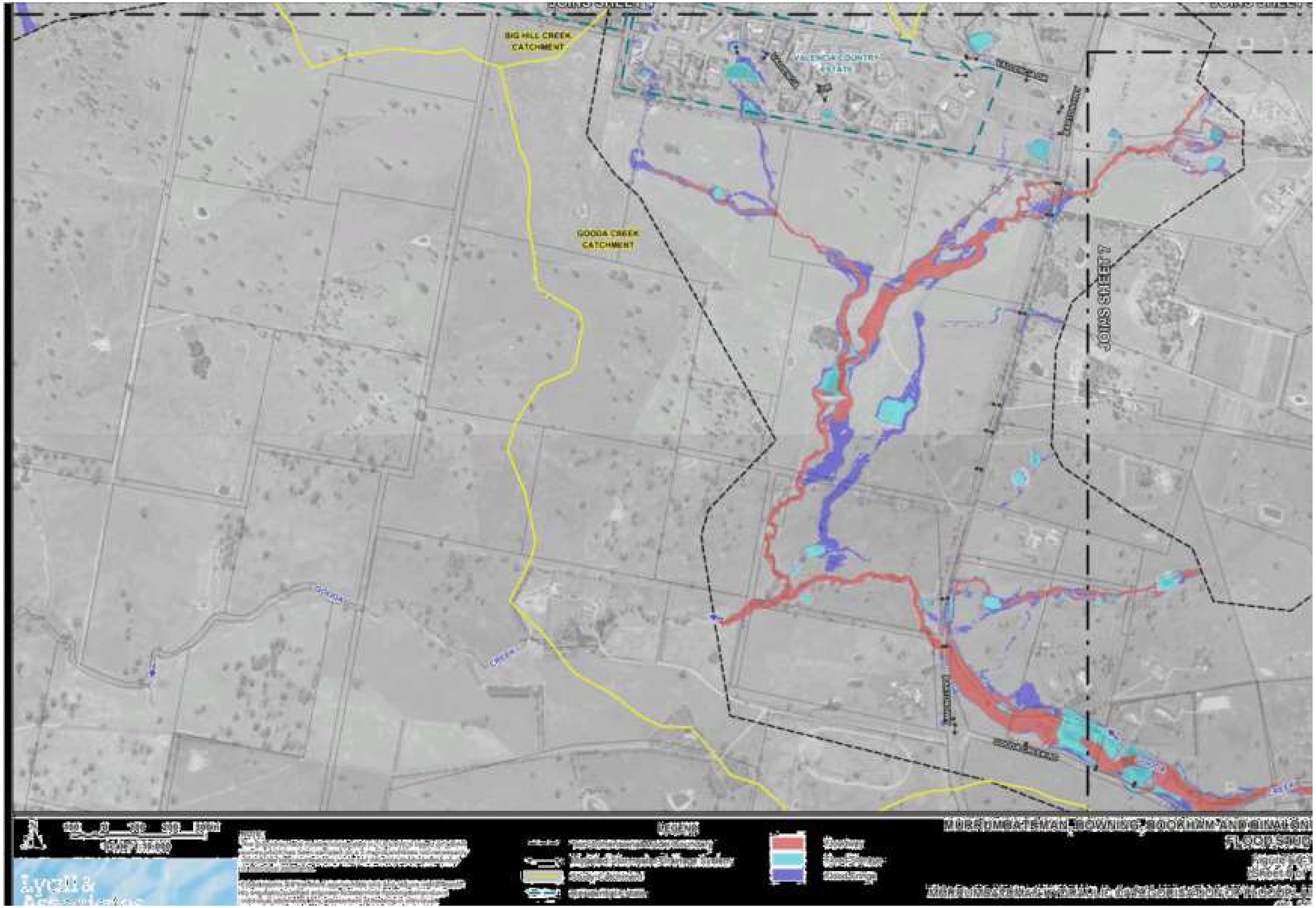
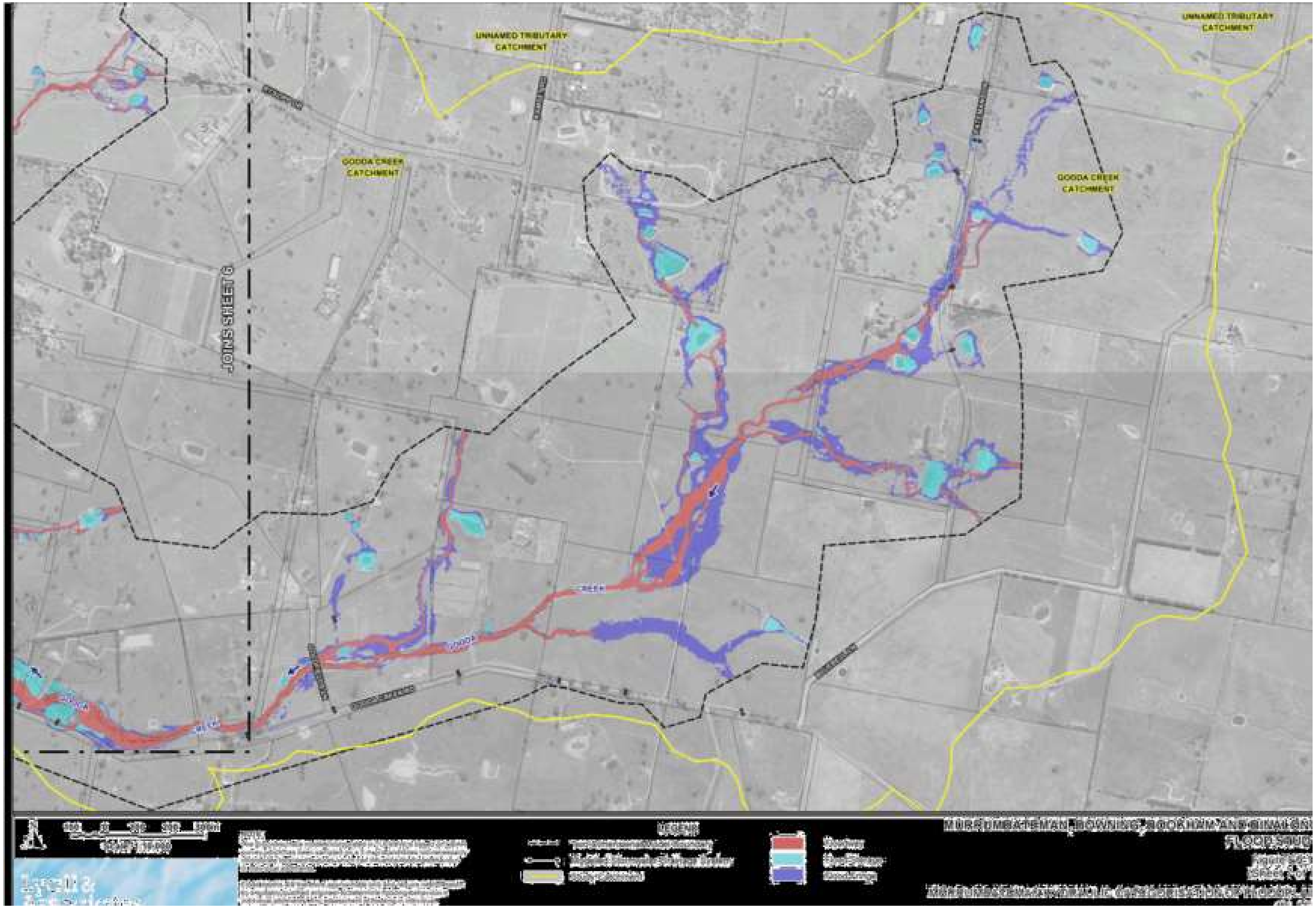
UNNAMED TRIBUTARY CATCHMENT
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 5
JOINS SHEET 6


DUNDOOS ESTATE
AMBLESIDE ESTATE
JOINS SHEET 4
JOINS SHEET 6
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
LEGEND


BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 7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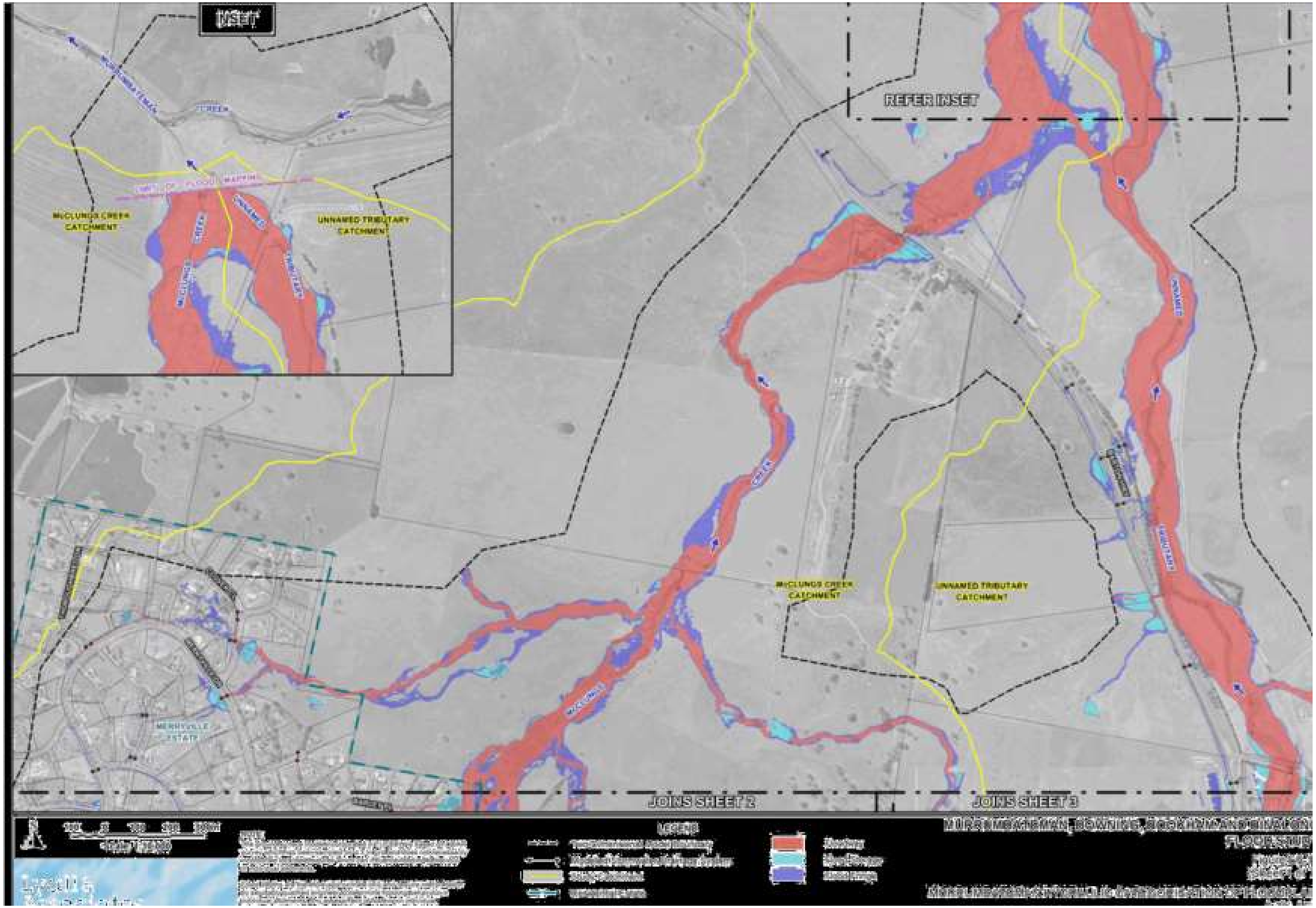
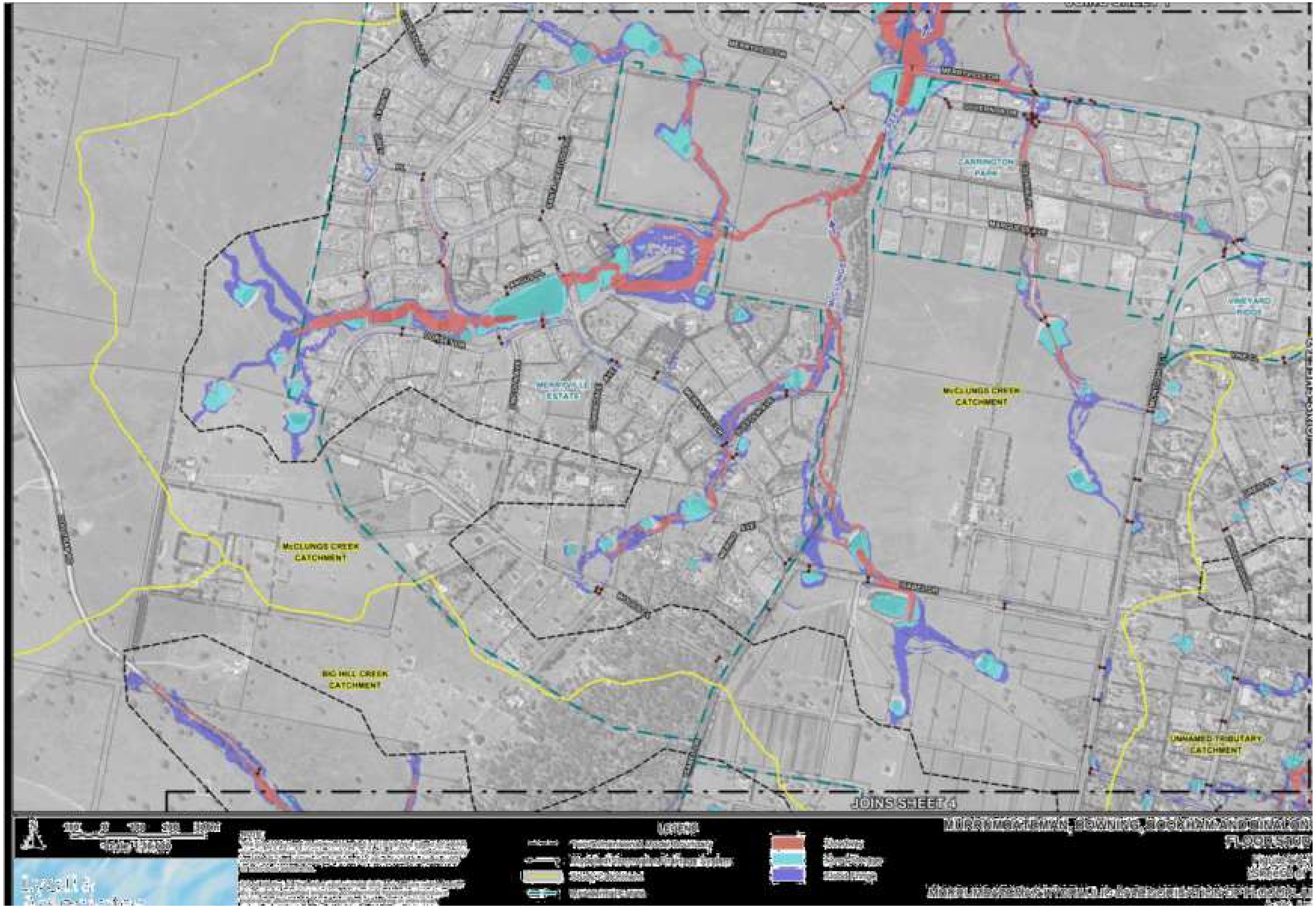
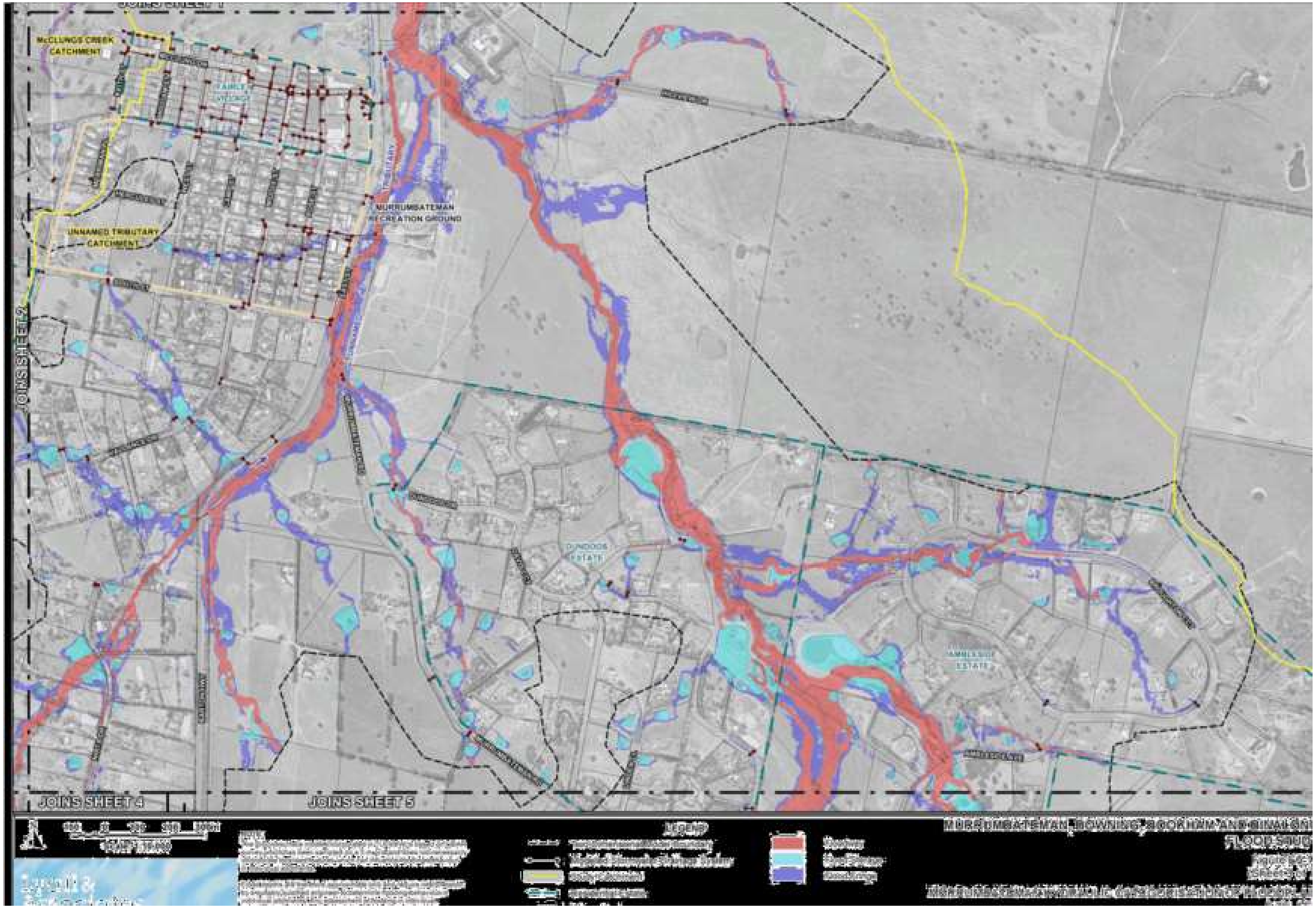
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
GOODA
CREEK


INSET
REFER INSET
LIMIT OF FLOOD MAPPING
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3
LEGEND


CARRINGTON PARK
VINEYARD RIDGE
MERRYVILLE ESTATE
McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4
LEGEND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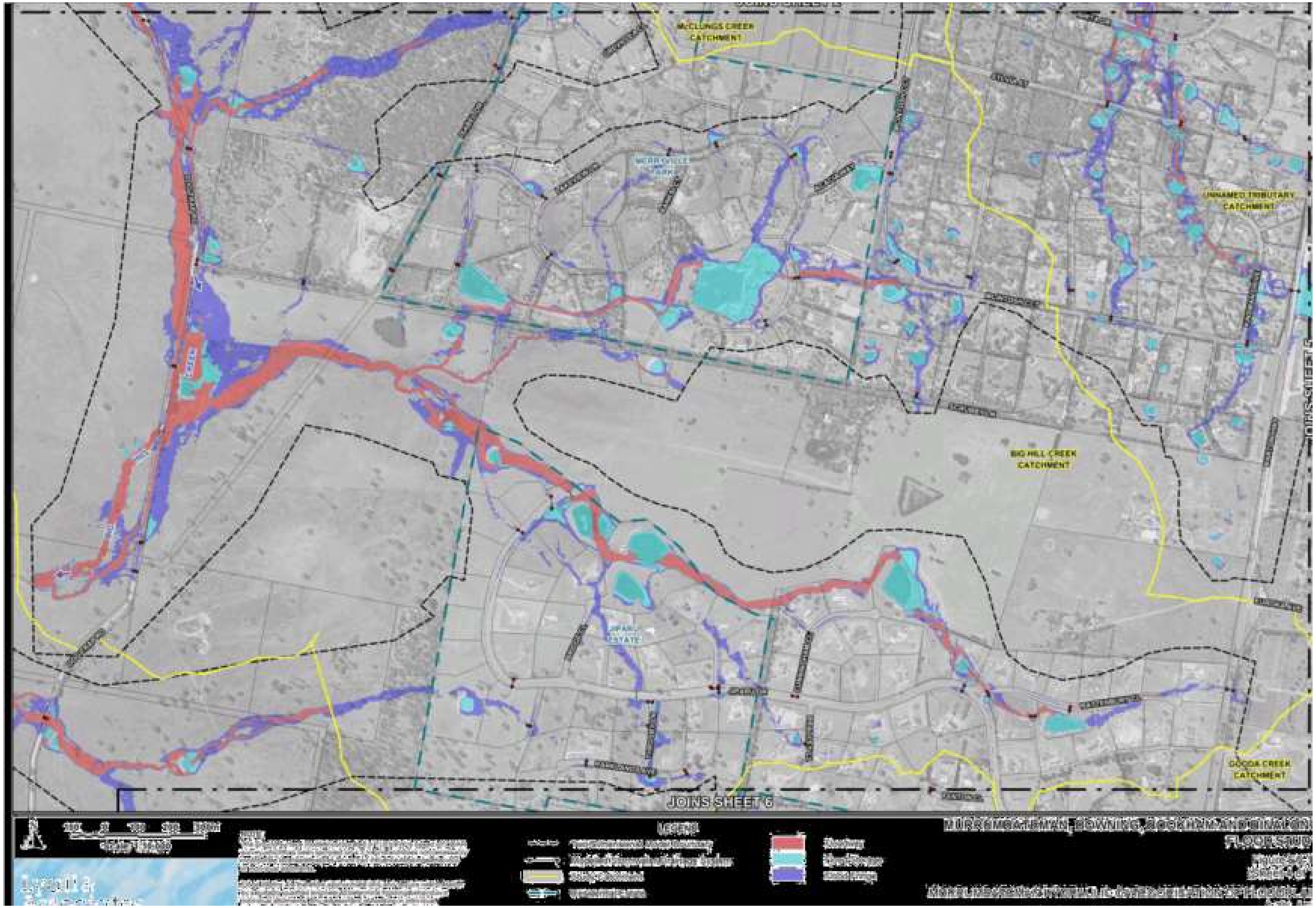
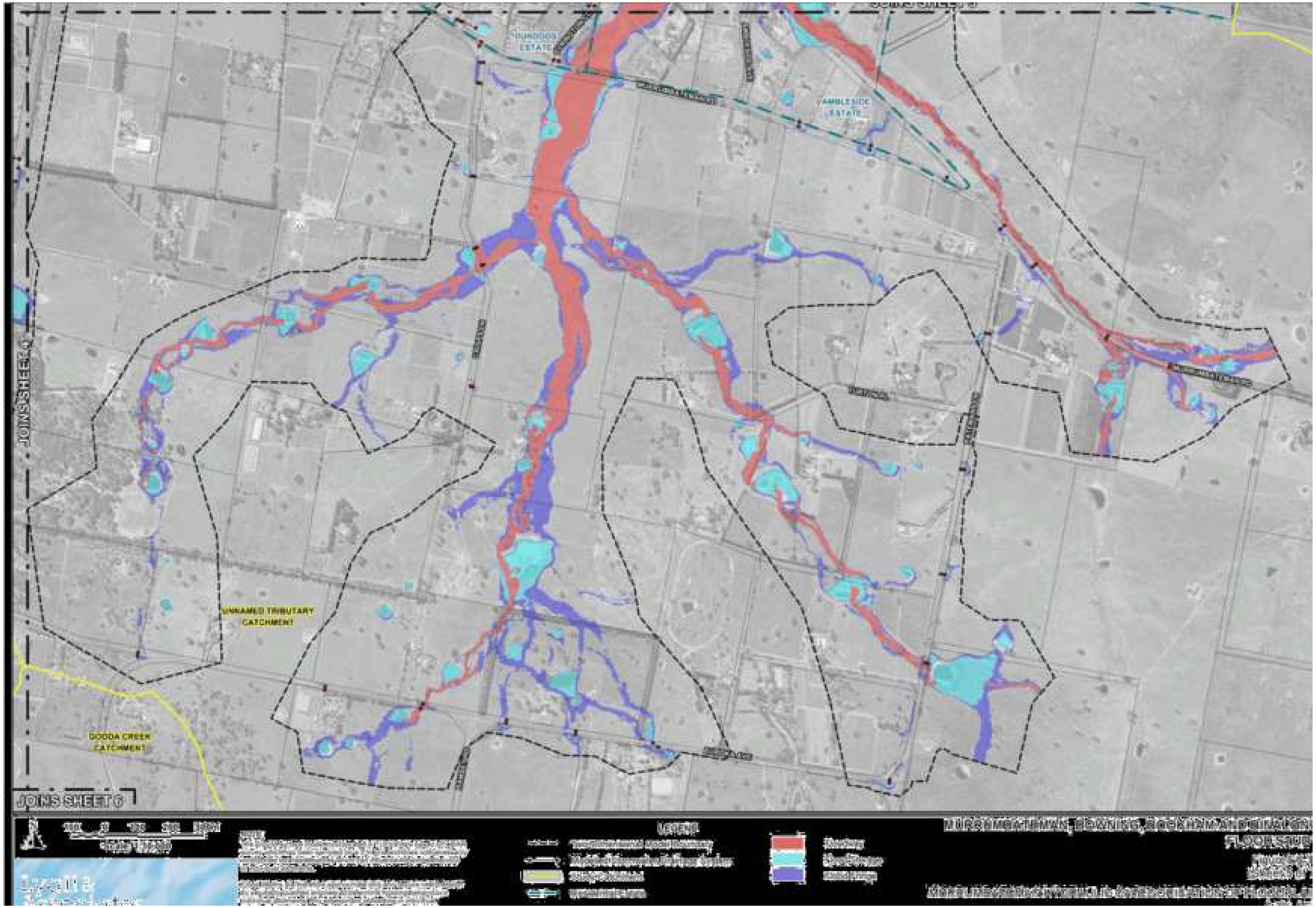
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5


McCLUNGS CREEK
CATCHMENT
UNNAMED TRIBUTARY
CATCHMENT
BIG HILL CREEK
CATCHMENT
GOODA CREEK
CATCHMENT
JOINS SHEET 6
JOINS SHEET 5
LEGEND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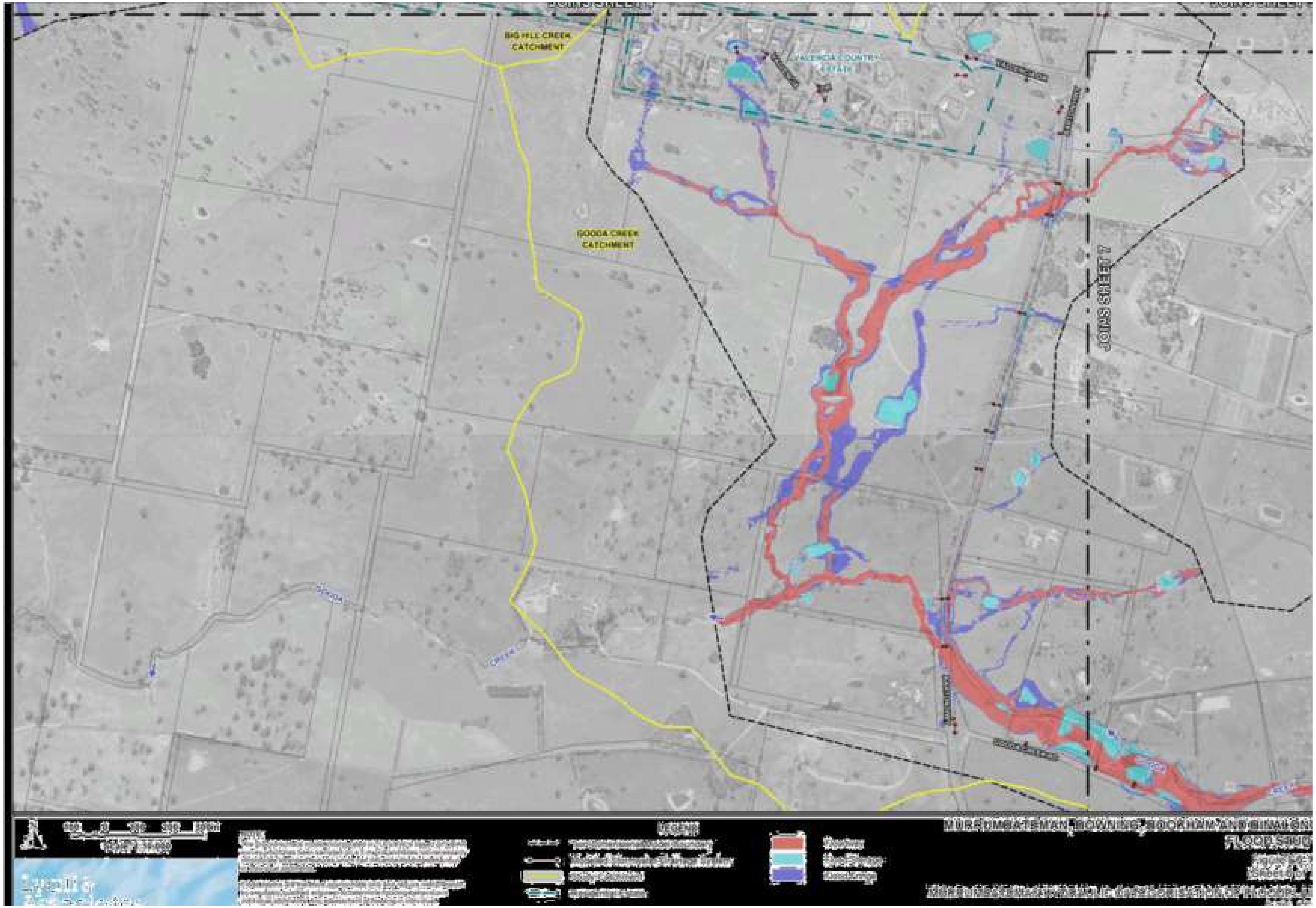
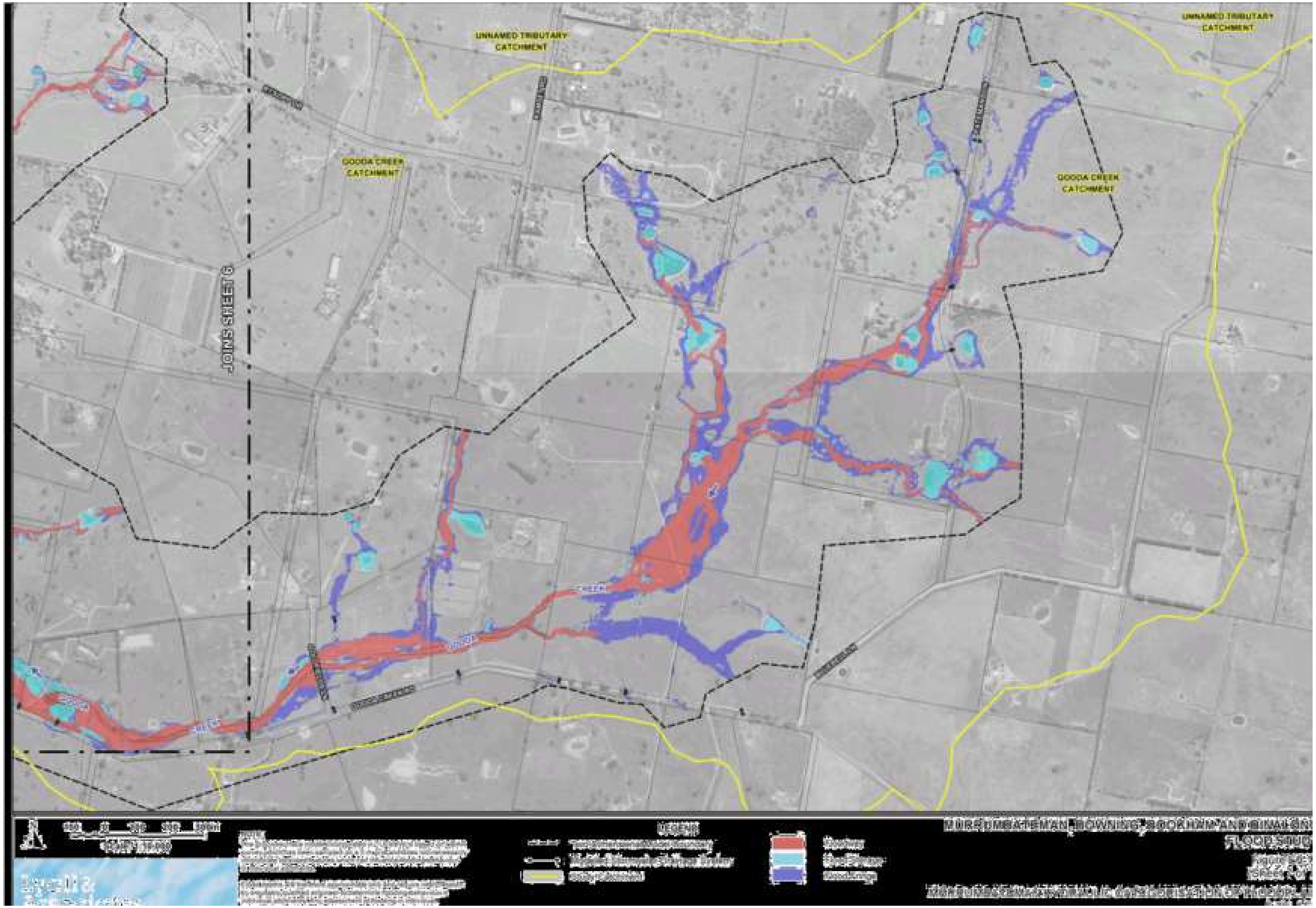
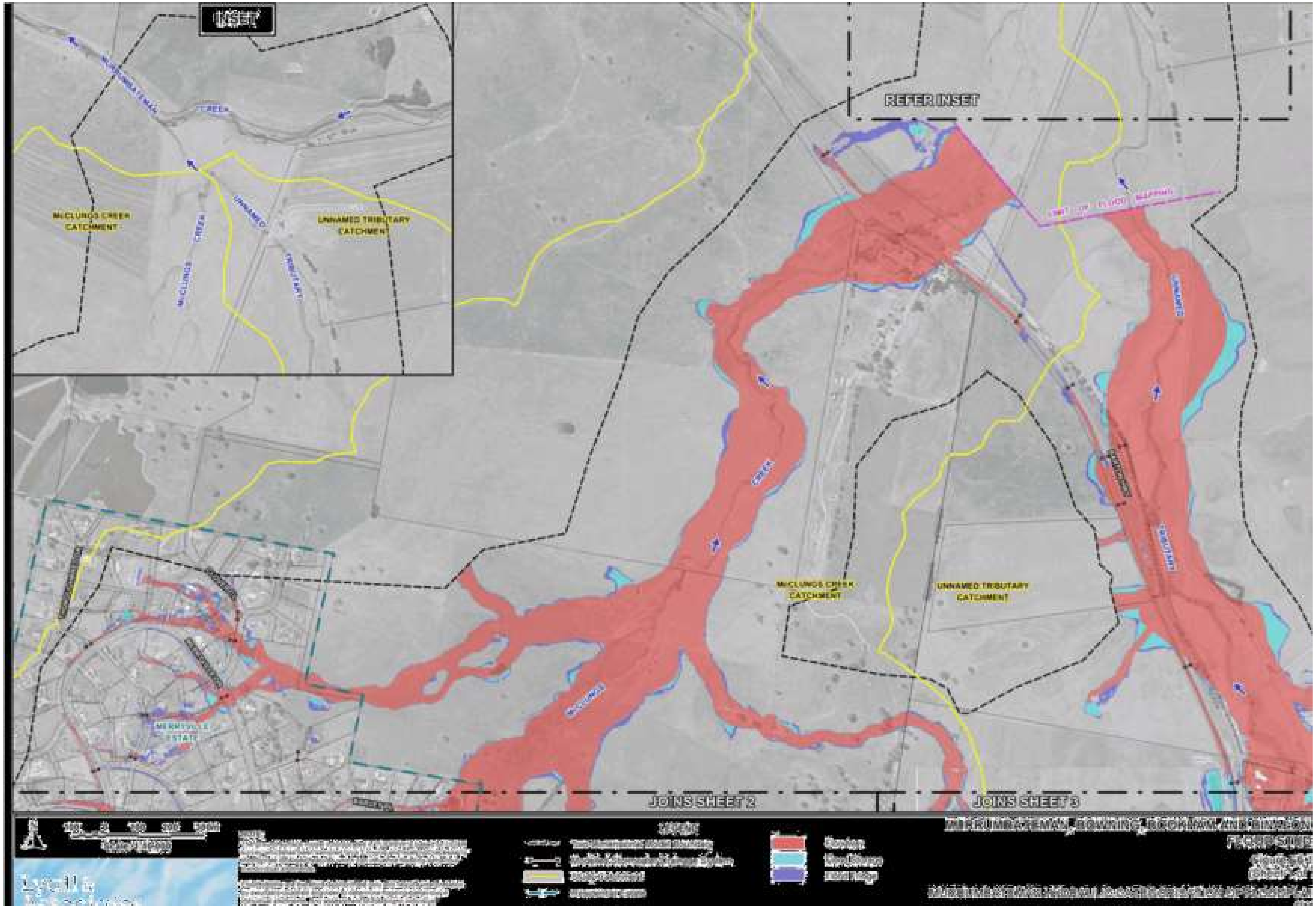
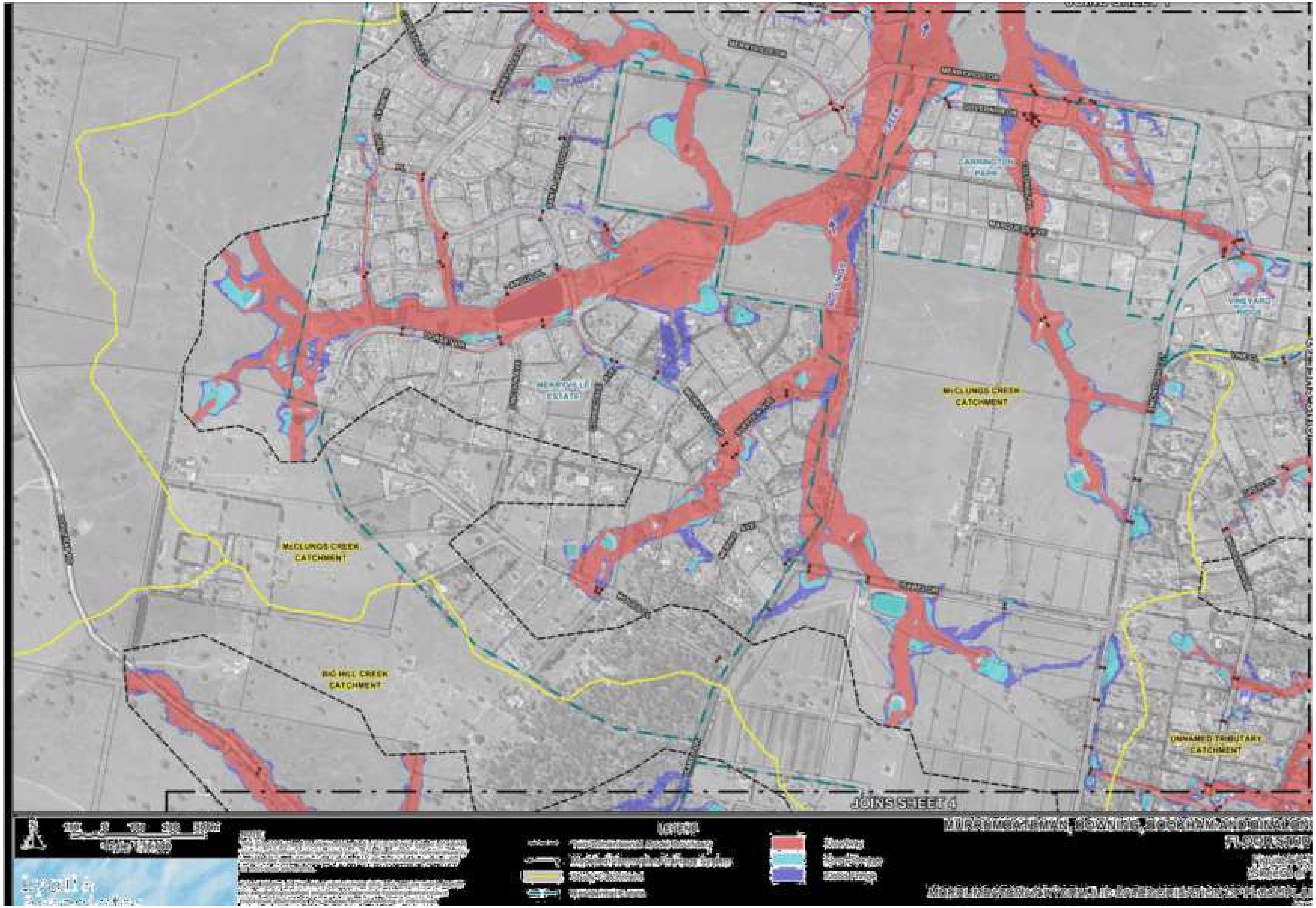
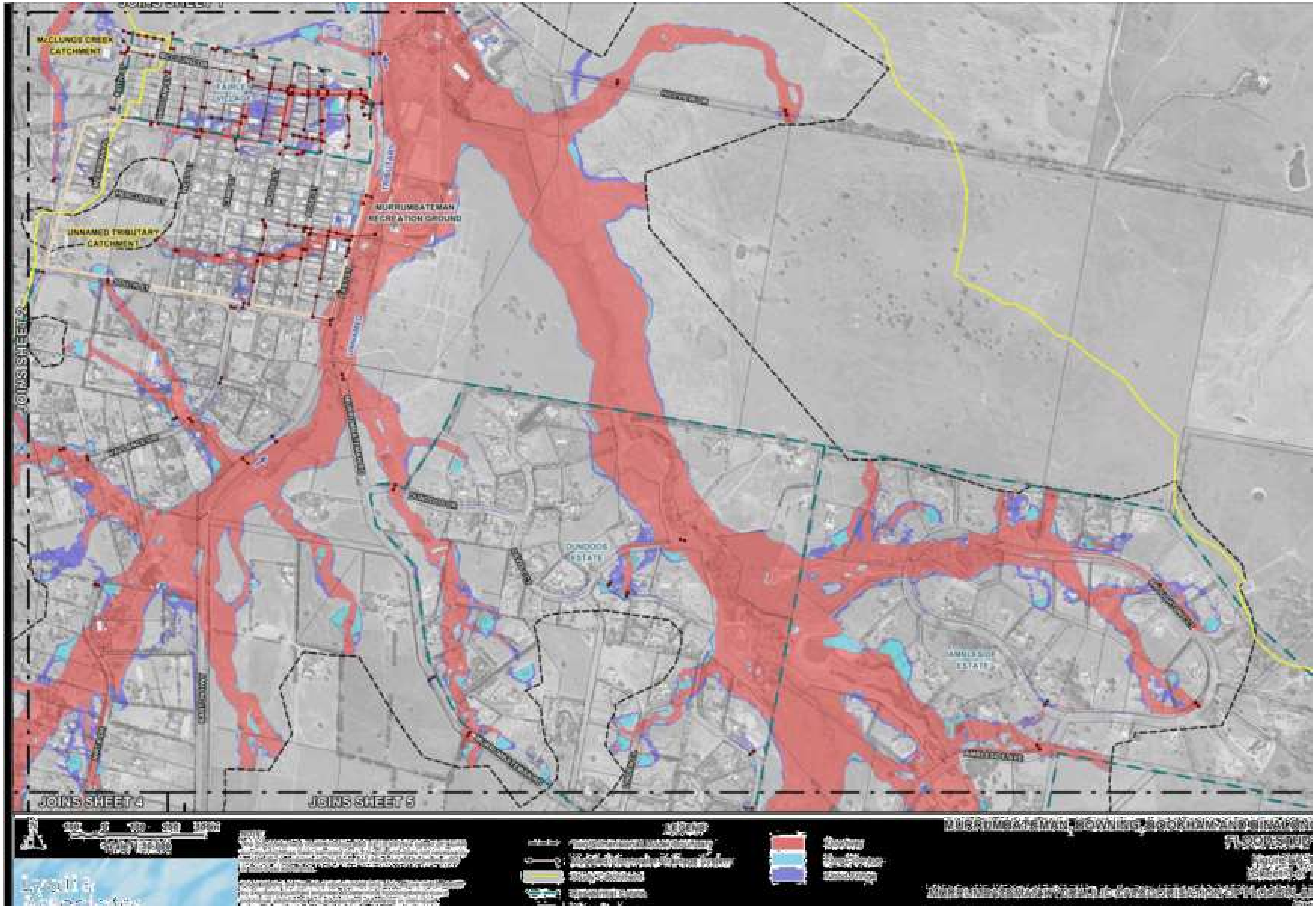
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6


BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
VALENCIA COUNTRY ESTATE
JOINS SHEET 7
GOODA
CREEK


UNNAMED TRIBUTARY CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6


INSET
REFER INSET
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN
CREEK
UNNAMED
TRIBUTARY
McCLUNGS
MERRYVILLE ESTATE
LIMIT OF FLOOD MAPPING
JOINS SHEET 2
JOINS SHEET 3
Floodway
Flood Storage
Flood Fringe


McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MERRYVILLE ESTATE
CANNINGTON PARK
VINEYARD RIDGE
JOINS SHEET 4
LEGEND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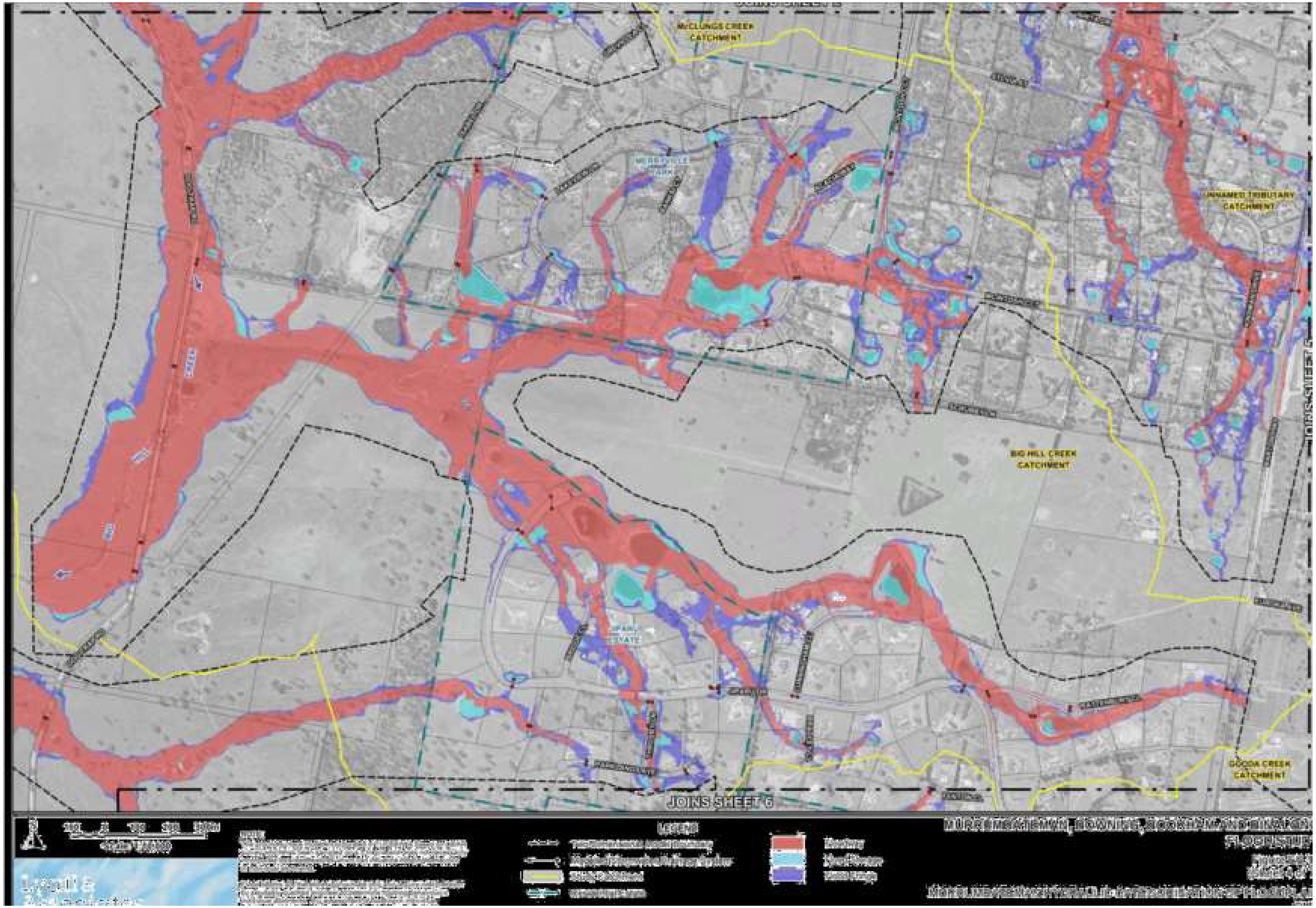
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5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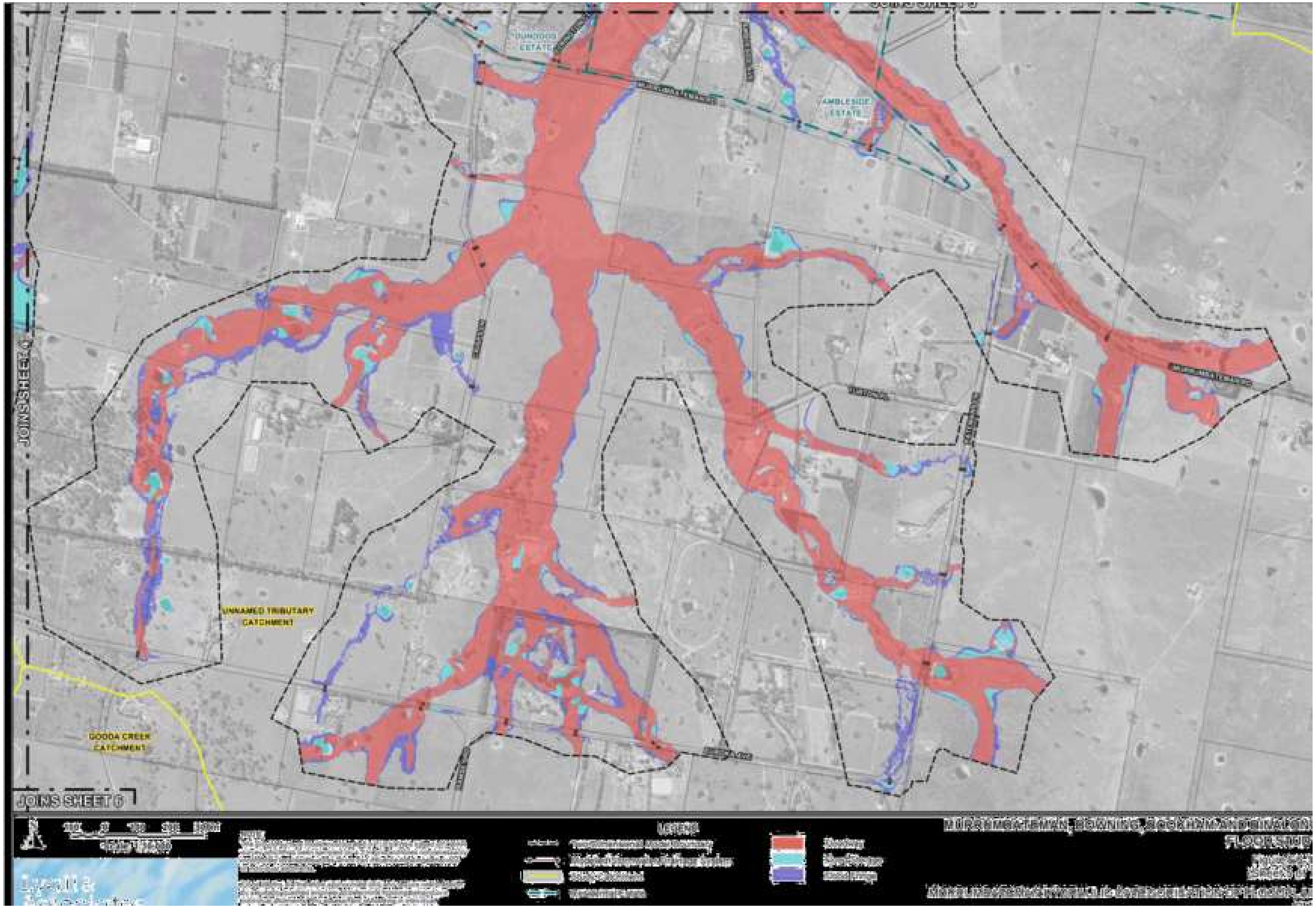
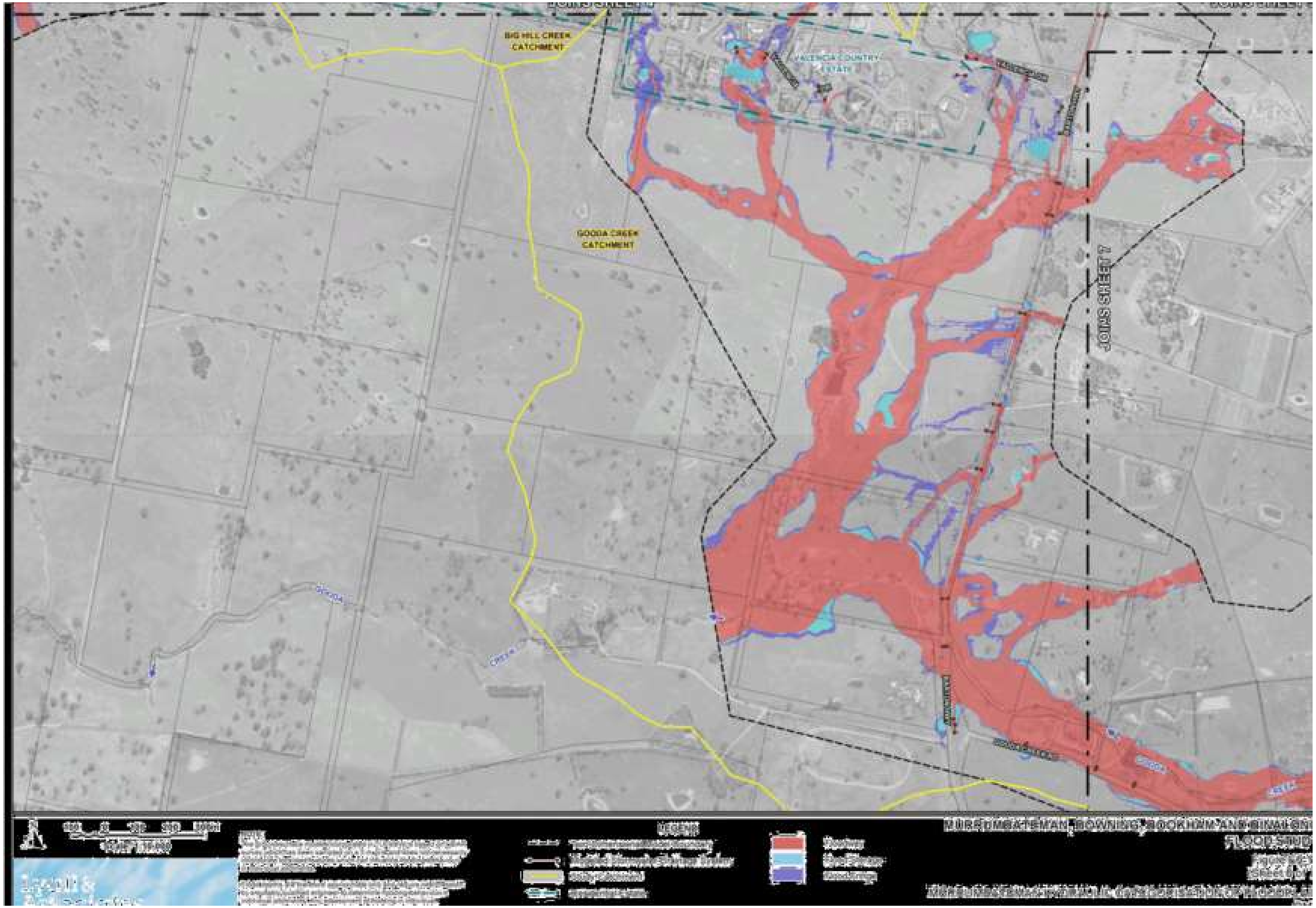
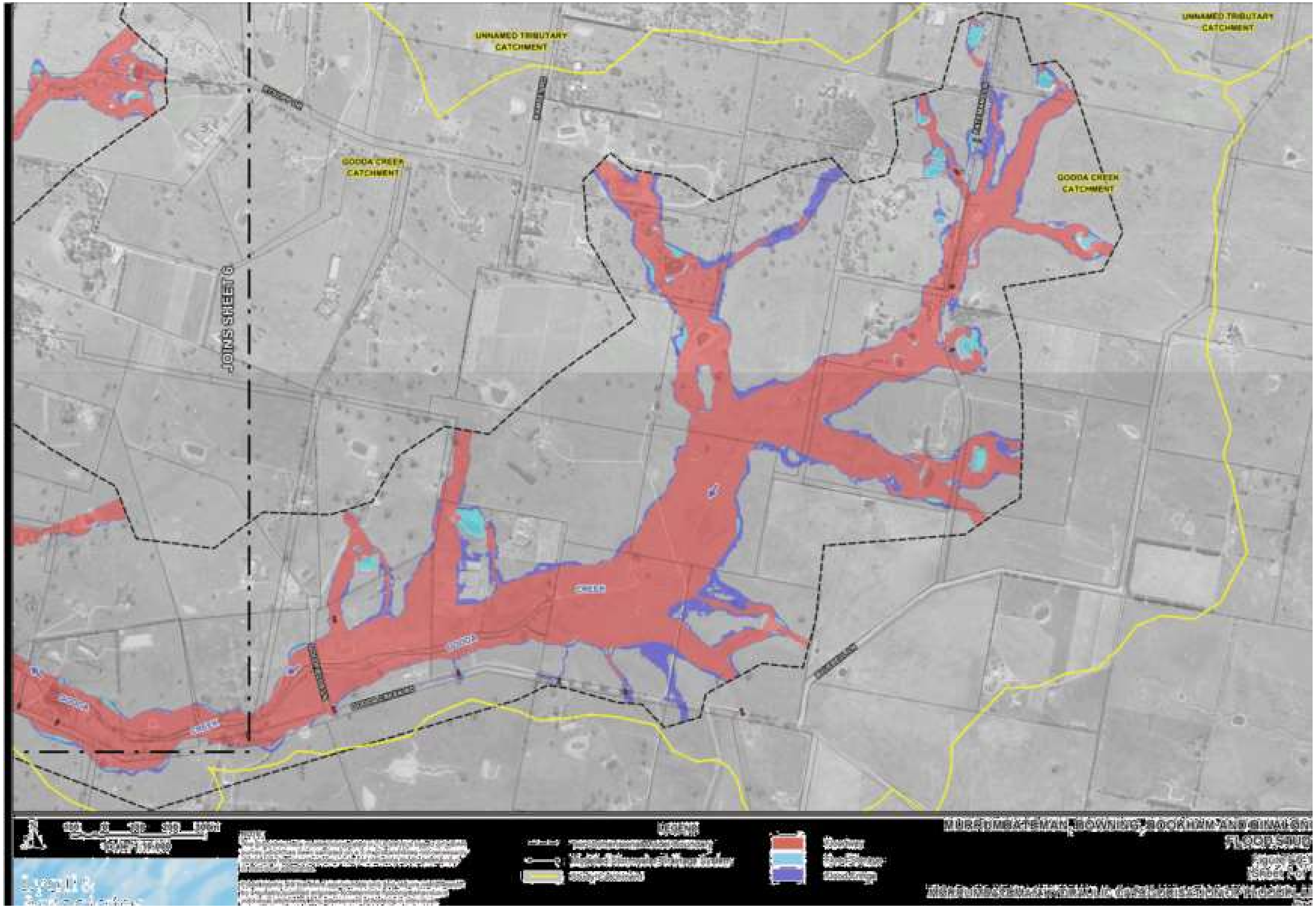
UNNAMED TRIBUTARY CATCHMENT
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
LEGEND


AMBLESIDE ESTATE
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 4
JOINS SHEET 6
LEGEND
FLOOD STUDY


BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 7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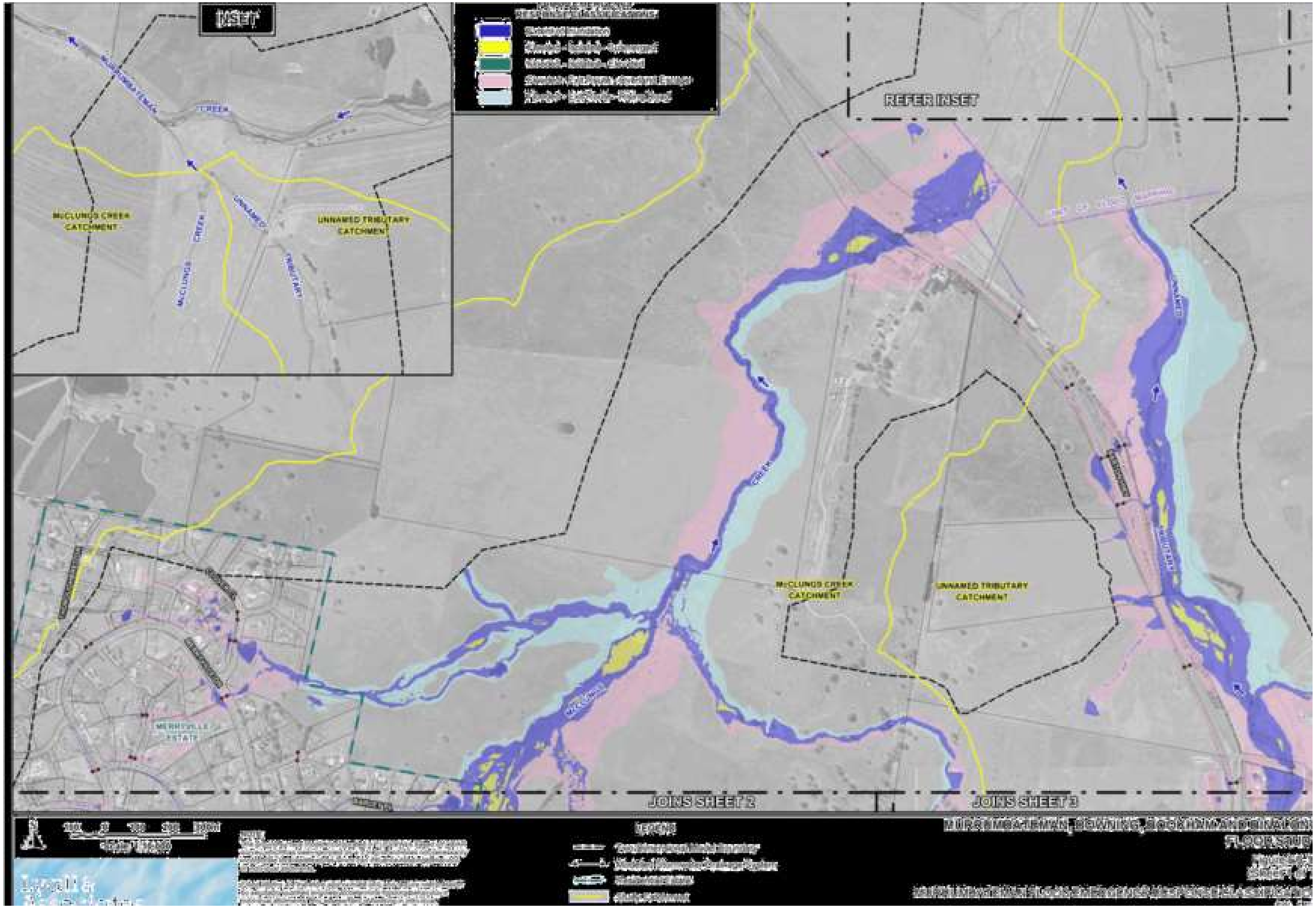
GOODA CREEK CATCHMENT
JOINS SHEET 6
CREEK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REFER INSET
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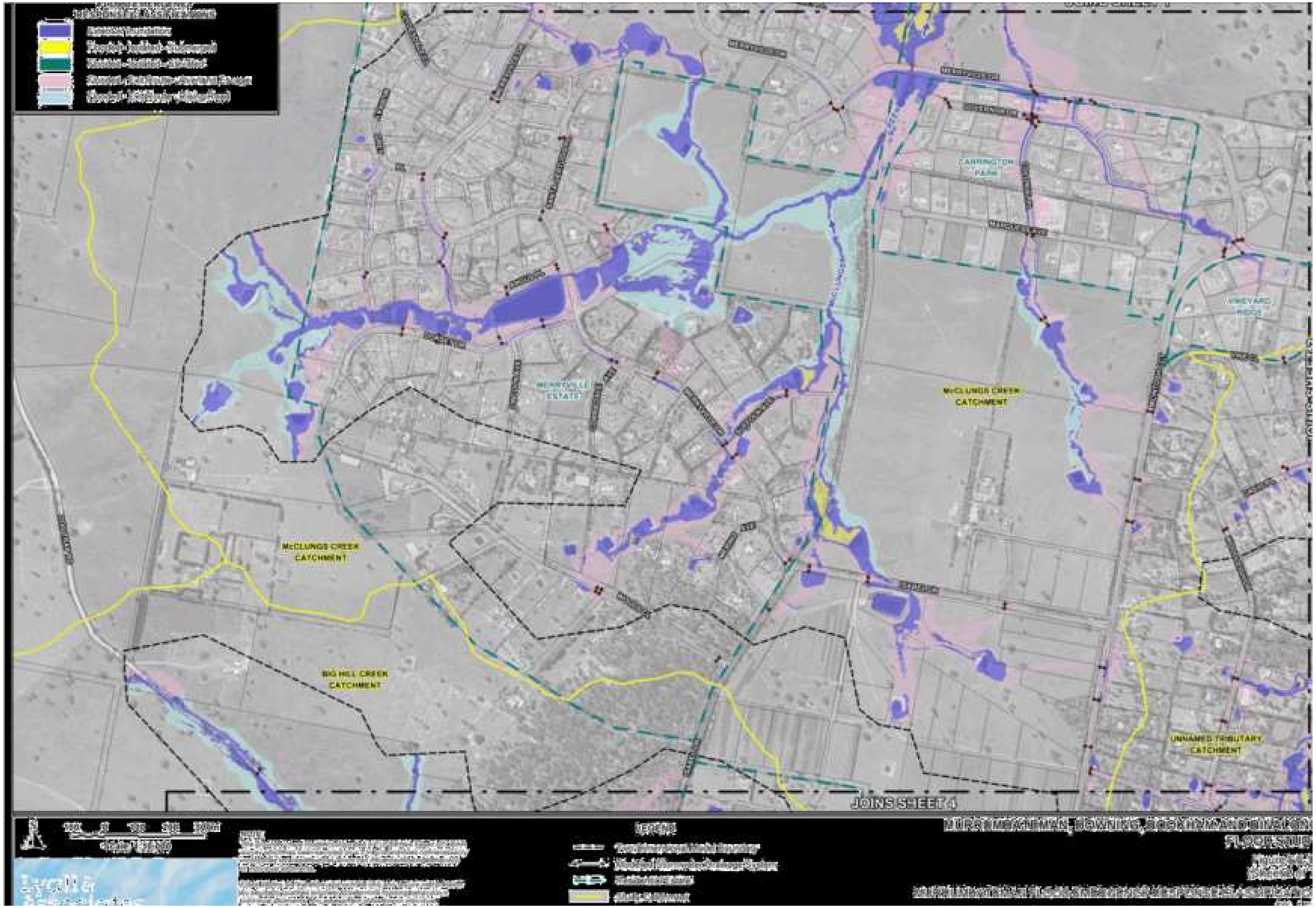
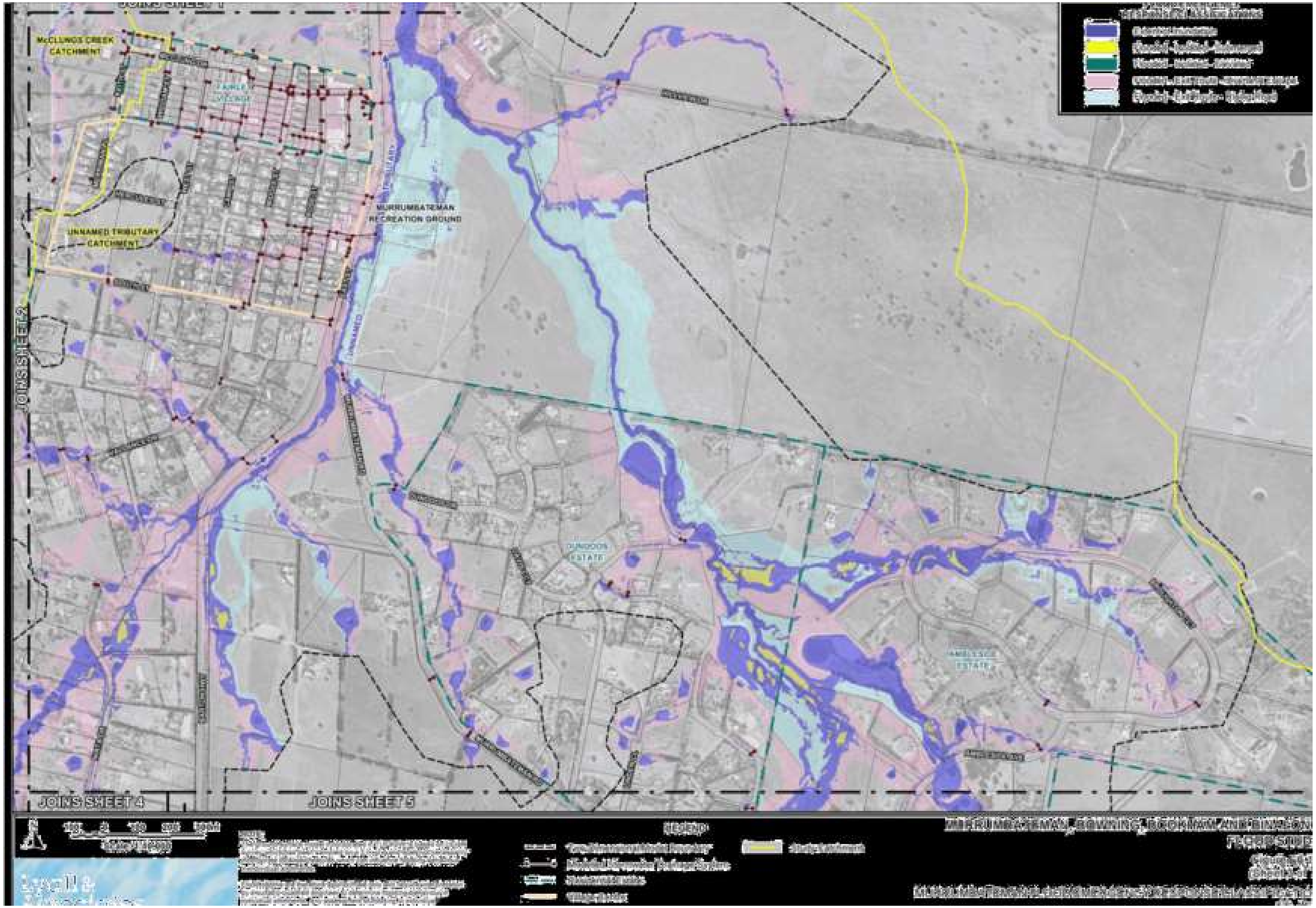
CATCHMENT
UNNAMED TRIBUTARY
CATCHMENT
MERRYVILLE
ESTATE
JOINS SHEET 2
JOINS SHEET 3


CANNINGTON PARK
VINEYARD RIDGE
MERRYVILLE ESTATE
McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4
LEGEND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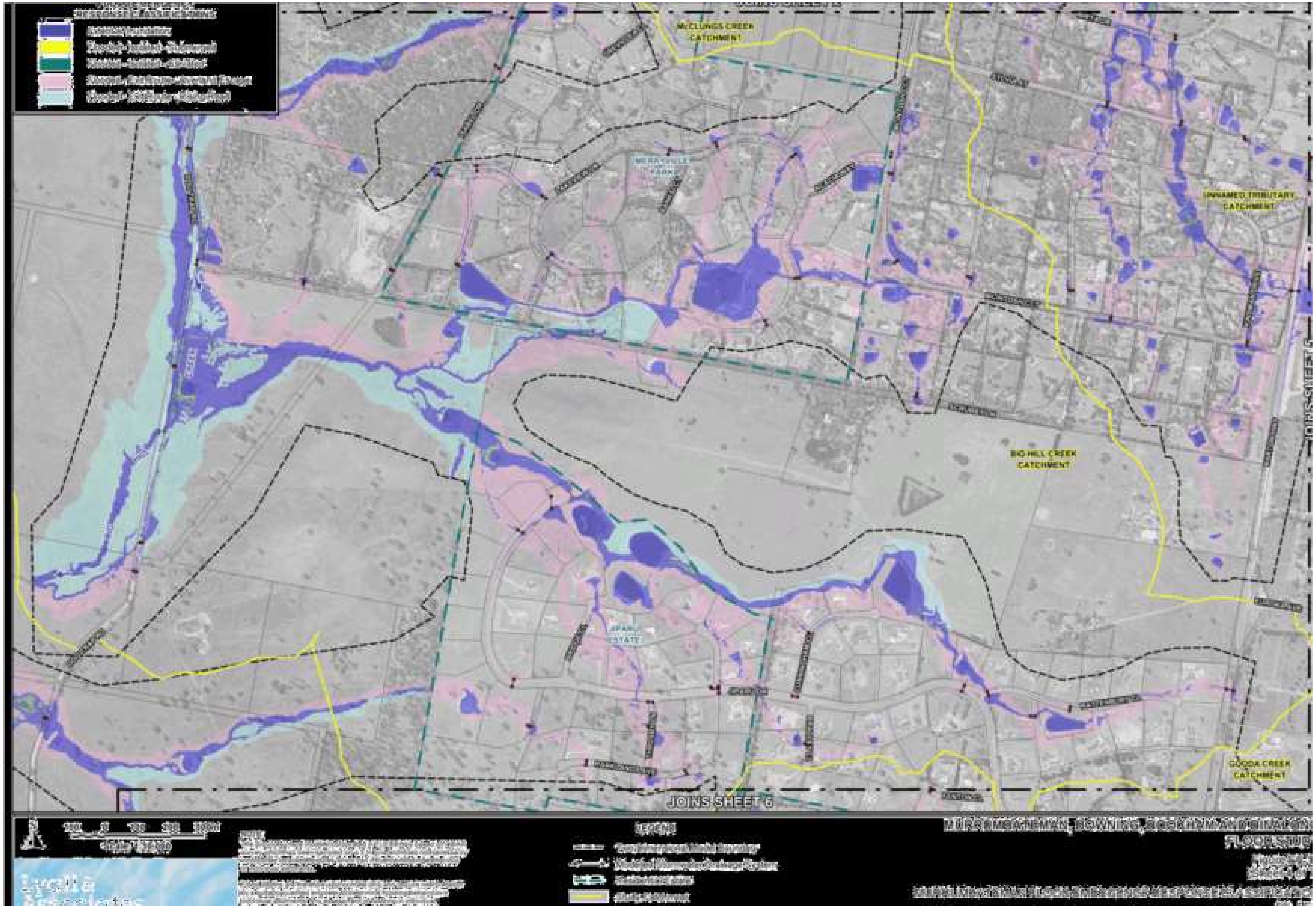
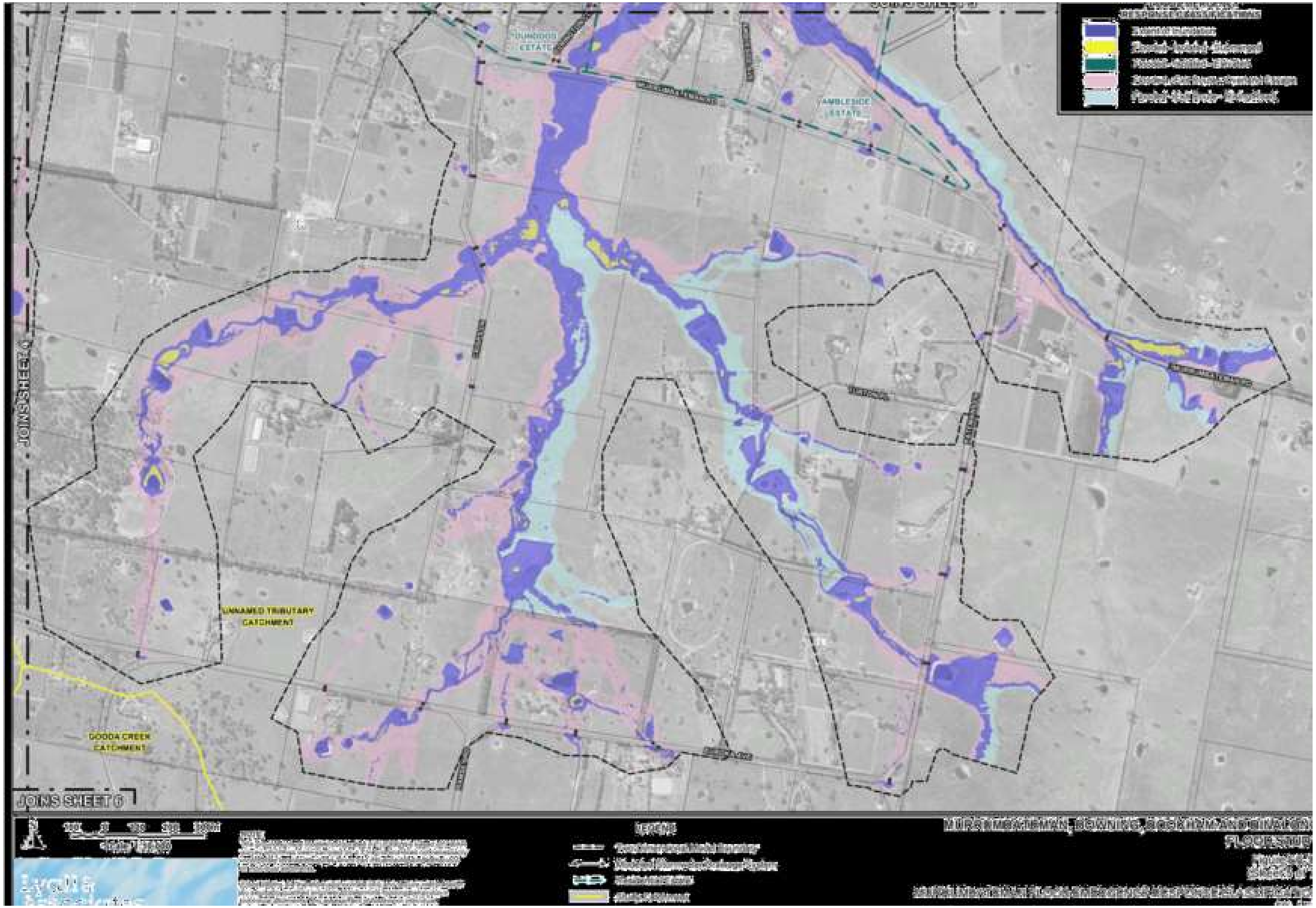
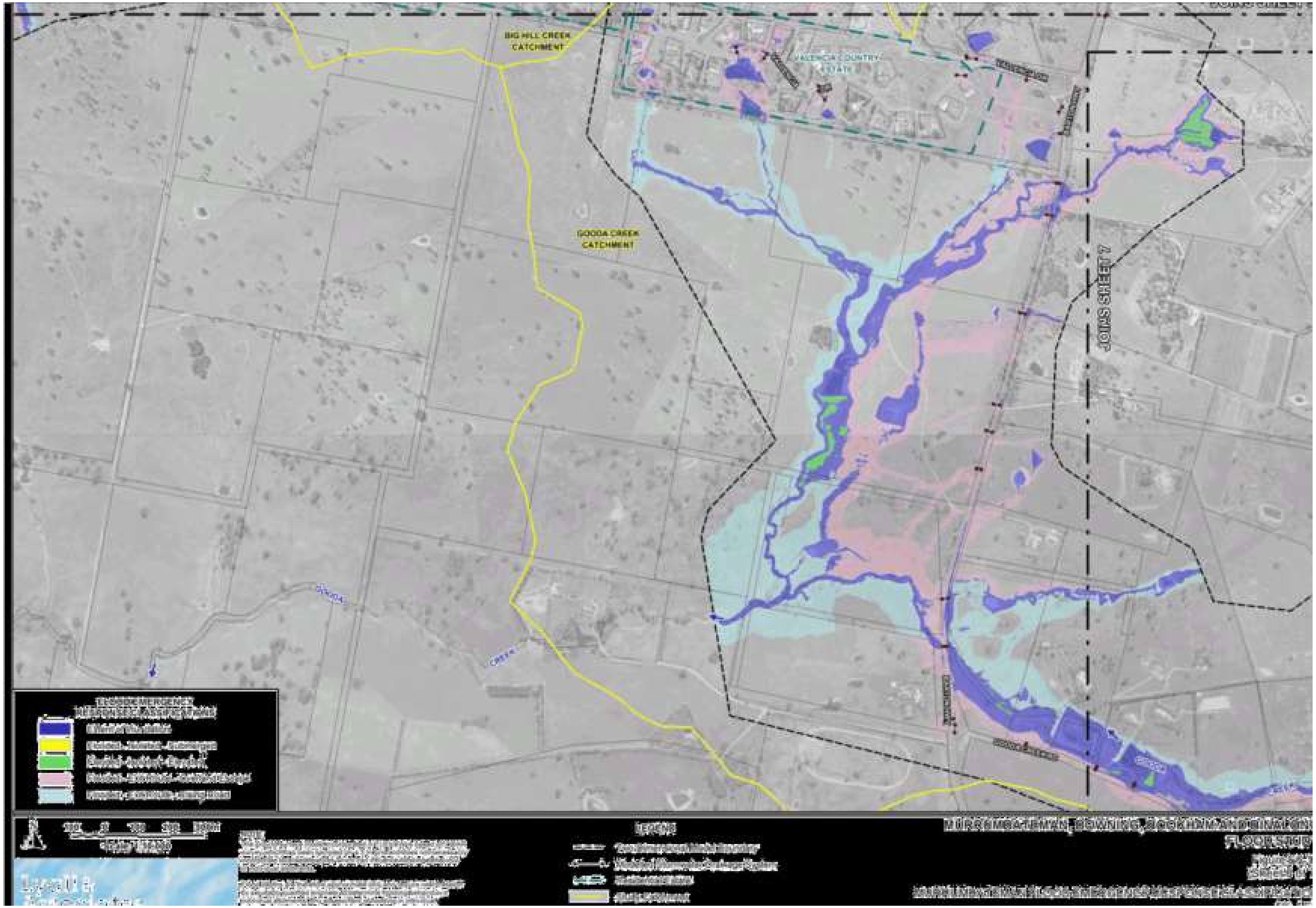
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5


McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
JOINS SHEET 5
LEGEND


JOINS SHEET 4
UNNAMED TRIBUTARY
CATCHMENT
GOODA CREEK
CATCHMENT
AMBLESIDE
ESTATE
JOINS SHEET 6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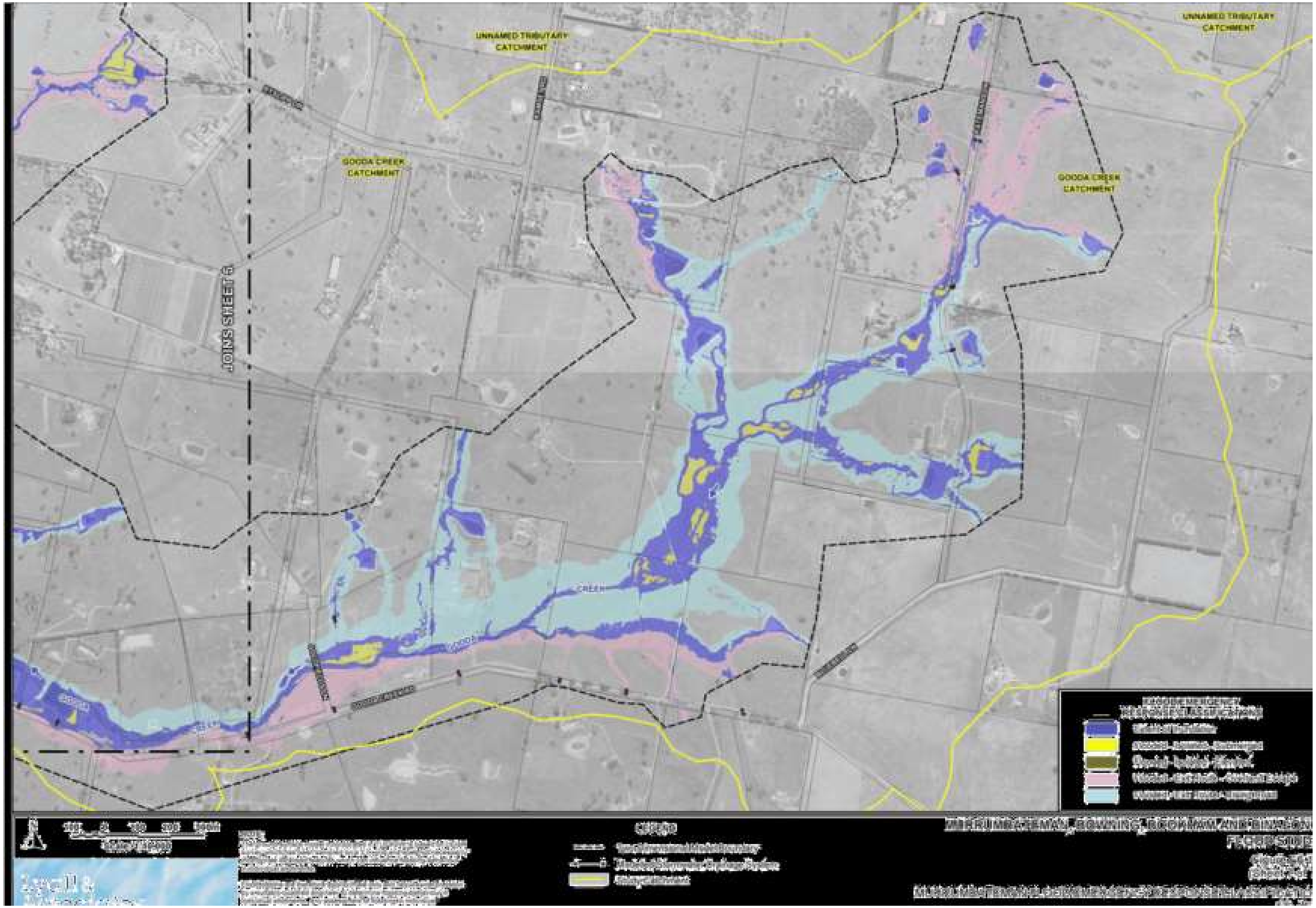
GOODA CREEK CATCHMENT
JOINS SHEET 7
LEGEND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GOODA CREEK CATCHMENT
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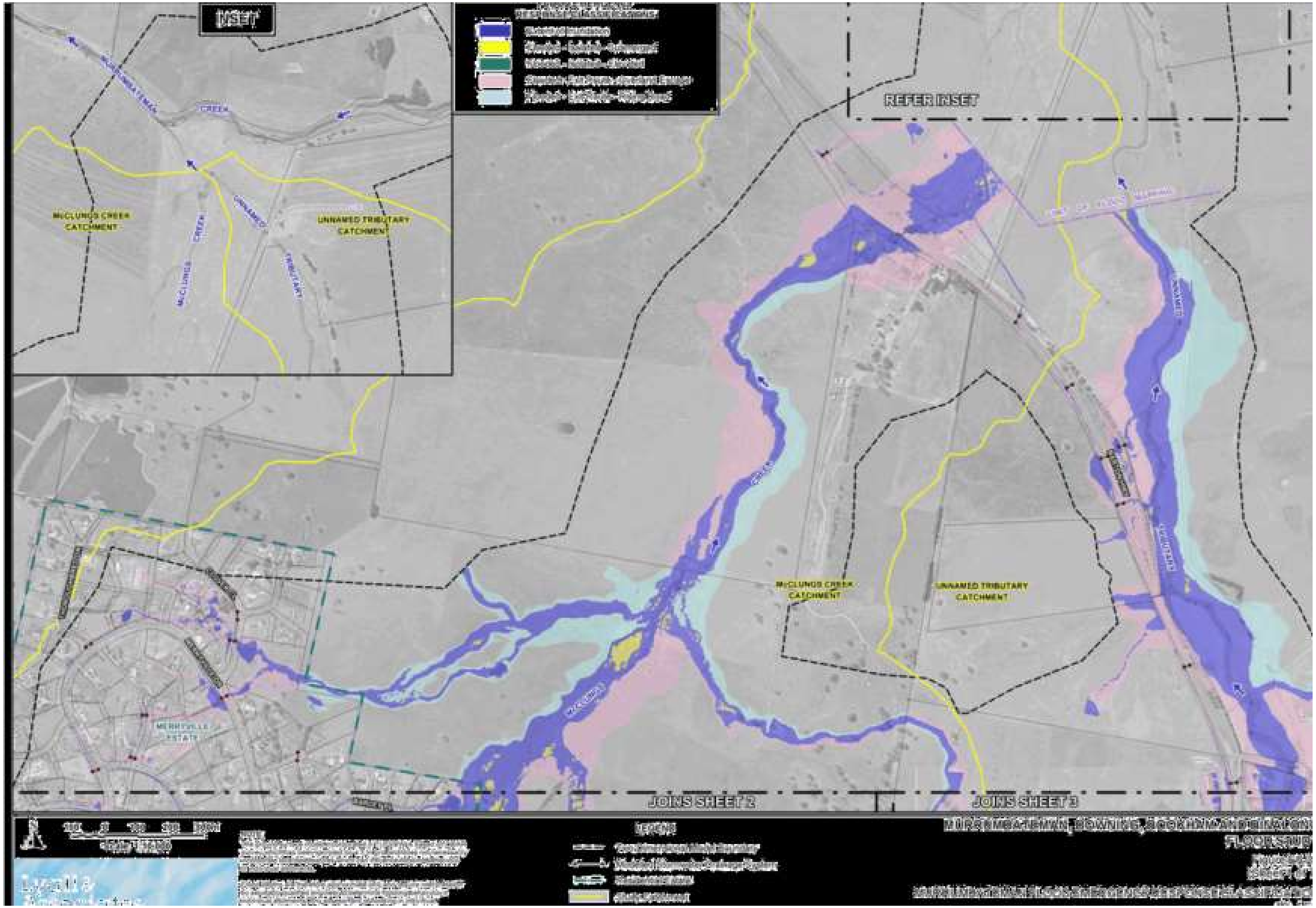
JOINS SHEET 5
CREEK
GOODA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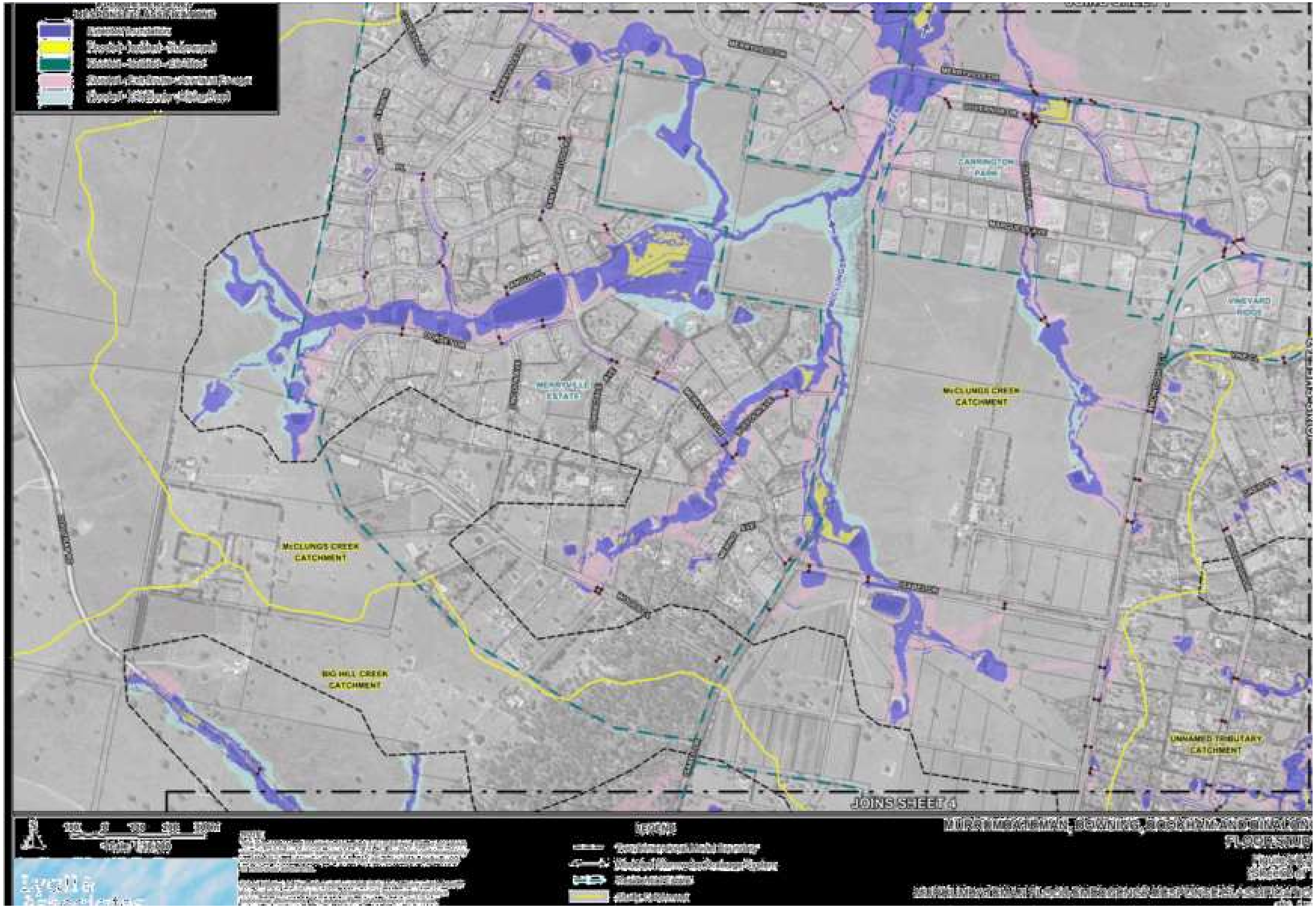
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 2
JOINS SHEET 3
LEGEND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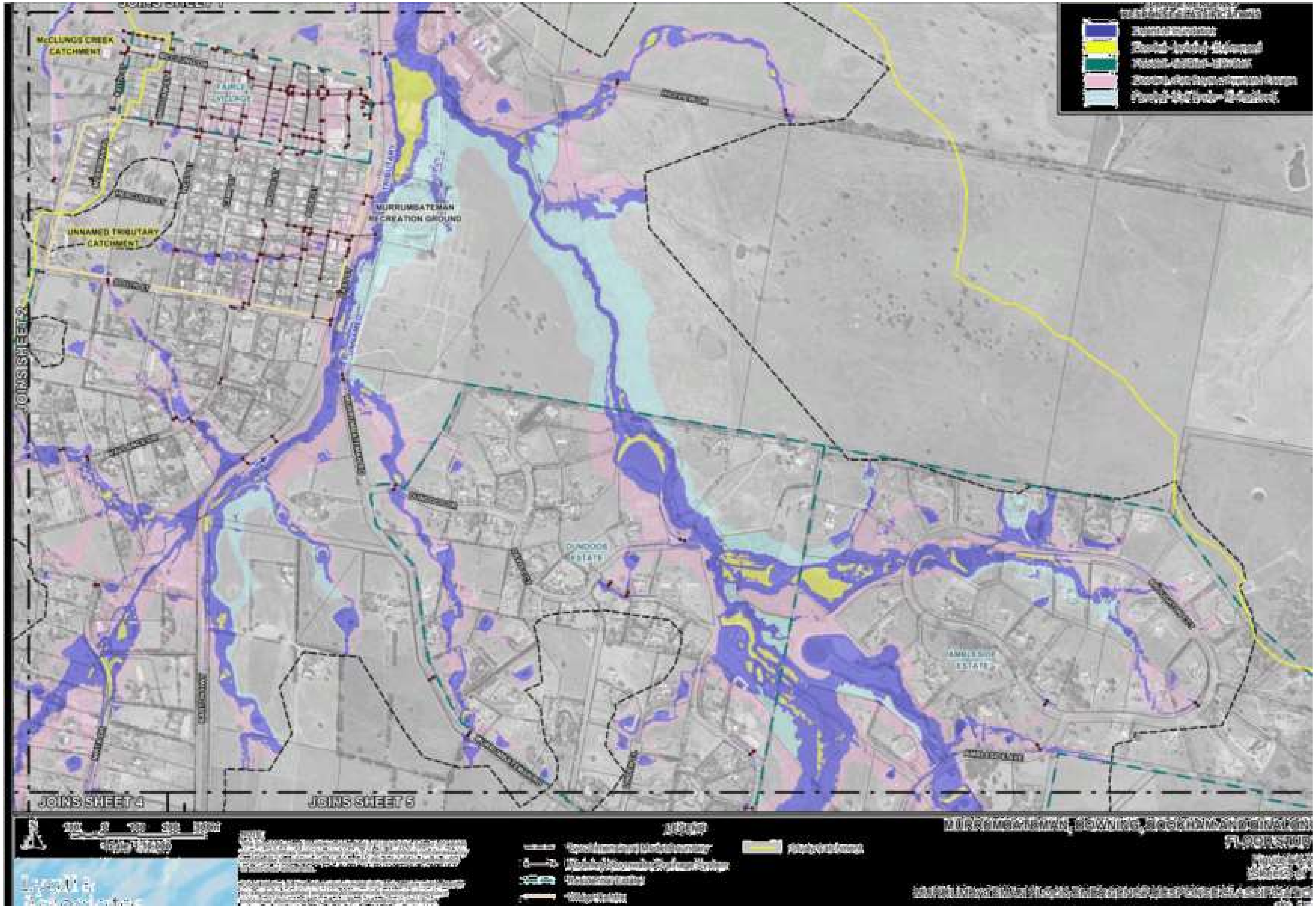
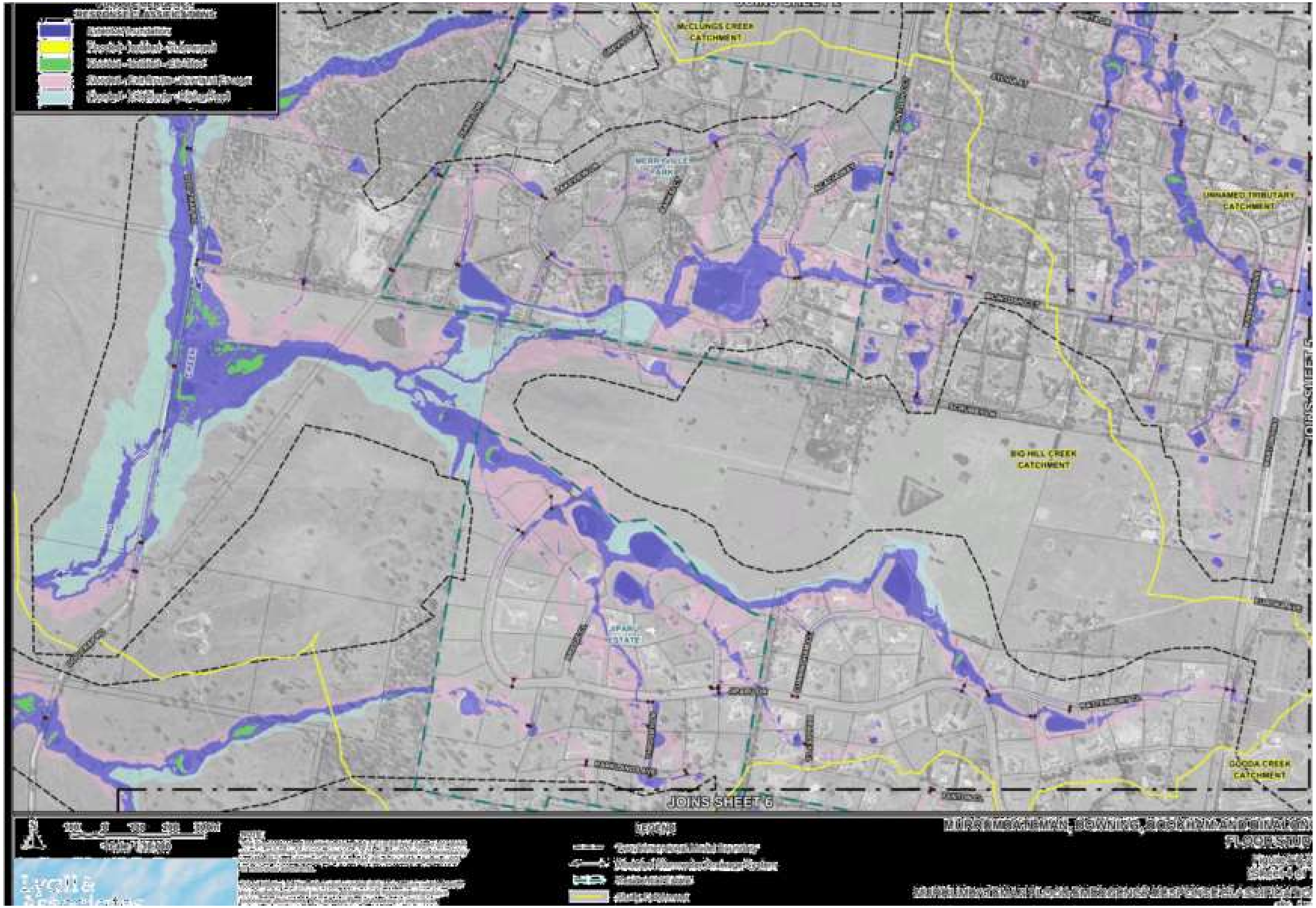
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4


McCLUNGS CREEK
CATCHMENT
UNNAMED TRIBUTARY
CATCHMENT
MURRUMBATEMAN
RECREATION GROUND
TRIBUTARY
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5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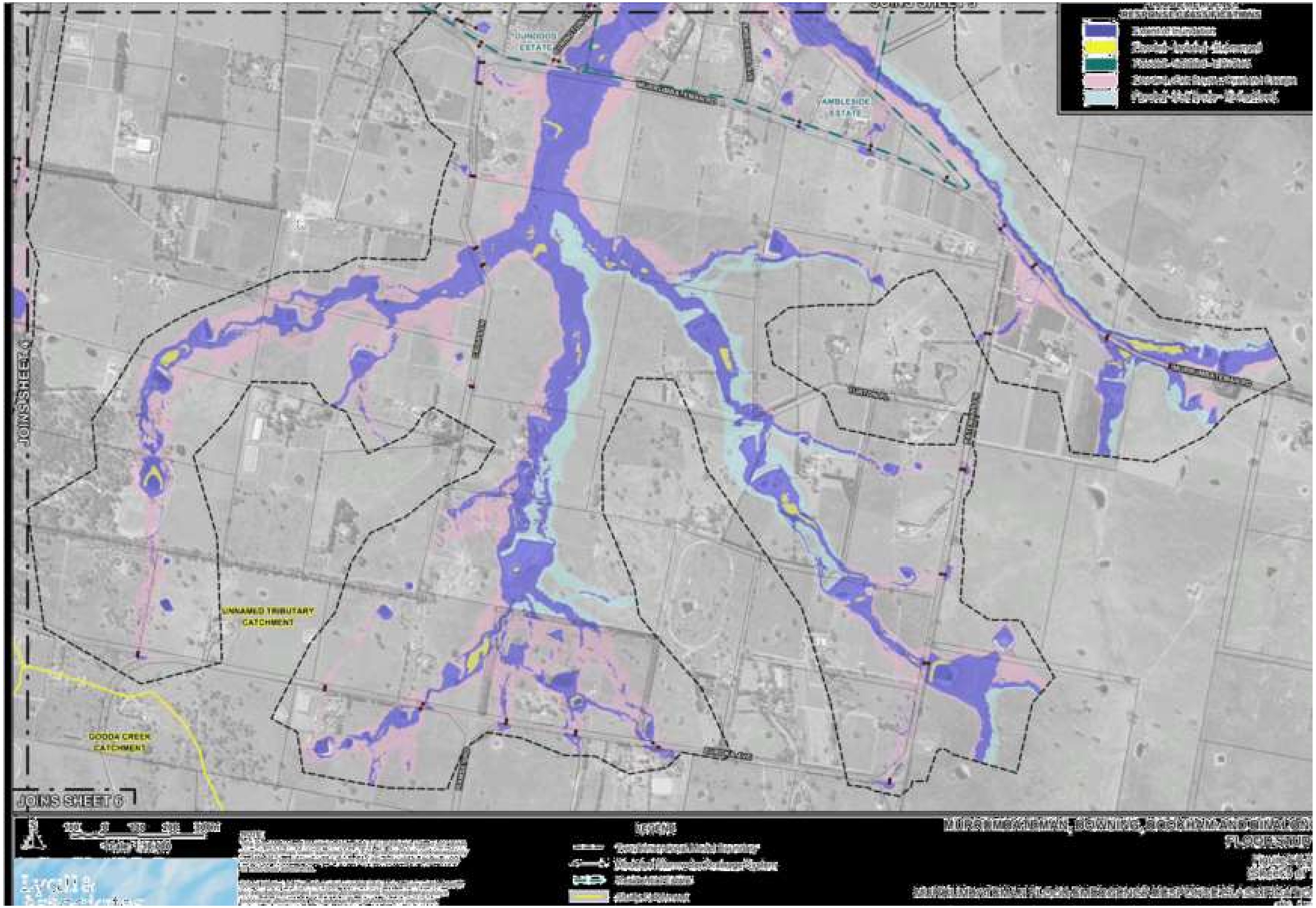
UNNAMED TRIBUTARY
CATCHMENT
BIG HILL CREEK
CATCHMENT
GOODA CREEK
CATCHMENT
JOINS SHEET 6
LEGEND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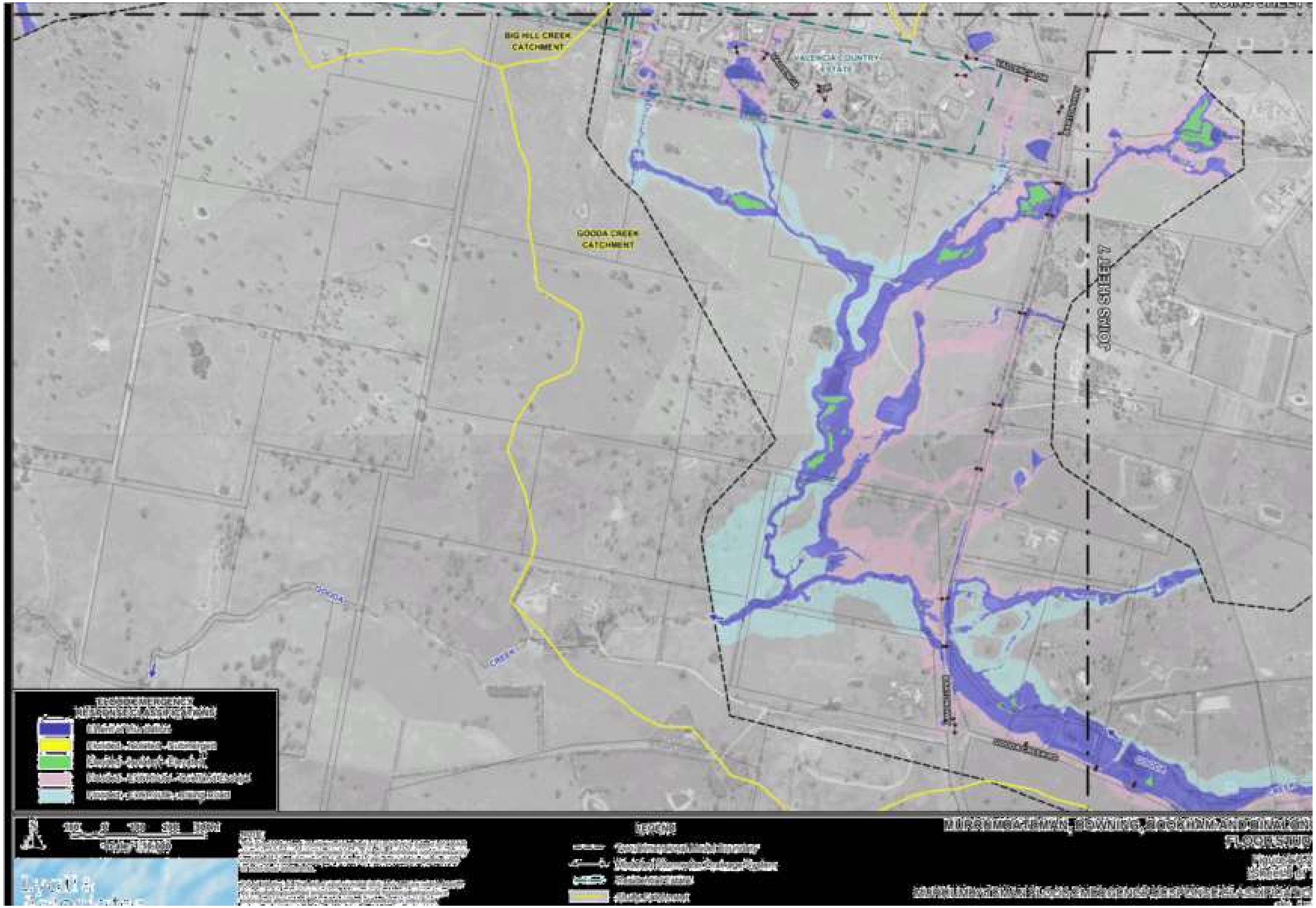
AMBLESIDE ESTATE
JOINS SHEET 4
JOINS SHEET 6
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
LEGEND
FLOOD STUDY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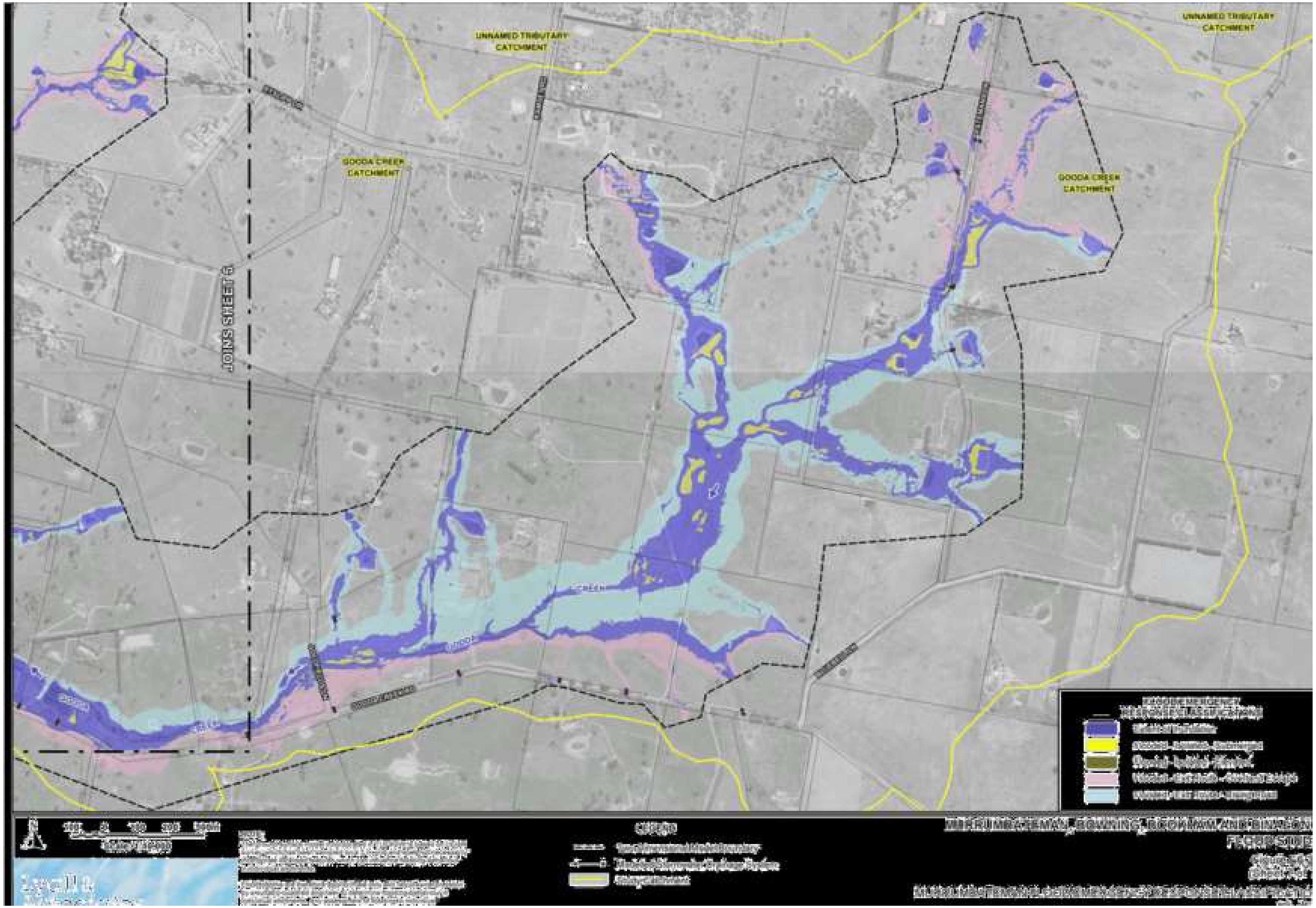
CATCHMENT
GOODA CREEK
CATCHMENT
VALENCIA COUNTRY
ESTATE
JOINS SHEET 7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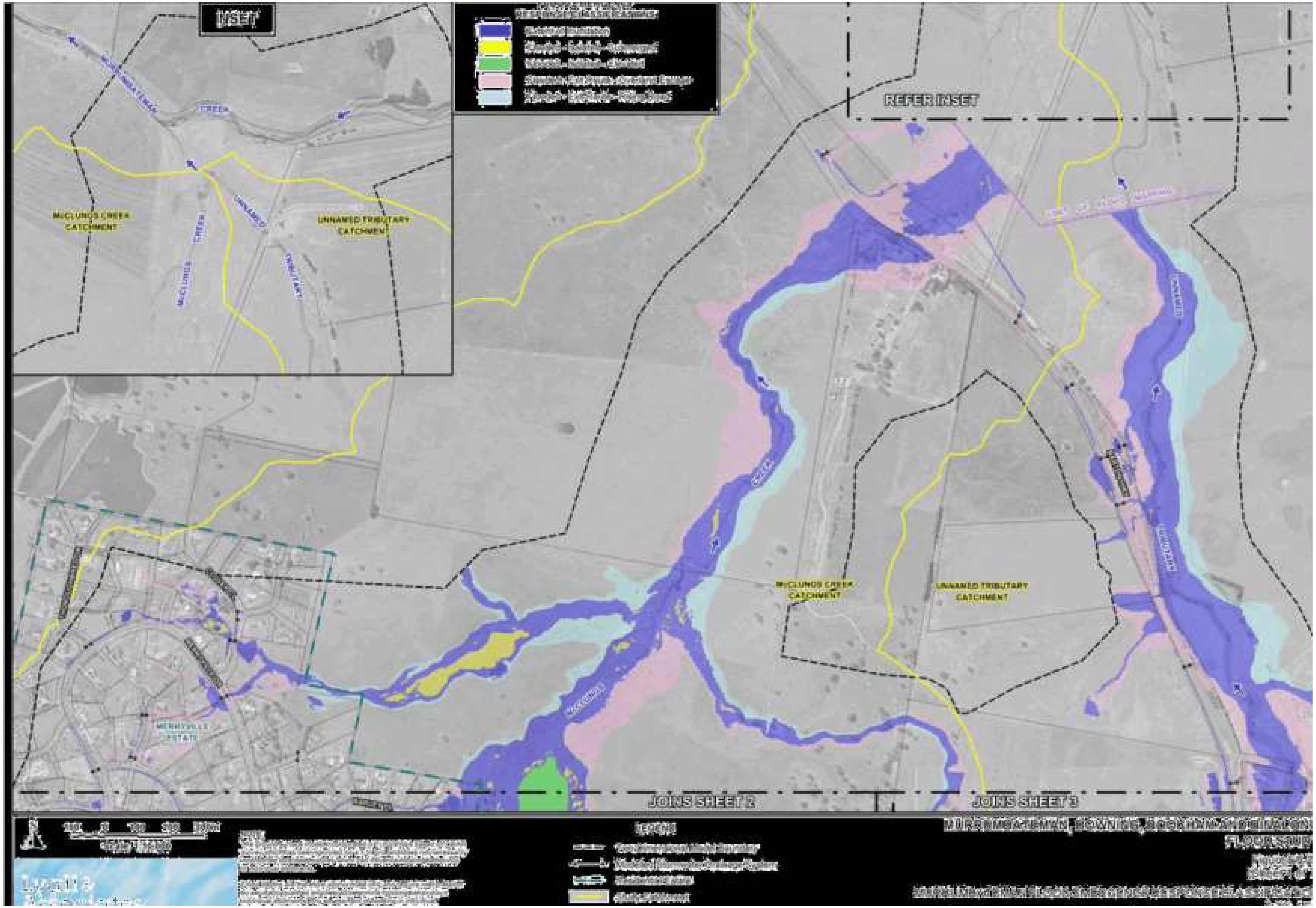
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 5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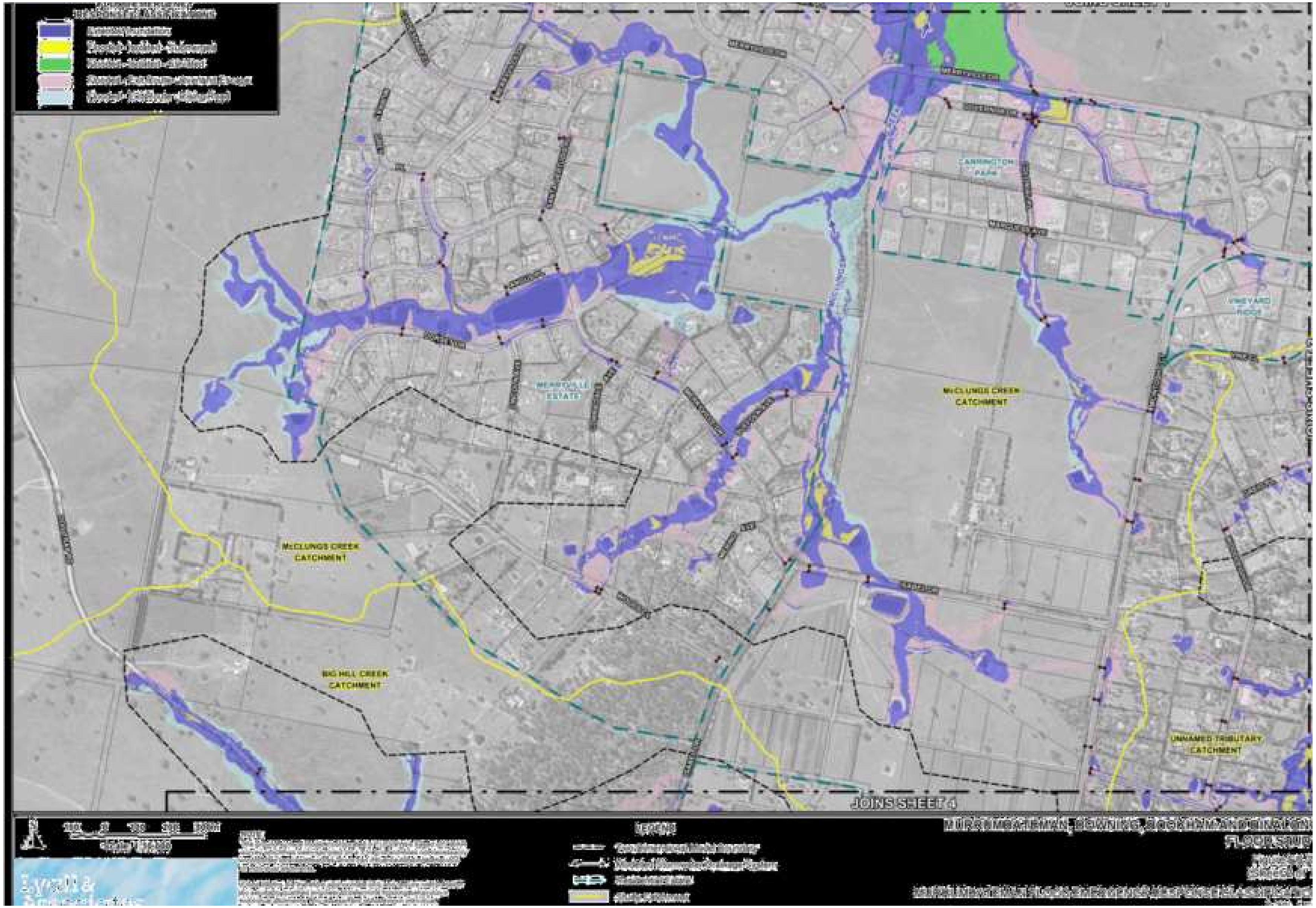
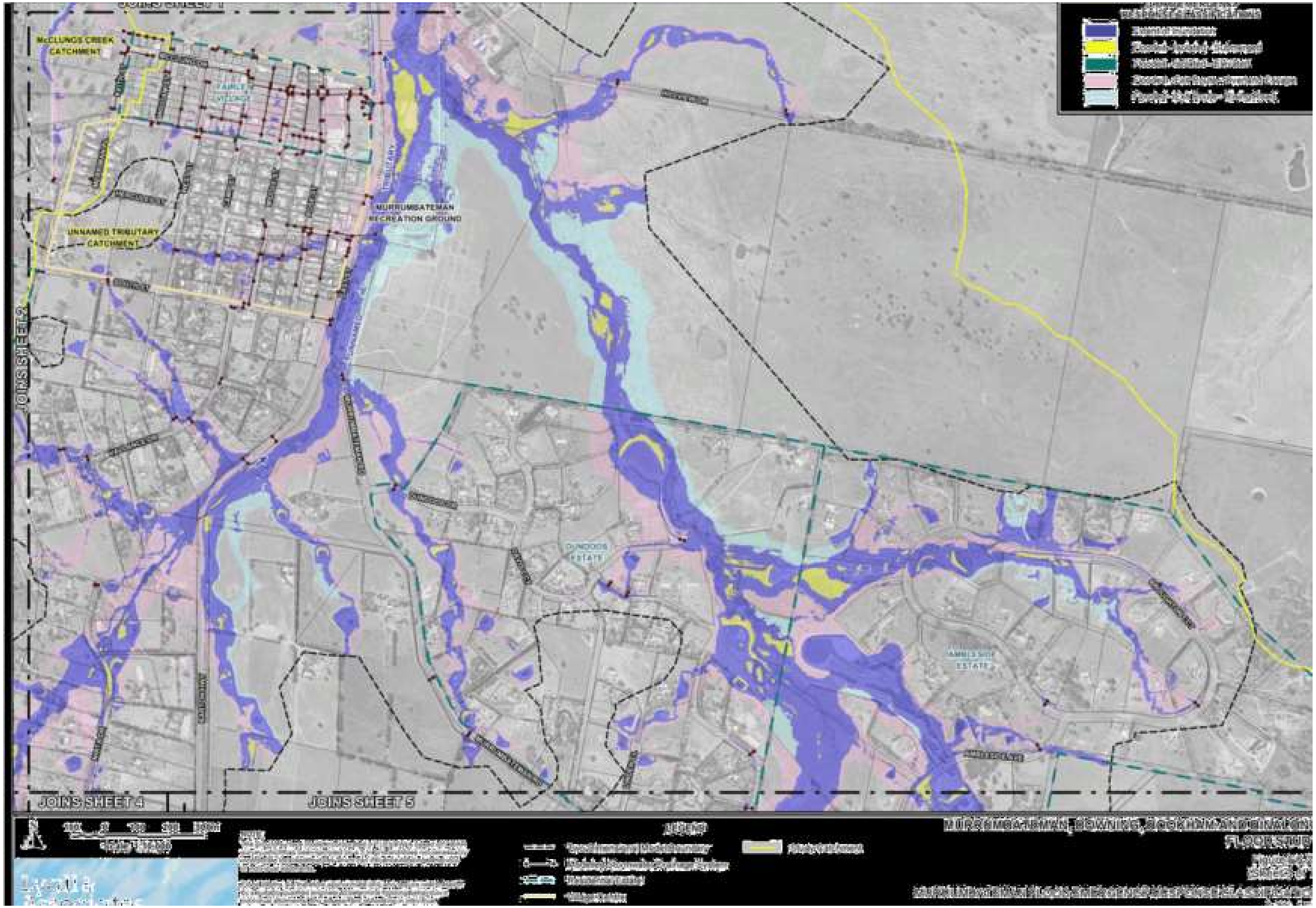
UNNAMED TRIBUTARY CATCHMENT
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3


CARRINGTON PARK
VINEYARD RIDGE
MERRYVILLE ESTATE
McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4
LEGEND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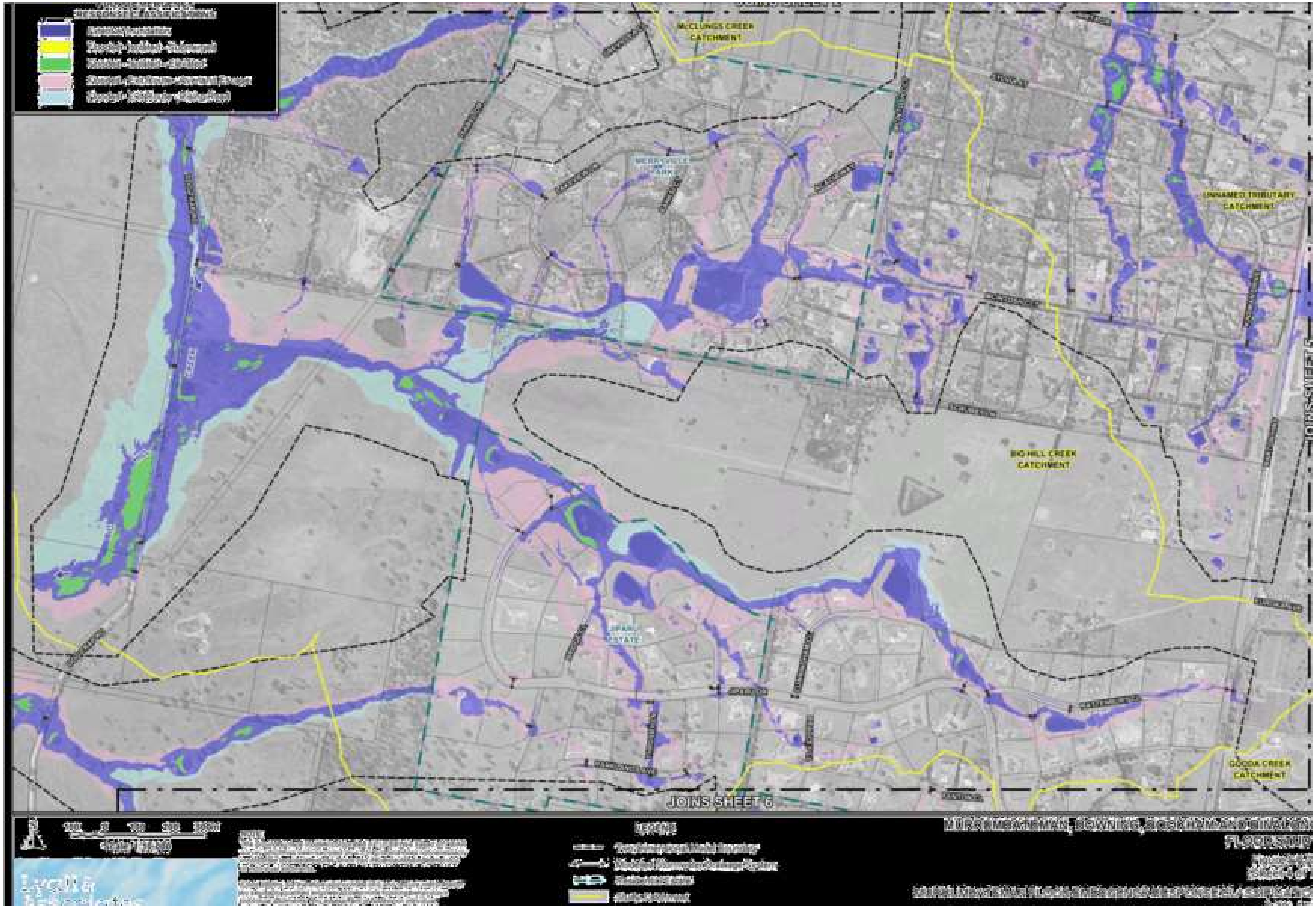
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5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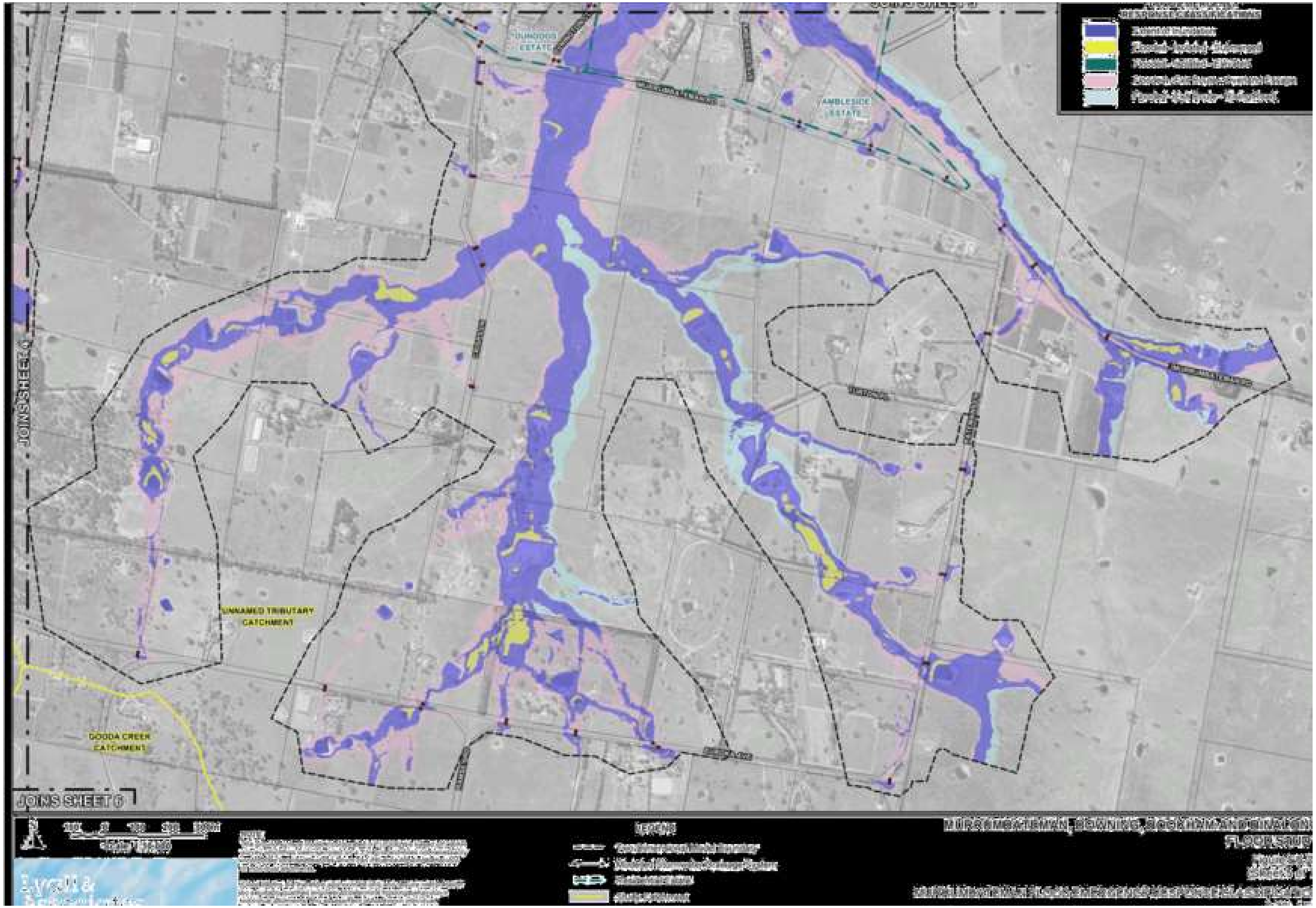
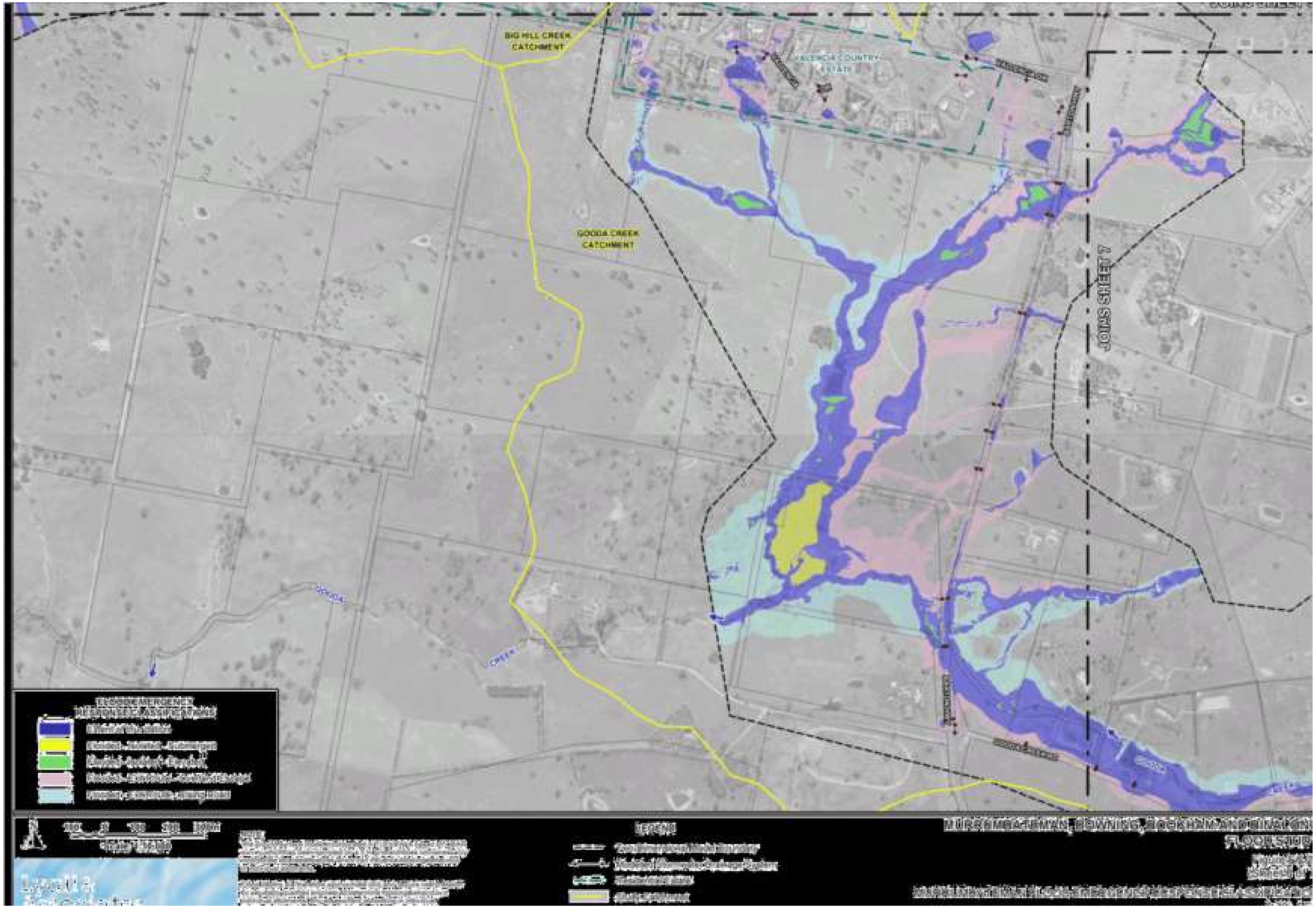
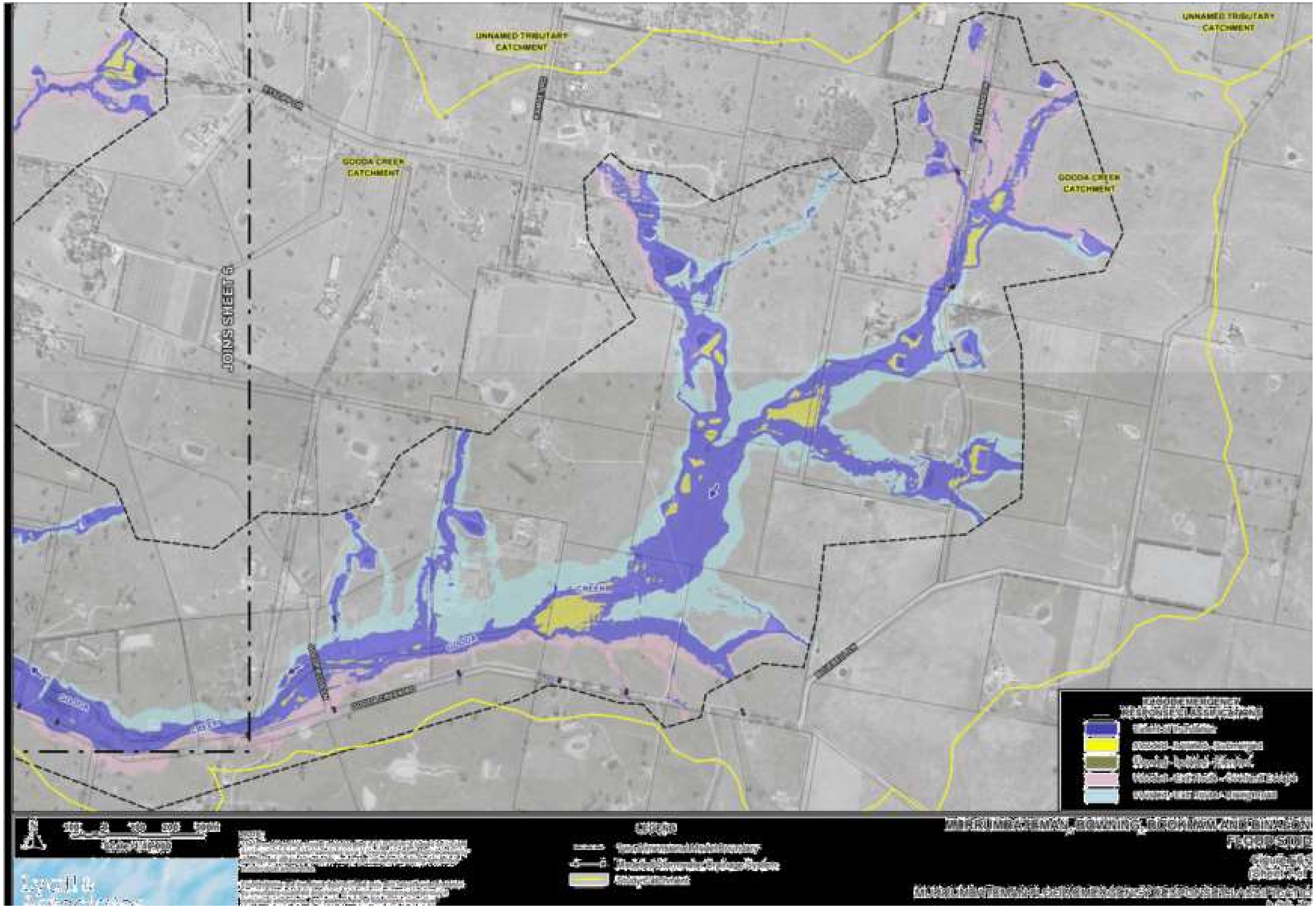
UNNAMED TRIBUTARY CATCHMENT
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
JOINS SHEET 5
LEGEND


DUNGOOS ESTATE
AMBLESIDE ESTATE
JOINS SHEET 4
JOINS SHEET 6
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
LEGEND


BIG HILL CREEK
CATCHMENT
GOODA CREEK
CATCHMENT
VALENCIA COUNTRY
ESTATE
JOINS SHEET 7
LEGEND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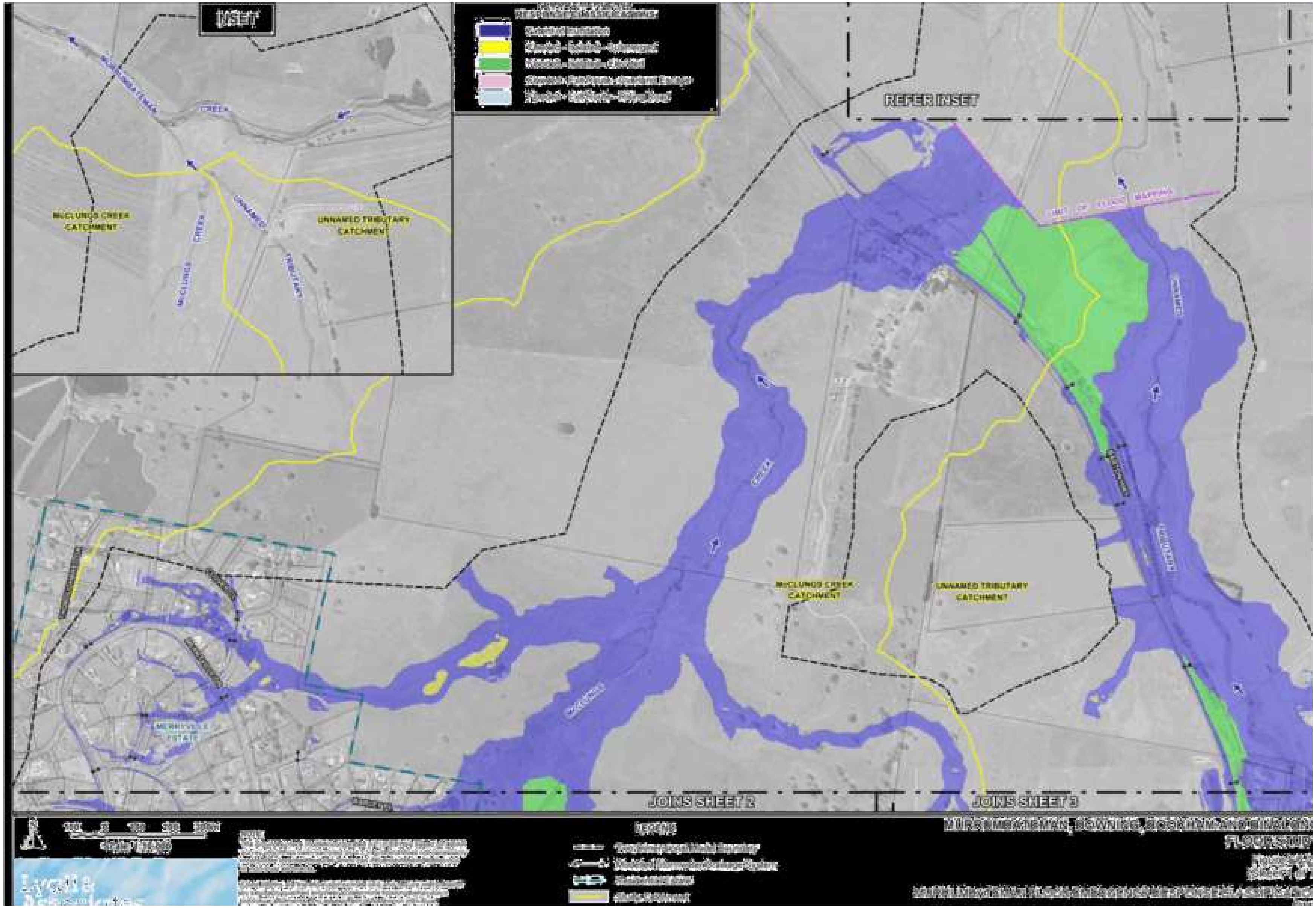
GOODA CREEK CATCHMENT
JOINS SHEET 5
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT


INSET
REFER INSET
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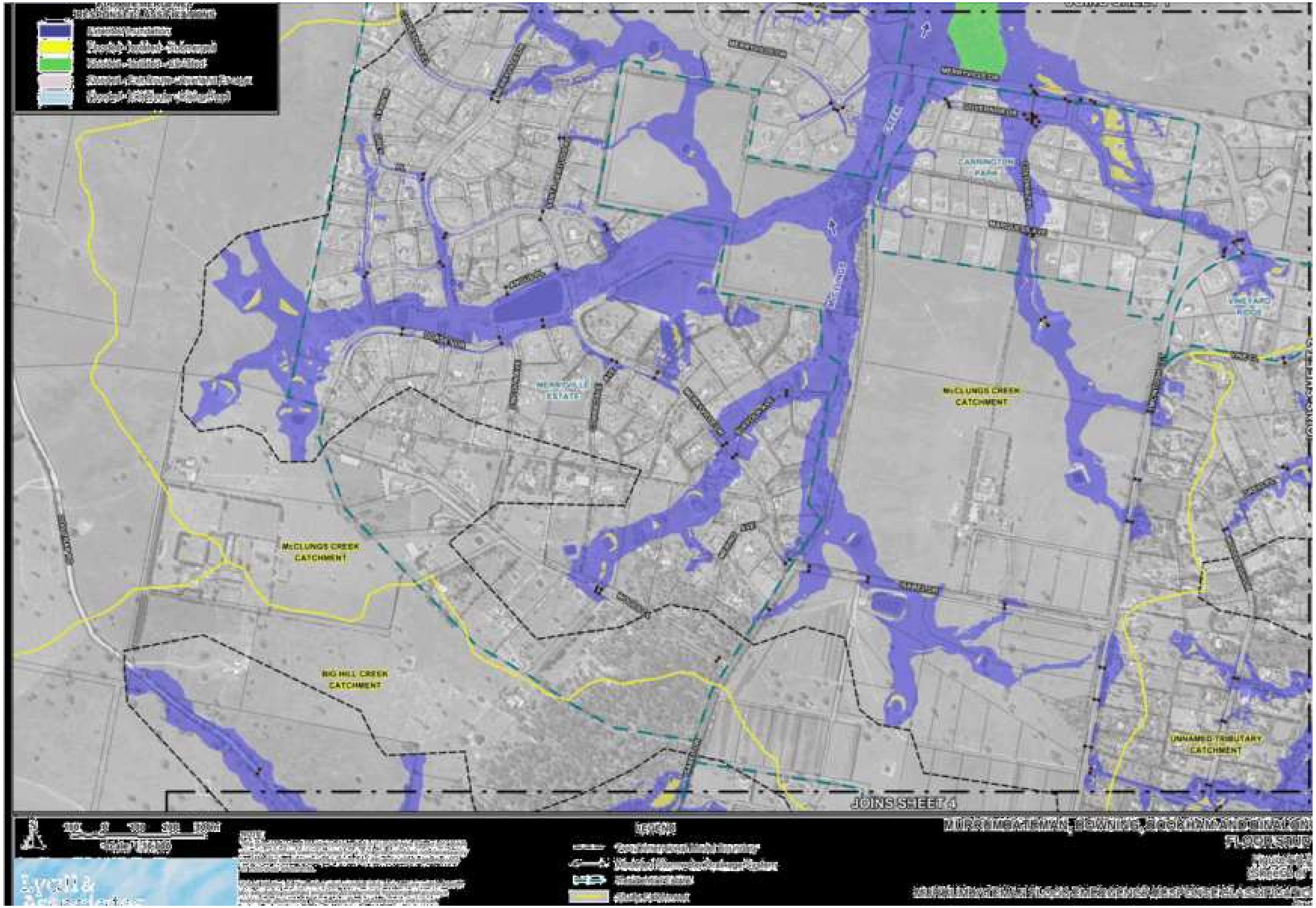
UNNAMED TRIBUTARY CATCHMENT
LIMIT OF FLOOD MAPPING
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3
LEGEND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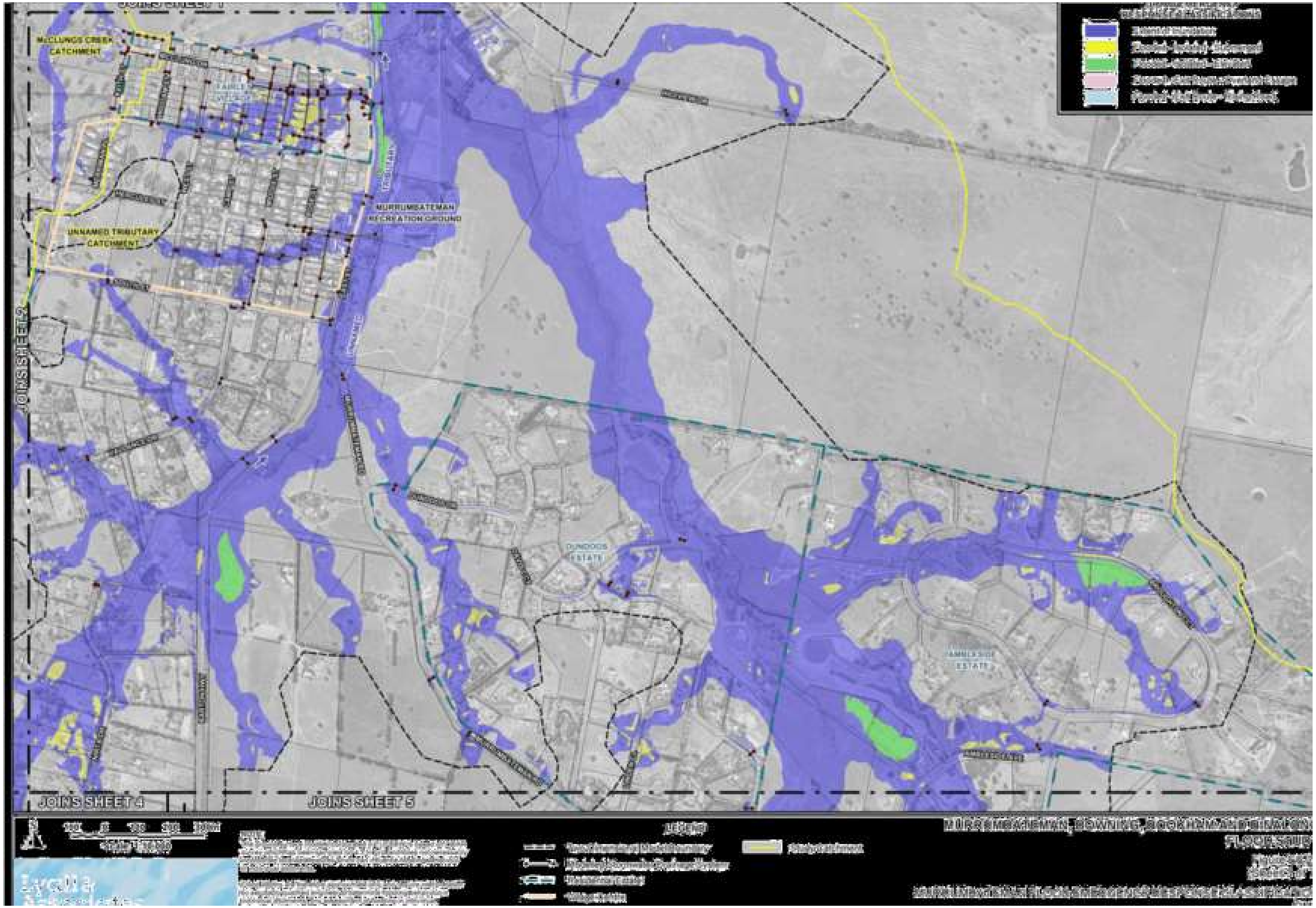
MERRYVILLE ESTATE
CARRINGTON PARK
VINEYARD RIDGE
JOINS SHEET 4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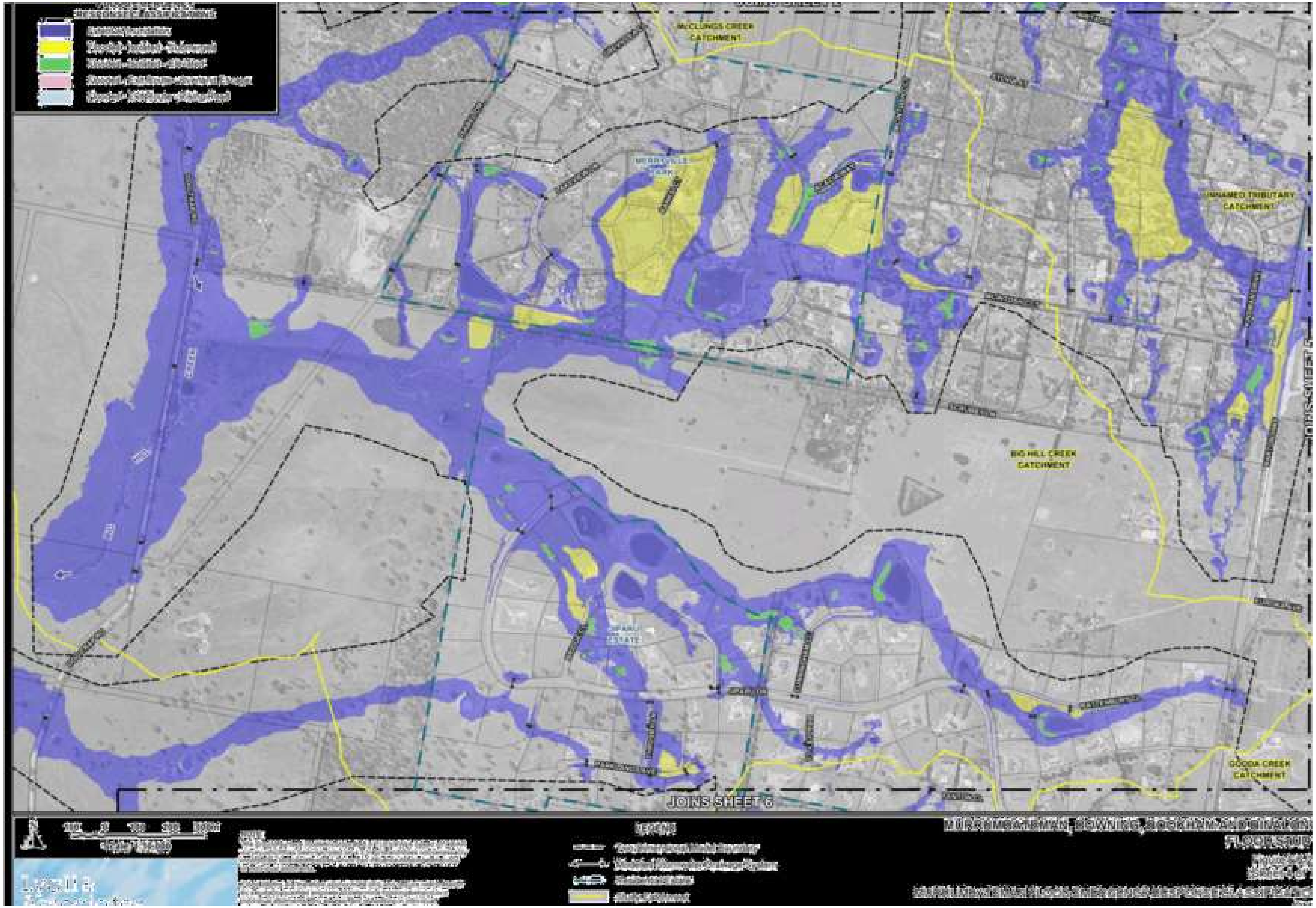
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5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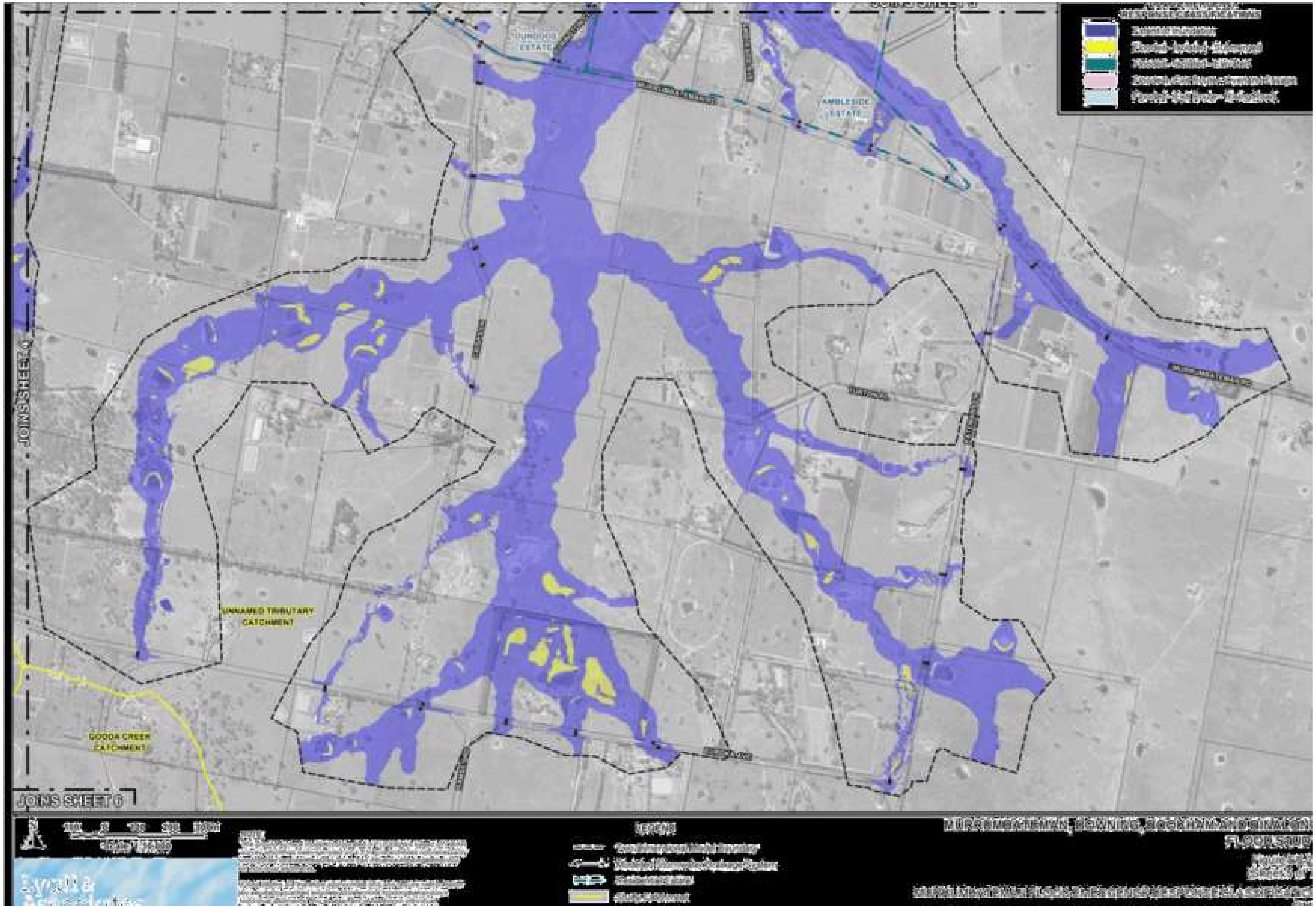
MERRYVILLE PARK
UNNAMED TRIBUTARY CATCHMENT
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
JOINS SHEET 5
LEGEND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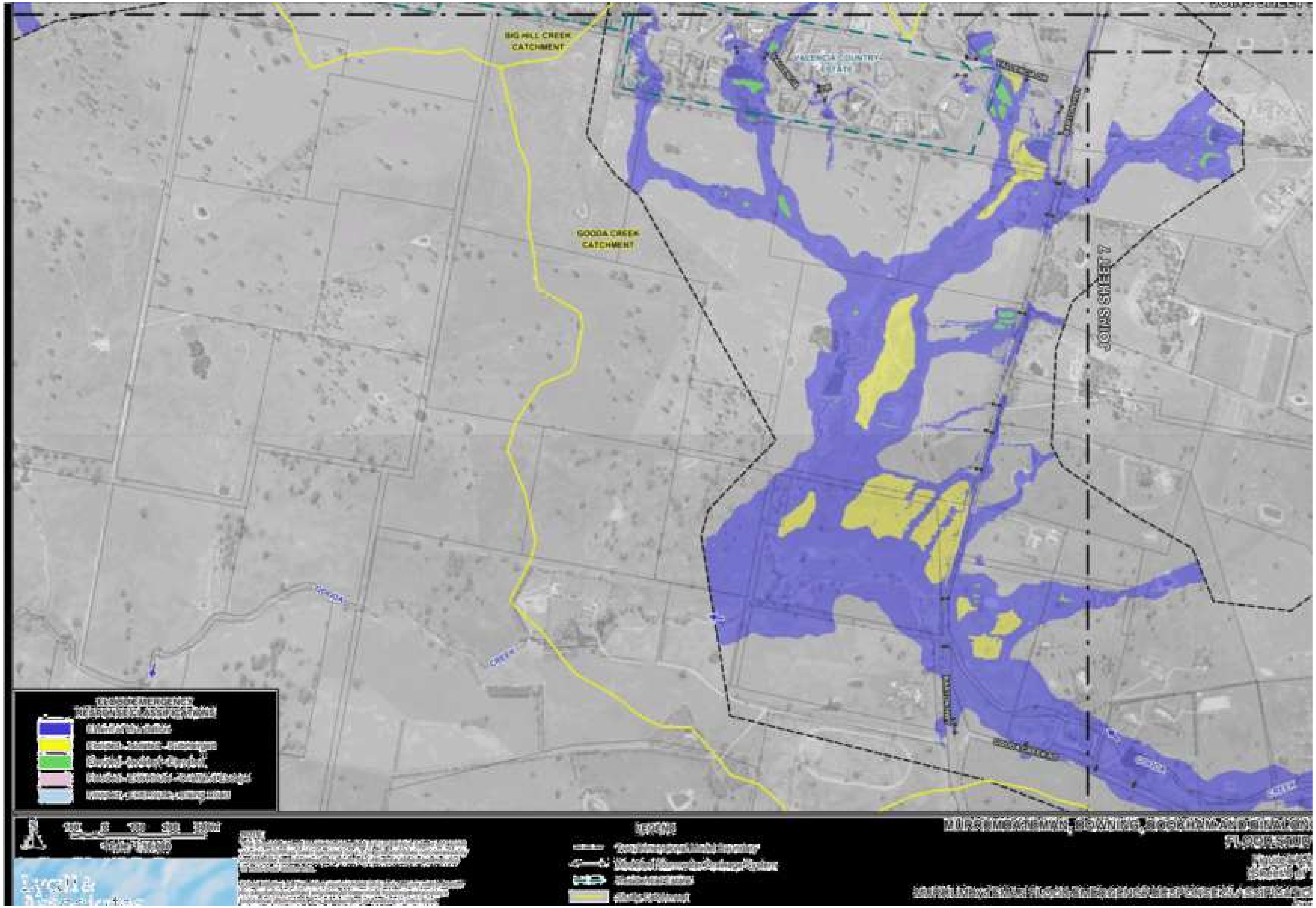
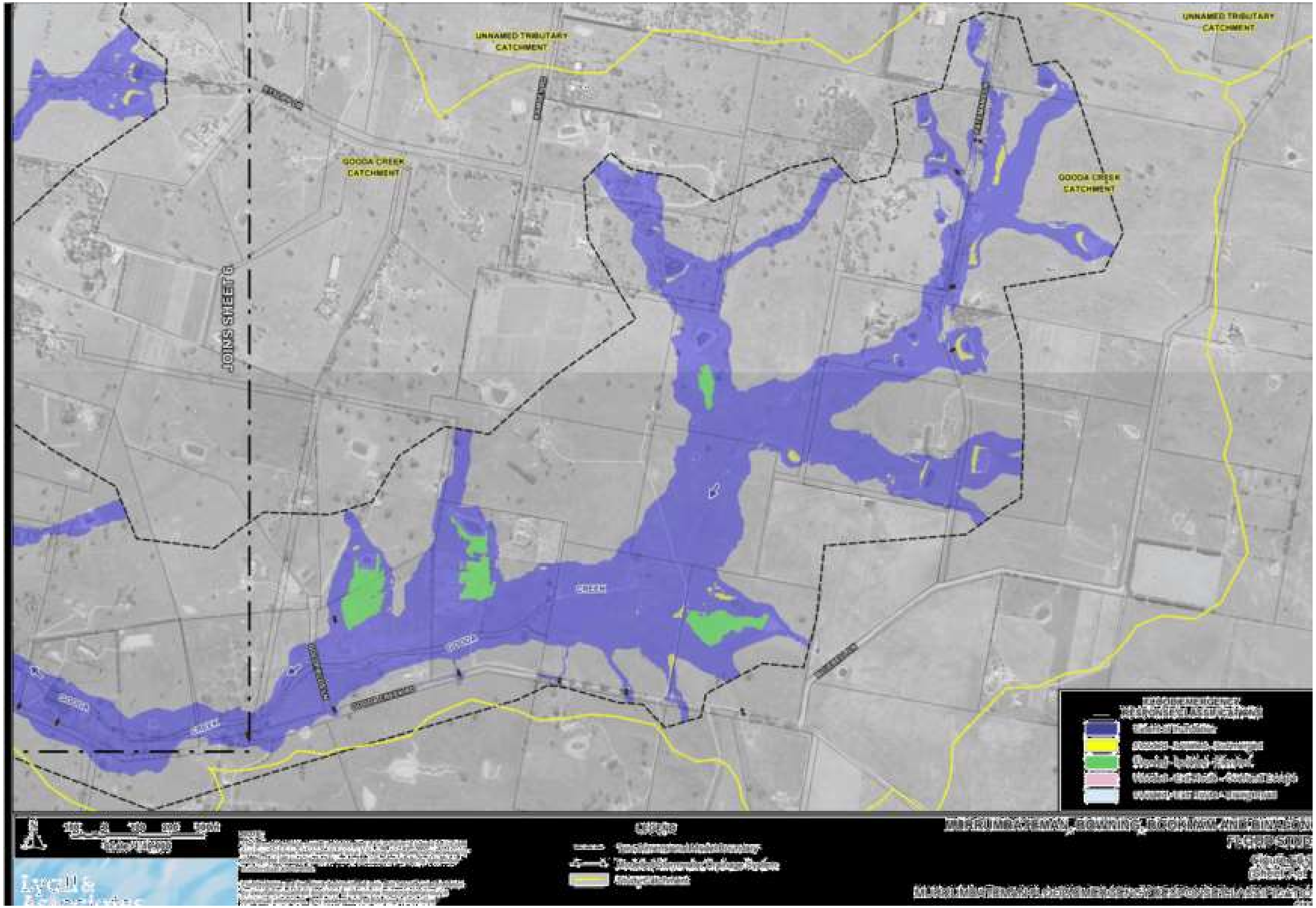
JOINS SHEET 4
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6


BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
VALENCIA COUNTRY ESTATE
JOINS SHEET 7
GOODA
CREEK
LEGEND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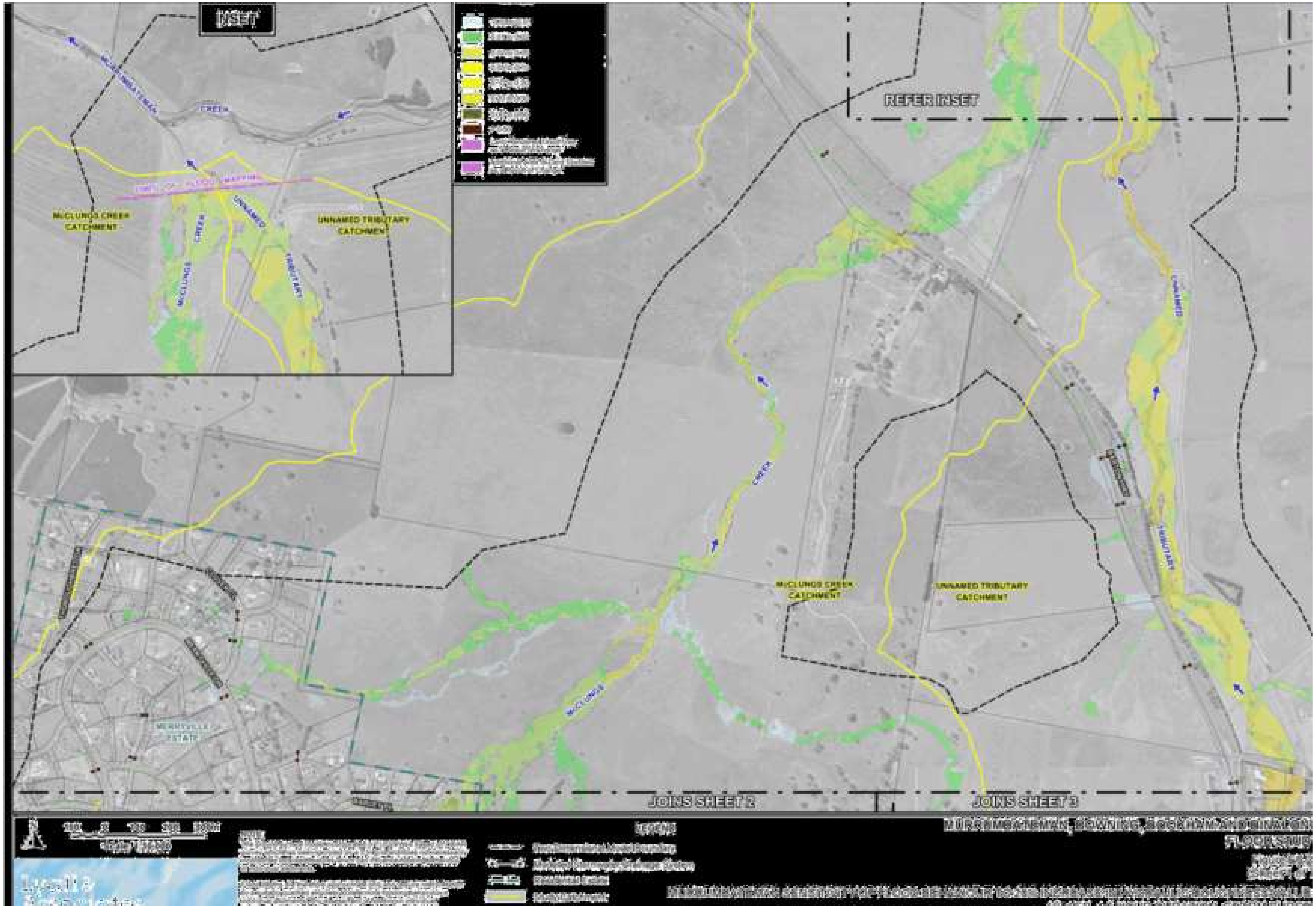
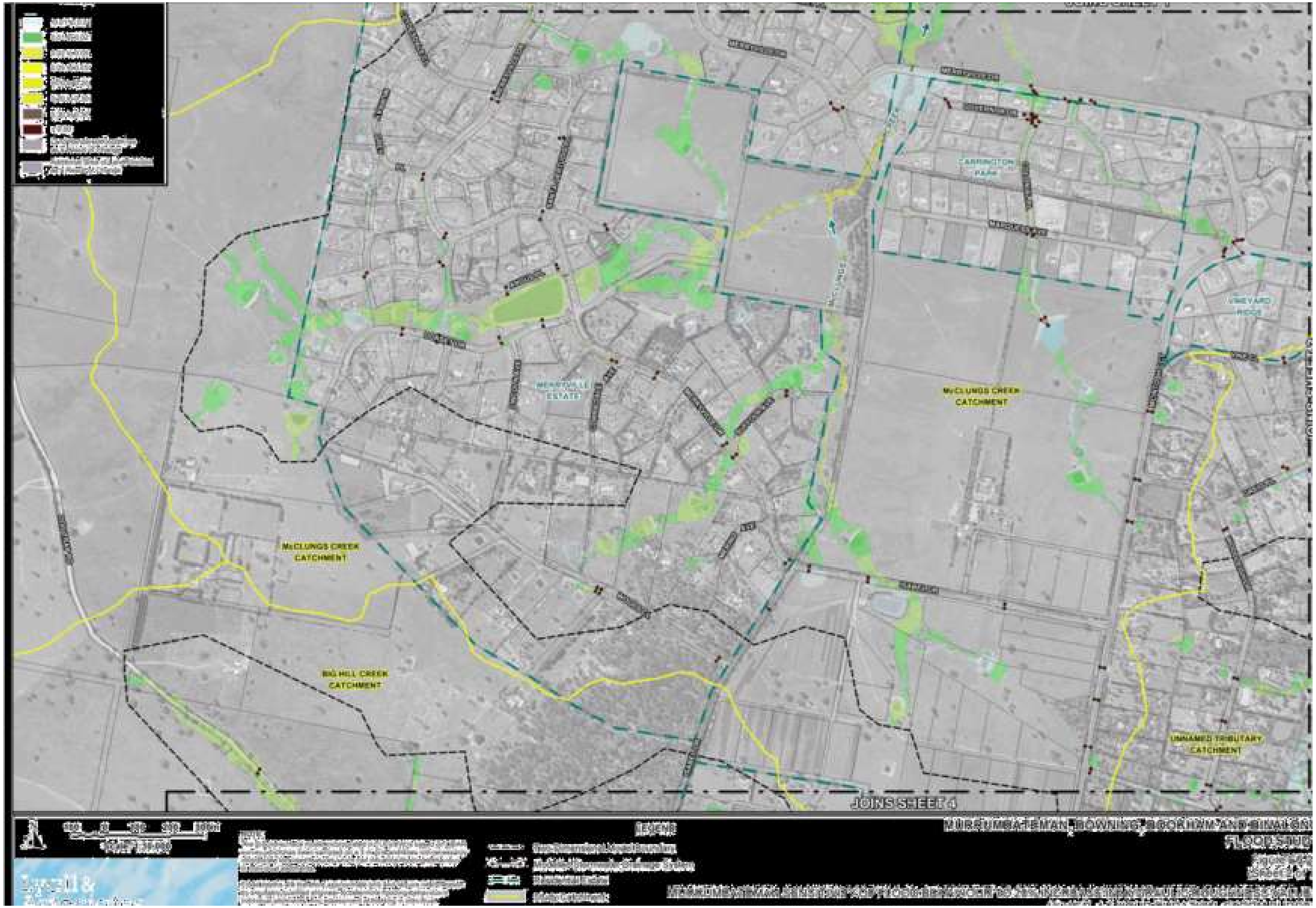
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
GOODA
CREEK
GOODA
CREEK


INSET
REFER INSET
MURRUMBATEMAN
CREEK
LIMIT OF FLOOD MAPPING
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
McCLUNGS
CREEK
UNNAMED
TRIBUTARY
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3
LEGEND


CARRINGTON PARK
MERRYVILLE ESTATE
McCLUNGS CREEK CATCHMENT
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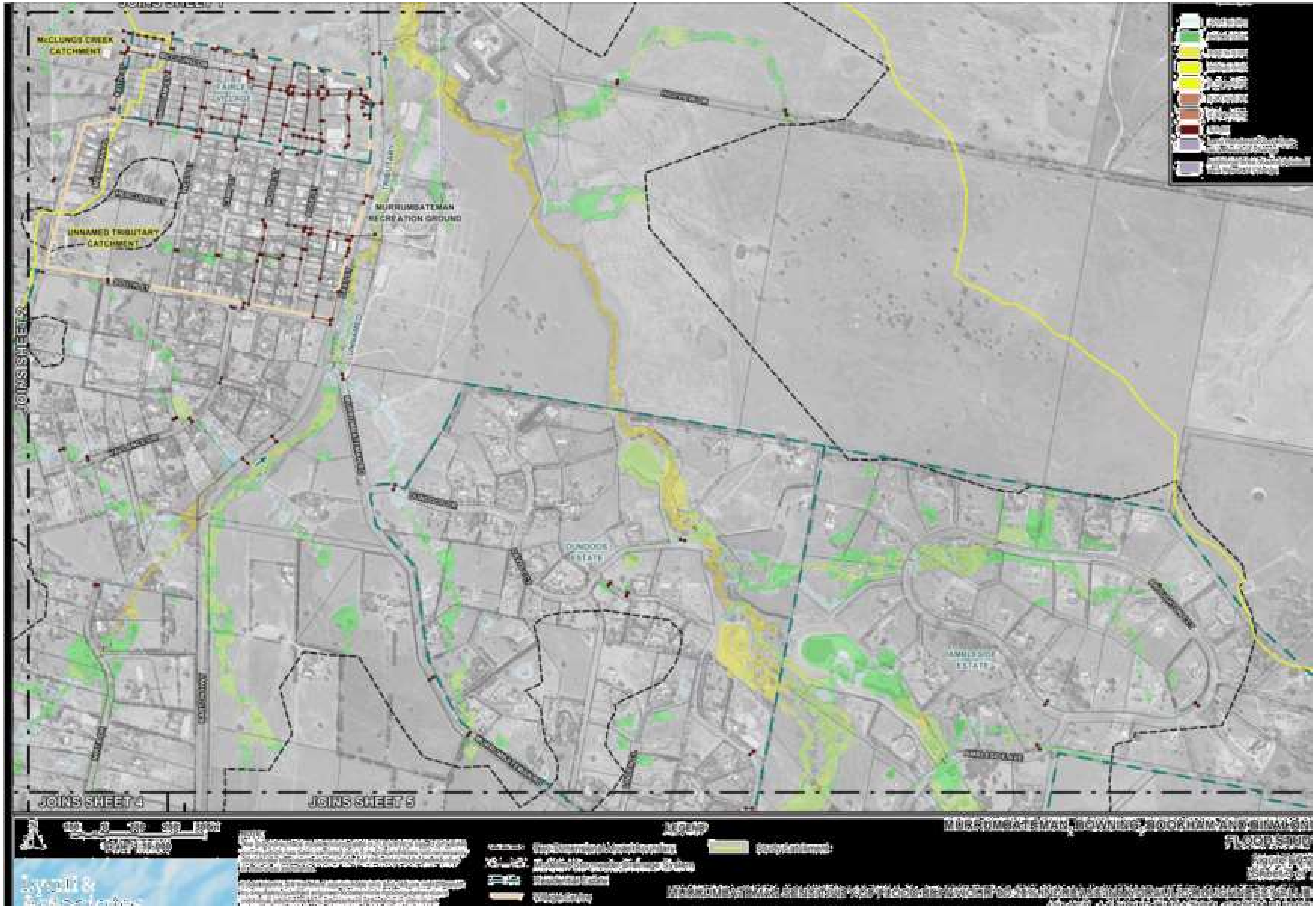
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
VINEYARD RIDGE
JOINS SHEET 4
LEGEND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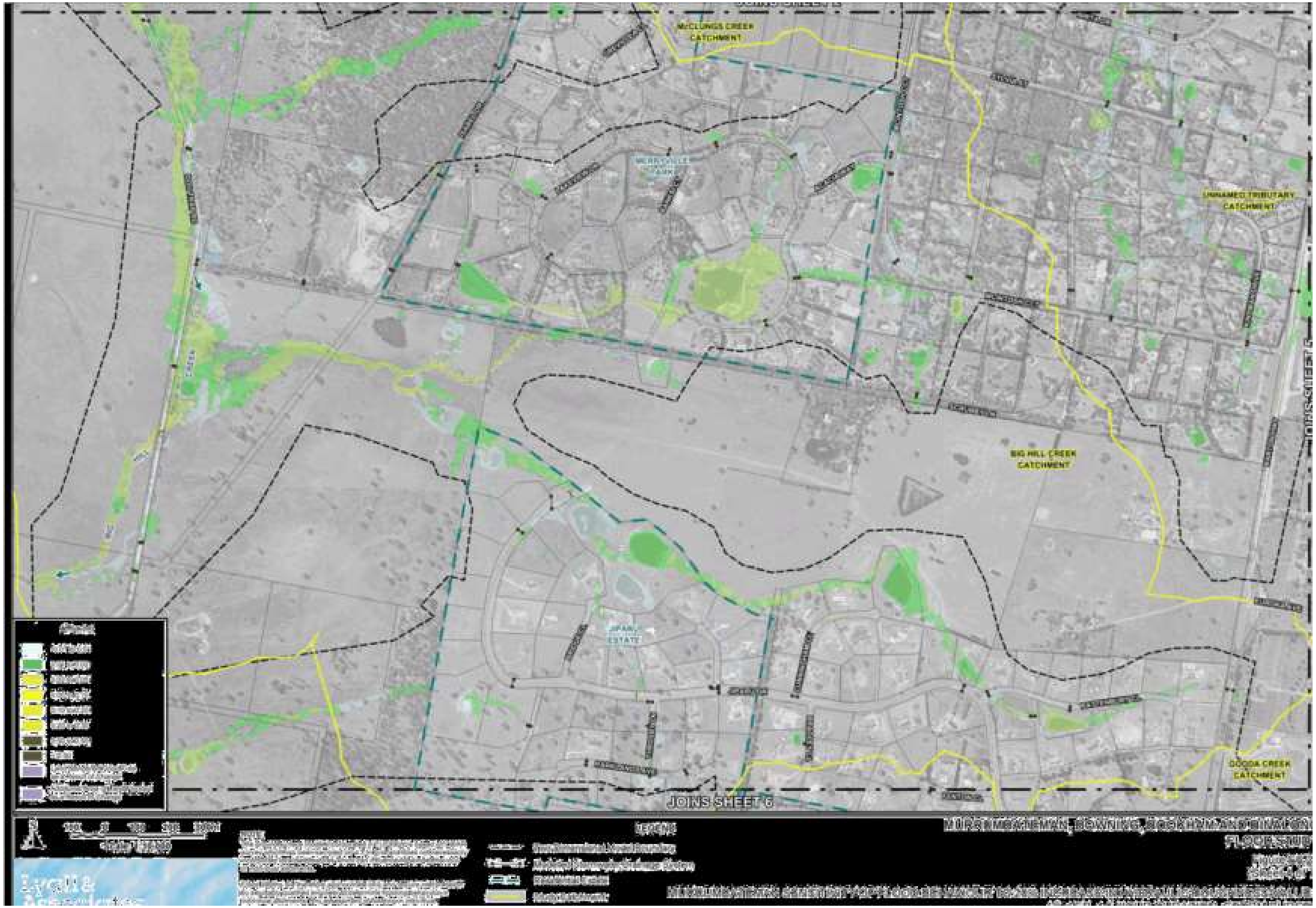
MURRUMBATEMAN RECREATION GROUND
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5
LEGEND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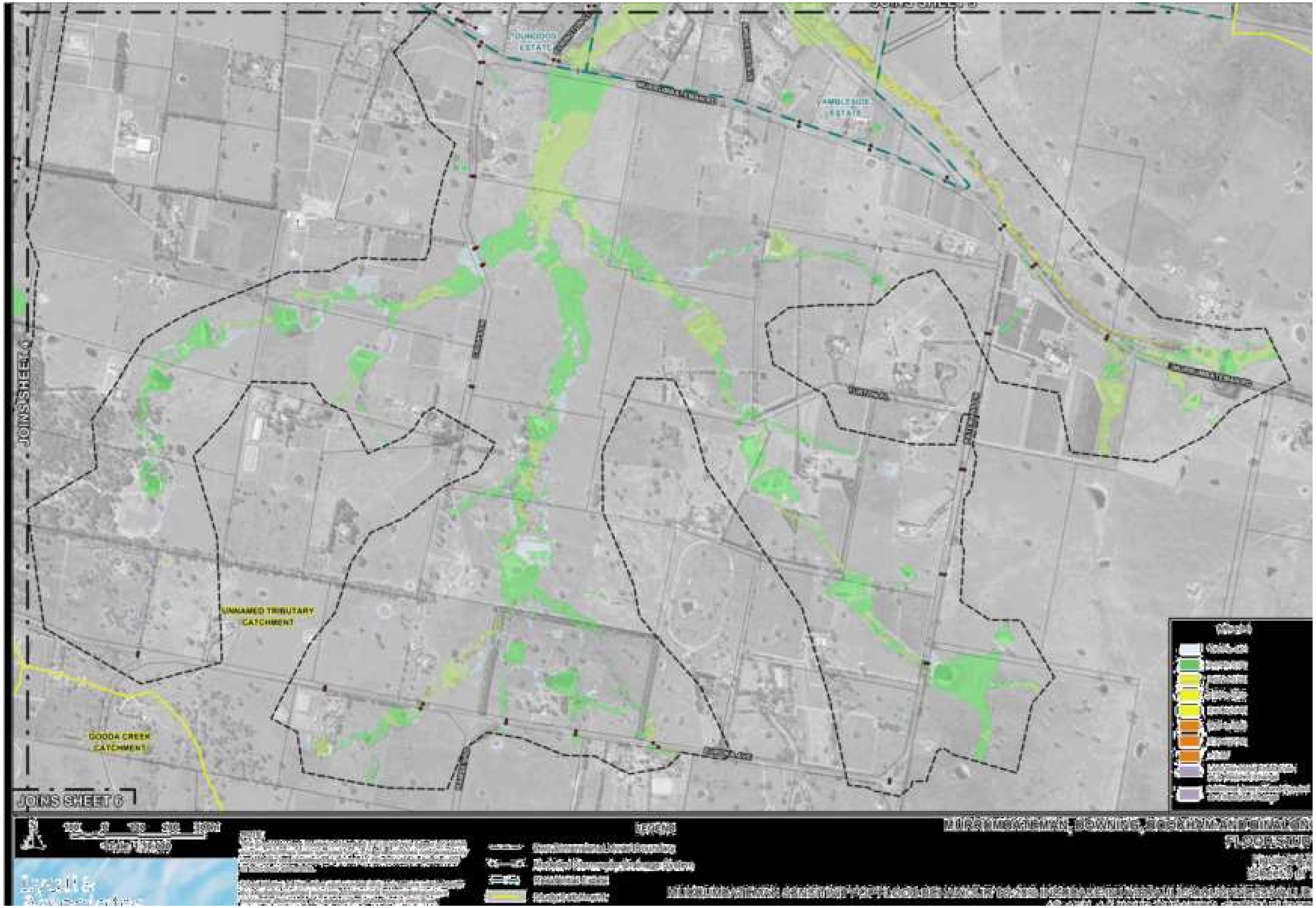
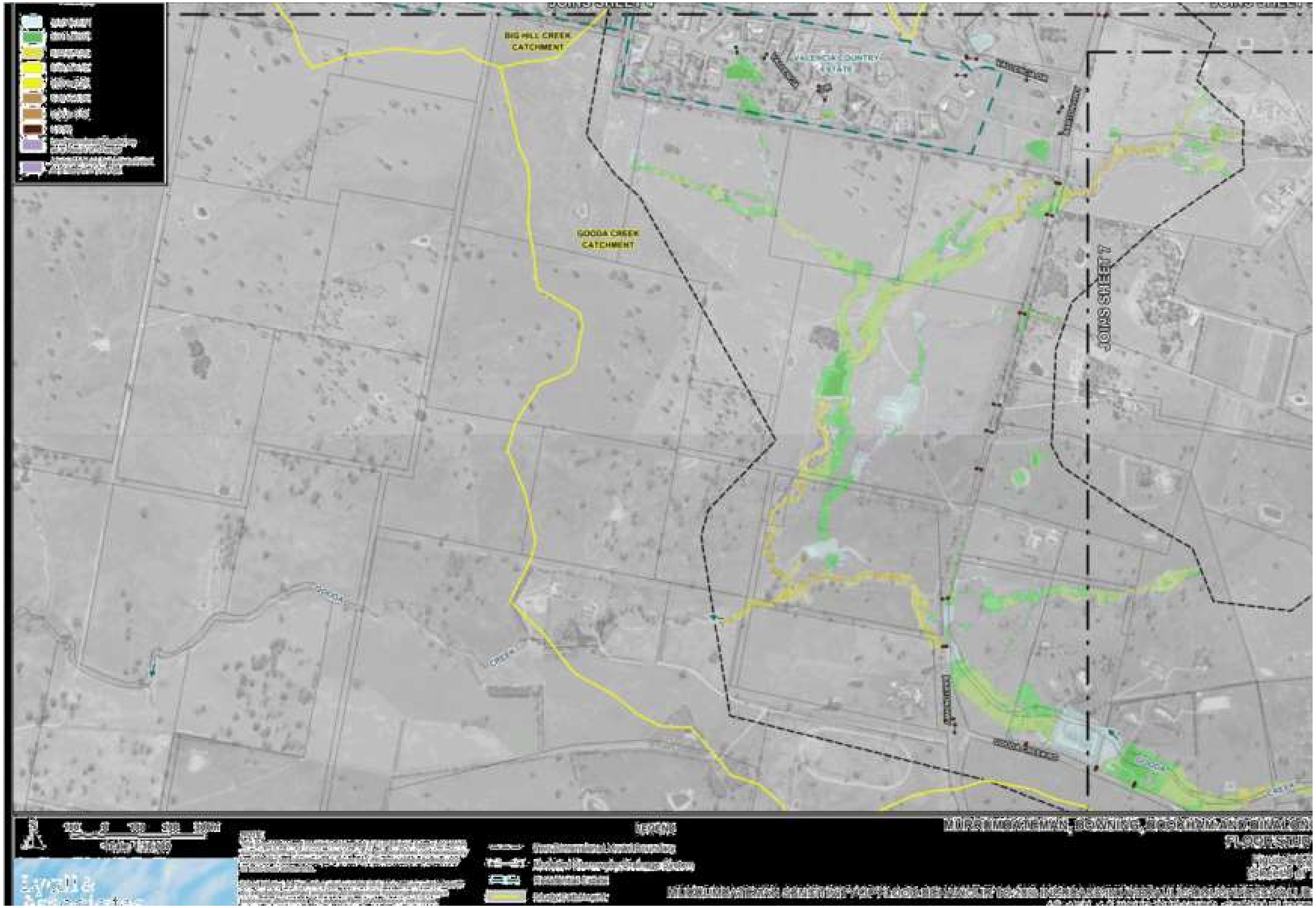
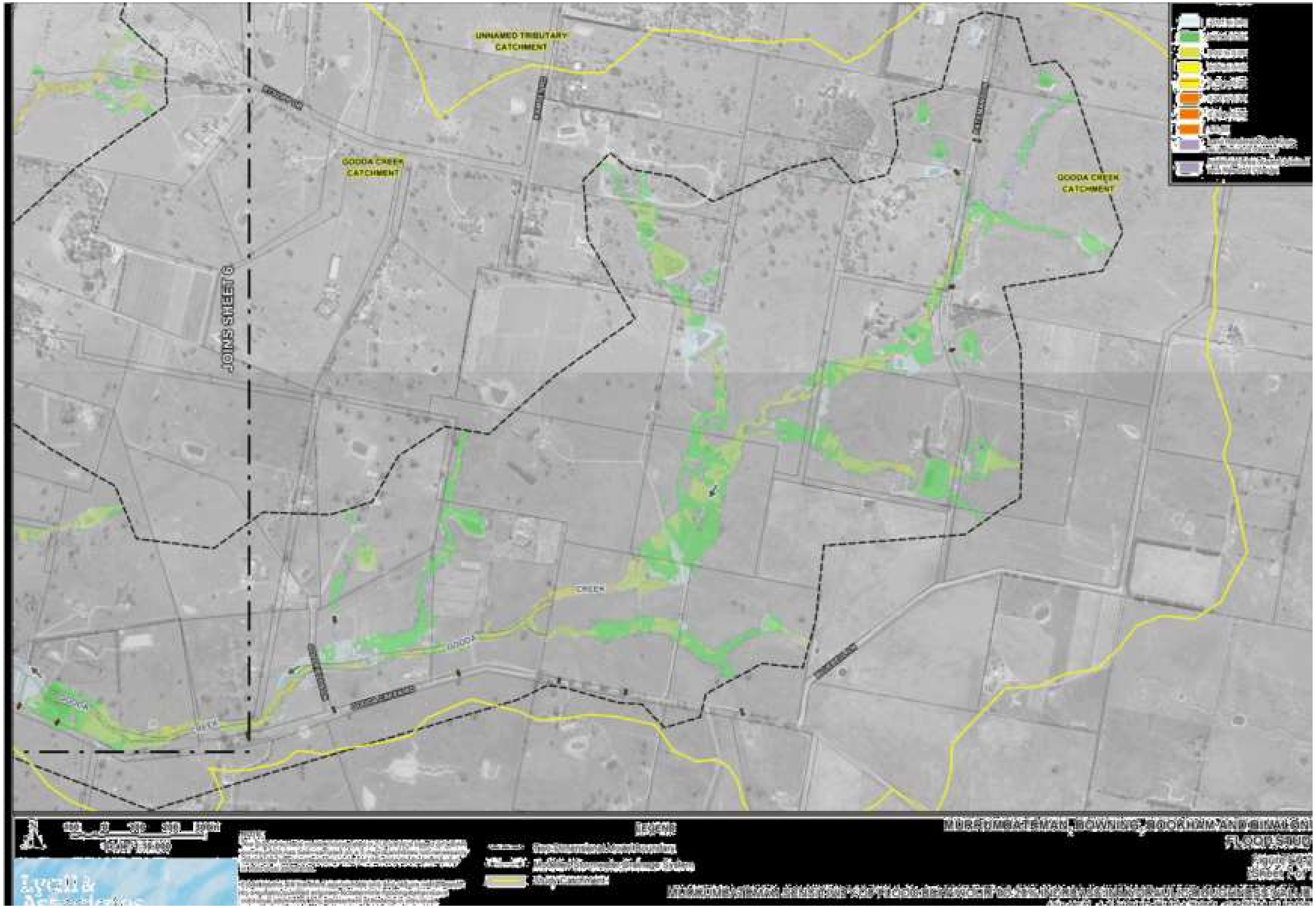
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
JOINS SHEET 5
LEGEND


AMBLESIDE ESTATE
JOINS SHEET 4
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
LEGEND


BIG HILL CREEK
CATCHMENT
GOODA CREEK
CATCHMENT
JOINS SHEET 7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GOODA CREEK CATCHMENT
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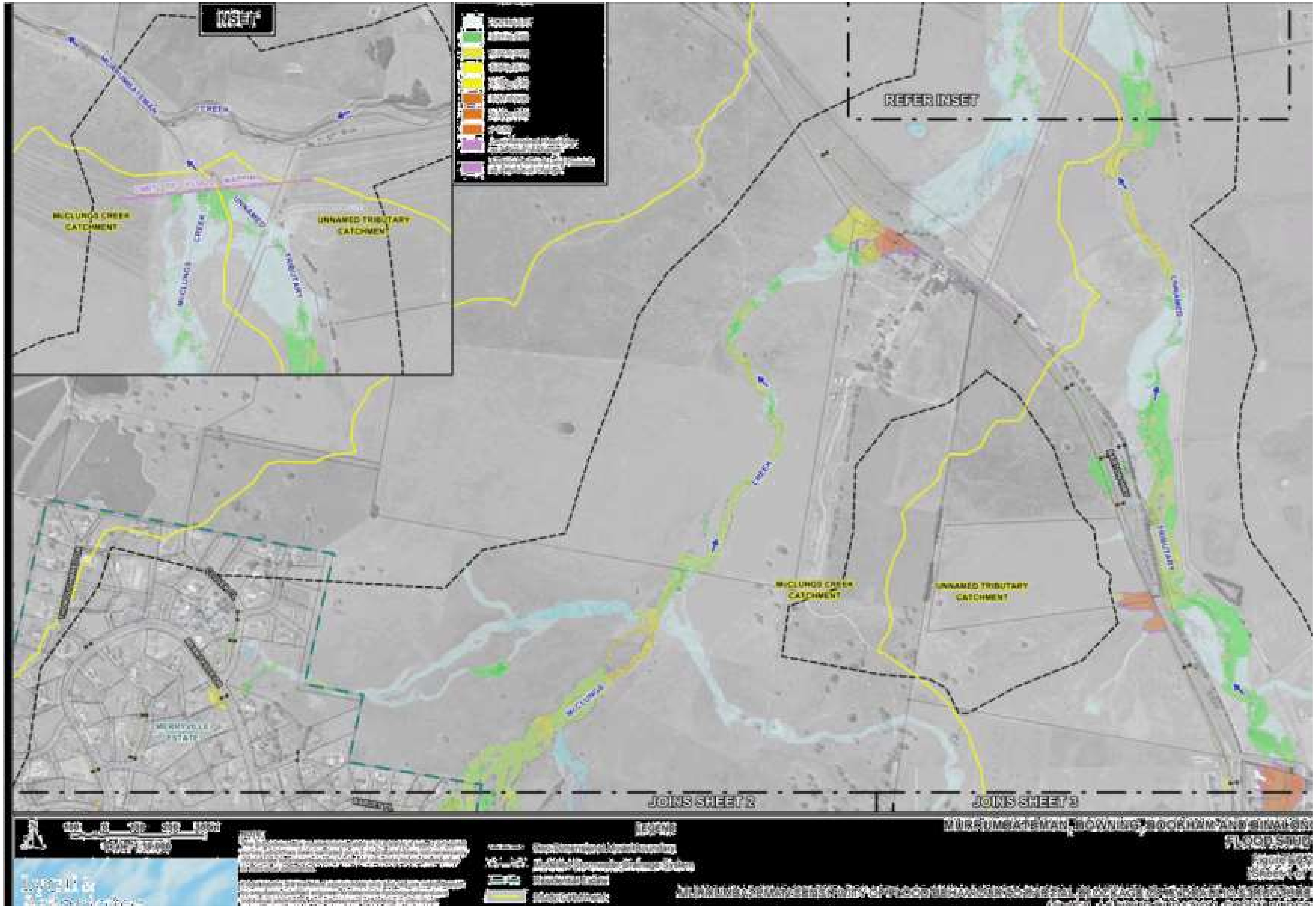
JOINS SHEET 6
GOODA
CREEK
GOODA
CREEK
LEGEND
Study Catchment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REFER INSET
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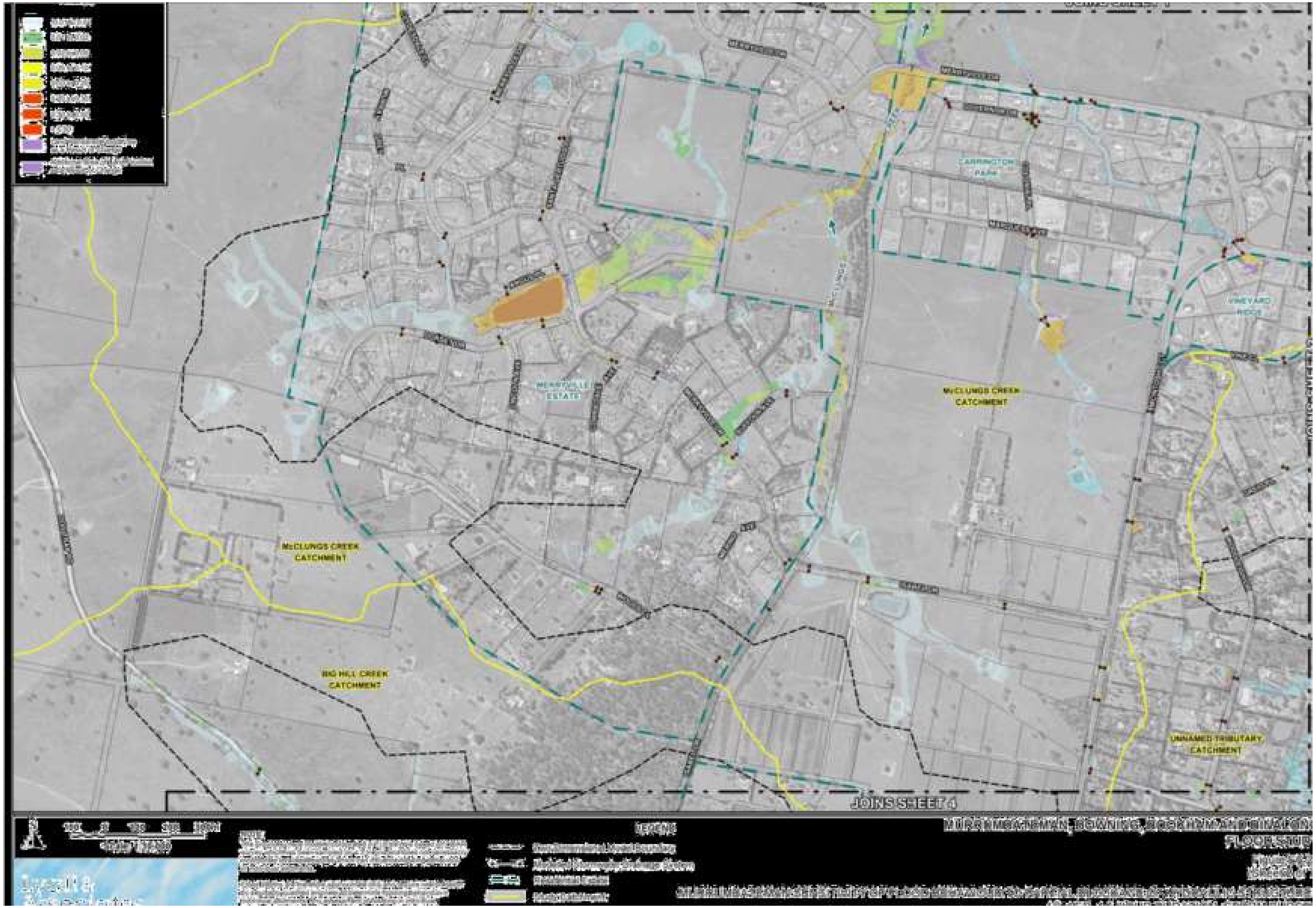
UNNAMED TRIBUTARY CATCHMENT
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3
LEGEND
MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALONG
FLOOD STUDY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VINEYARD RIDGE
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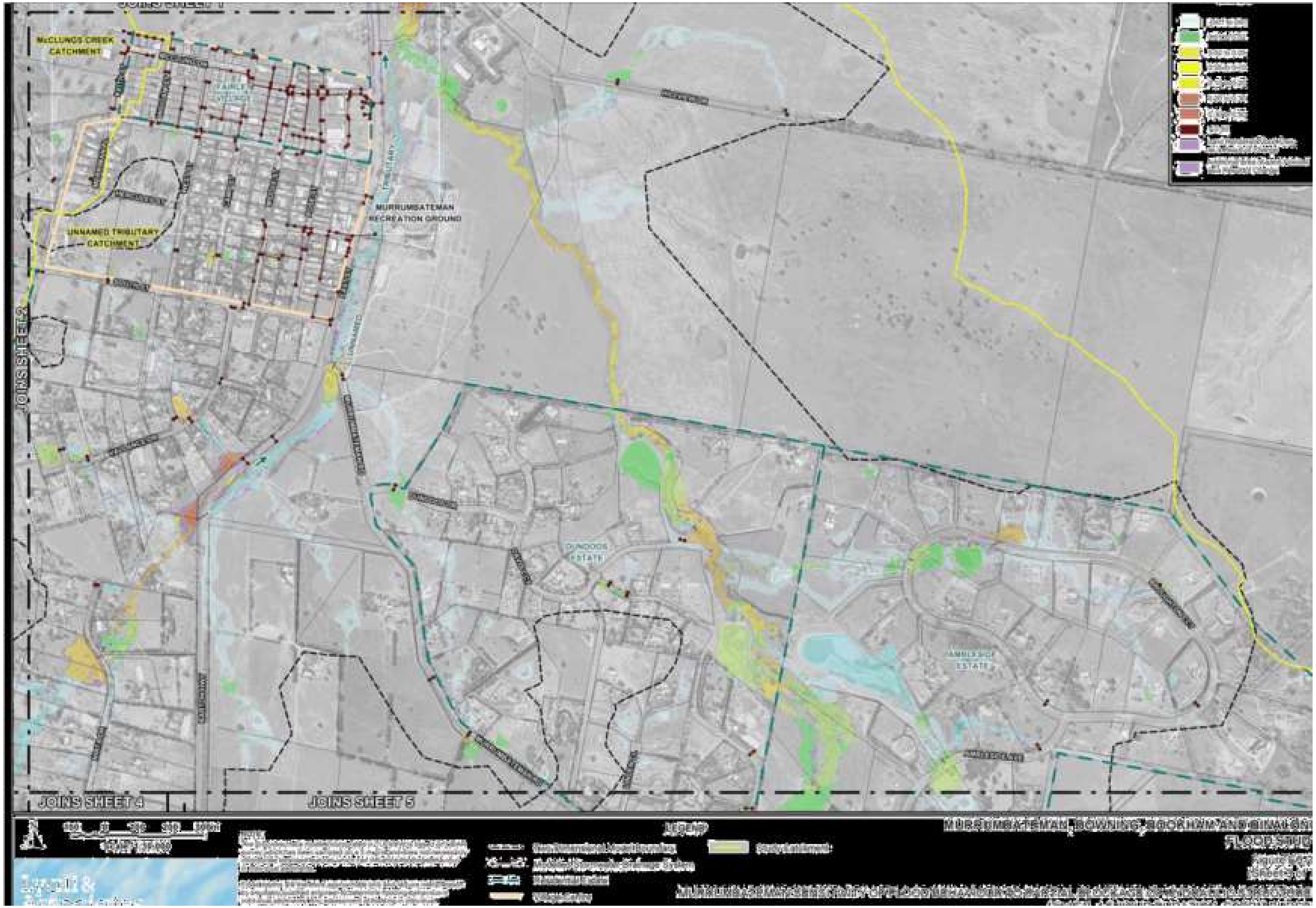
JOINS SHEET 4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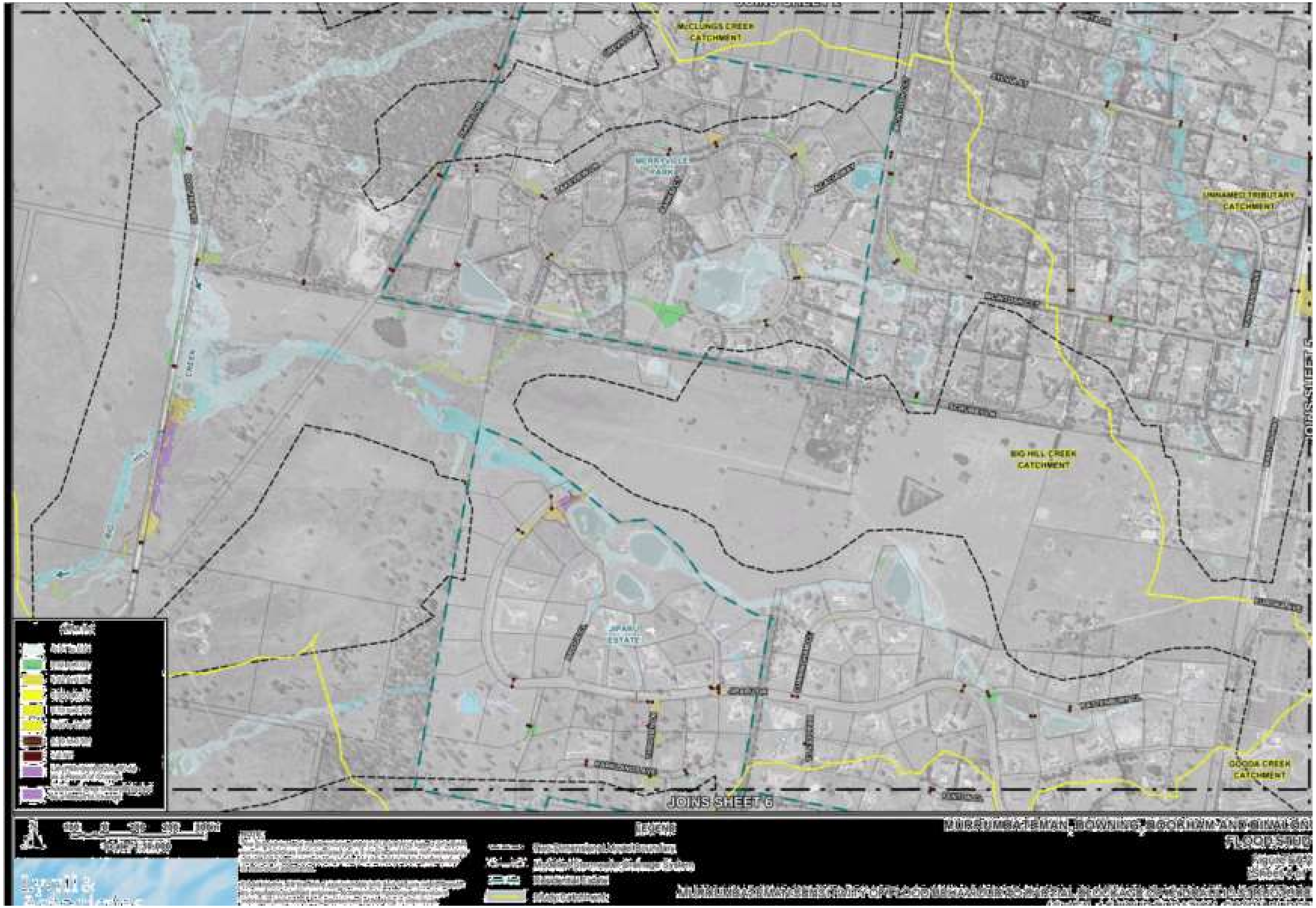
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5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MERRYVILLE PARK
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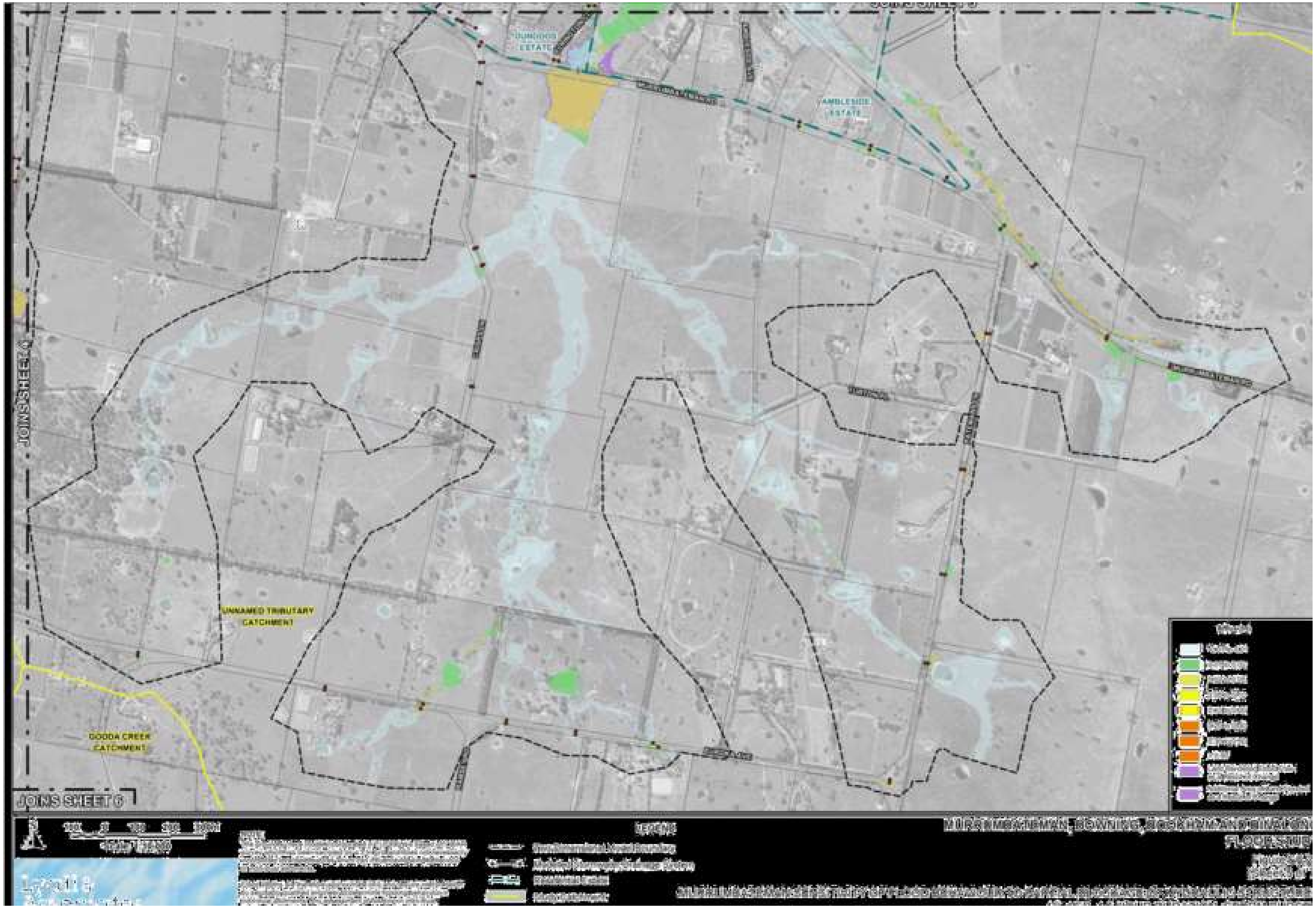
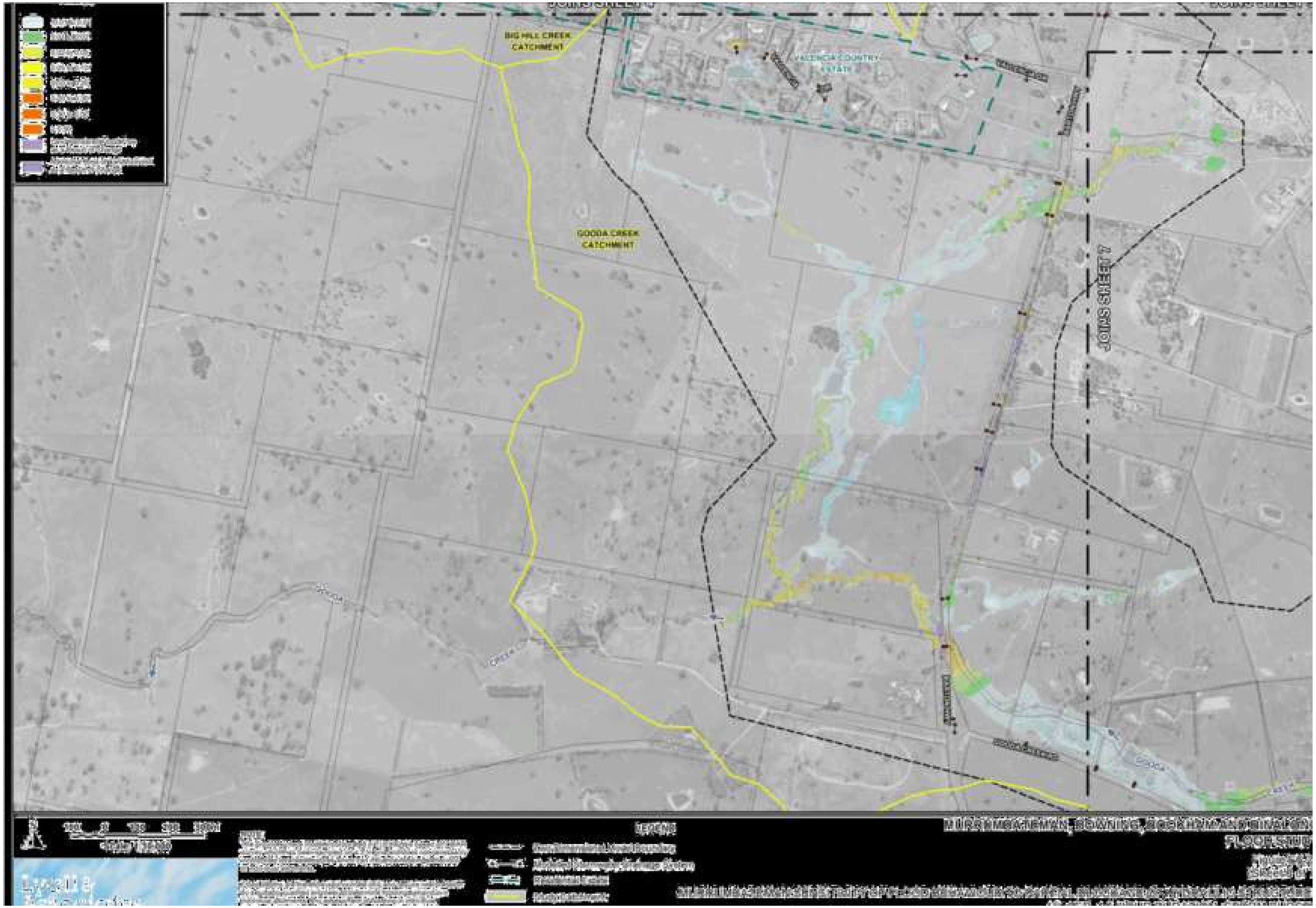
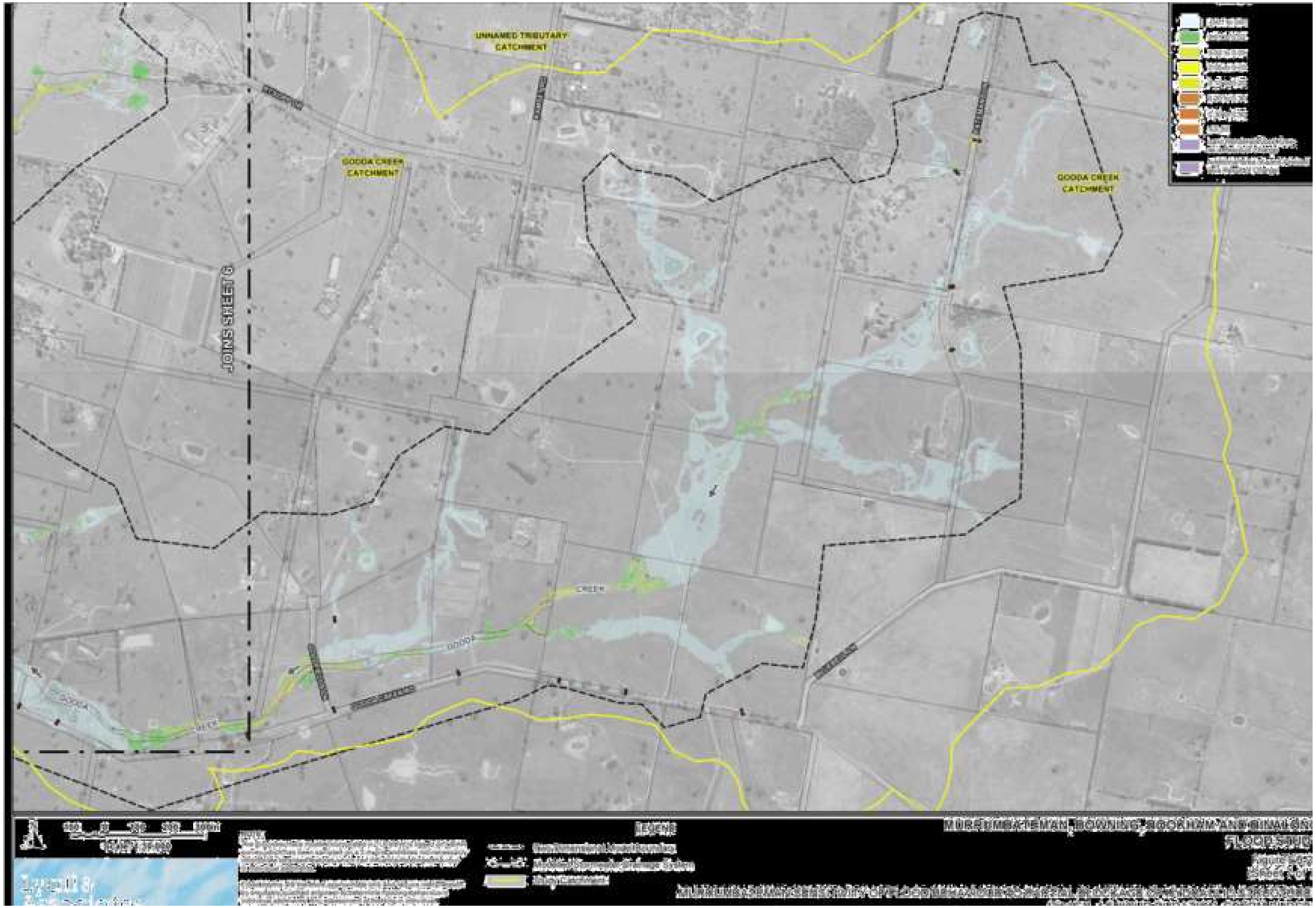
BIG HILL CREEK CATCHMENT
JIPARU ESTATE
GOODA CREEK CATCHMENT
JOINS SHEET 5
JOINS SHEET 6
LEGEND


DUNGOOS ESTATE
AMBLESIDE ESTATE
JOINS SHEET 4
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
LEGEND


BIG HILL CREEK
CATCHMENT
GOODA CREEK
CATCHMENT
JOINS SHEET 7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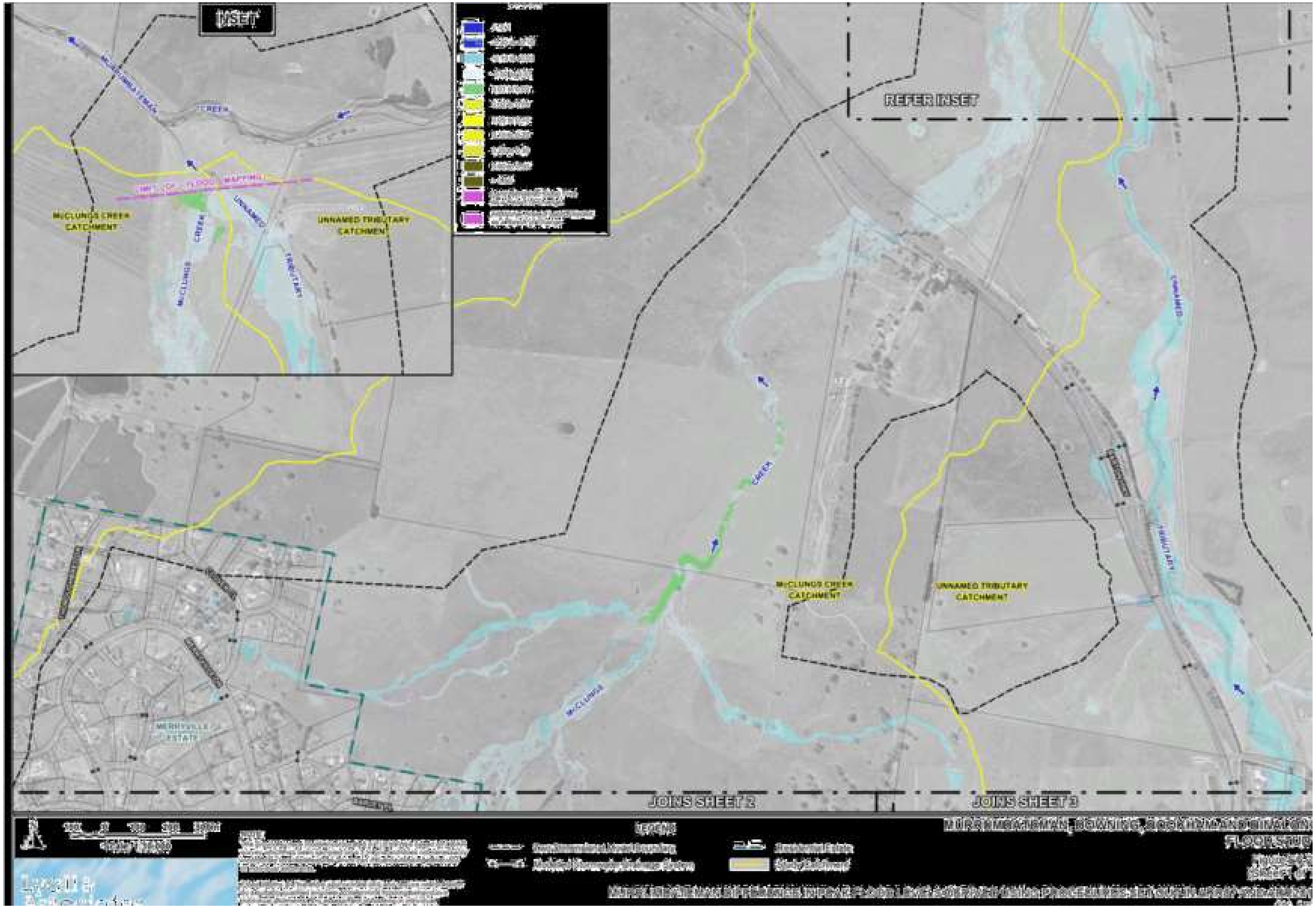
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
CREEK
GOODA
LEGEND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McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
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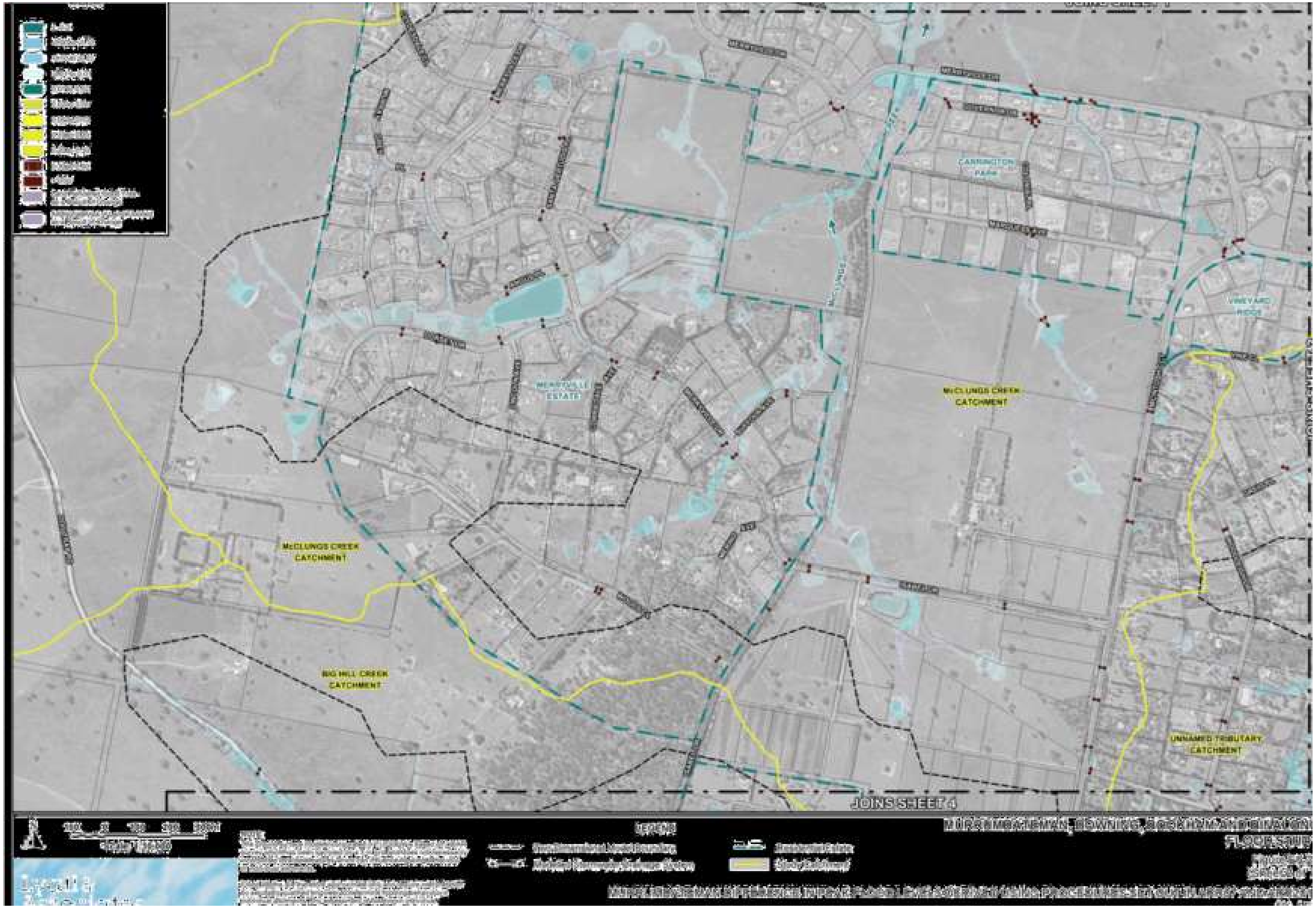
UNNAMED TRIBUTARY CATCHMENT
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3
LEGEND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VINEYARD RIDGE
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McCLUNGS CREEK CATCHMENT
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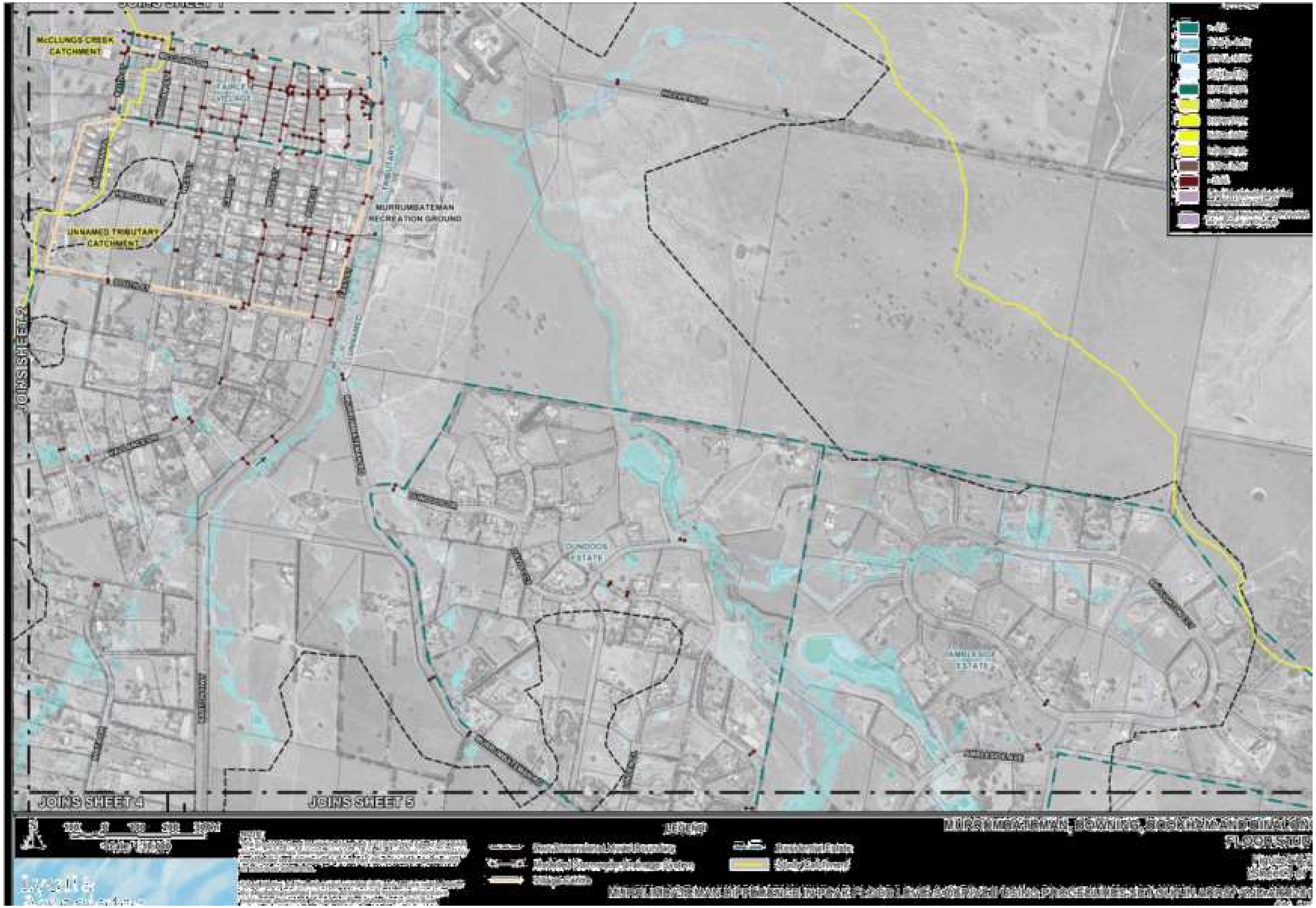
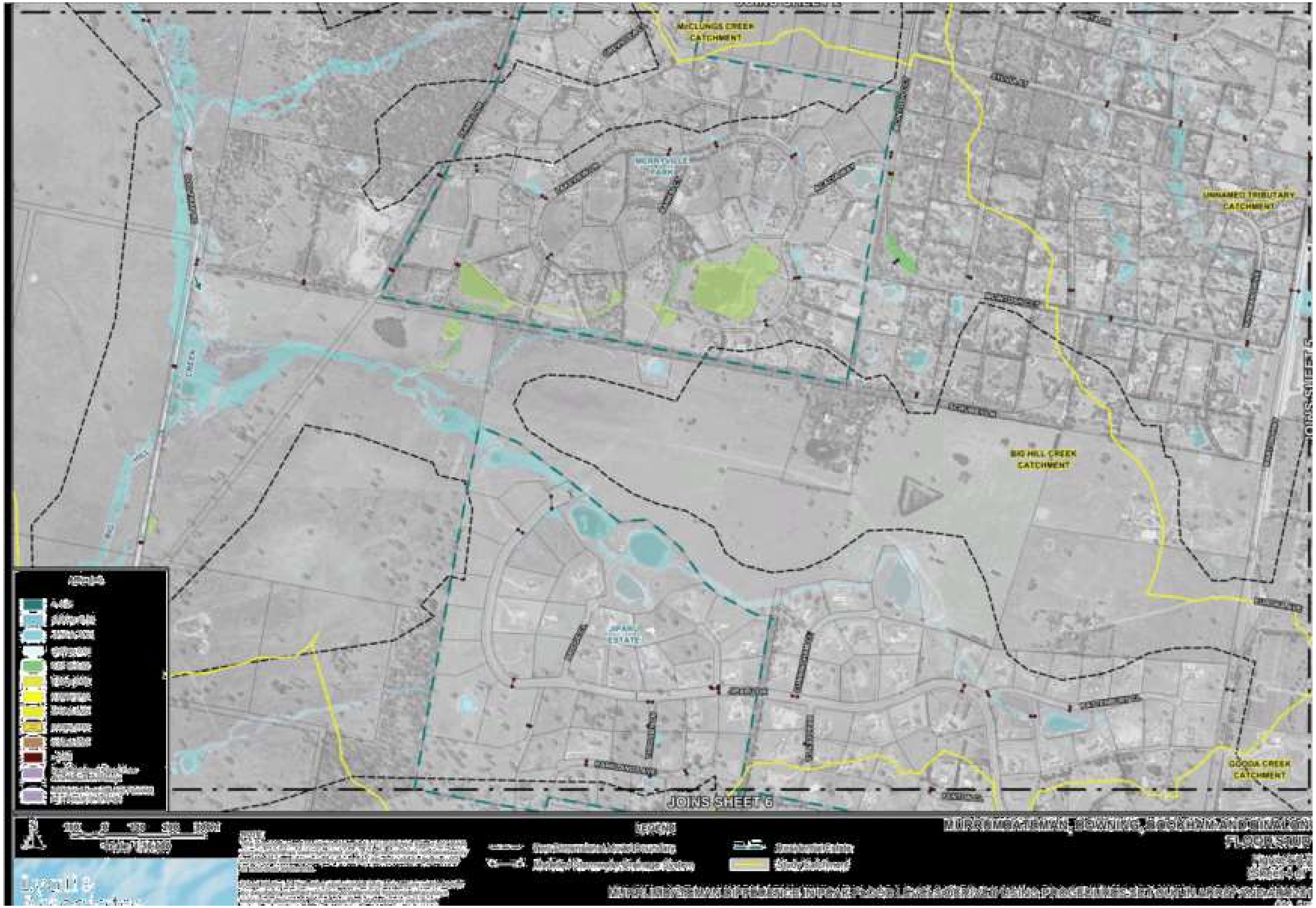
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4


McCLUNGS CREEK
CATCHMENT
UNNAMED TRIBUTARY
CATCHMENT
MURRUMBATEMAN
RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5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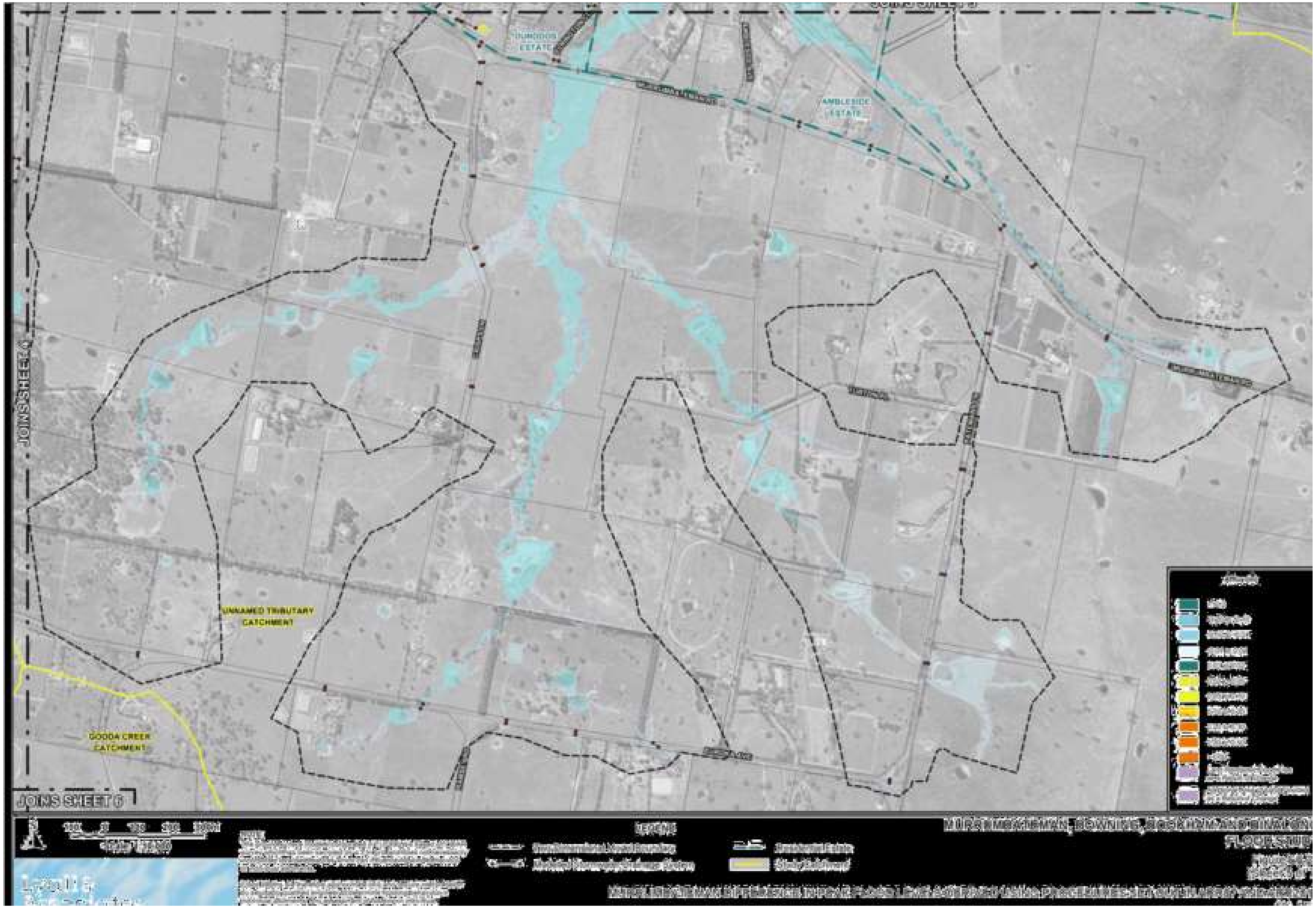
UNNAMED TRIBUTARY CATCHMENT
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 5
JOINS SHEET 6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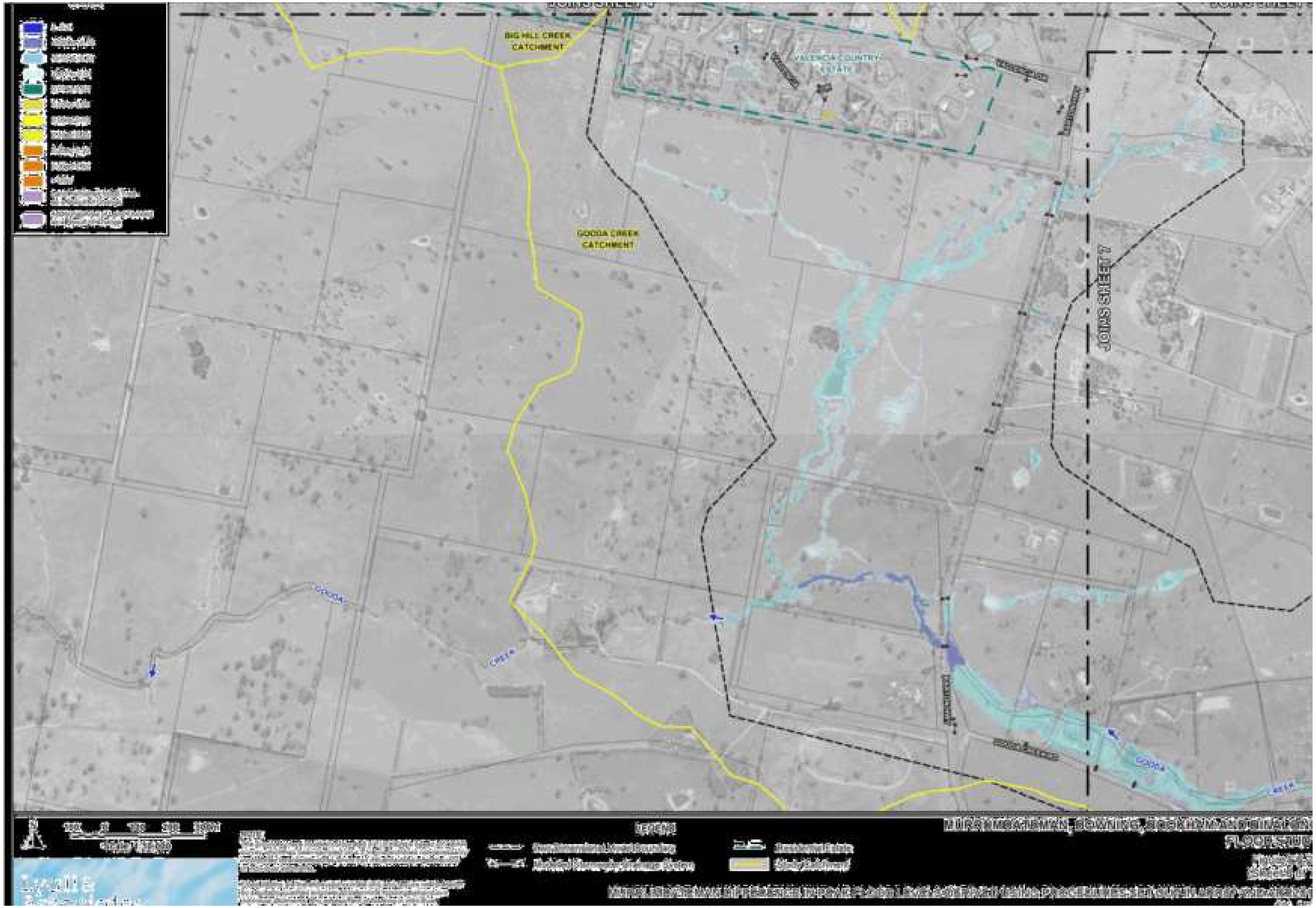
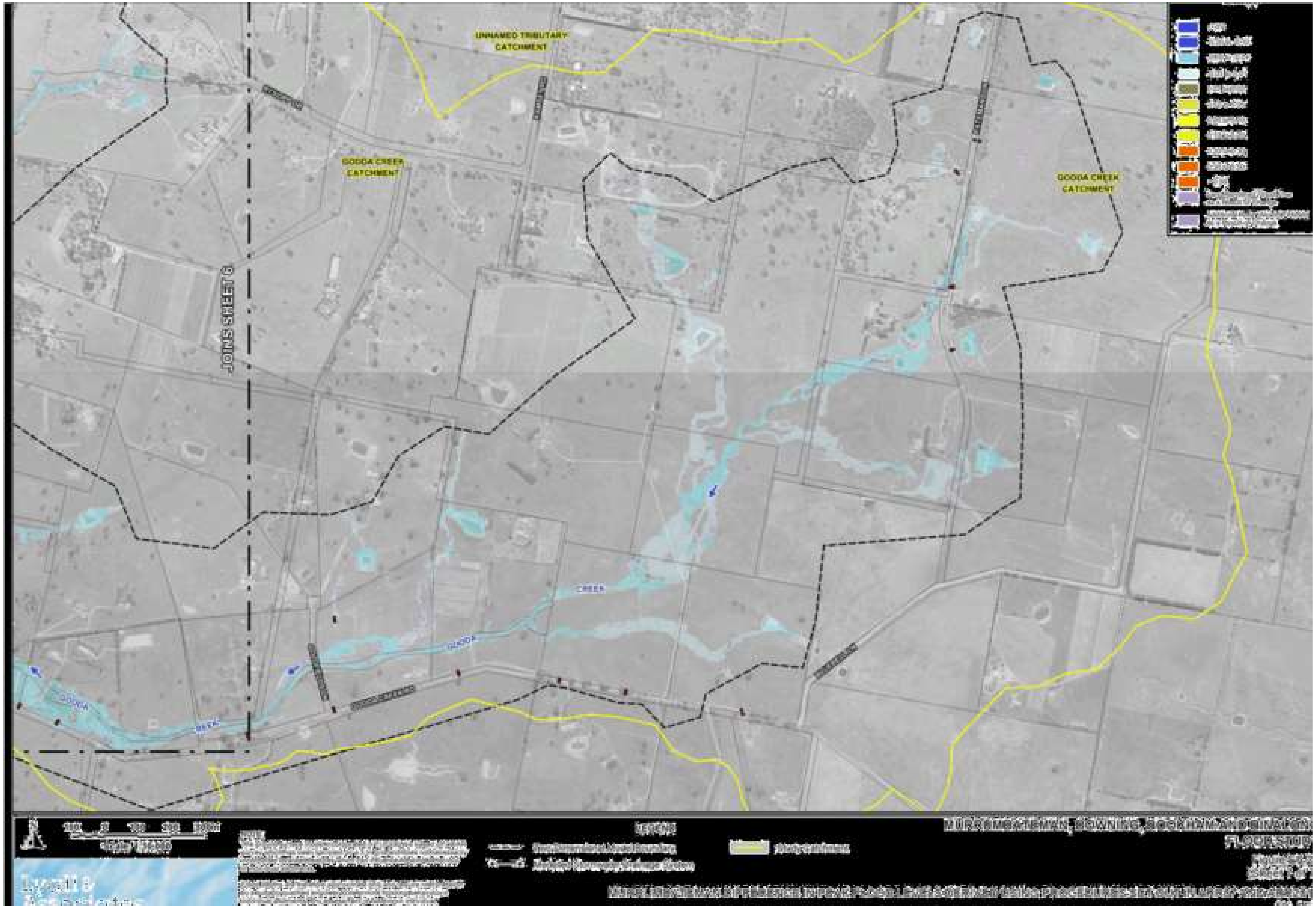
GOODA CREEK CATCHMENT
JOINS SHEET 4
JOINS SHEET 6
LEGEND


BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 7
GOODA
CREEK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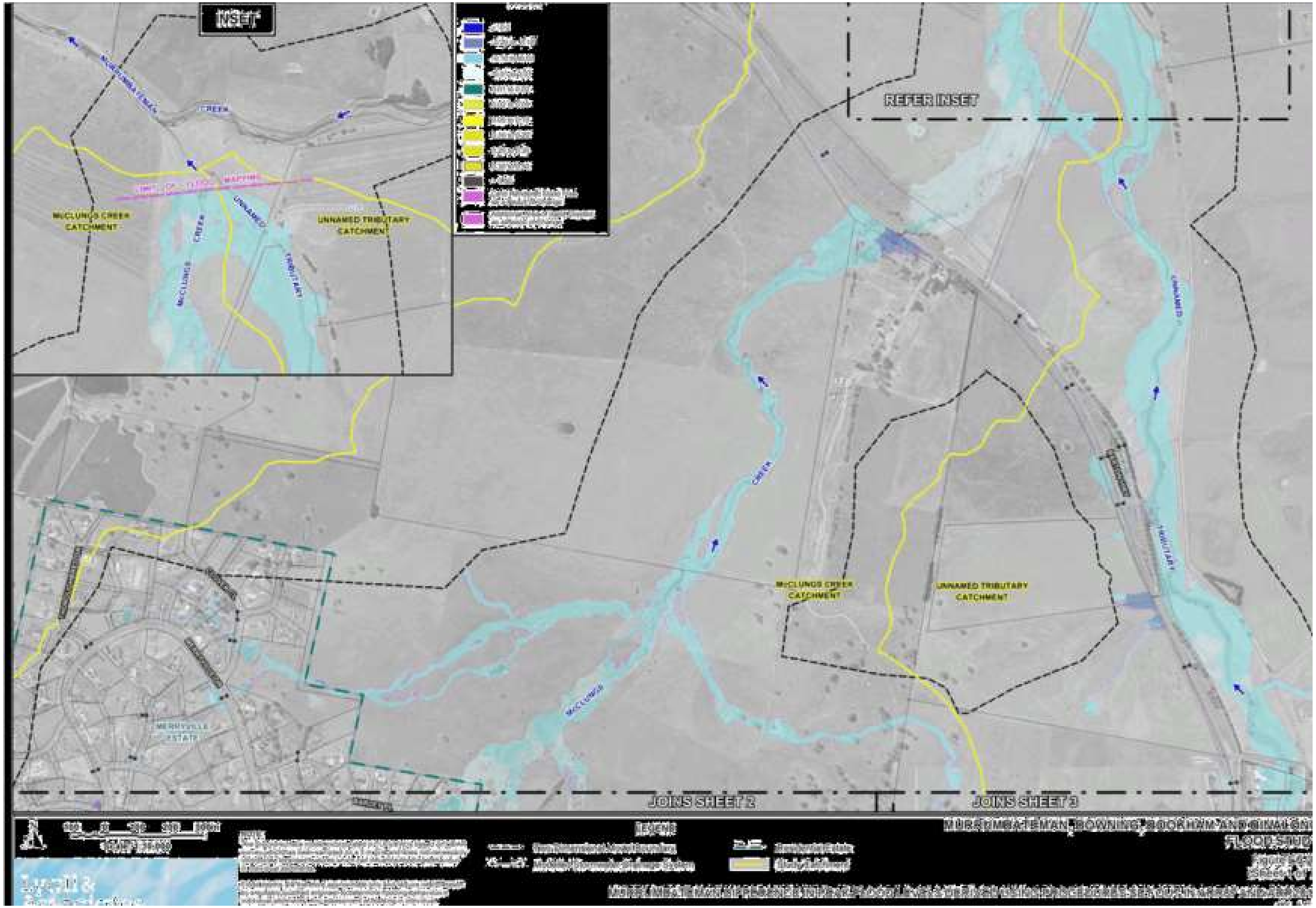
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
CREEK
GOODA
GOODA
CREEK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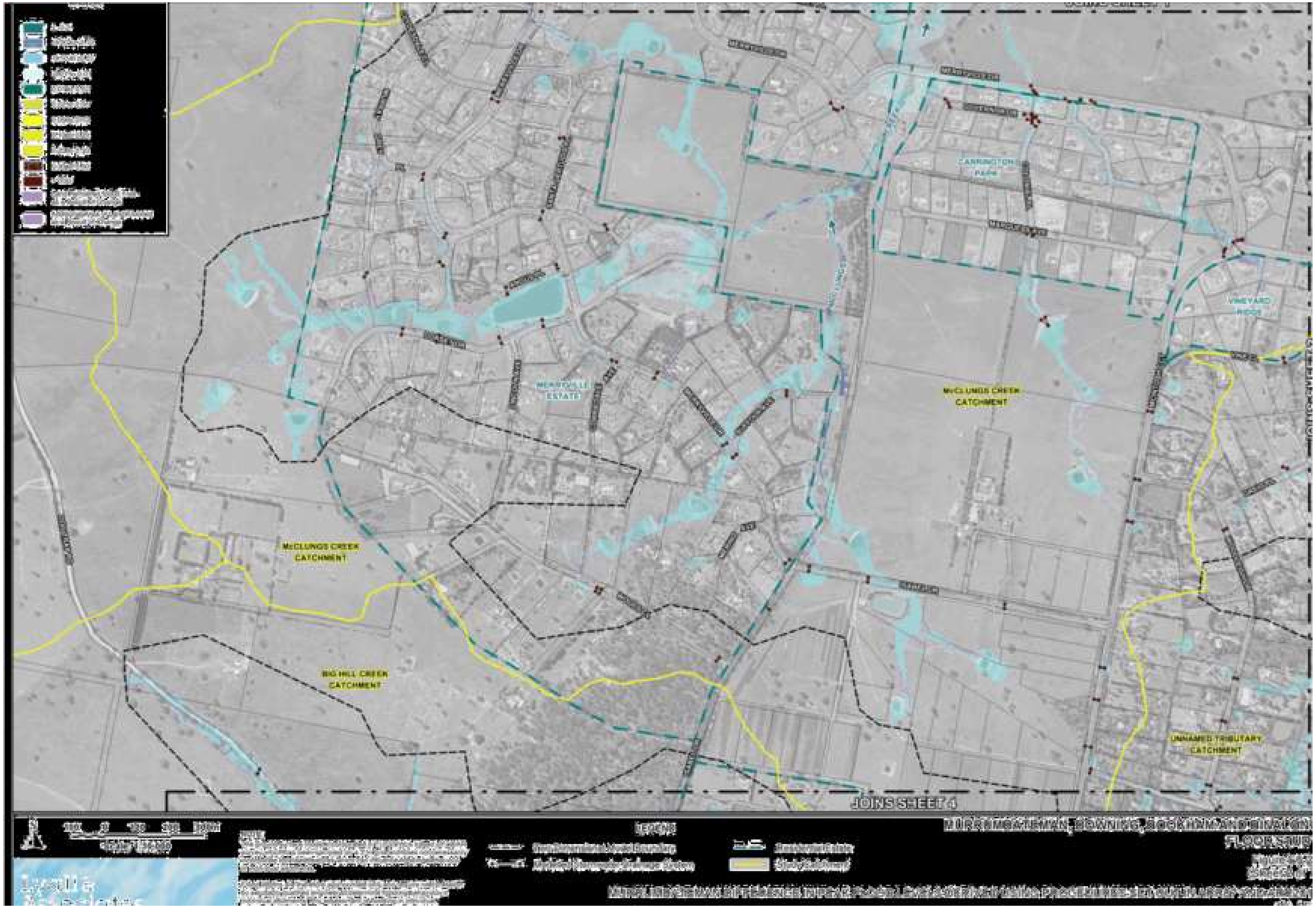
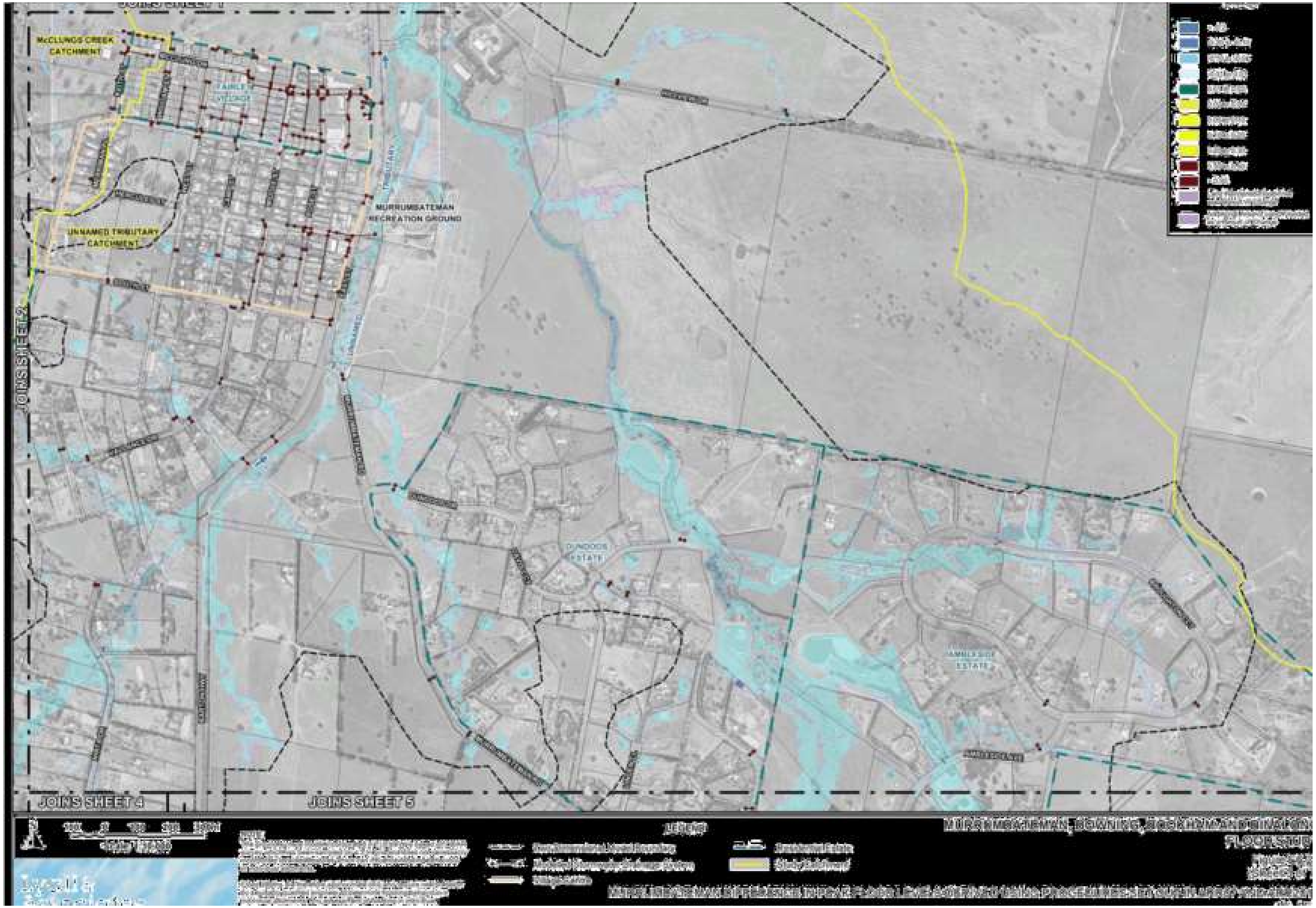
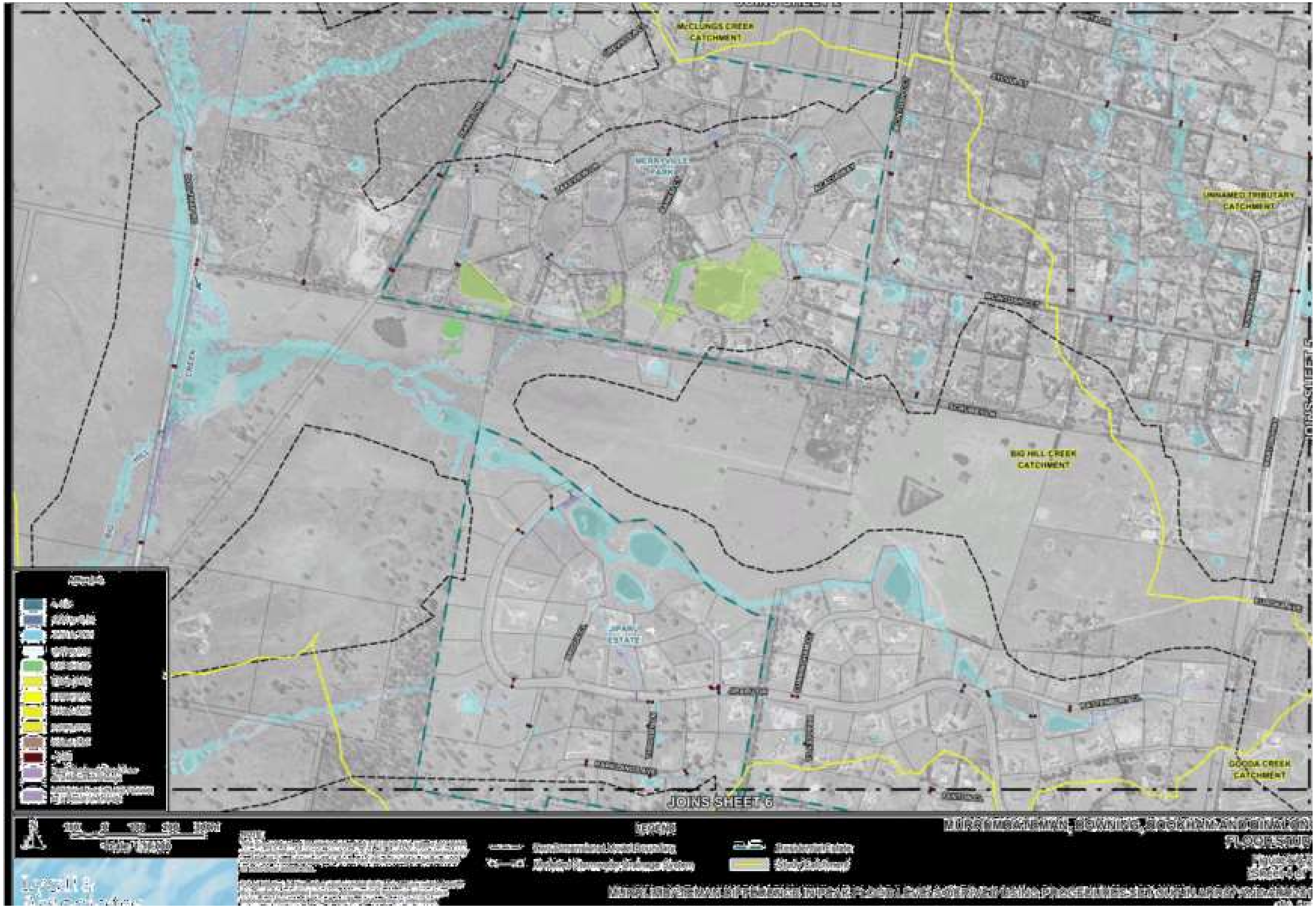
McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
McCLUNGS CREEK
UNNAMED TRIBUTARY
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3
LEGEND


CARRINGTON PARK
VINEYARD RIDGE
MERRYVILLE ESTATE
McCLUNGS CREEK CATCHMENT
McCLUNGS CREEK CATCHMENT
BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4
LEGEND


McCLUNGS CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
MURRUMBATEMAN RECREATION GROUND
TRIBUTARY
UNNAMED
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5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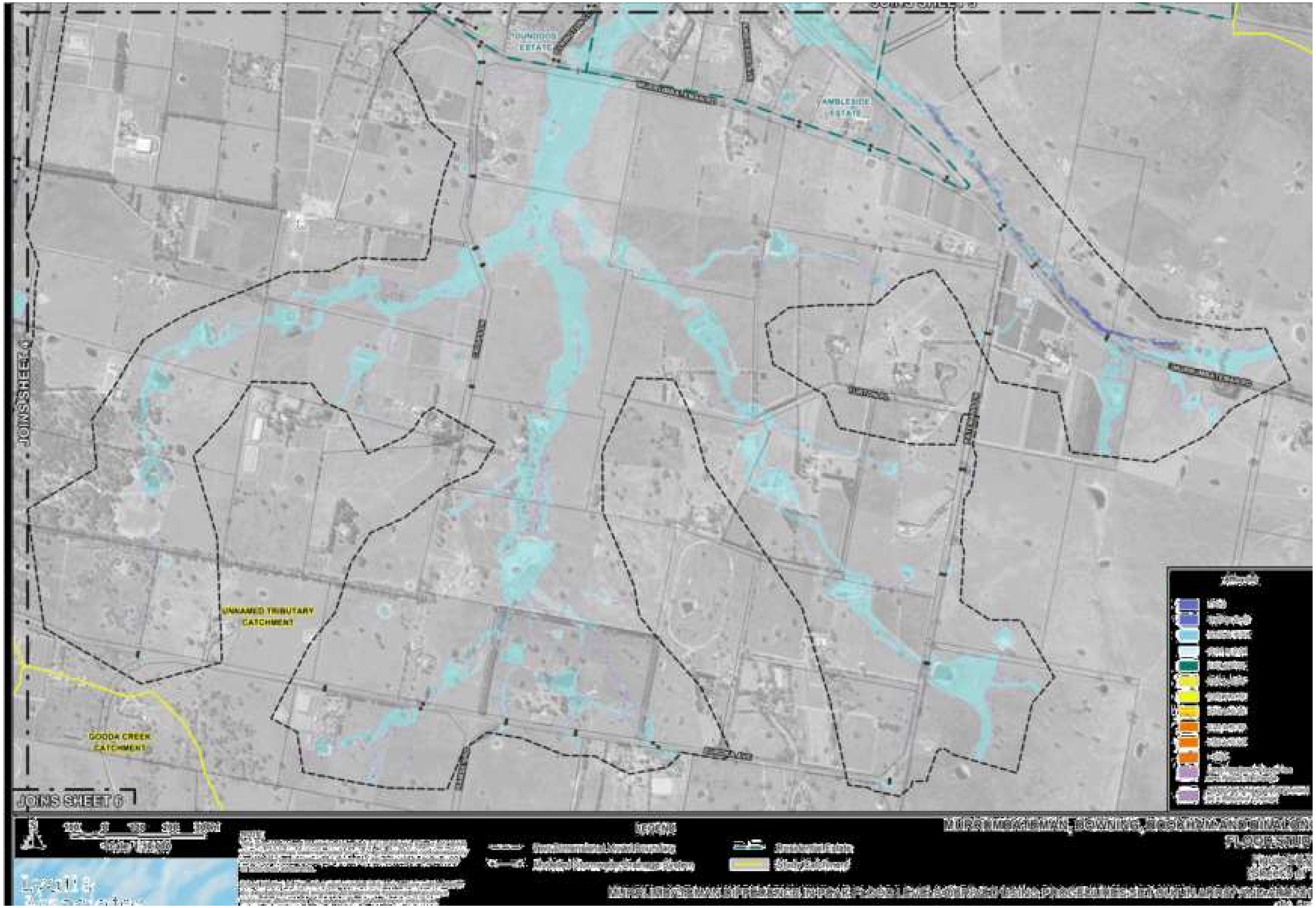
MERRYVILLE PARK
UNNAMED TRIBUTARY CATCHMENT
BIG HILL CREEK CATCHMENT
JIPARU ESTATE
GOODA CREEK CATCHMENT
JOINS SHEET 6
JOINS SHEET 5
LEGEND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JOINS SHEET 4
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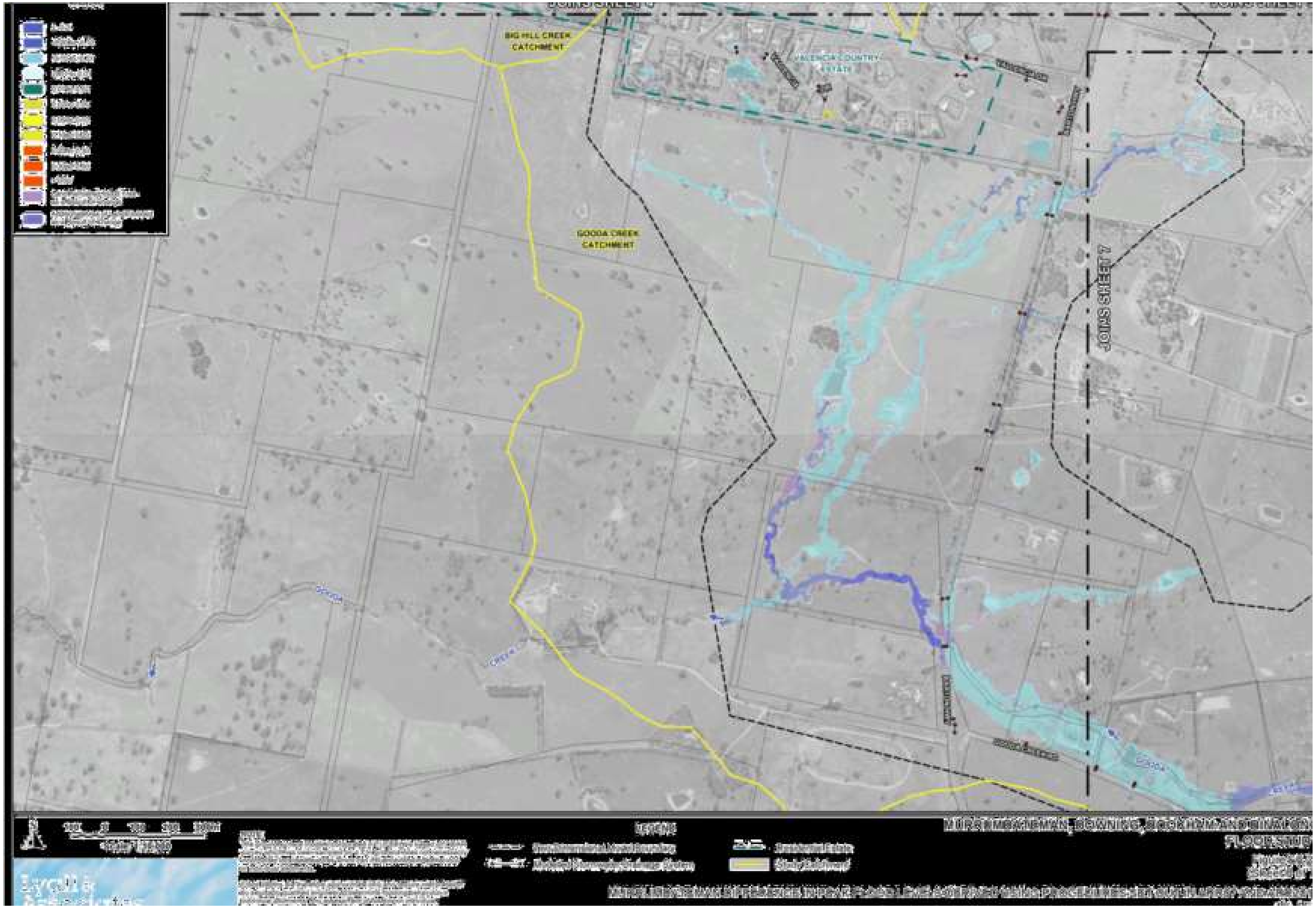
GOODA CREEK CATCHMENT
JOINS SHEET 6
LEGEND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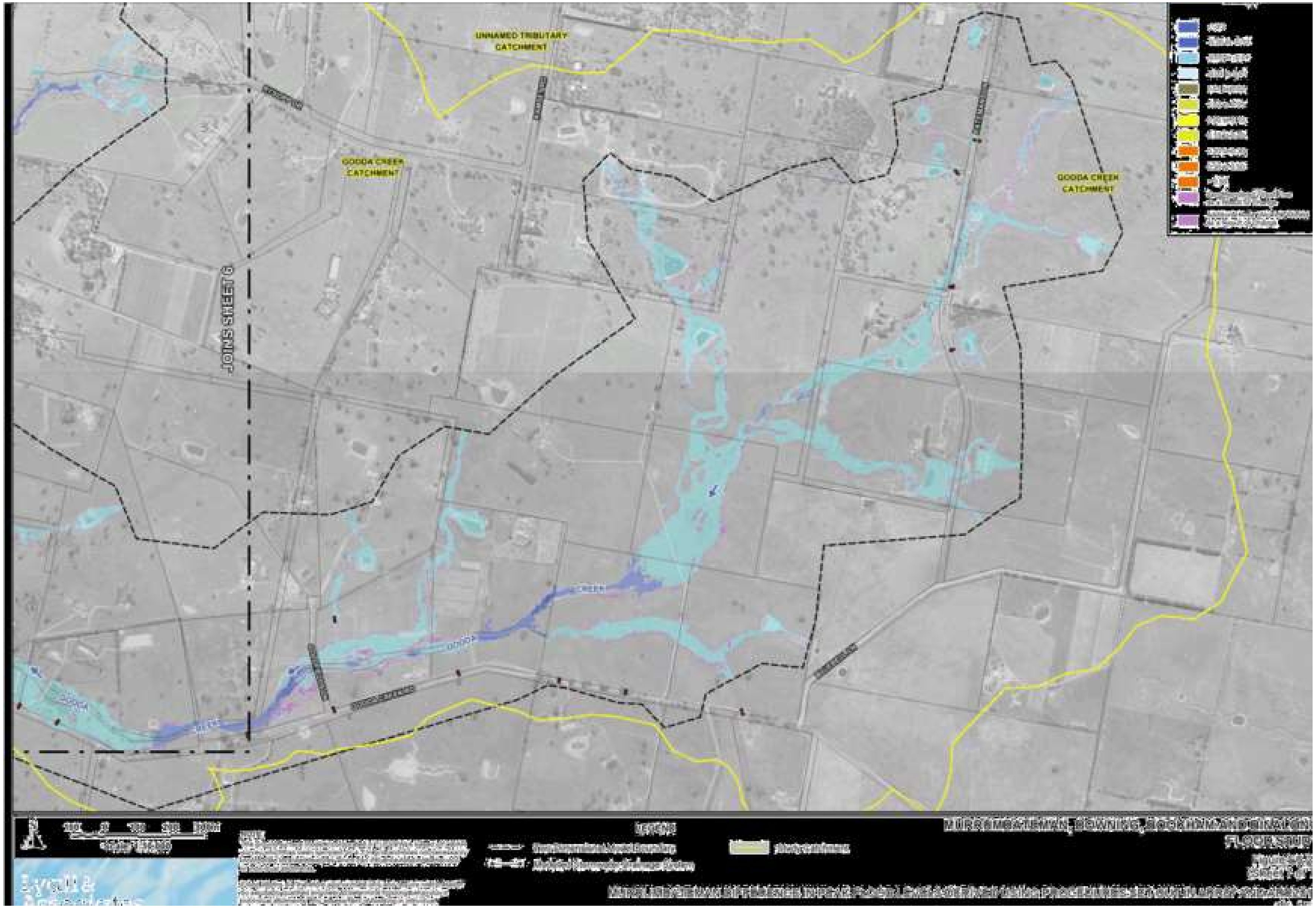
VALENCIA COUNTRY ESTATE
GOODA CREEK CATCHMENT
JOINS SHEET 7
GOODA
CREEK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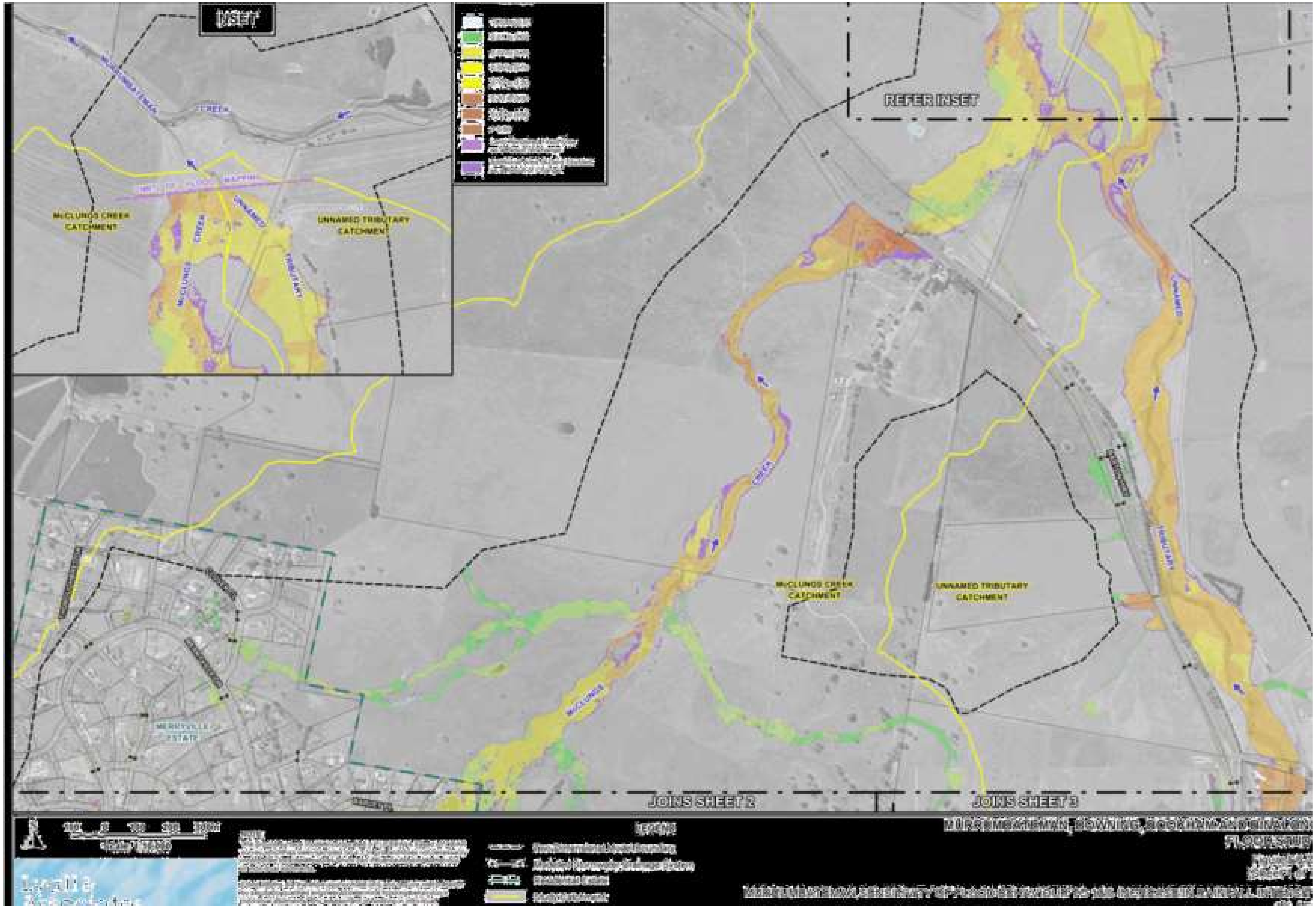
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
GOODA
CREEK
LEGEND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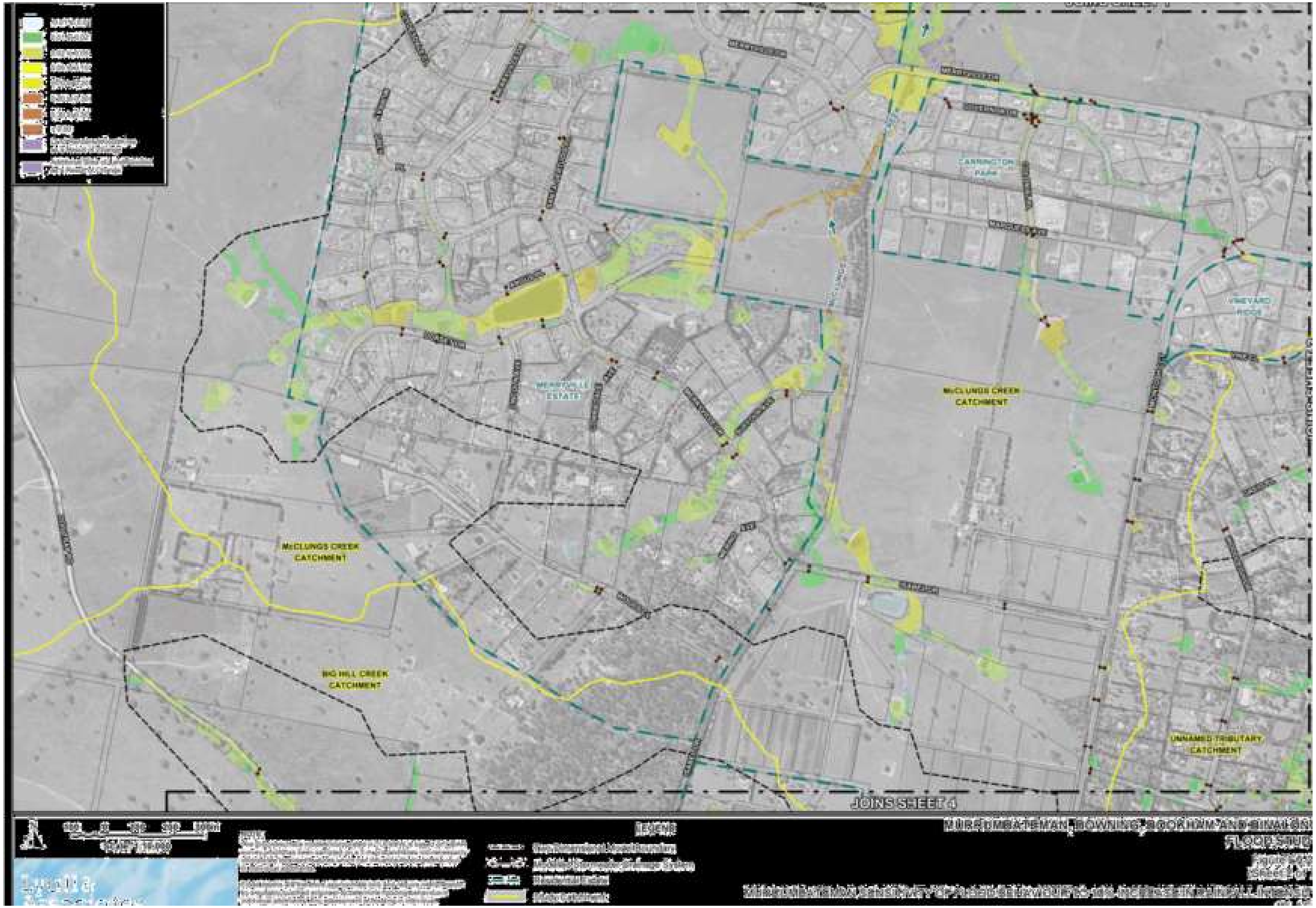
UNNAMED TRIBUTARY CATCHMENT
MERRYVILLE ESTATE
JOINS SHEET 2
JOINS SHEET 3
LEGEND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VINEYARD RIDGE
MERRYVILLE ESTATE
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BIG HILL CREEK CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
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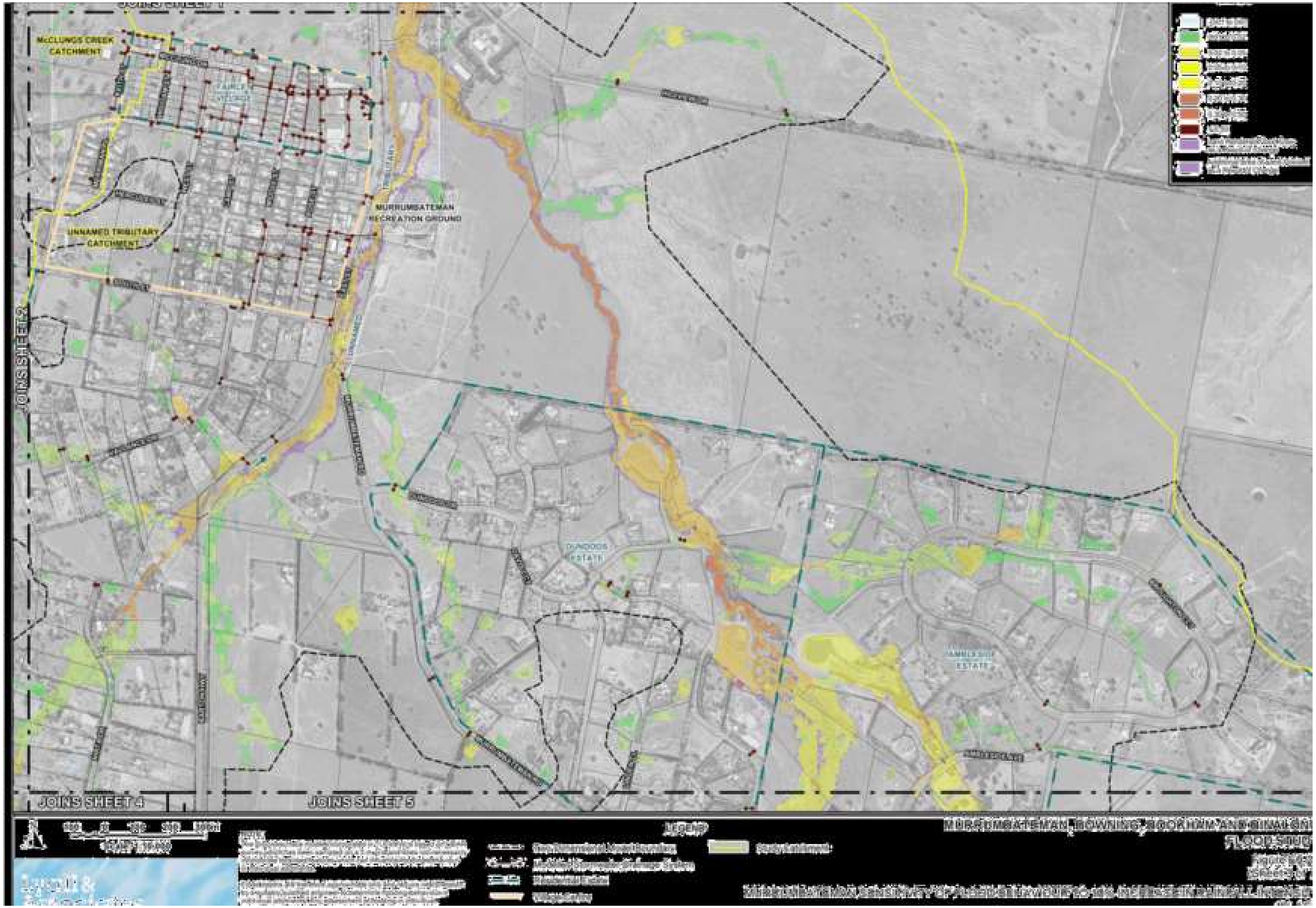
LEGEND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JOINS SHEET 4
JOINS SHEET 5
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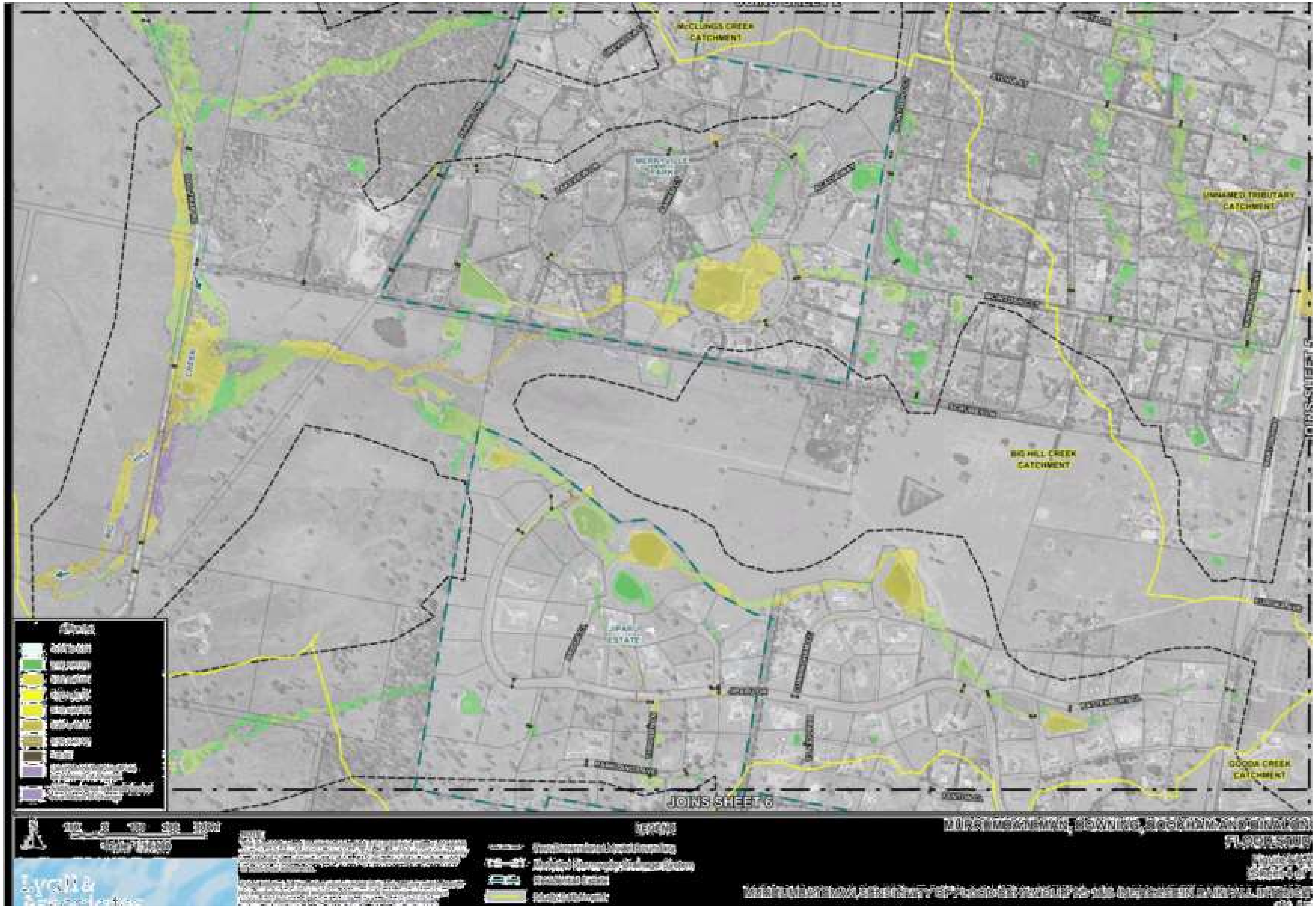
LEGEND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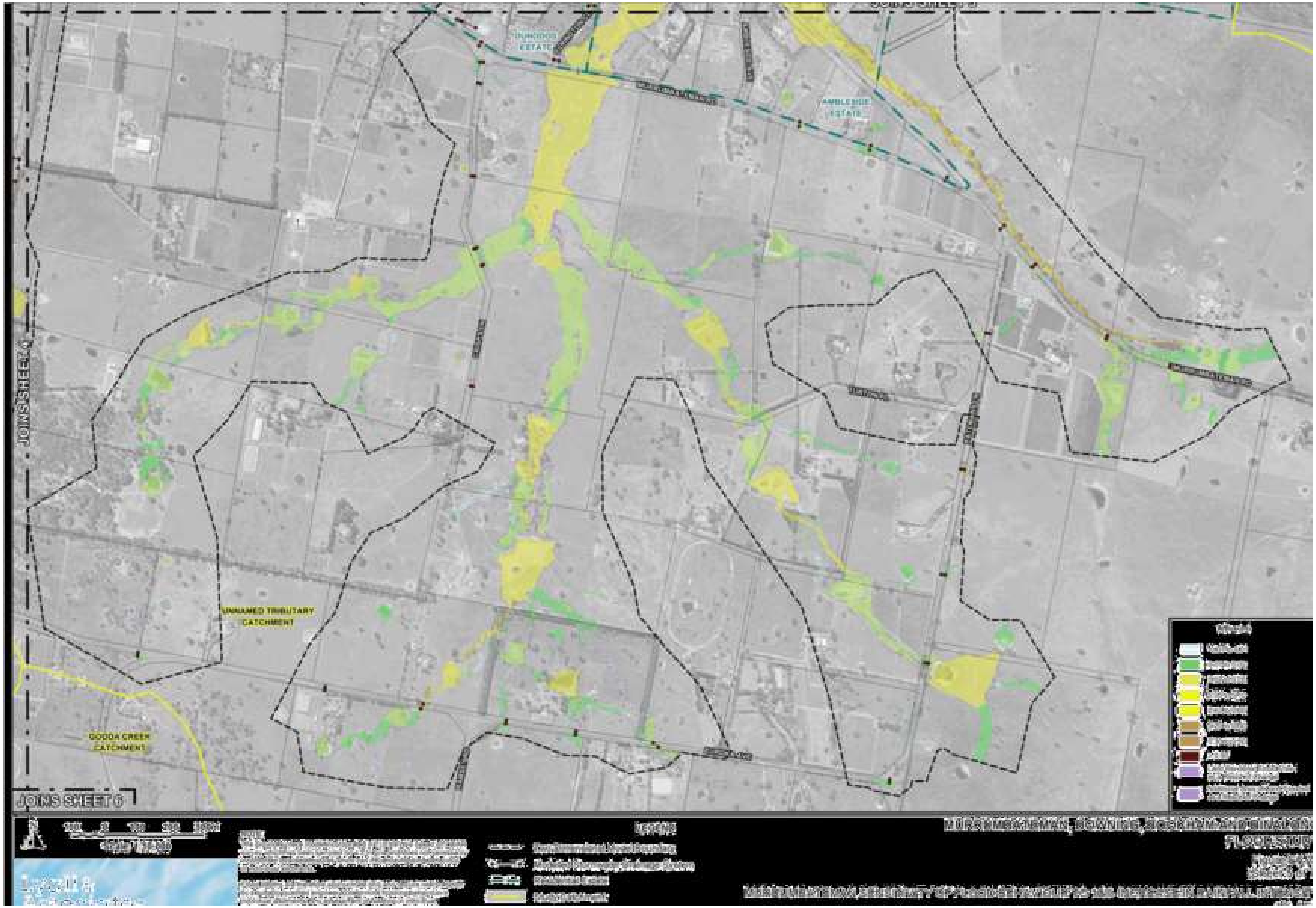
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
JOINS SHEET 5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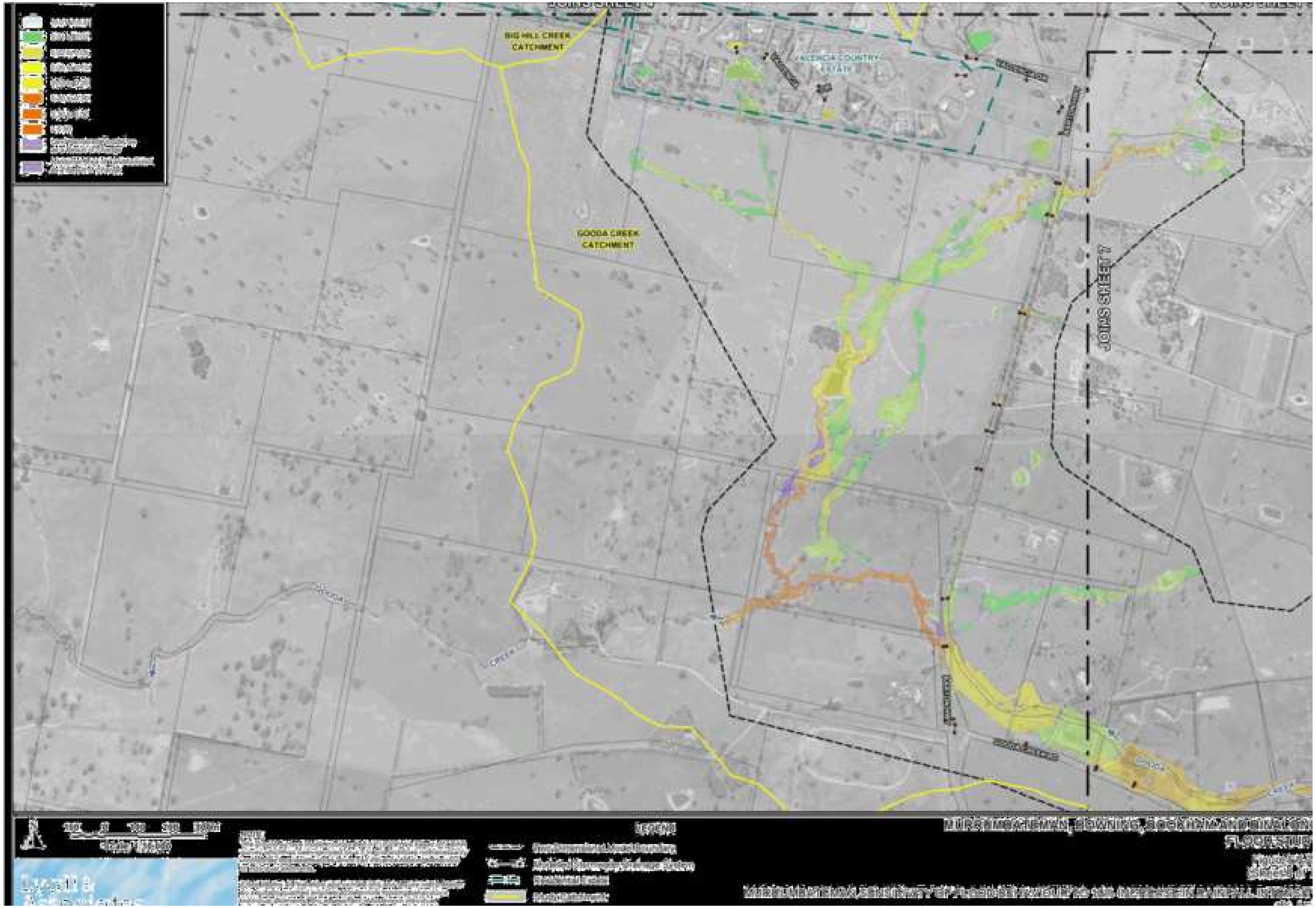
GOODA CREEK CATCHMENT
JOINS SHEET 6
LEGEND
FLOOD STUDY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GOODA CREEK CATCHMENT
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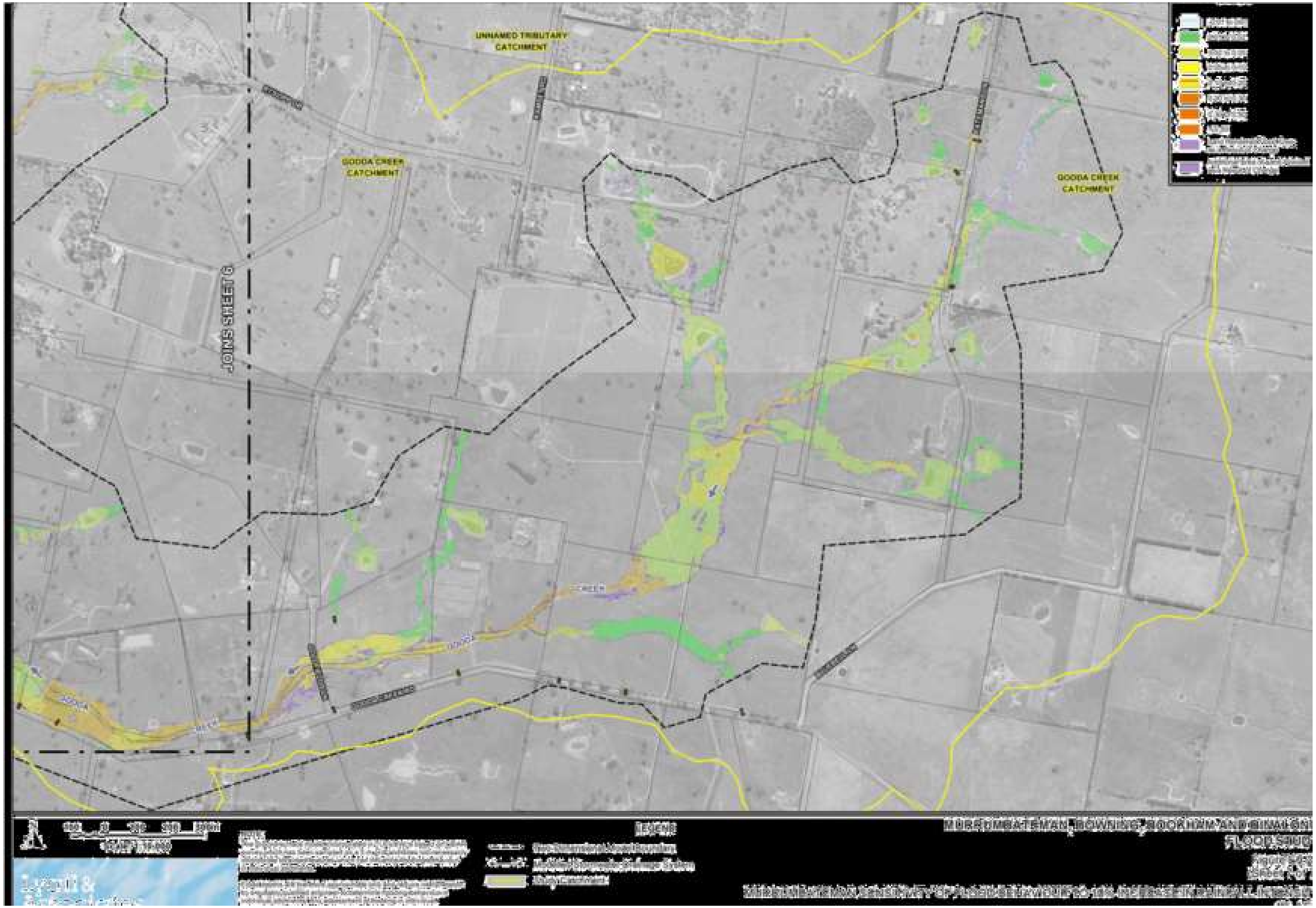
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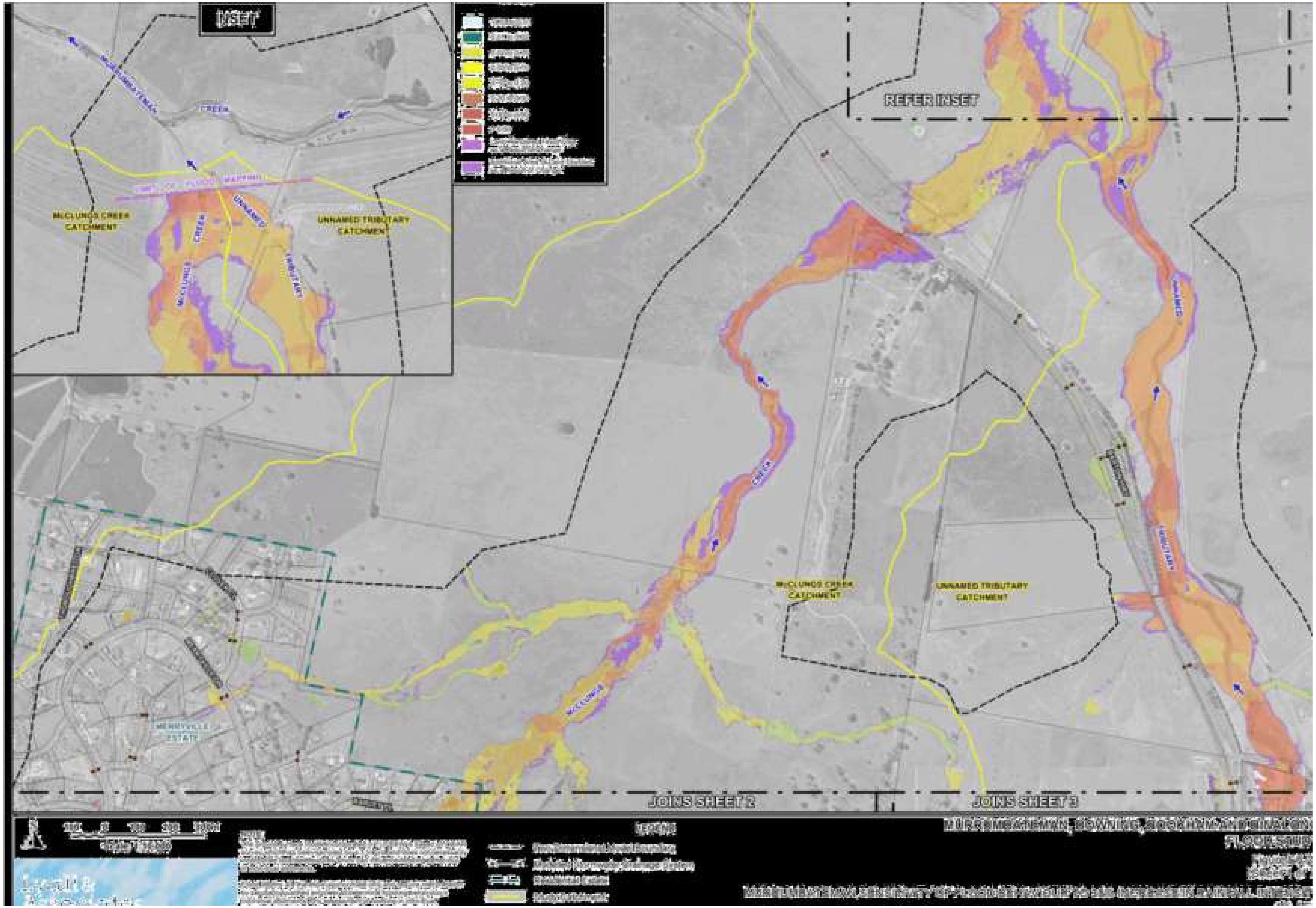
GOODA CREEK
CATCHMENT
GOODA CREEK
CATCHMENT
JOINS SHEET 6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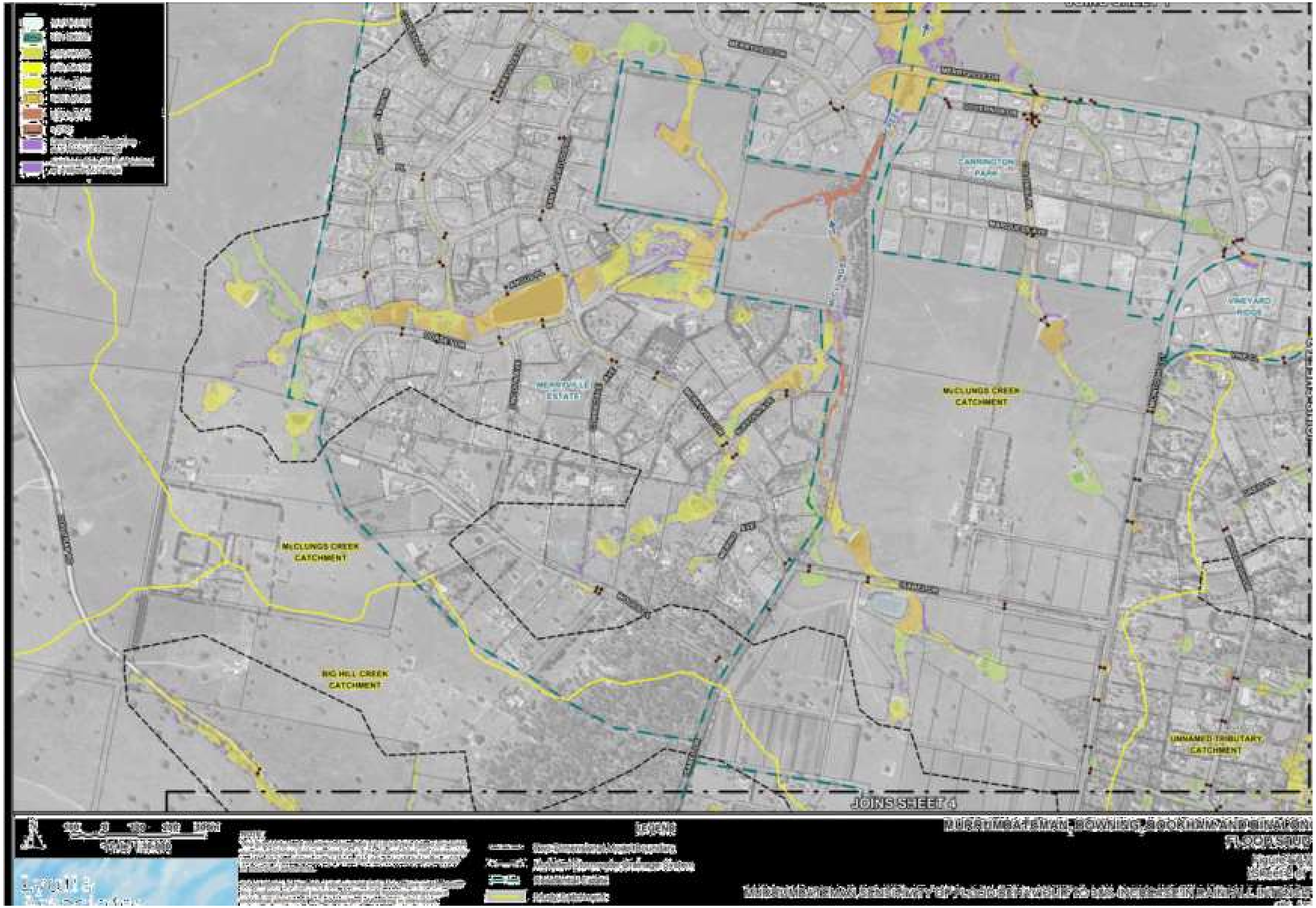
JOINS SHEET 3
LEGEND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VINEYARD RIDGE
MERRYVILLE ESTATE
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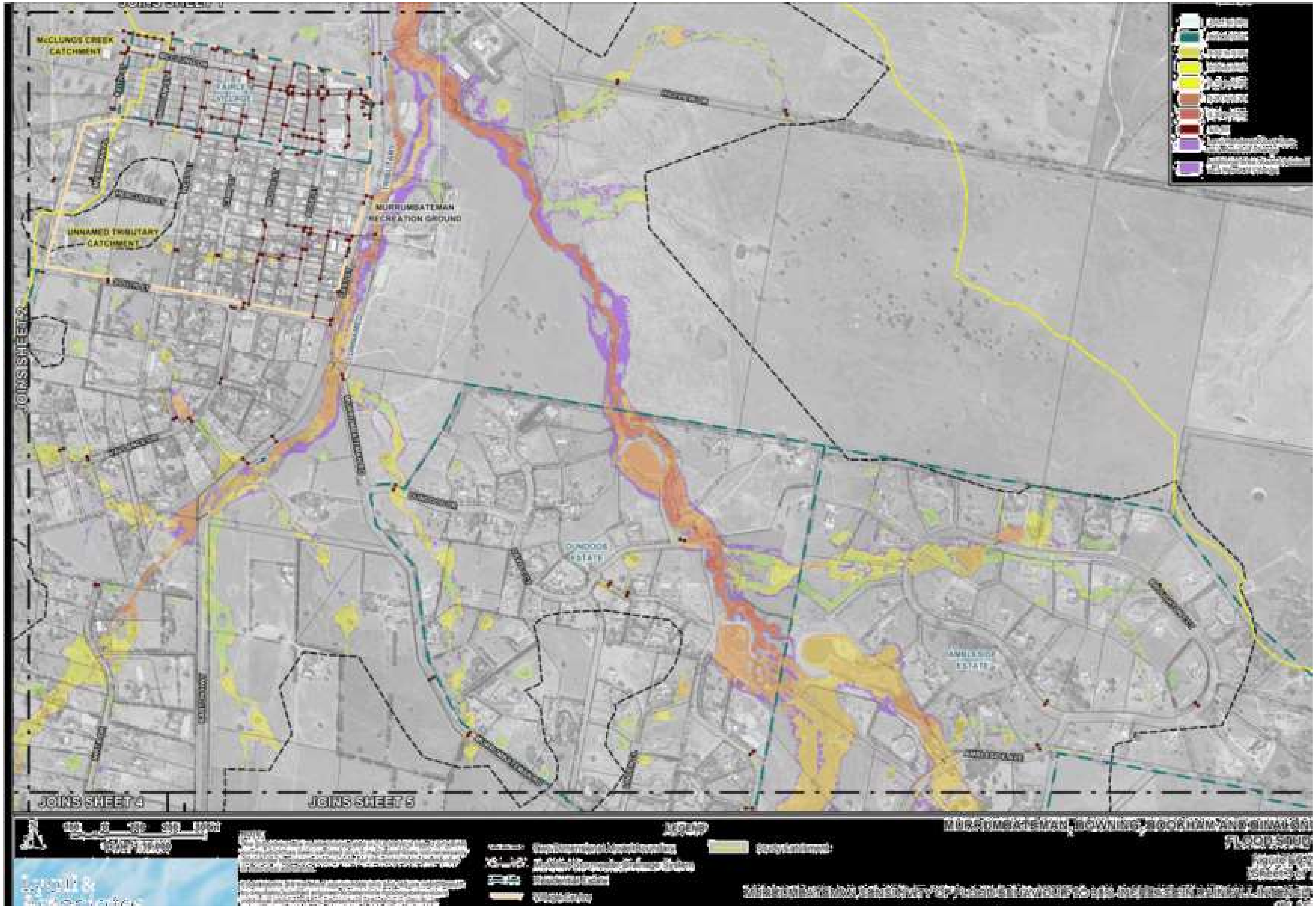
UNNAMED TRIBUTARY CATCHMENT
JOINS SHEET 4
LEGEND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CATCHMENT
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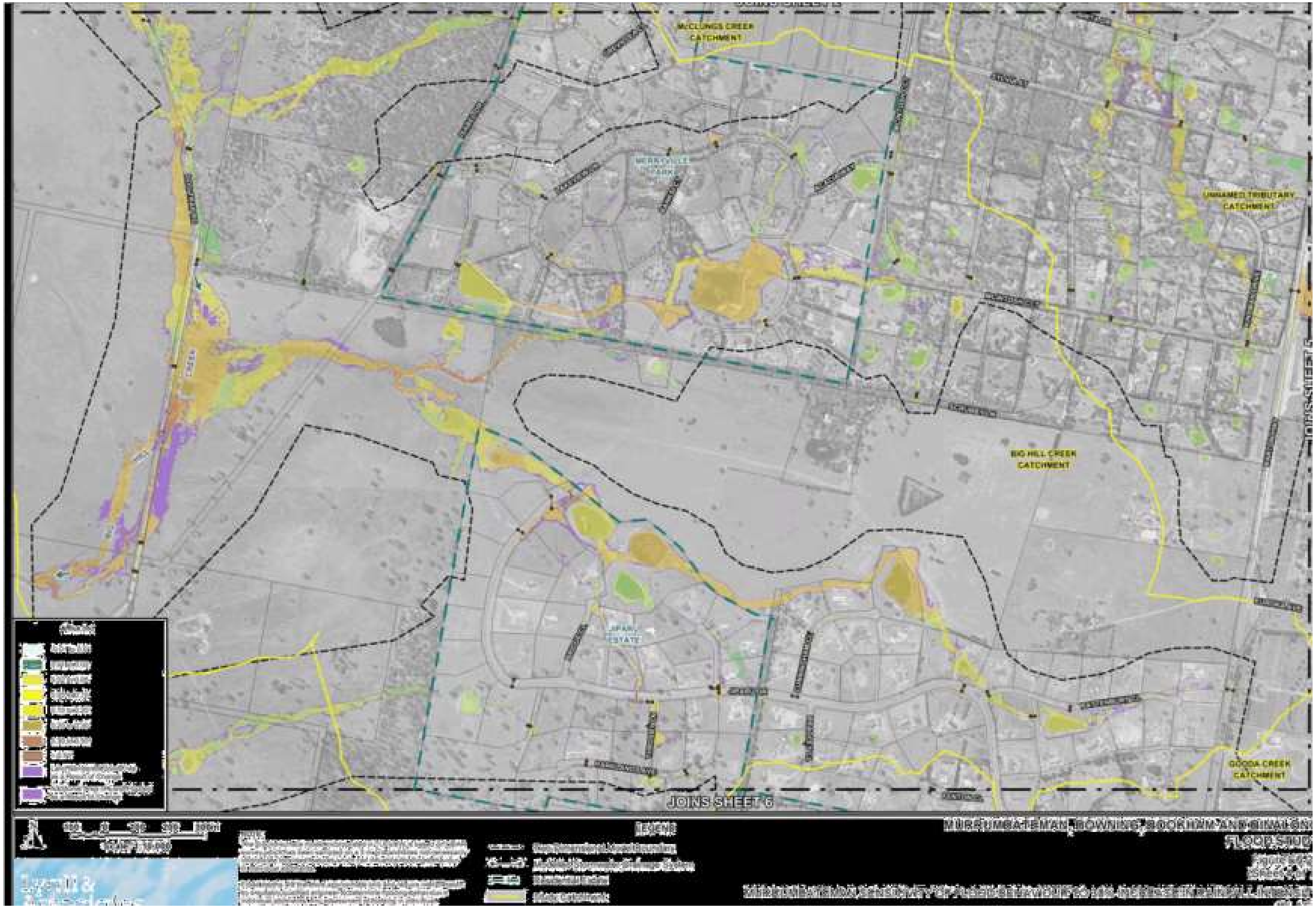
RECREATION GROUND
JOINS SHEET 2
JOINS SHEET 4
JOINS SHEET 5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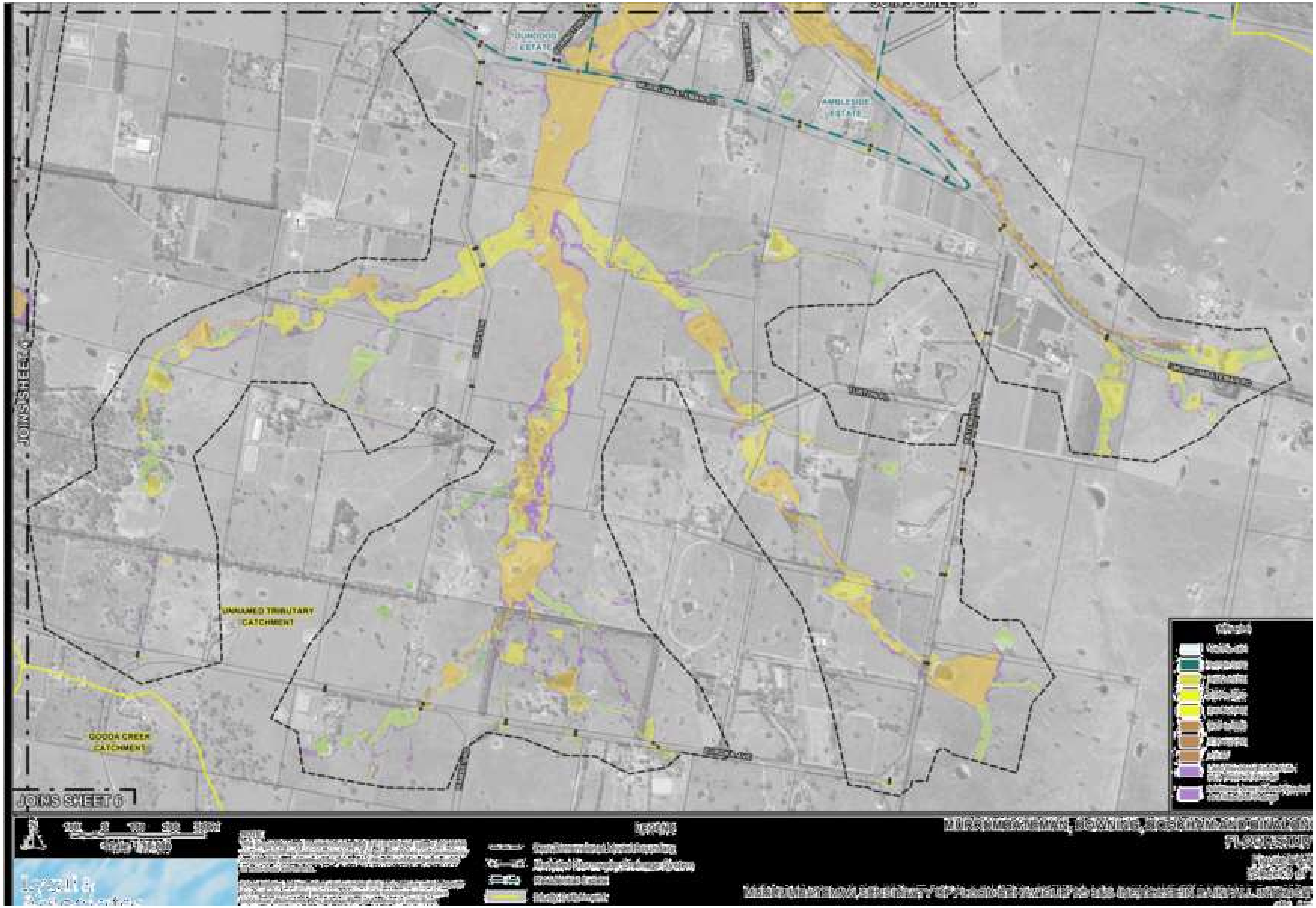
BIG HILL CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
JOINS SHEET 5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JOINS SHEET 6
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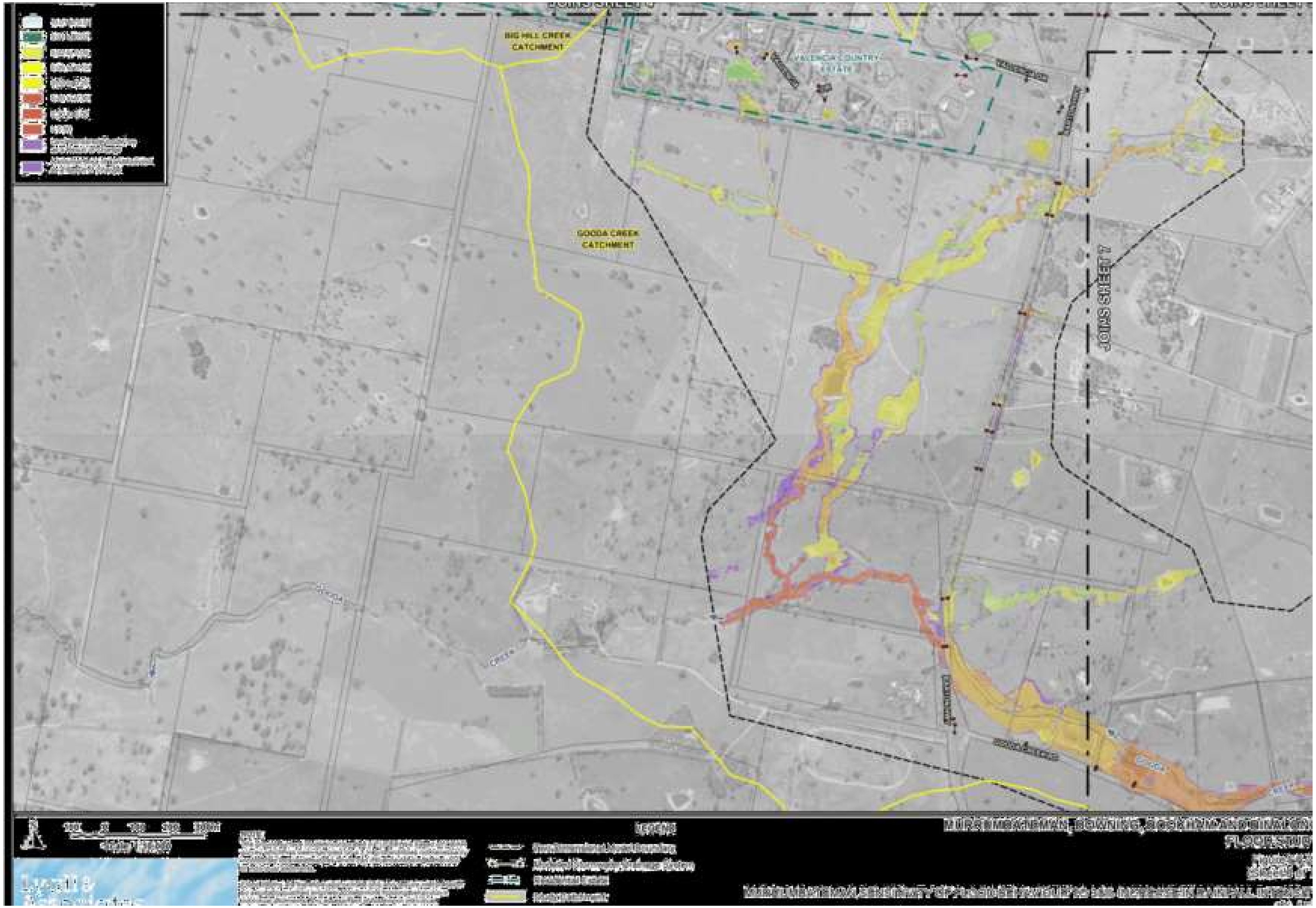
GOODA CREEK CATCHMENT
AMBLESIDE ESTATE
LEGEND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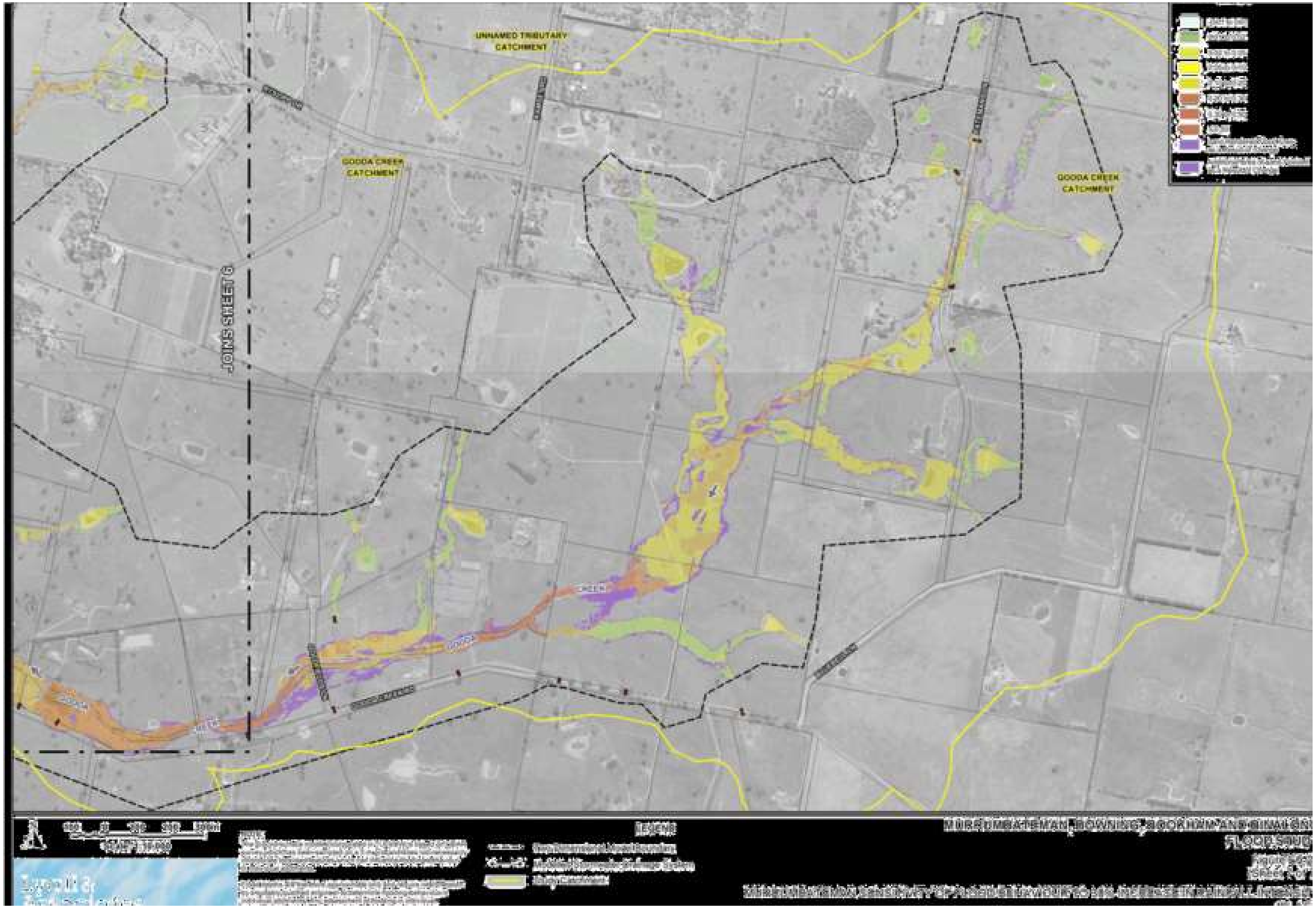
GOODA CREEK
CATCHMENT
VALENCIA COUNTRY
ESTATE
JOINS SHEET 7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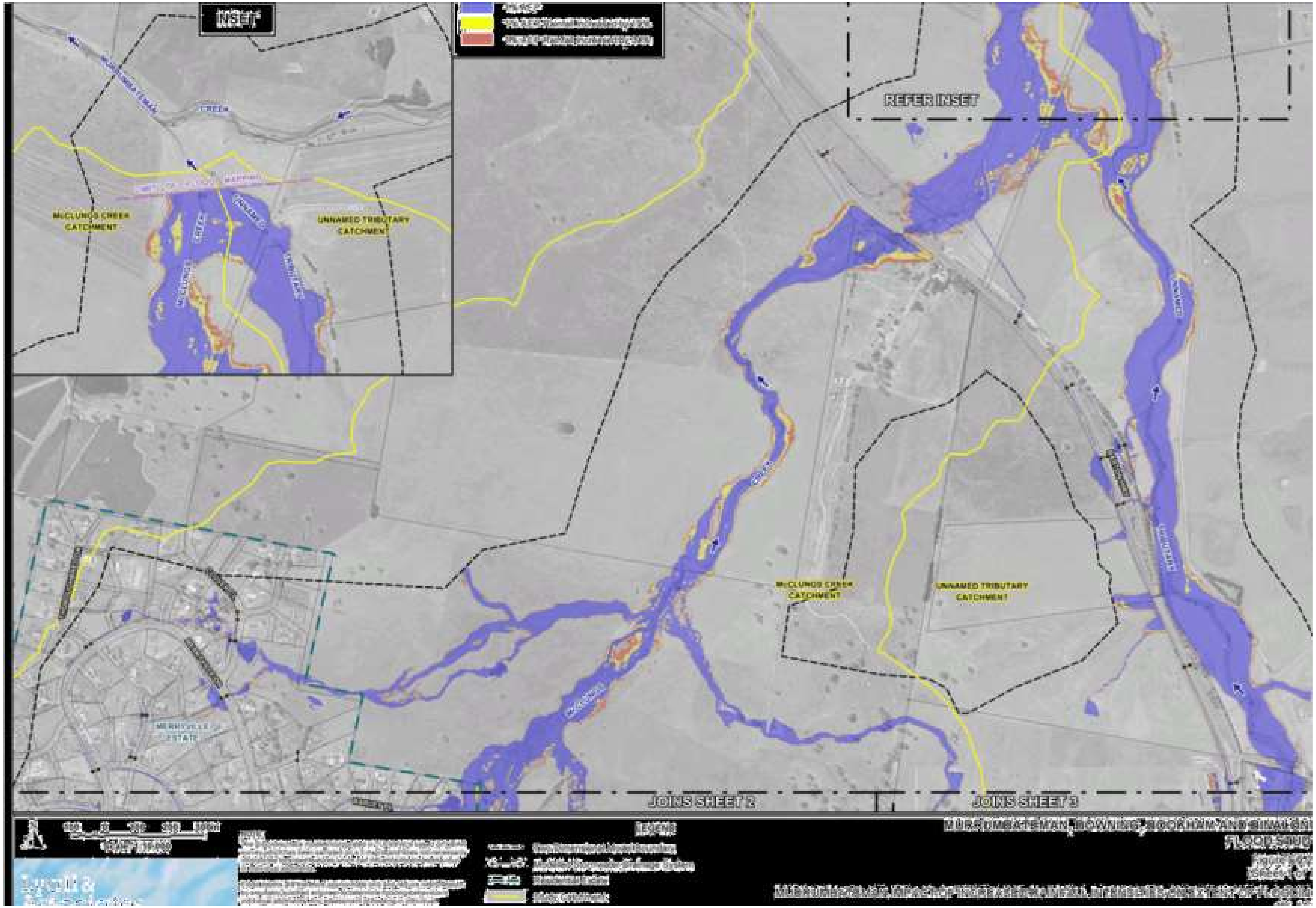
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
CREEK
GOODA
LEGEND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UNNAMED TRIBUTARY CATCHMENT
MERRYVILLE ESTATE
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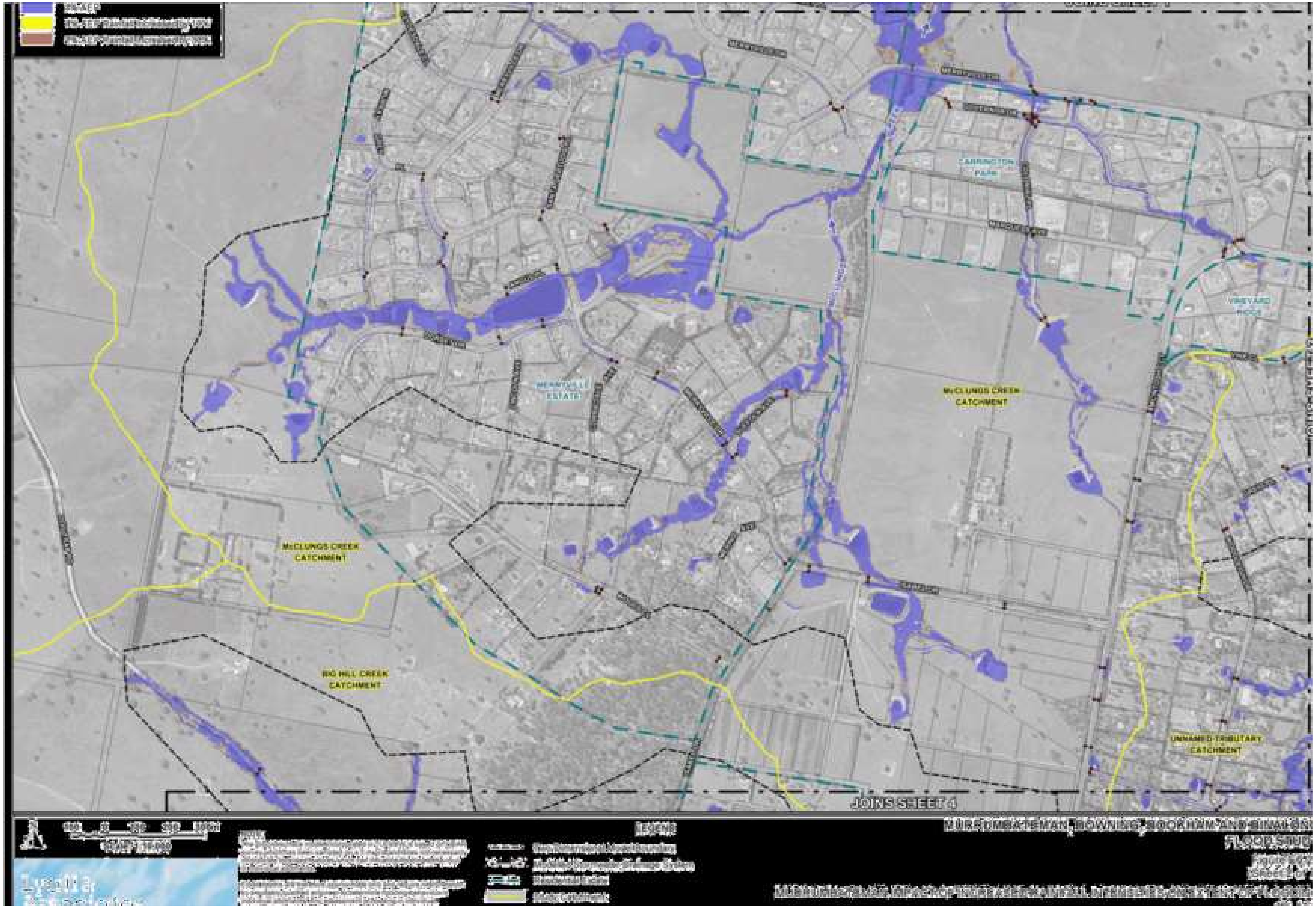
JOINS SHEET 3
LEGEND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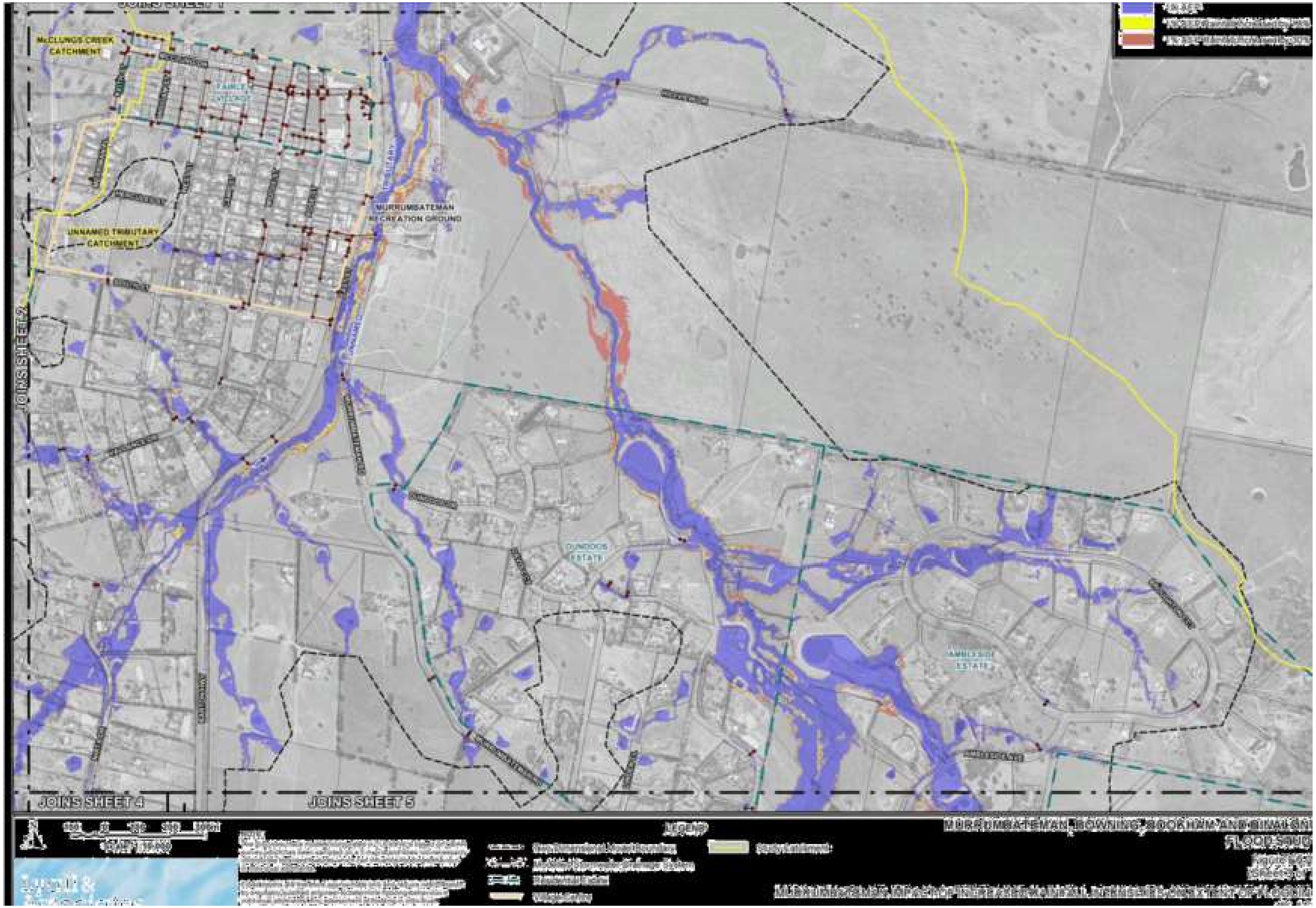
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MURRUMBATEMAN RECREATION GROUND
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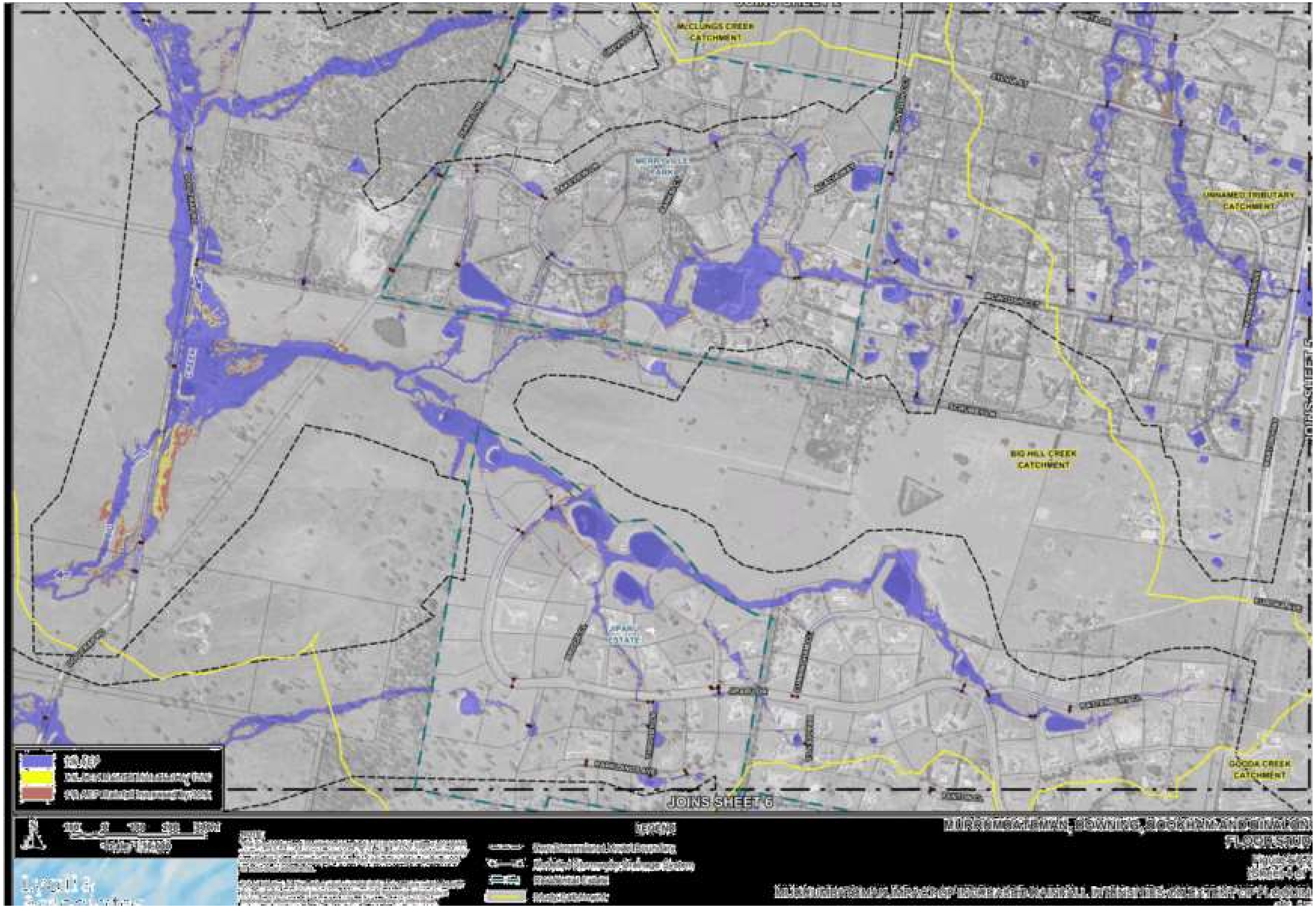
JOINS SHEET 4
JOINS SHEET 5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CATCHMENT
UNNAMED TRIBUTARY
CATCHMENT
BIG HILL CREEK
CATCHMENT
GOODA CREEK
CATCHMENT
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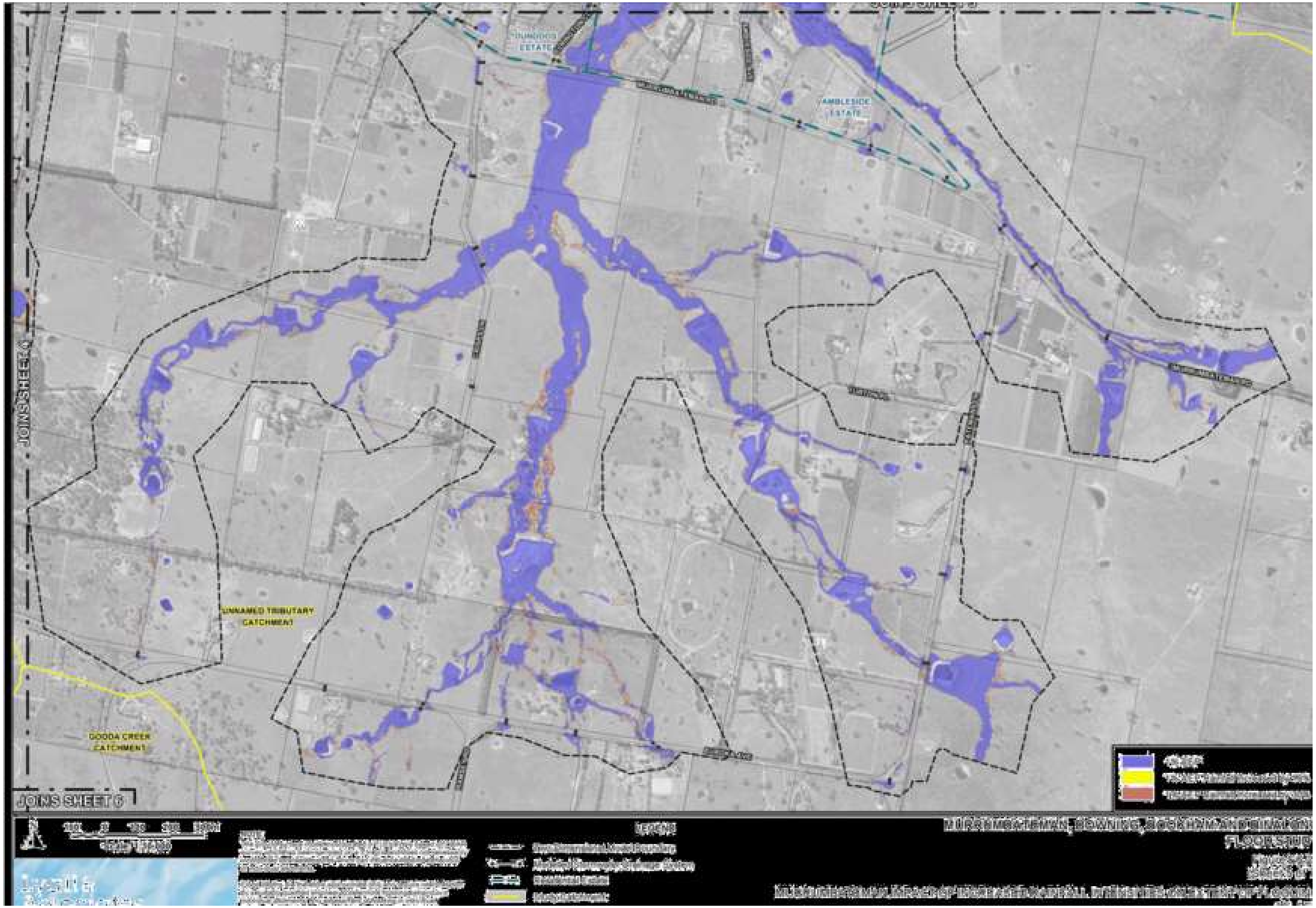
JOINS SHEET 5
10 AEP
LEGEND
FLOOD STUDY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AMBLESIDE ESTATE
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JOINS SHEET 6
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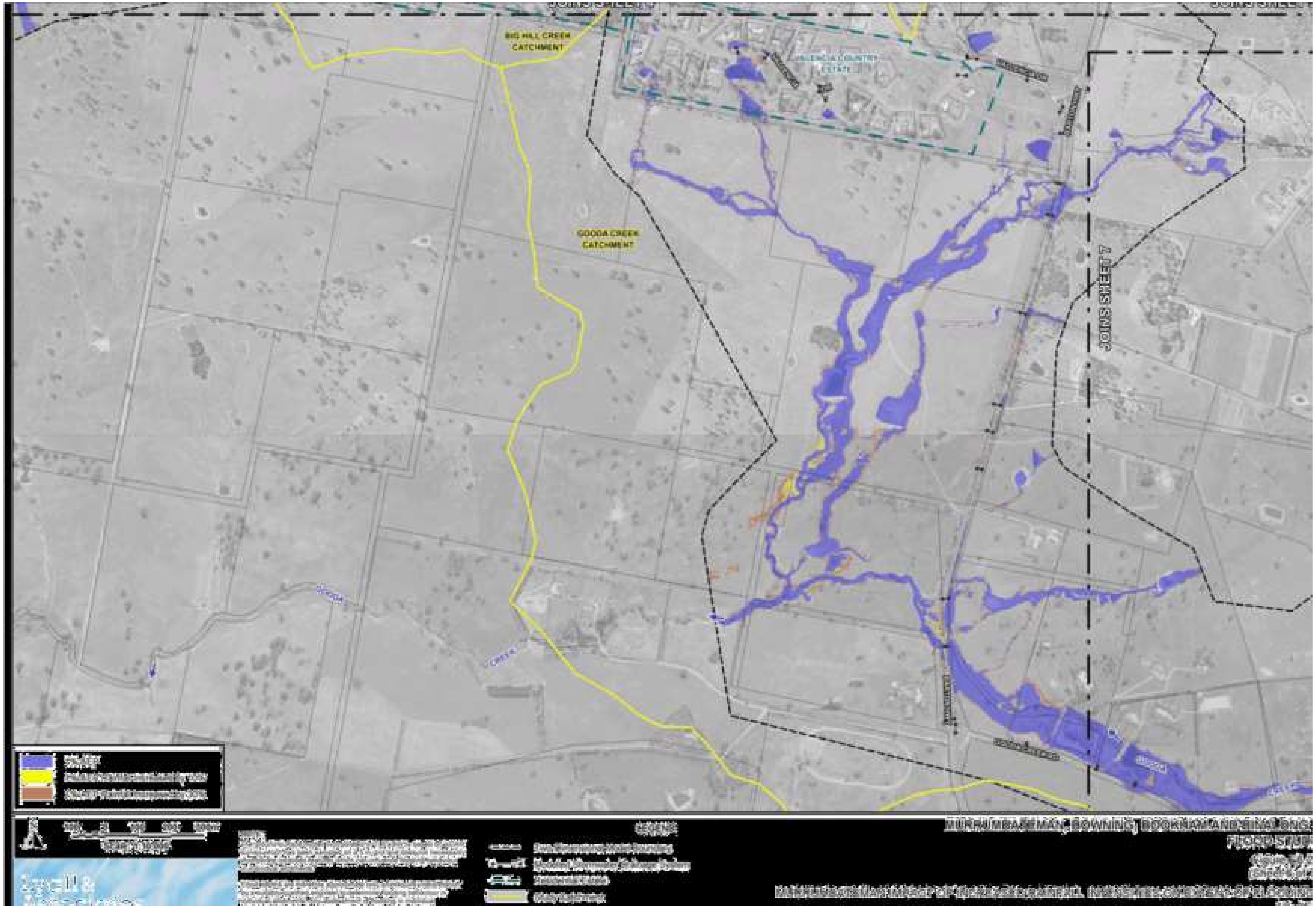
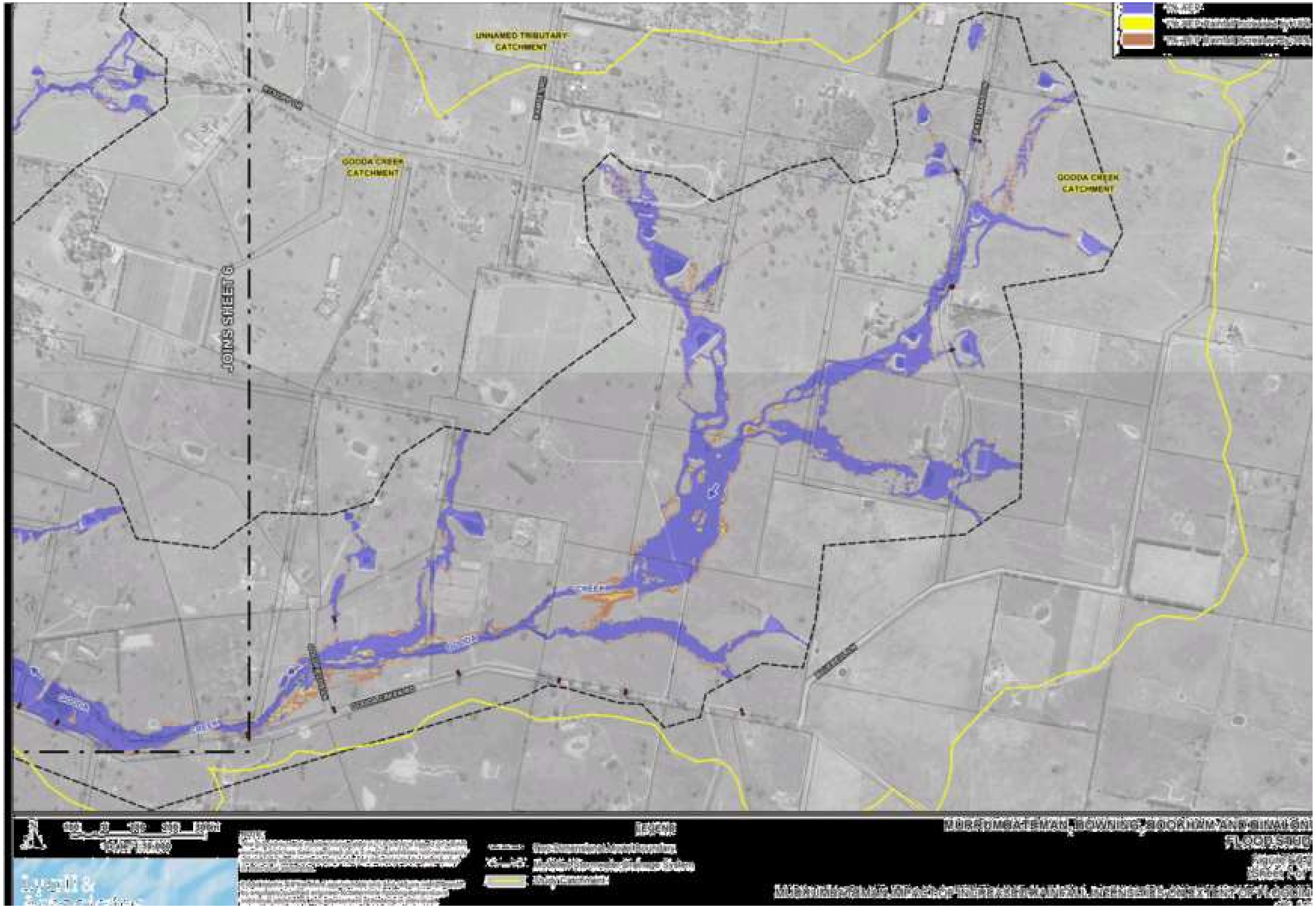
GOODA CREEK CATCHMENT
LEGEND


BIG HILL CREEK
CATCHMENT
GOODA CREEK
CATCHMENT
JOINS SHEET 7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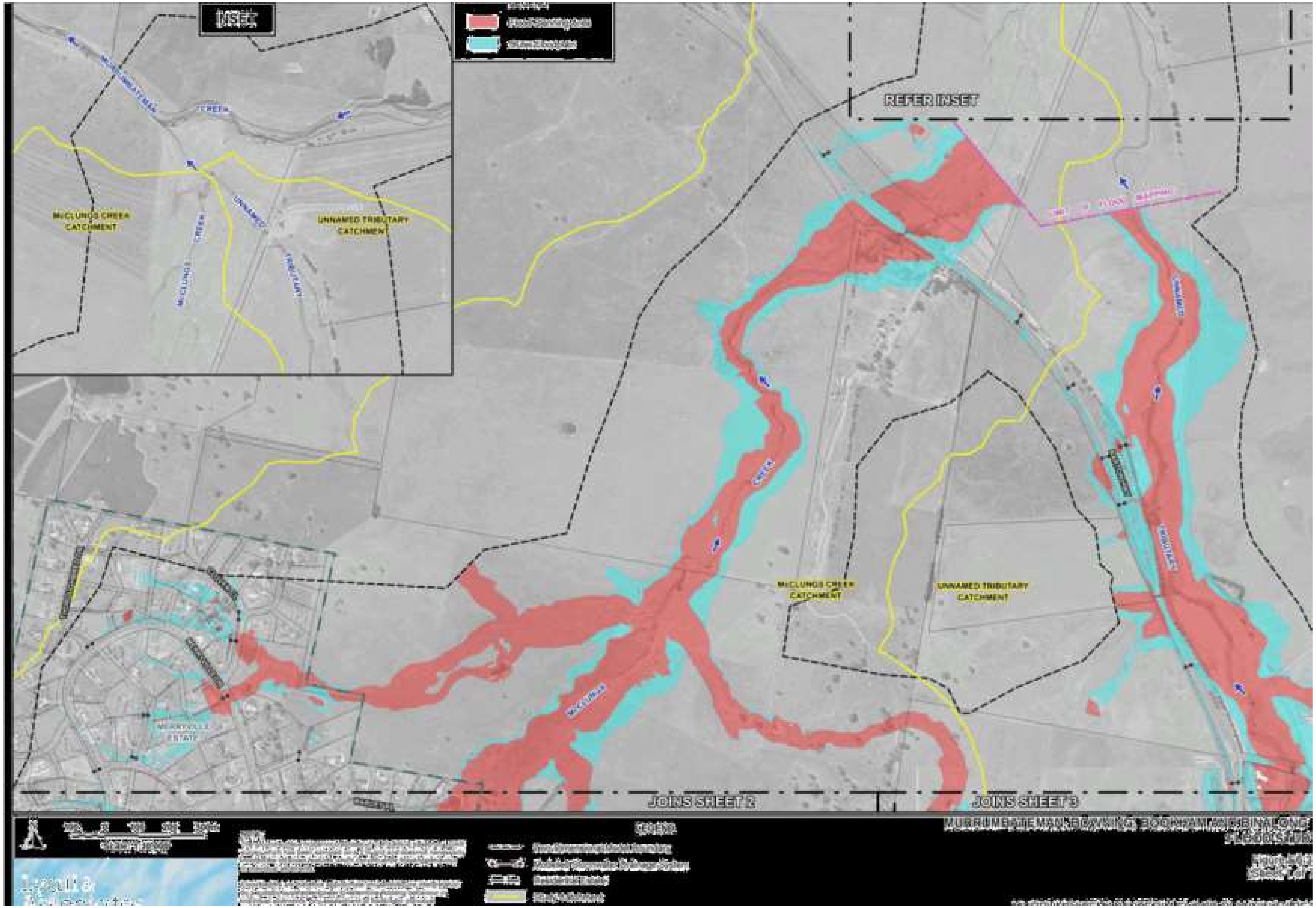
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 6
LEGEND
FLOOD STUDY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CREEK
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TRIBUTARY
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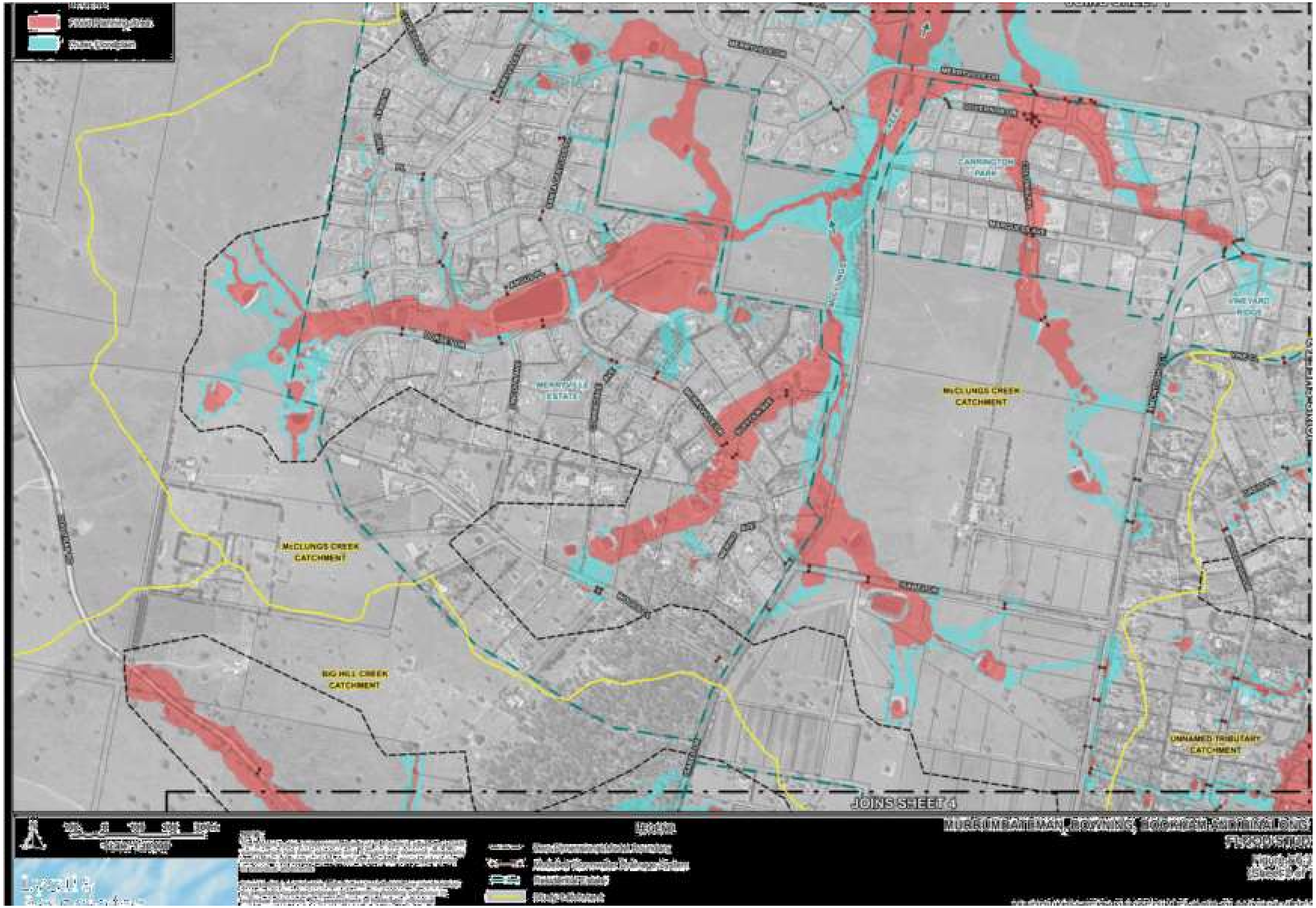
CREEK
JOINS SHEET 2
JOINS SHEET 3
LEGEND


CARRINGTON PARK
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BIG HILL CREEK CATCHMENT
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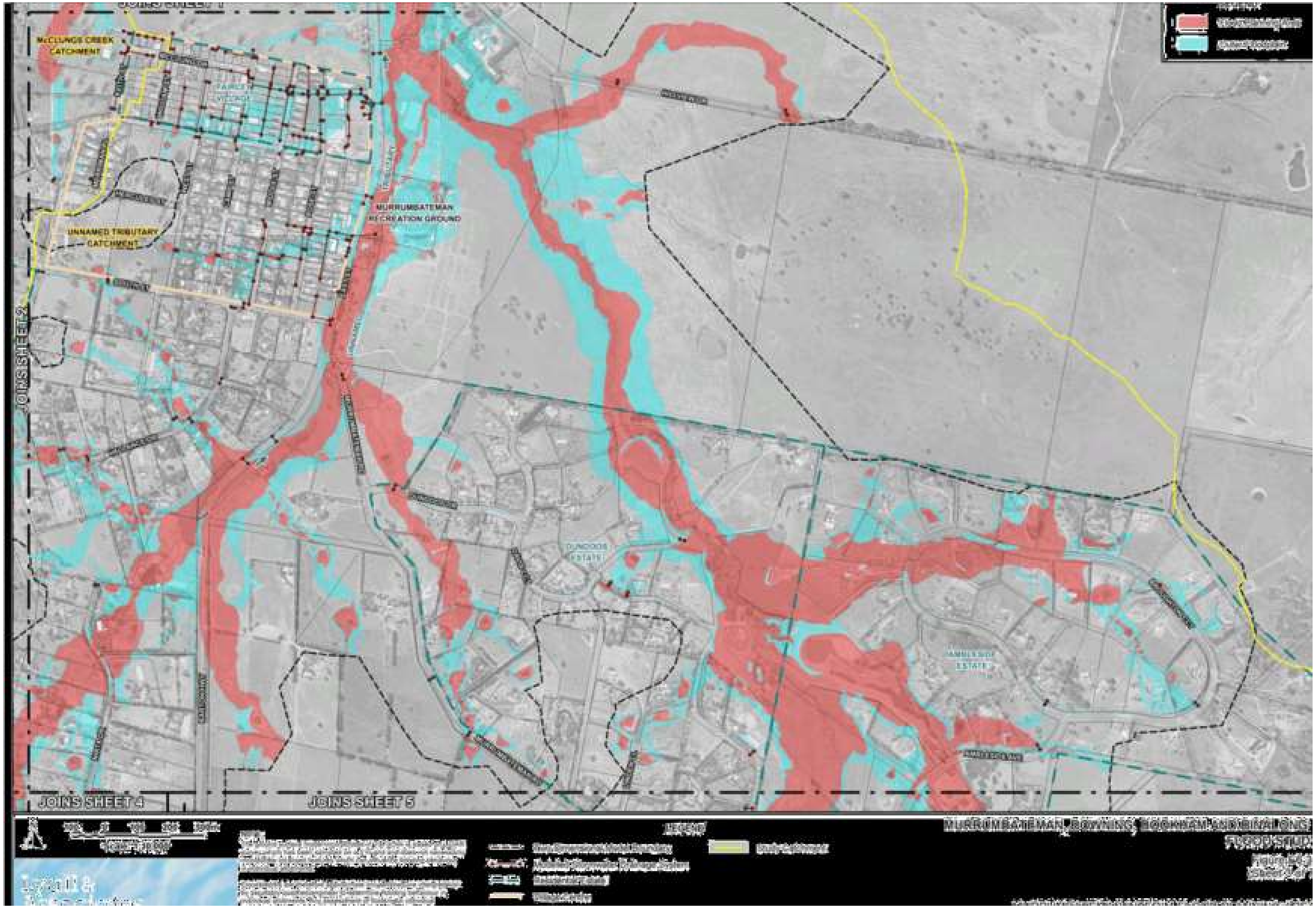
JOINS SHEET 4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MURRUMBATEMAN RECREATION GROUND
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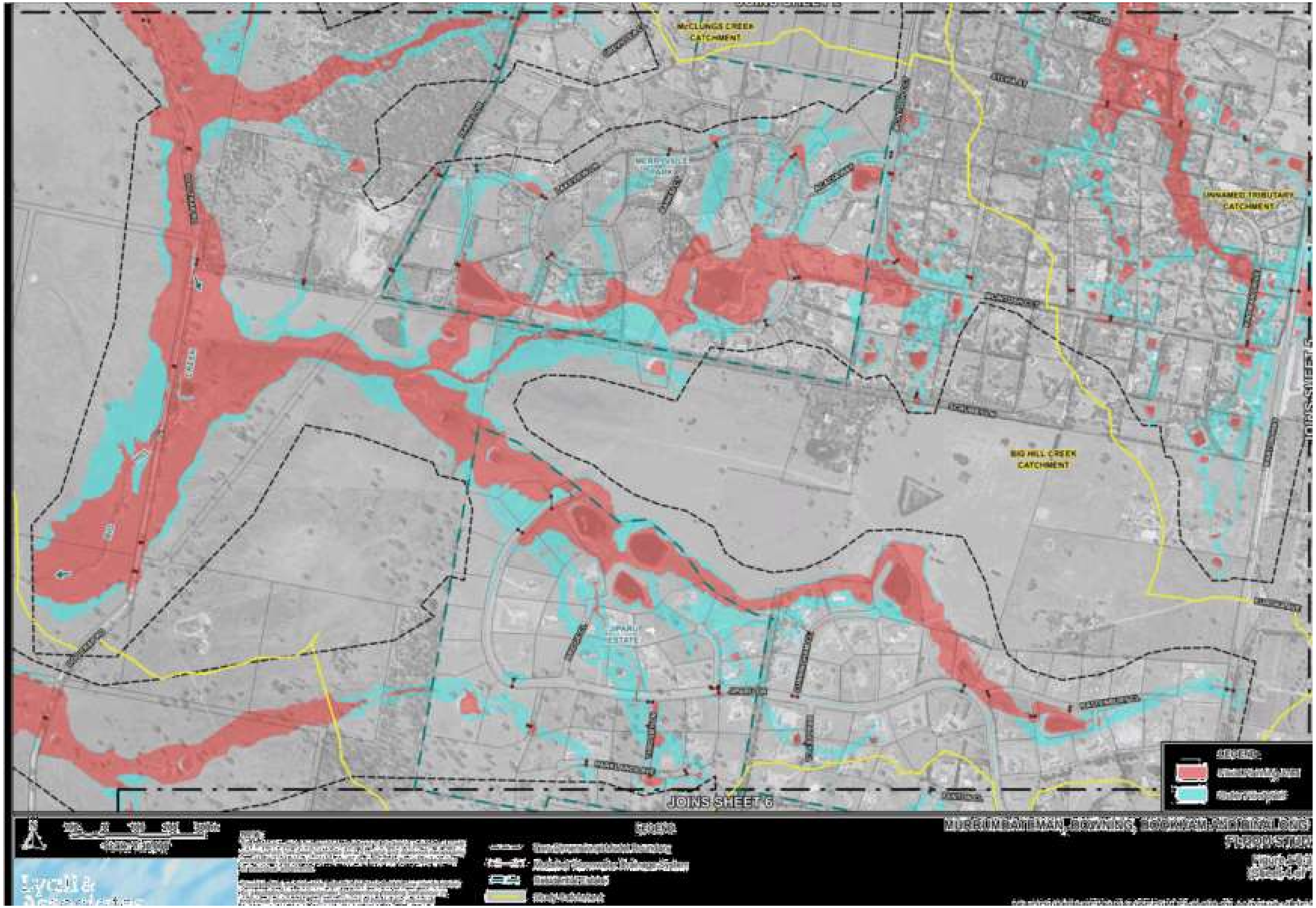
JOINS SHEET 4
JOINS SHEET 5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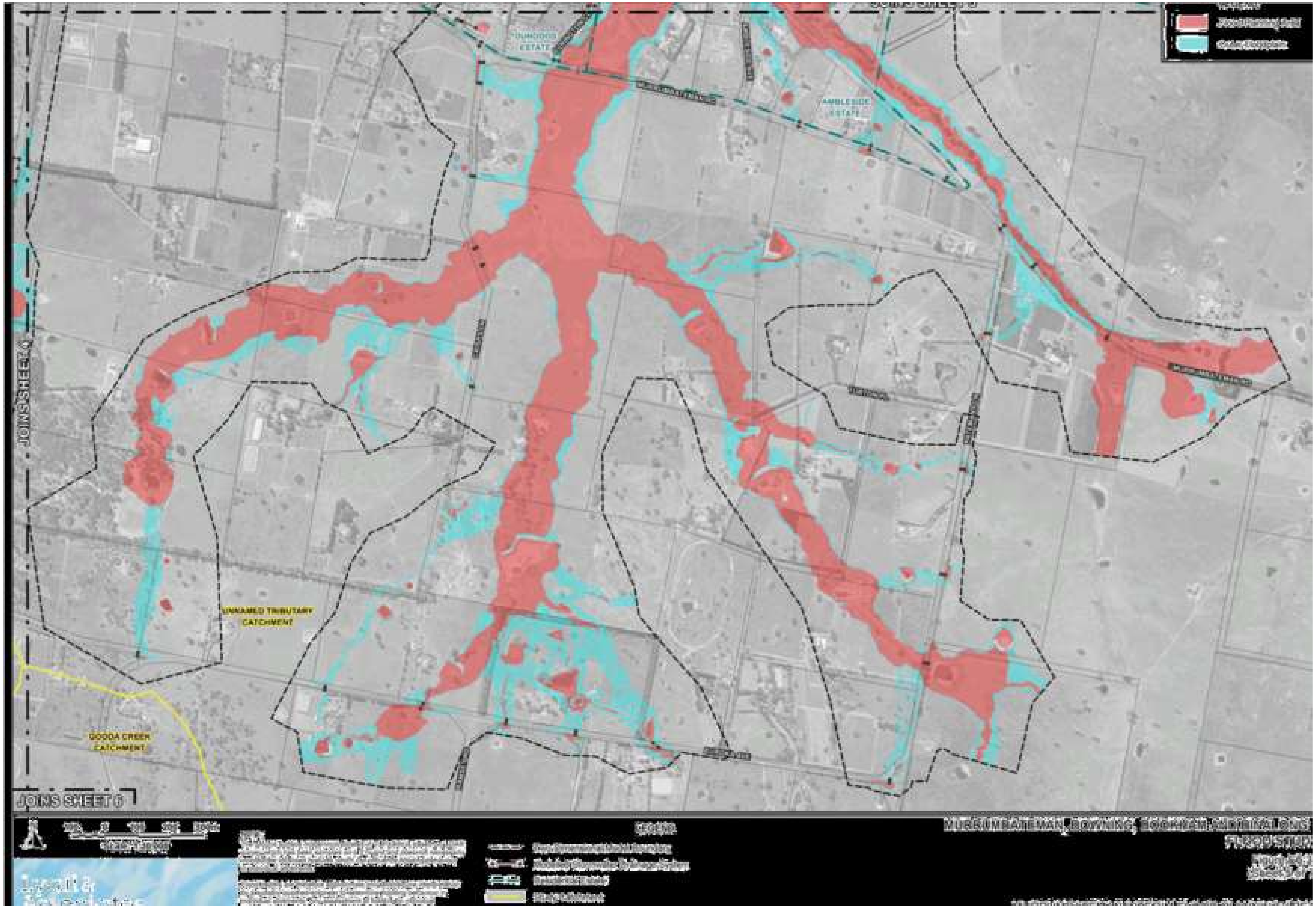
JOINS SHEET 6
LEGEND
MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALONG FLOOD STUDY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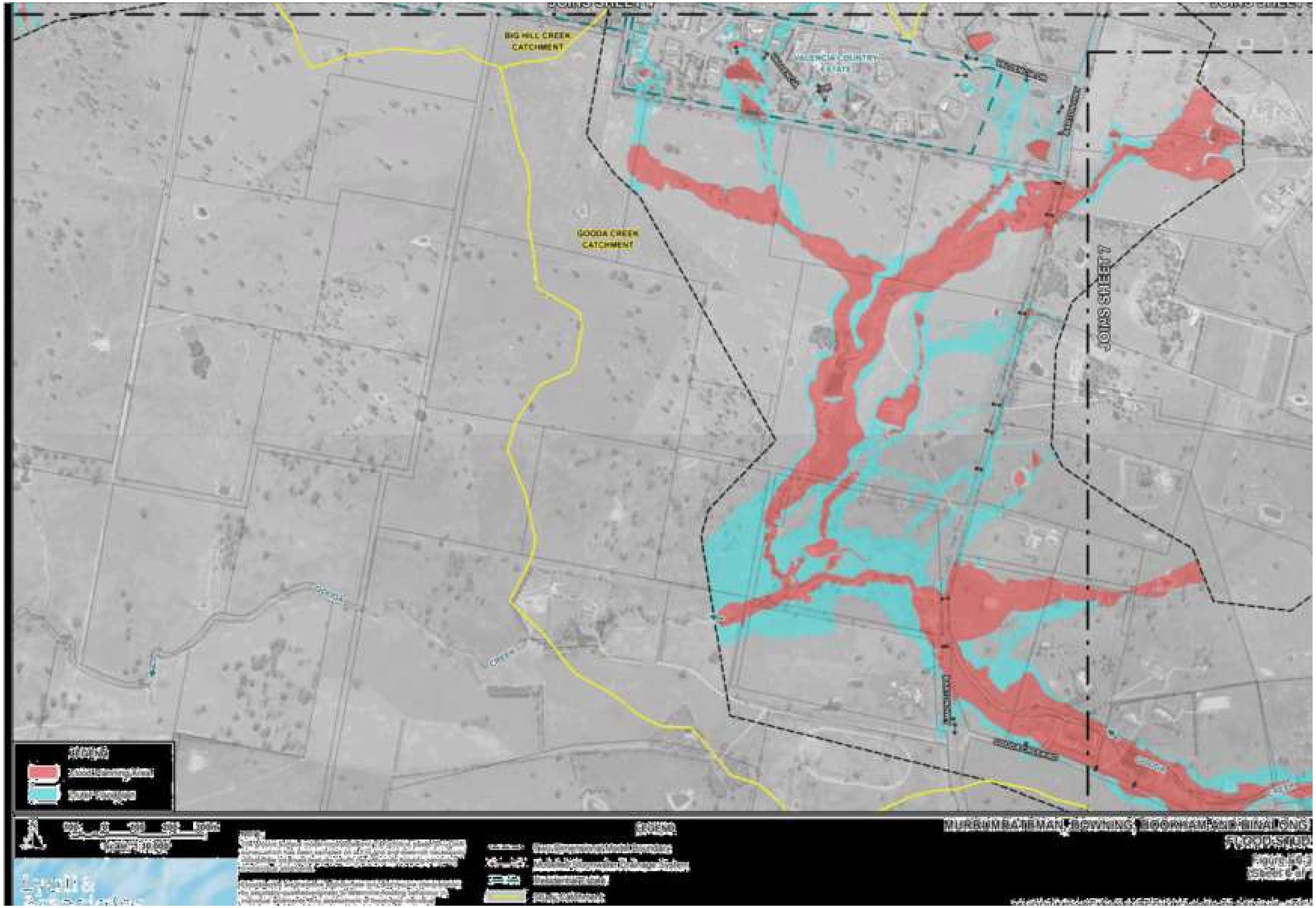
GOODA CREEK CATCHMENT
AMBLESIDE ESTATE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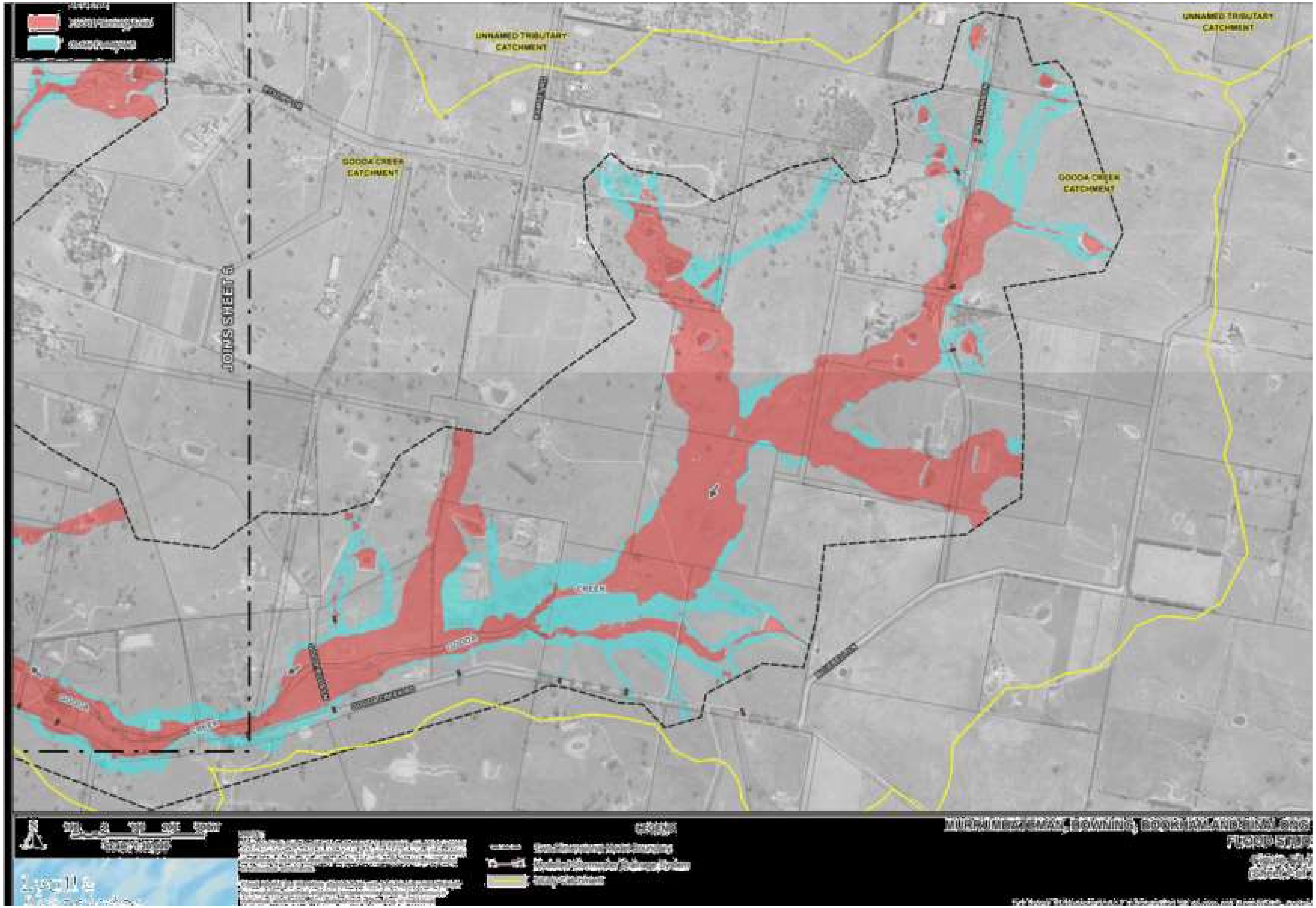
GOODA CREEK CATCHMENT
VALENCIA COUNTRY ESTATE
JOINS SHEET 7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UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 5
CREEK

YASS VALLEY COUNCIL

MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALONG FLOOD STUDY

AUGUST 2020

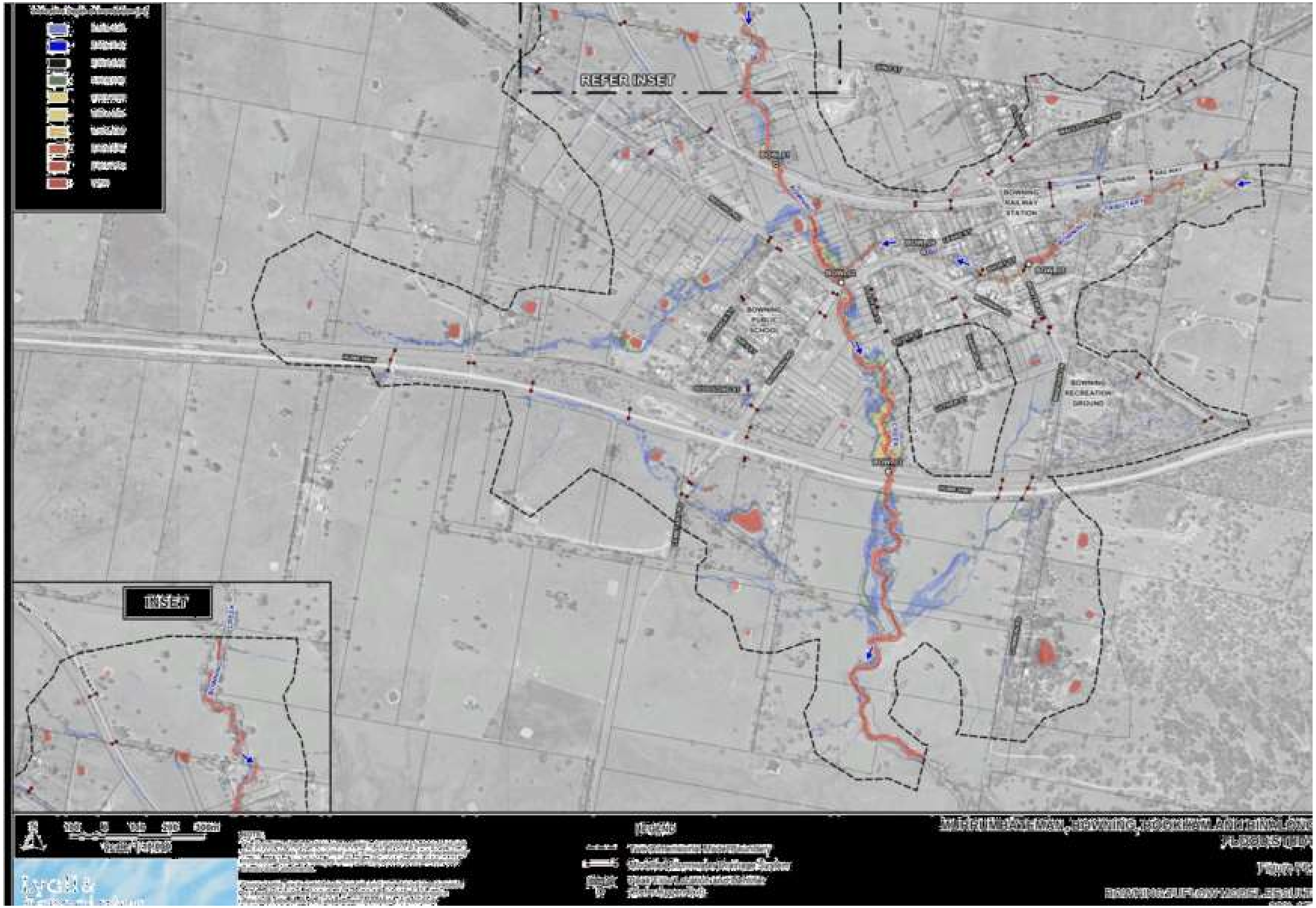
VOLUME 3 – APPENDICES F, G AND H FIGURES

Job No: ES454 File: MBBBFS_V3_Figures_[Rev 1.3].docx	Date: August 2020 Rev No: 1.3	Principal: SAB Author: SAB/TDR

APPENDIX F

HYDRAULIC MODELLING OF DESIGN FLOODS AT BOWNING

LIST OF FIGURES (APPENDIX F)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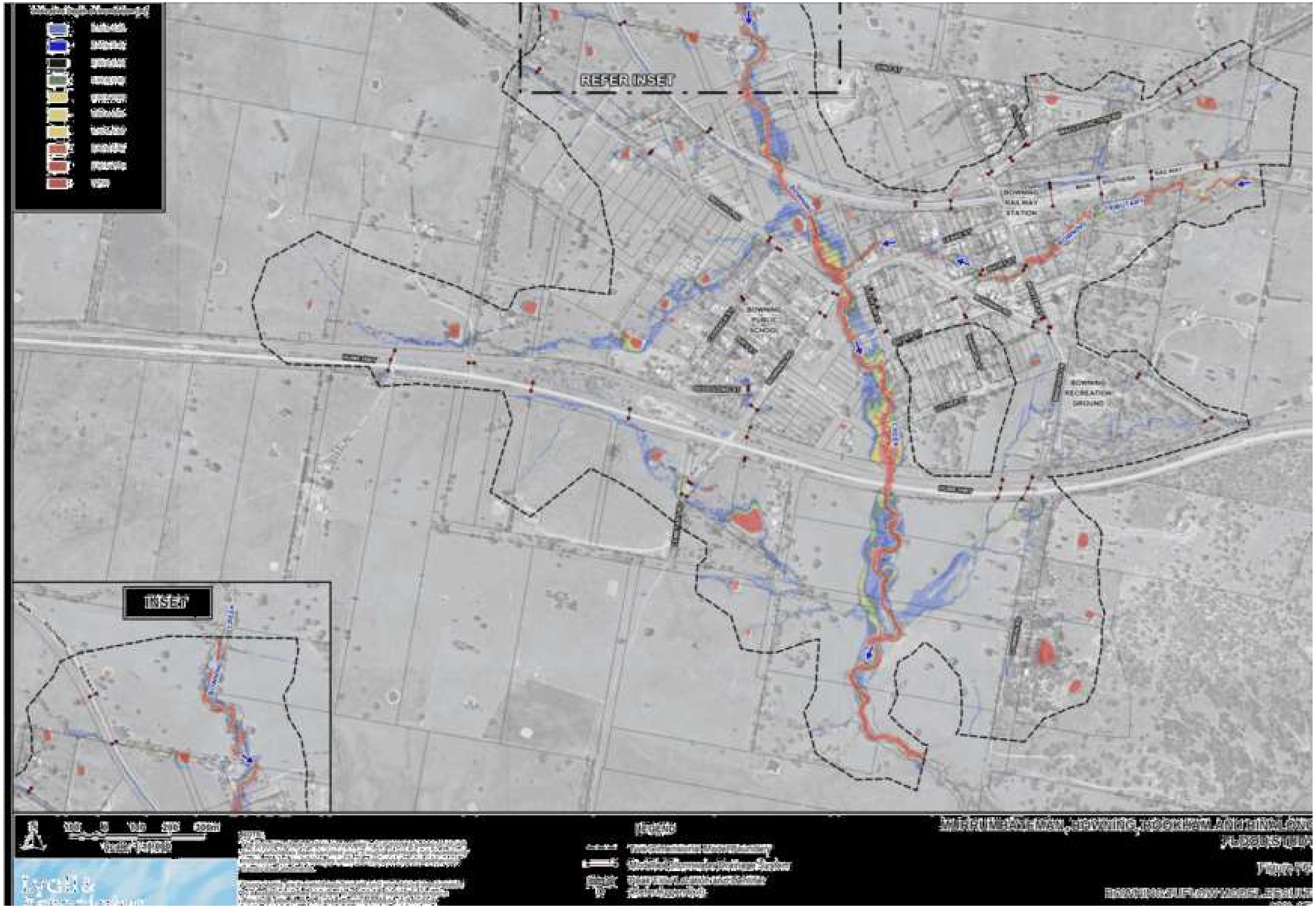
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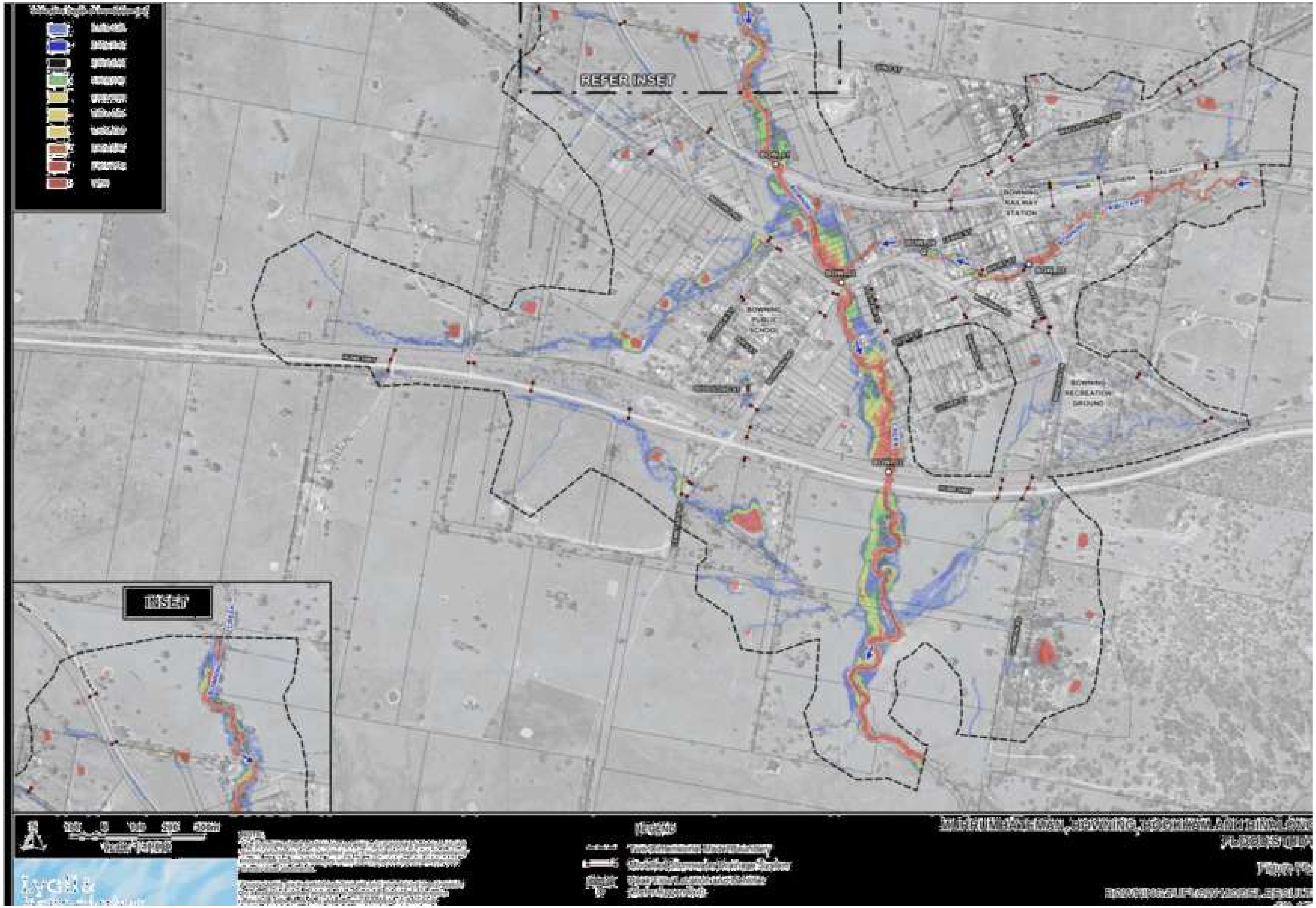
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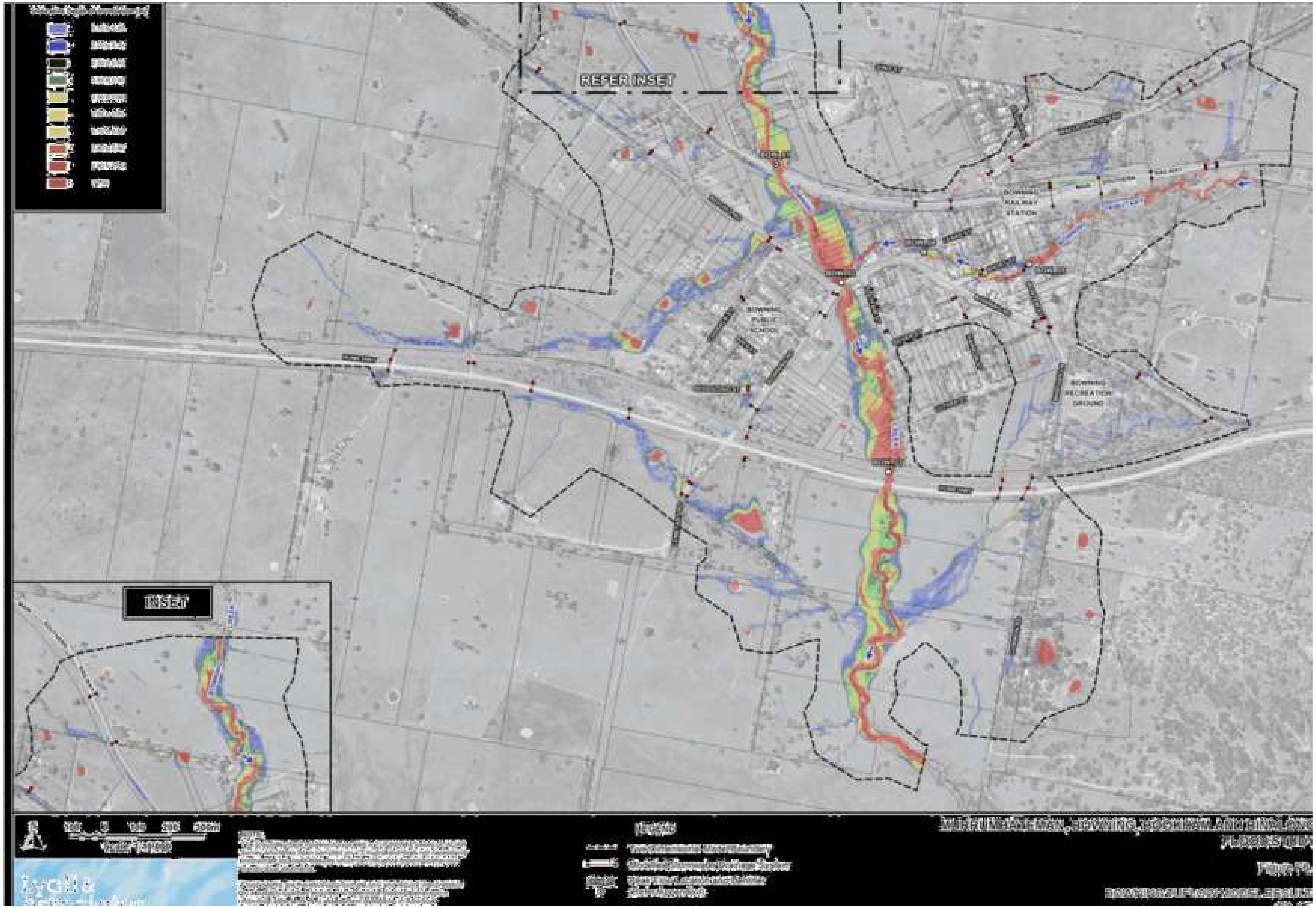
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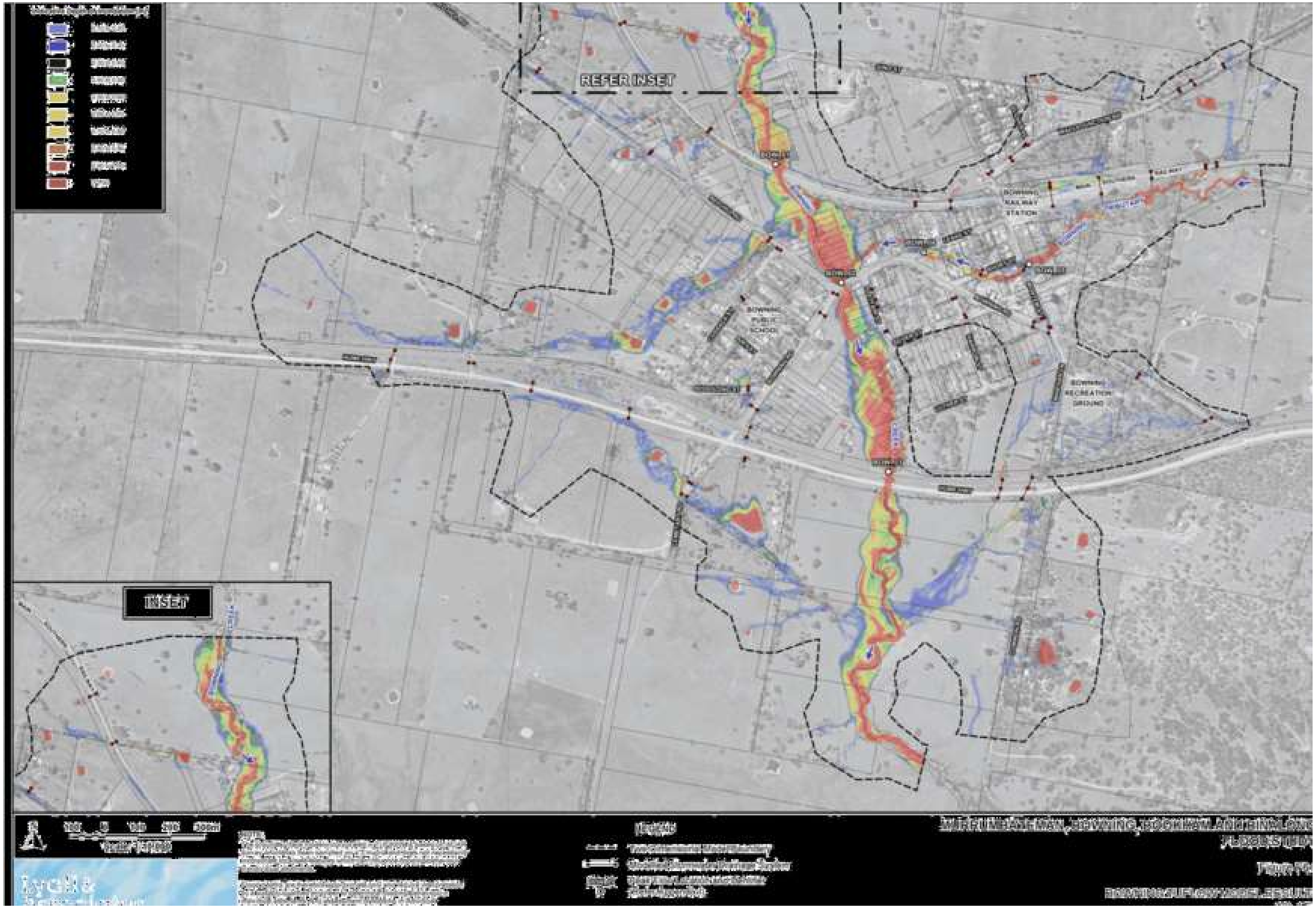
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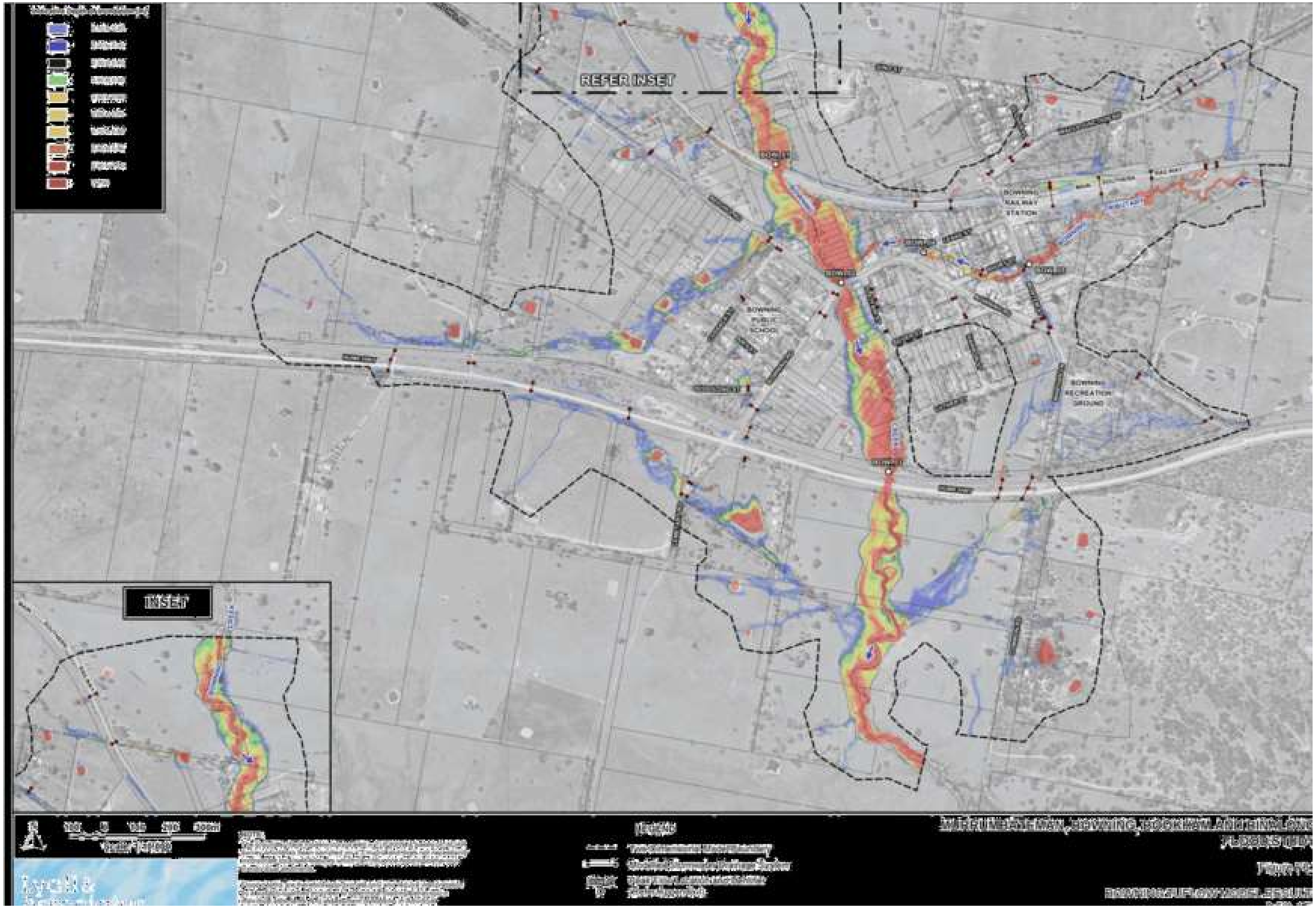
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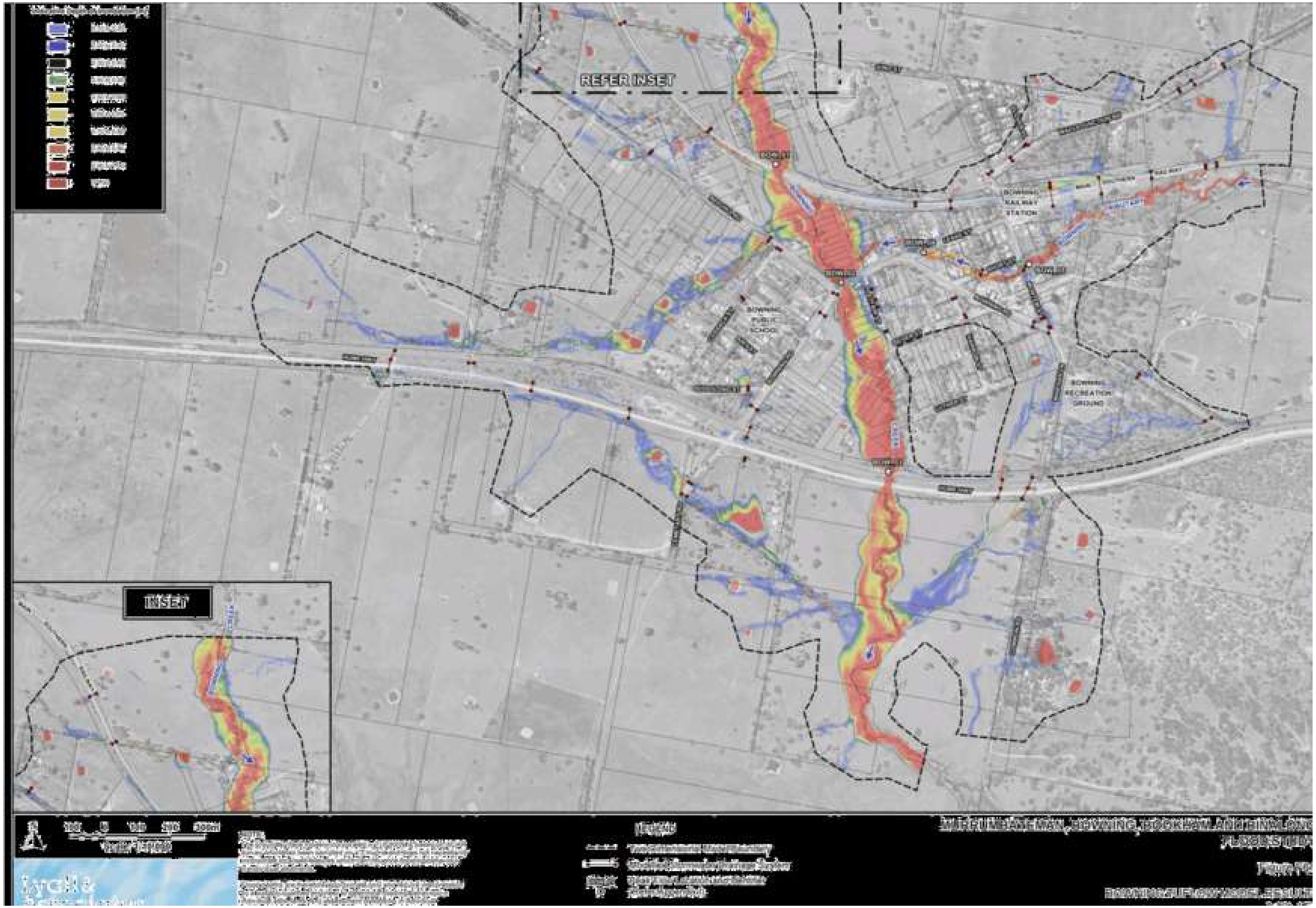
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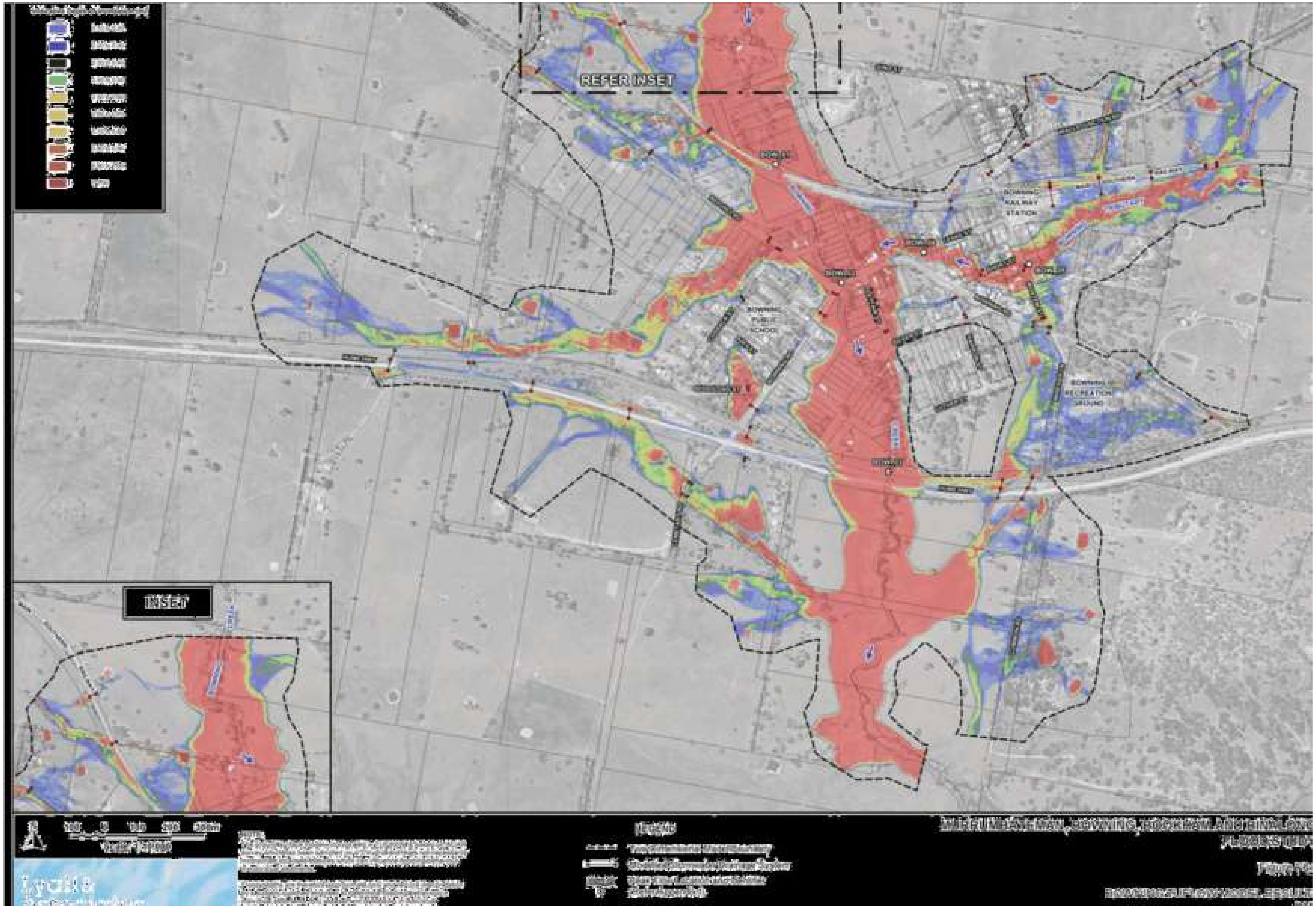
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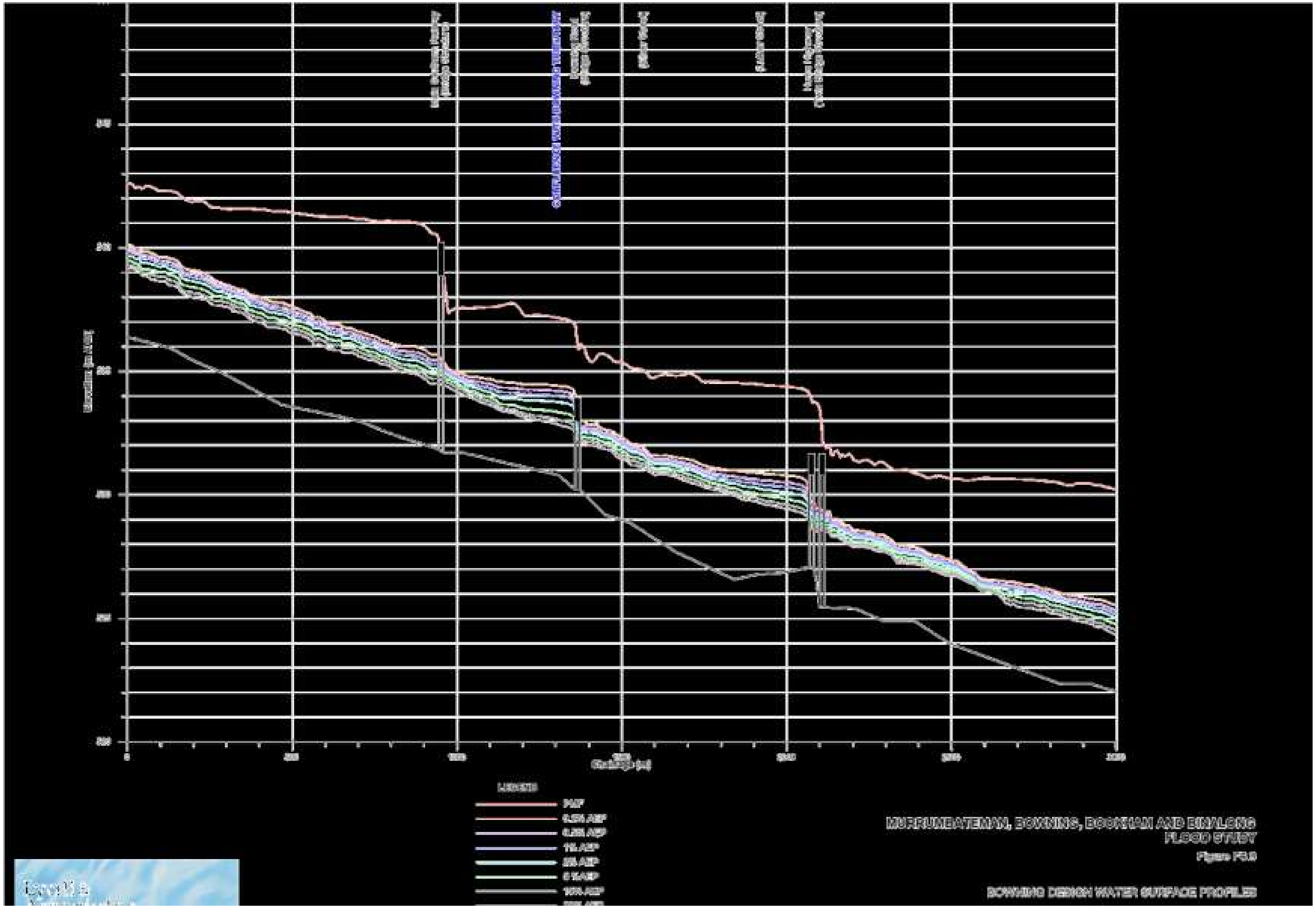
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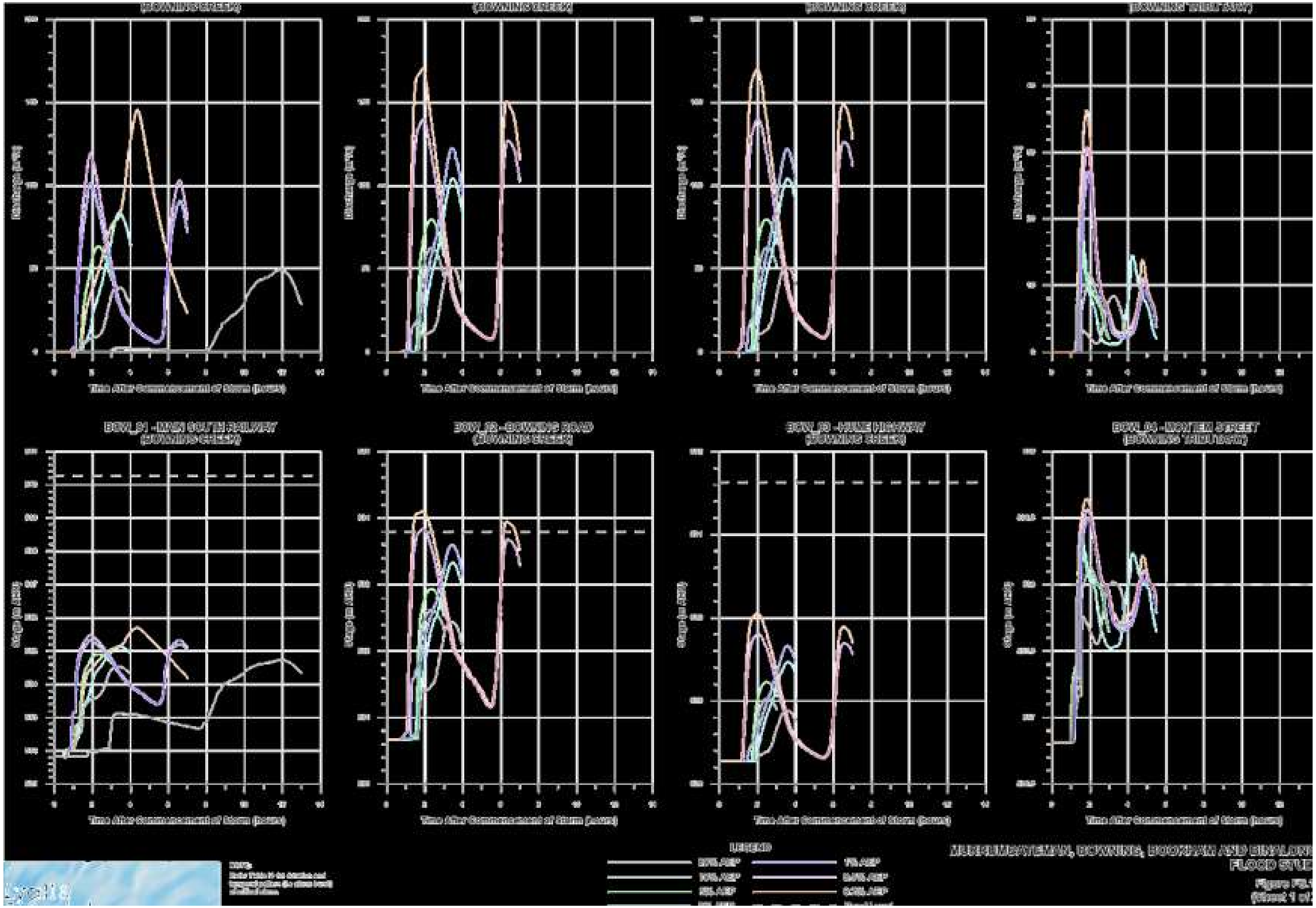
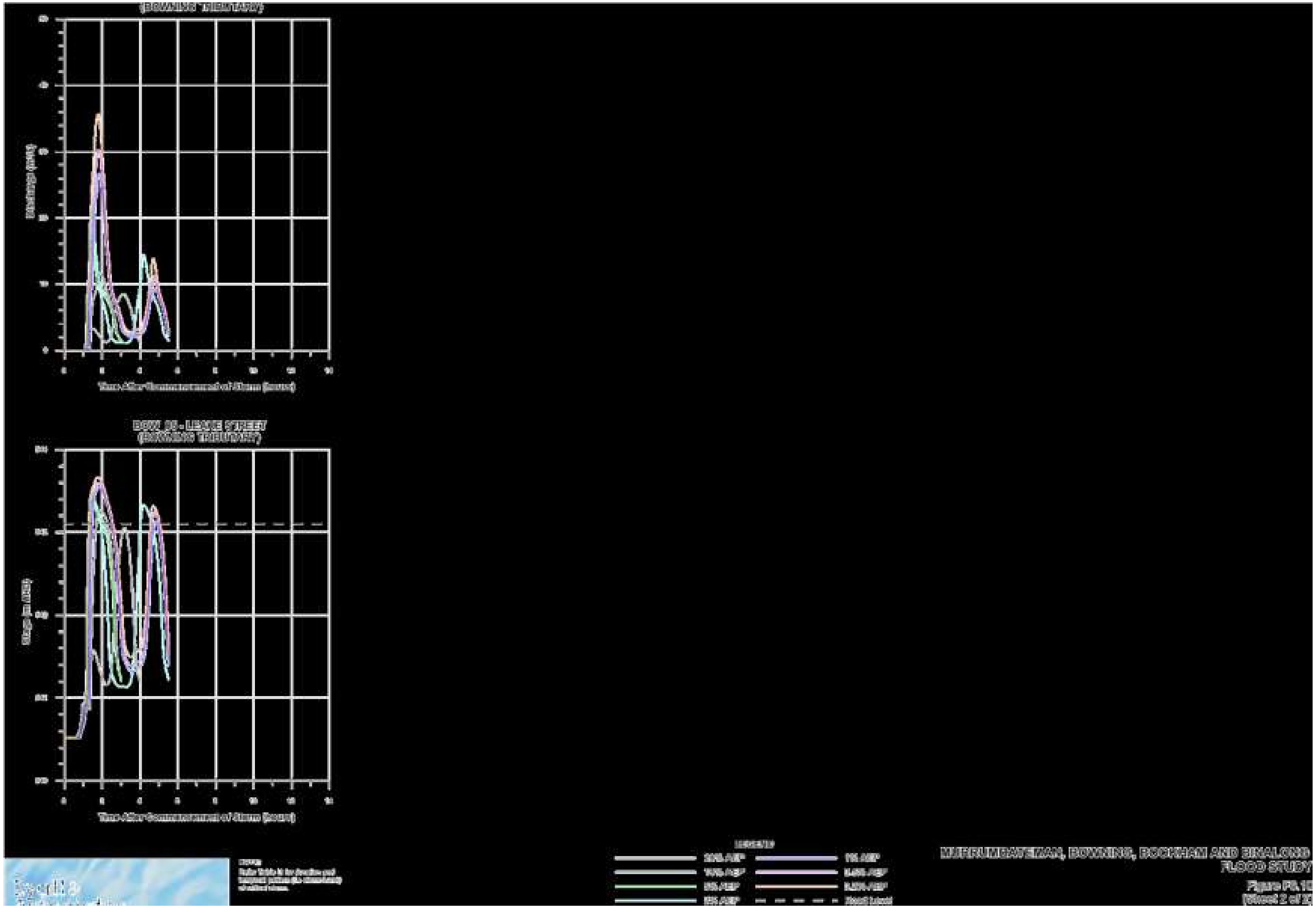
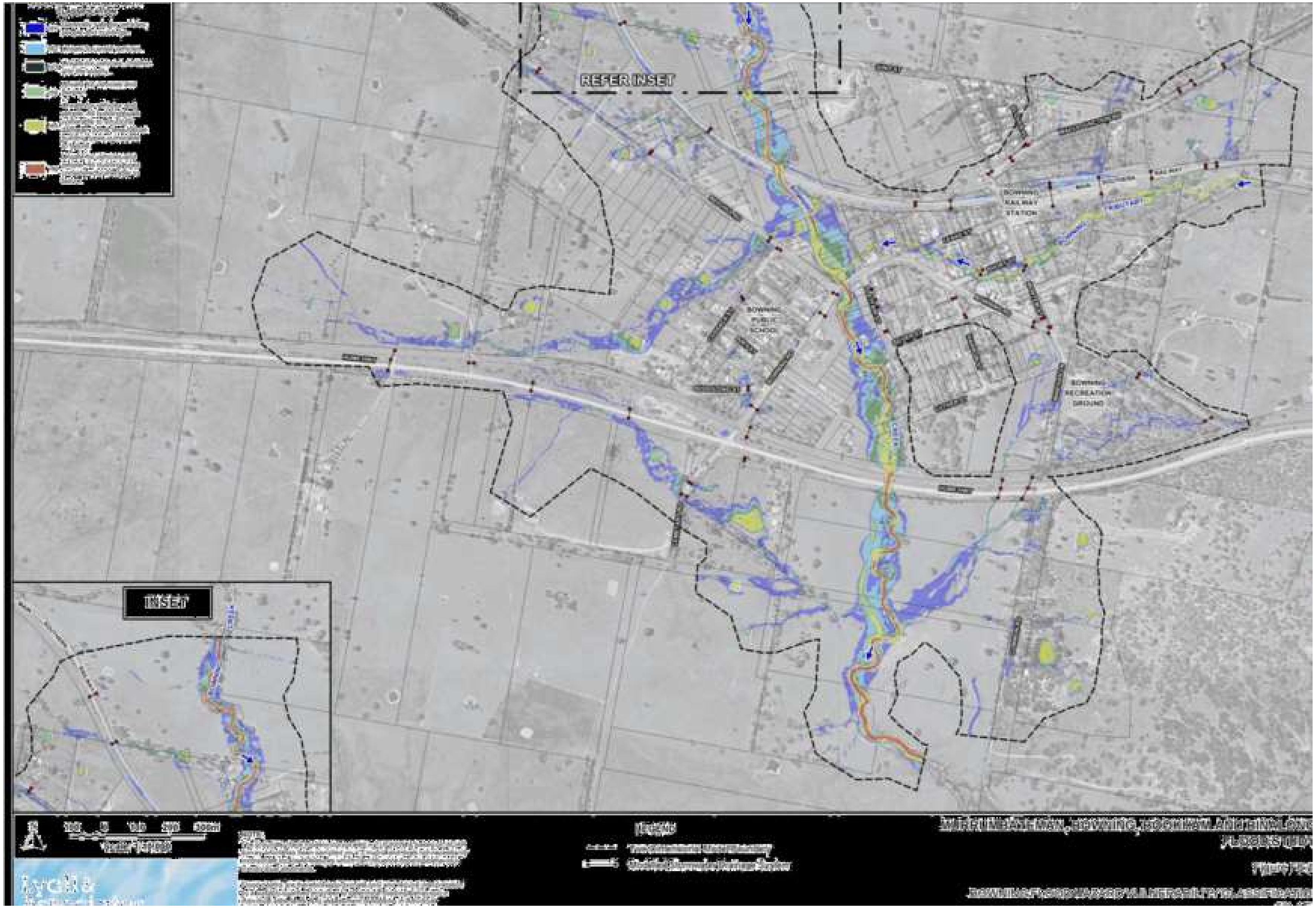
FLOOD STUDY
BOWNING DESIGN WATER SURFACE PROFILES




(BOWNING TRIBUTARY)
BOW_05 - LEAKE STREET
(BOWNING TRIBUTARY)
MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALONG
FLOOD STUDY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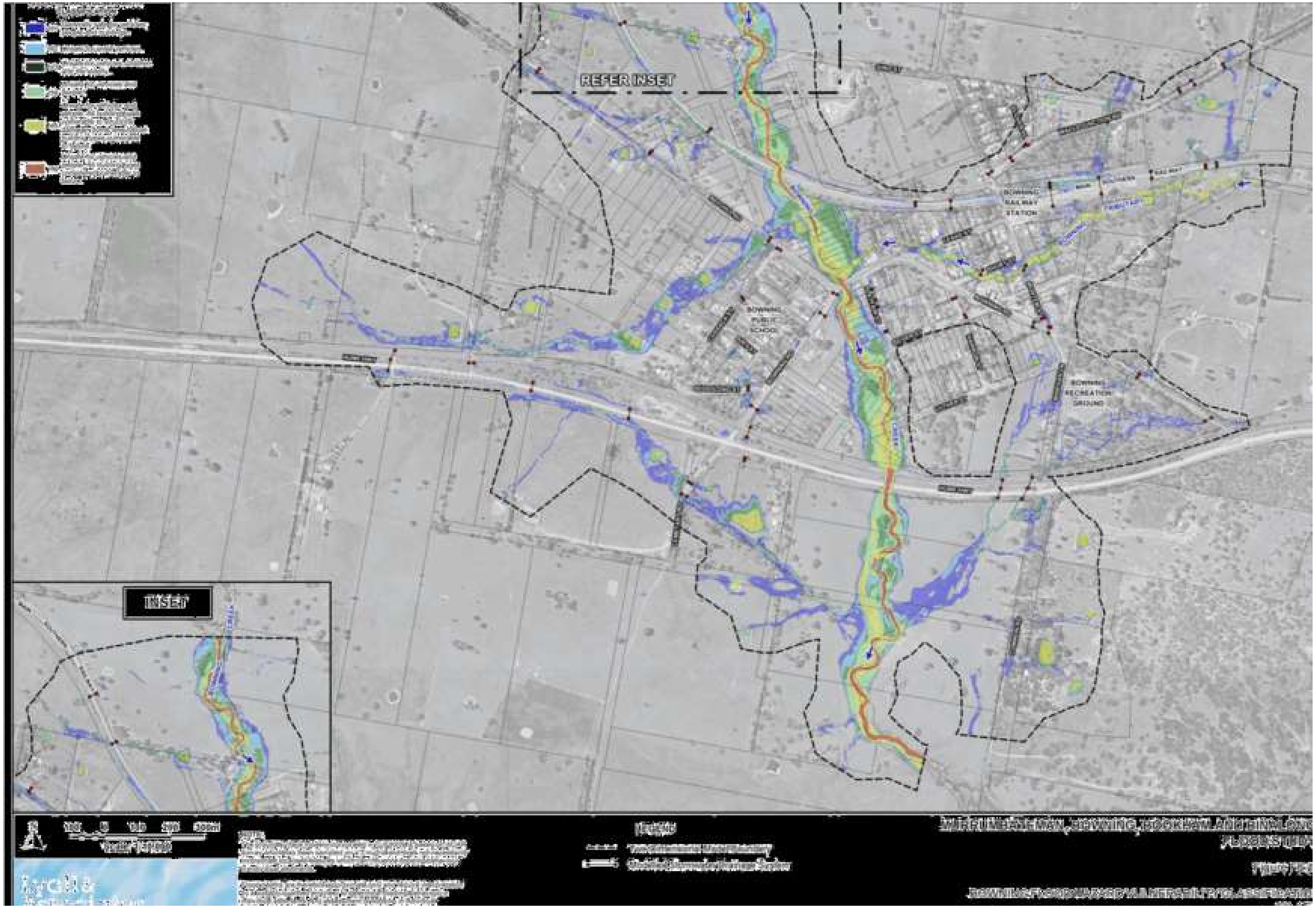
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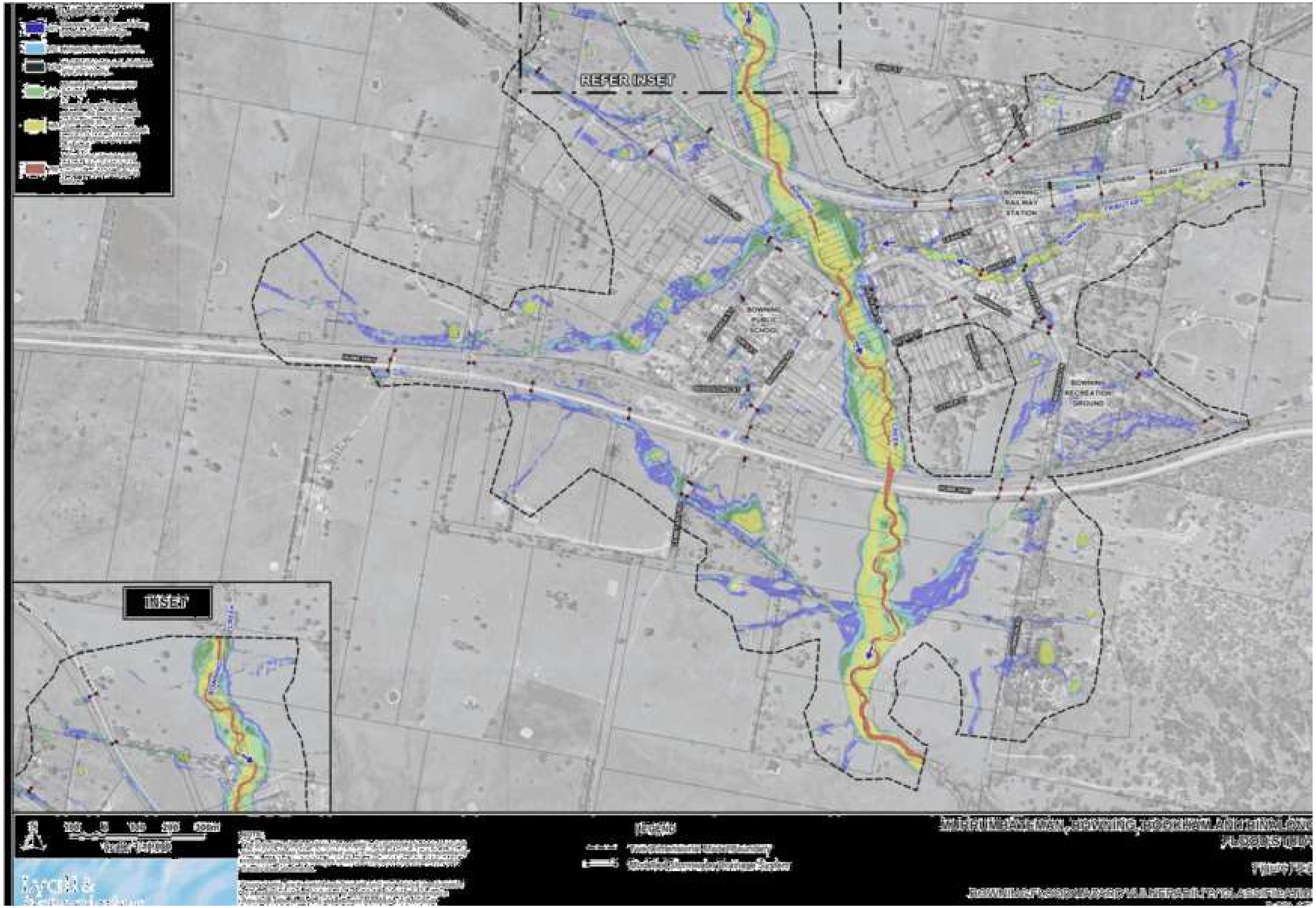
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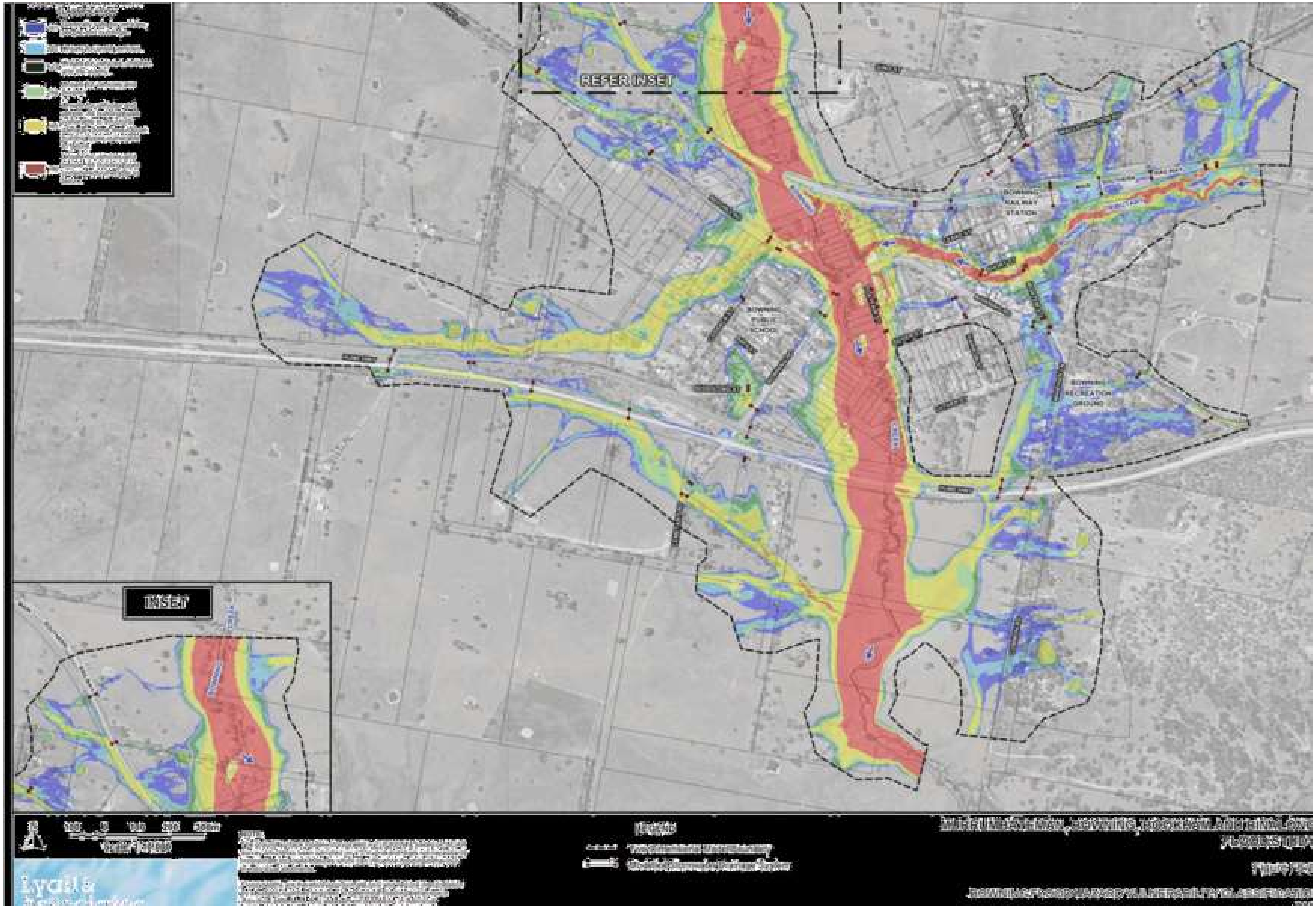
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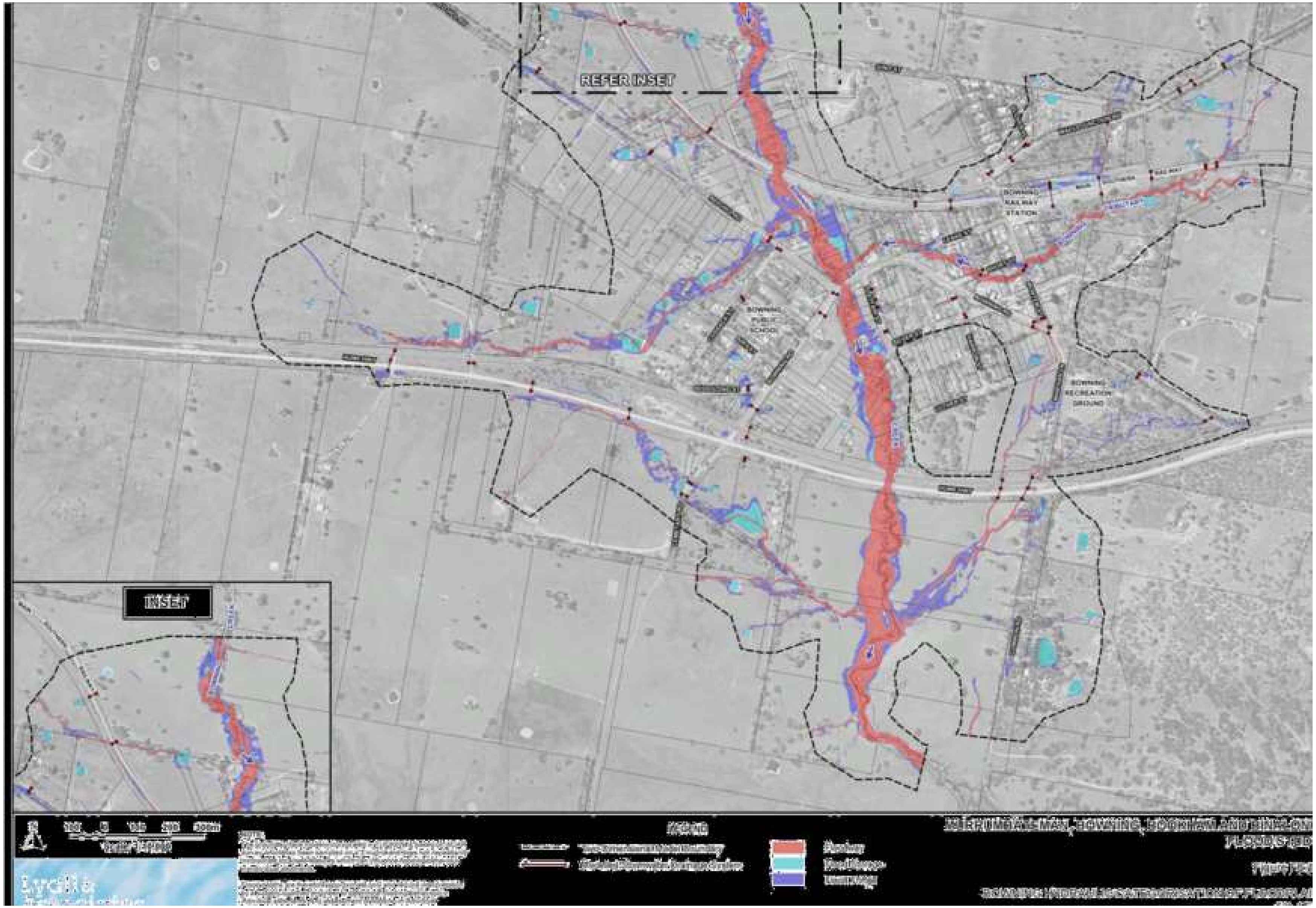
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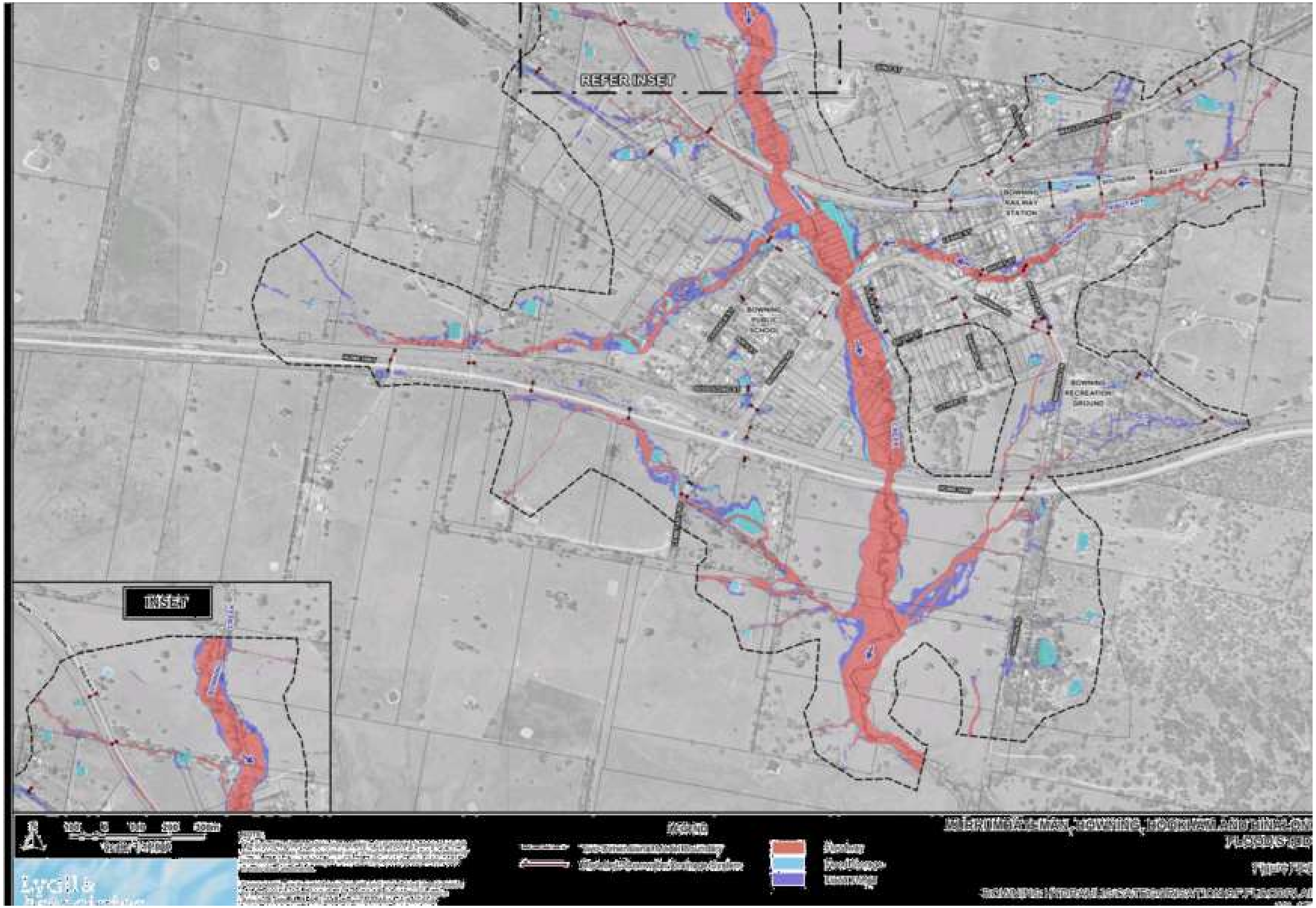
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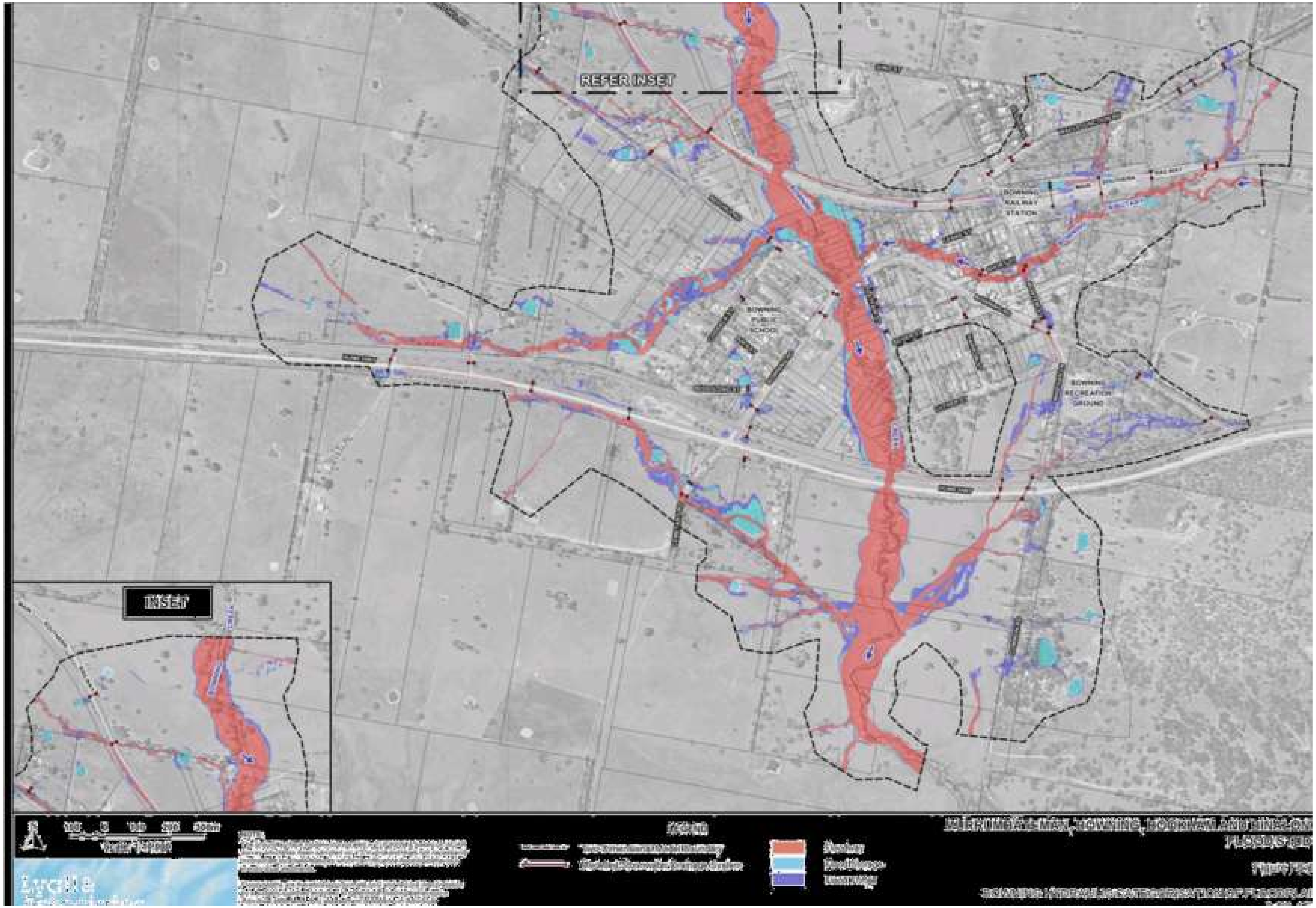
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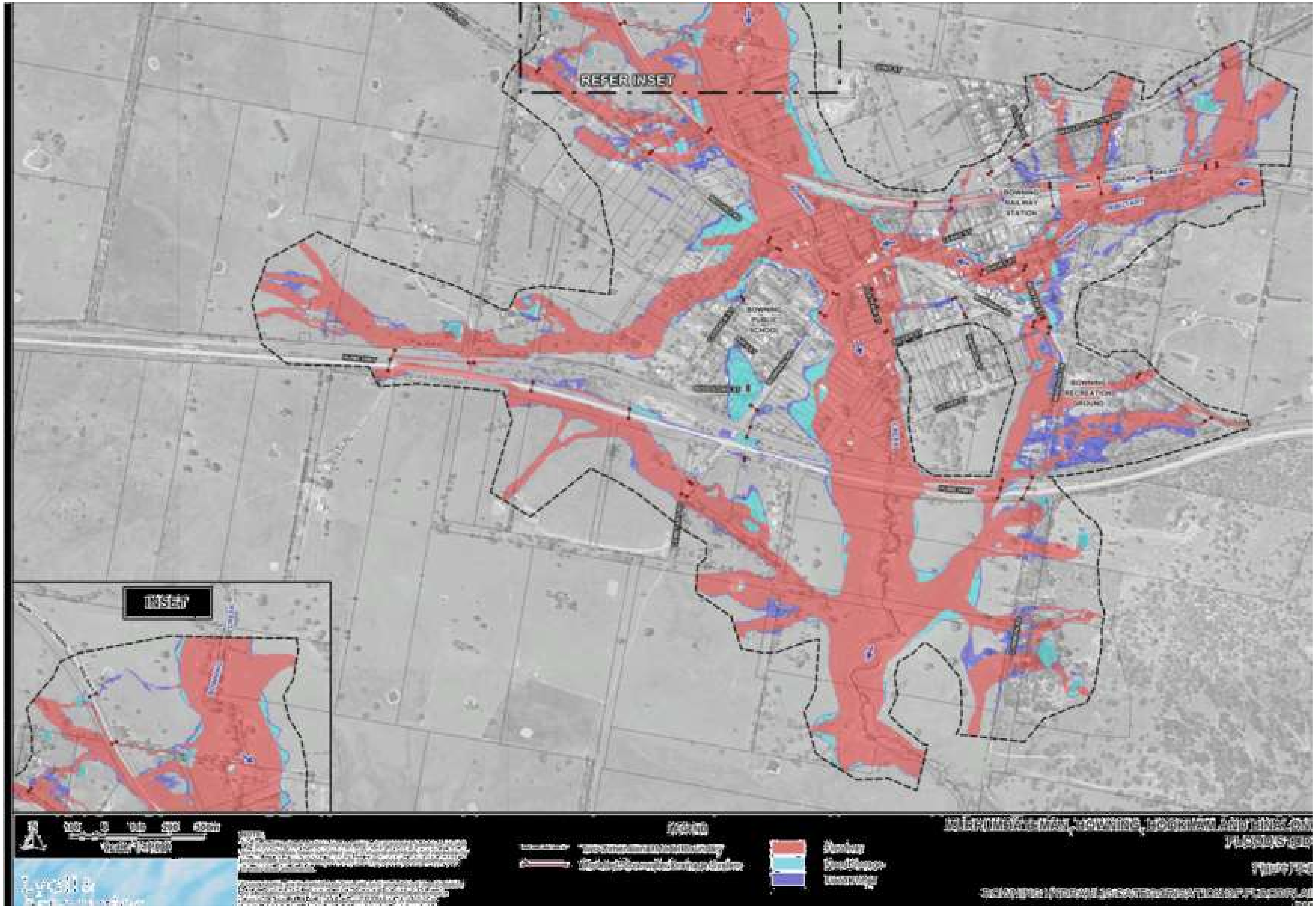
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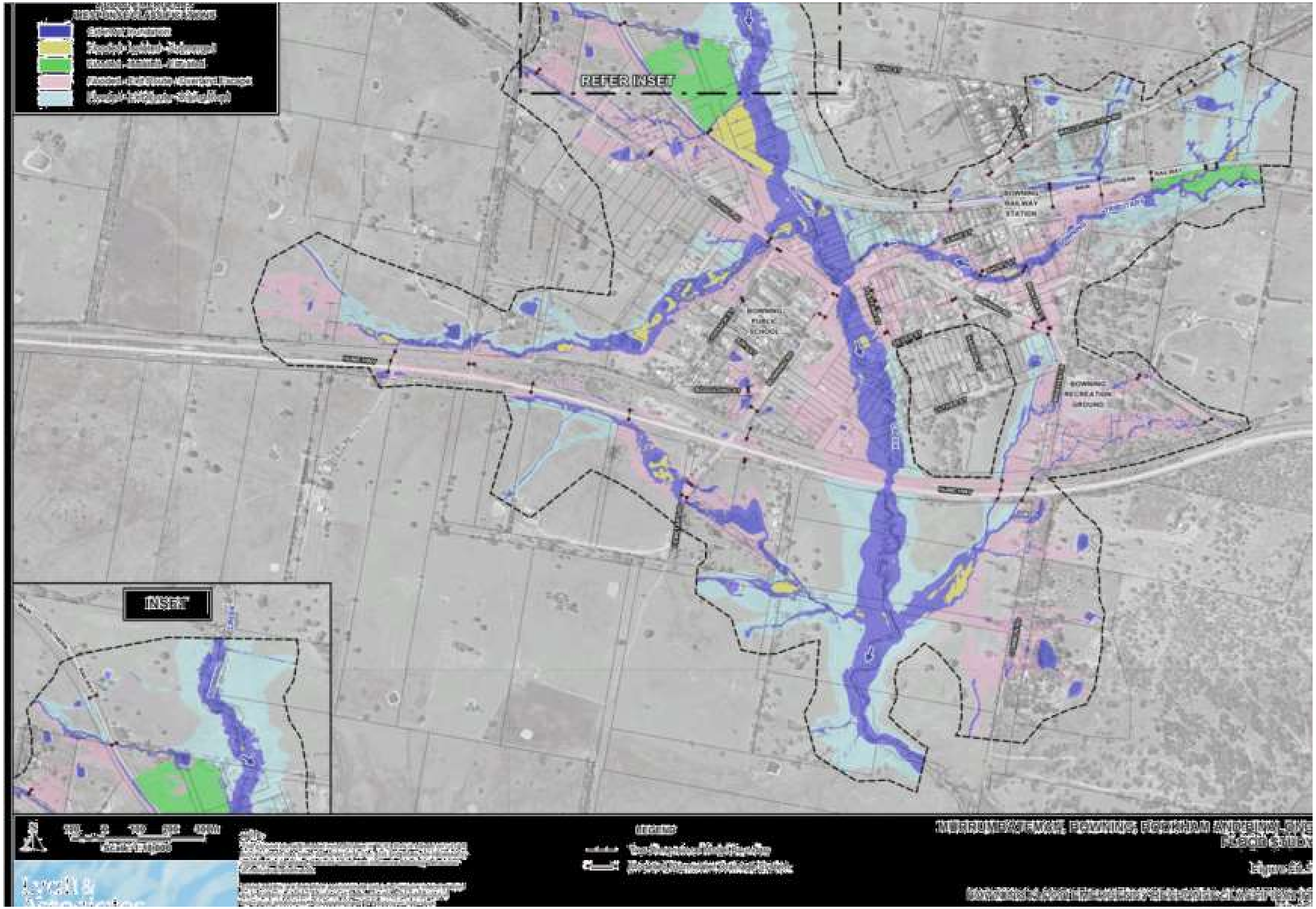
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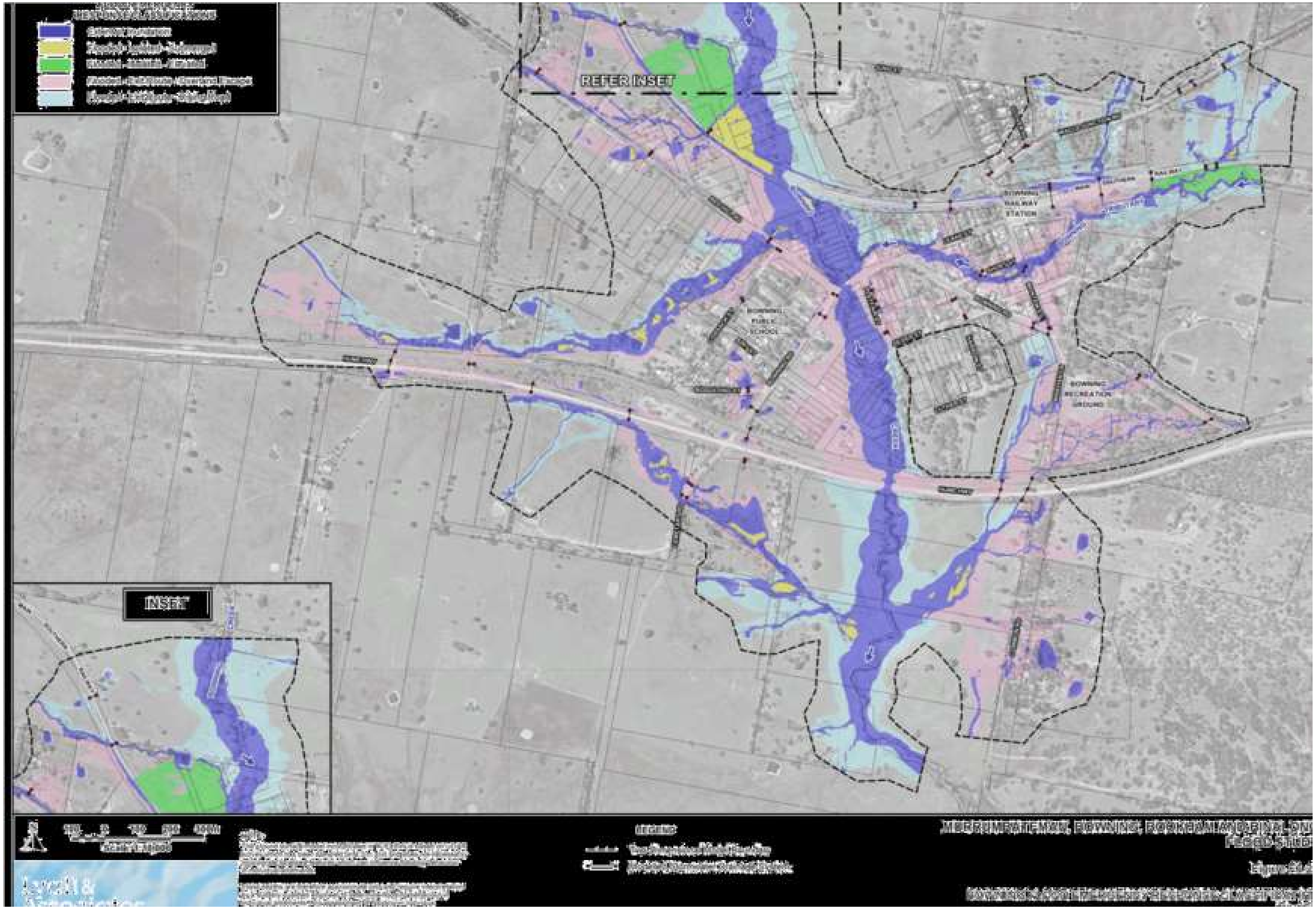
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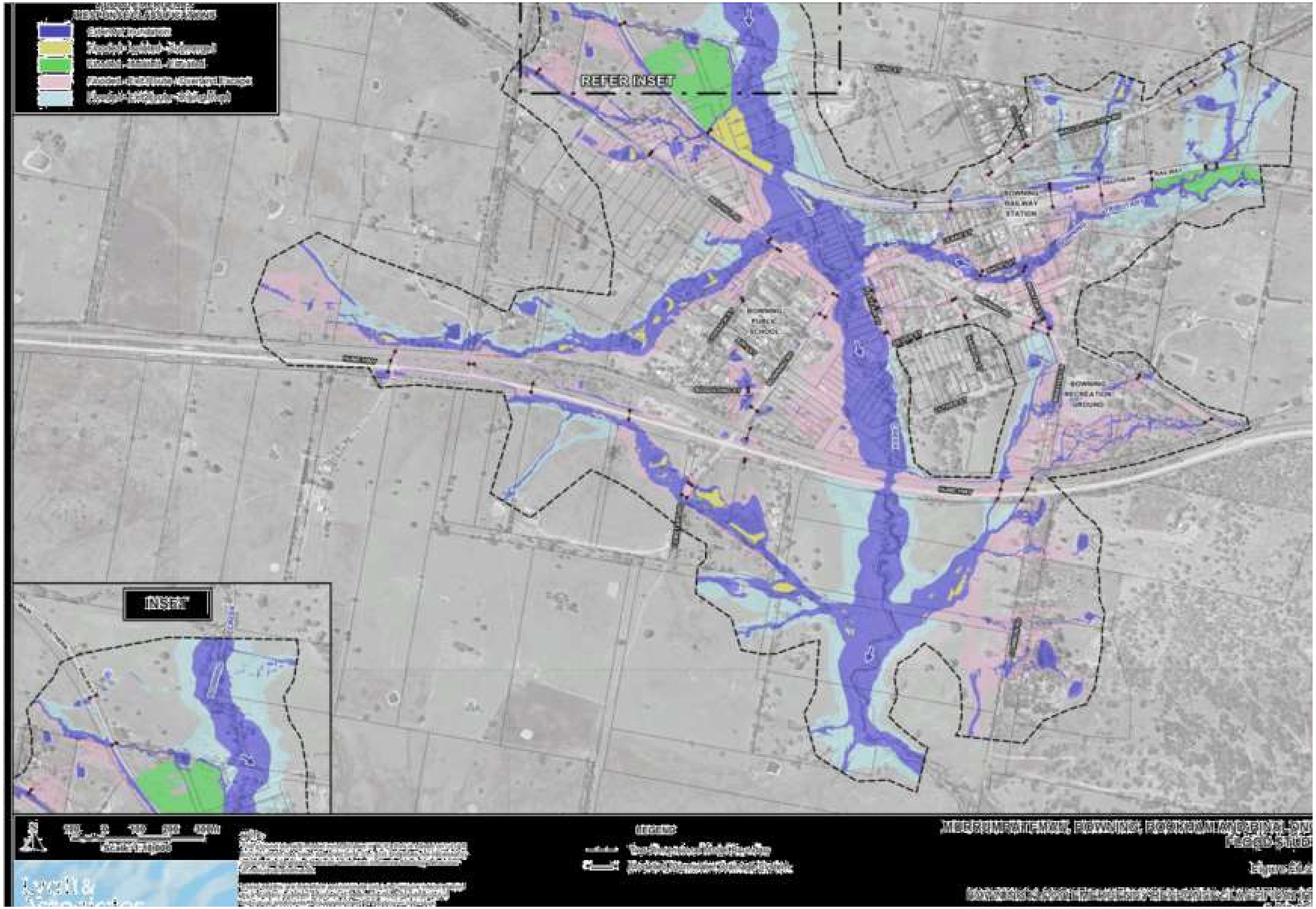
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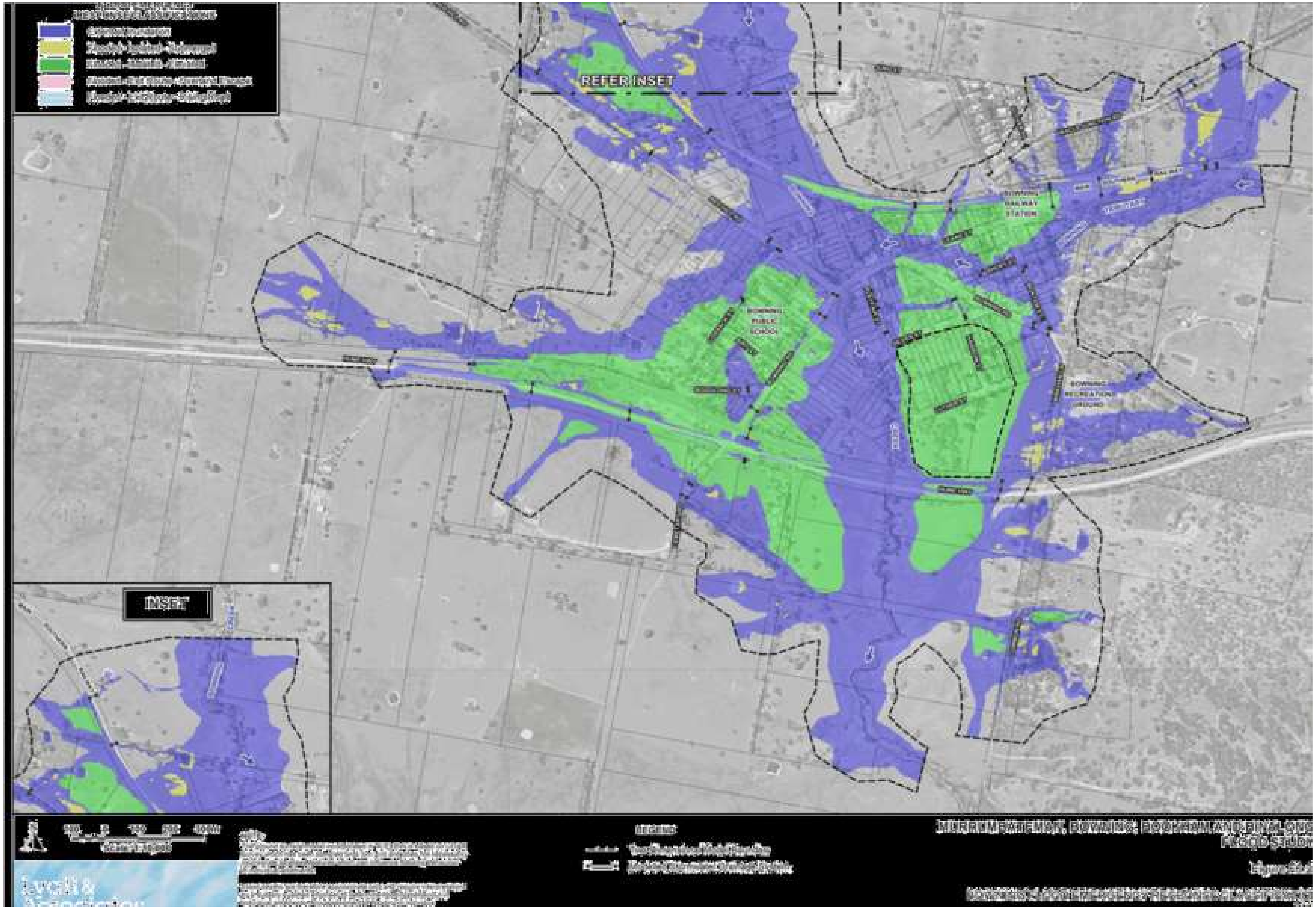
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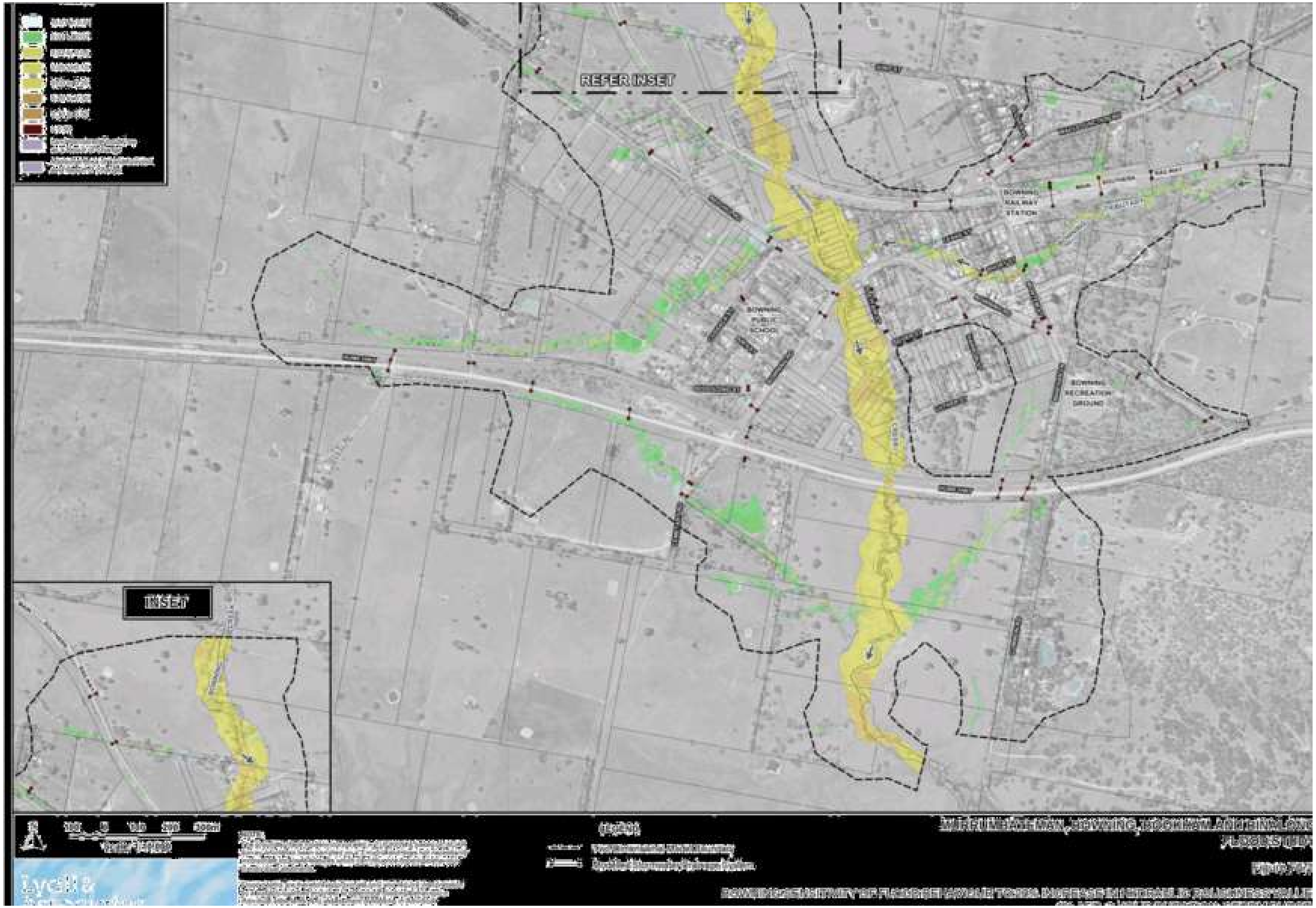
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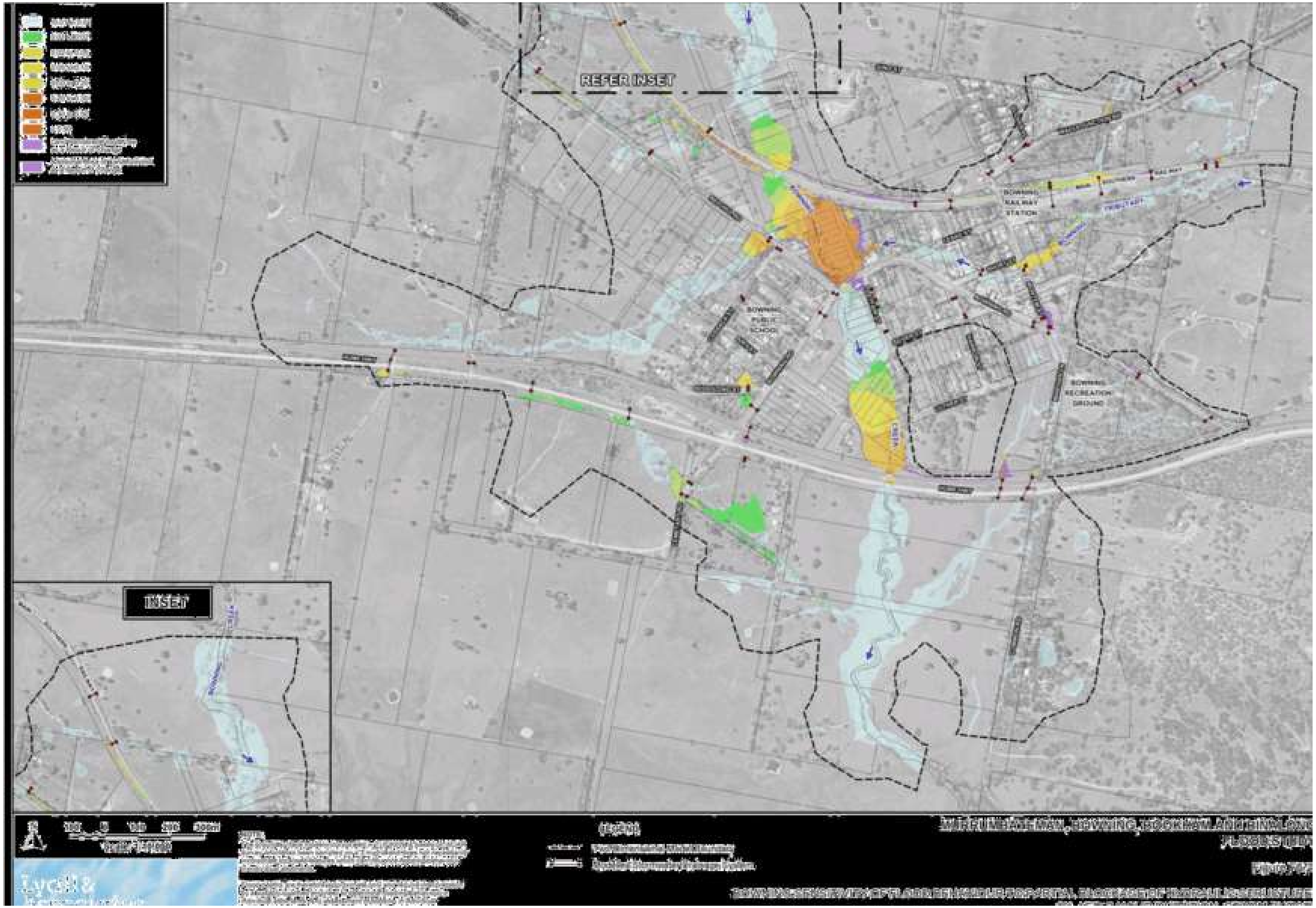
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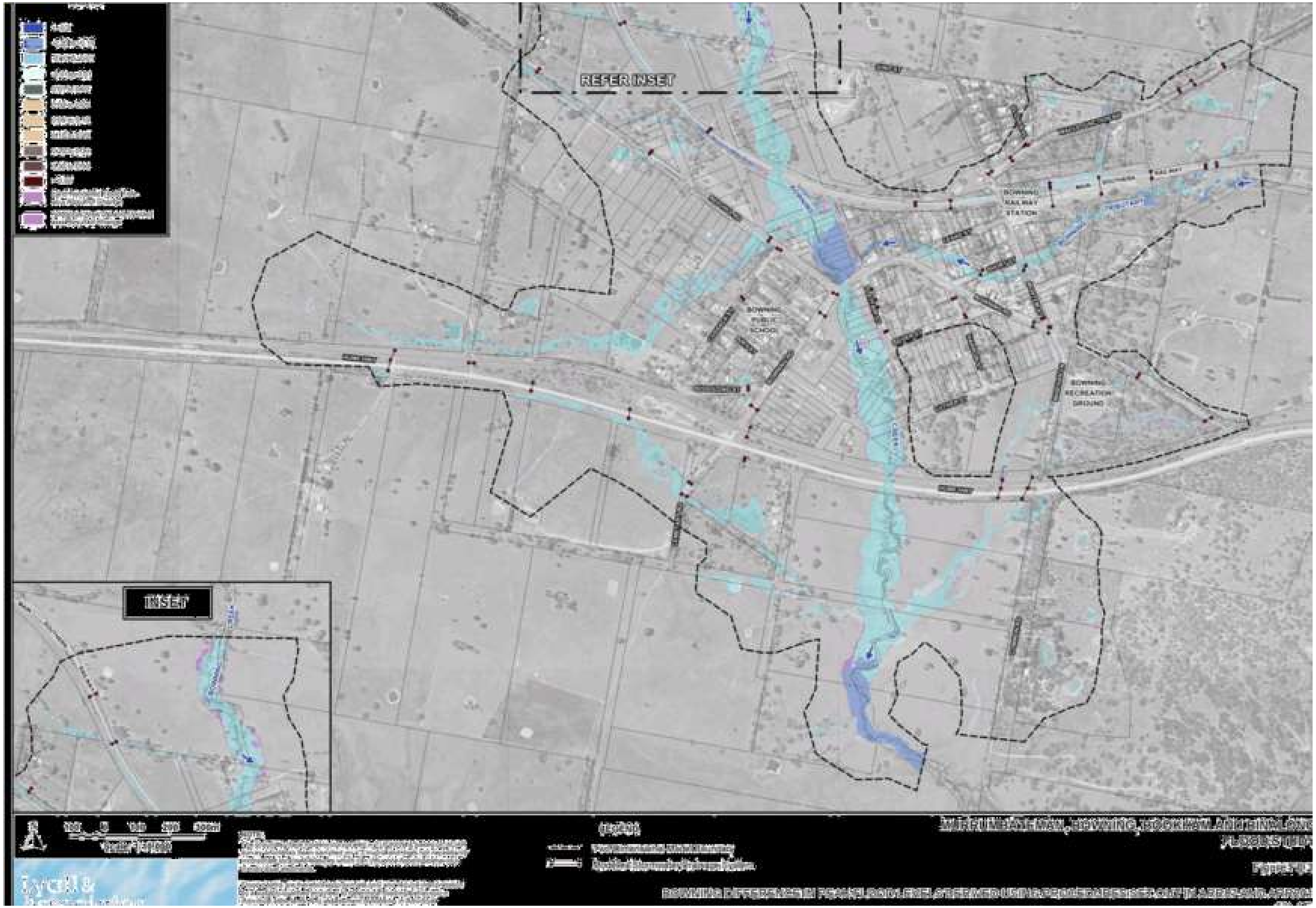
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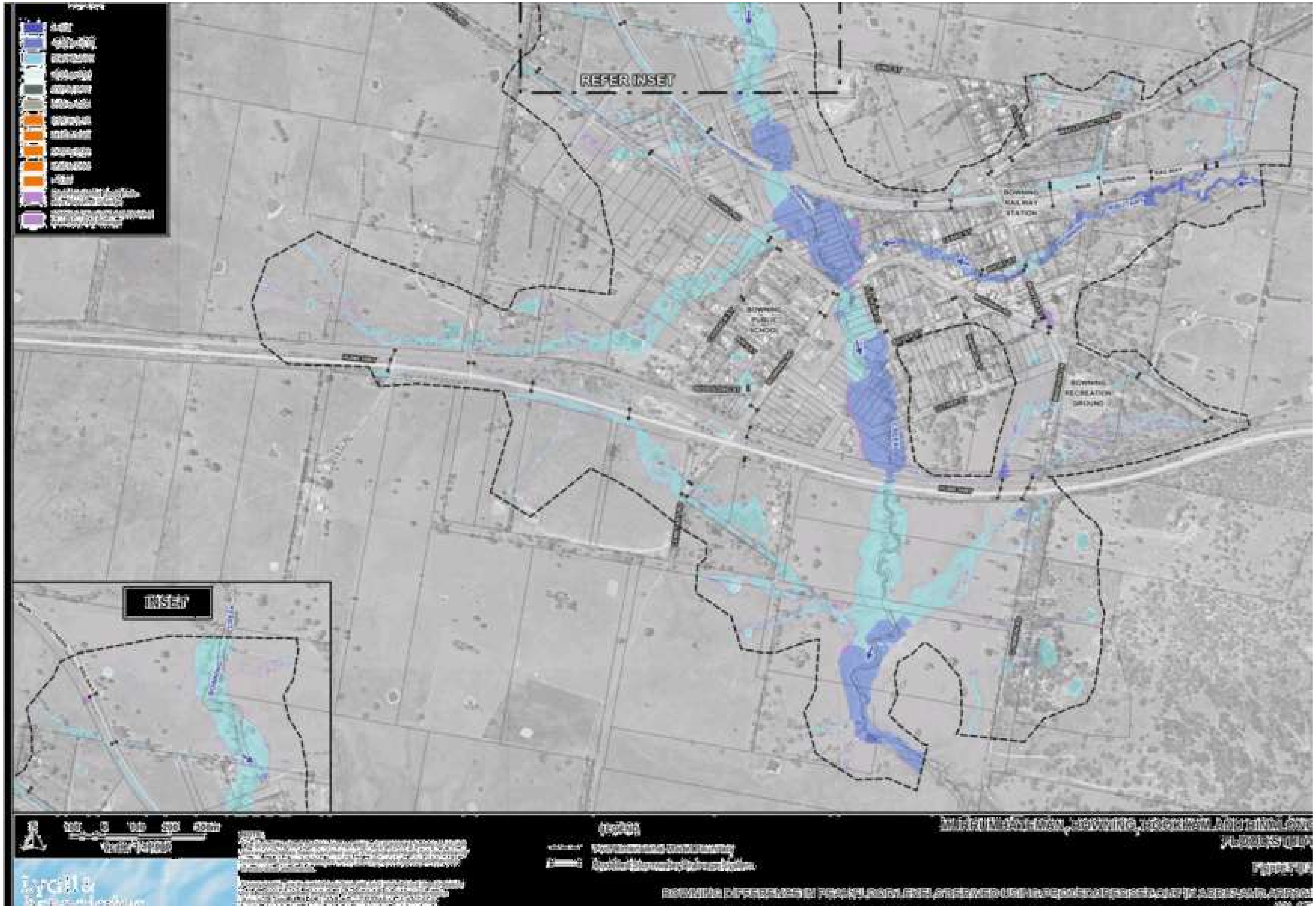
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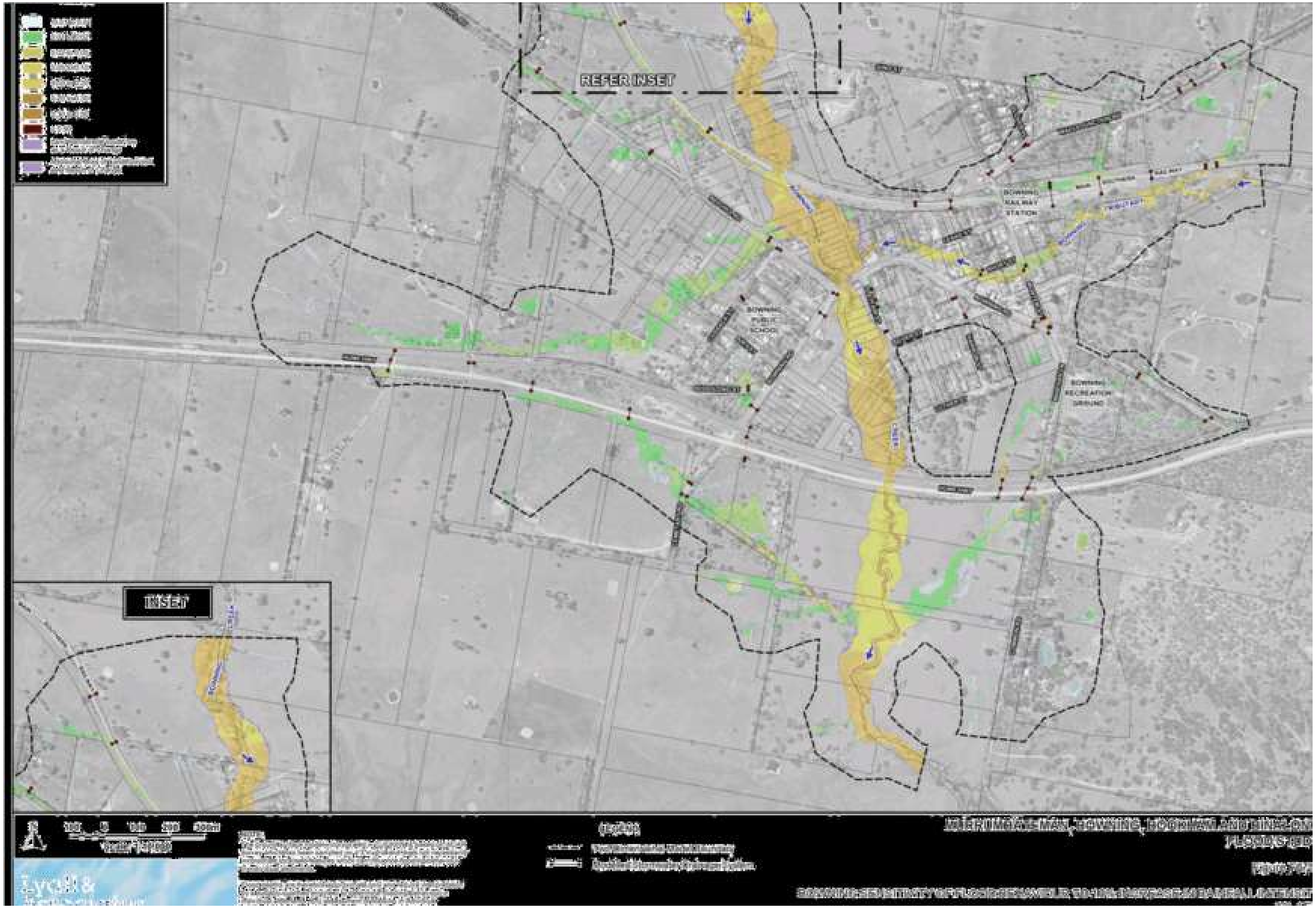
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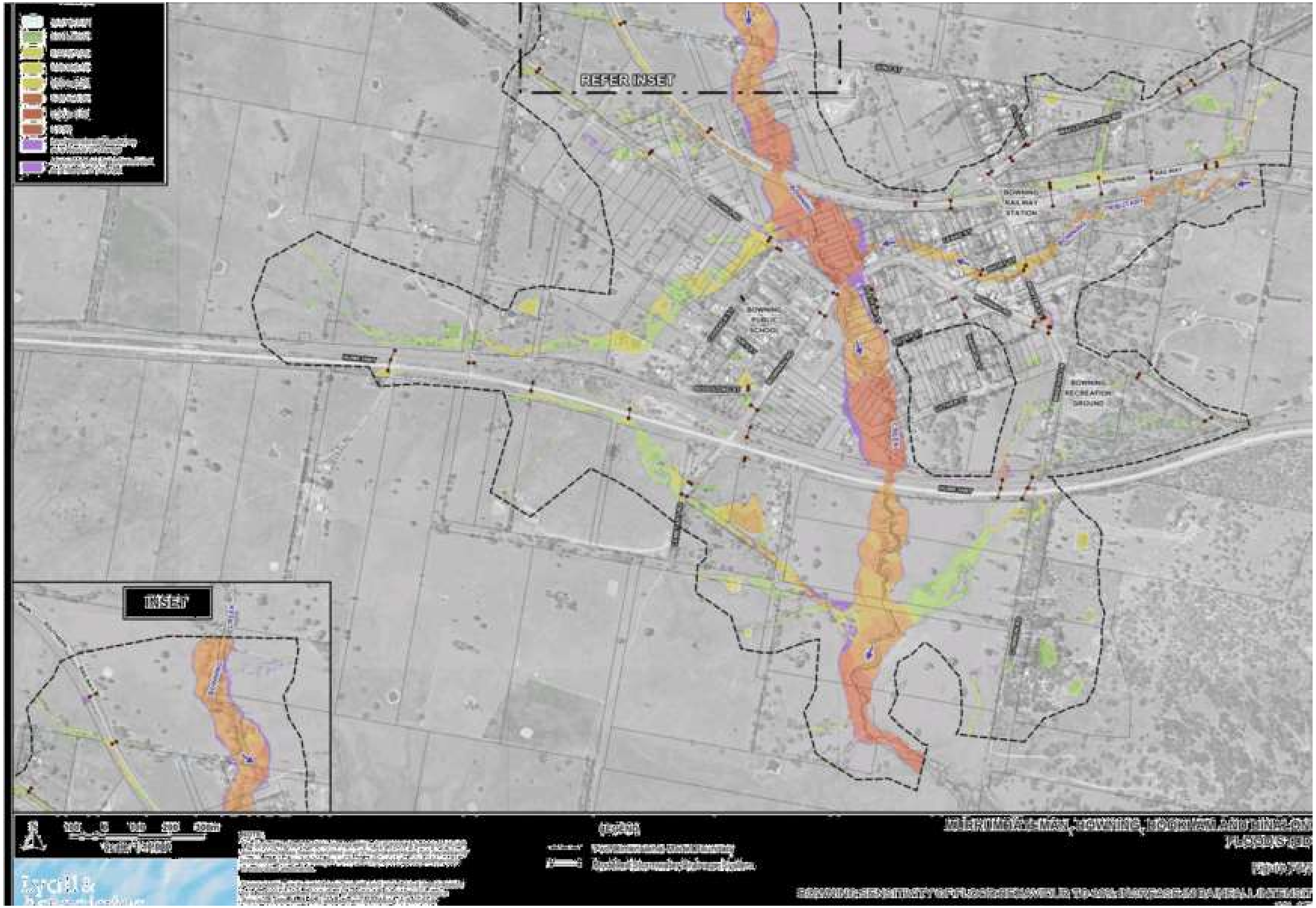
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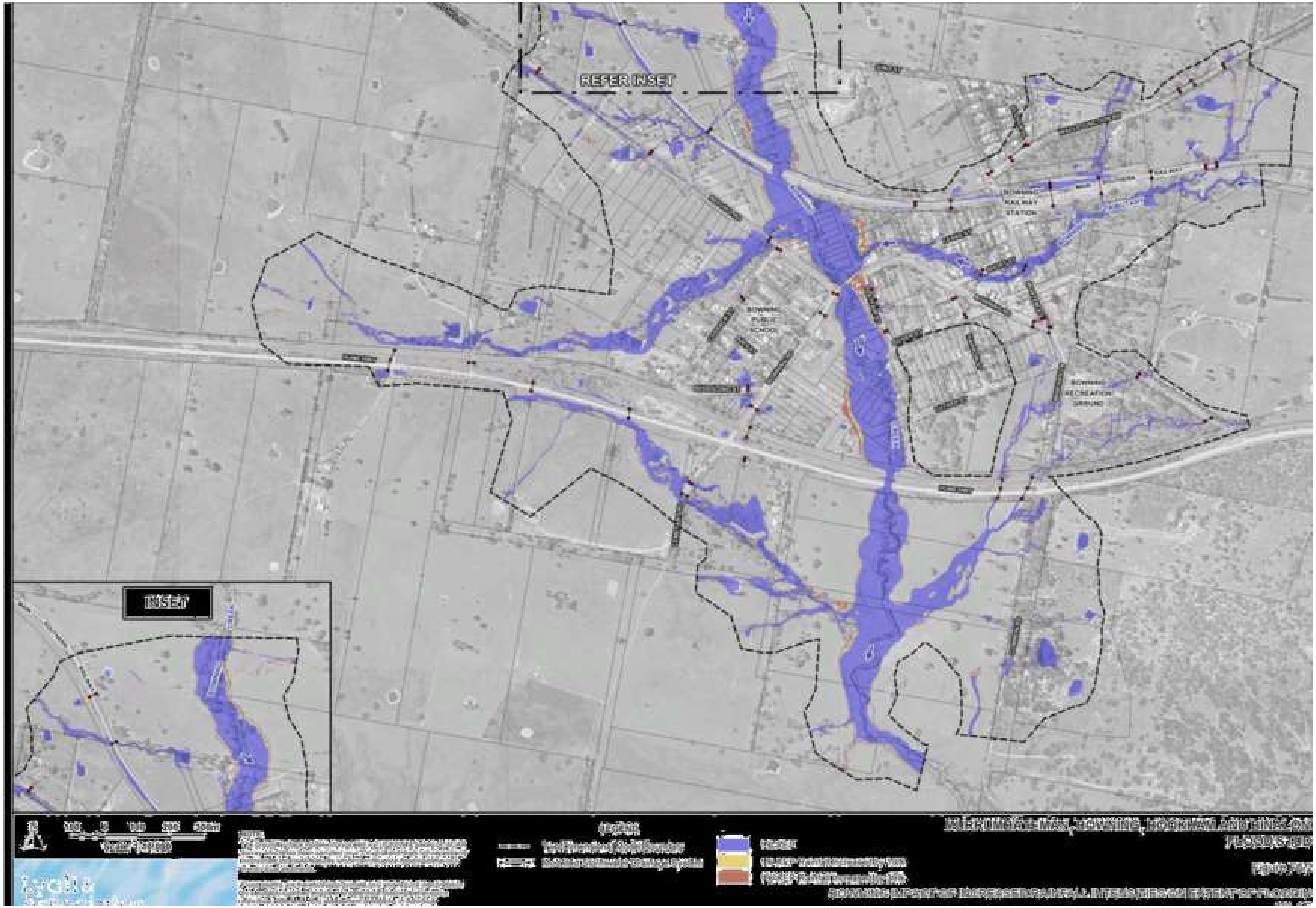
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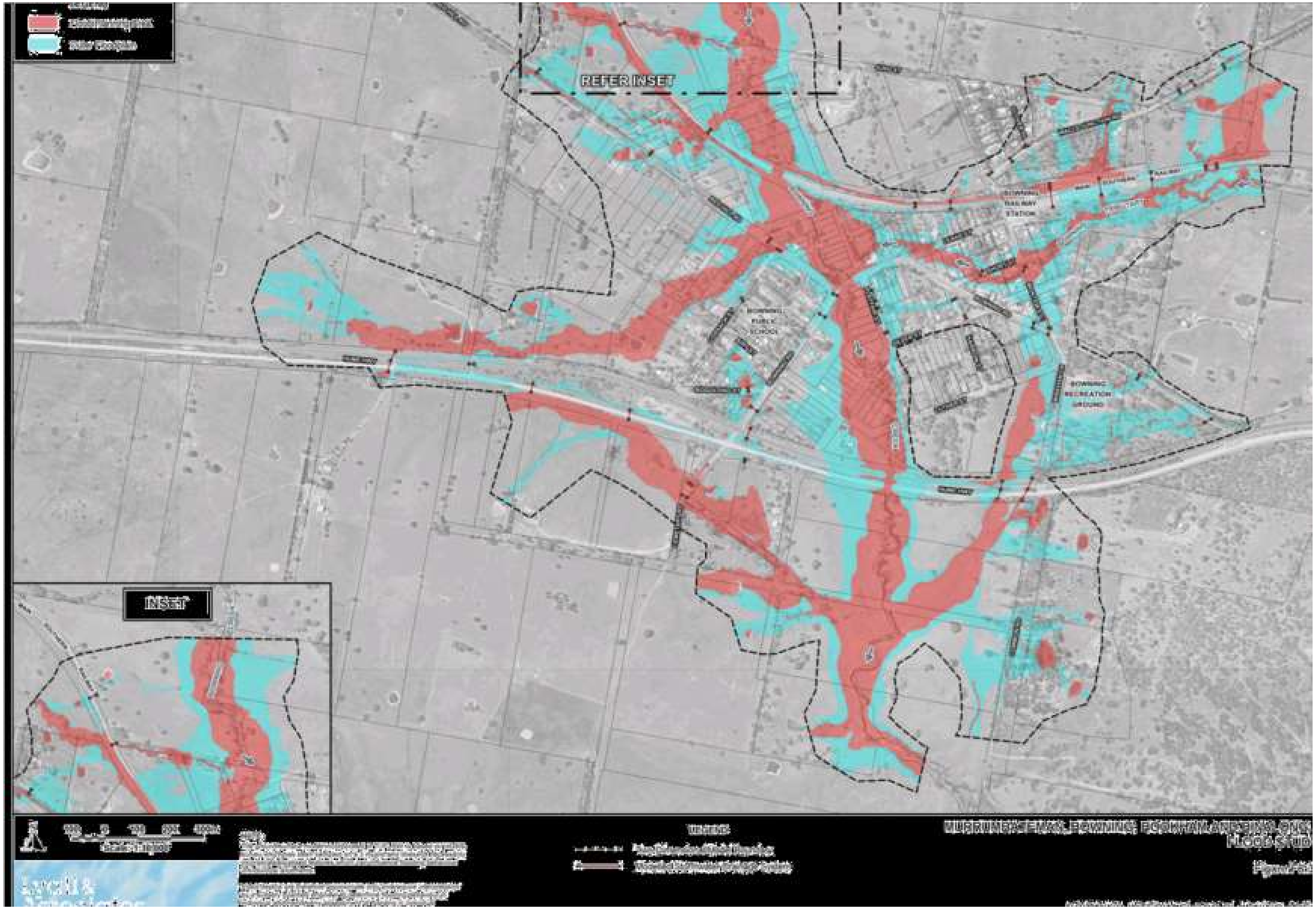
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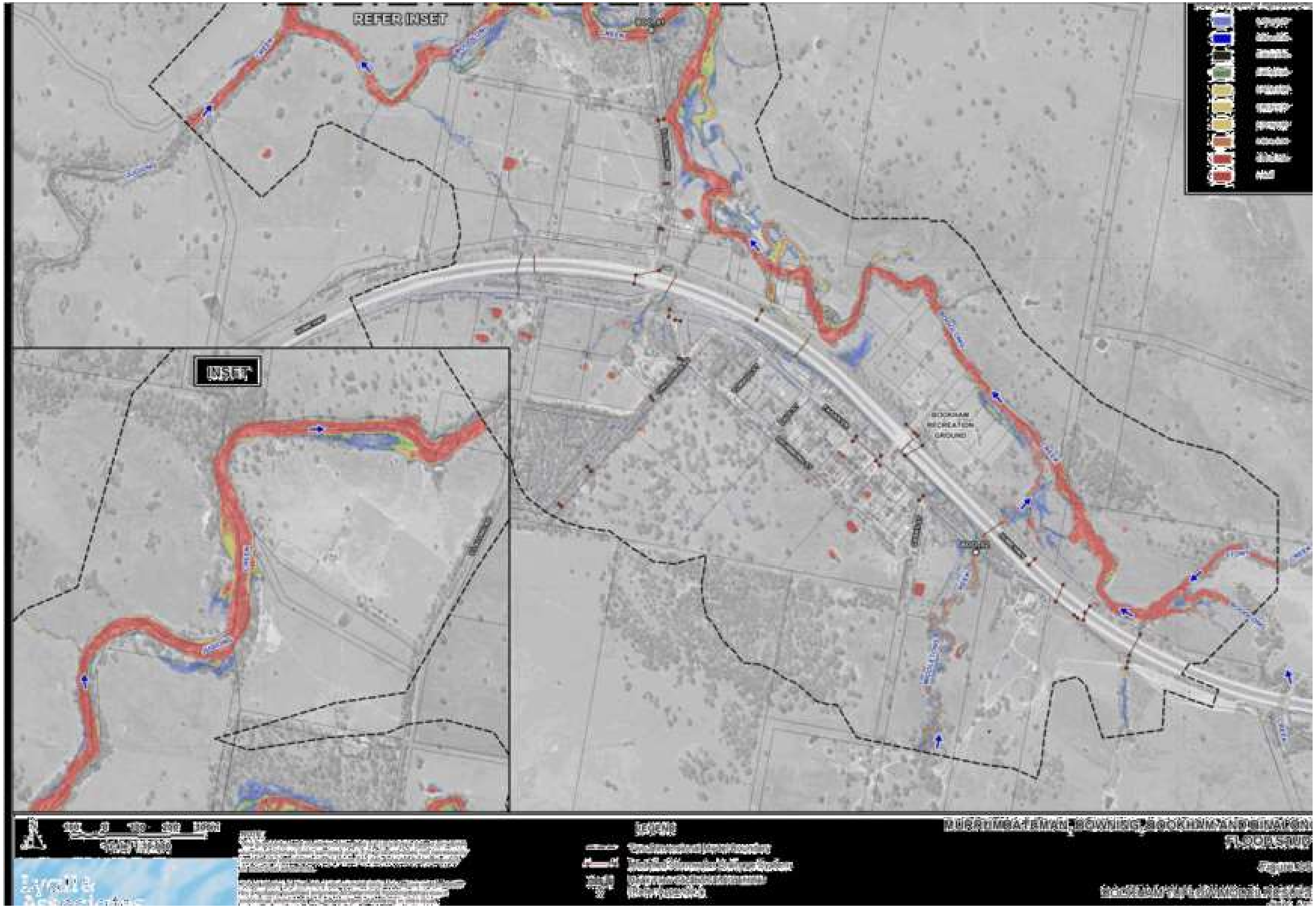
APPENDIX G

HYDRAULIC MODELLING OF DESIGN FLOODS AT BOOKHAM

LIST OF FIGURES (APPENDIX G)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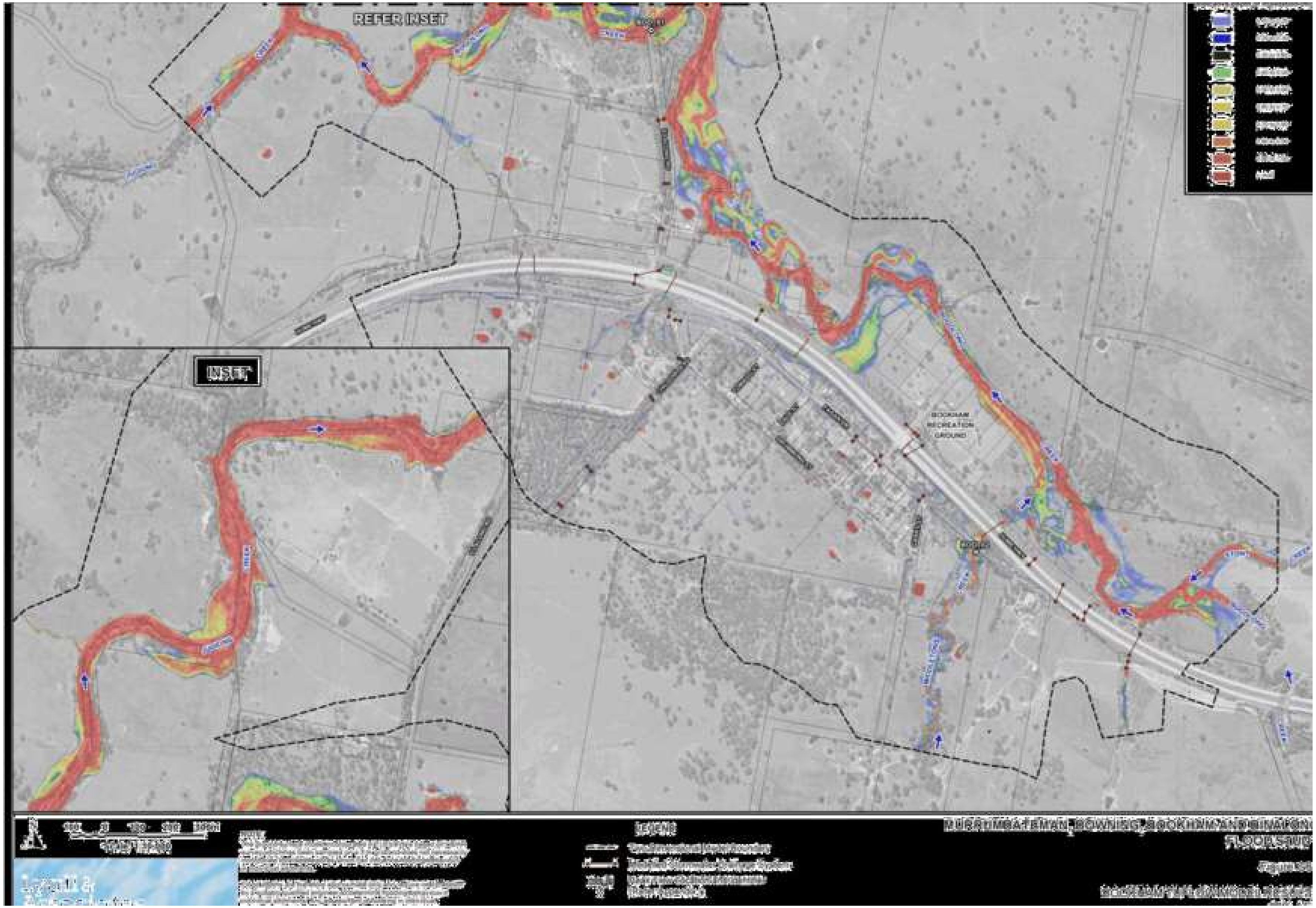

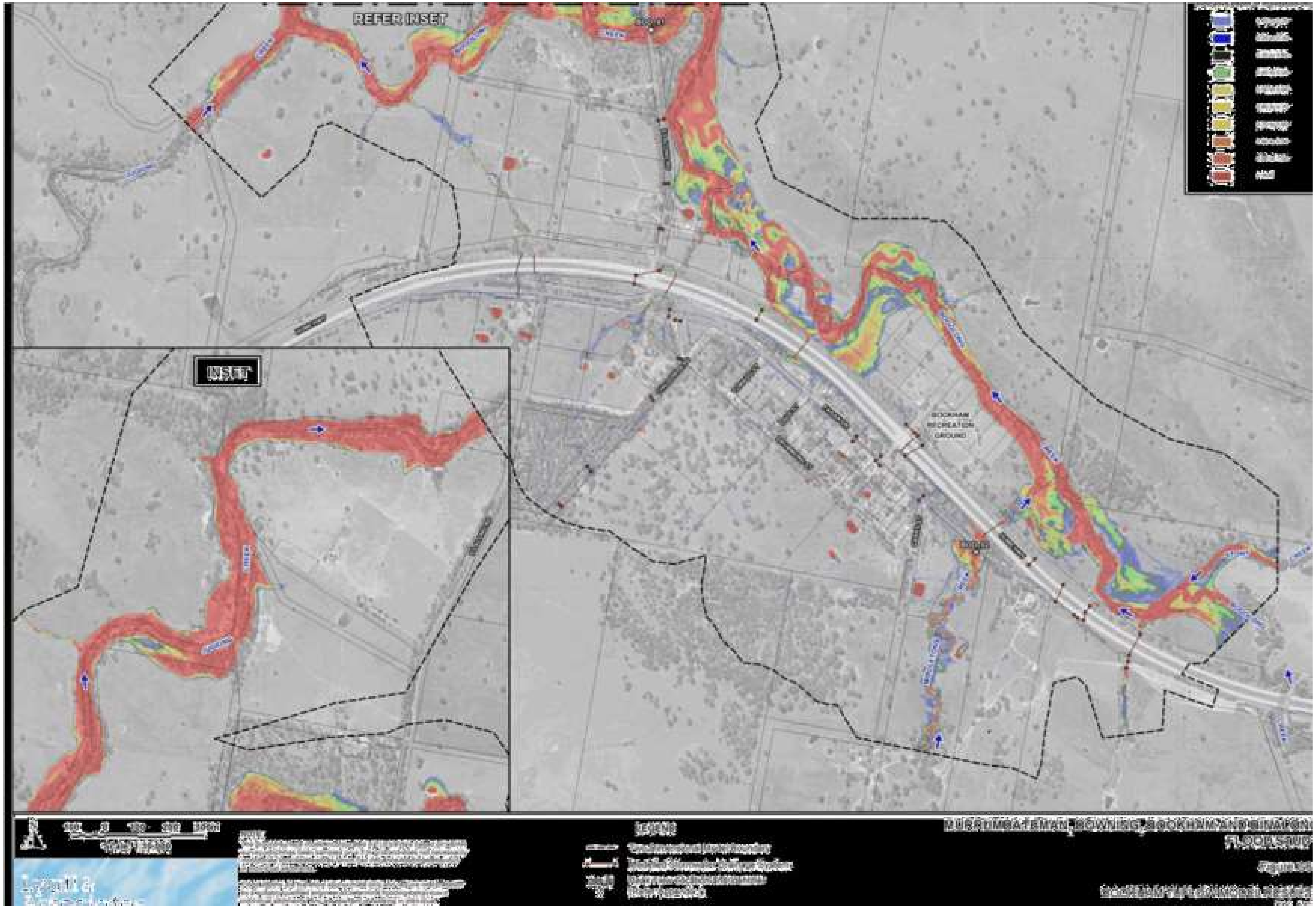
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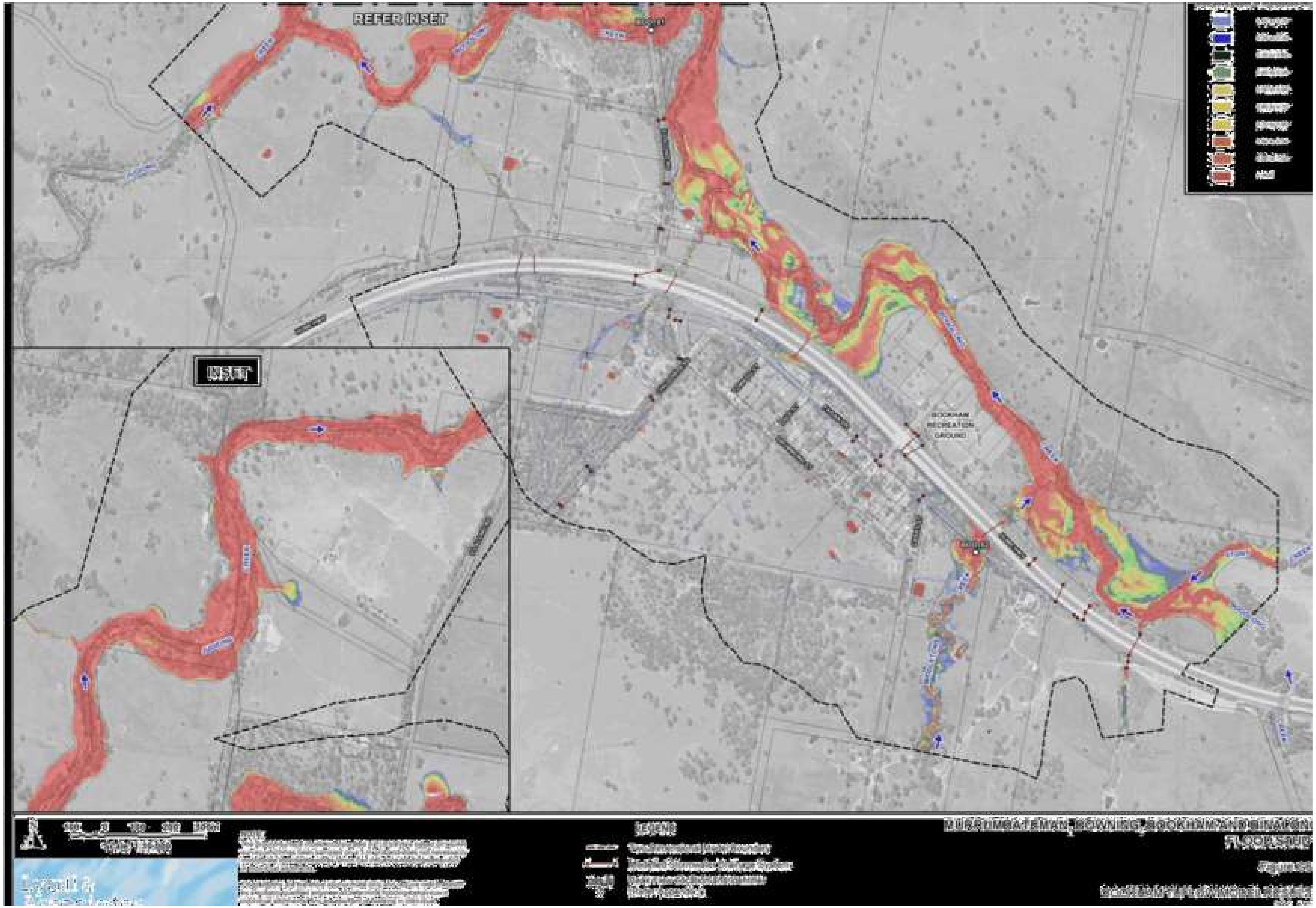
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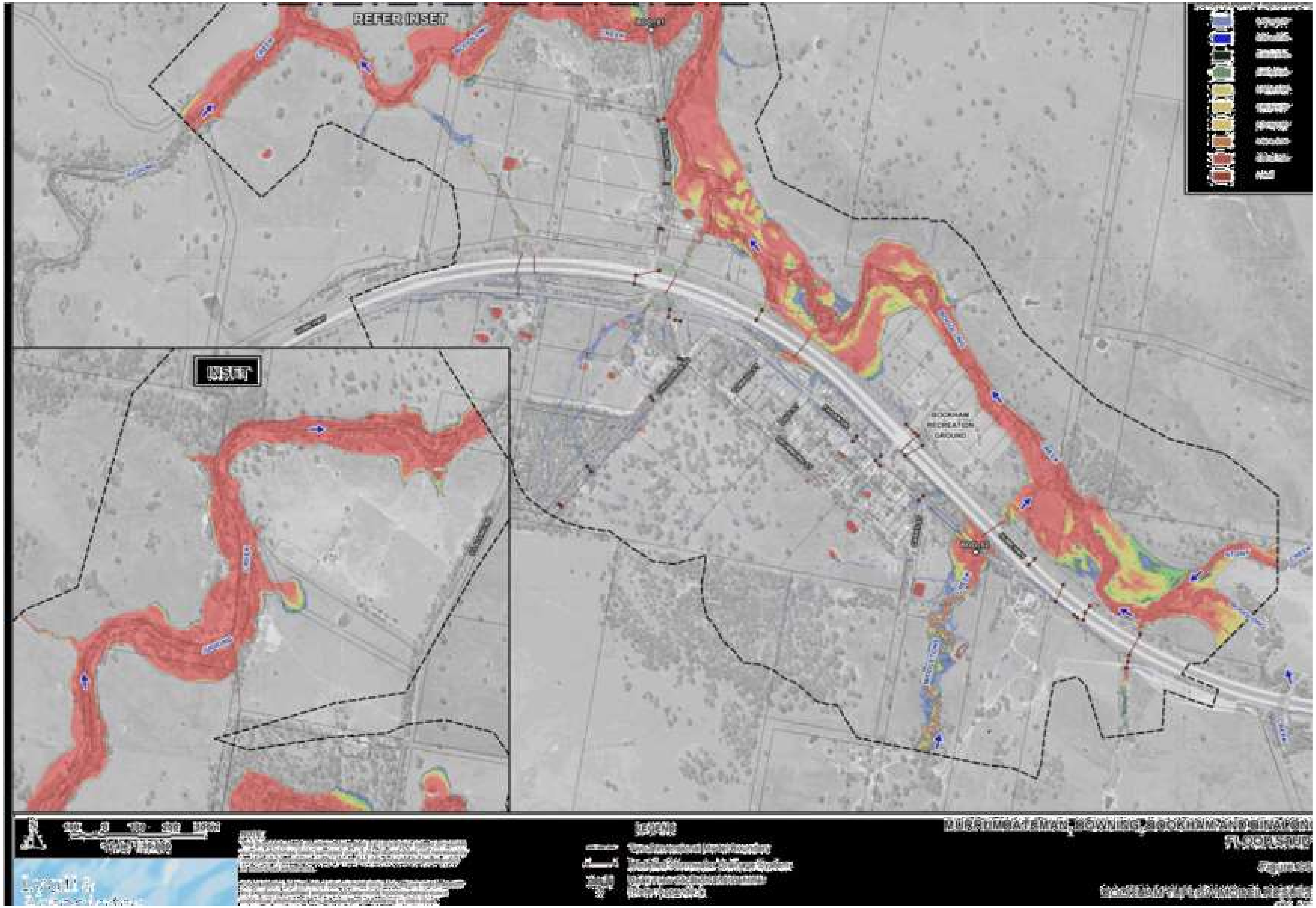
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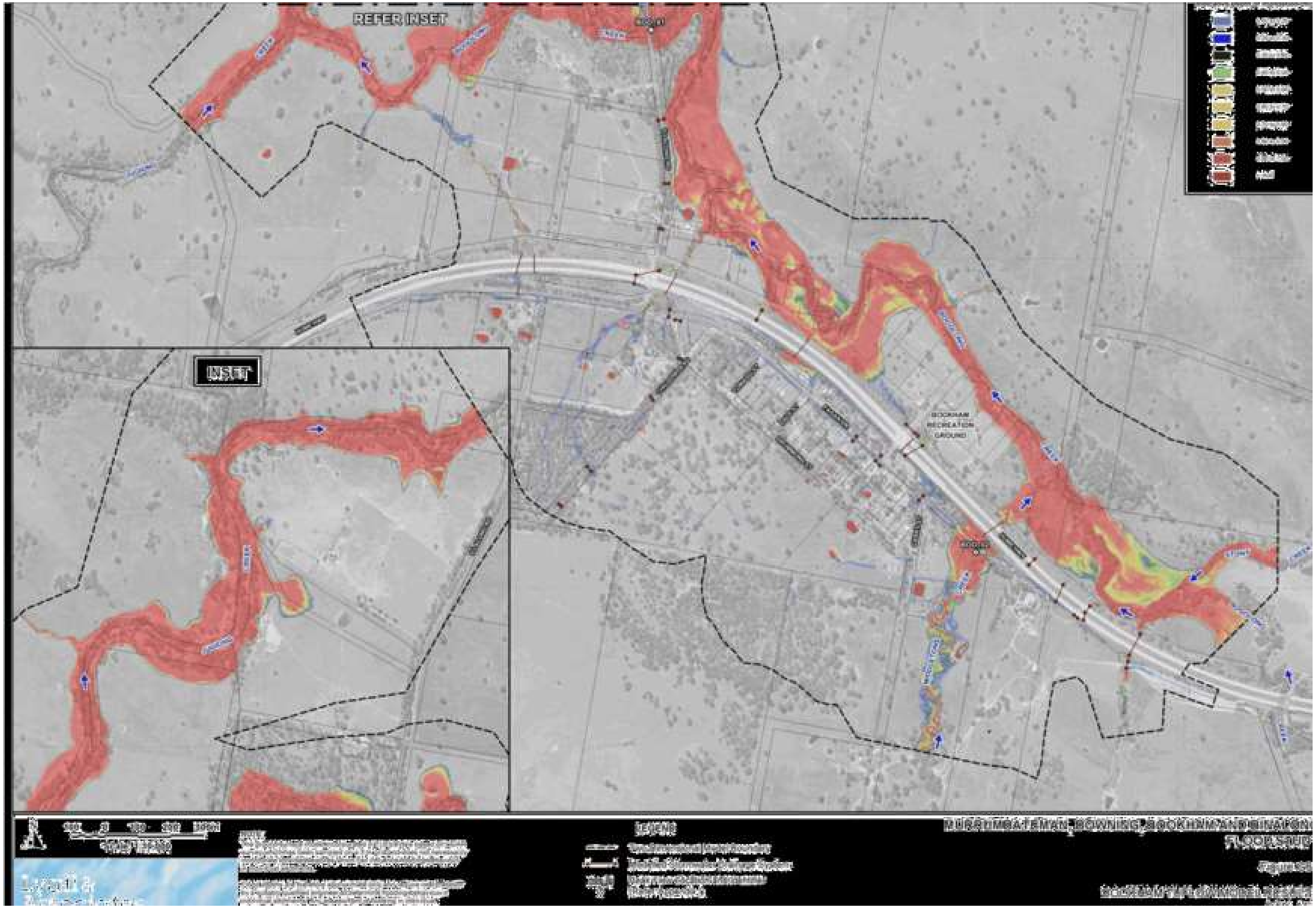
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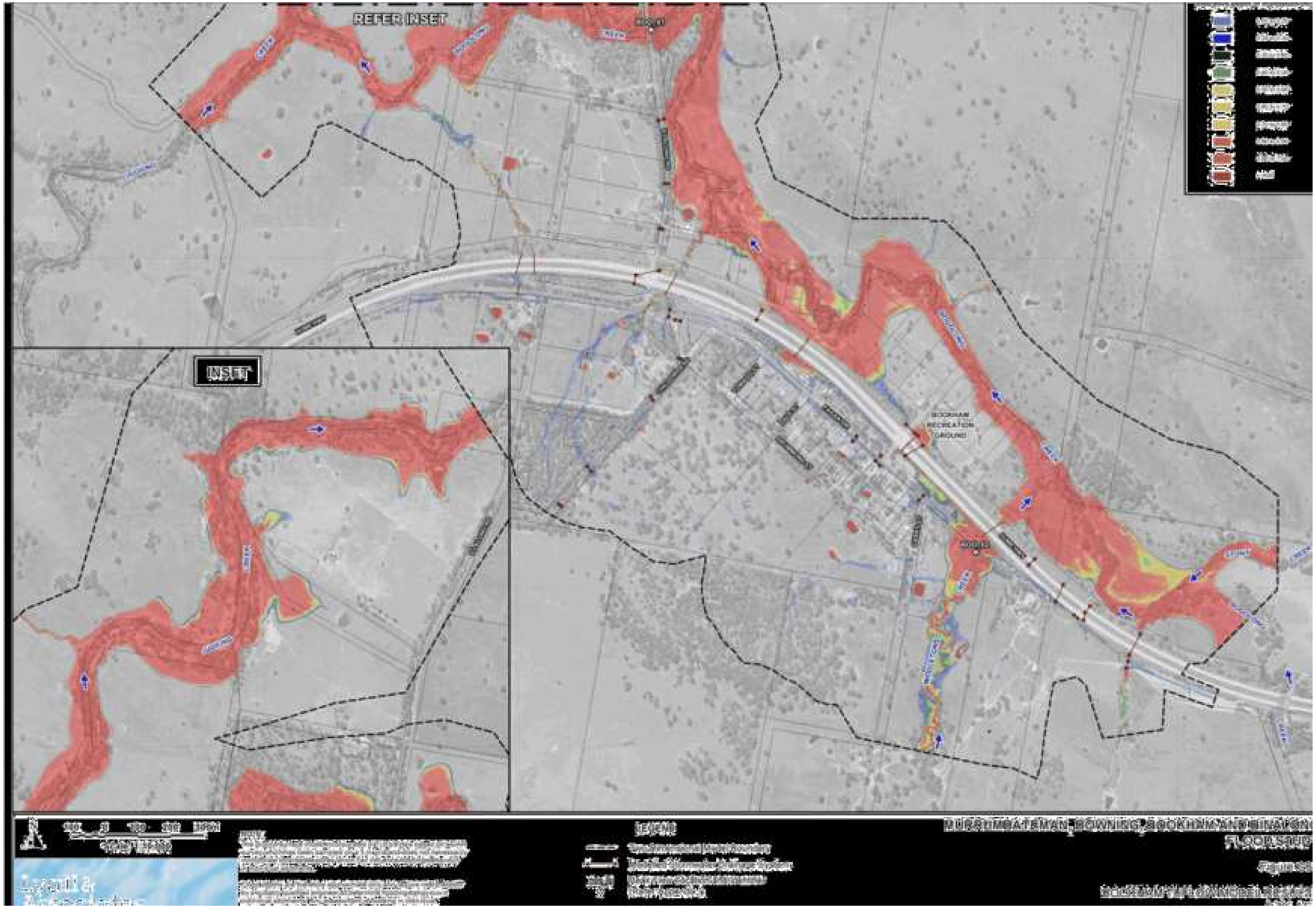
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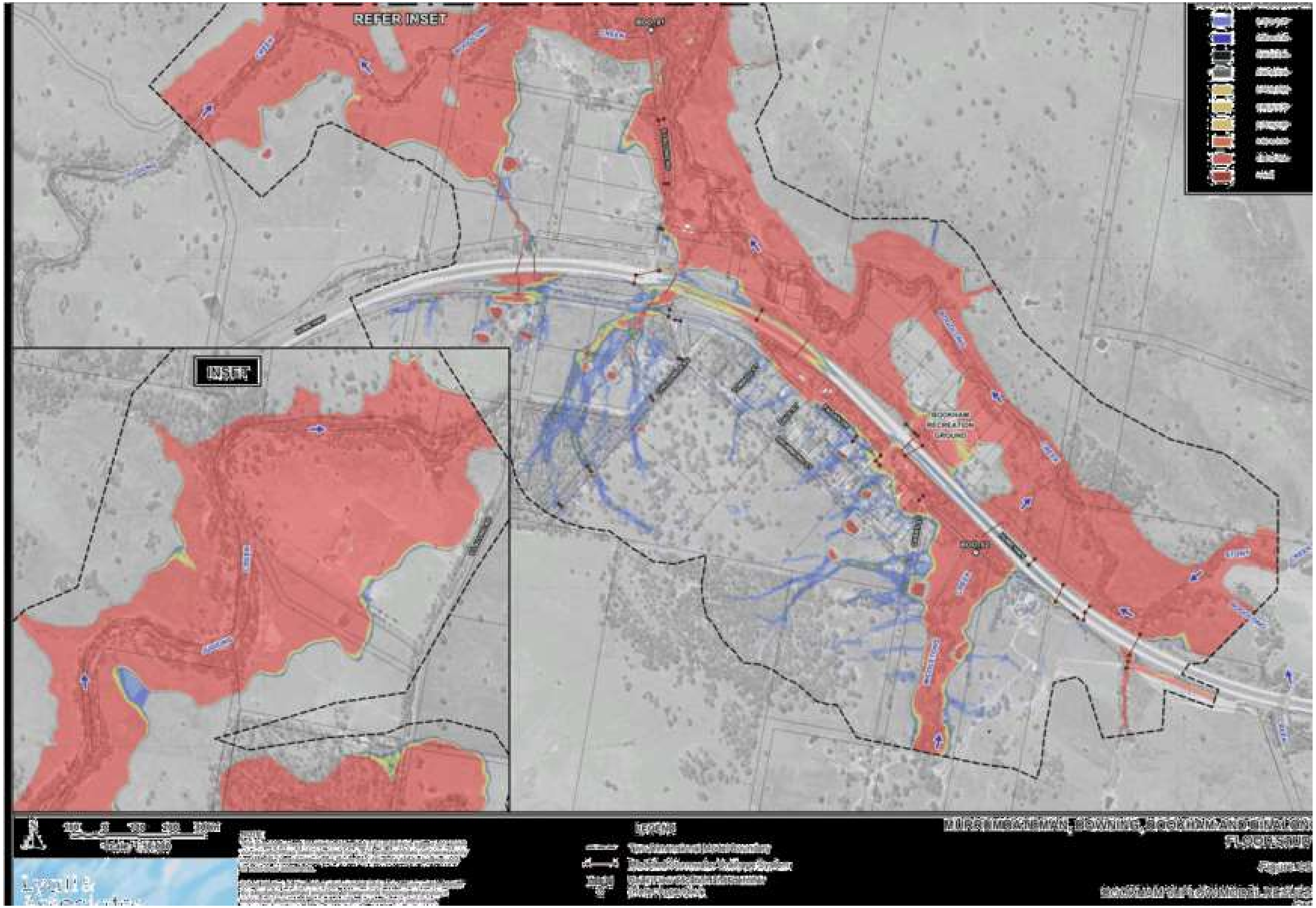
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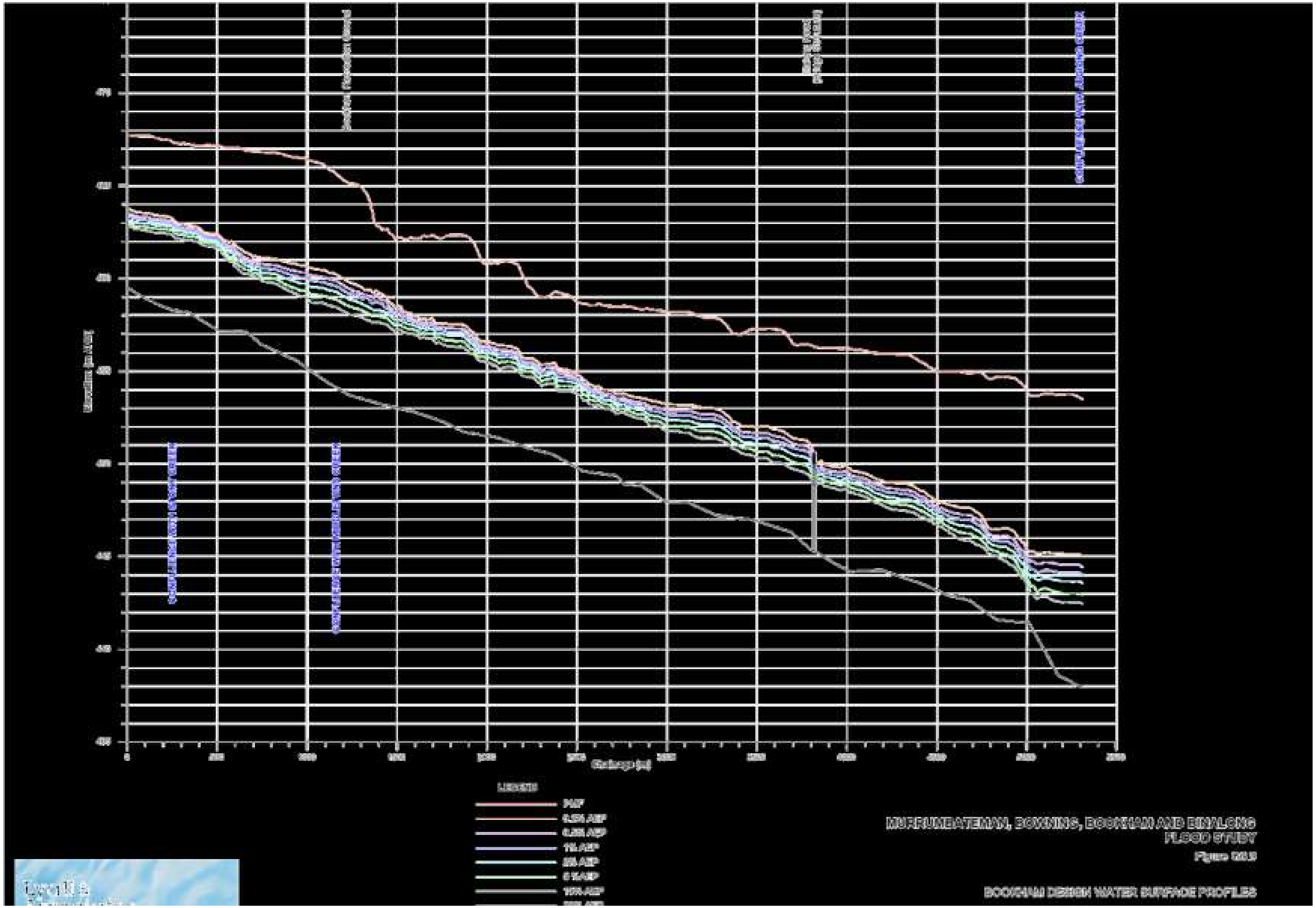
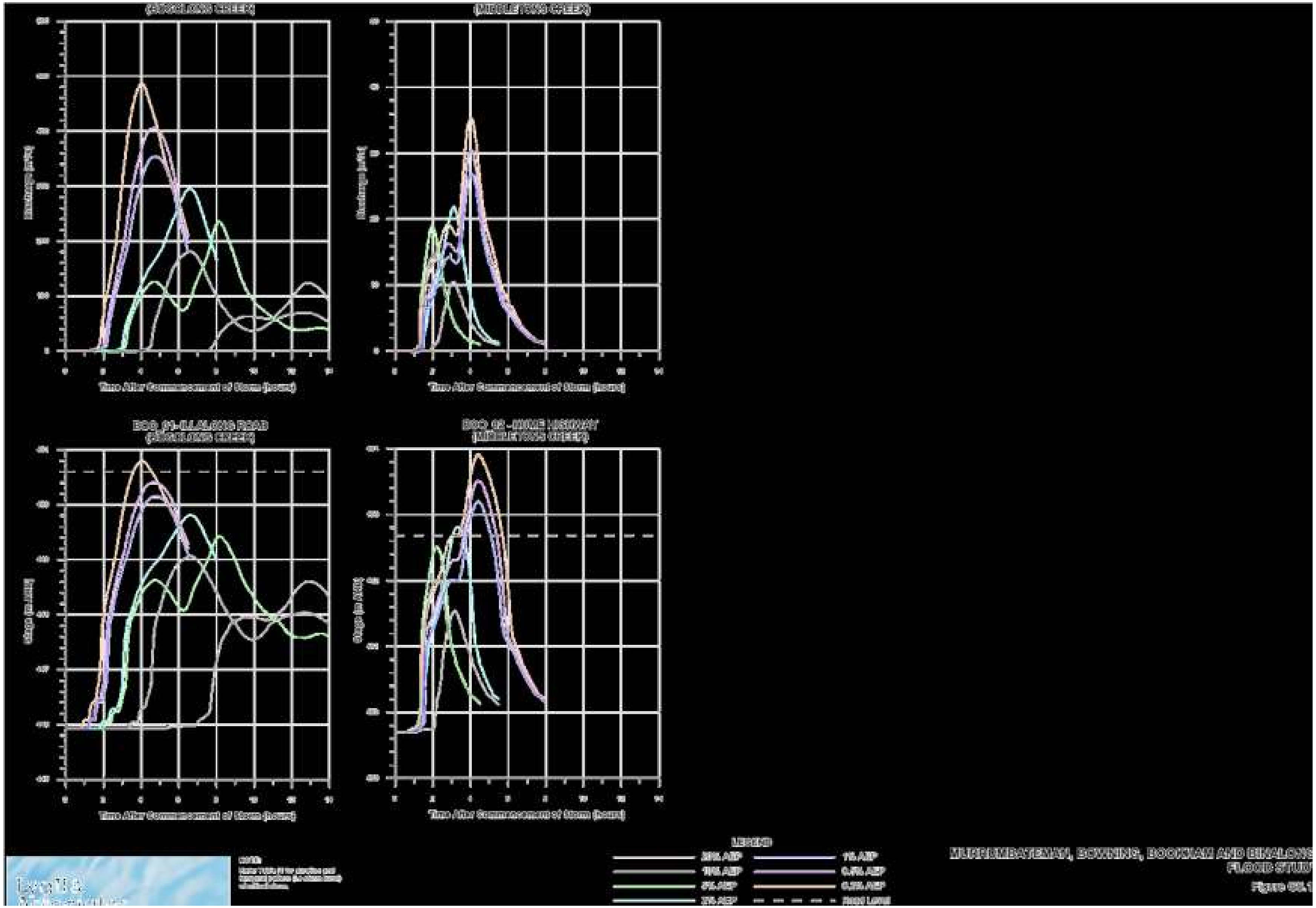
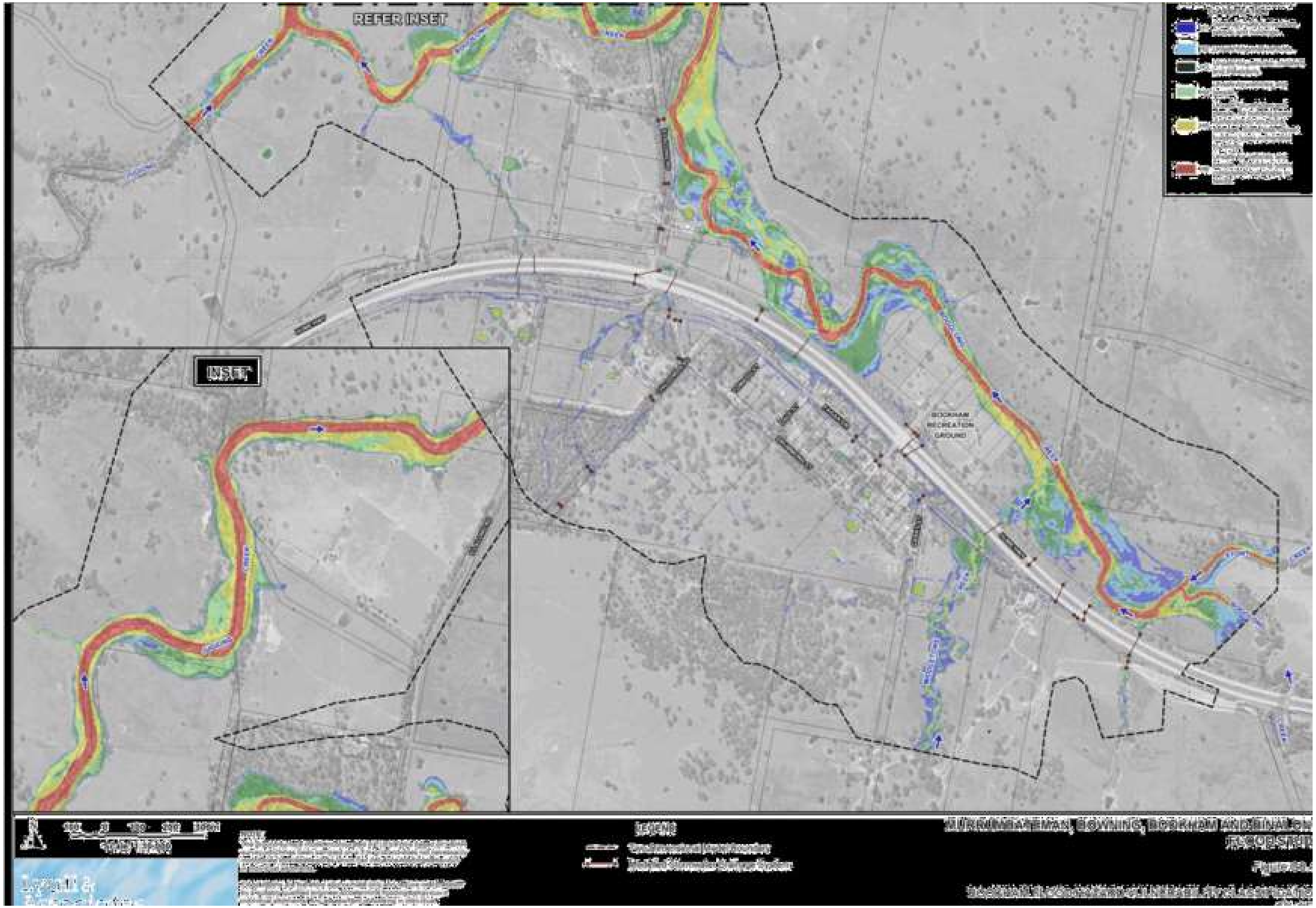

MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALONG
FLOOD STUDY
BOOKHAM DESIGN WATER SURFACE PROFILES

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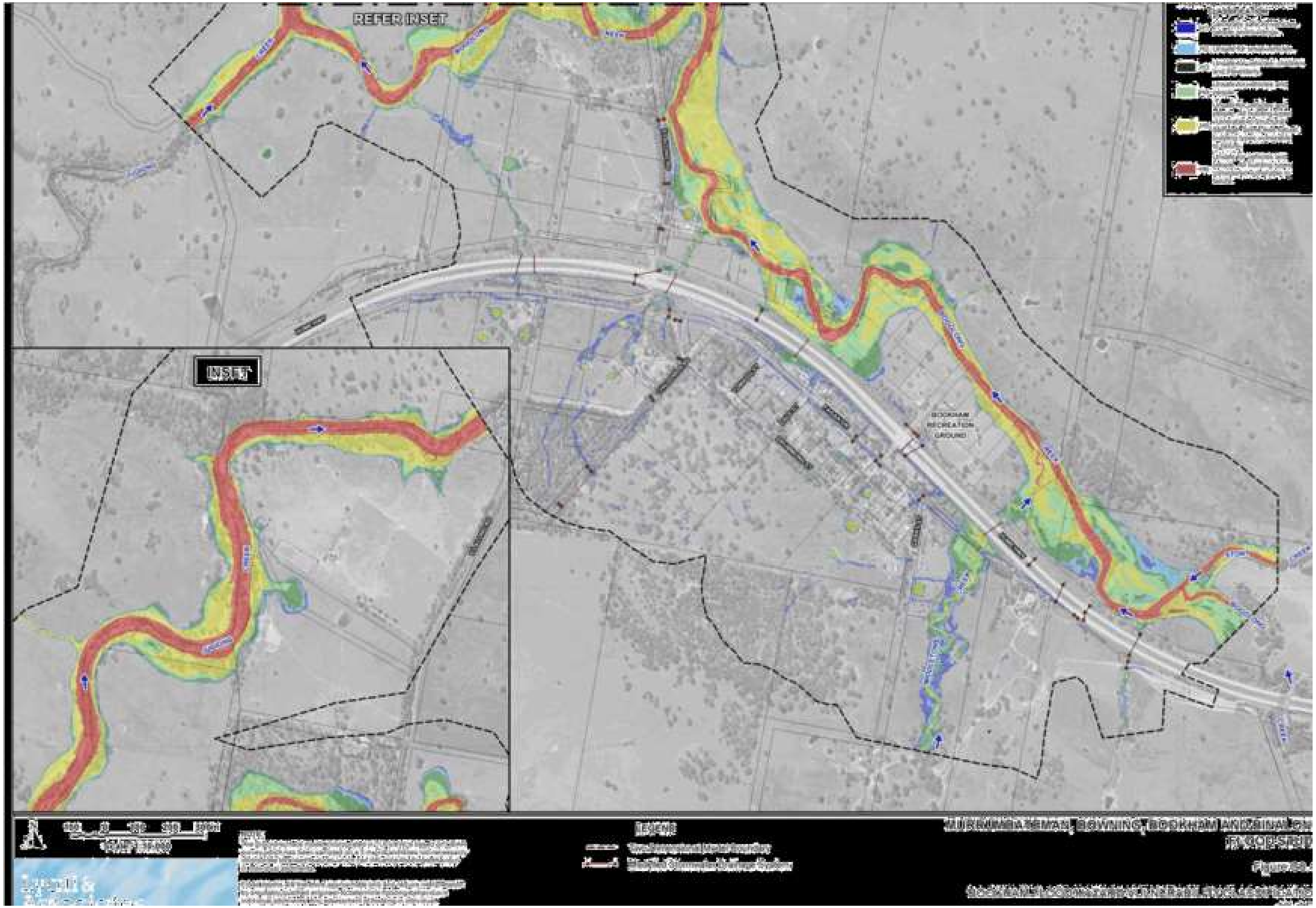
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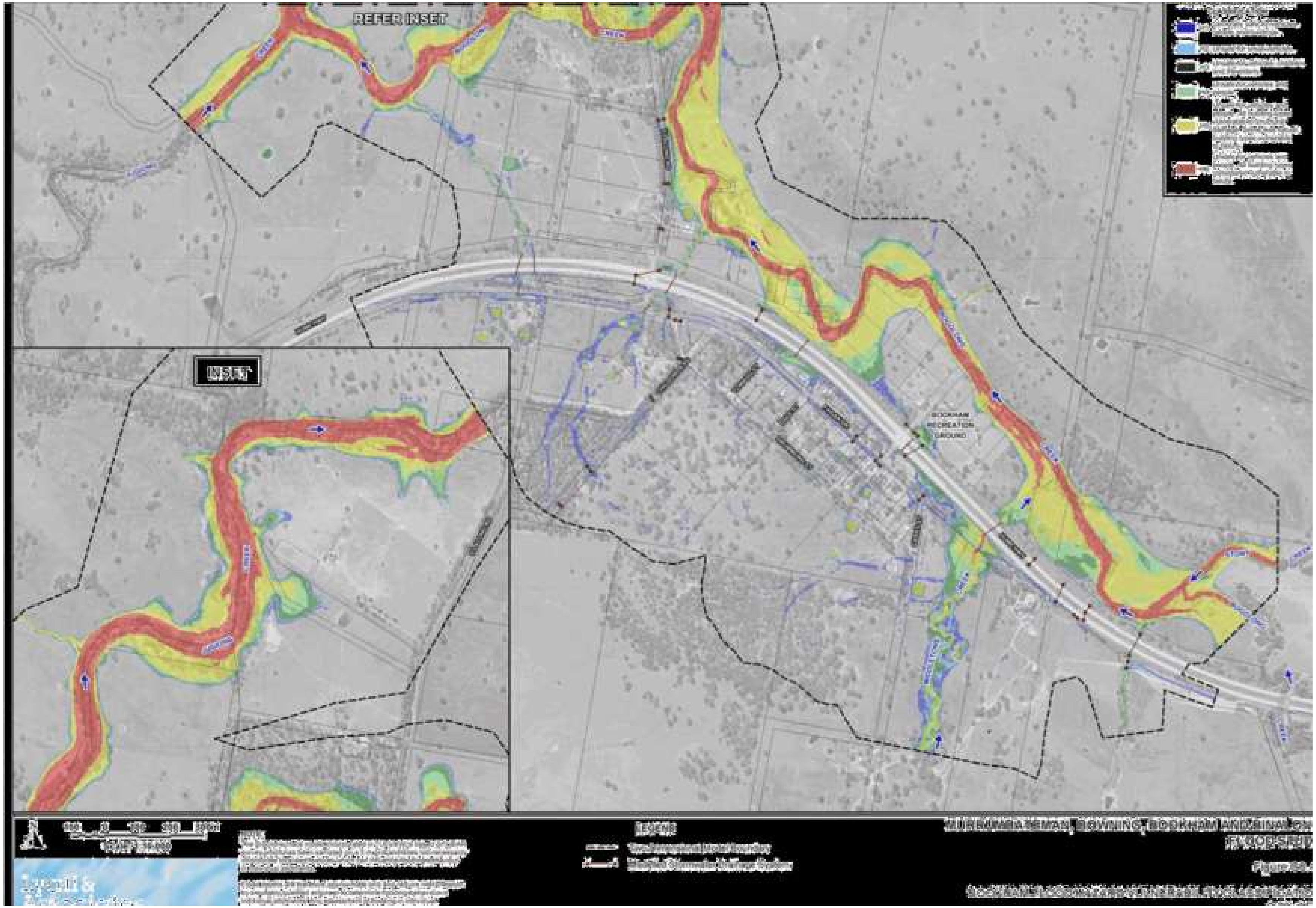
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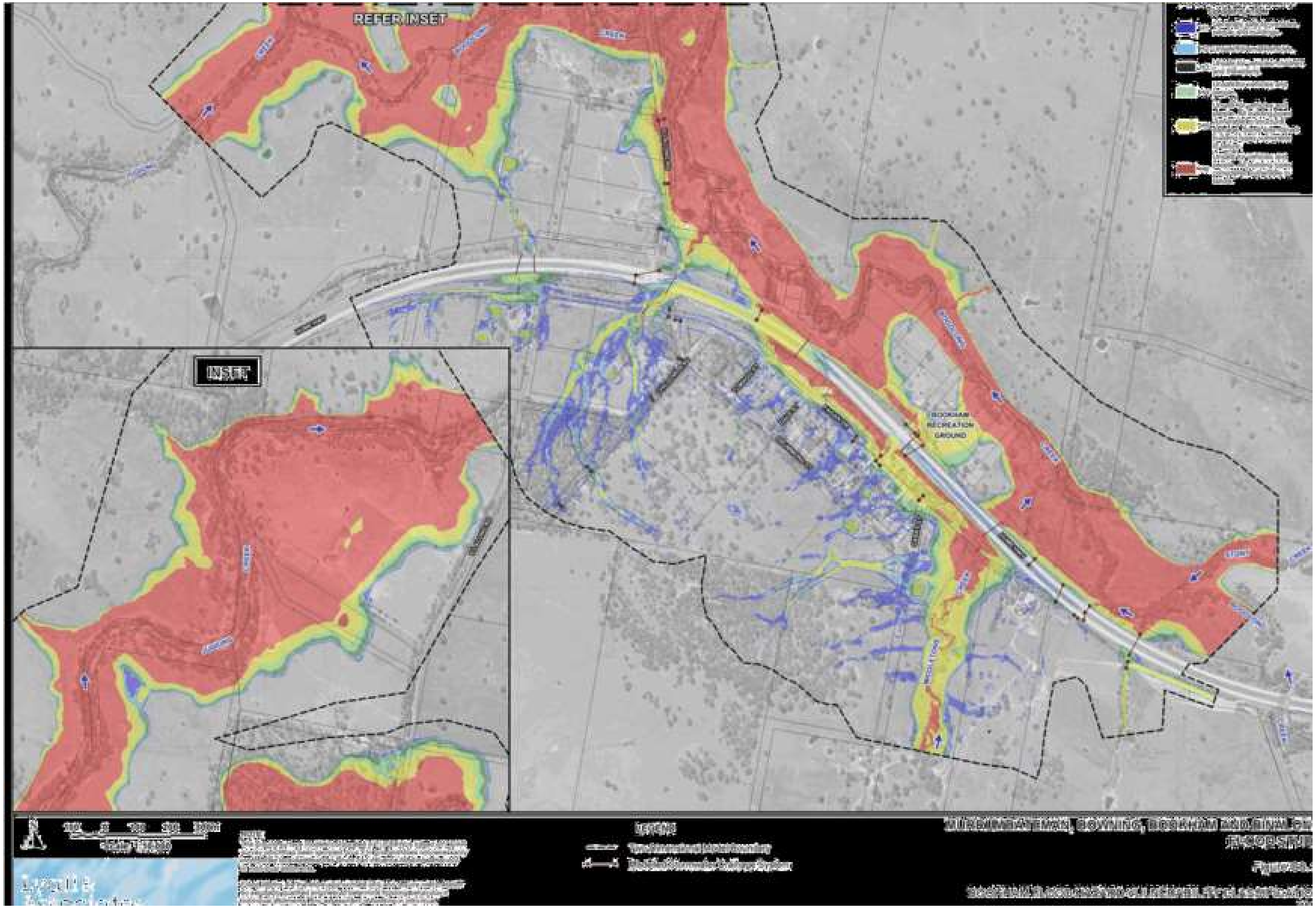
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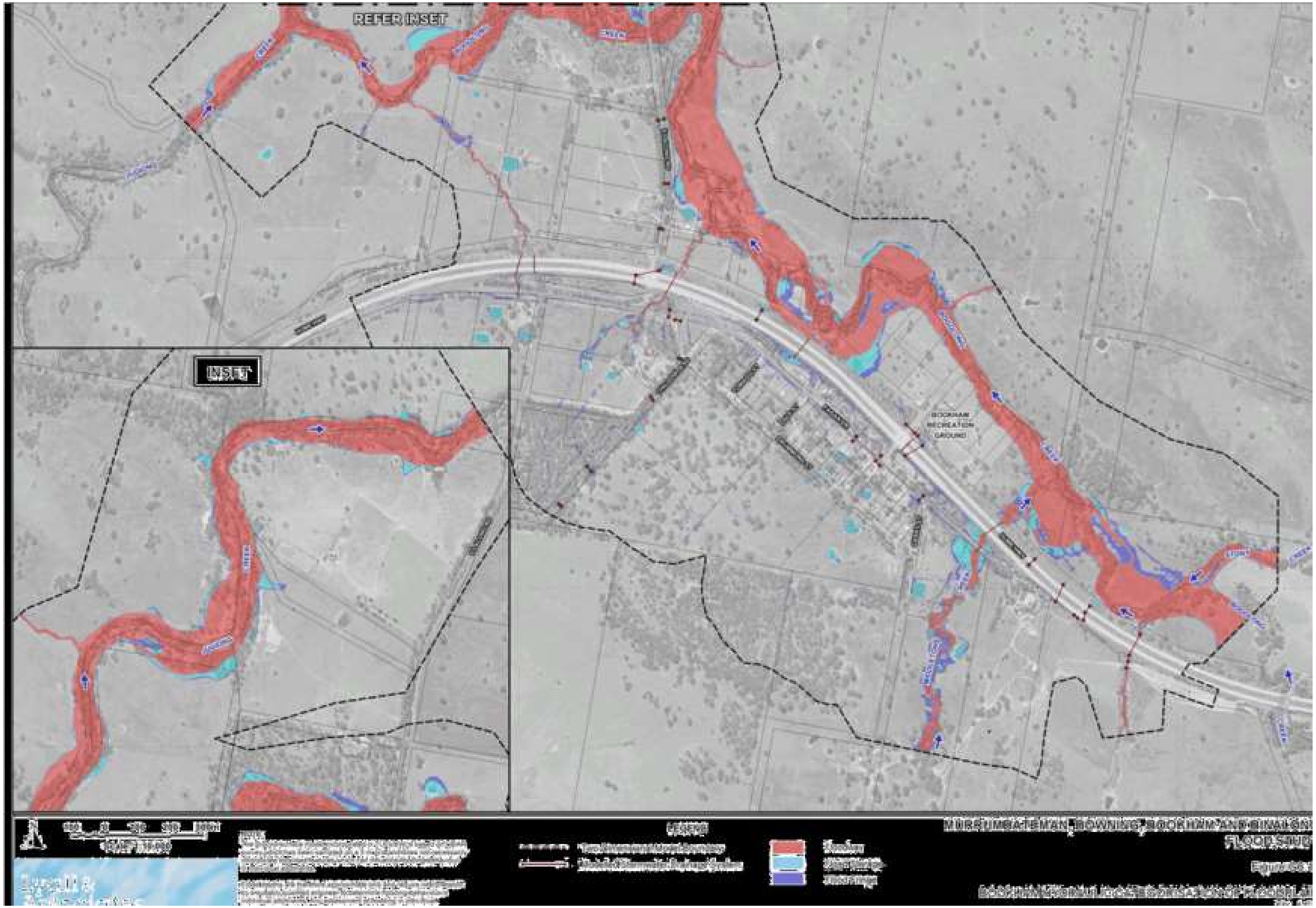
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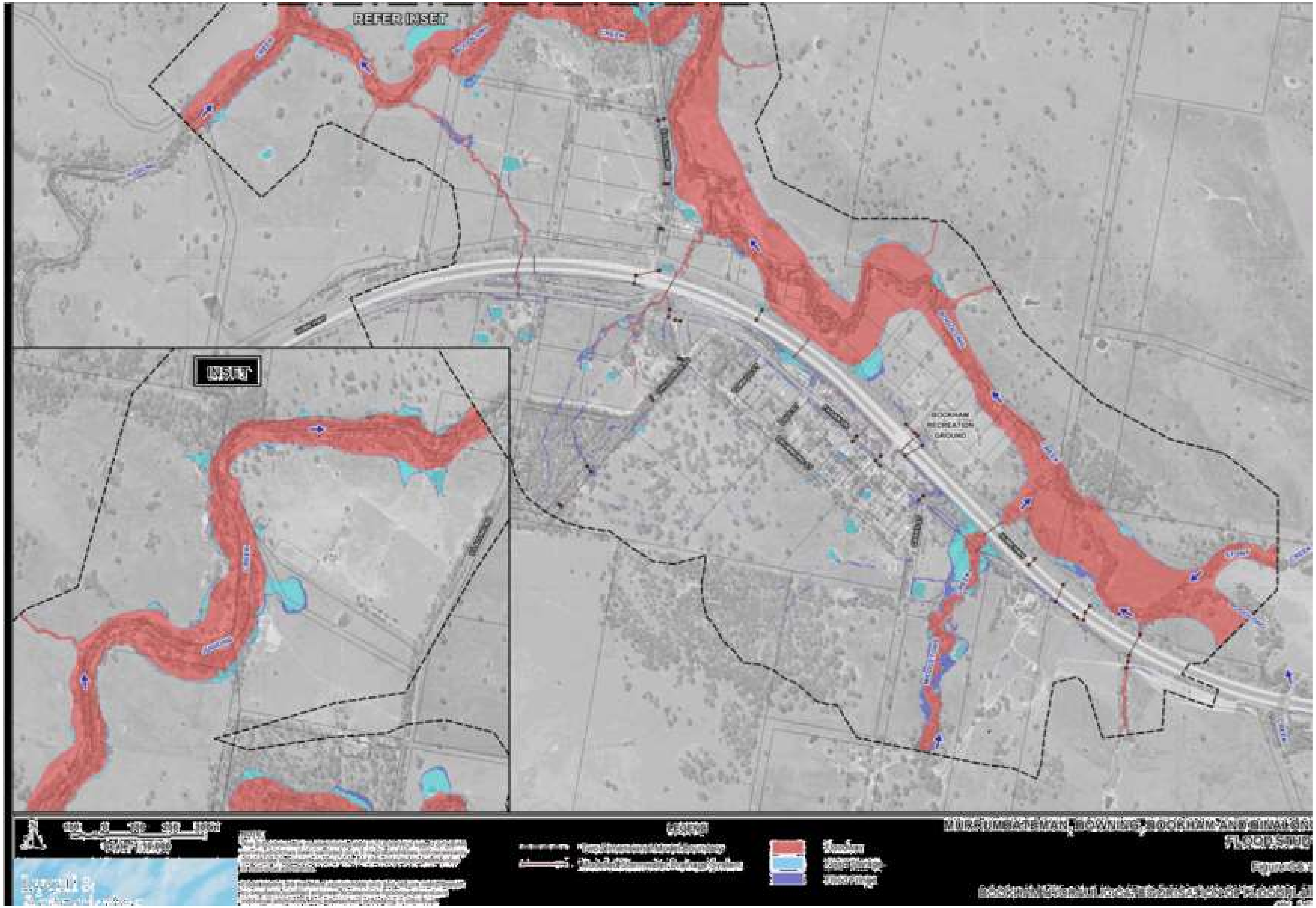
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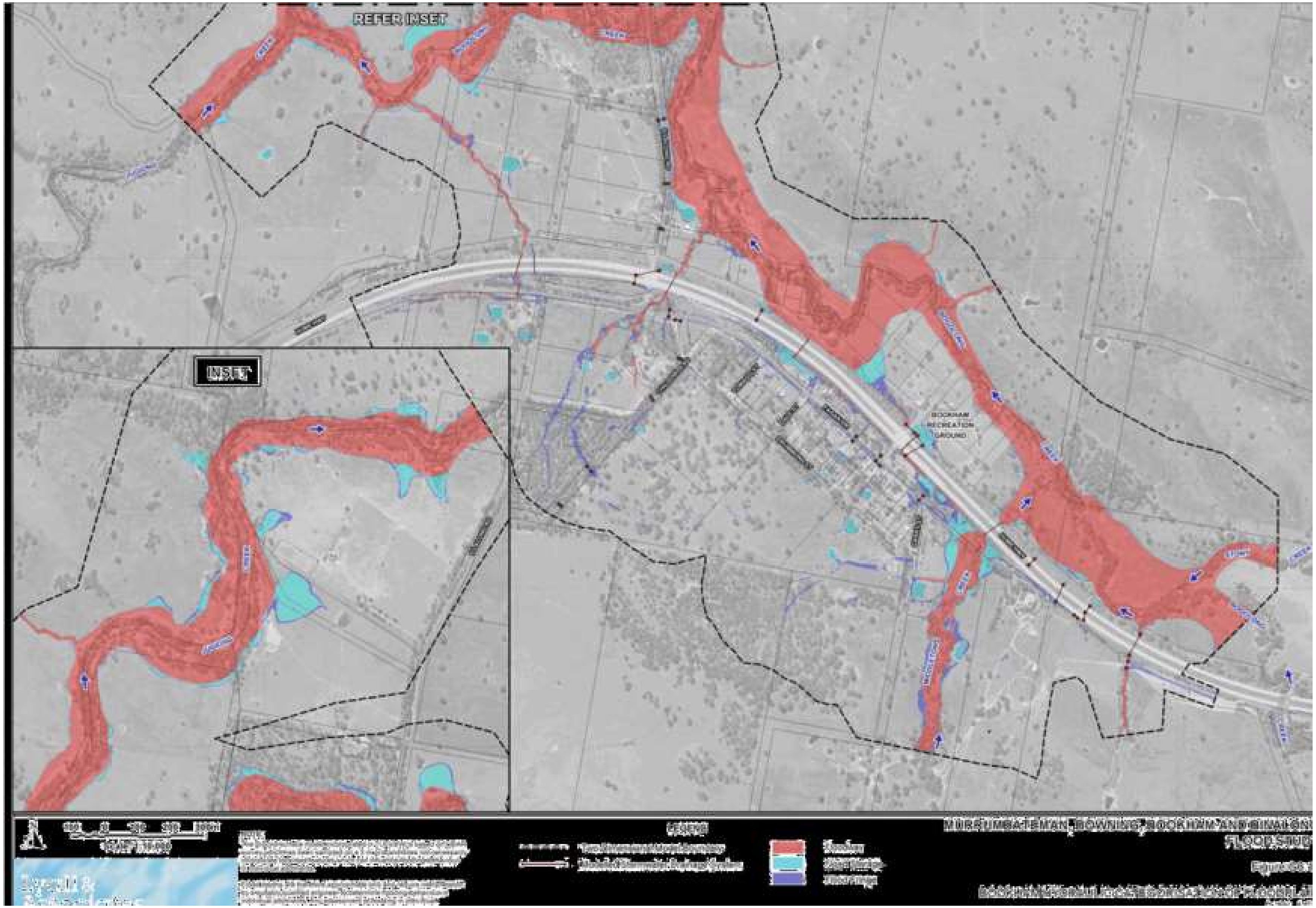
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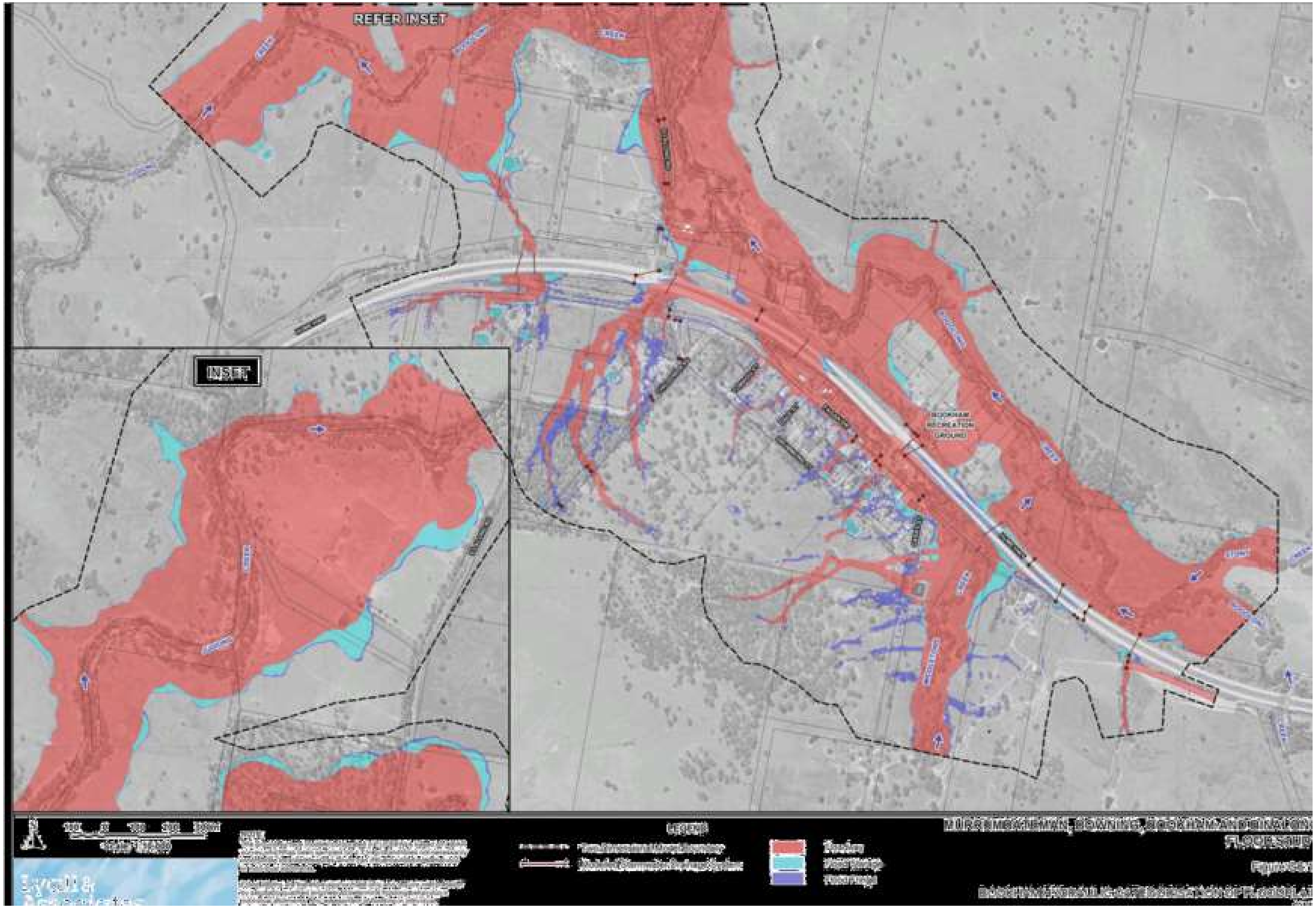
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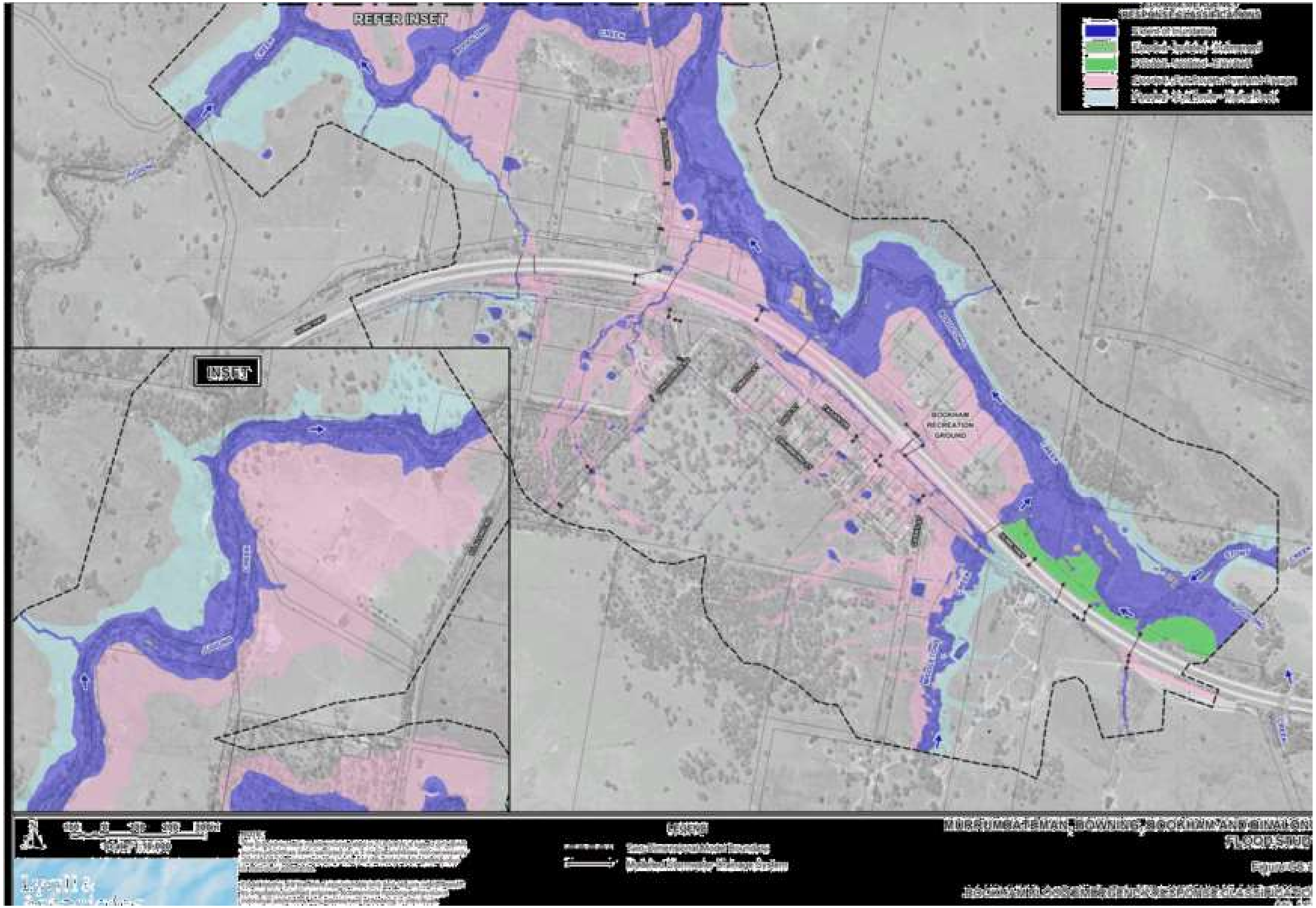
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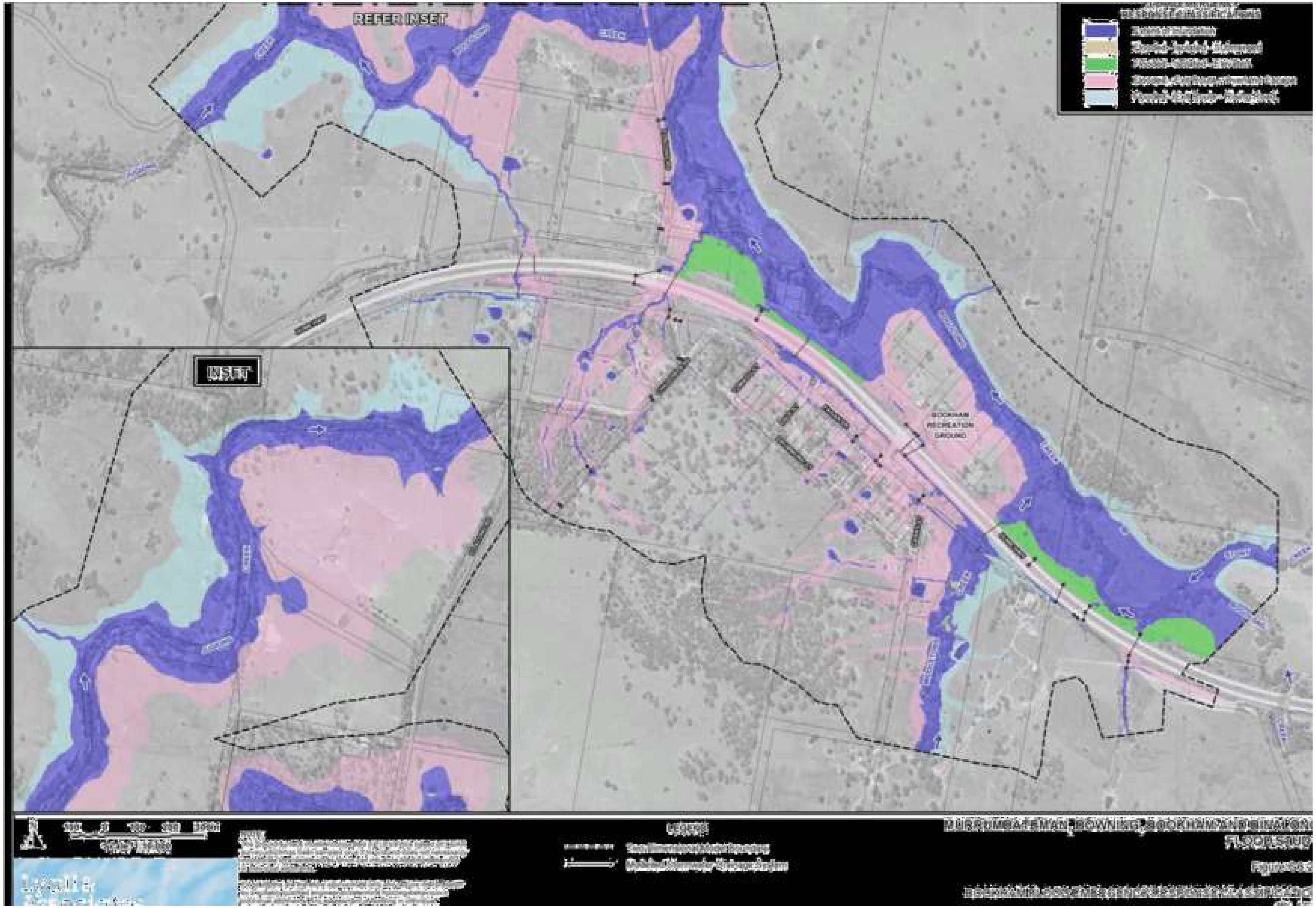
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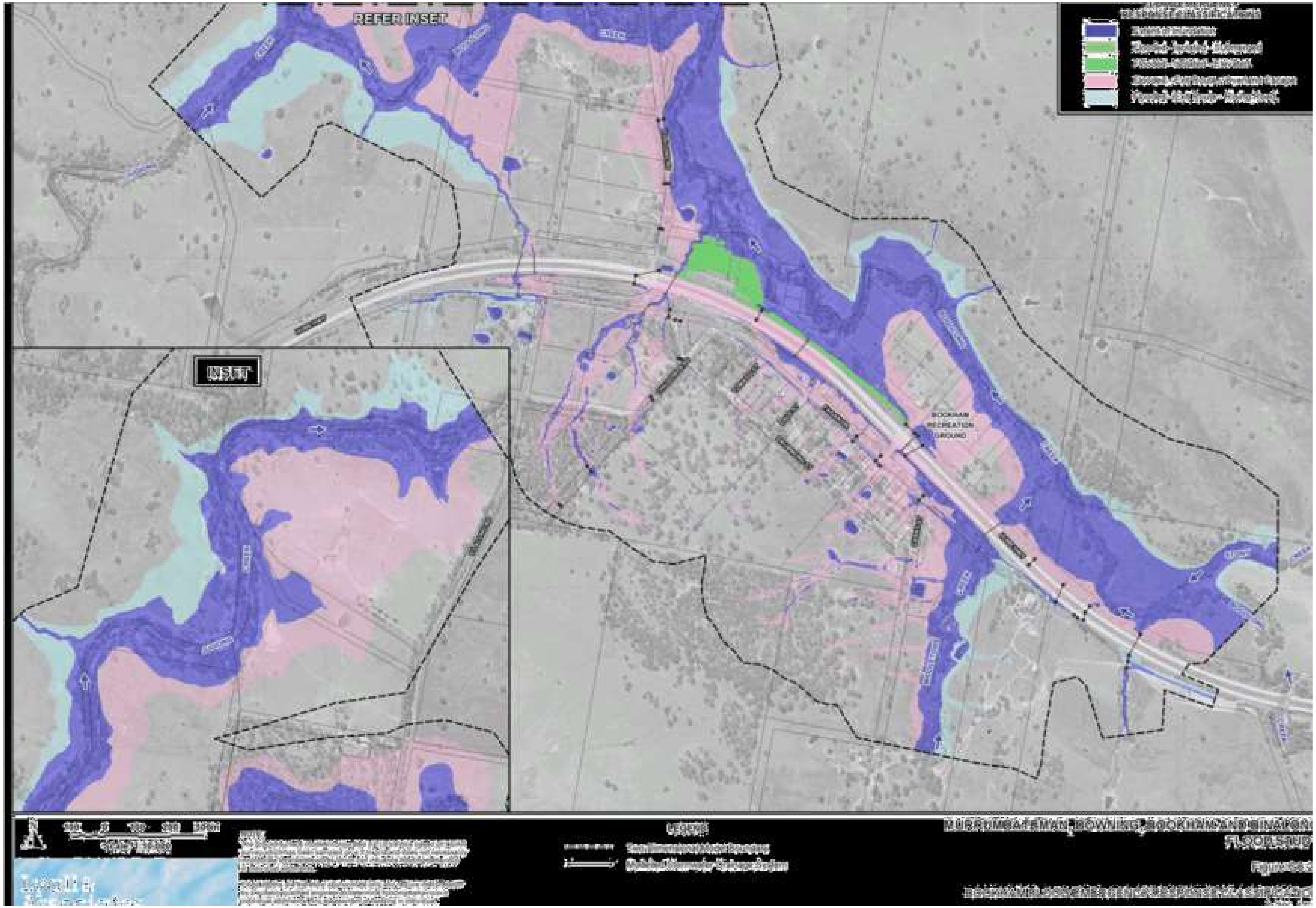
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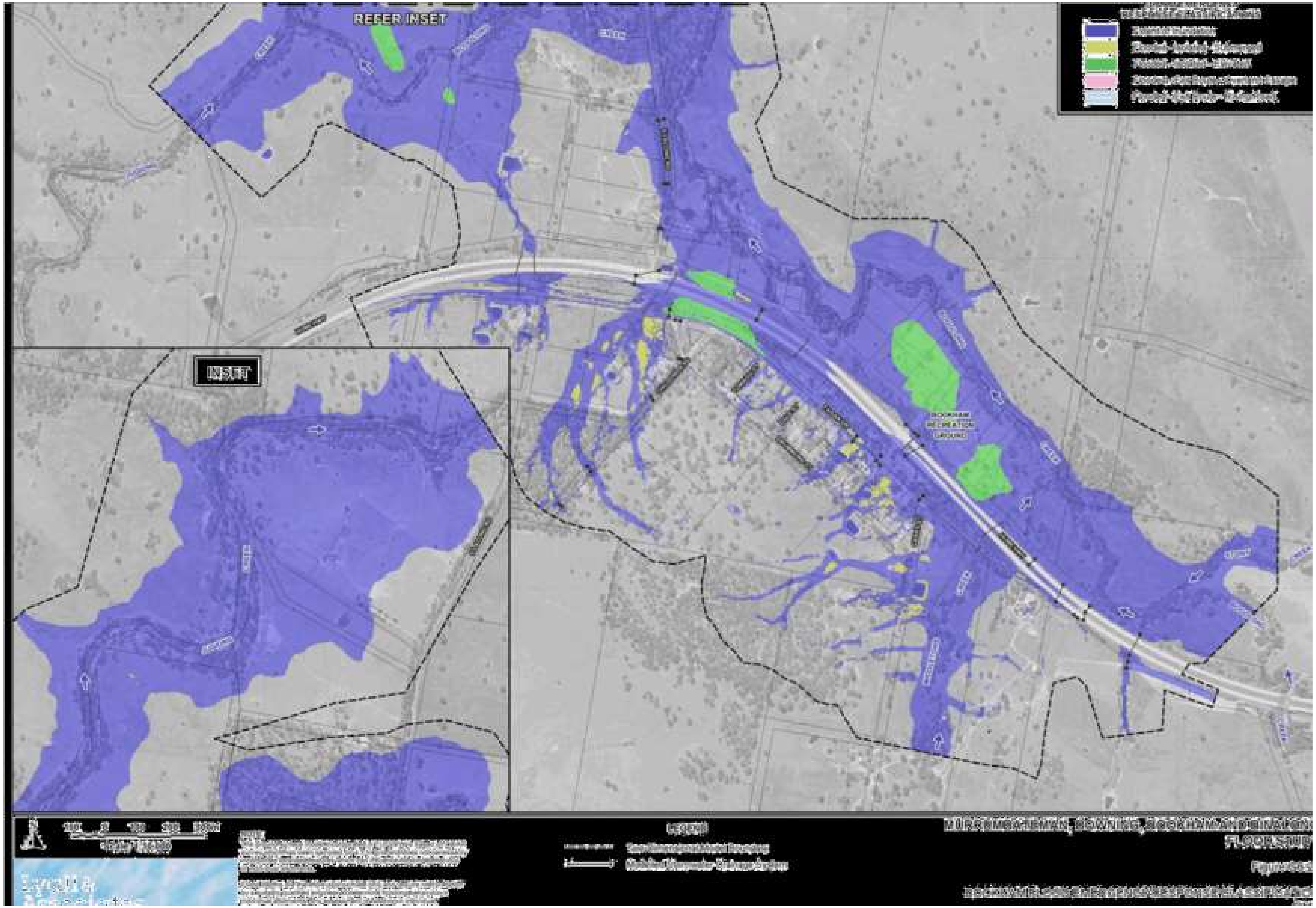
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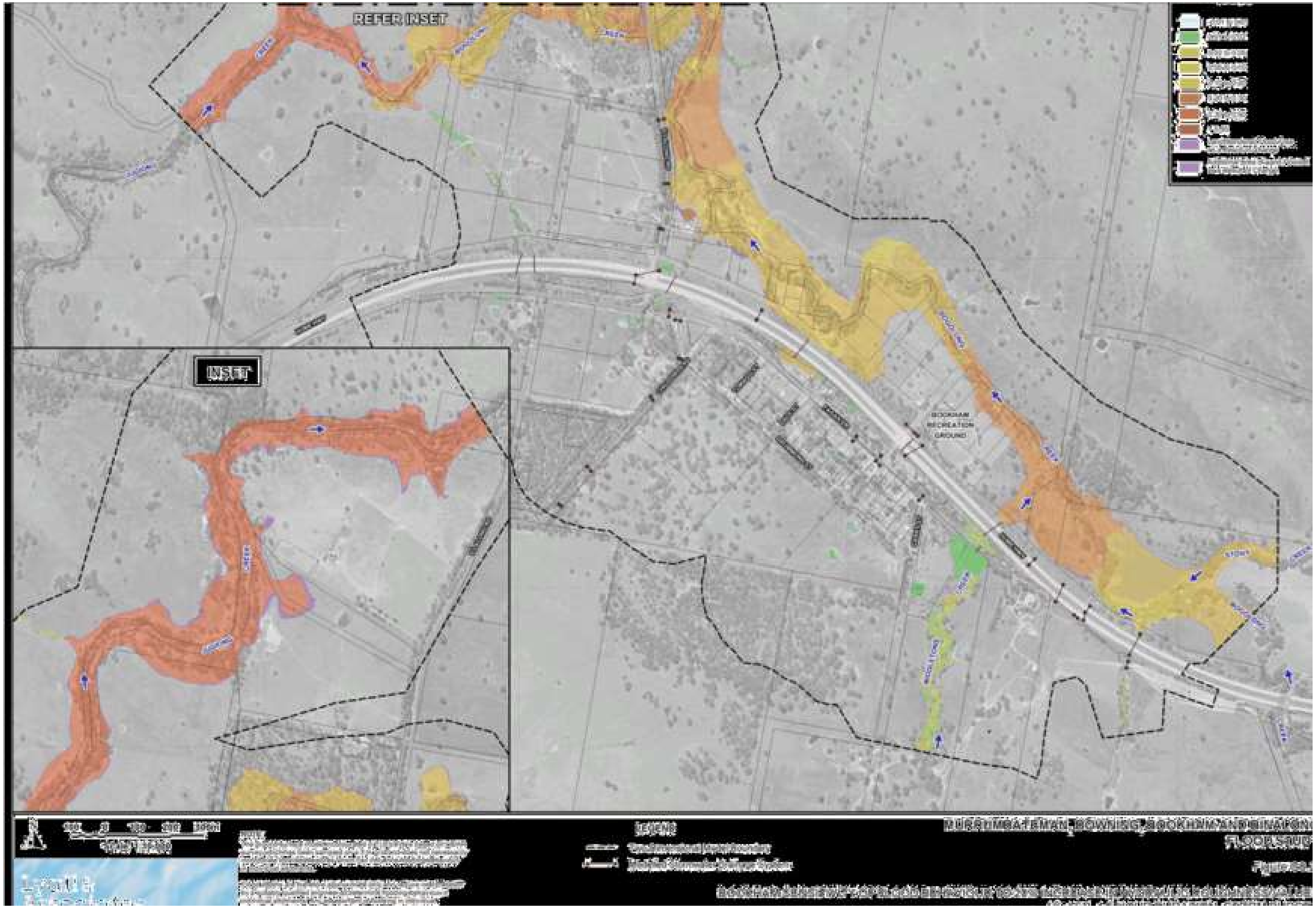
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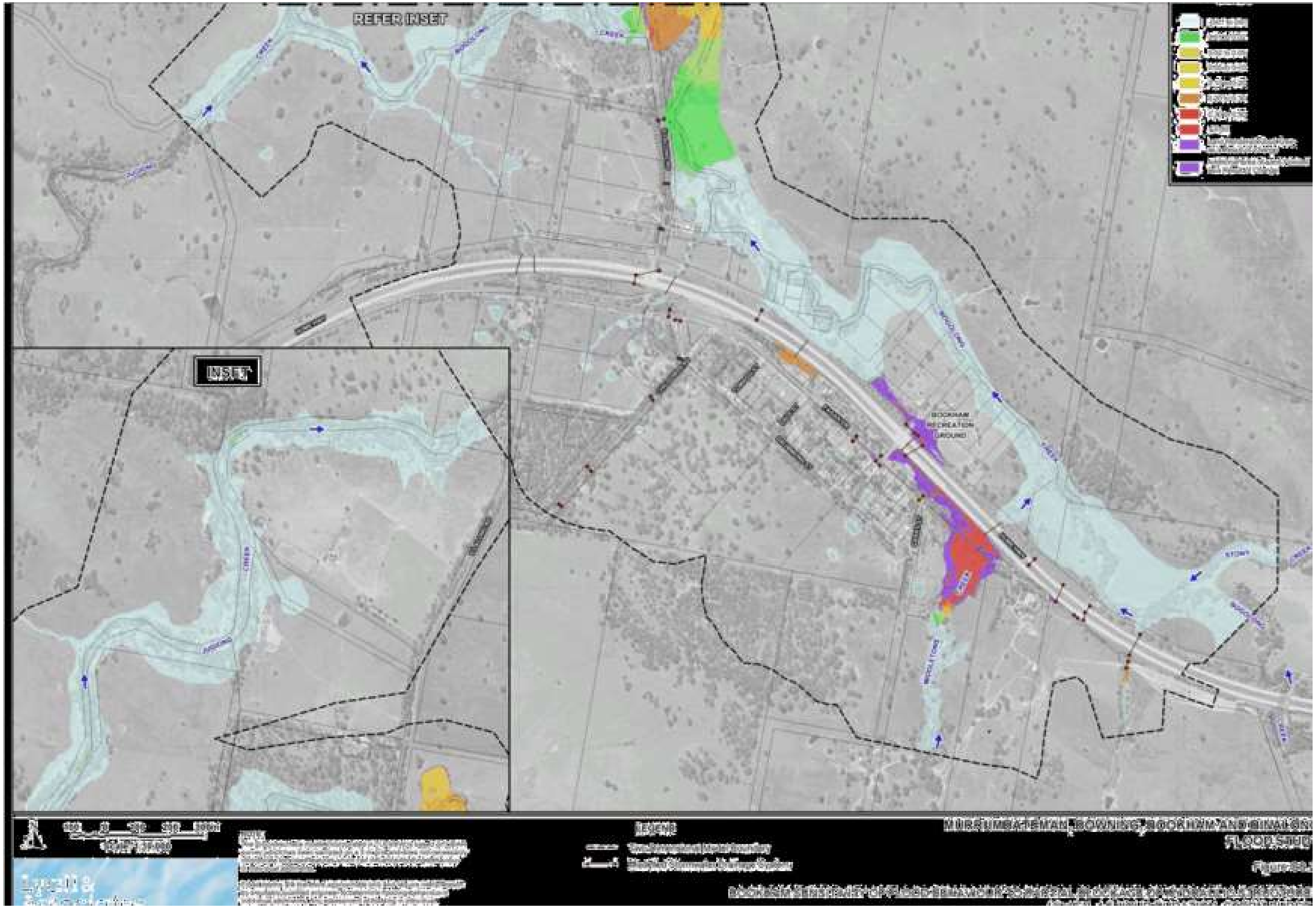
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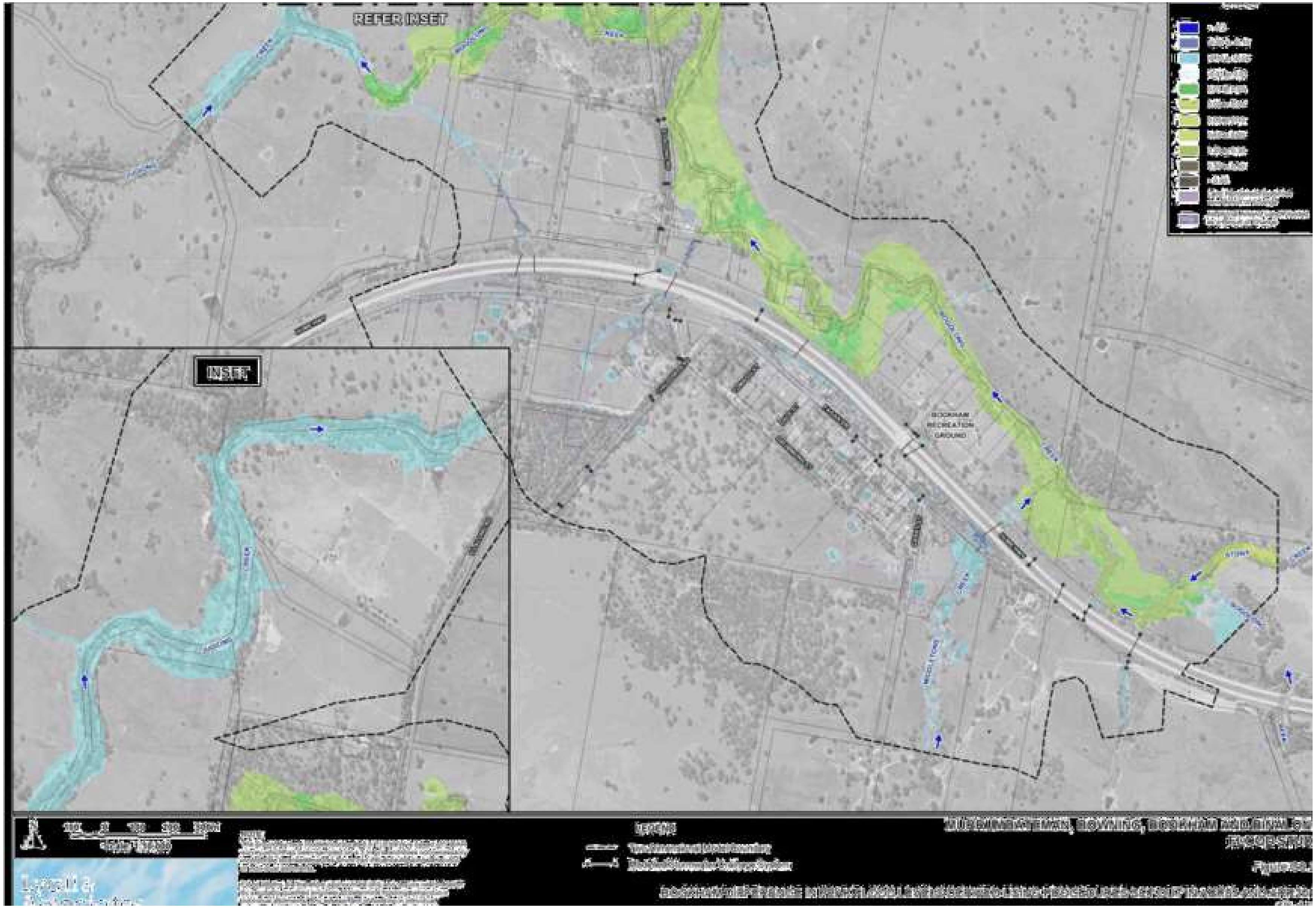
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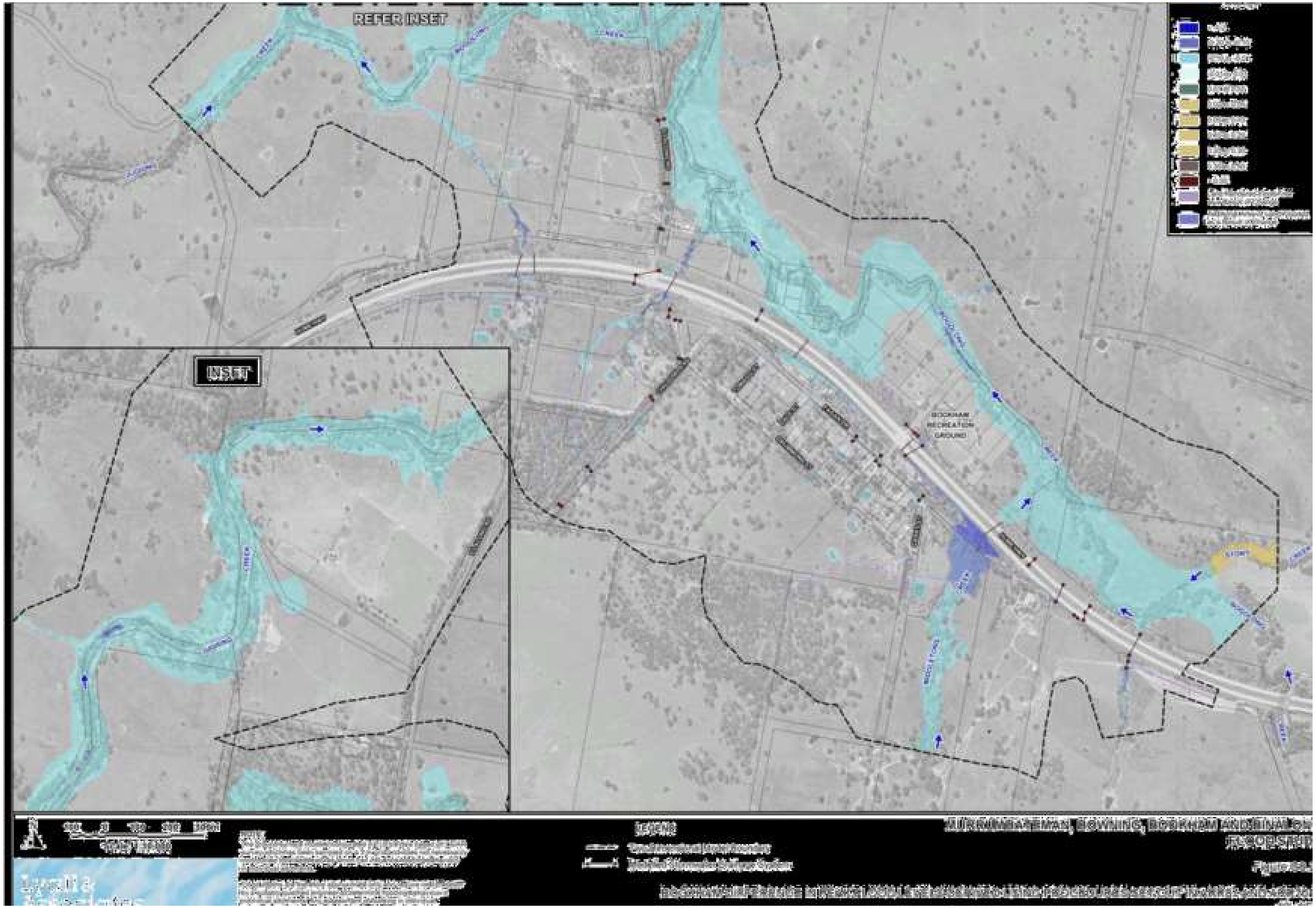
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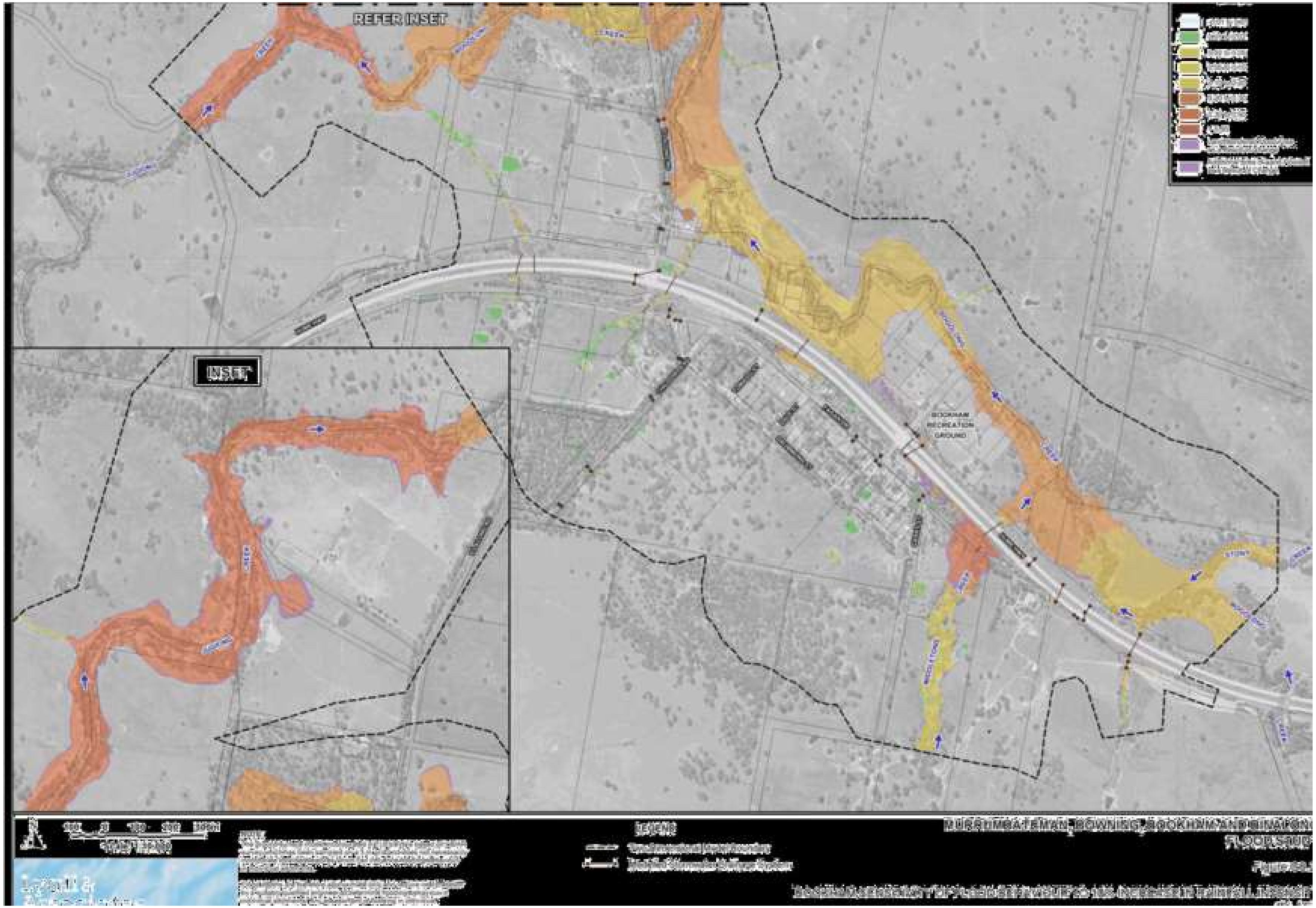
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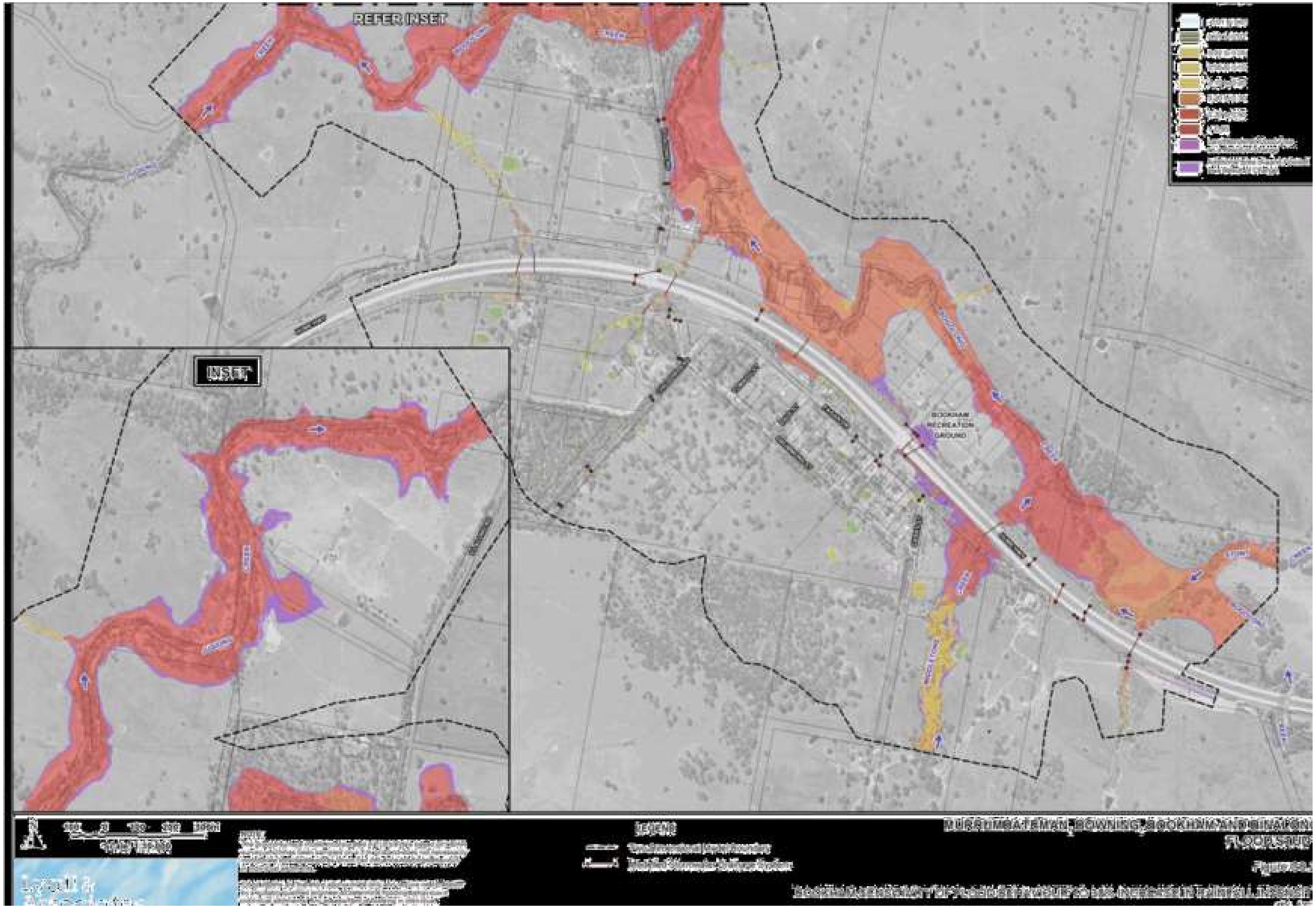
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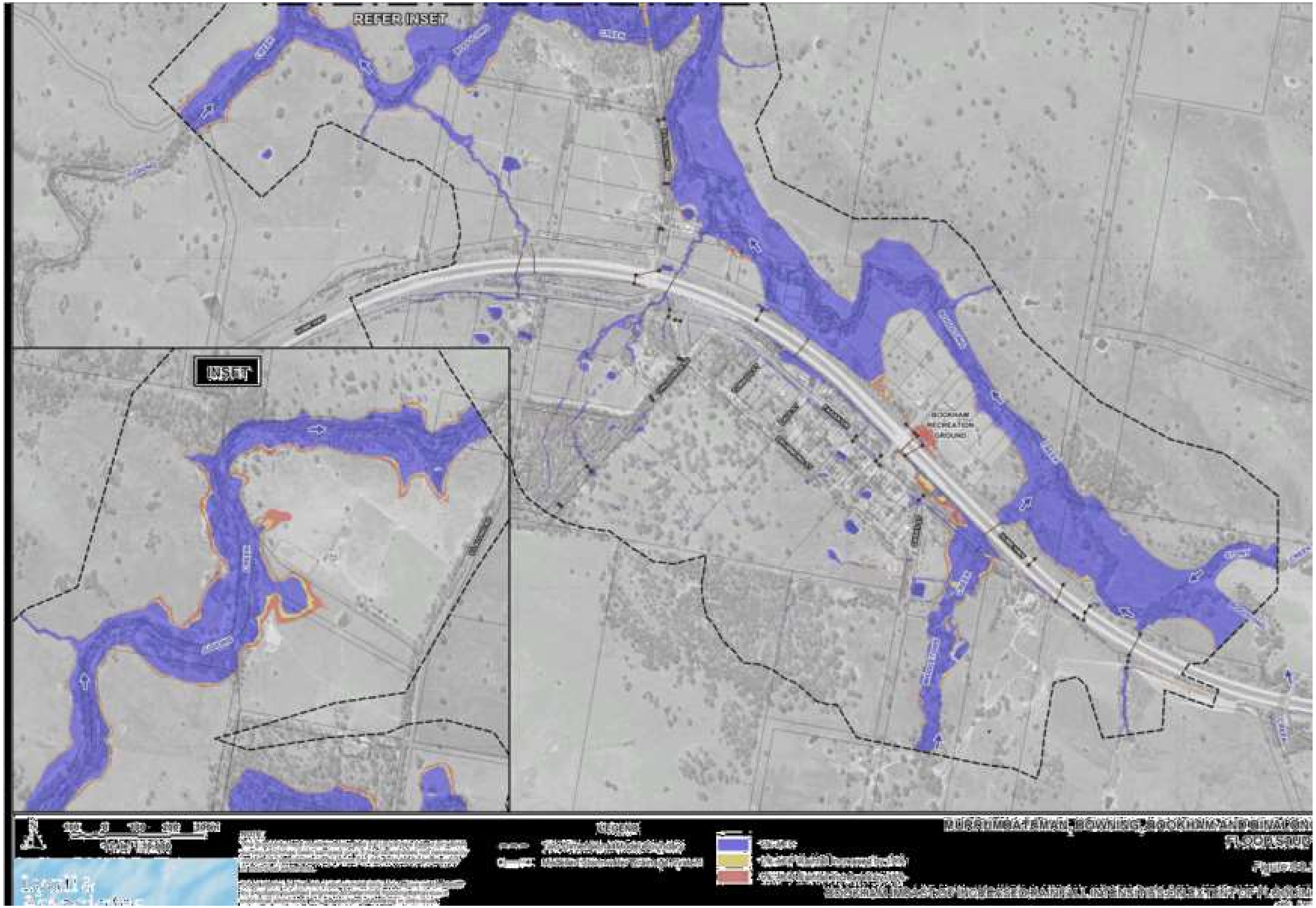
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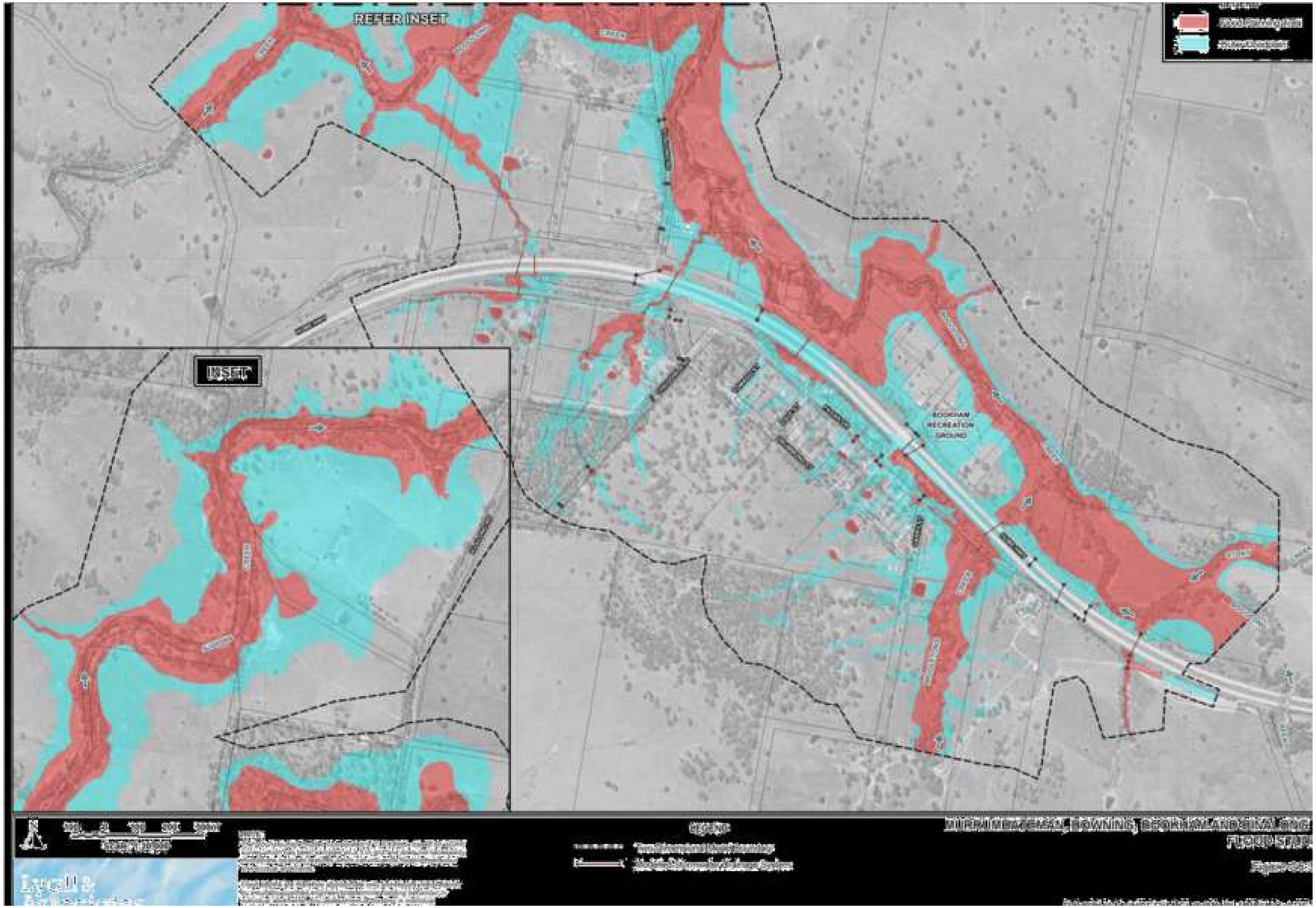
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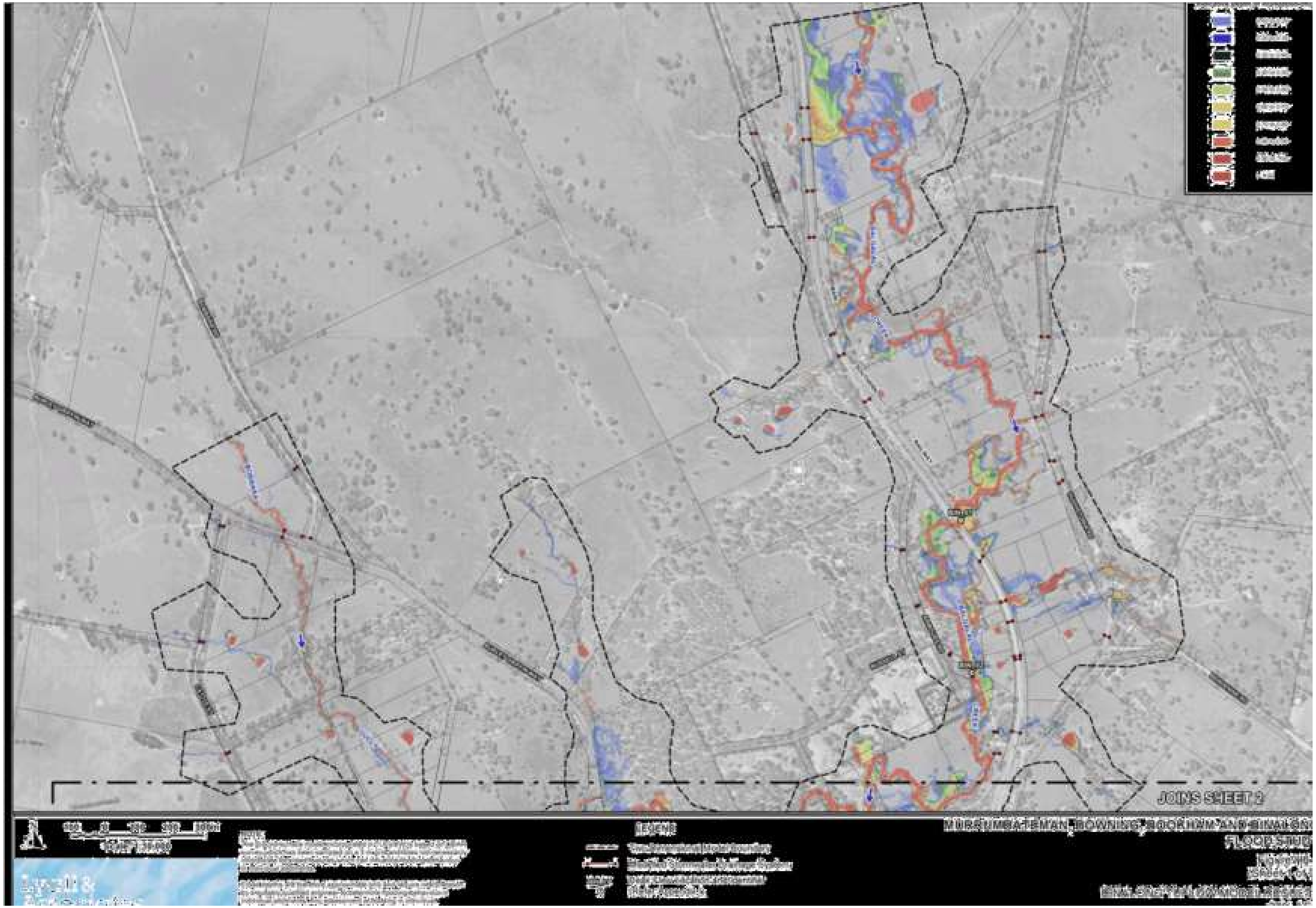
APPENDIX H

HYDRAULIC MODELLING OF DESIGN FLOODS AT BINALONG

LIST OF FIGURES (APPENDIX H)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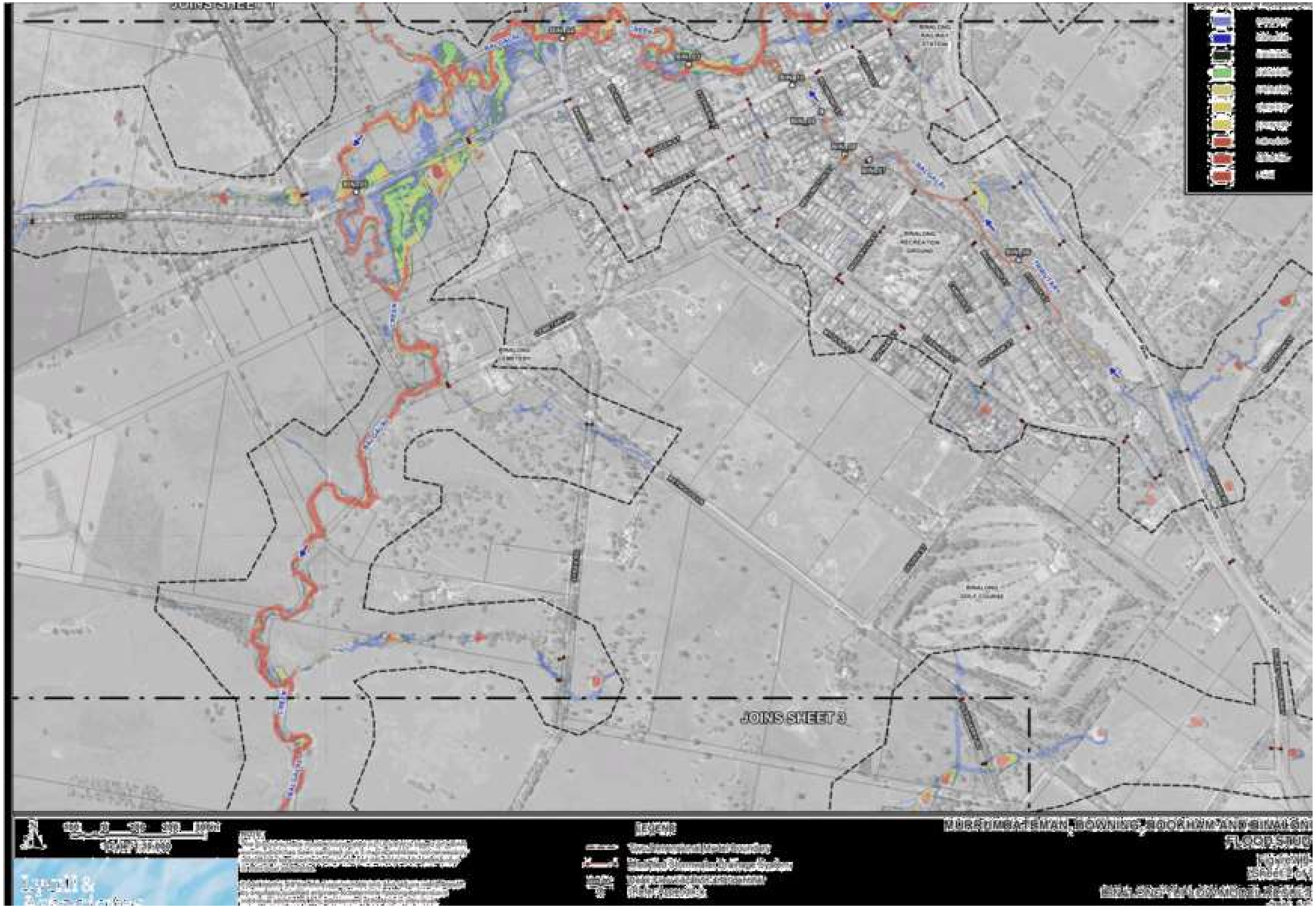
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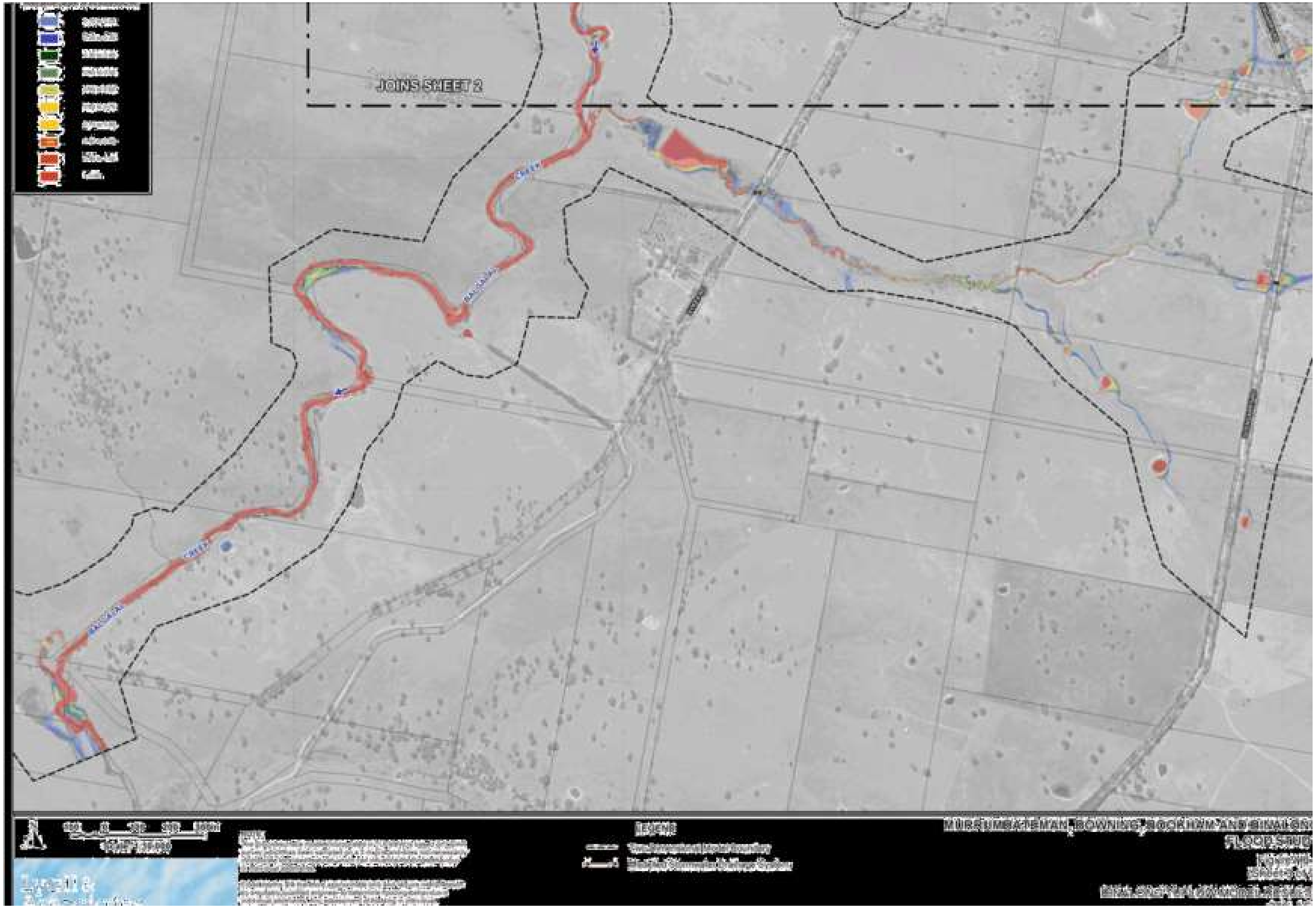
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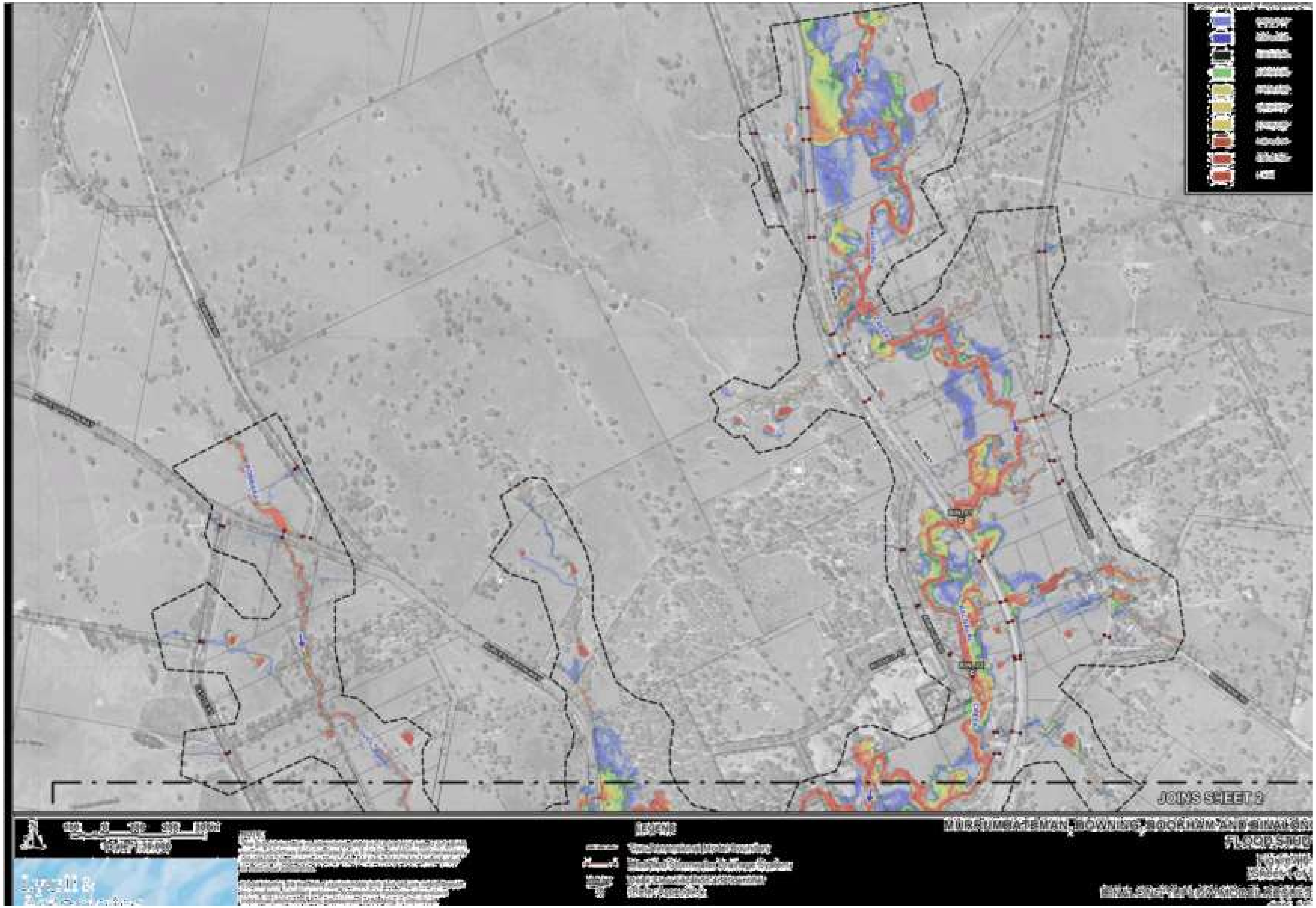
FLOOD STUDY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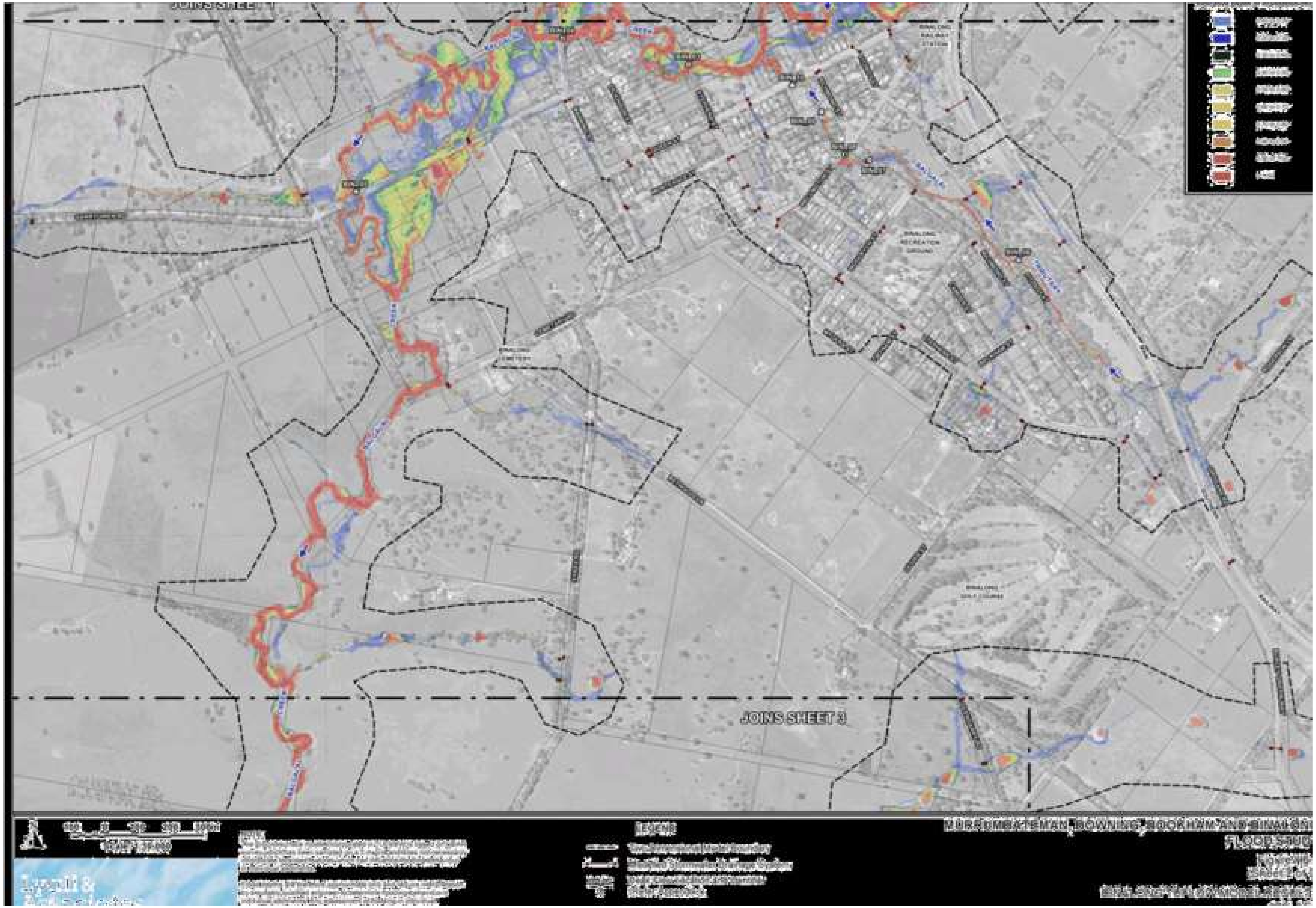
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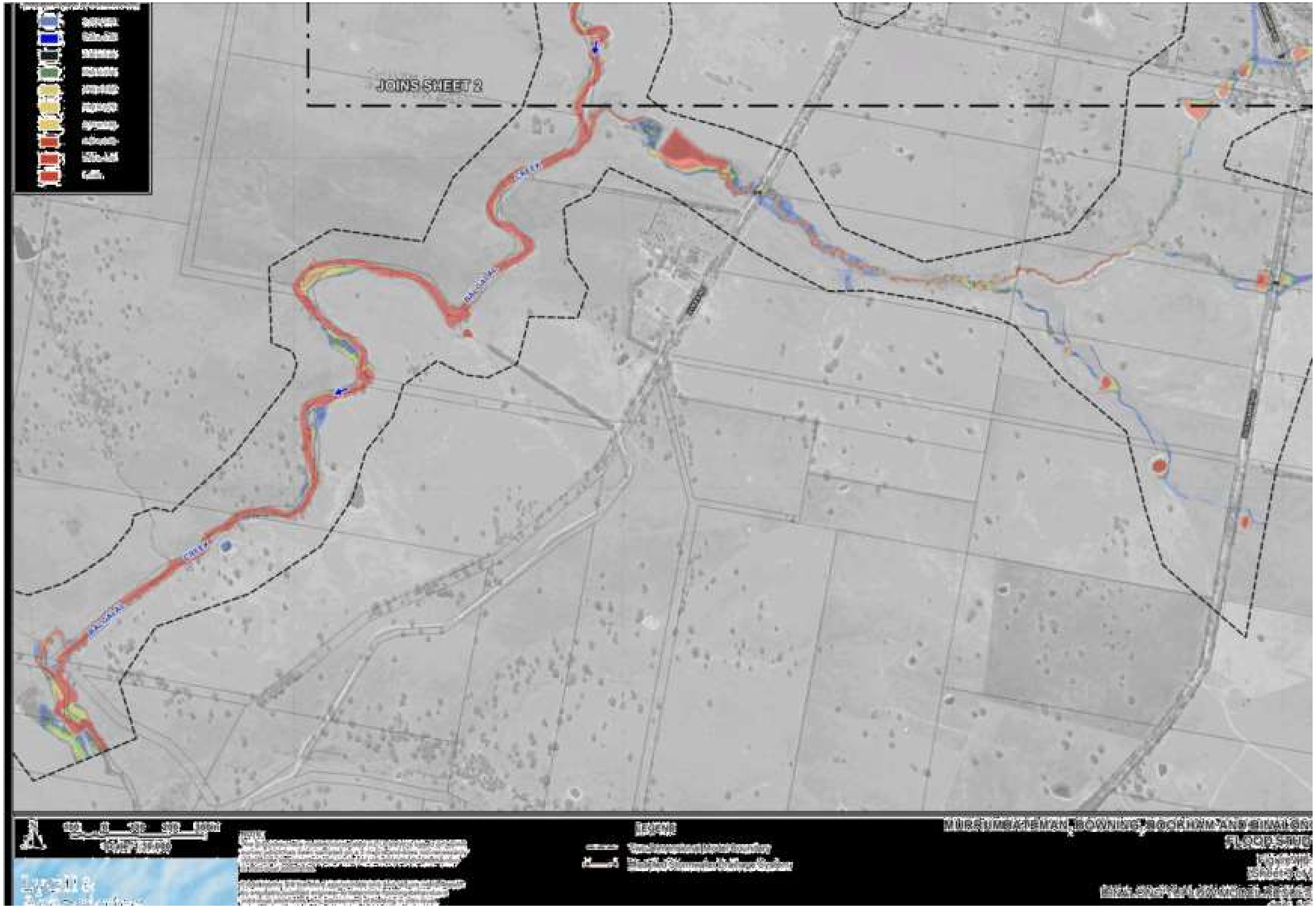
BINALONG RECREATION GROUND
BINALONG GOLF COURSE
LEGEND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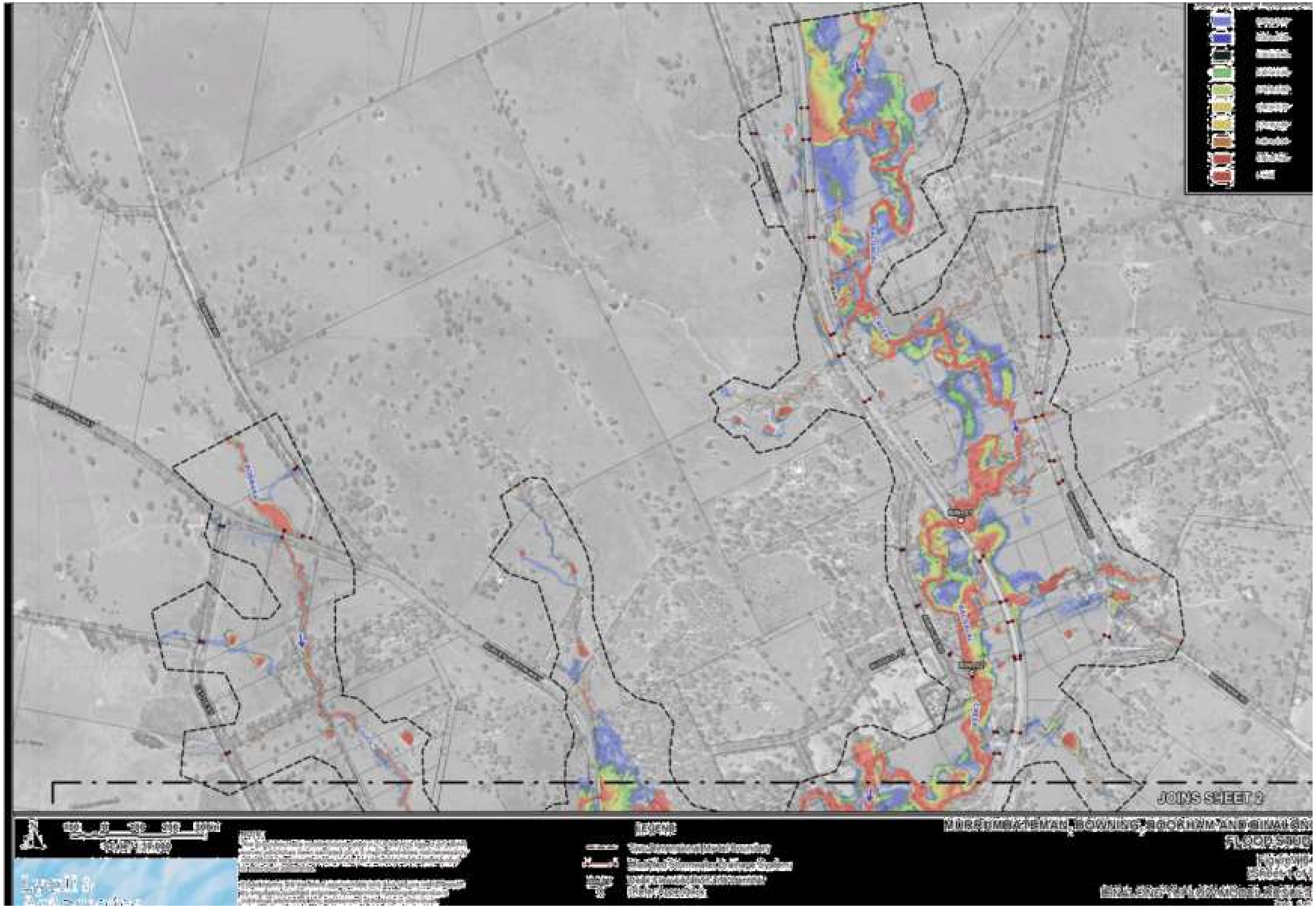
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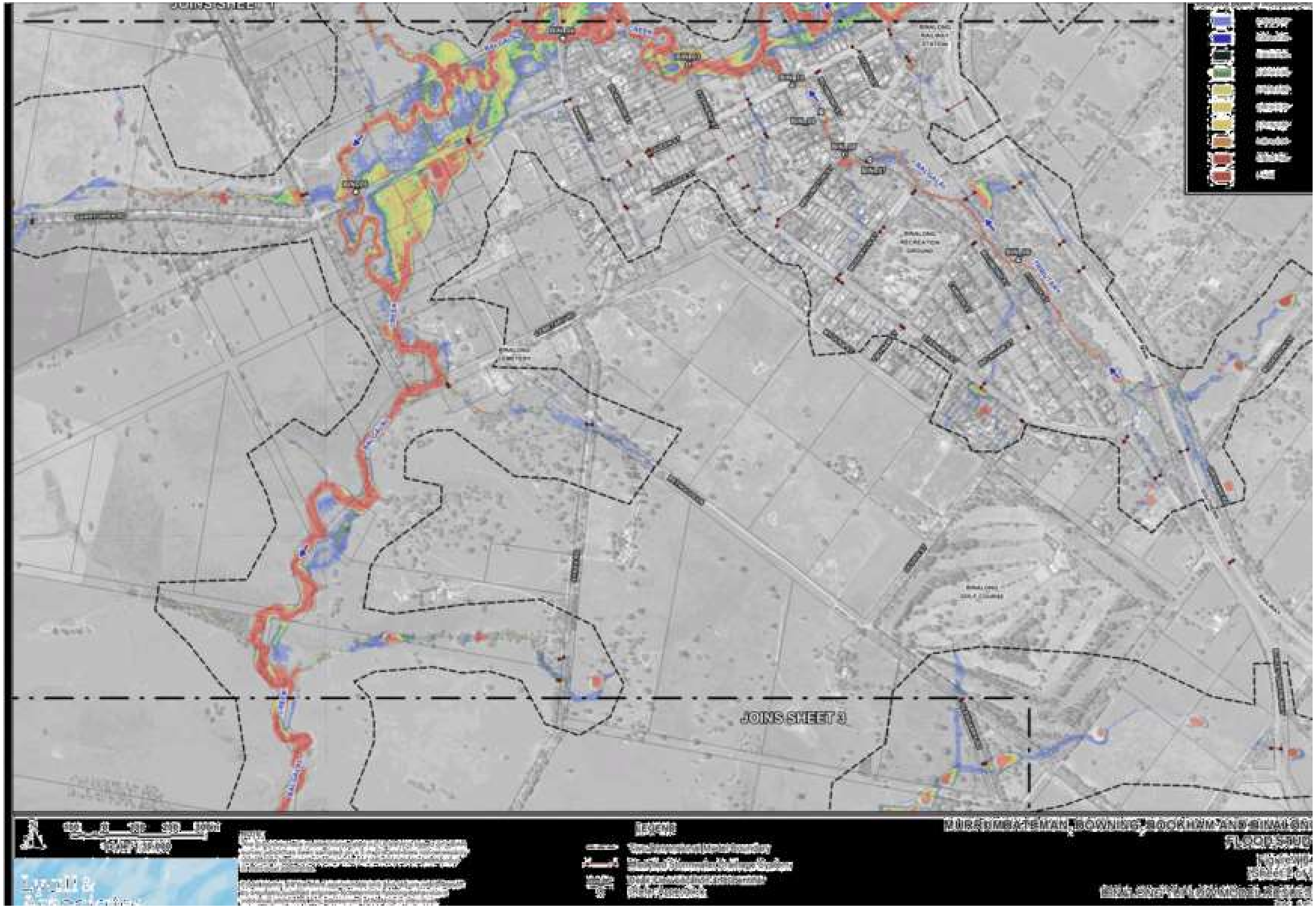
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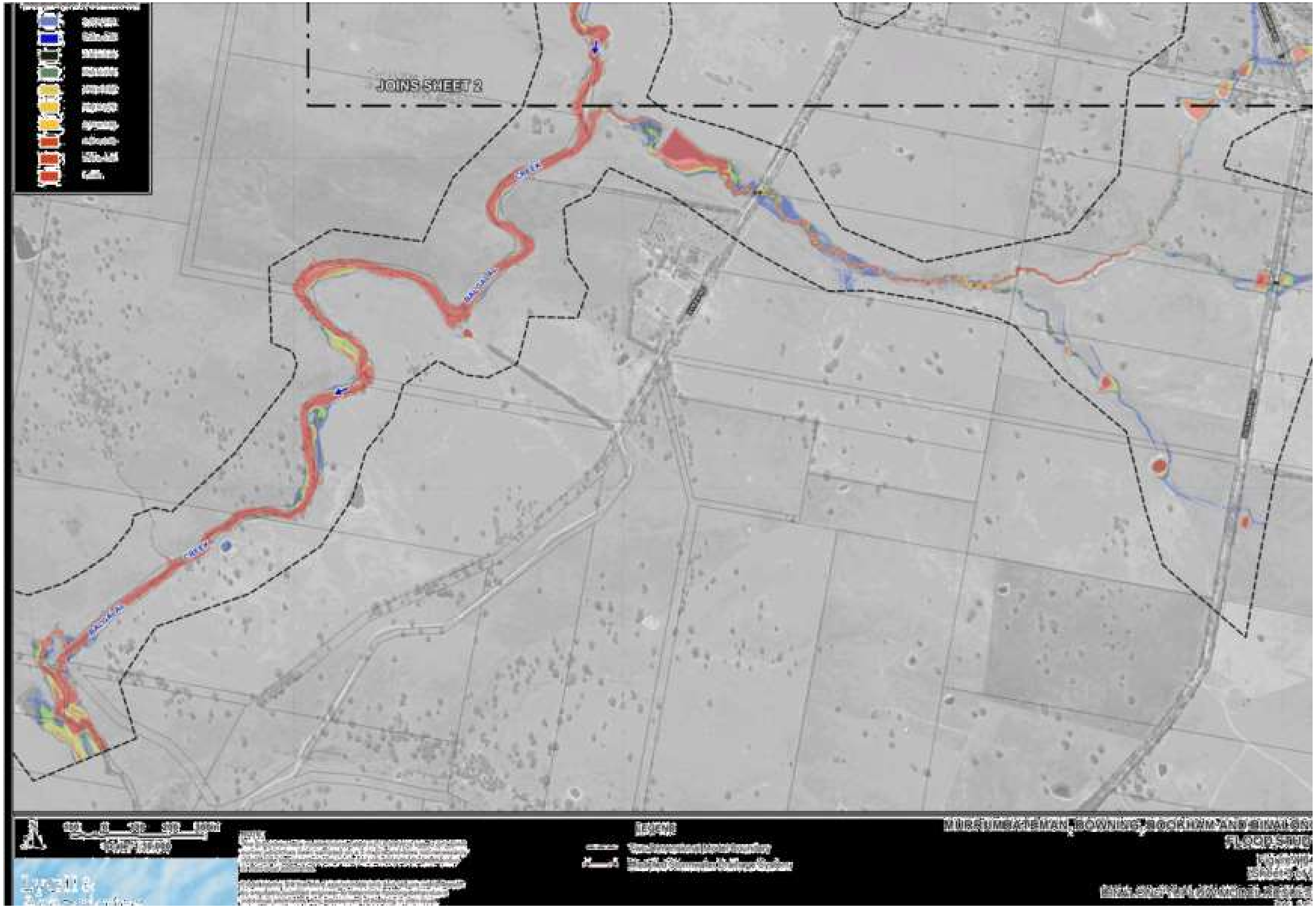
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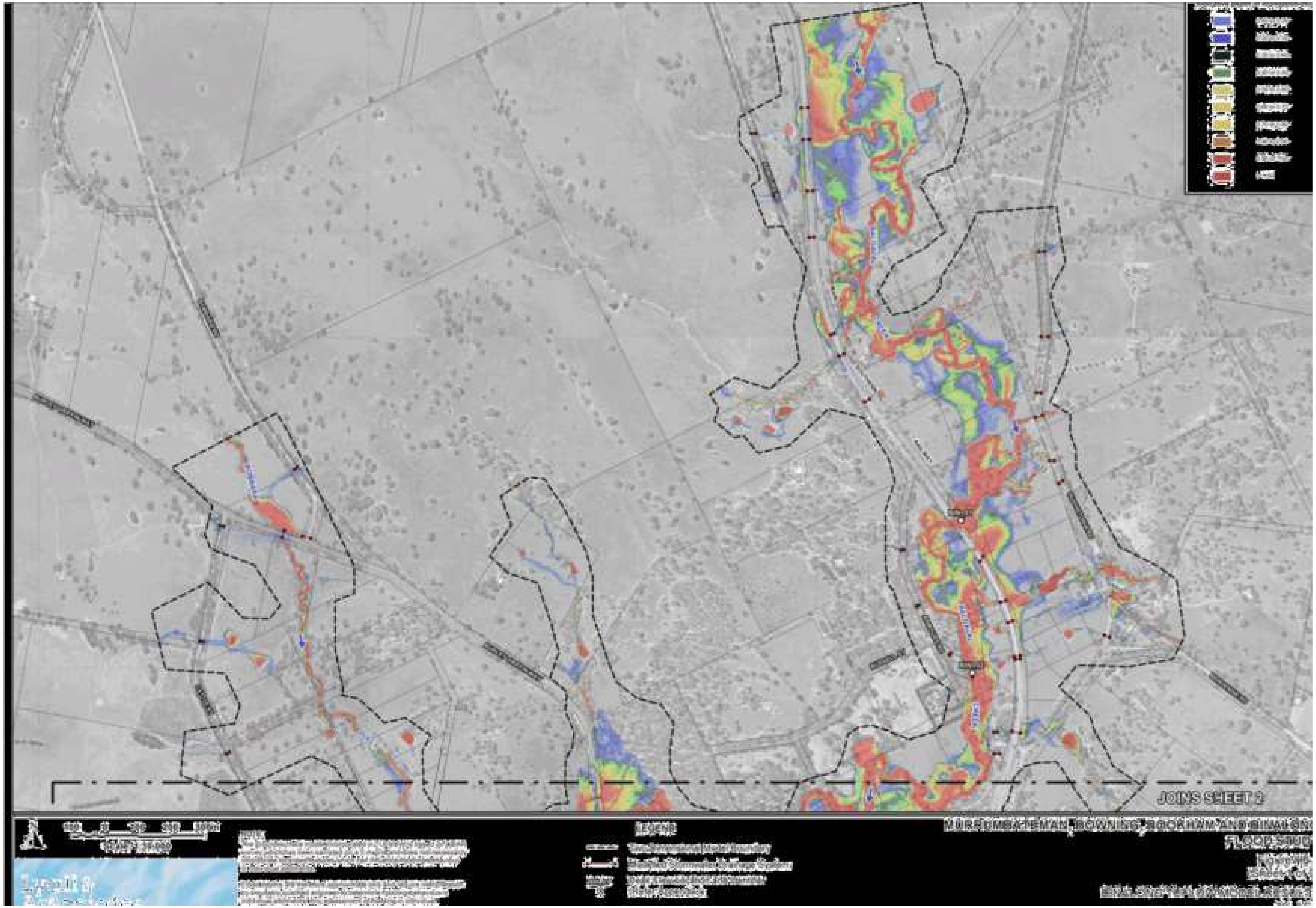
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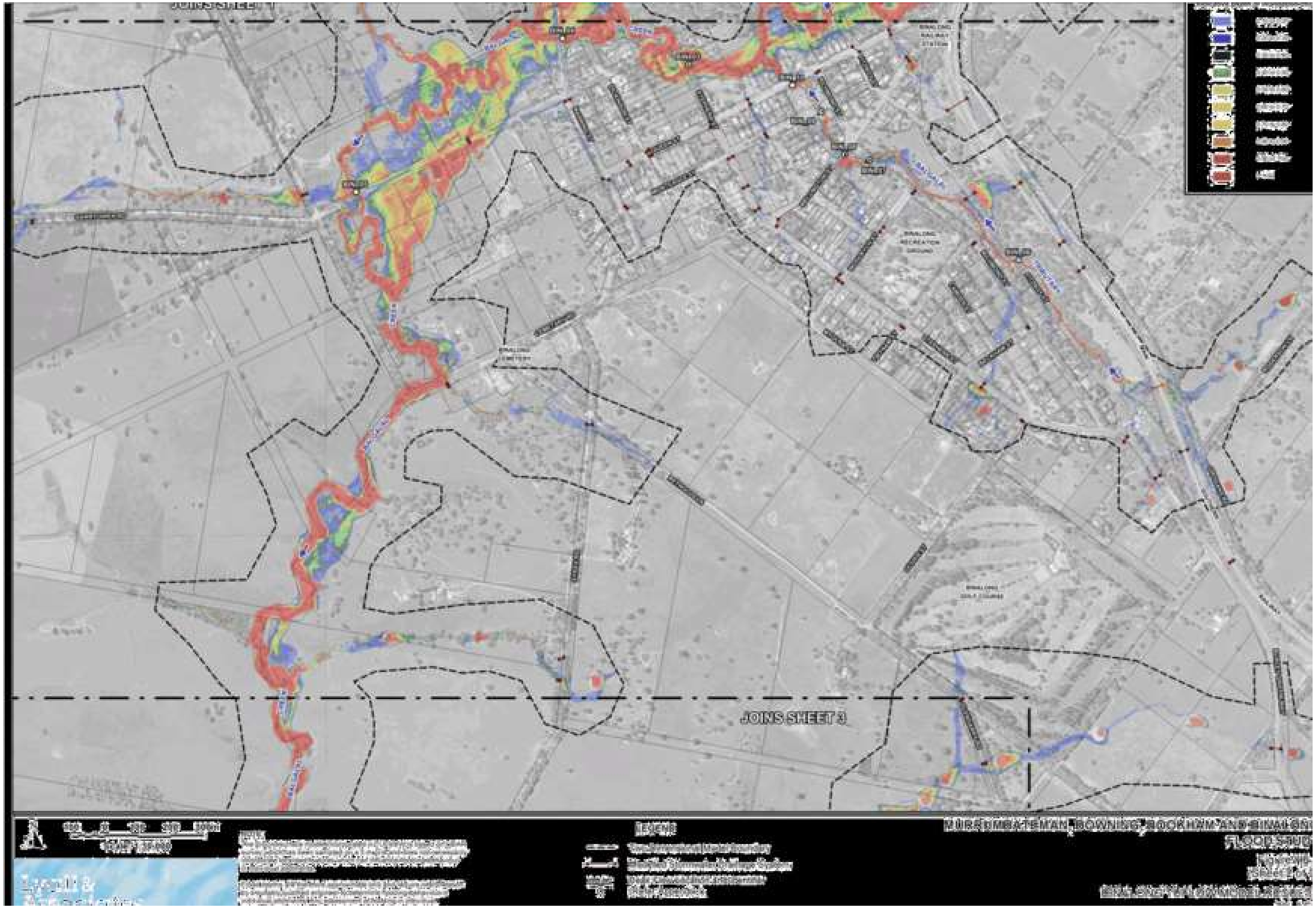
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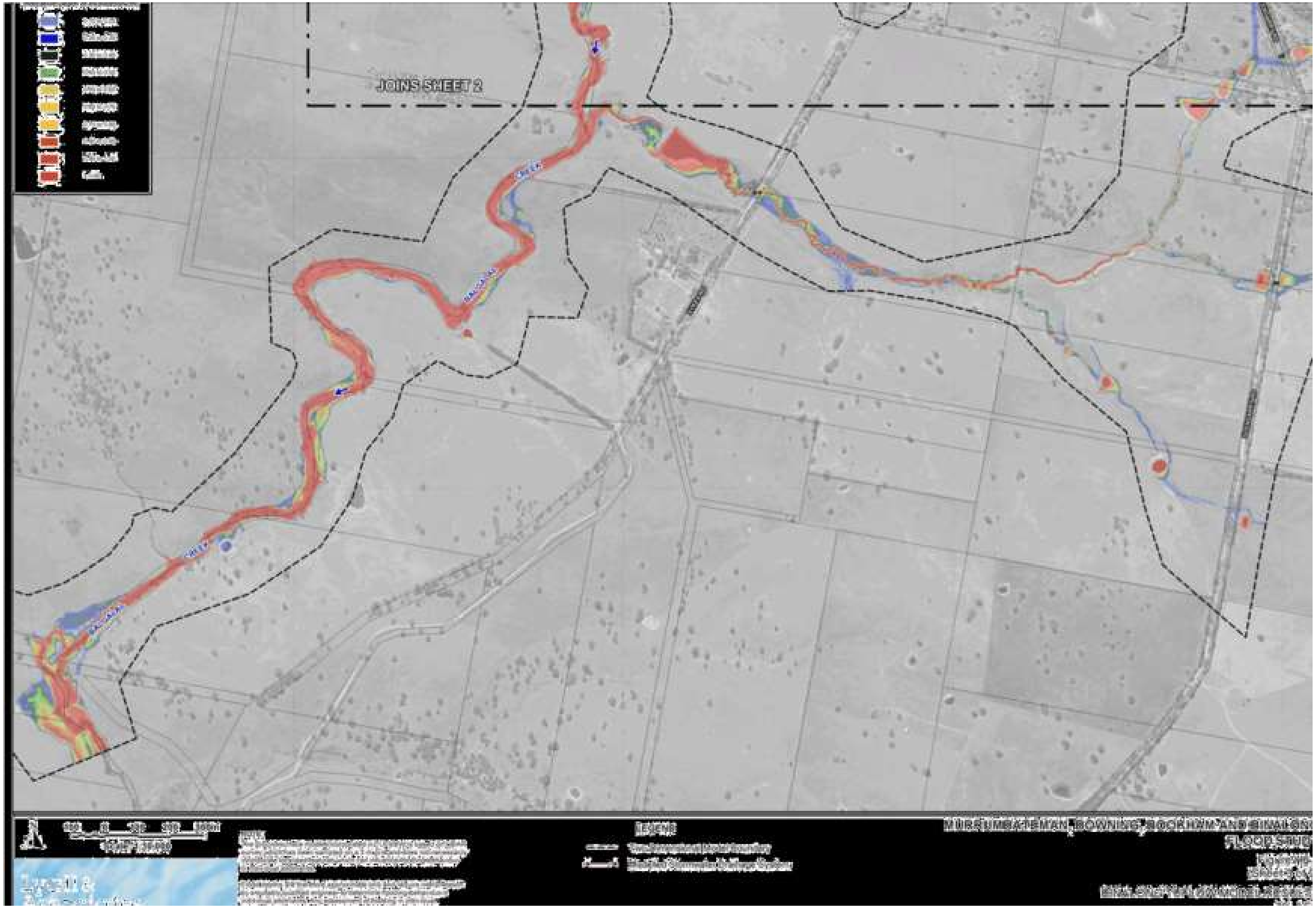
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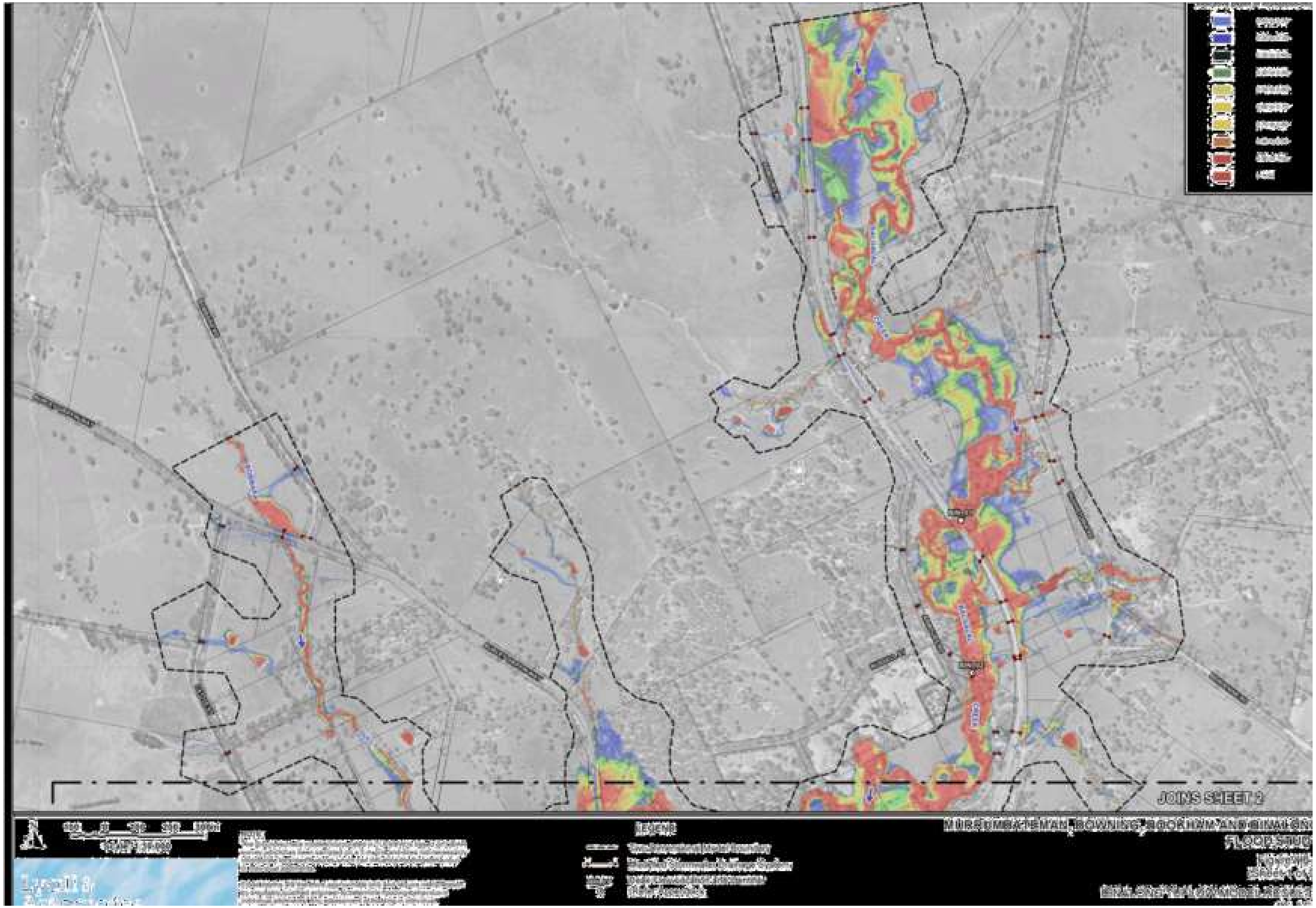
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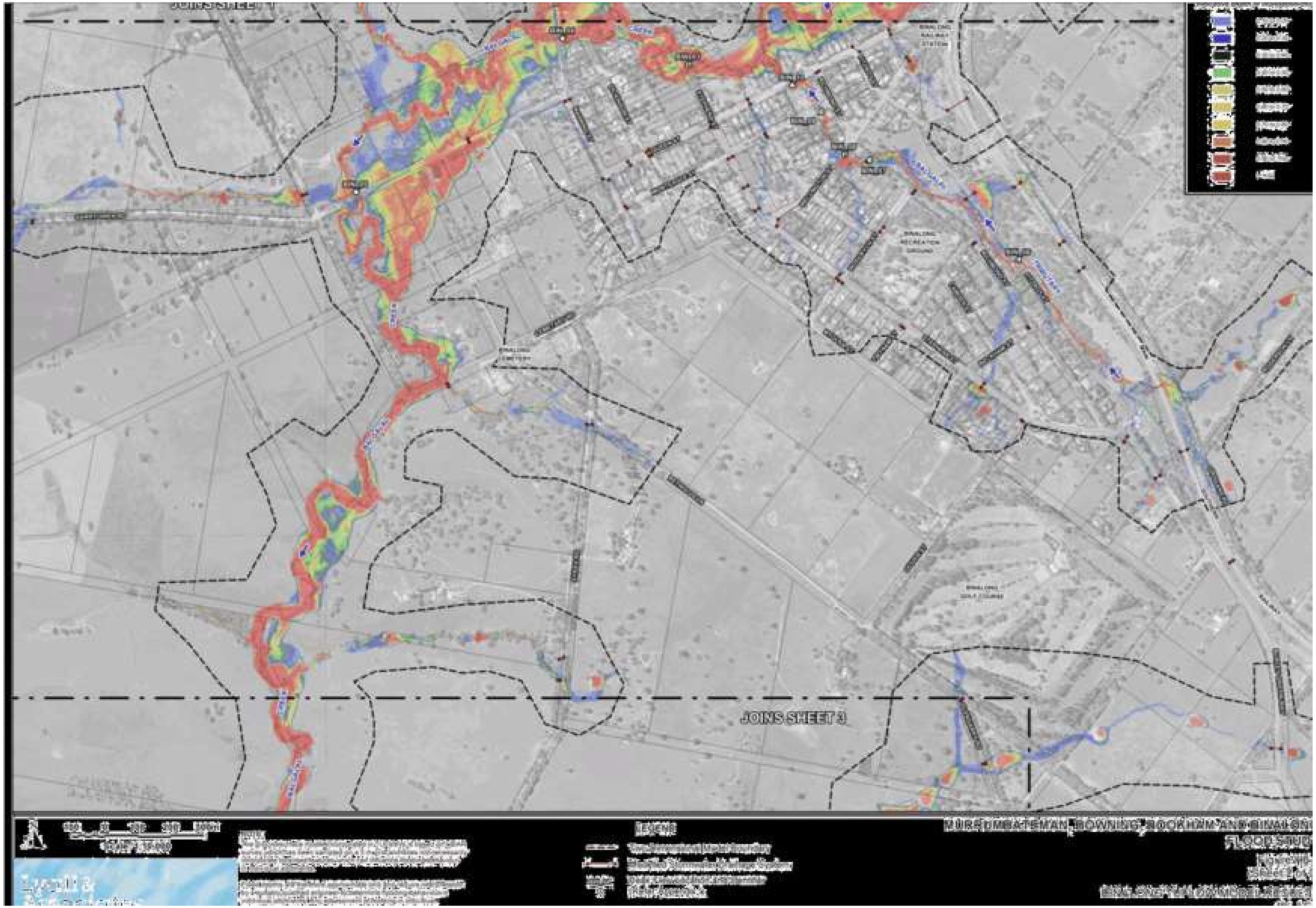
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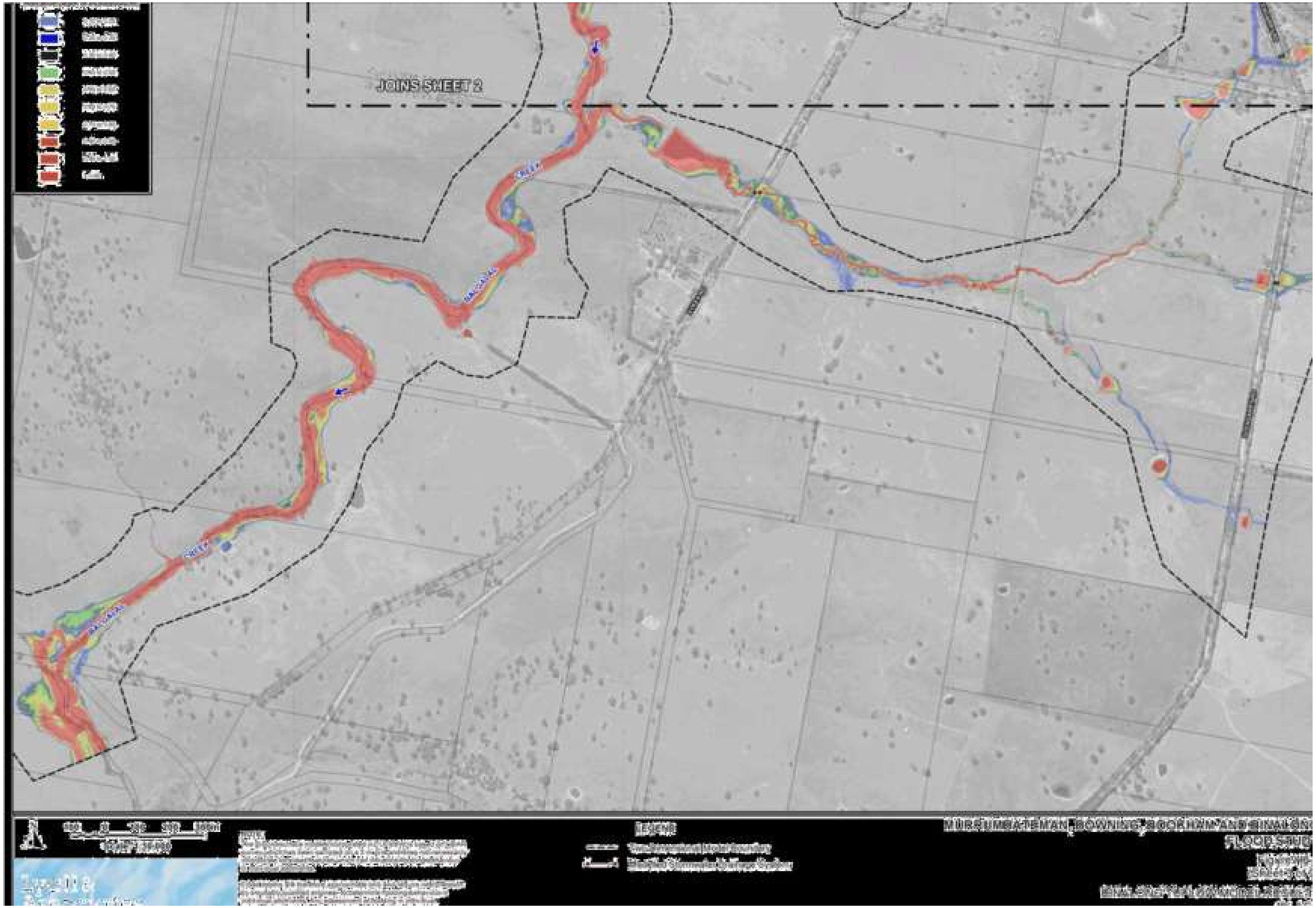
BINALONG RECREATION GROUND
BINALONG GOLF COURSE
LEGEND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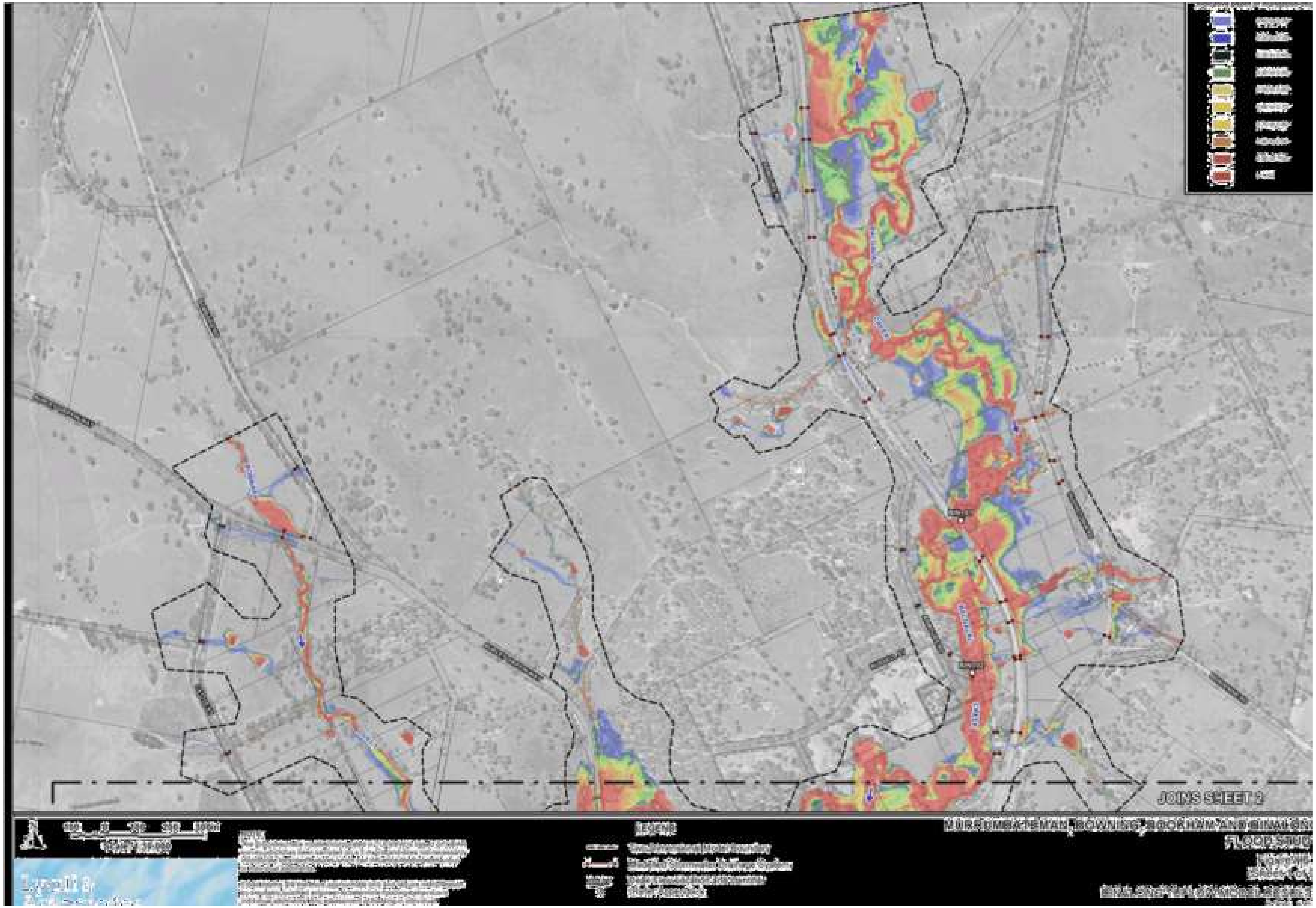
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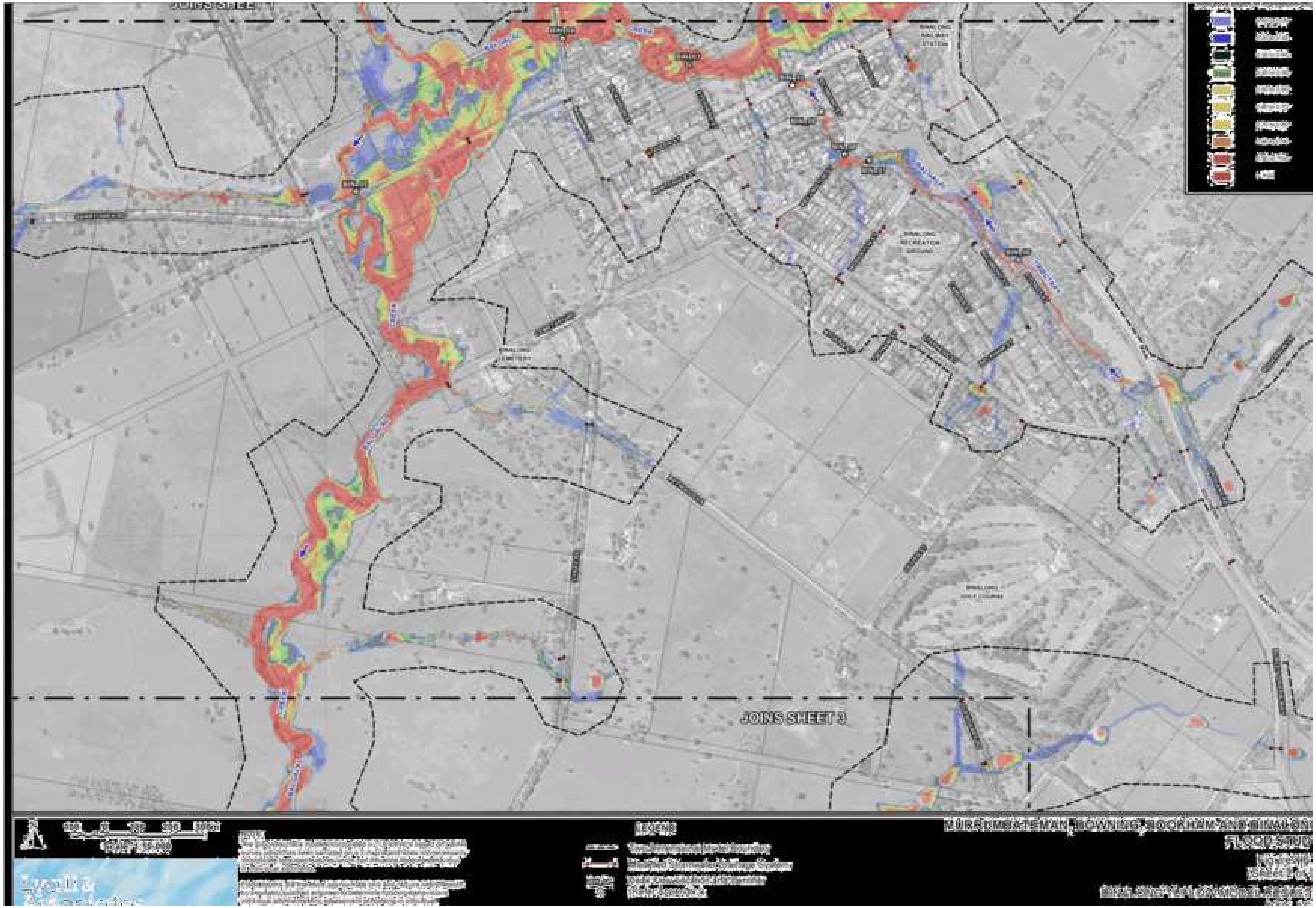
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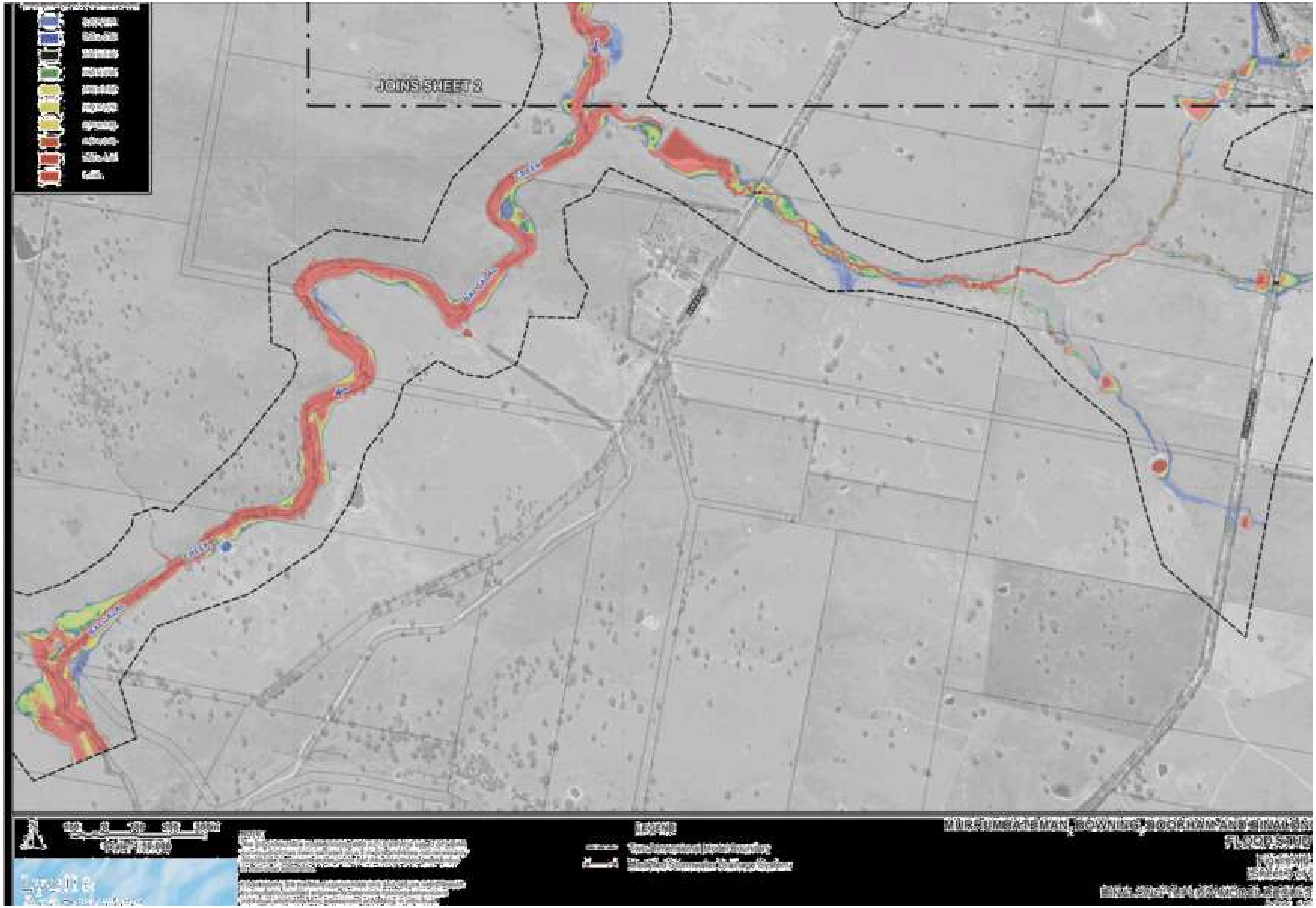
BINALONG RECREATION GROUND
BINALONG GOLF COURSE
FLOOD STUDY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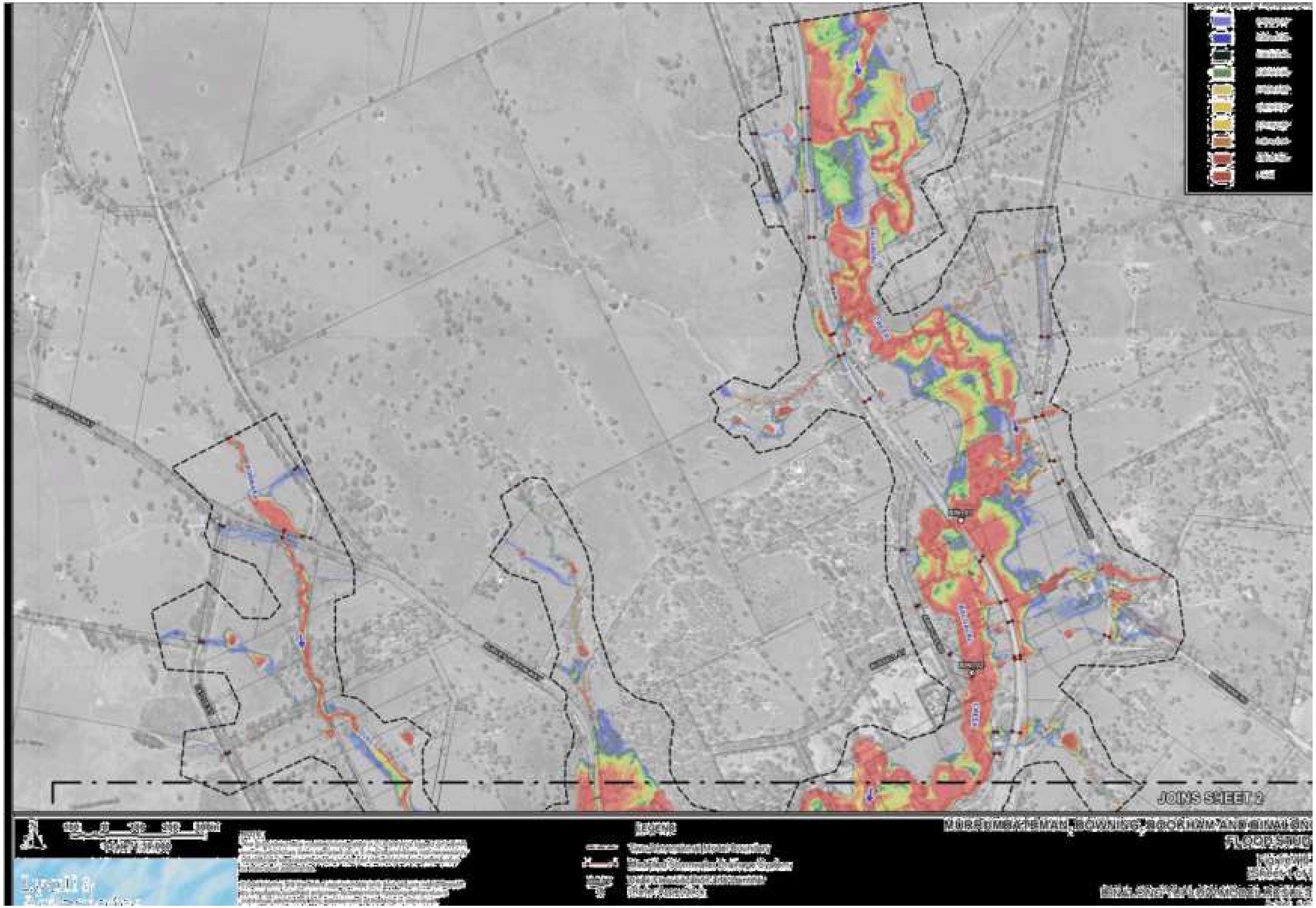
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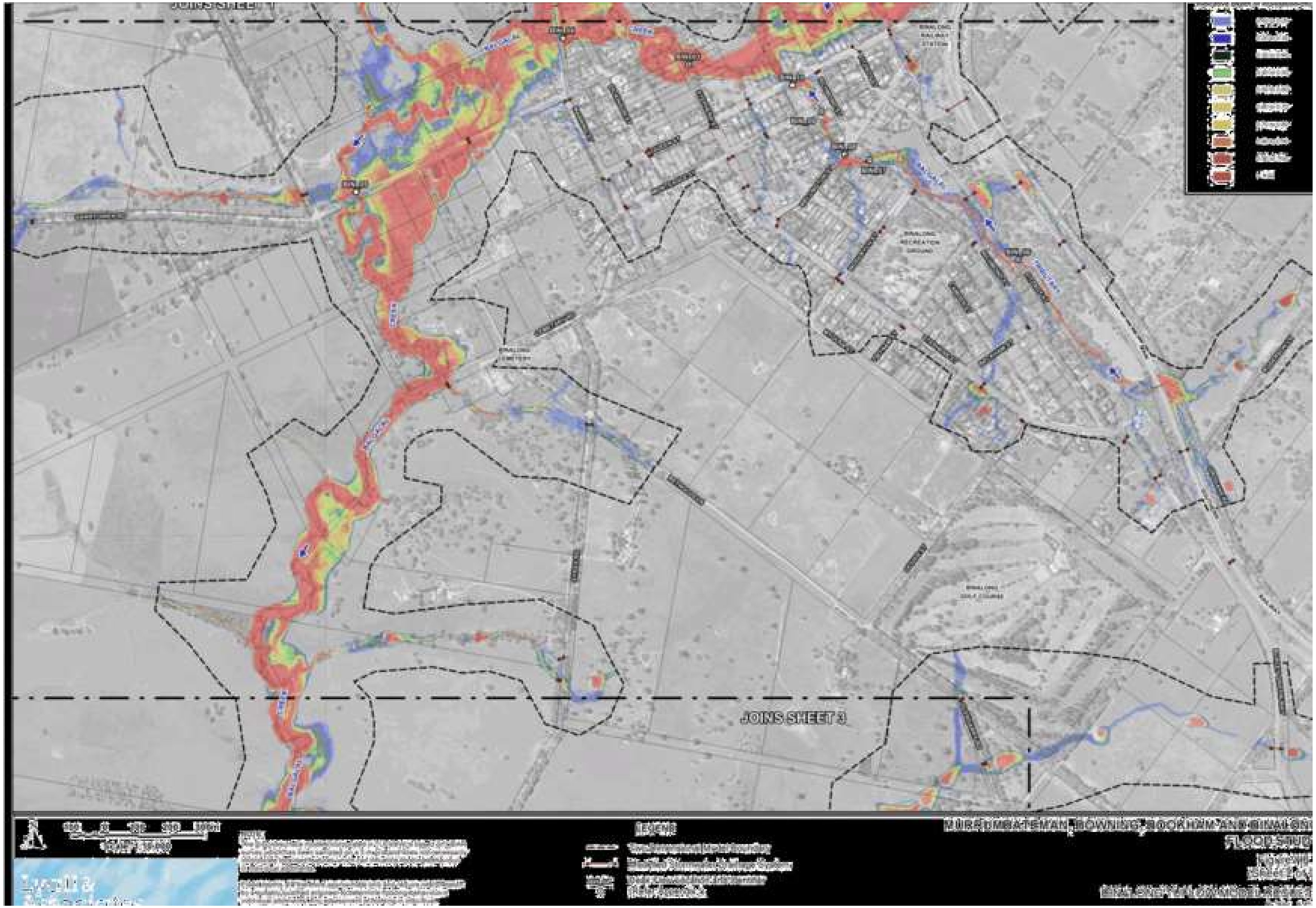
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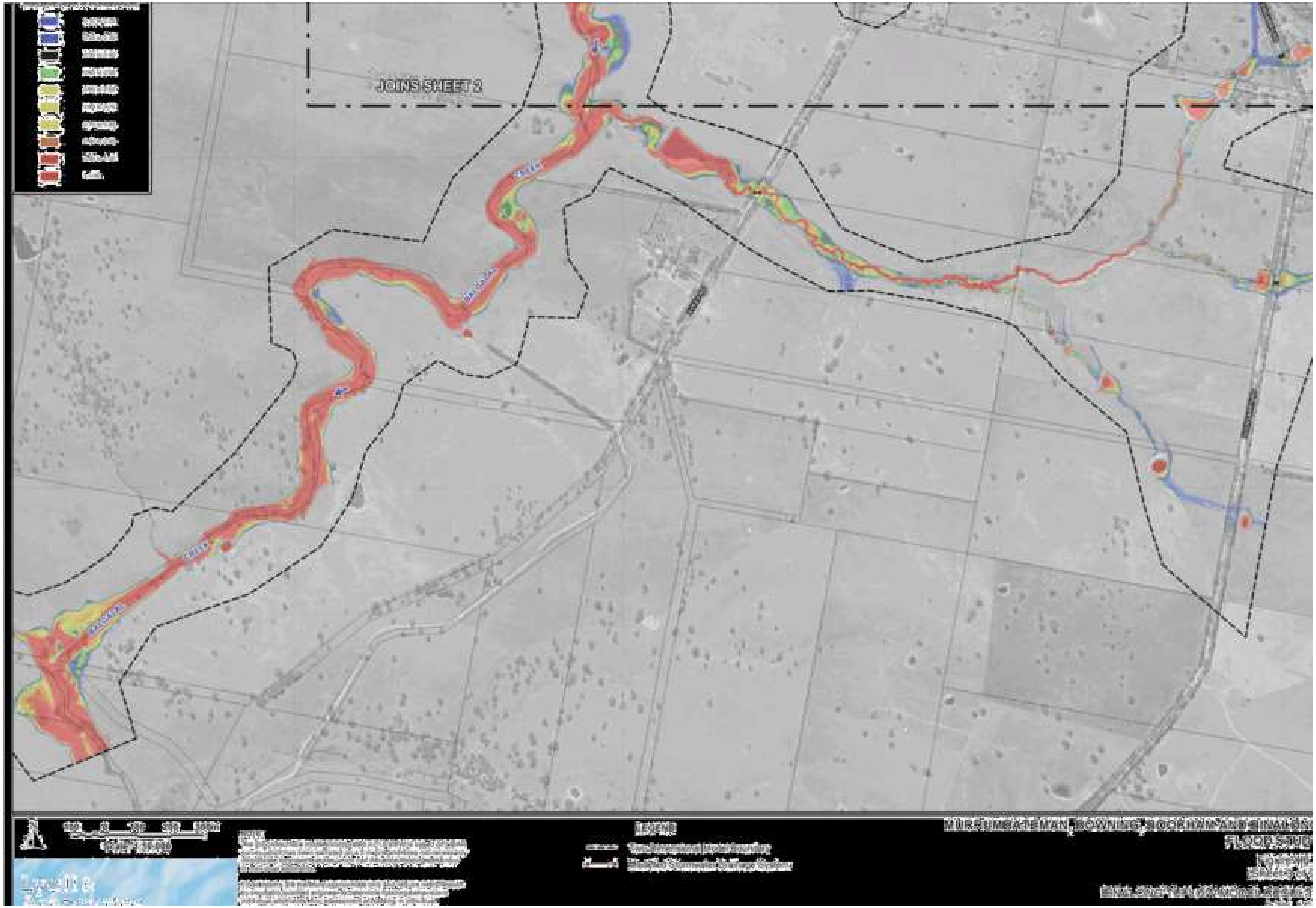
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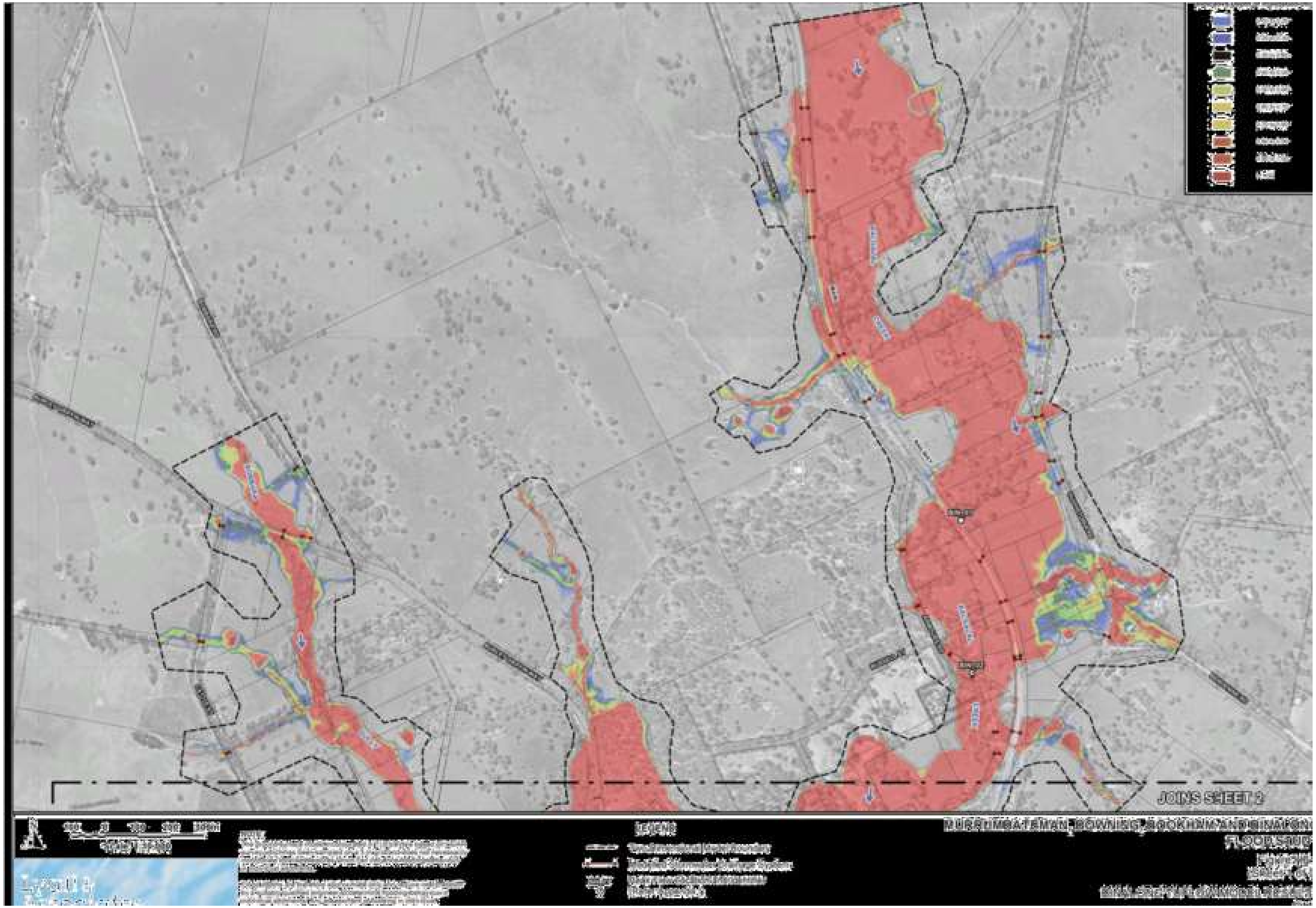
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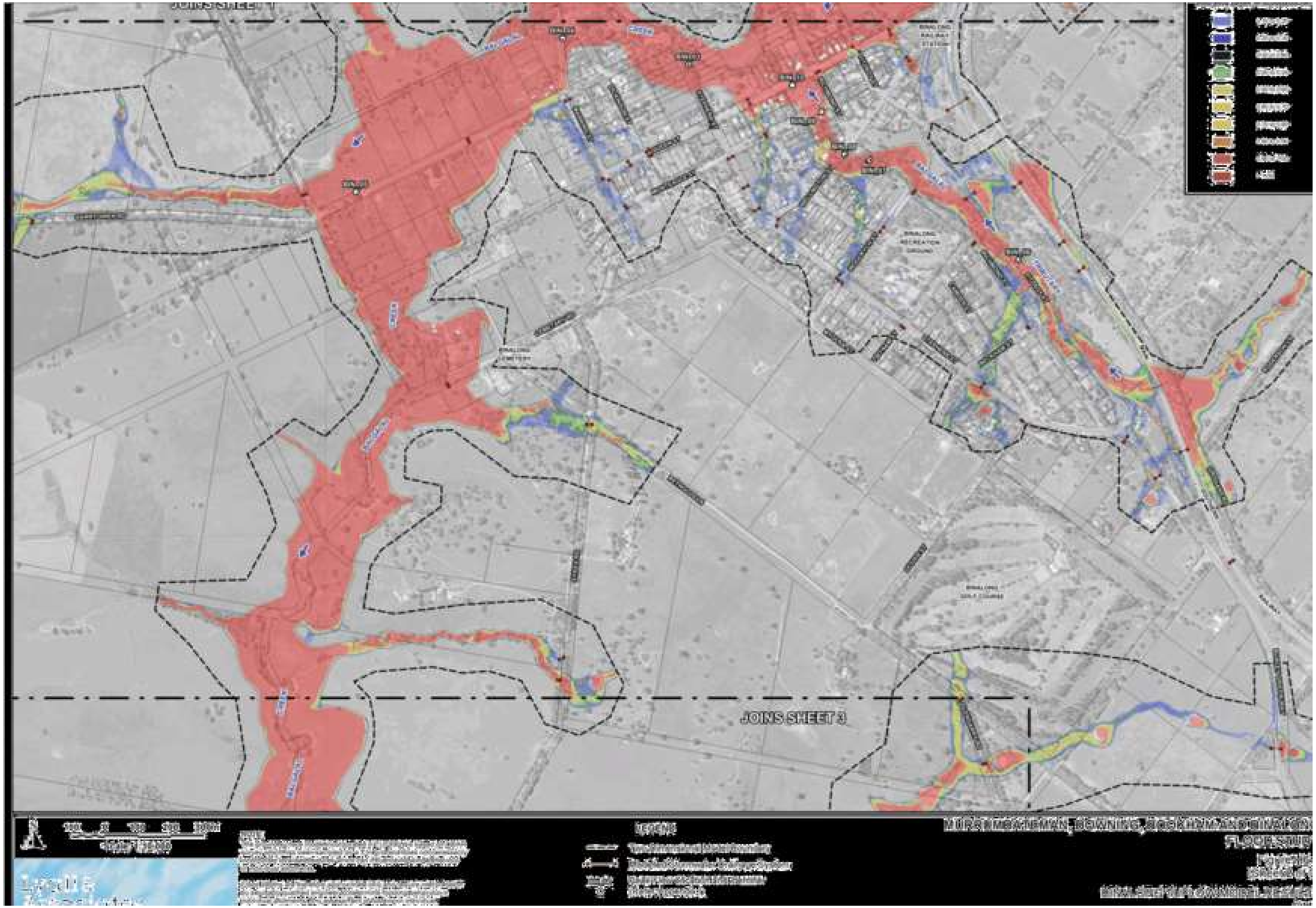
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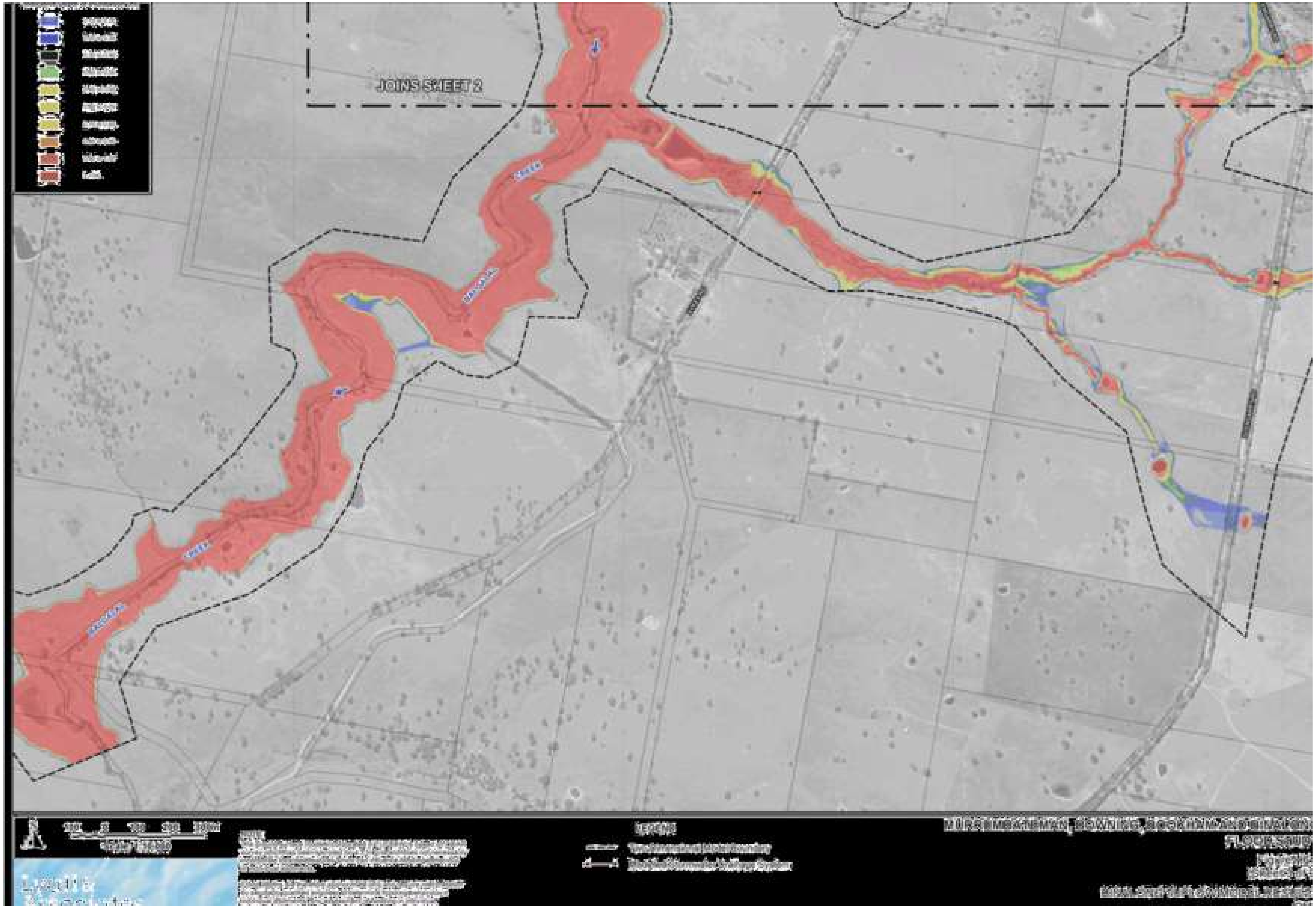
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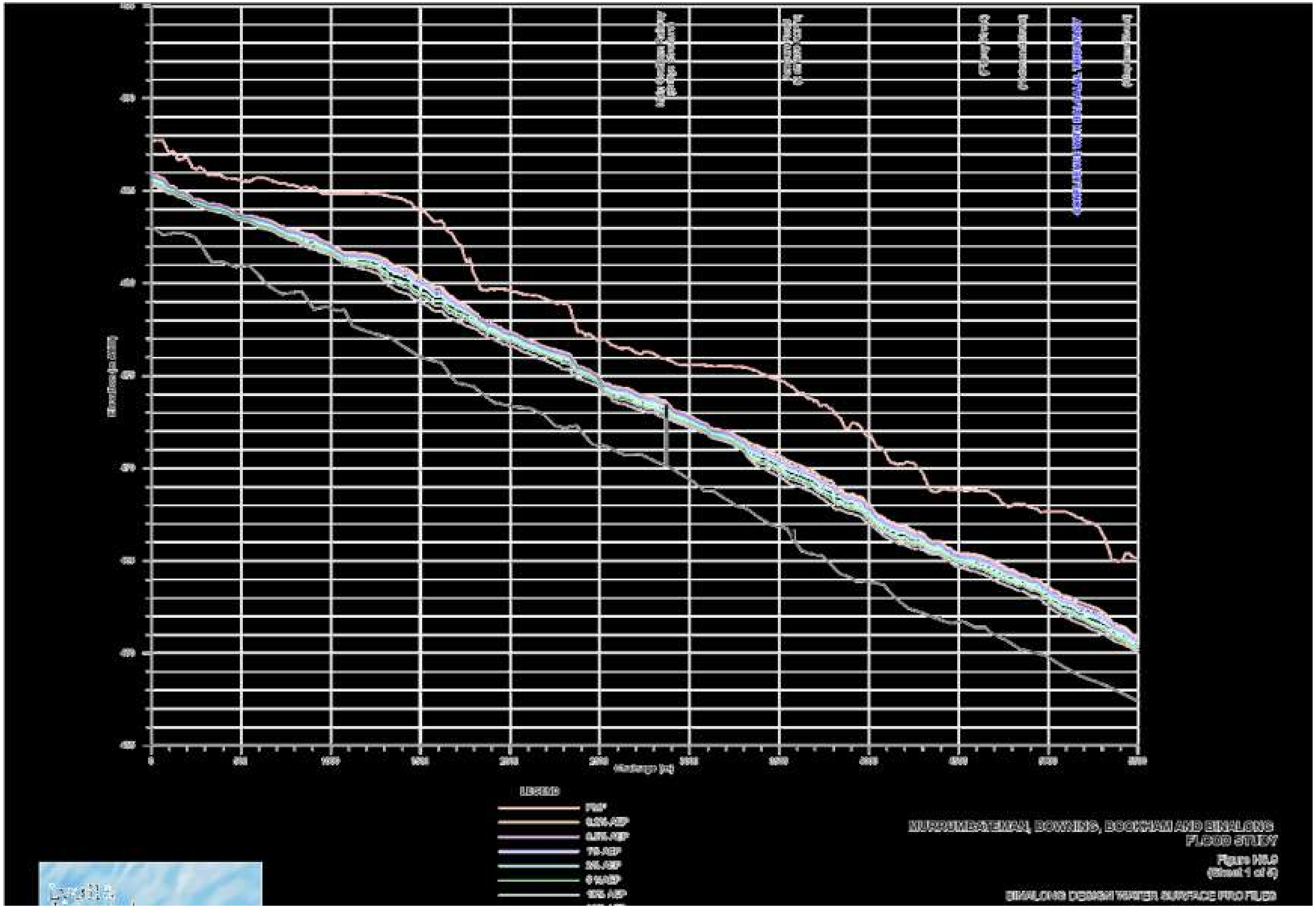
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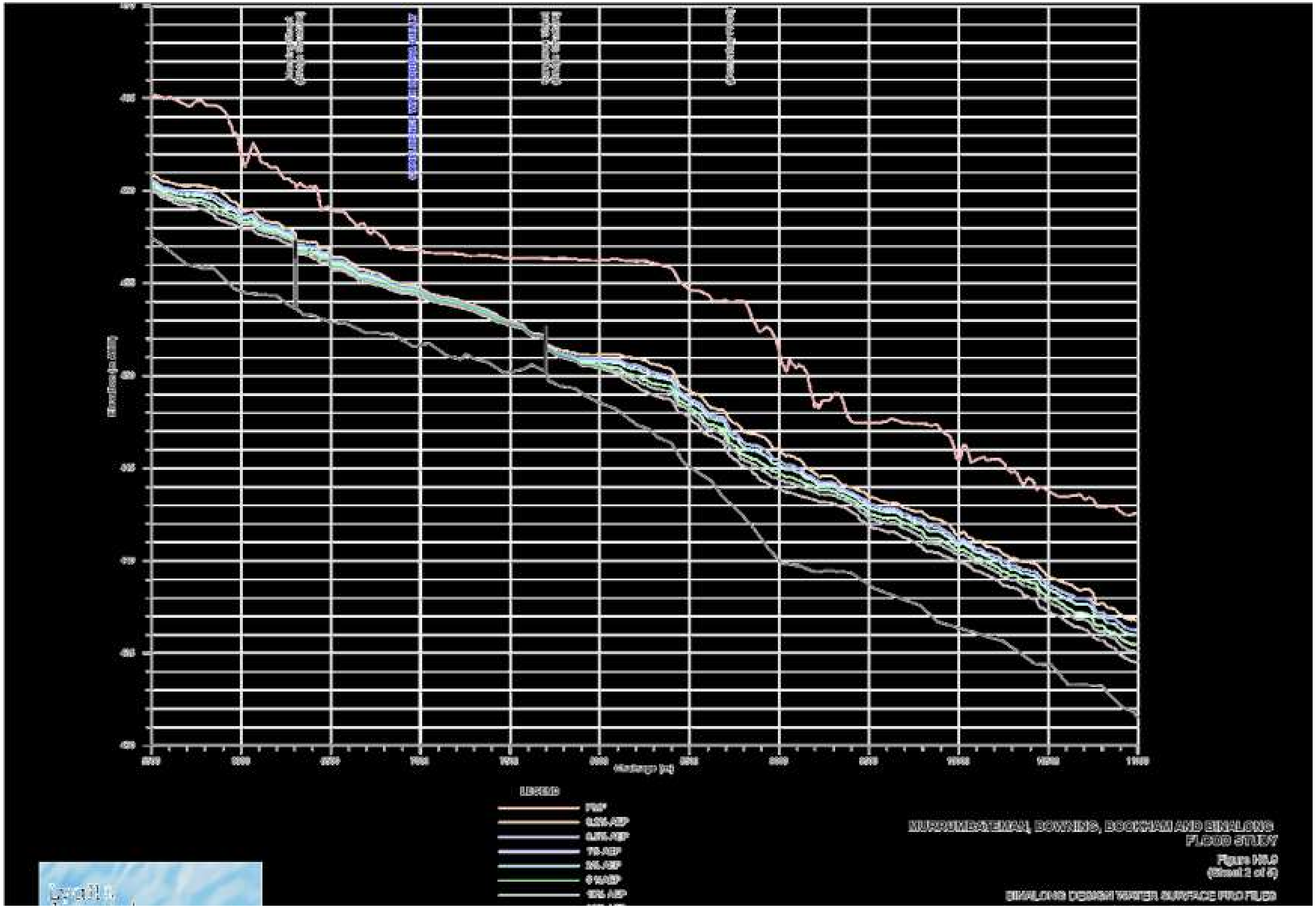
FLOOD STUDY
BINALONG DESIGN WATER SURFACE PROFILES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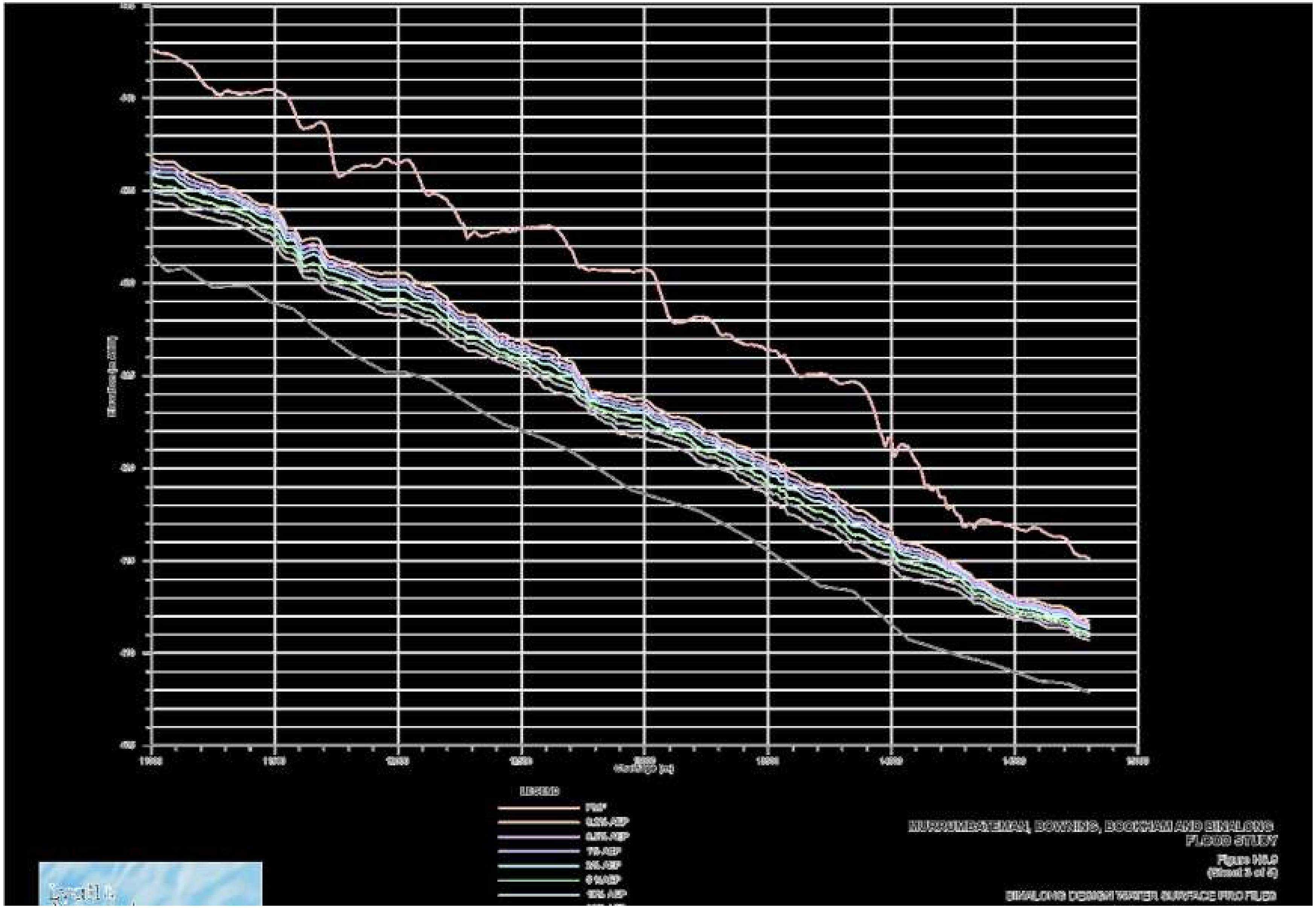
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0.5% AEP
1% AEP
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5% AEP
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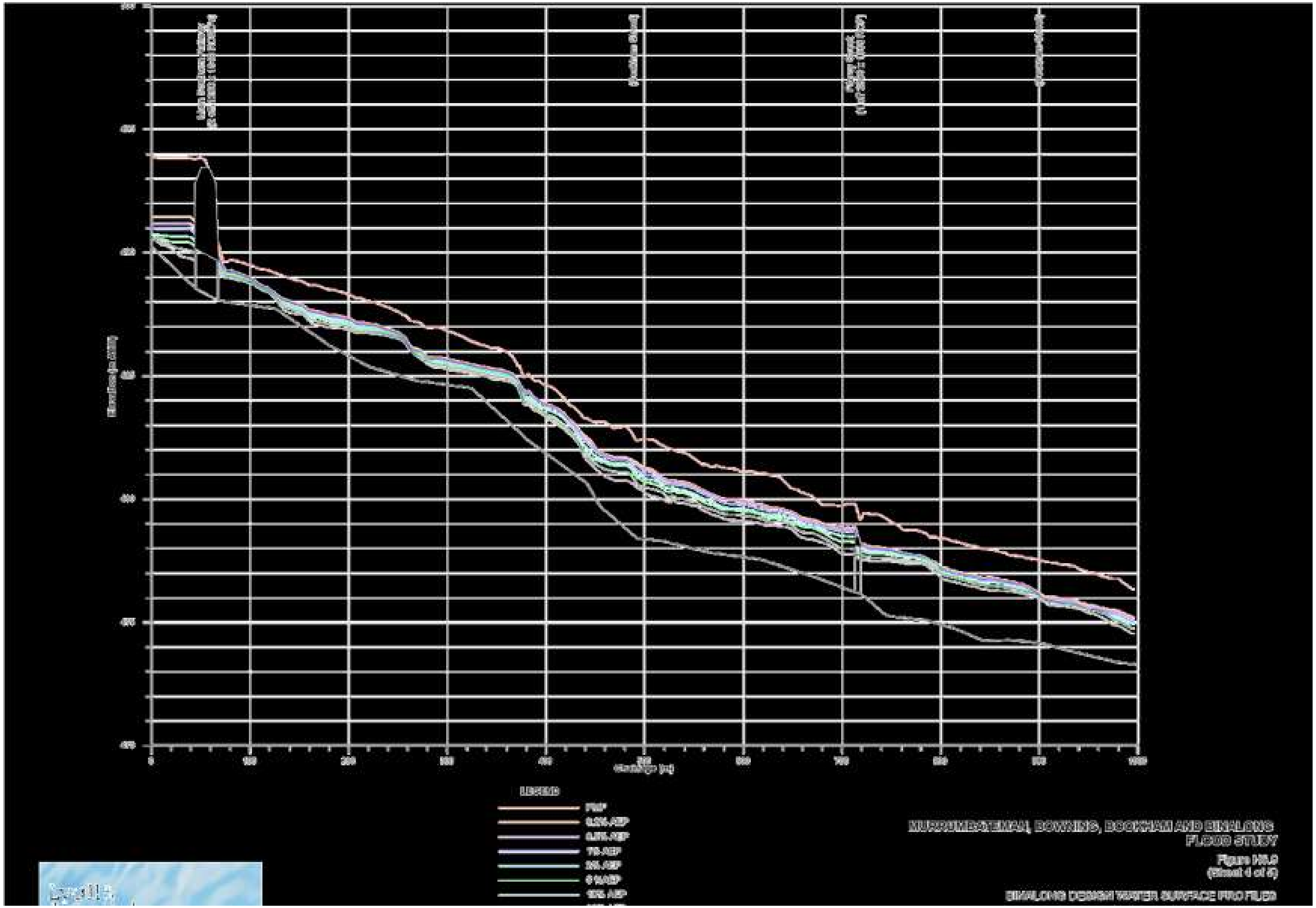
FLOOD STUDY
BINALONG DESIGN WATER SURFACE PROFILES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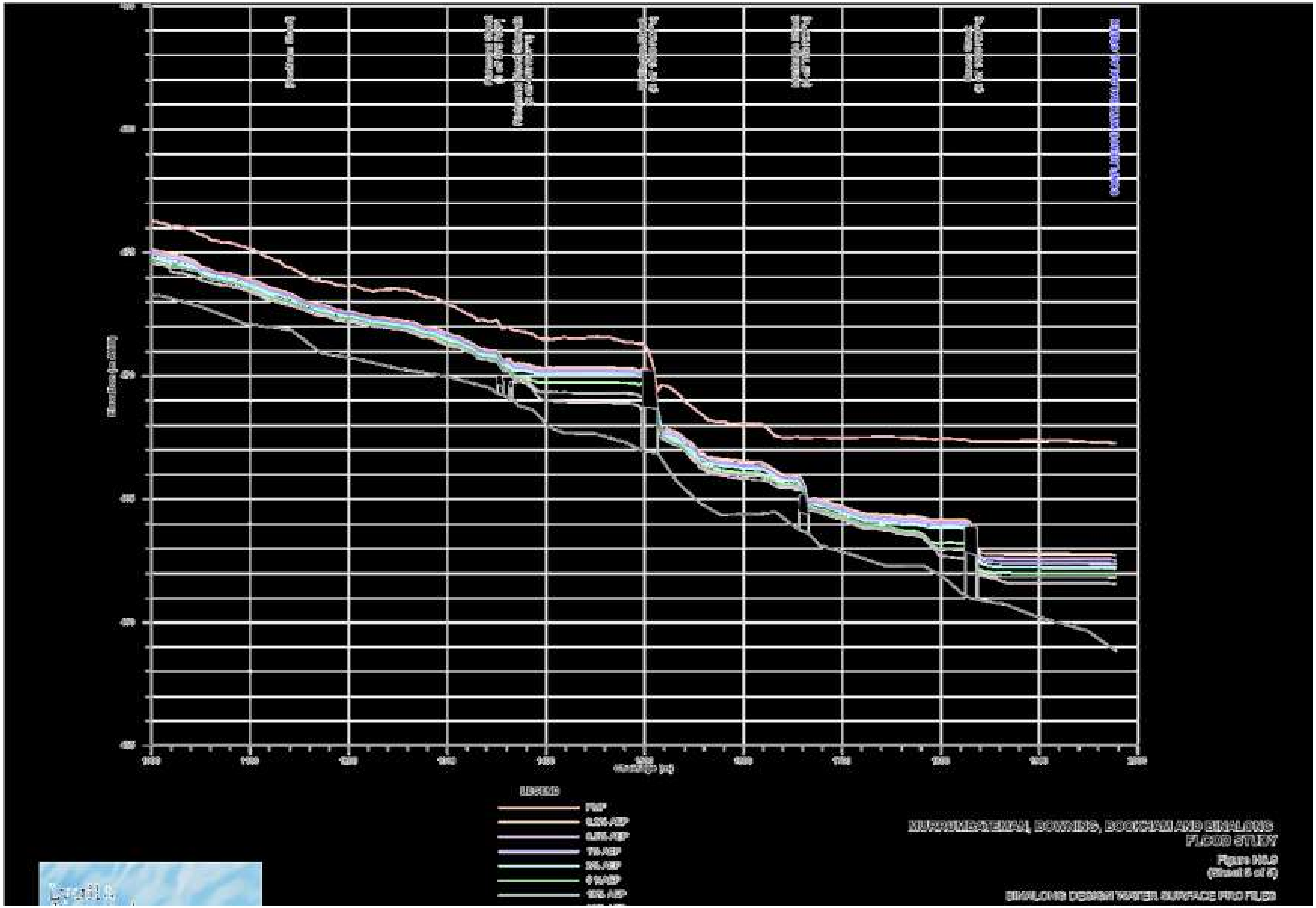
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FLOOD STUDY
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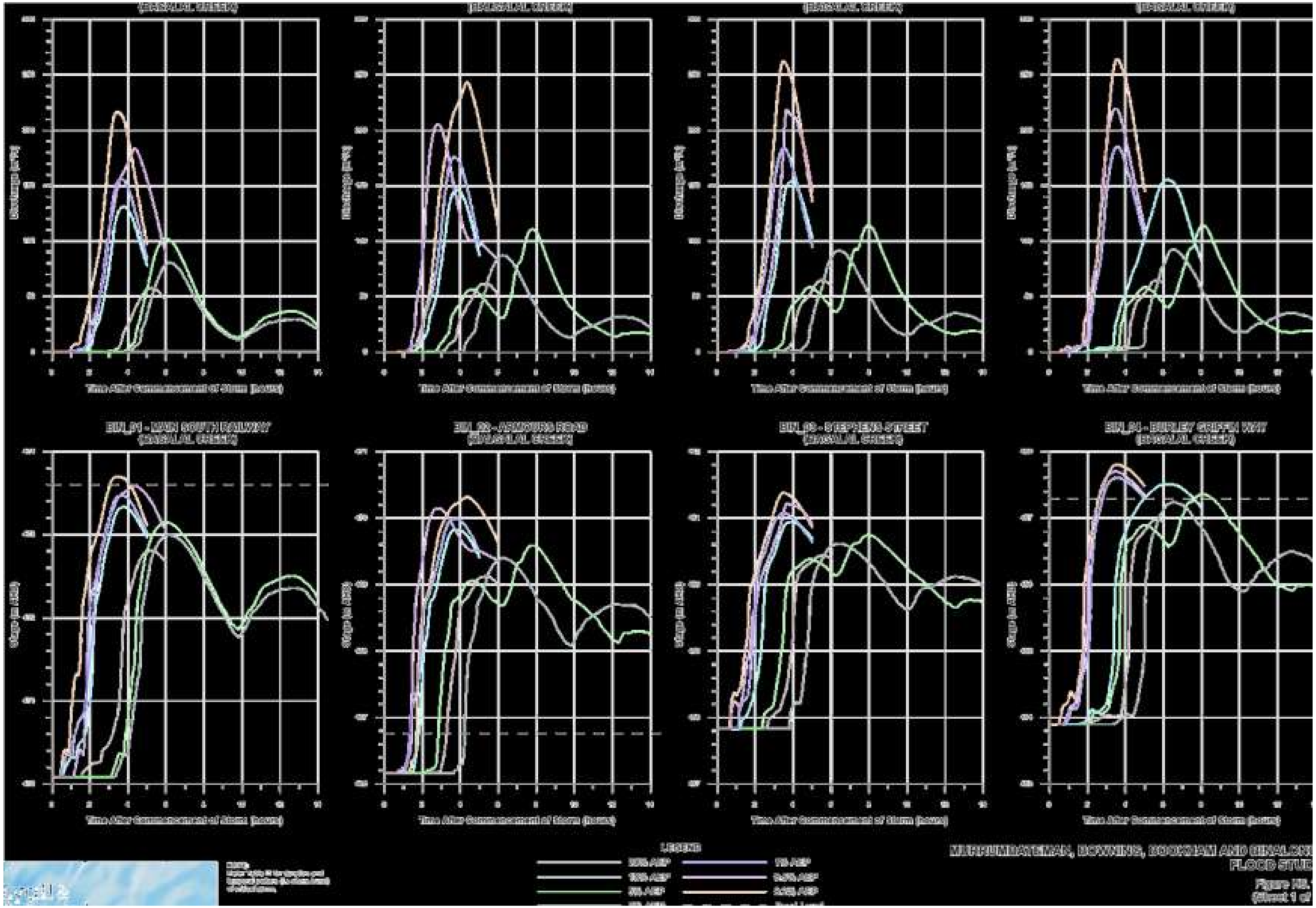

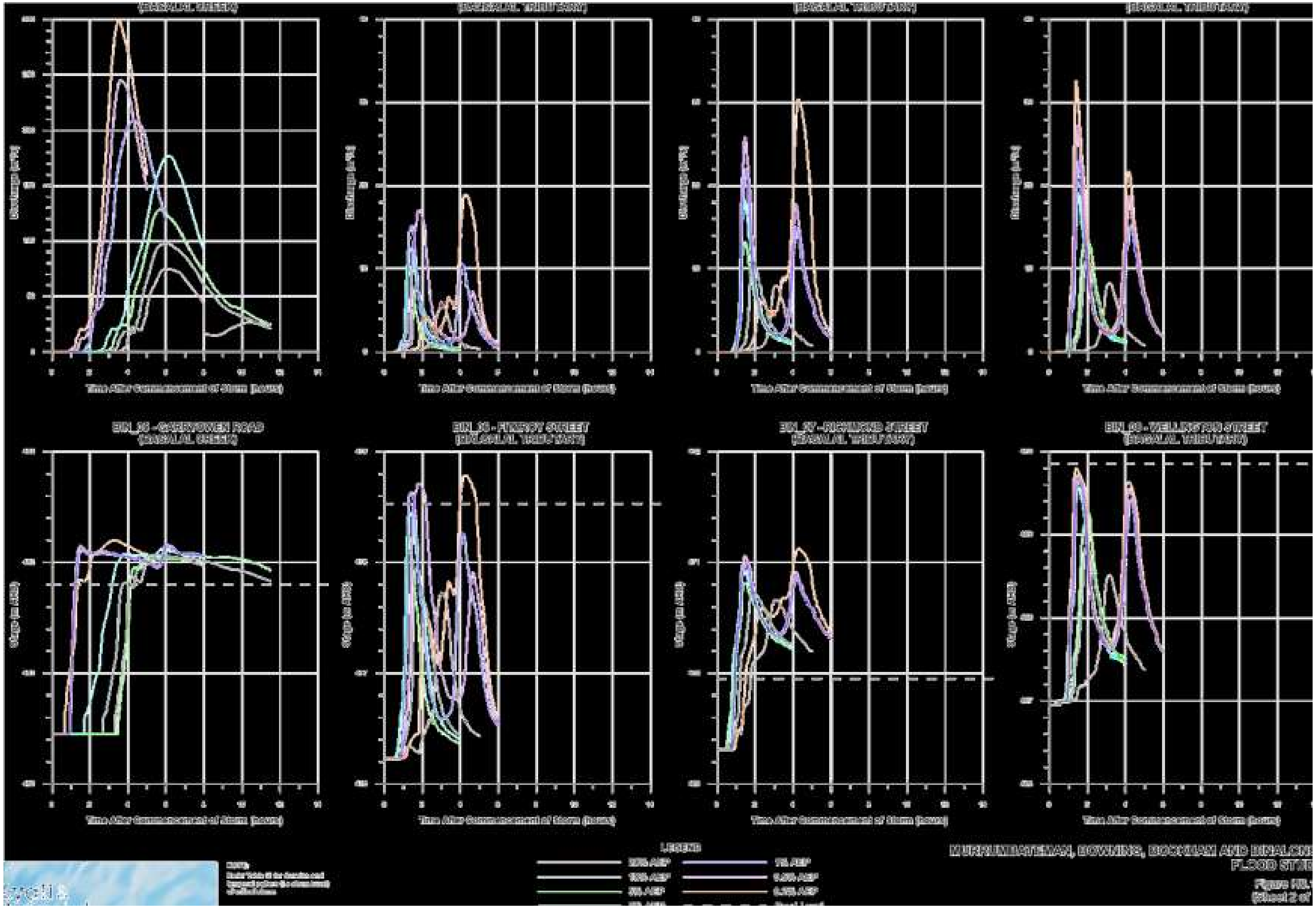

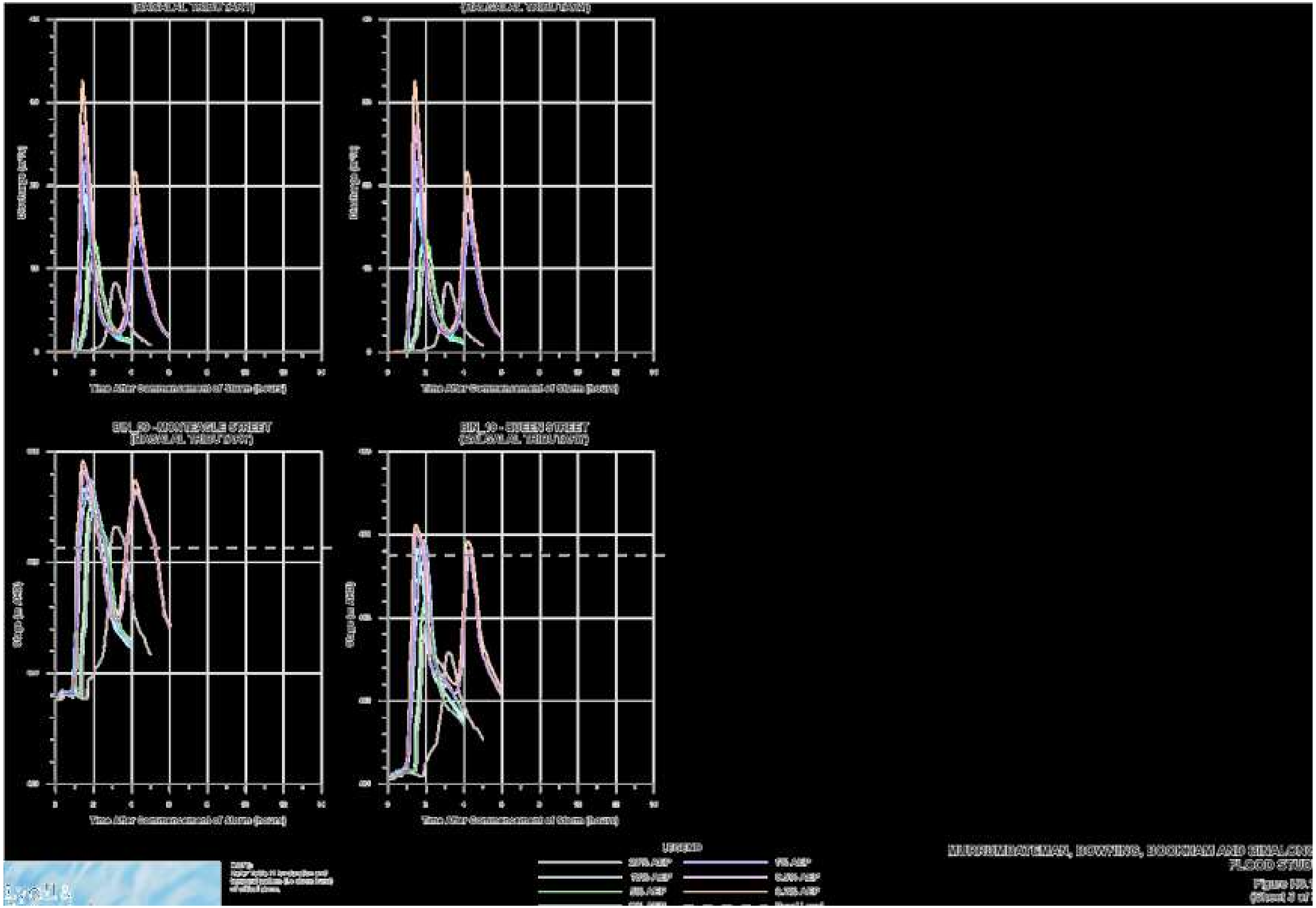

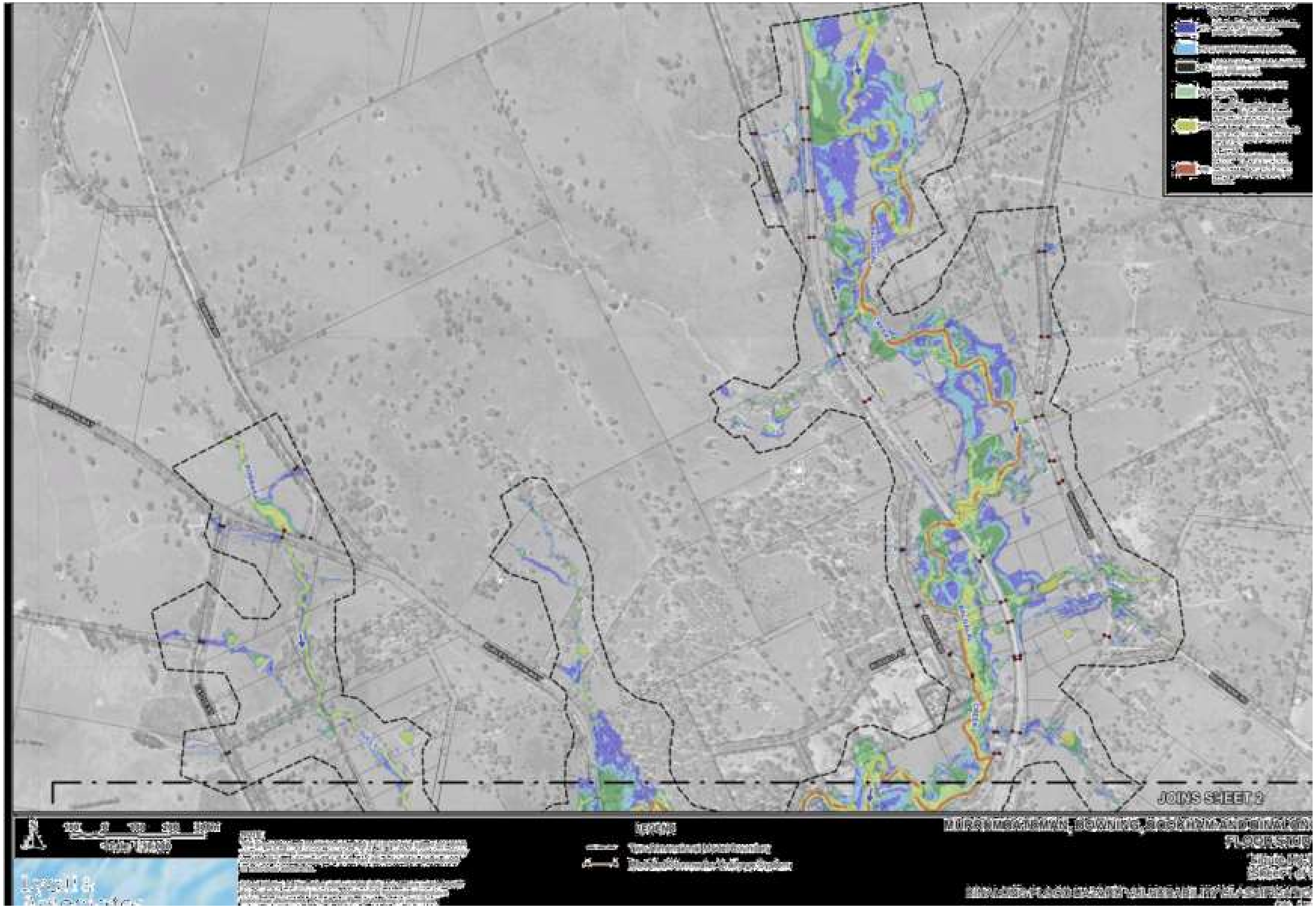
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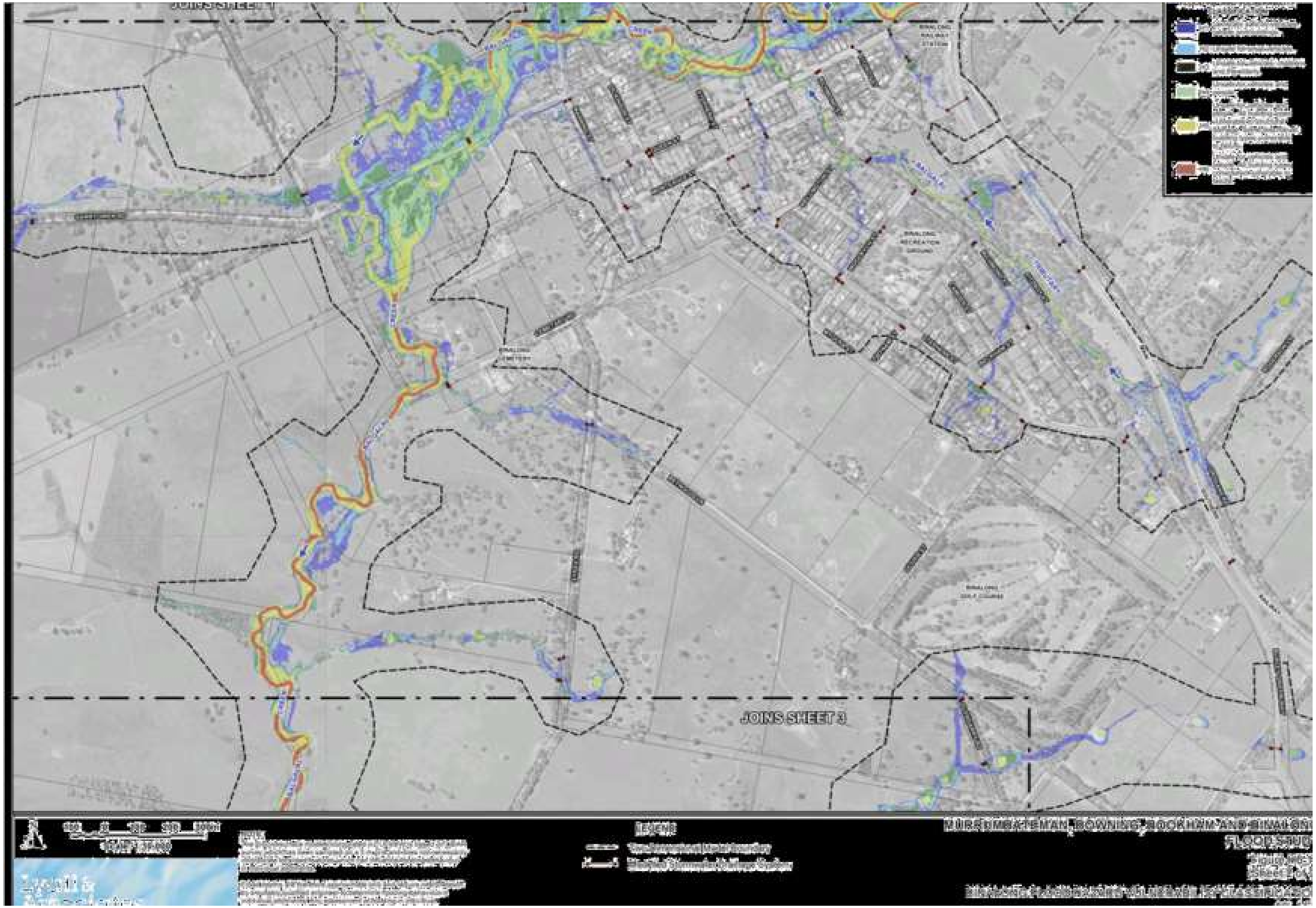
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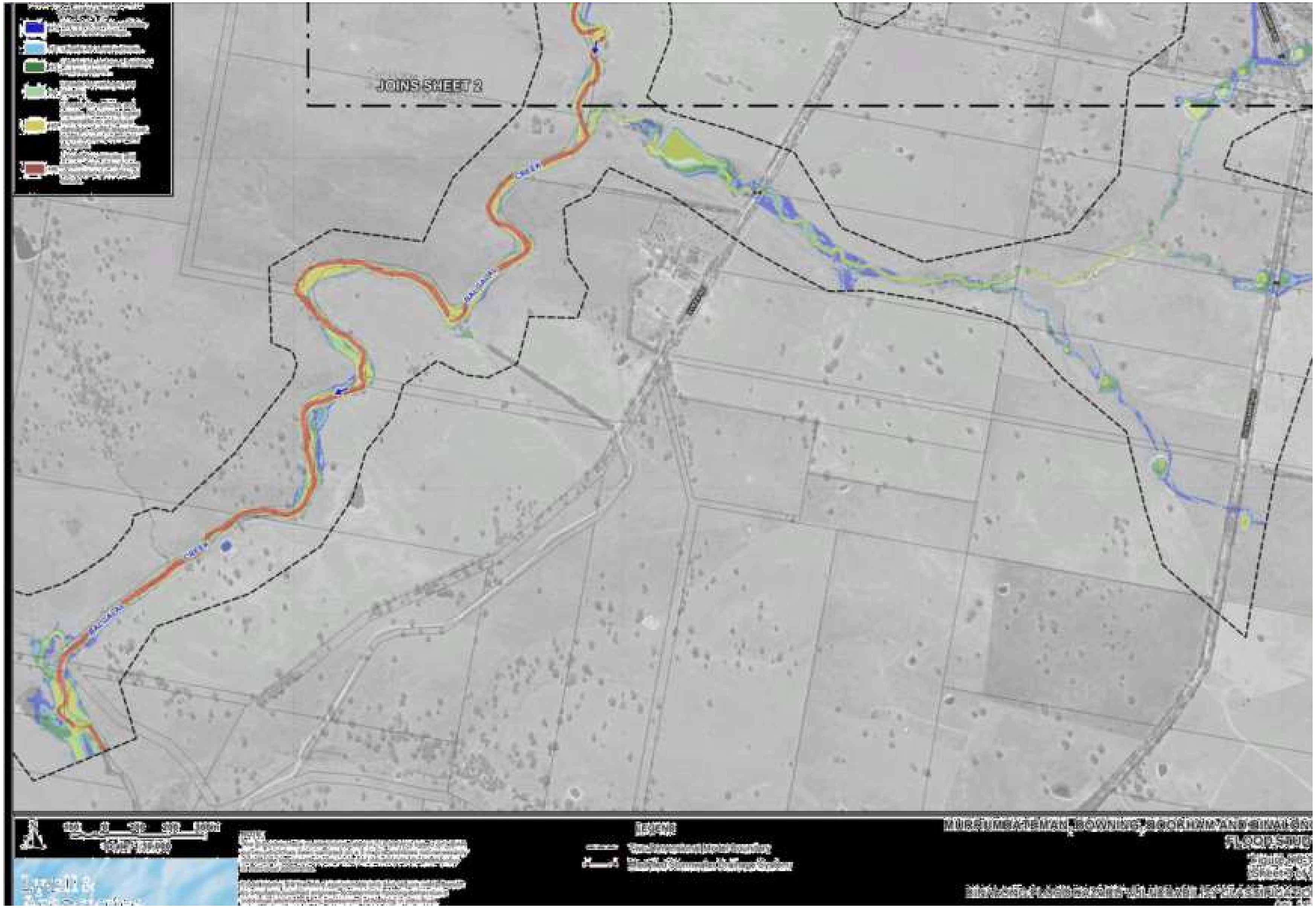
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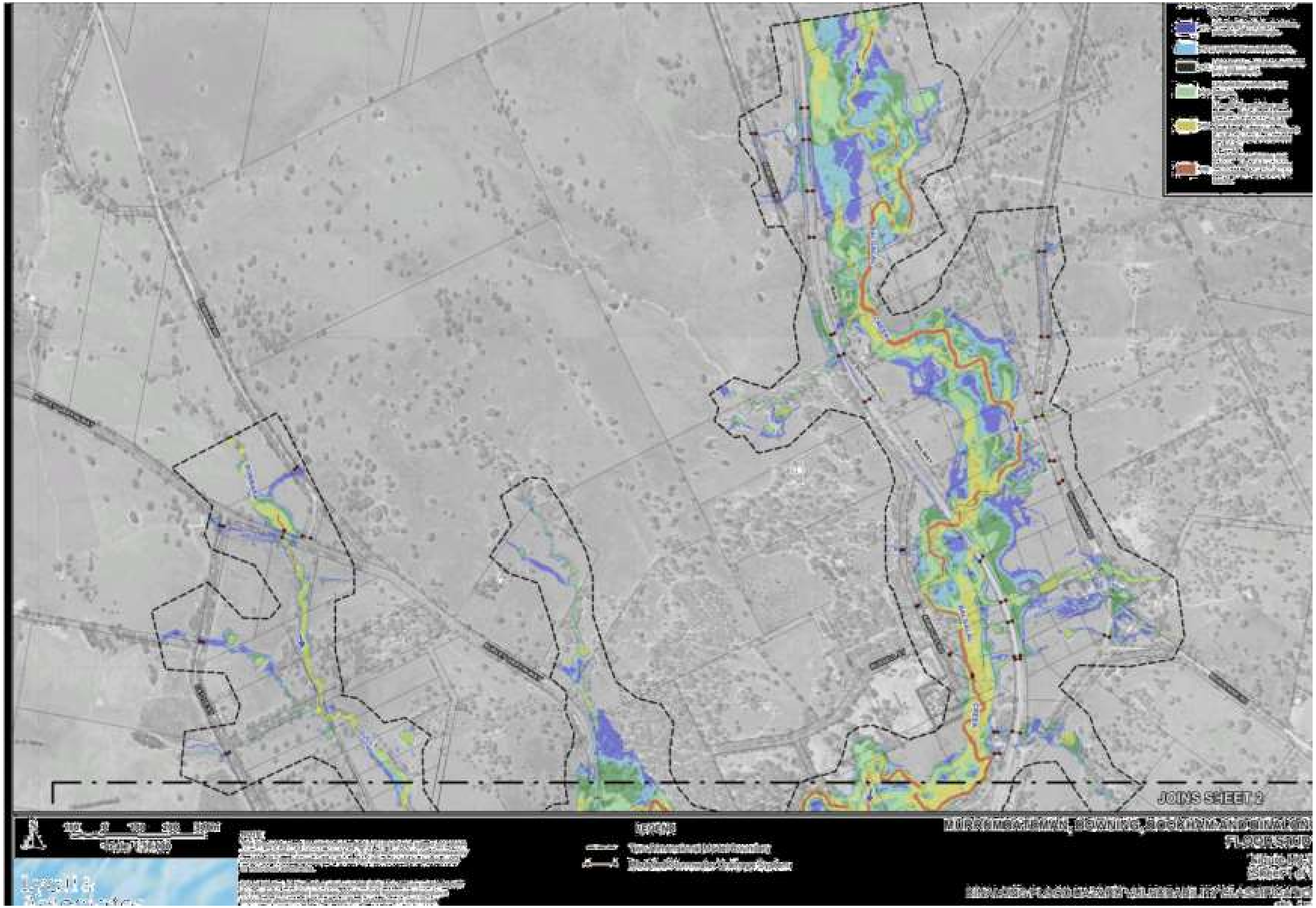
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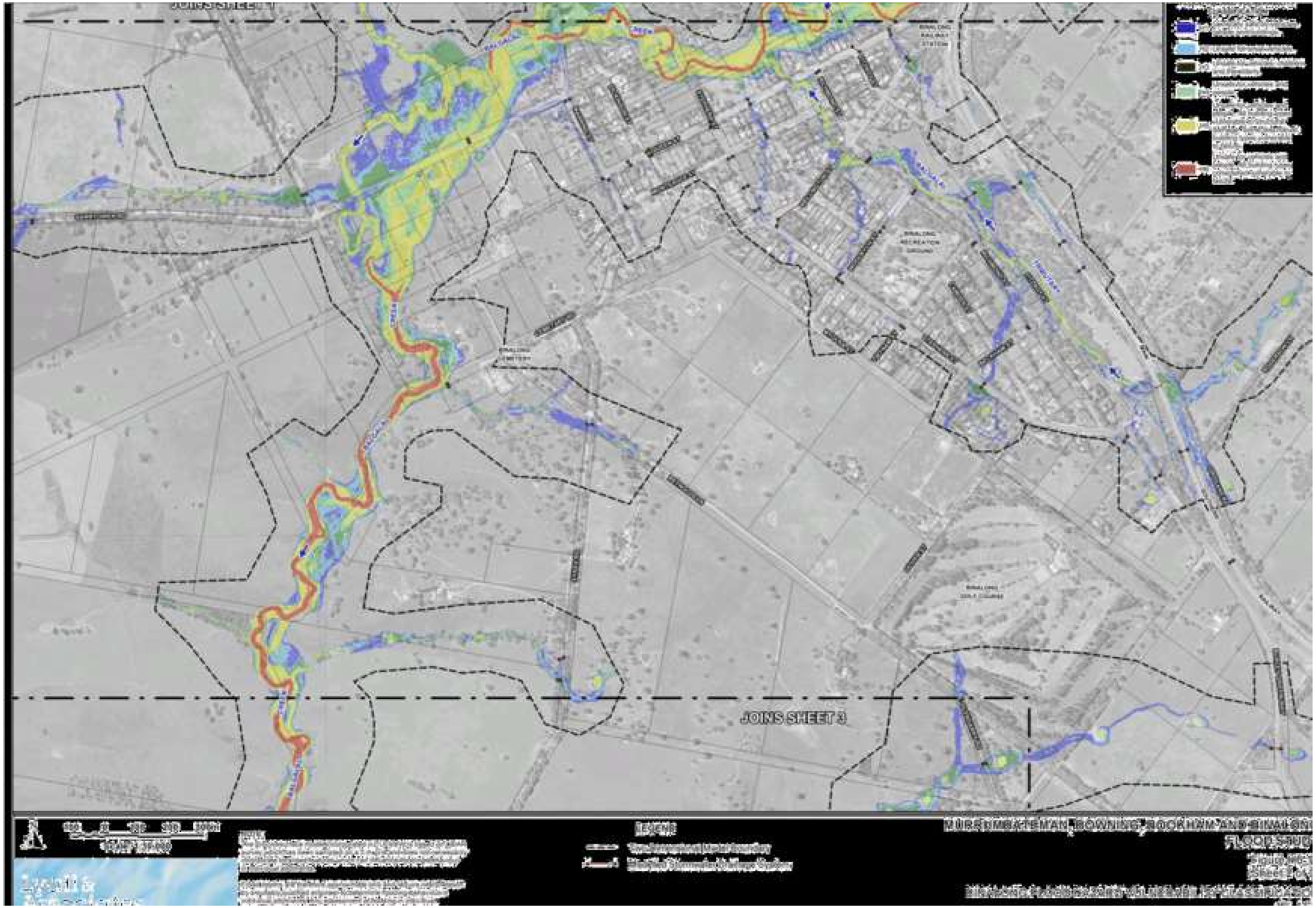
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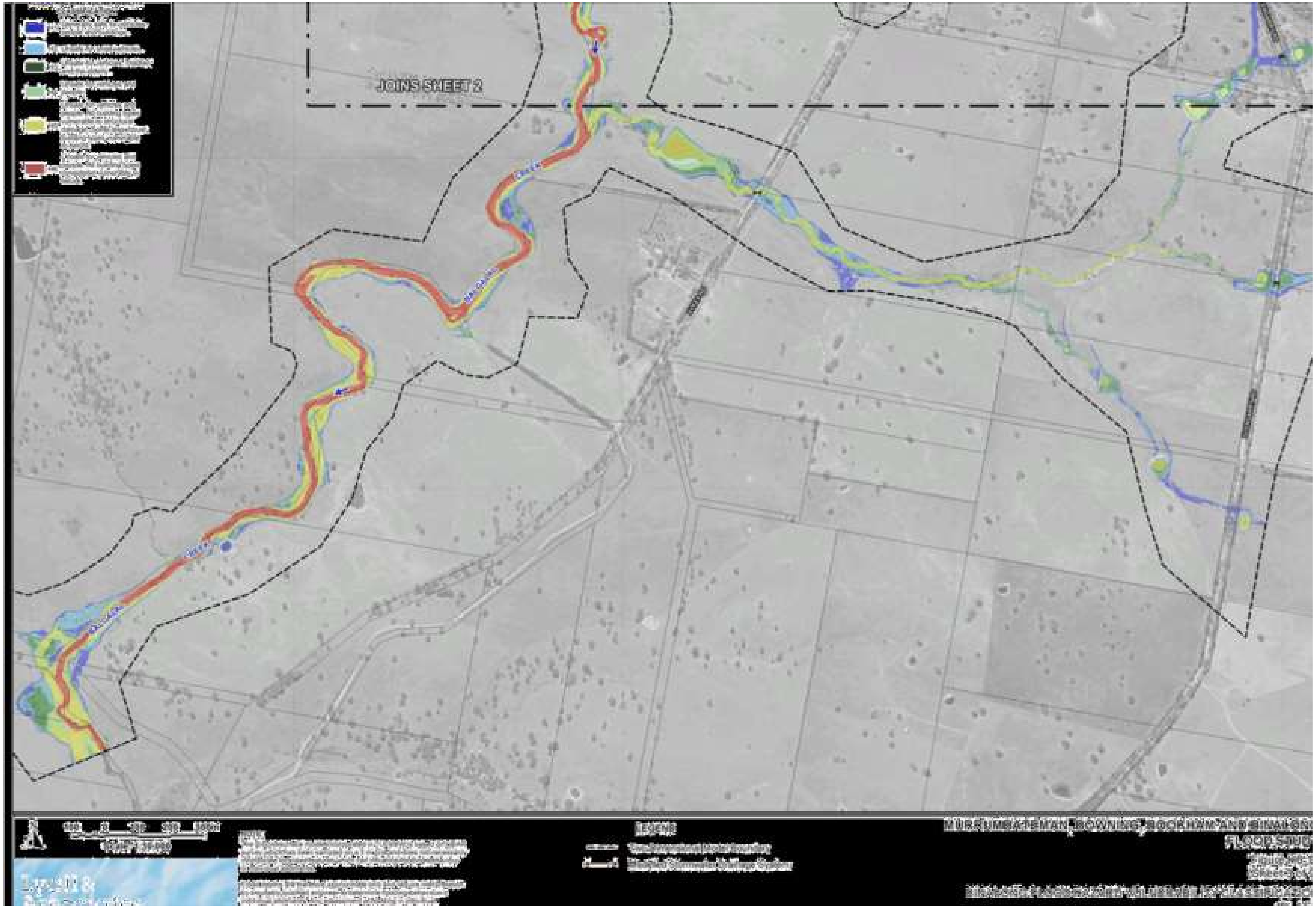
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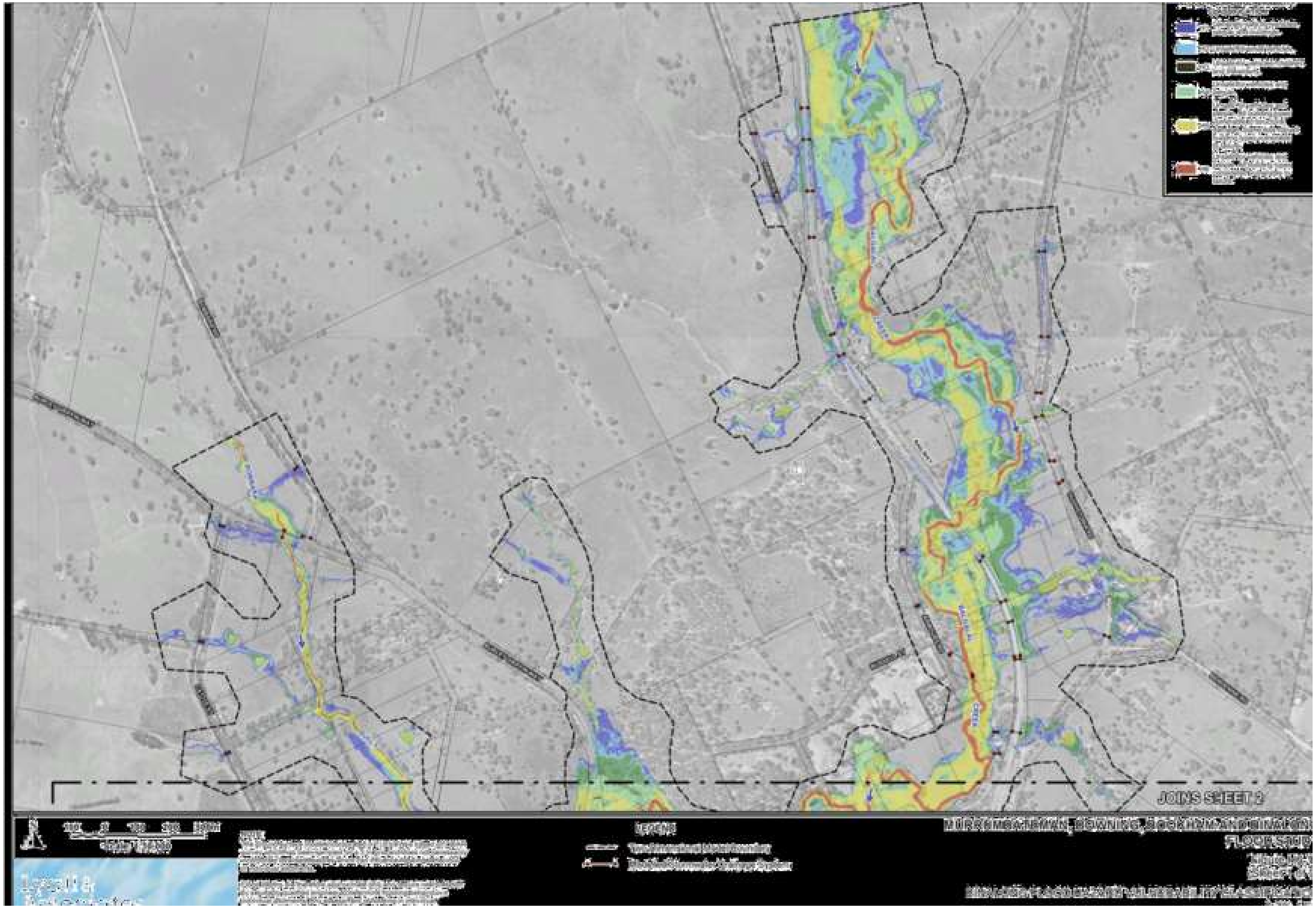
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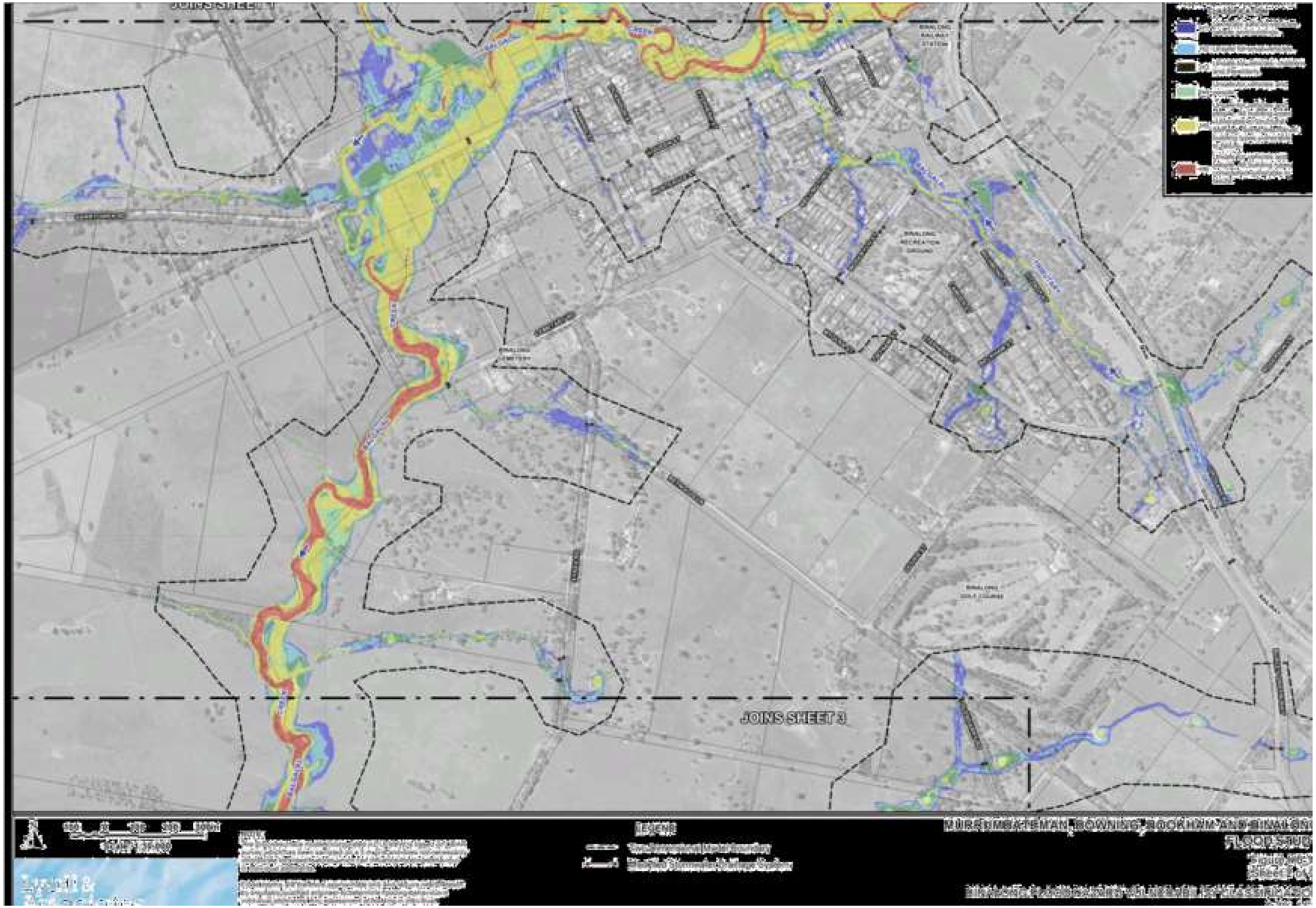
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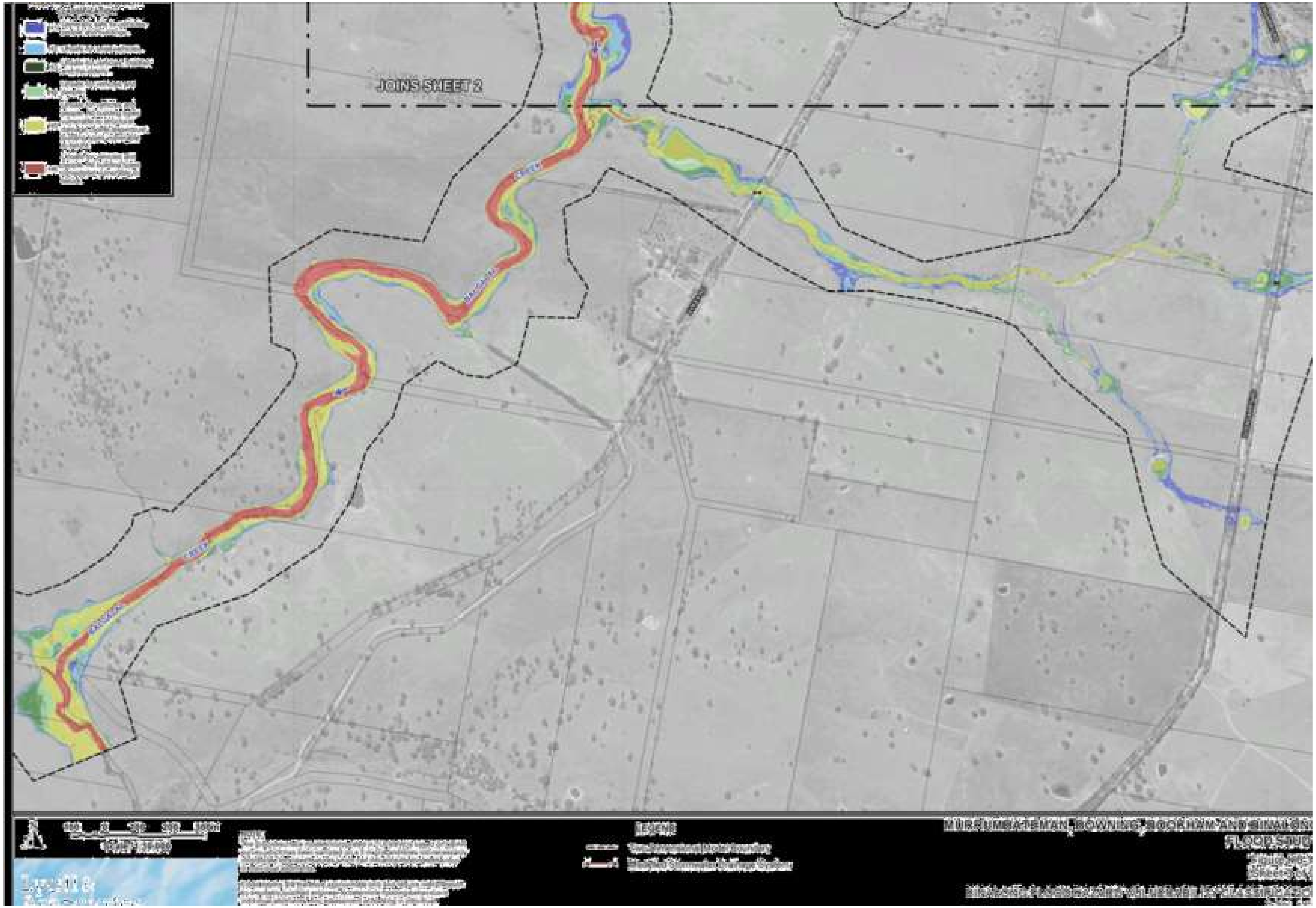
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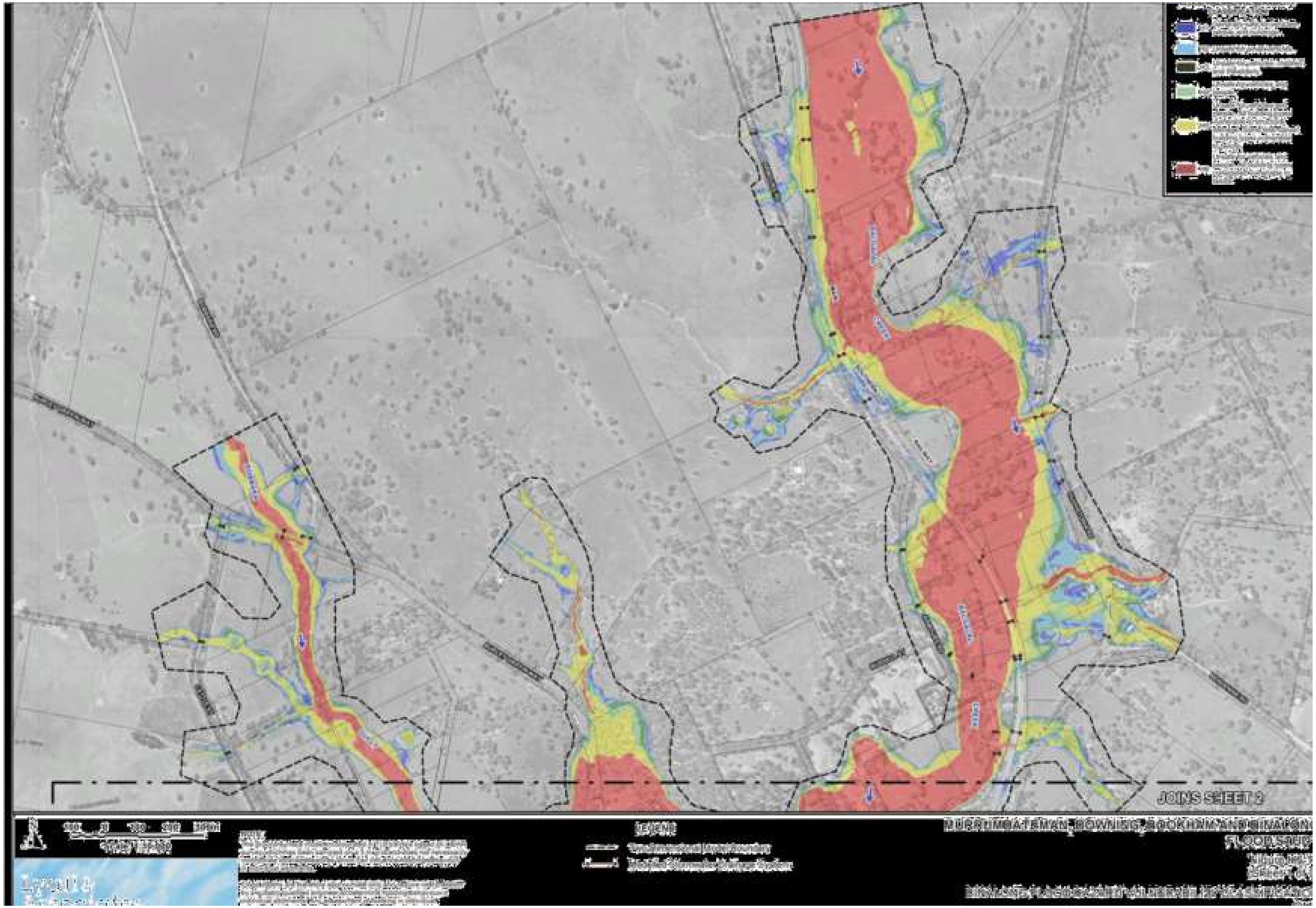
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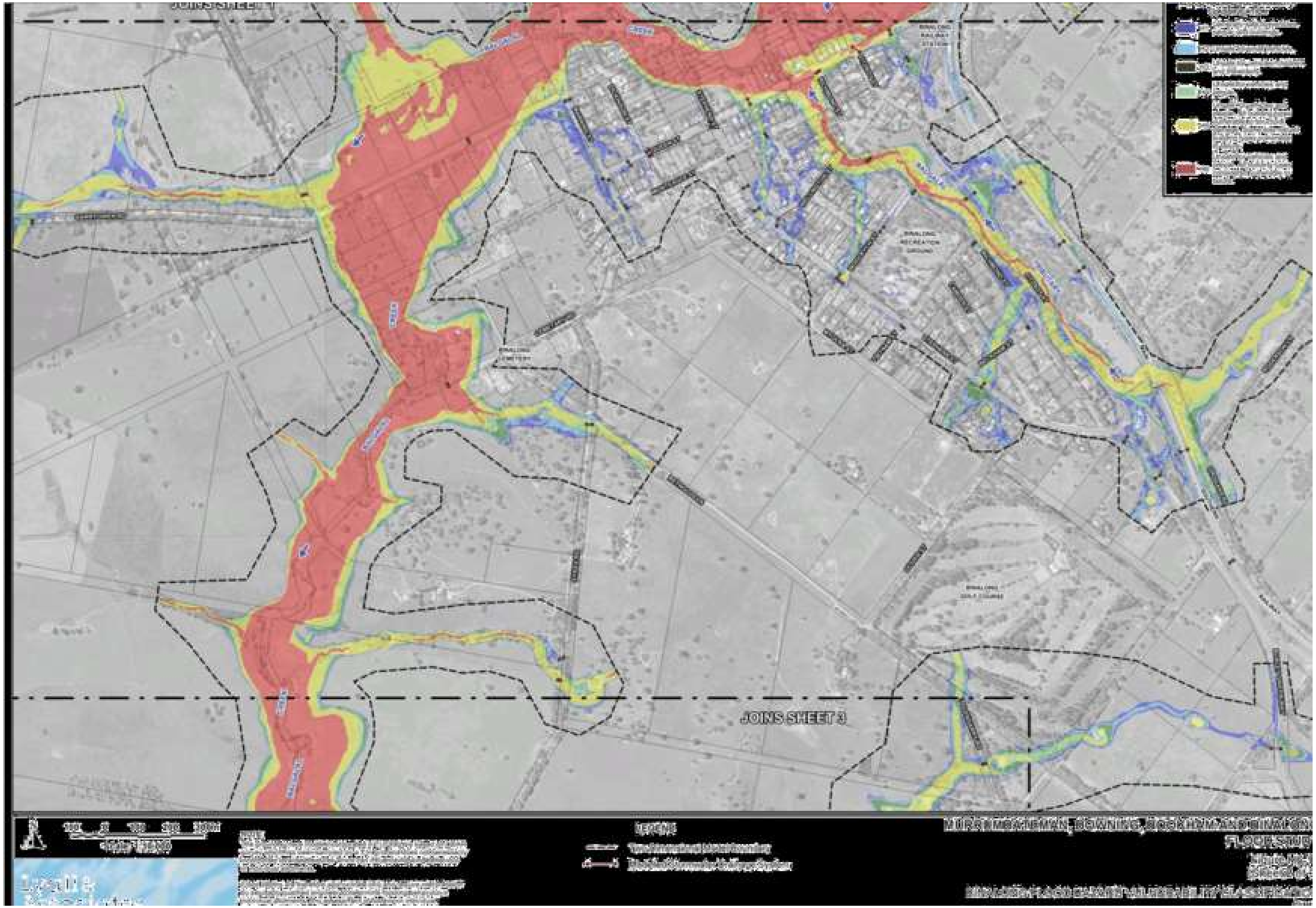
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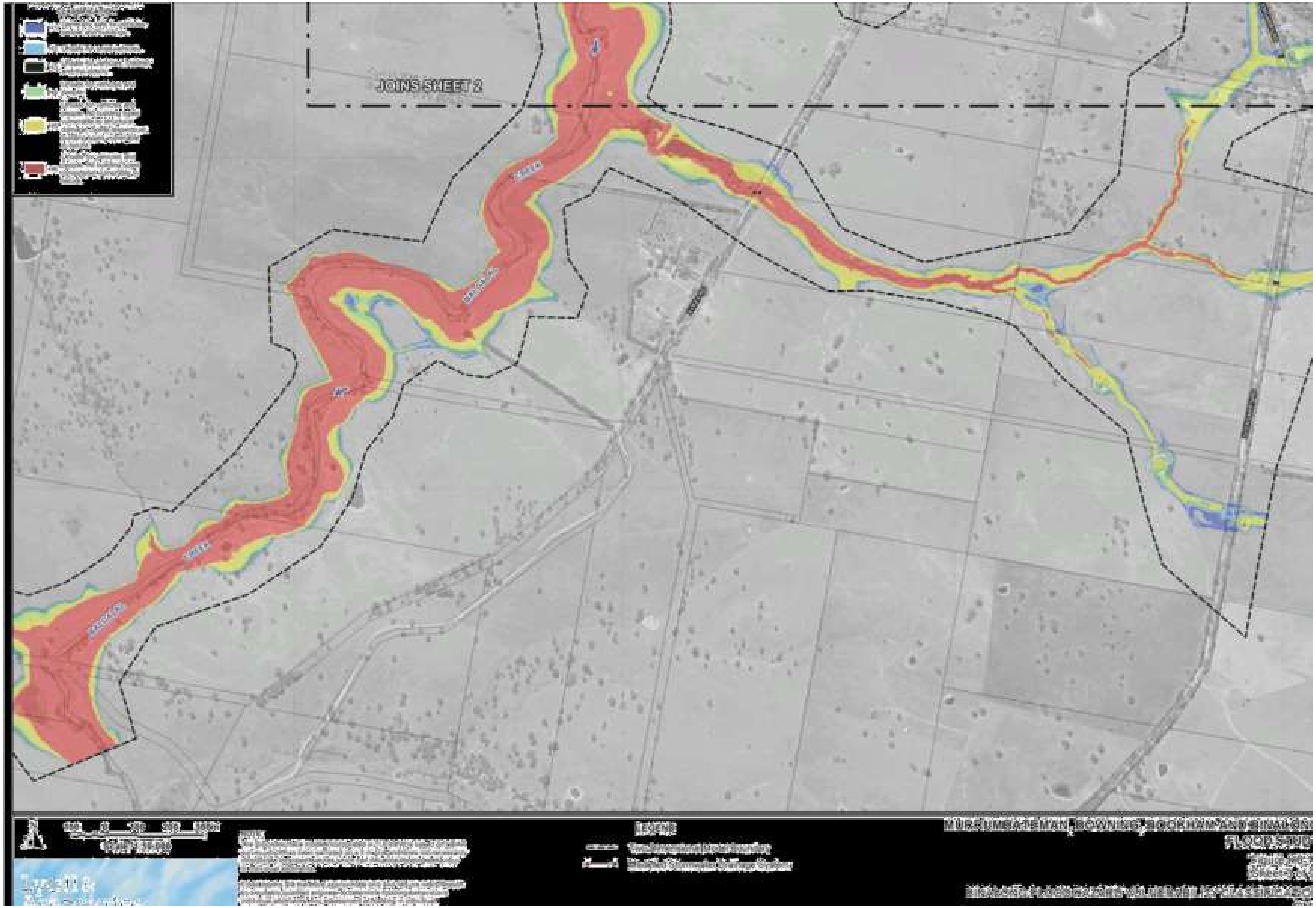
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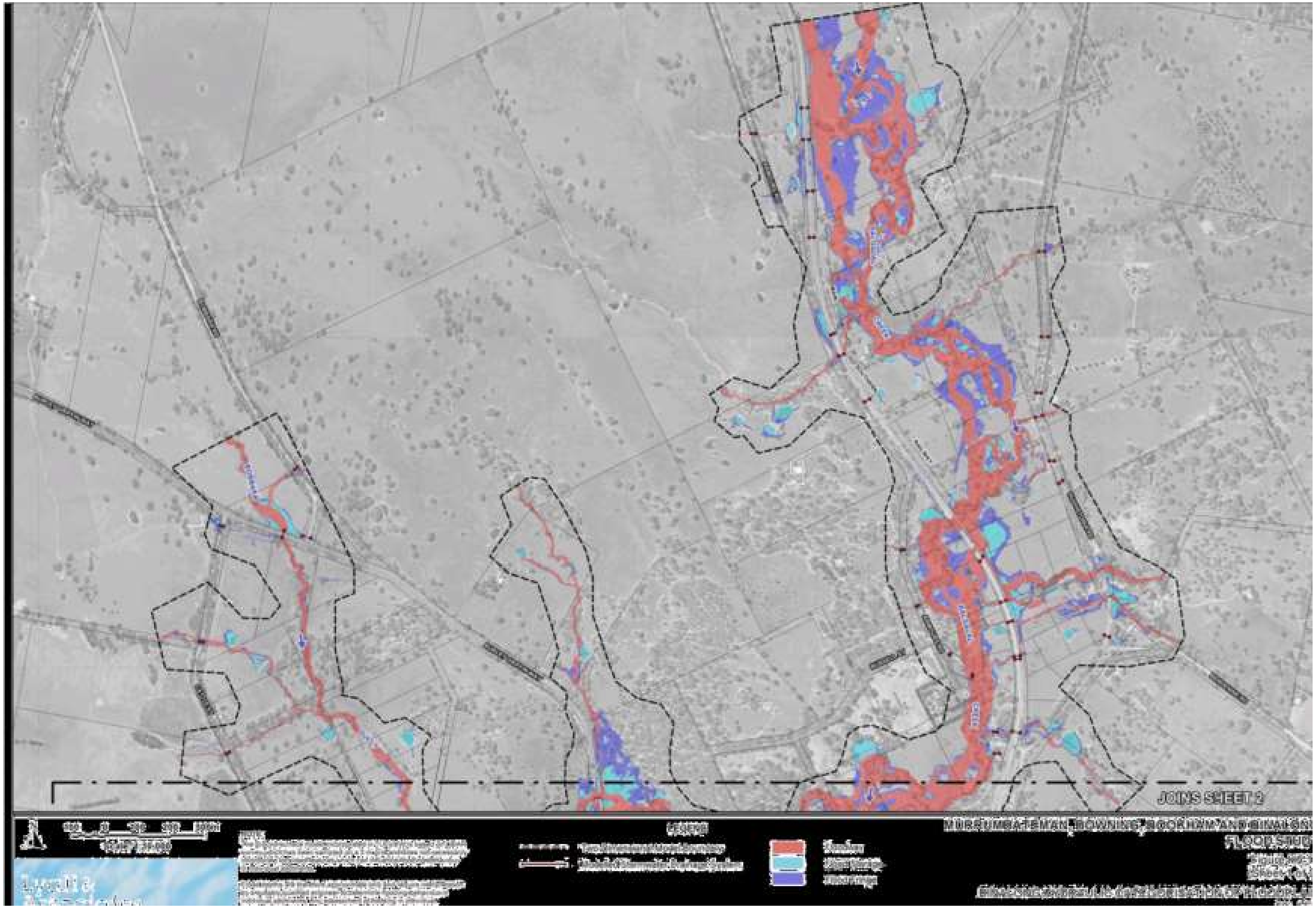
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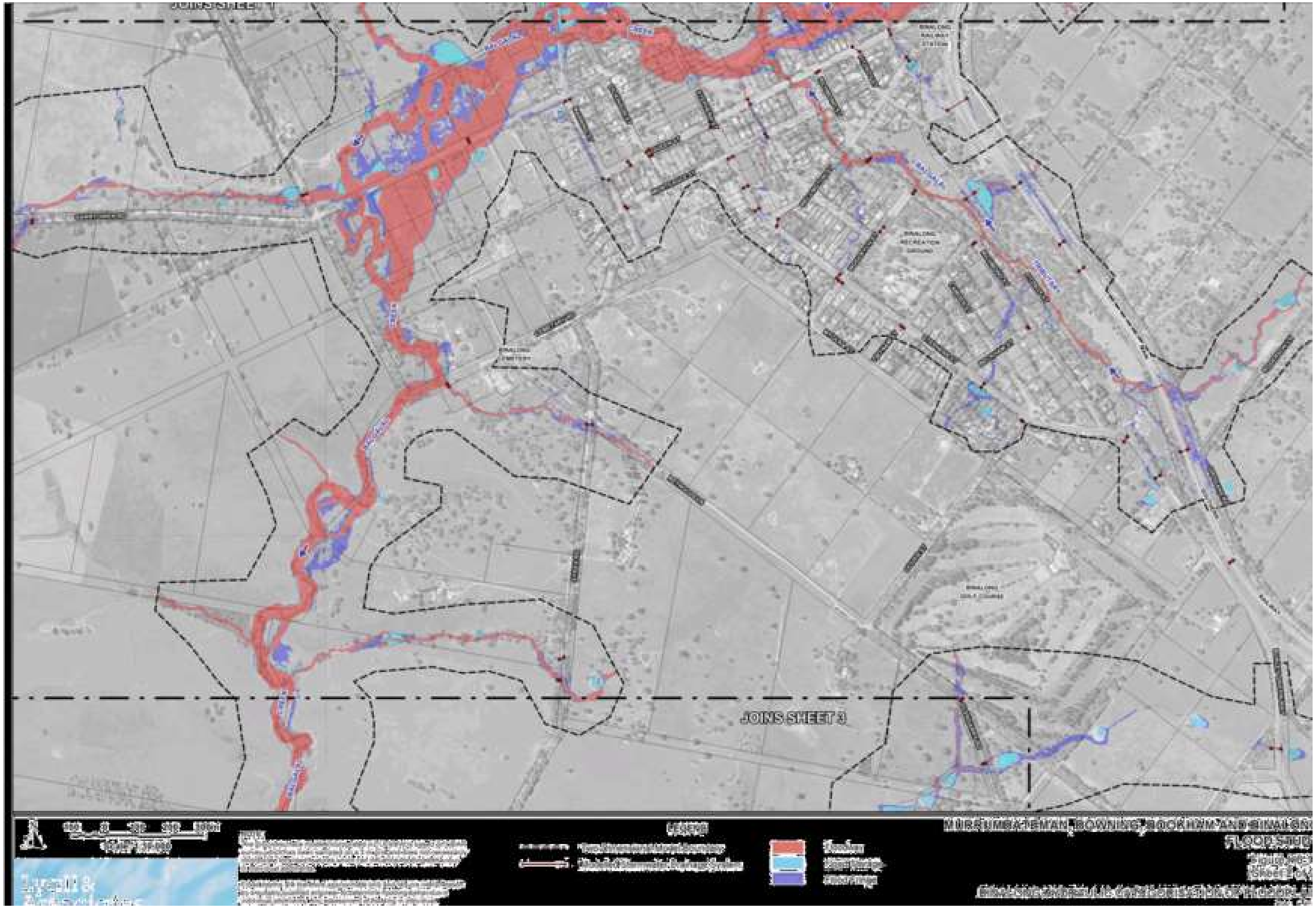
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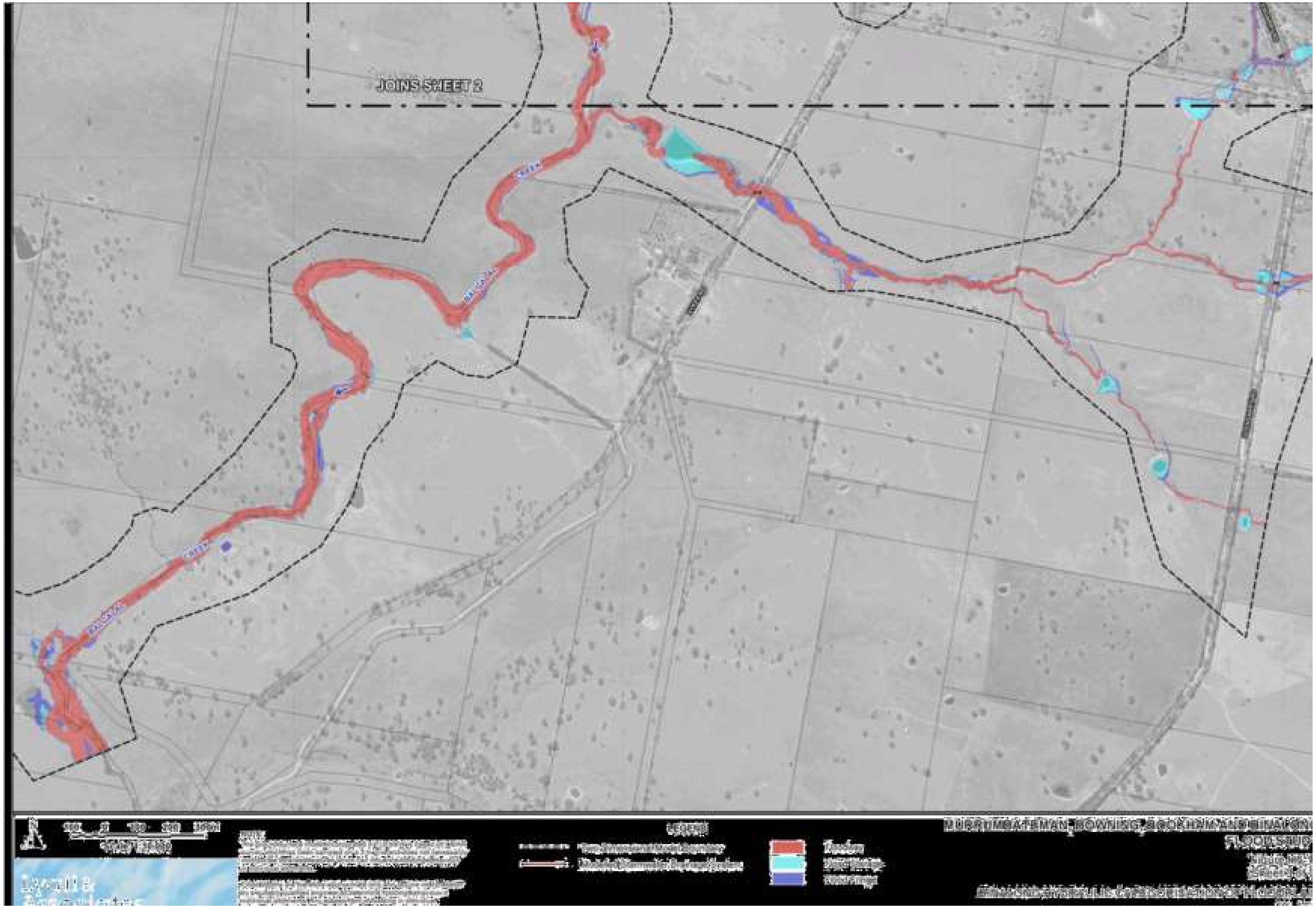
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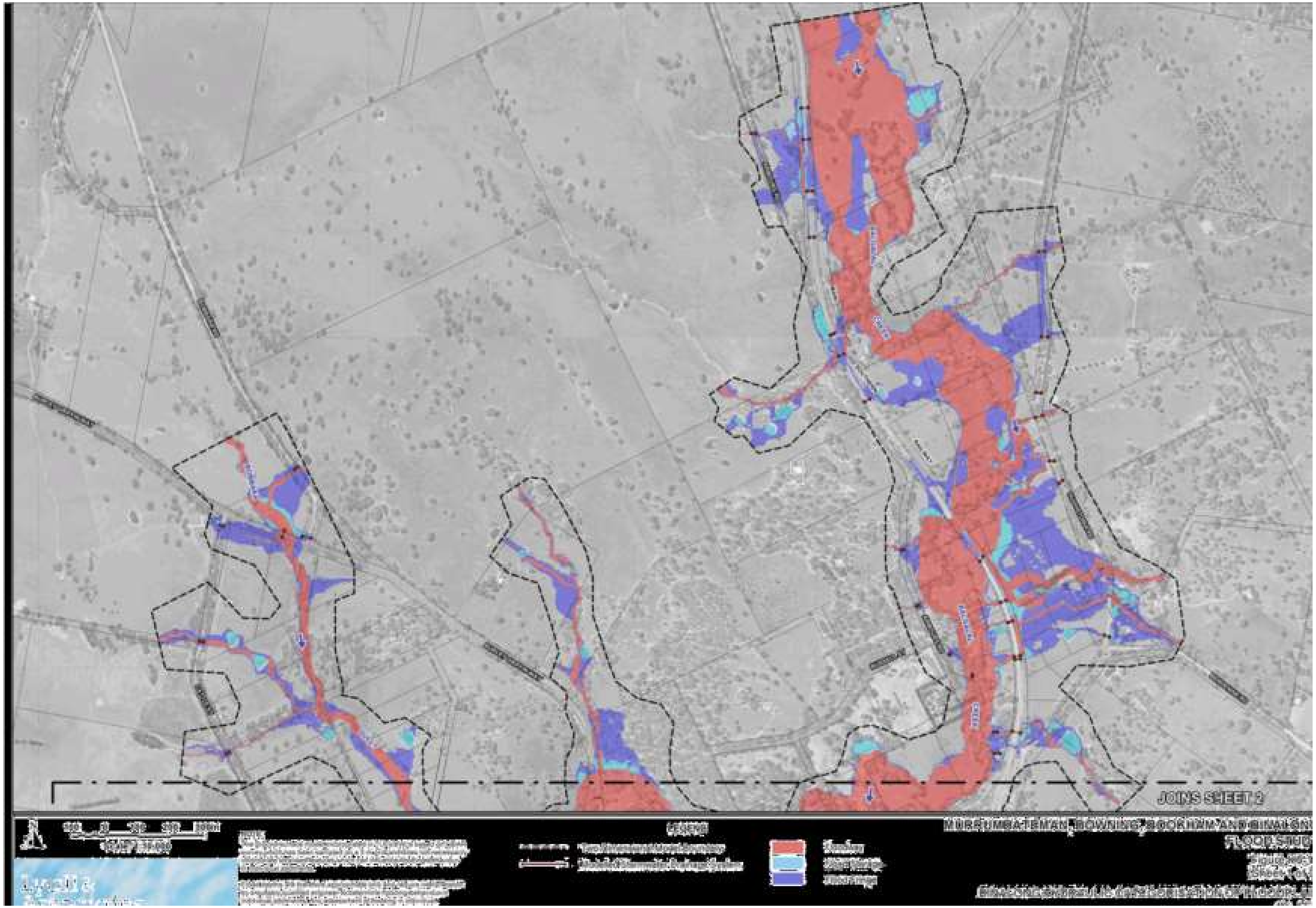
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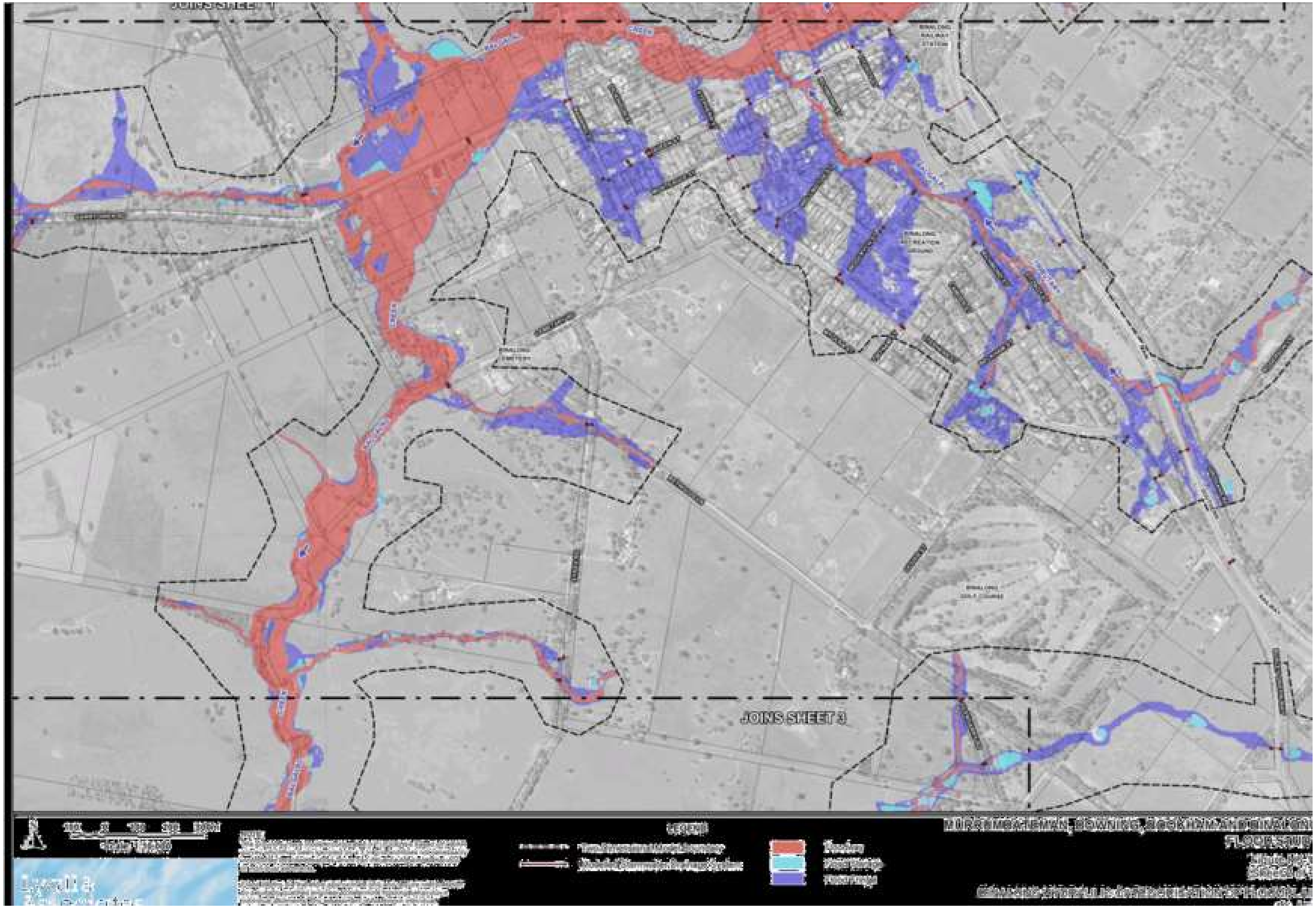
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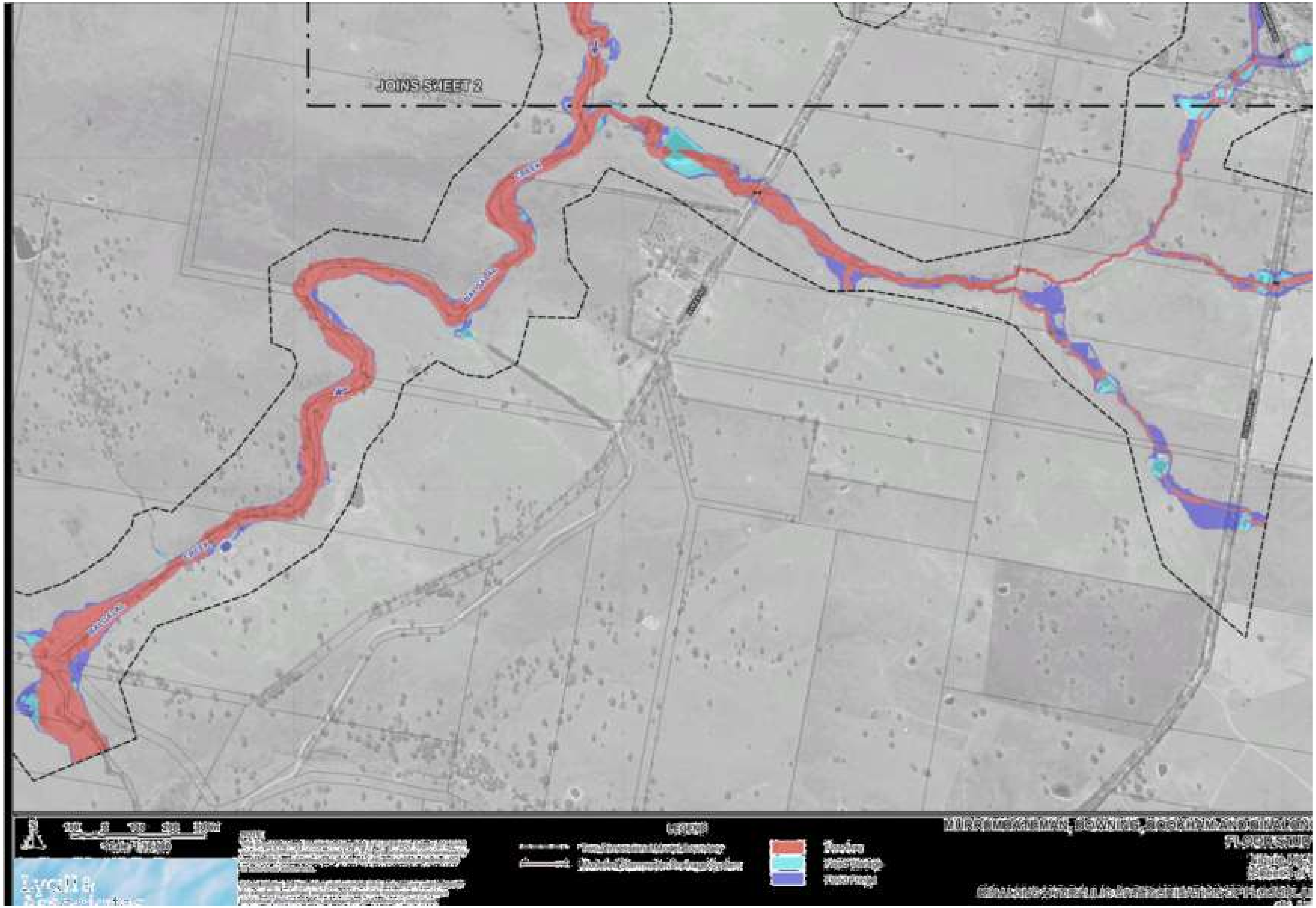
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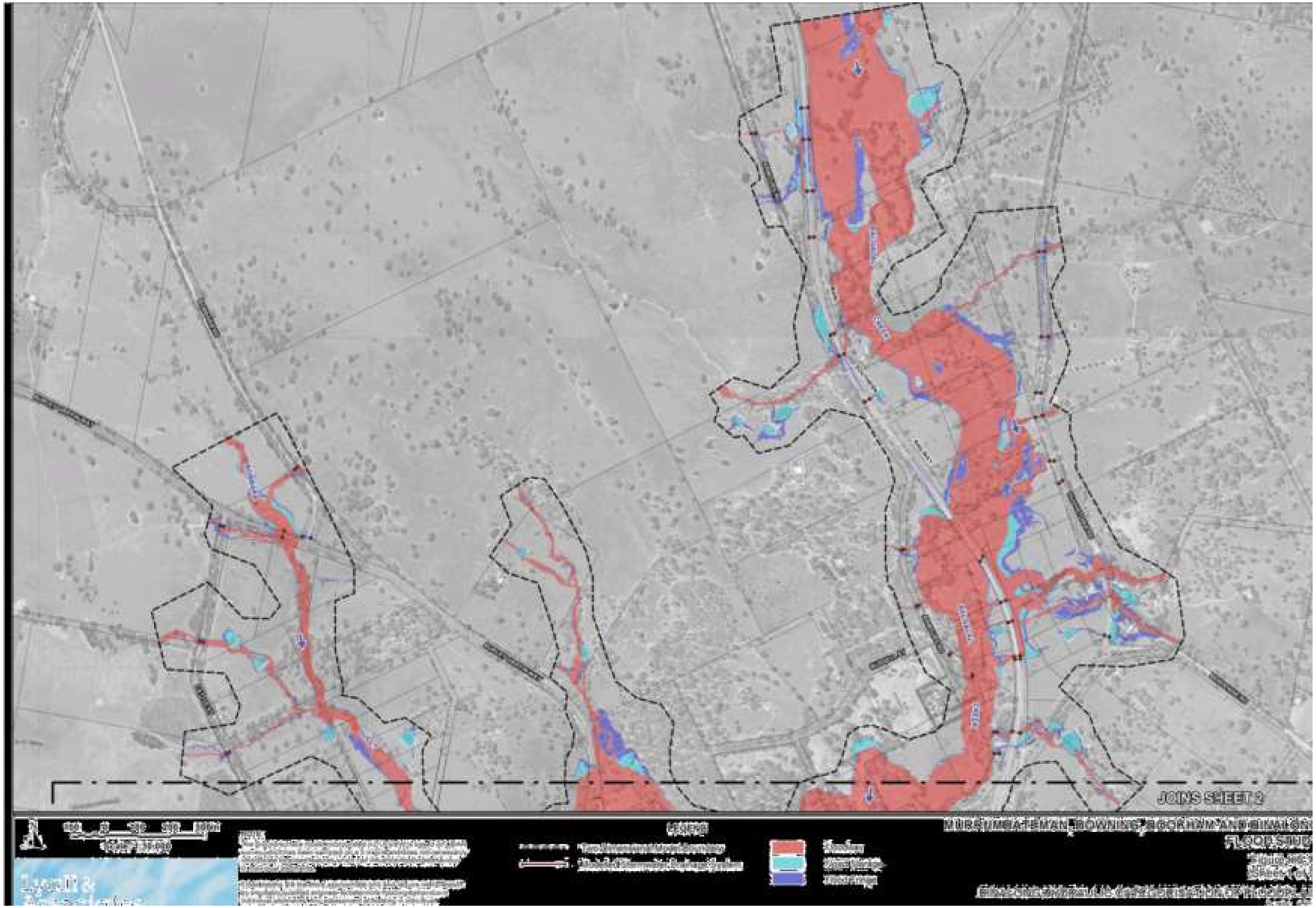
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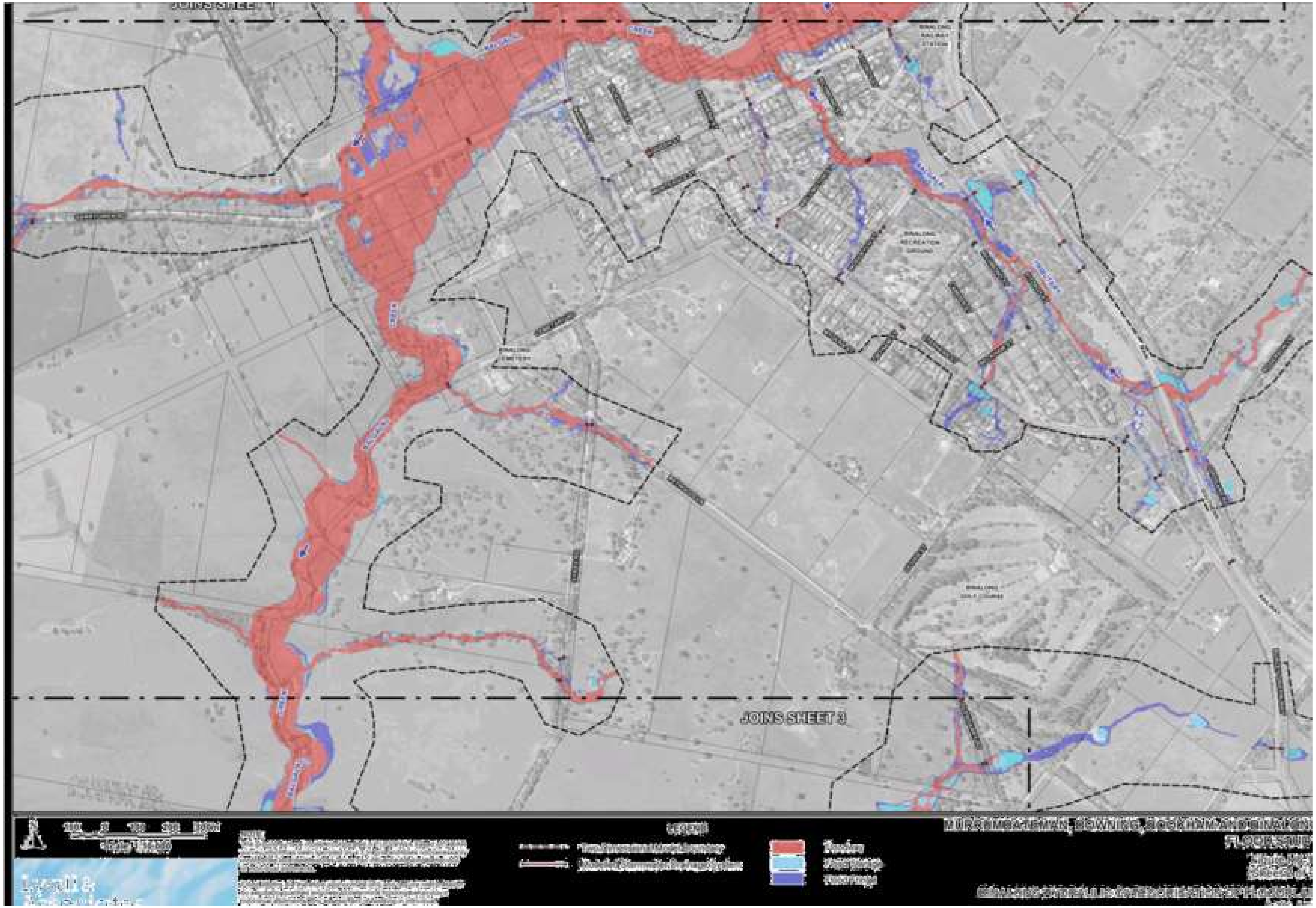
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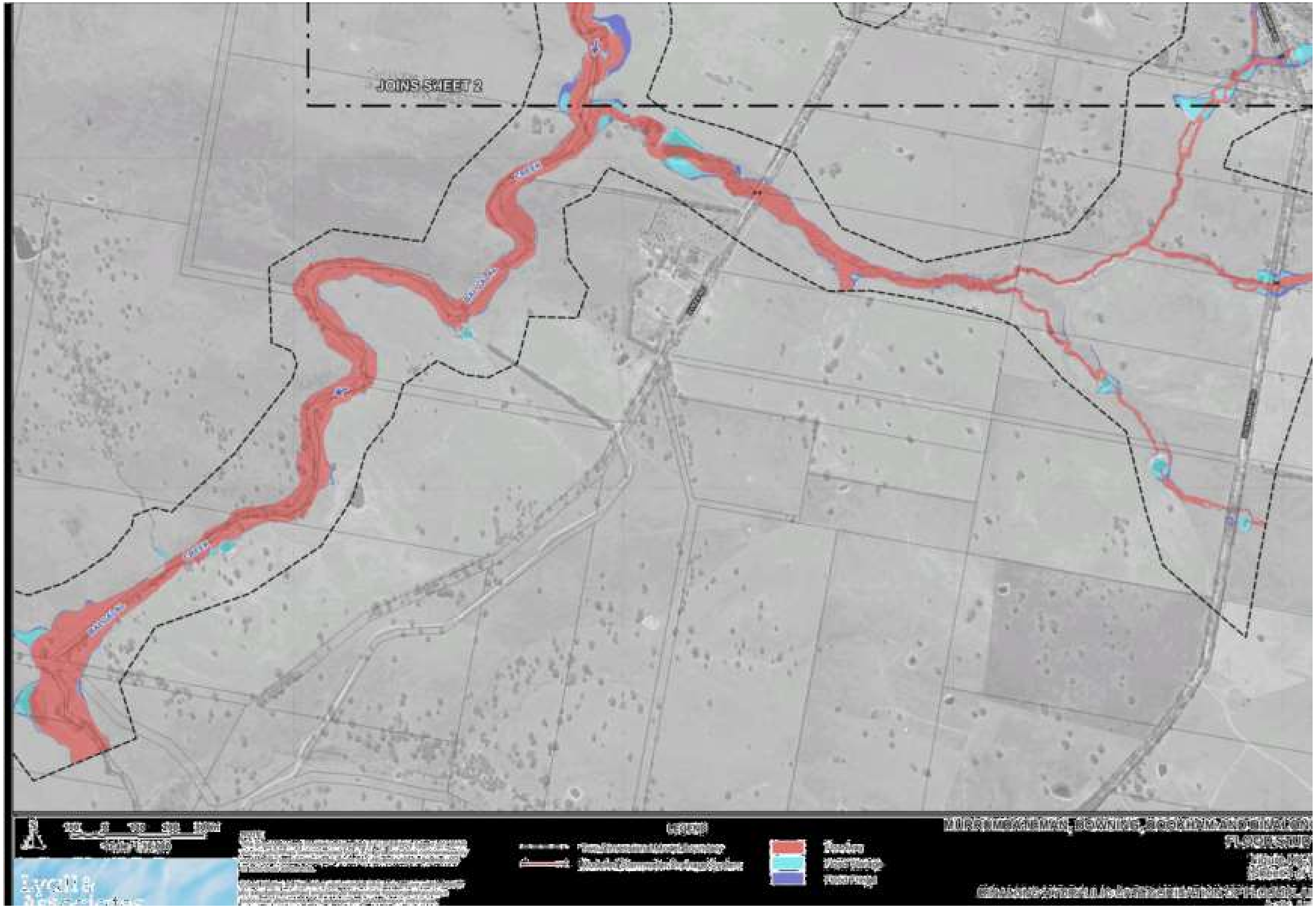
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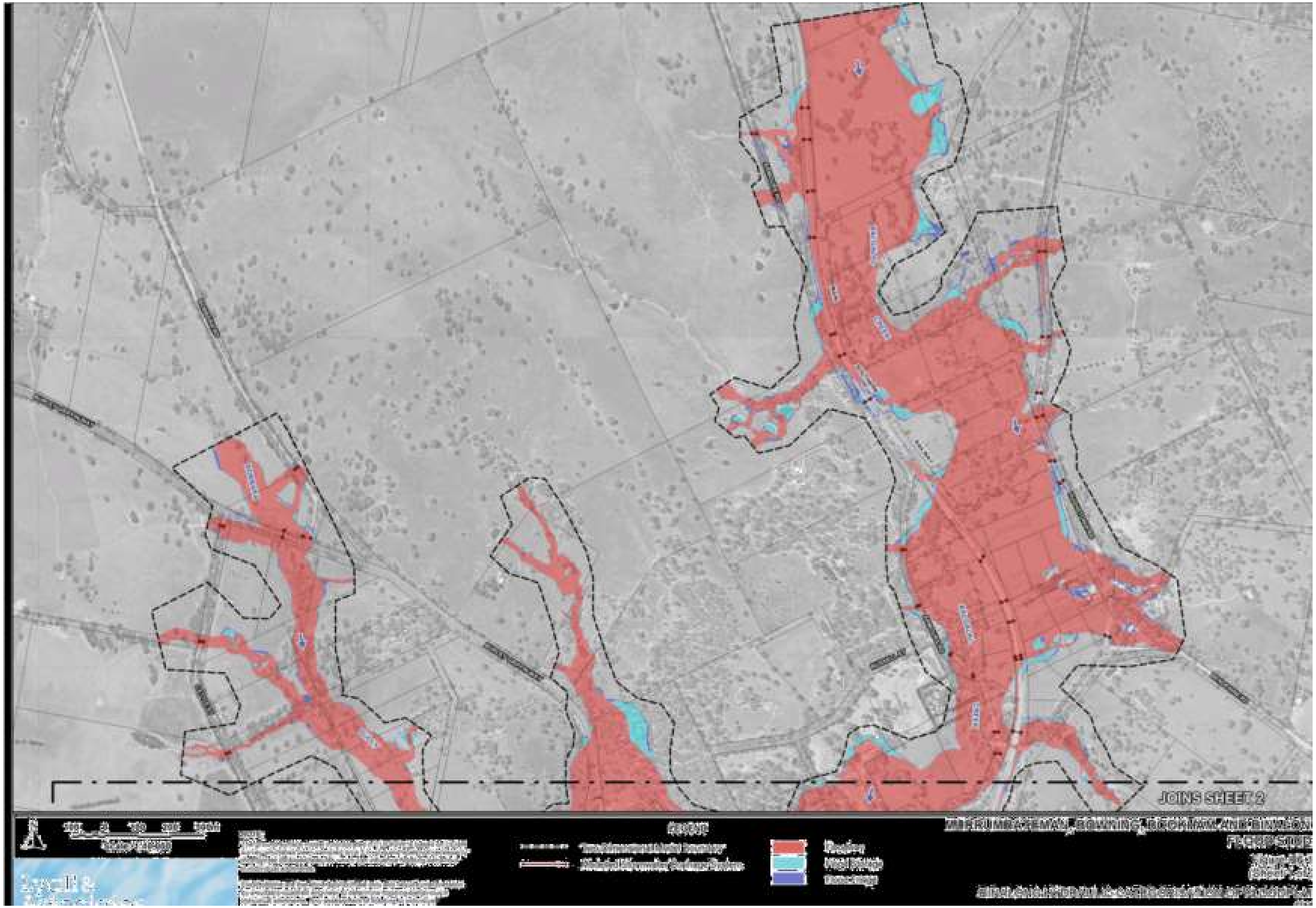
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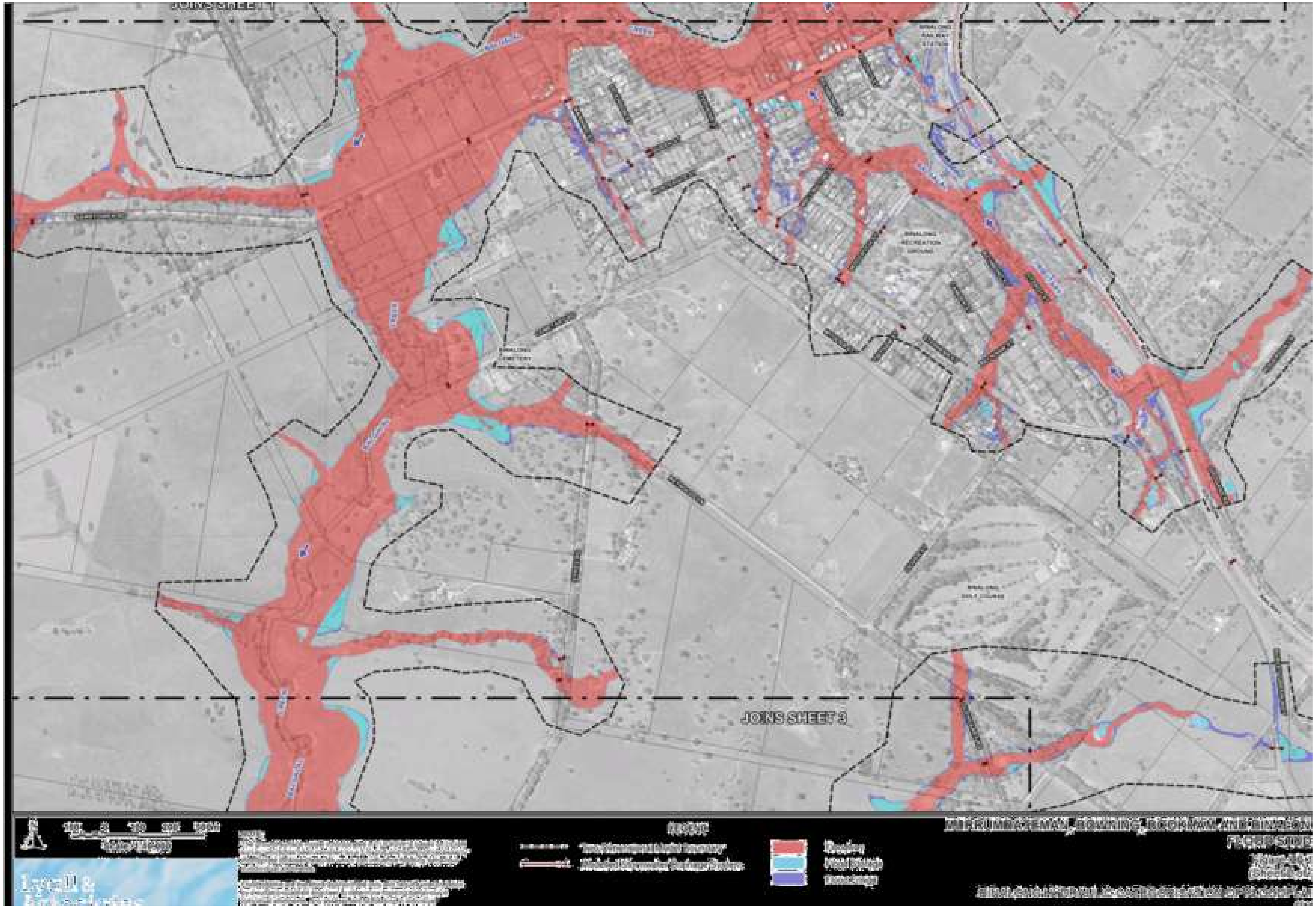
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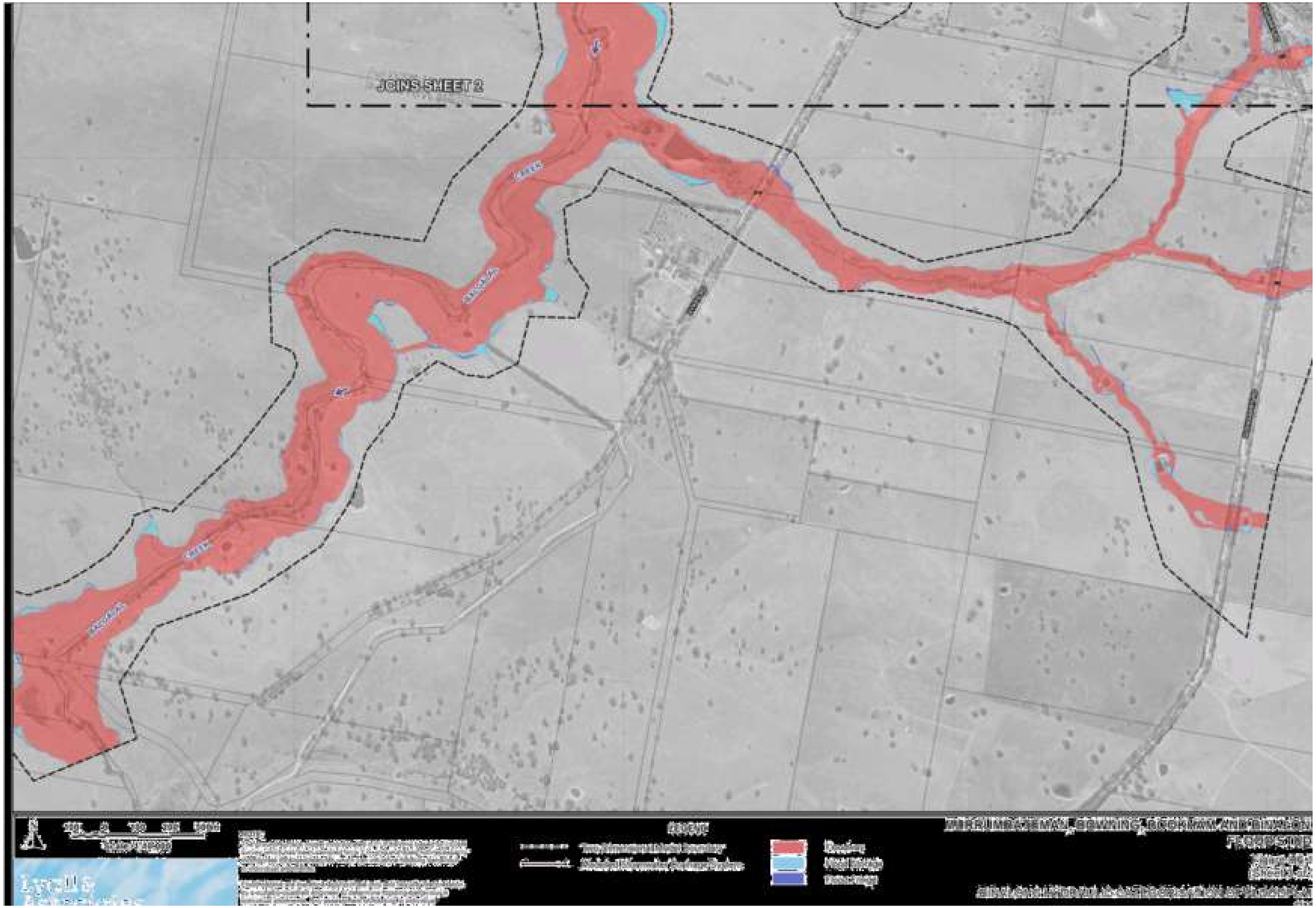
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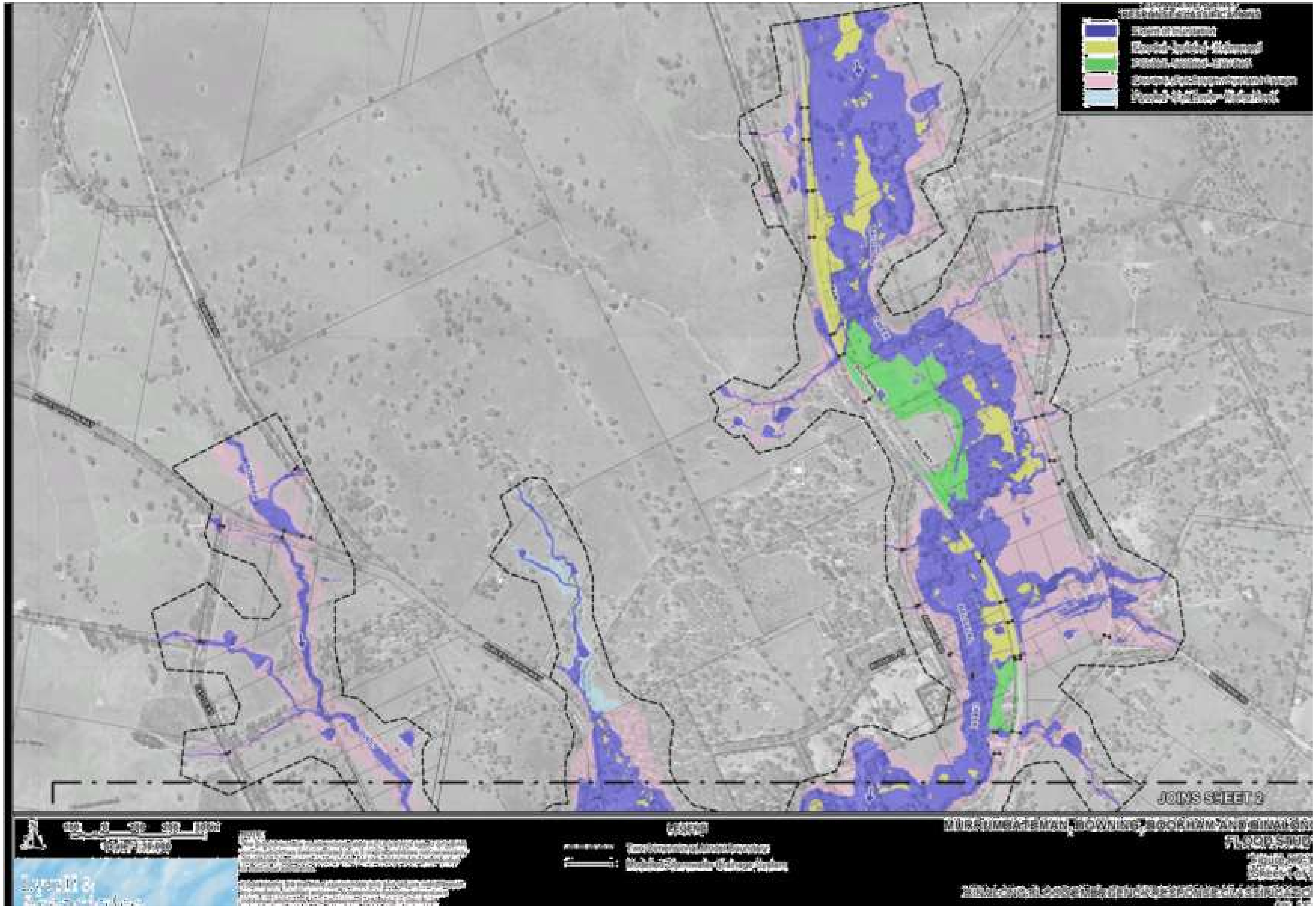
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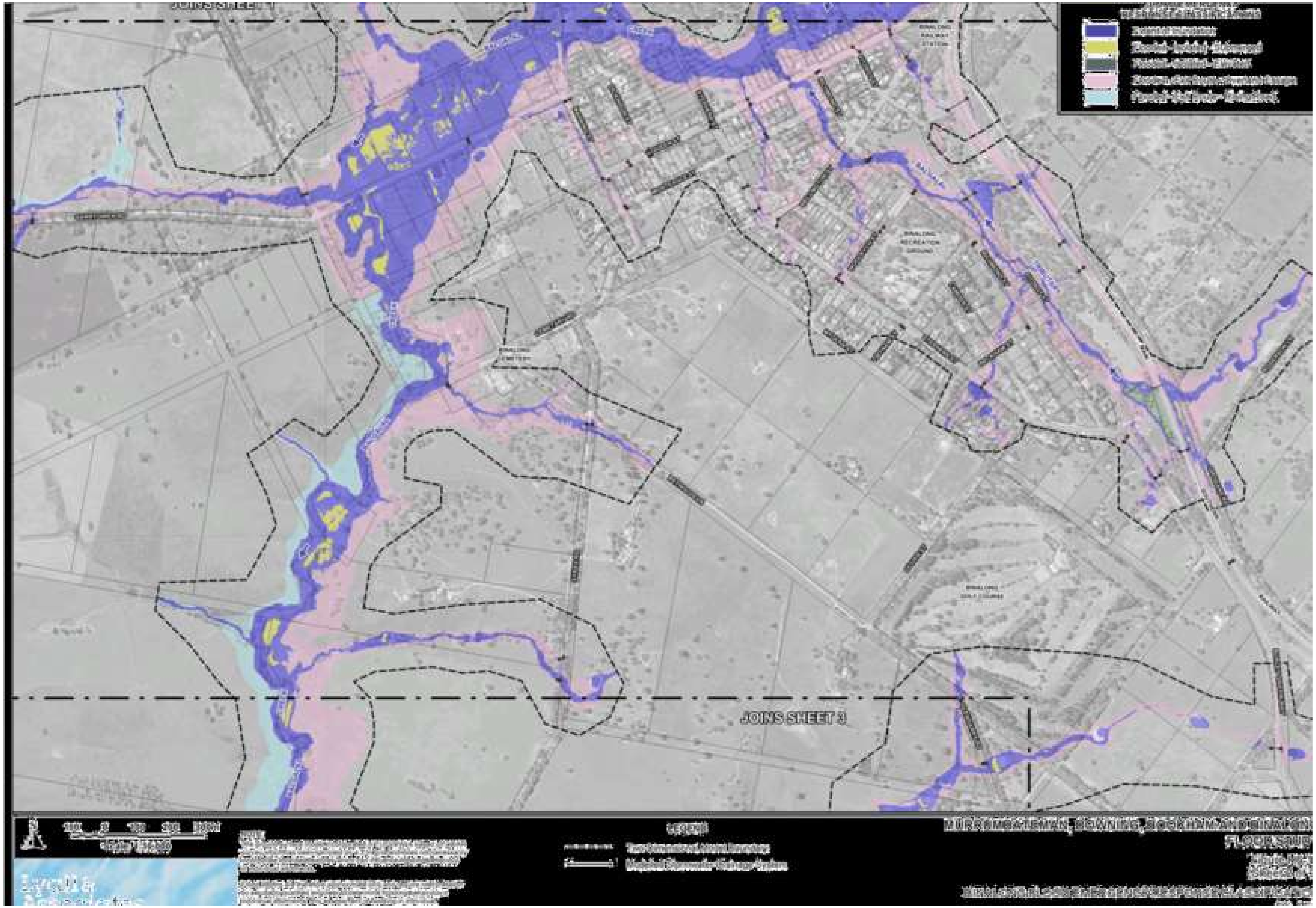
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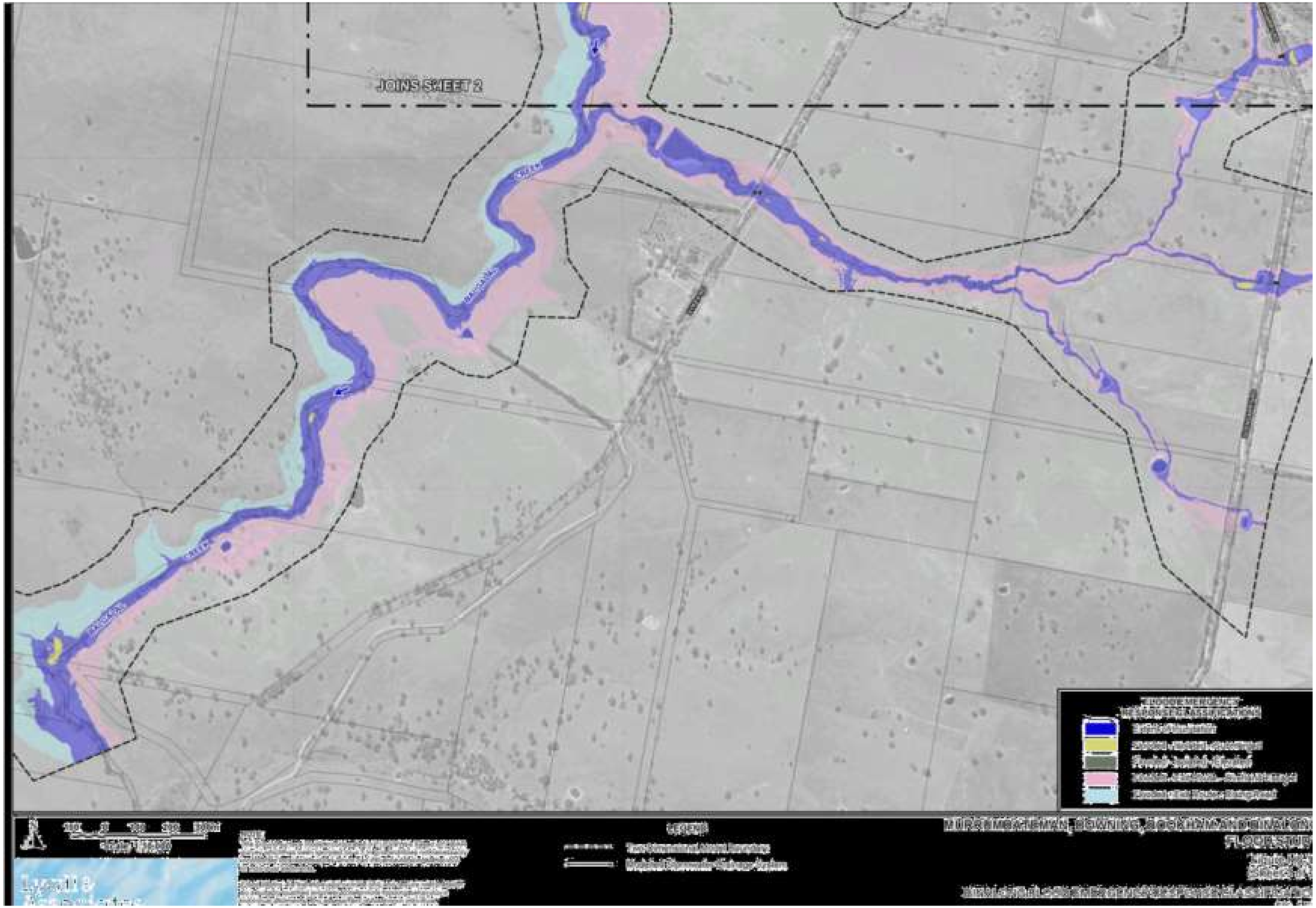
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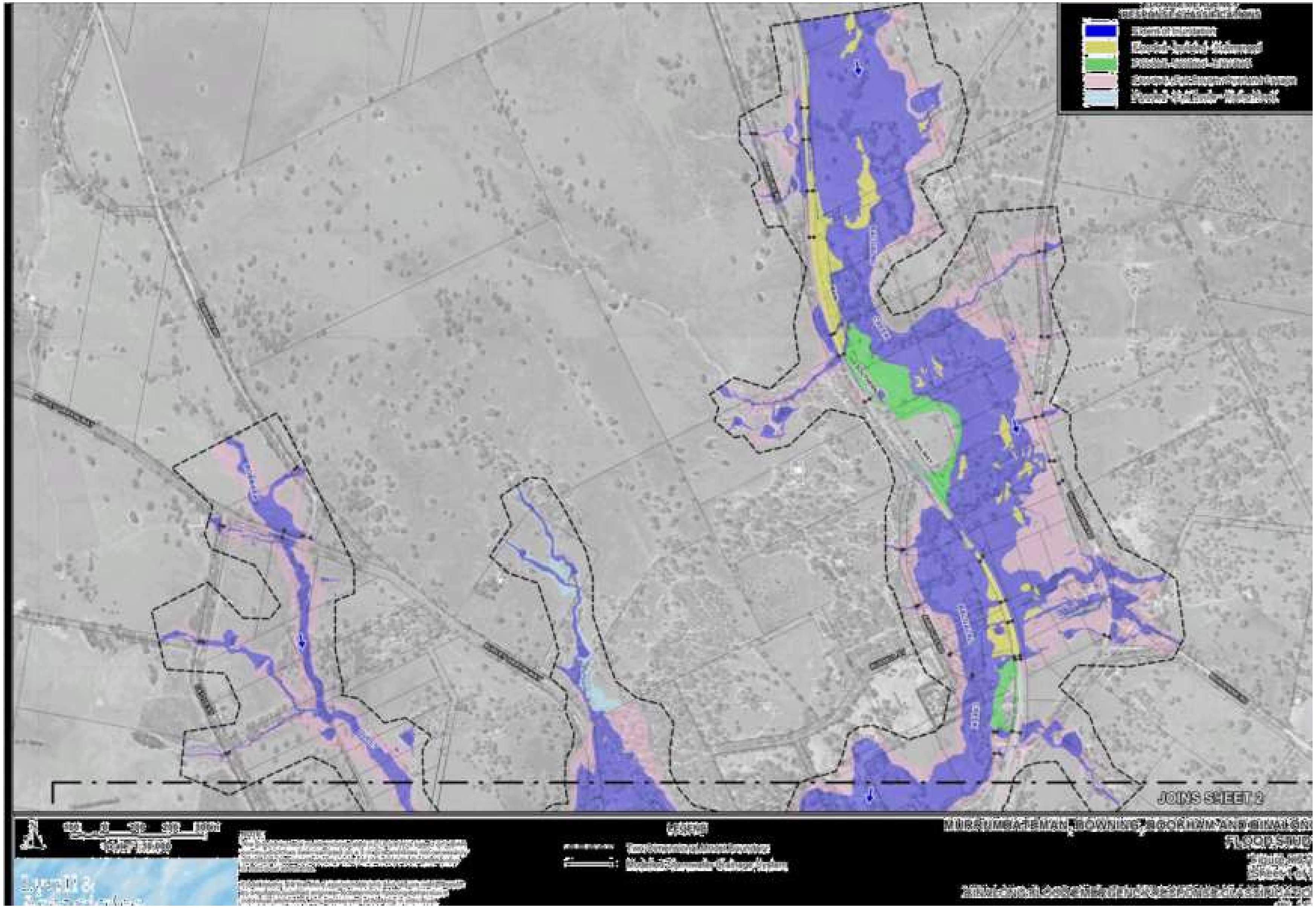
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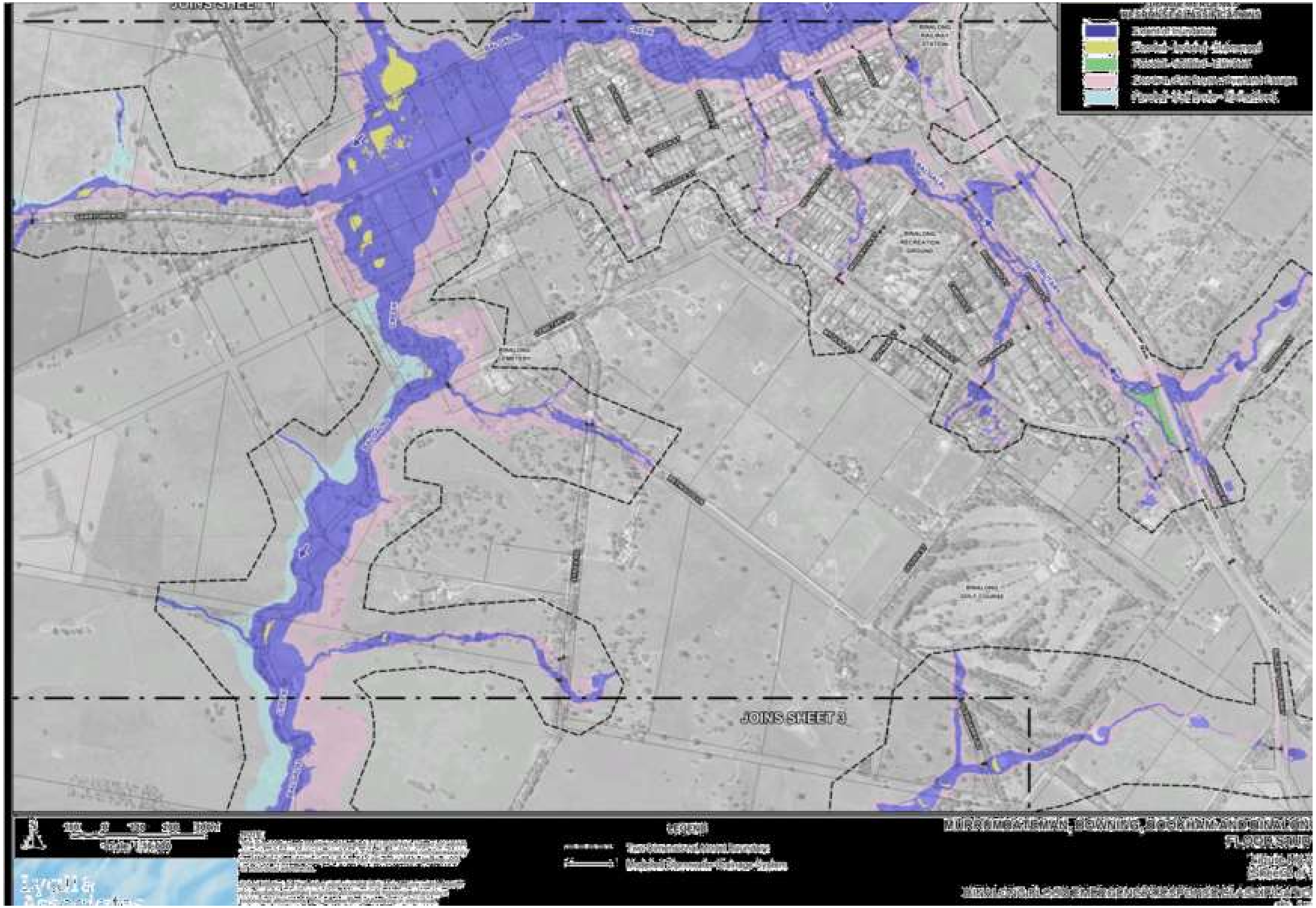
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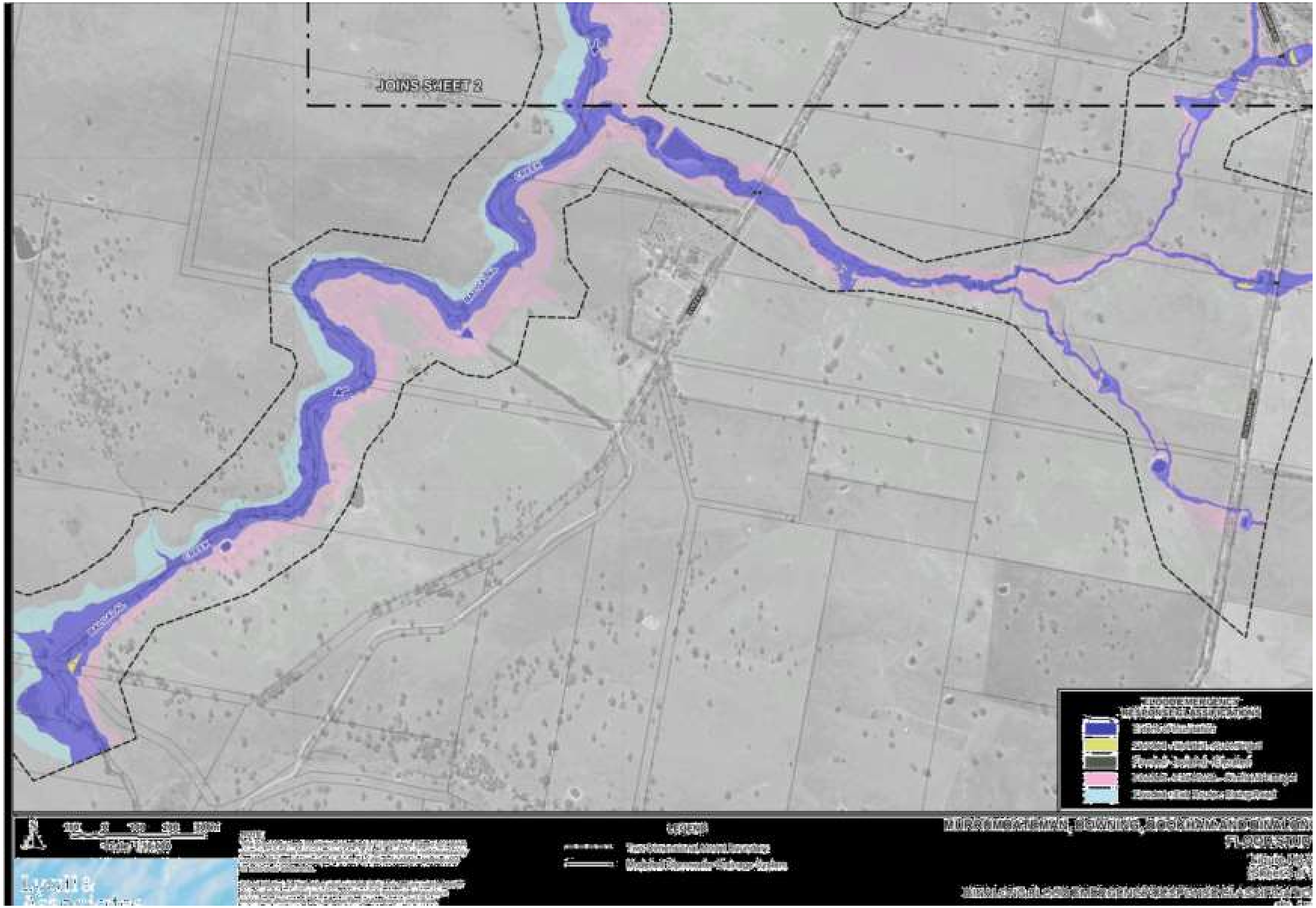
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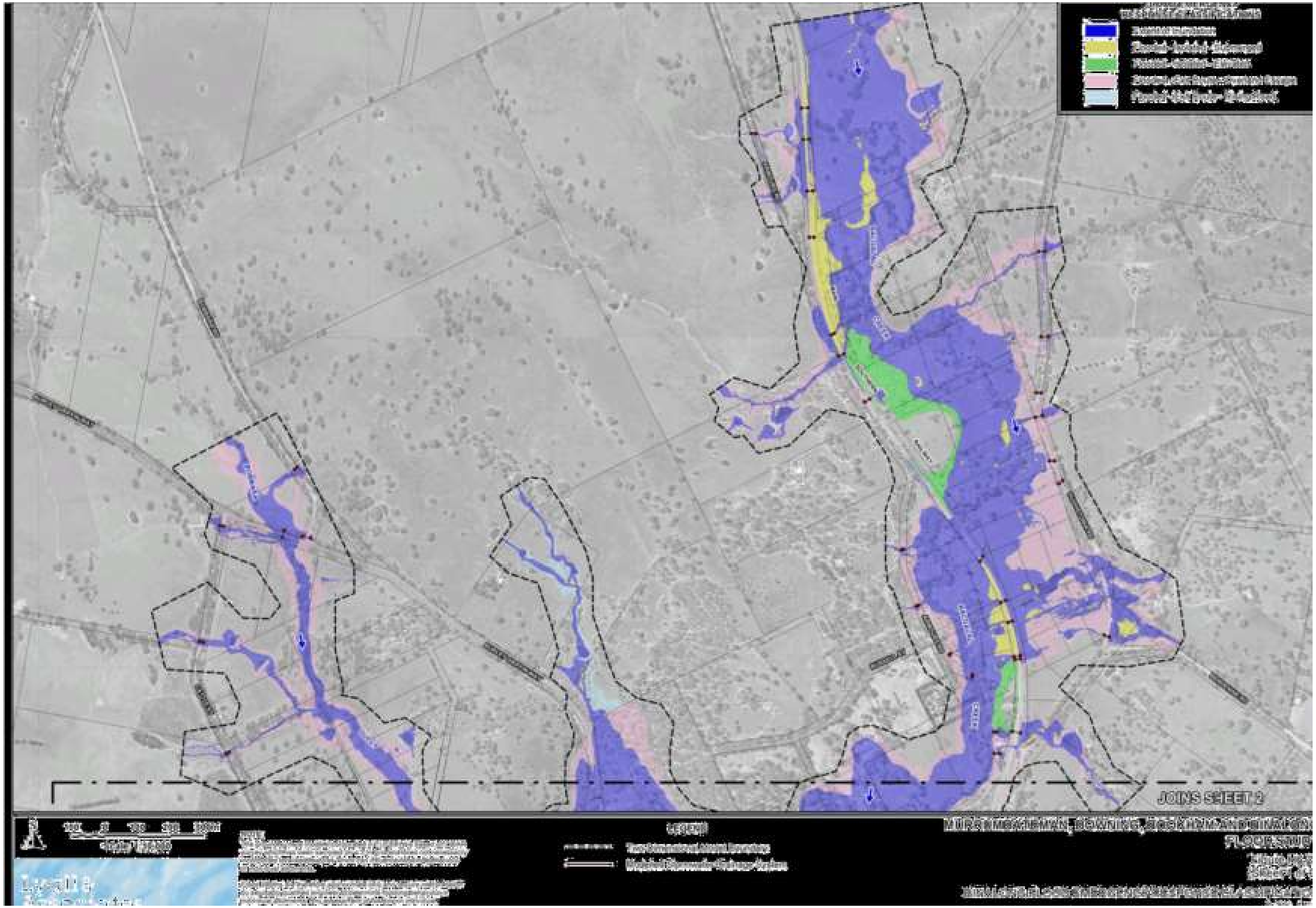
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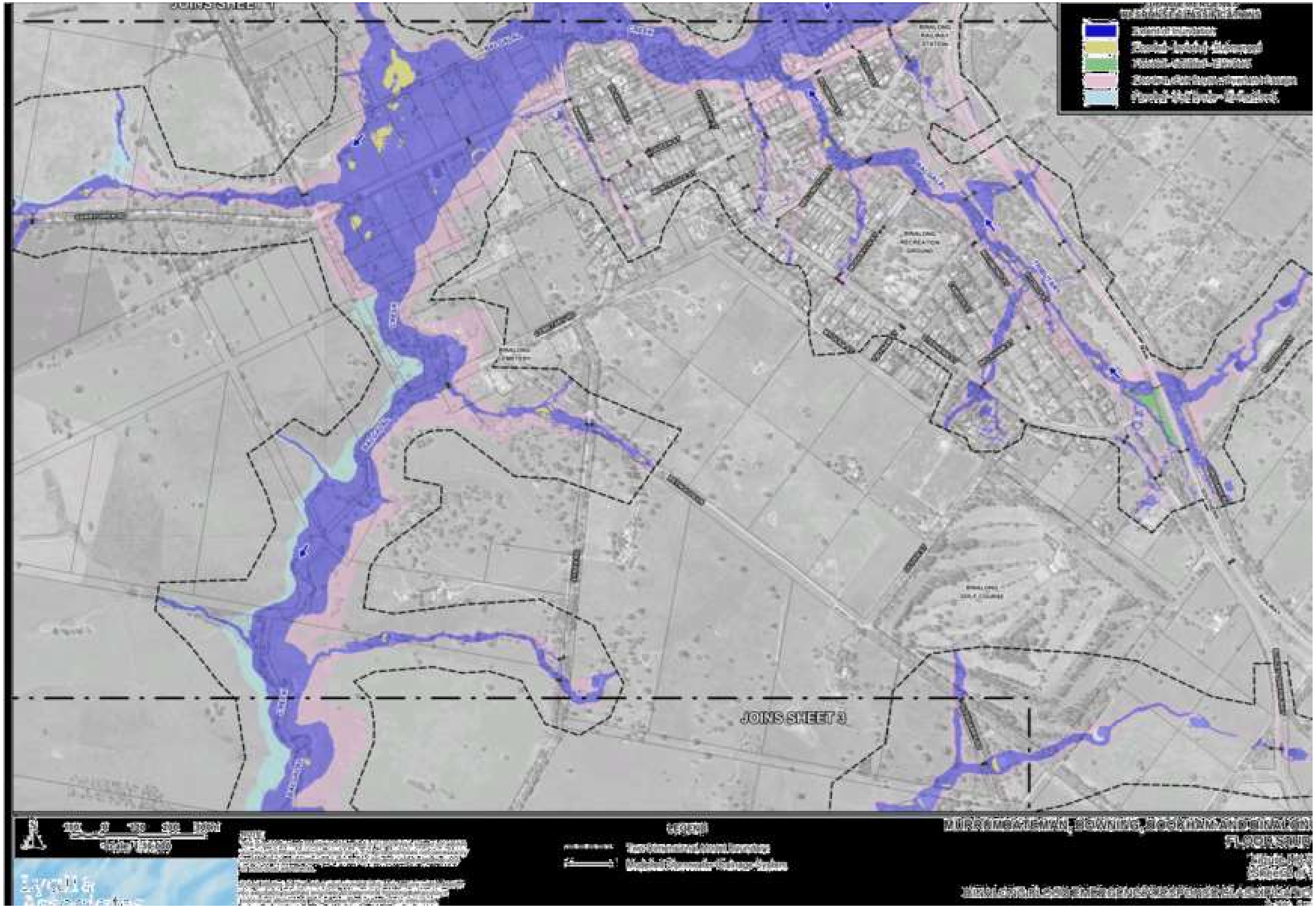
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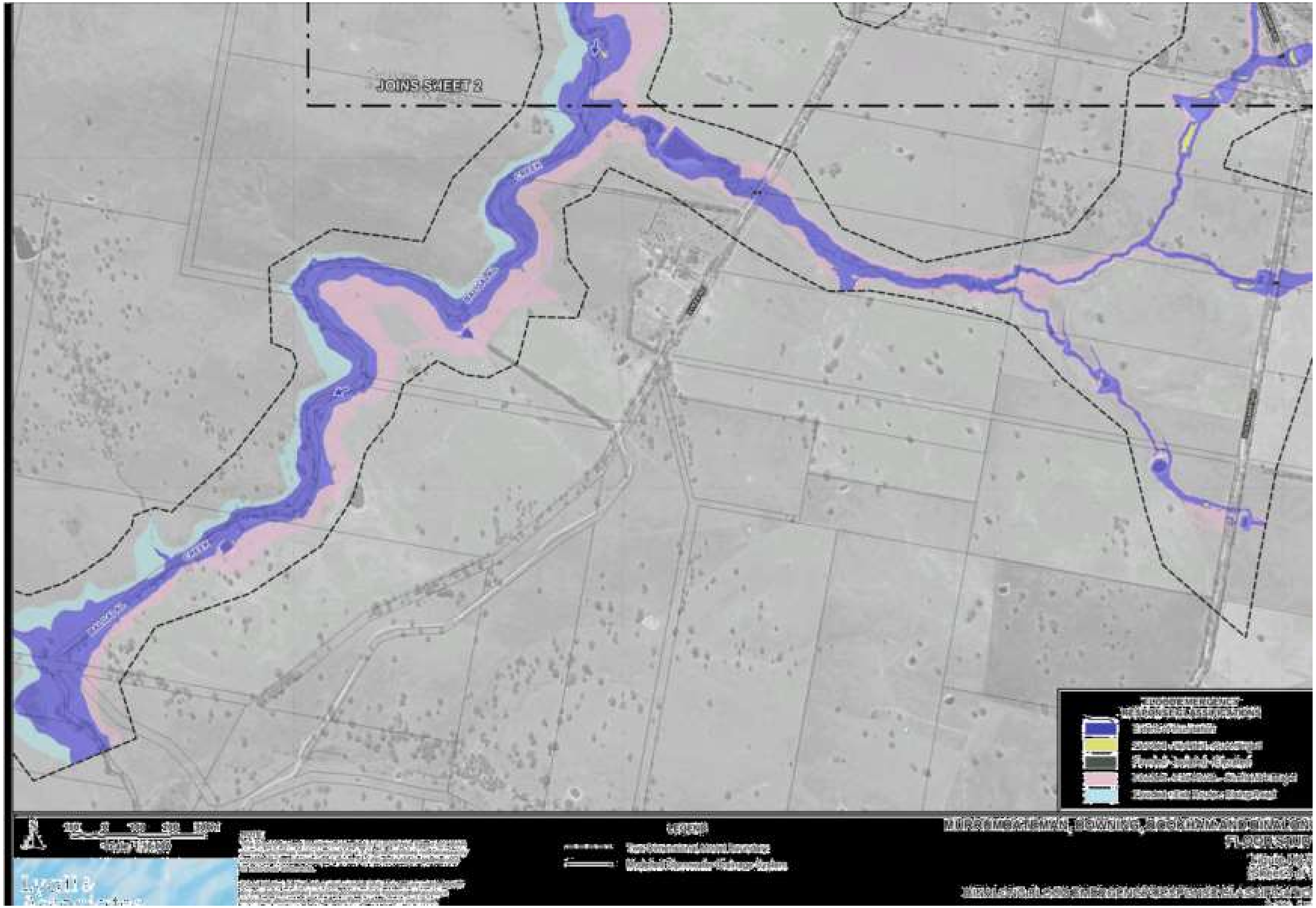
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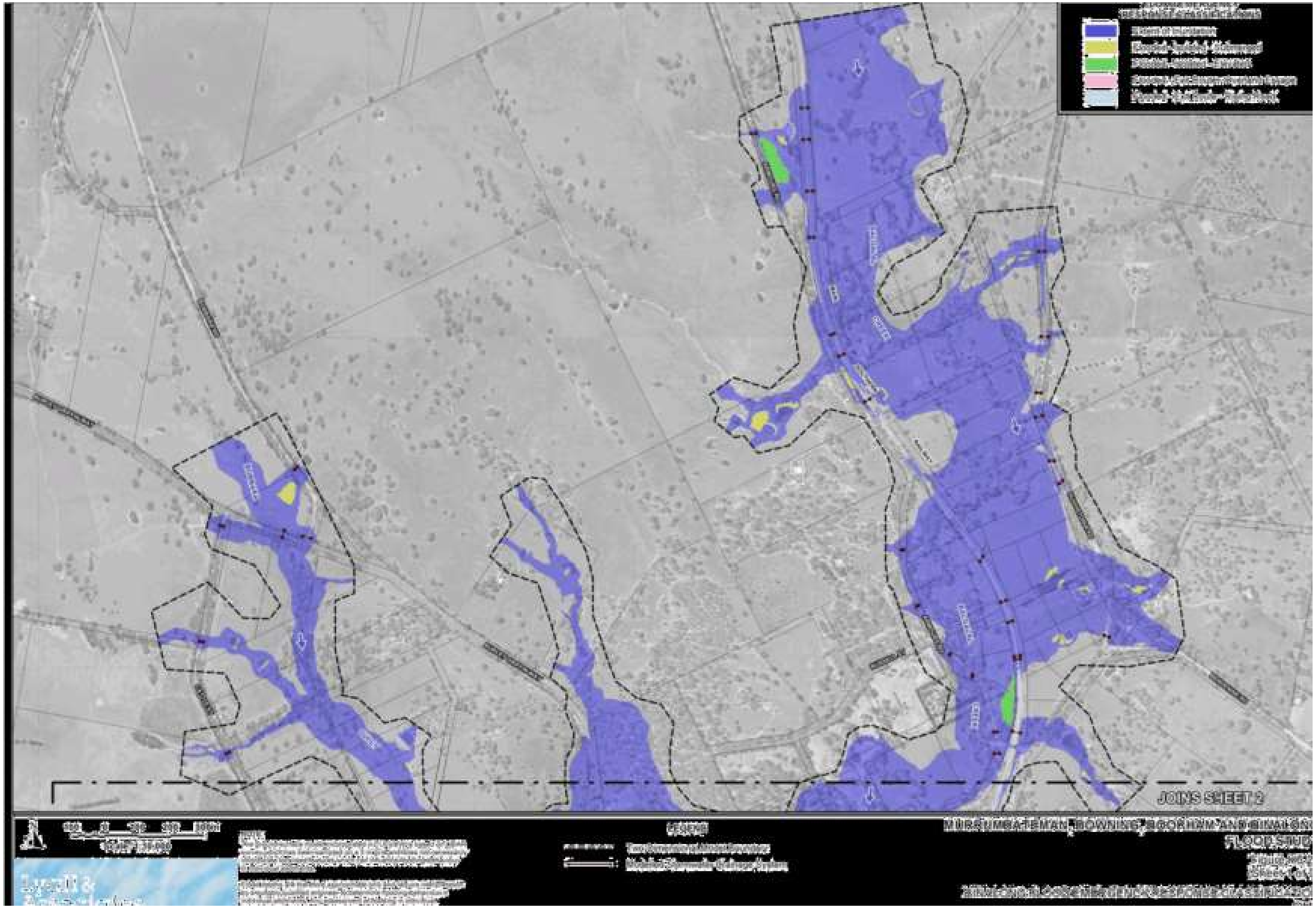
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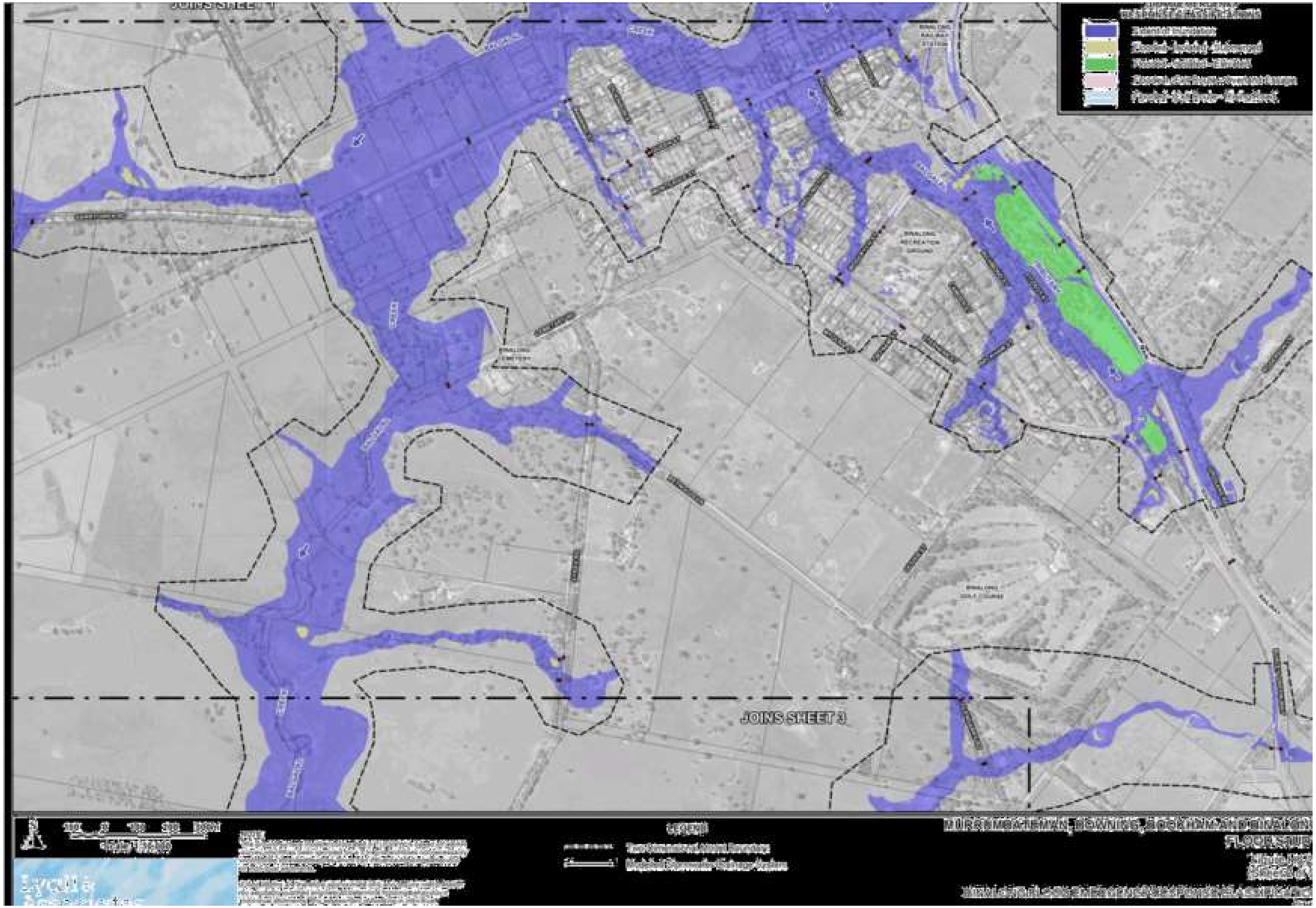
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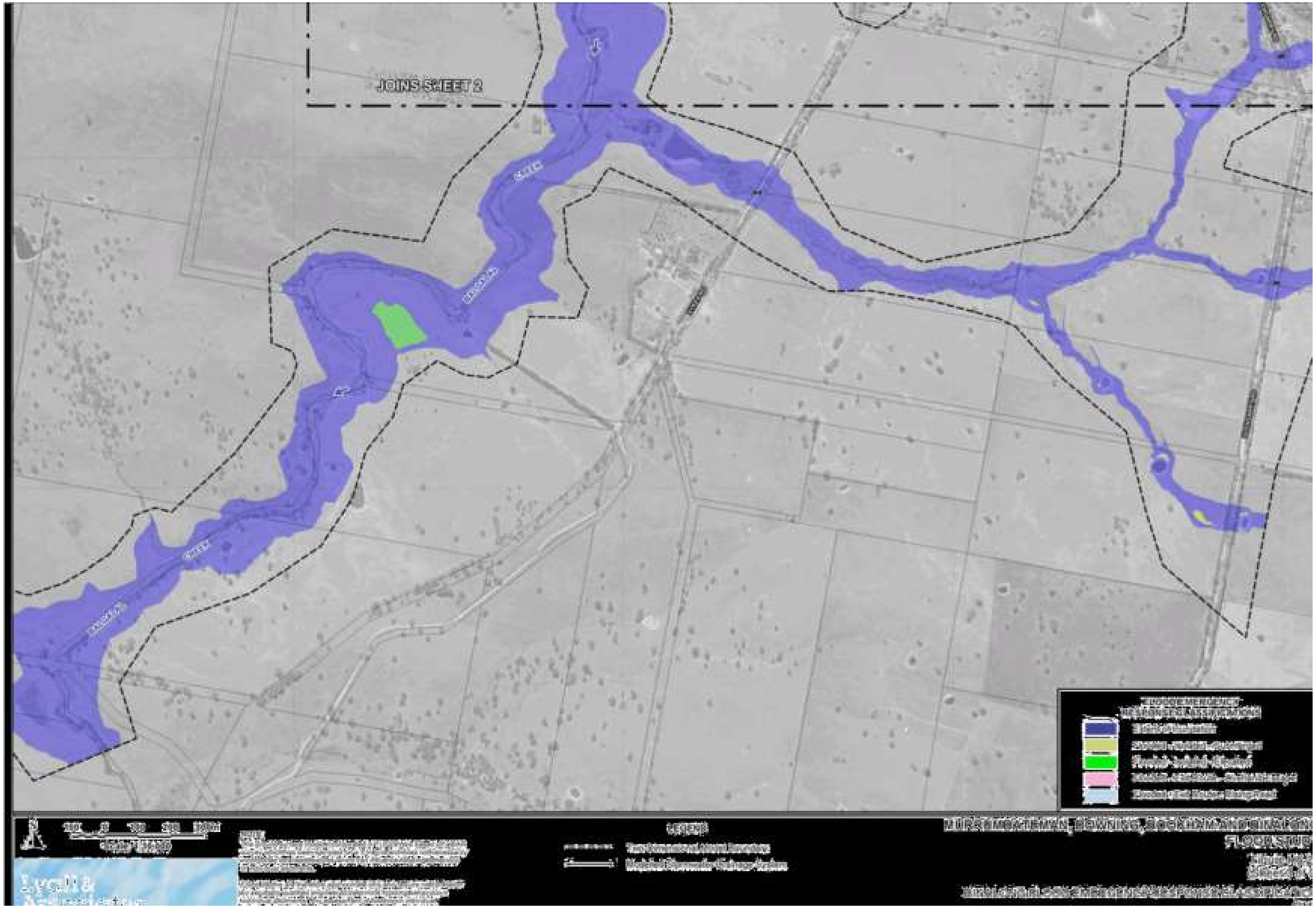
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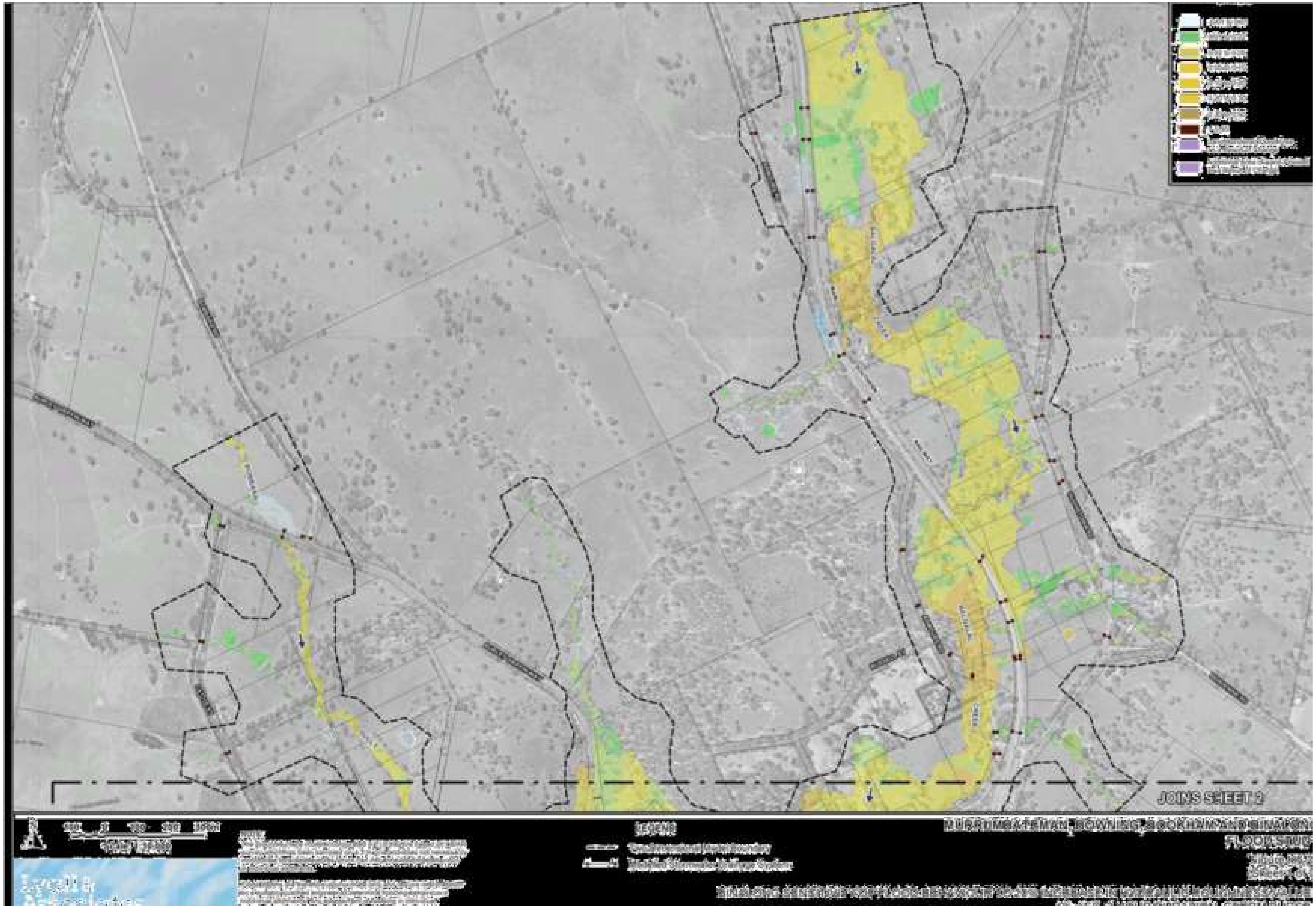
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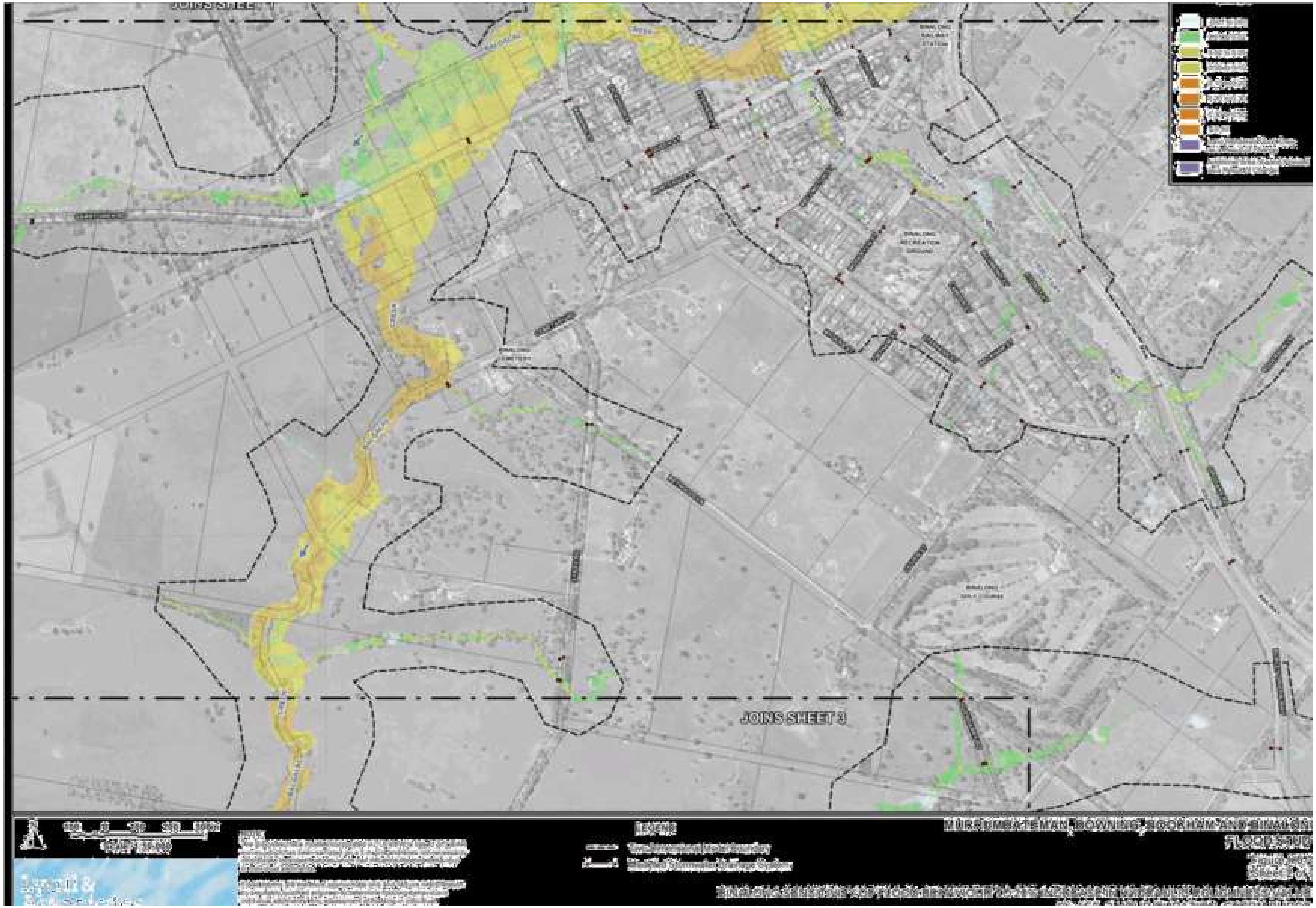
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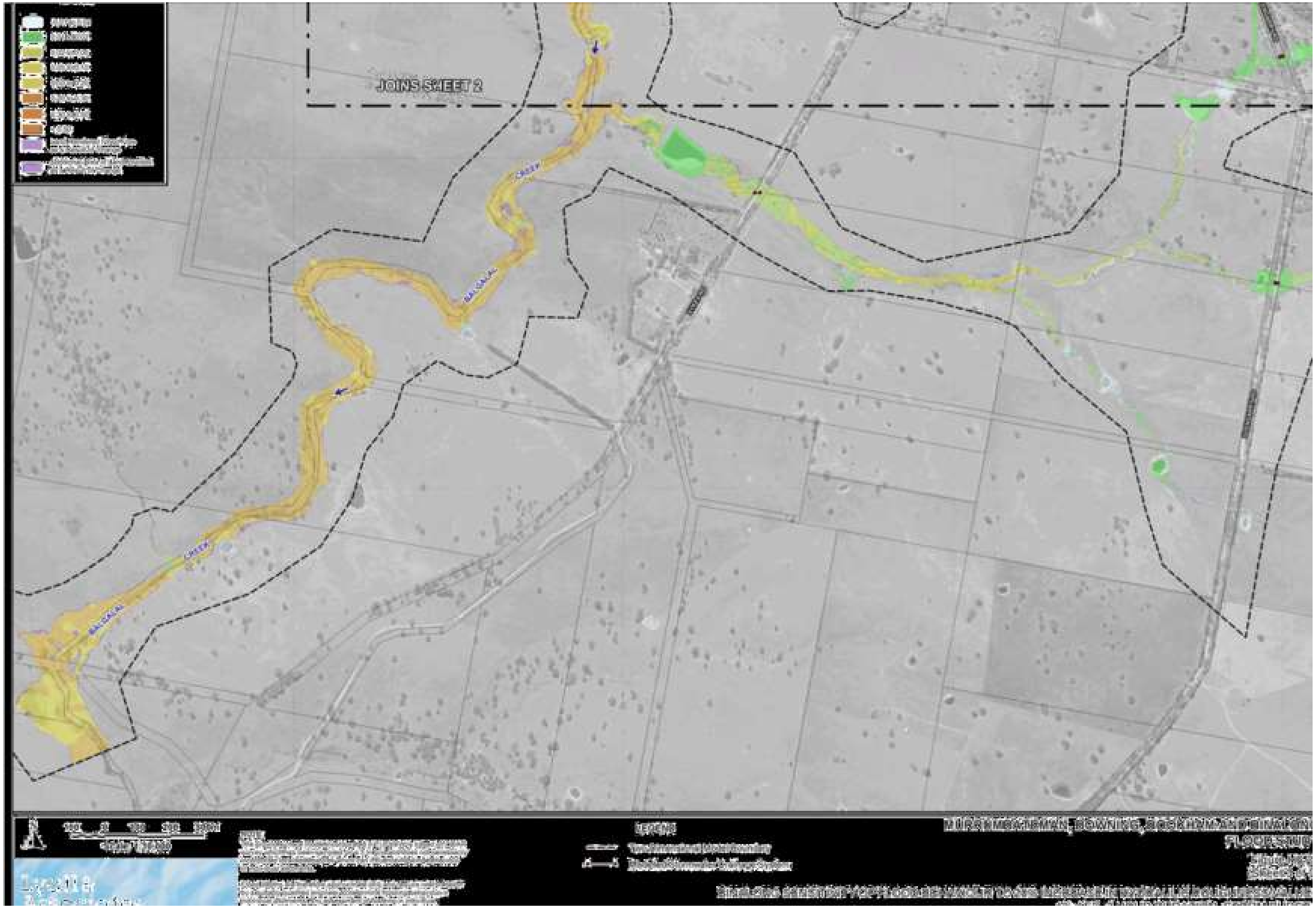
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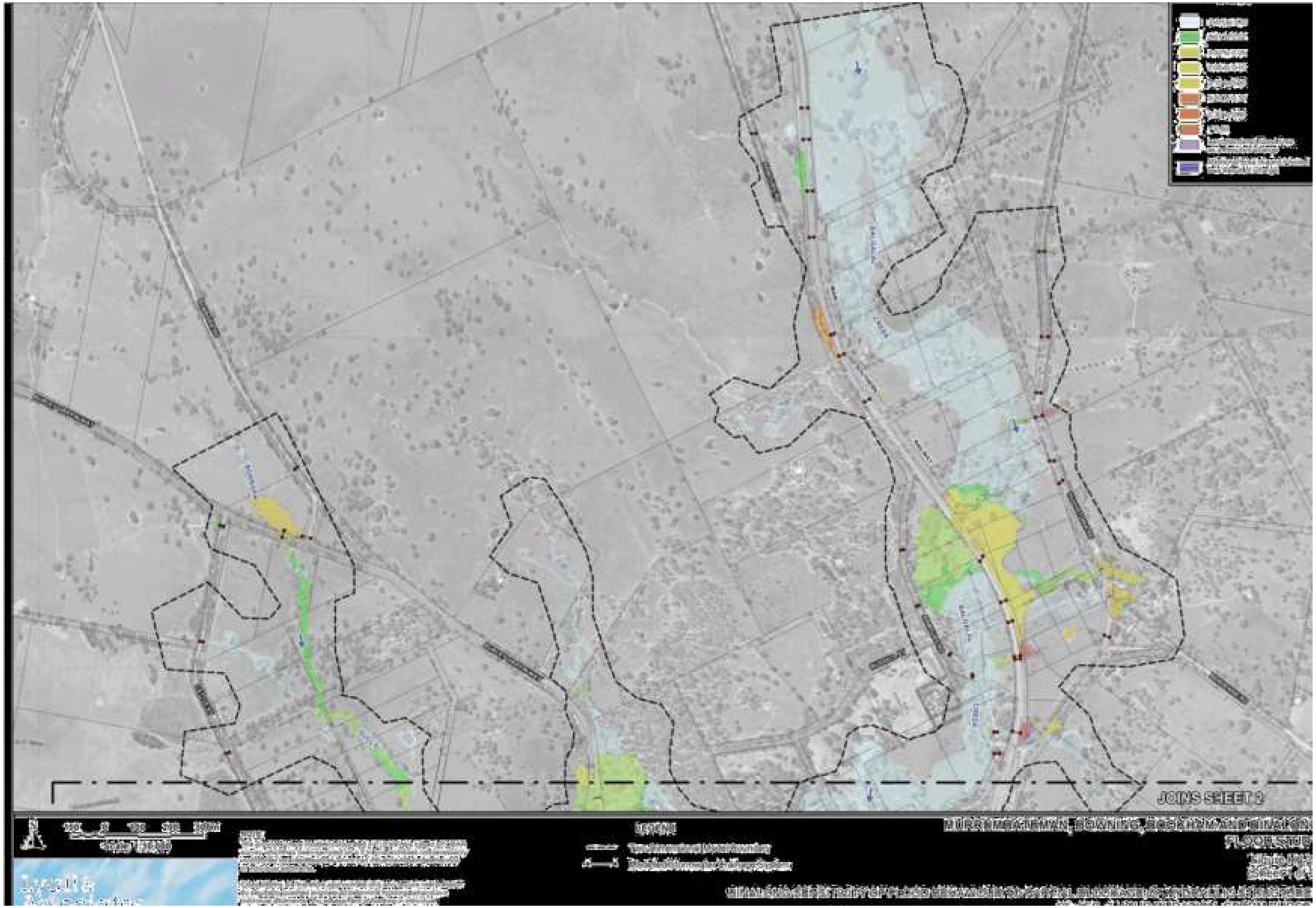
BALGALAL
CREEK
BALGALAL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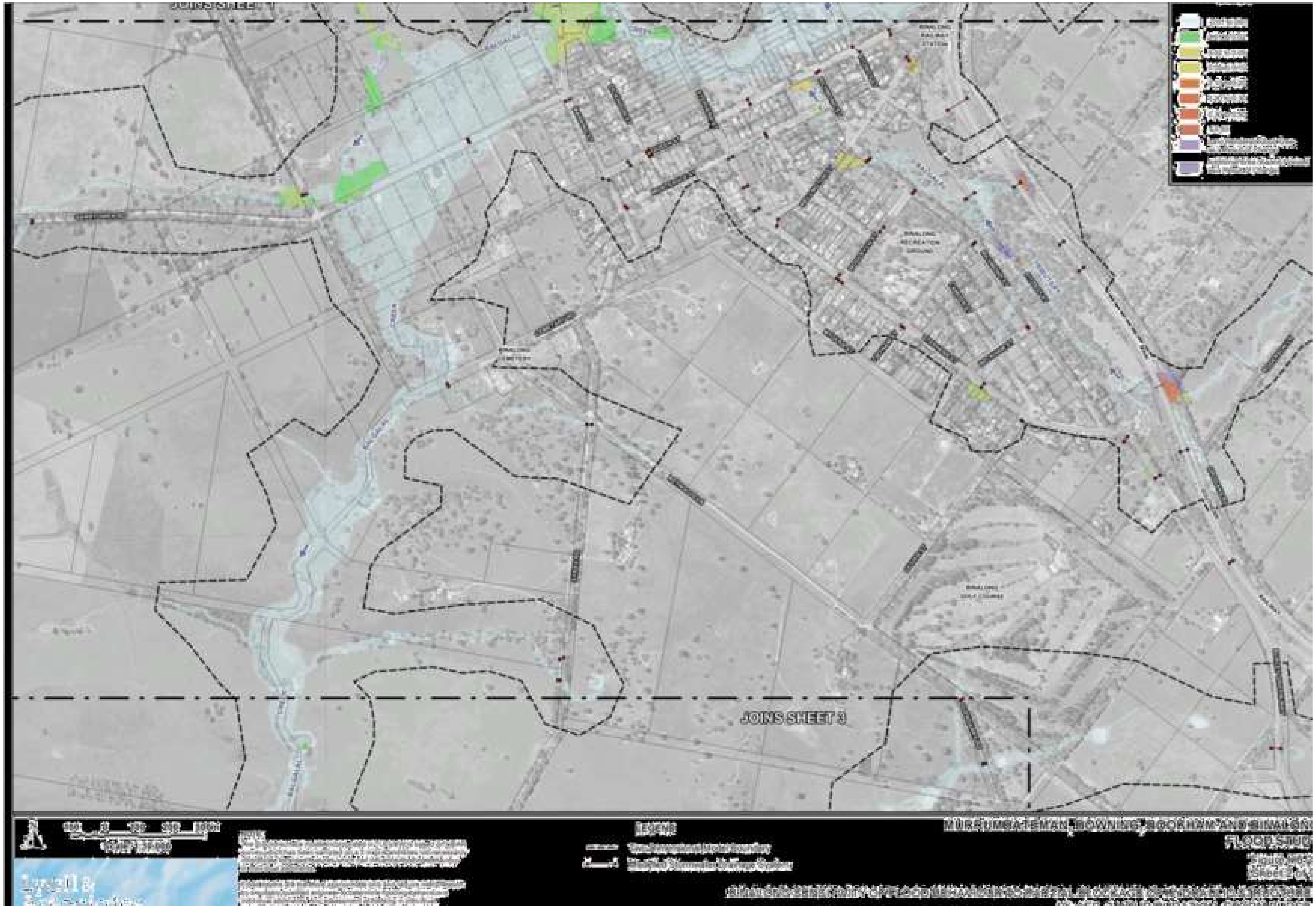
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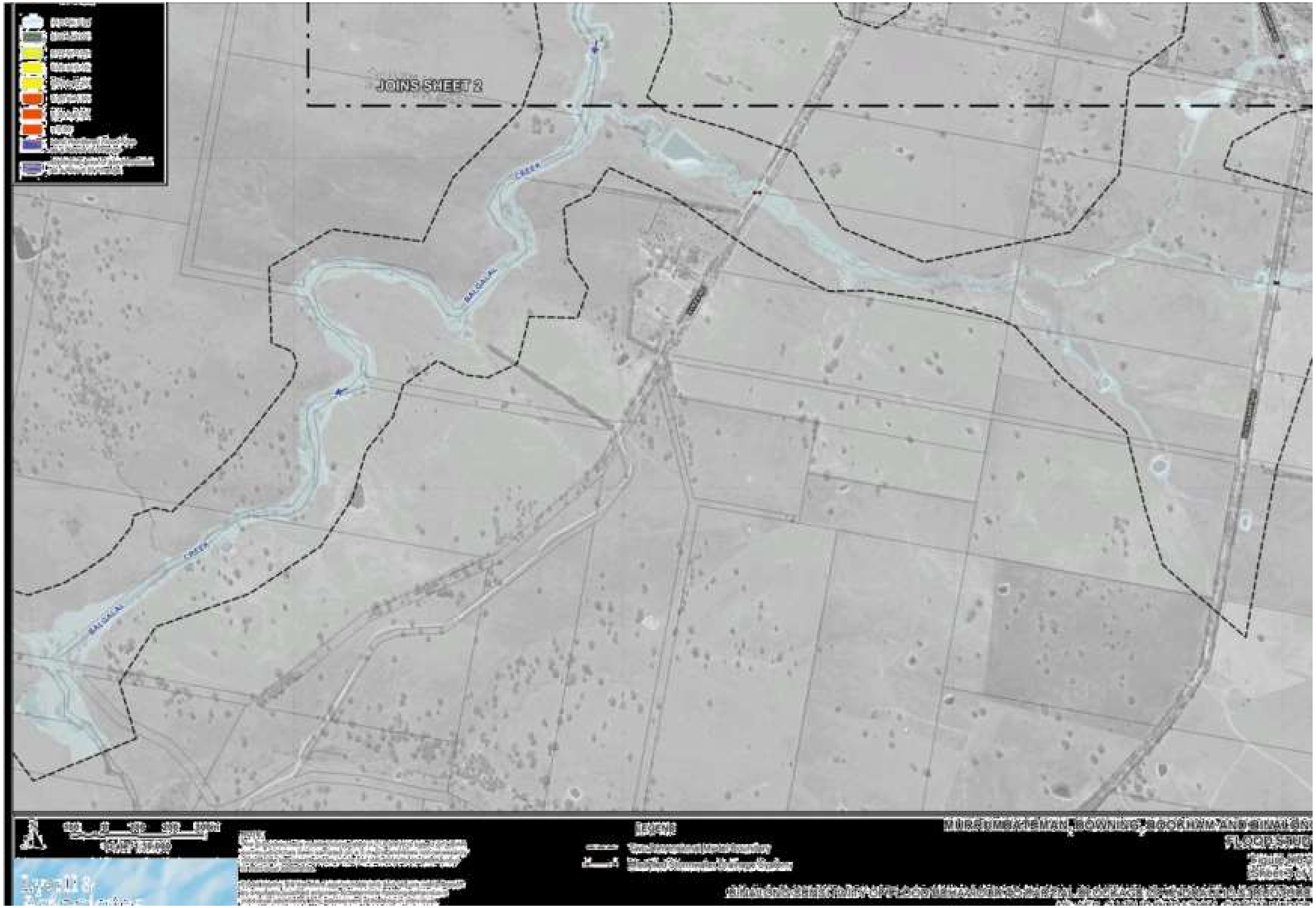
BINALONG RECREATION GROUND
BINALONG GOLF COURSE
LEGEND
FLOOD STUDY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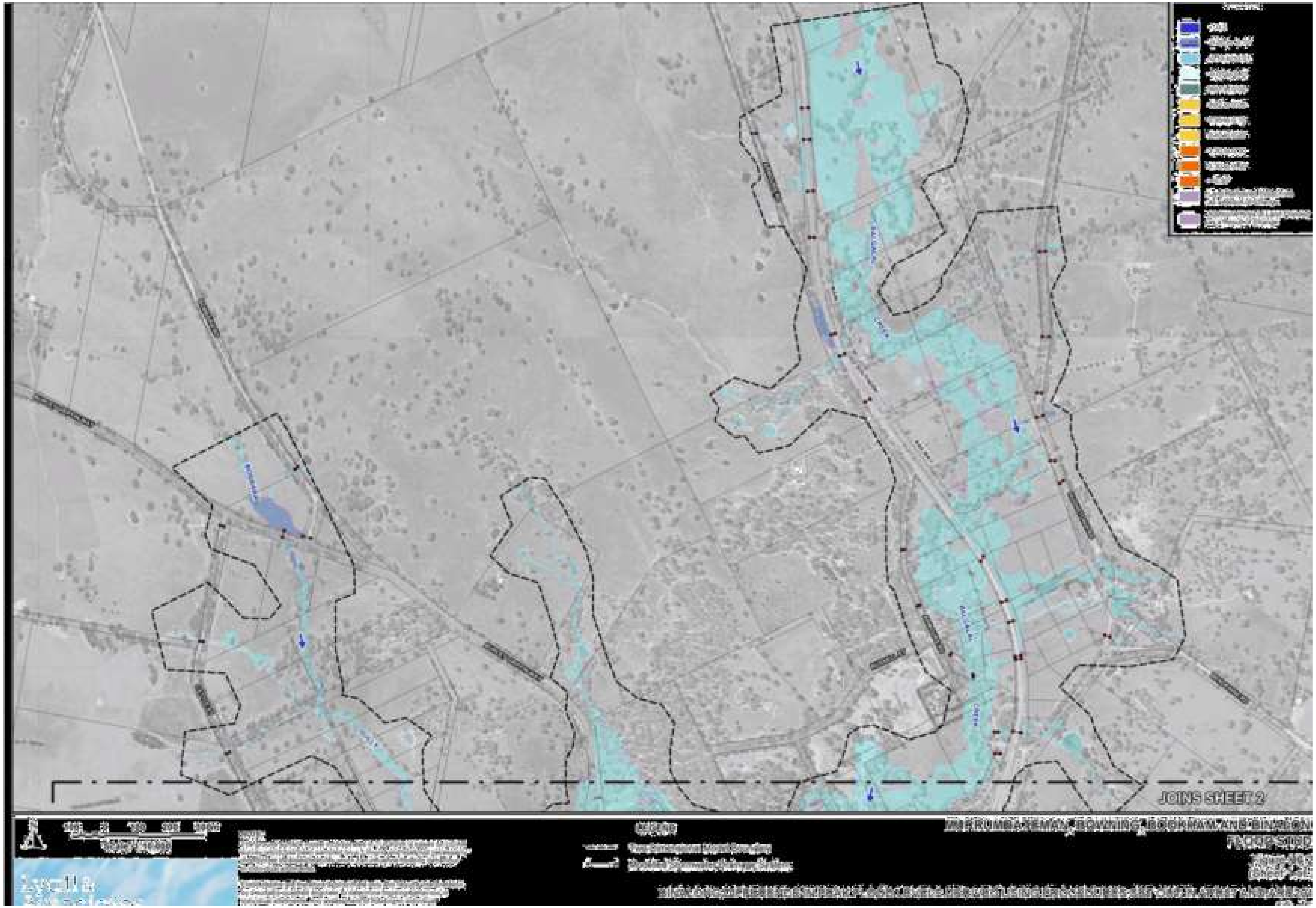
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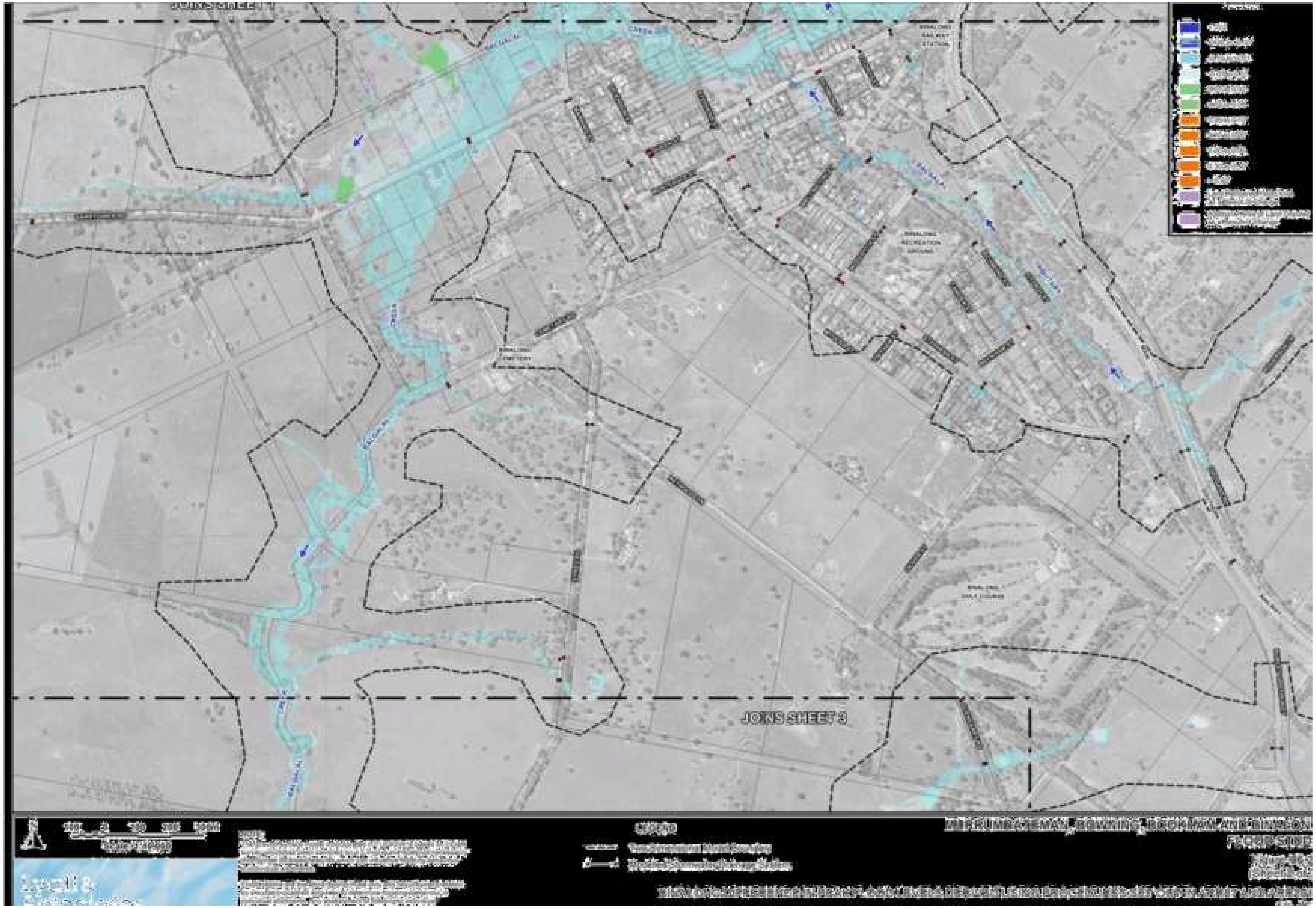
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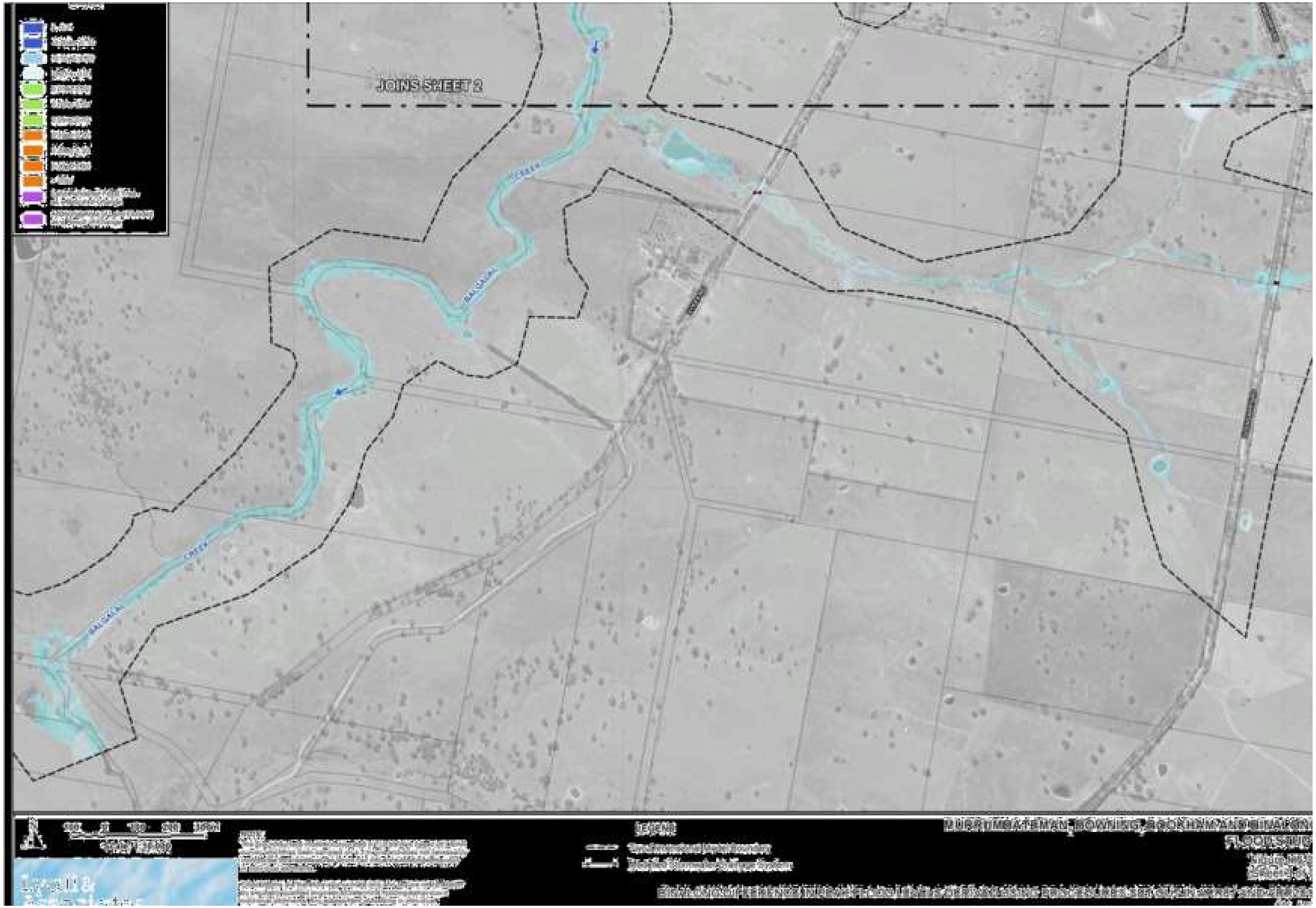
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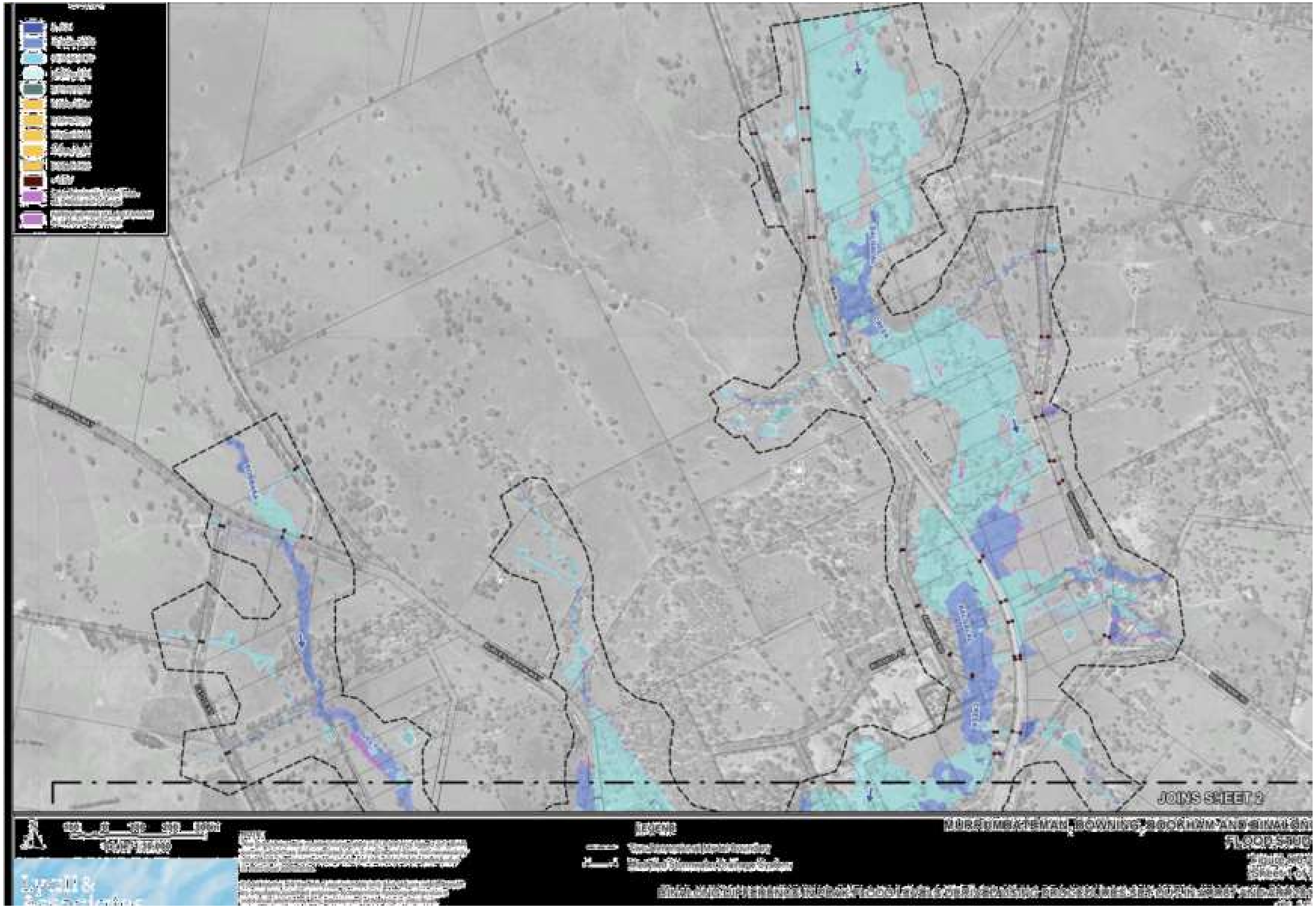
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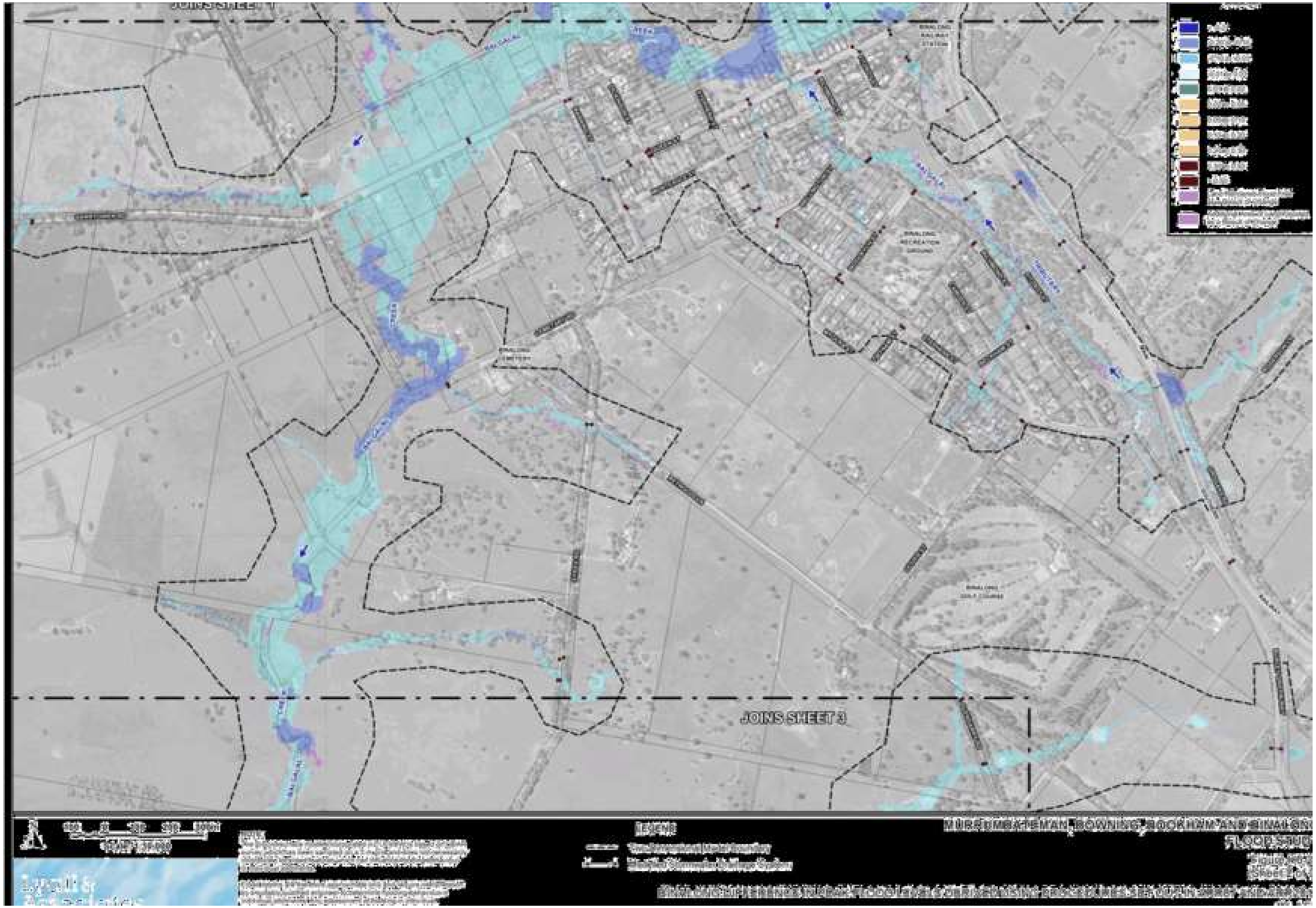
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BINALONG RECREATION GROUND
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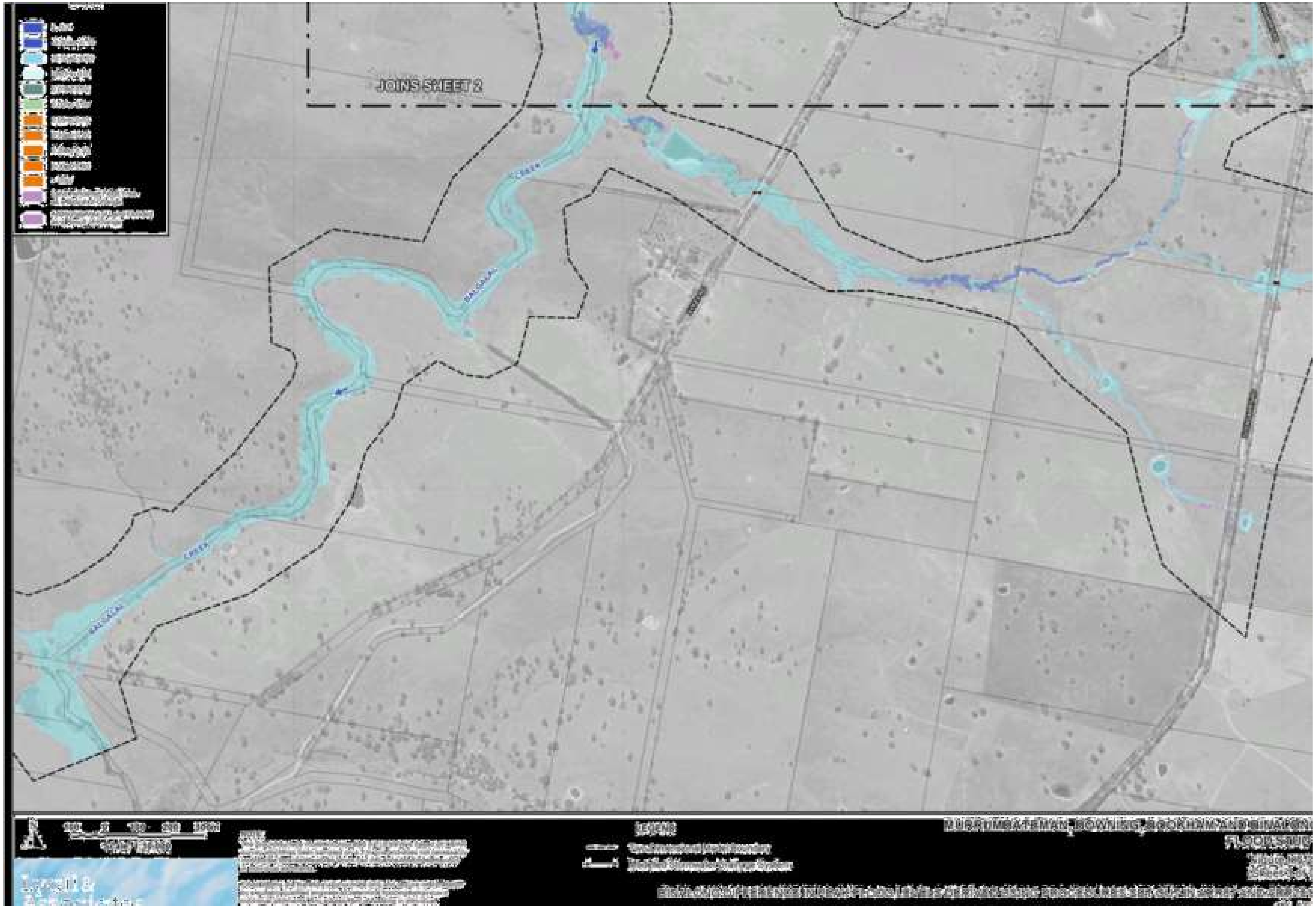
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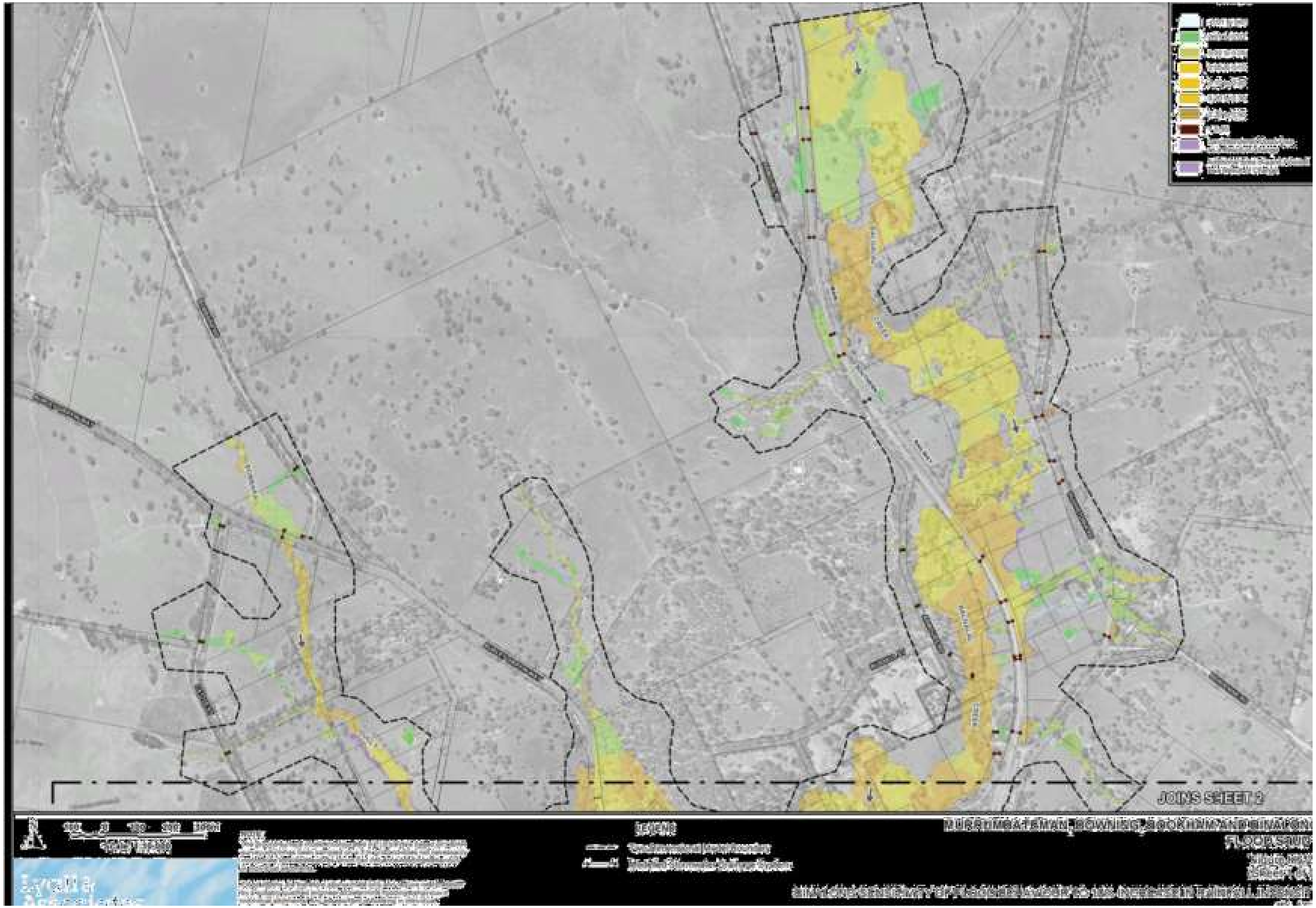
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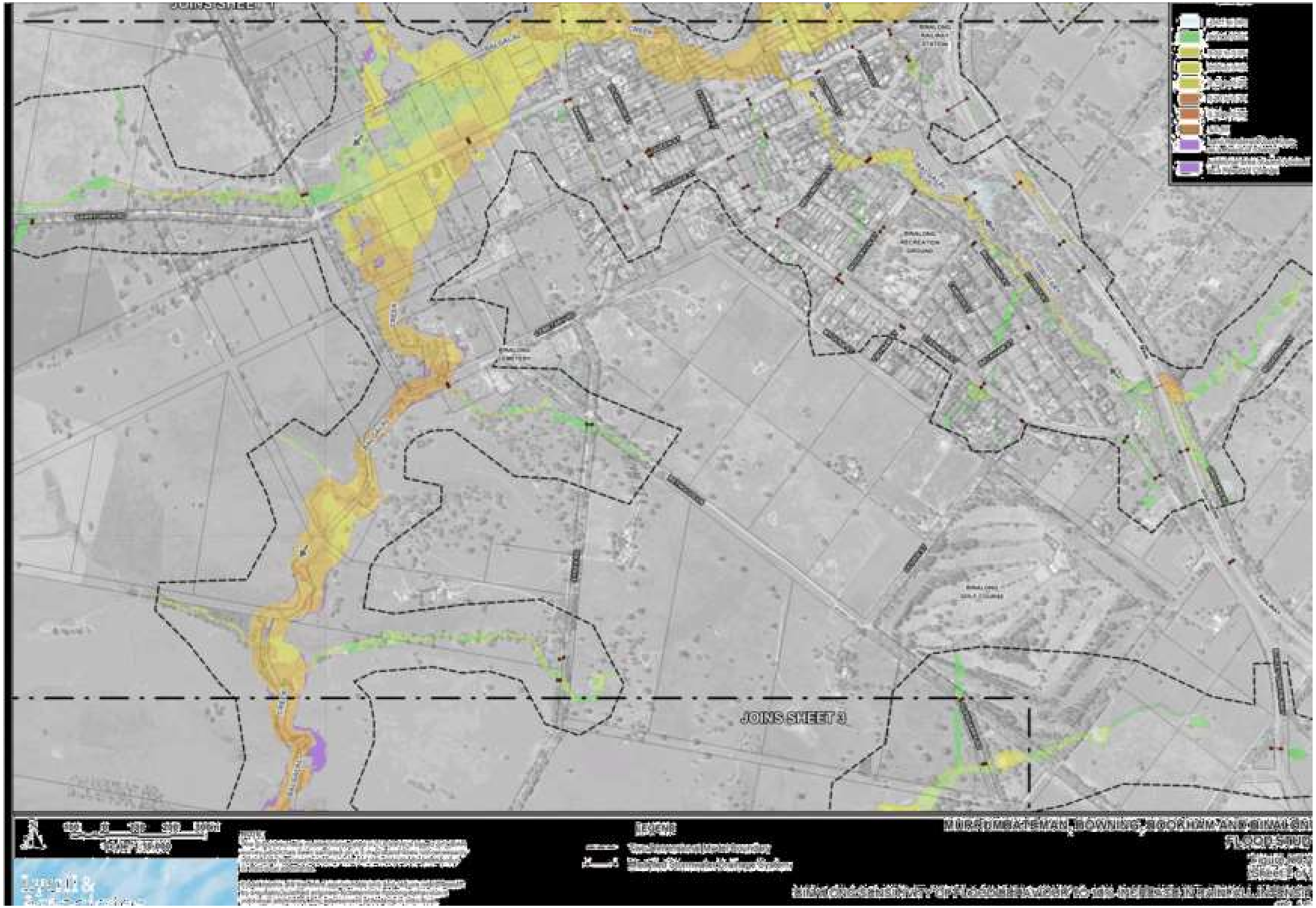
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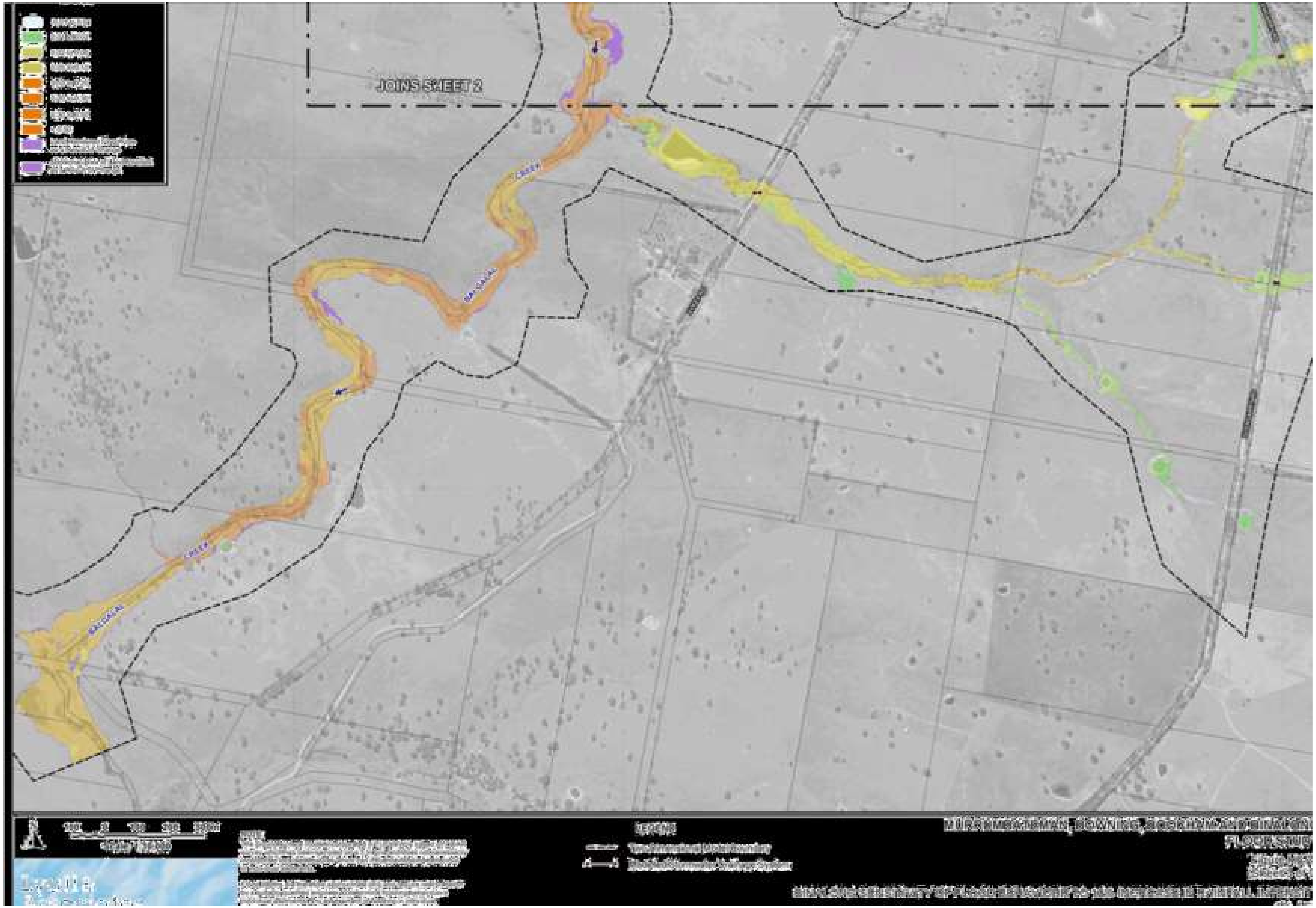
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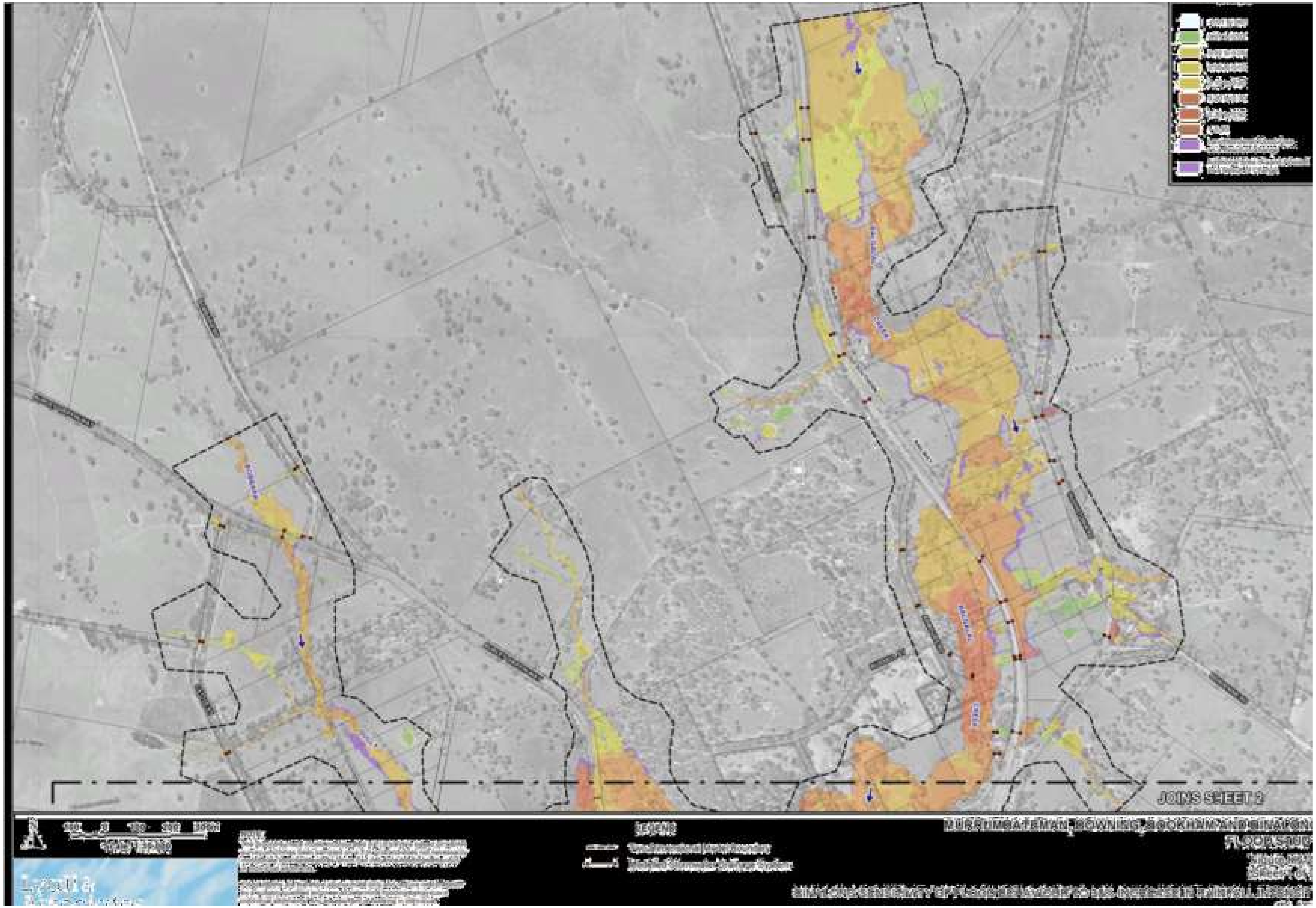
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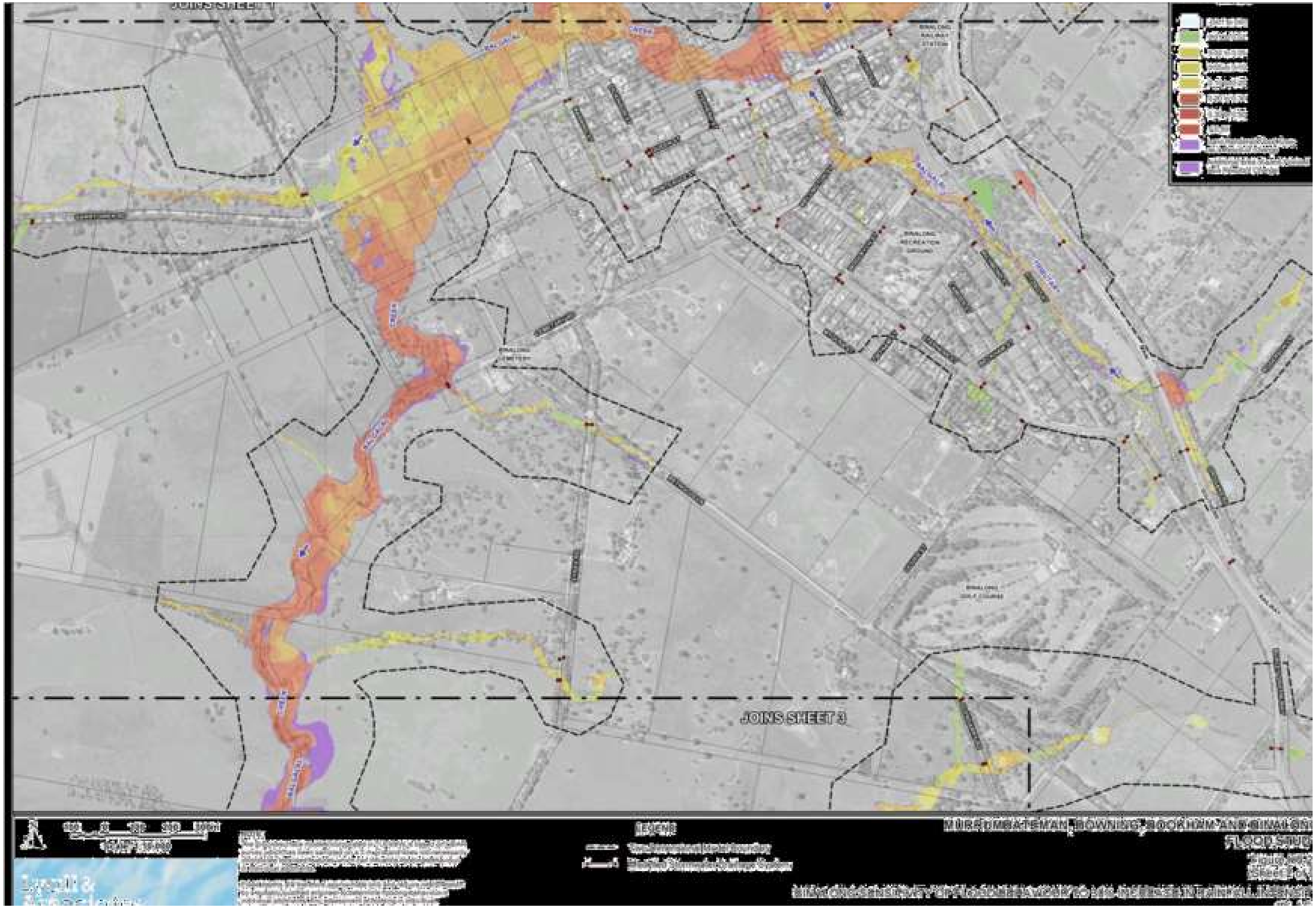
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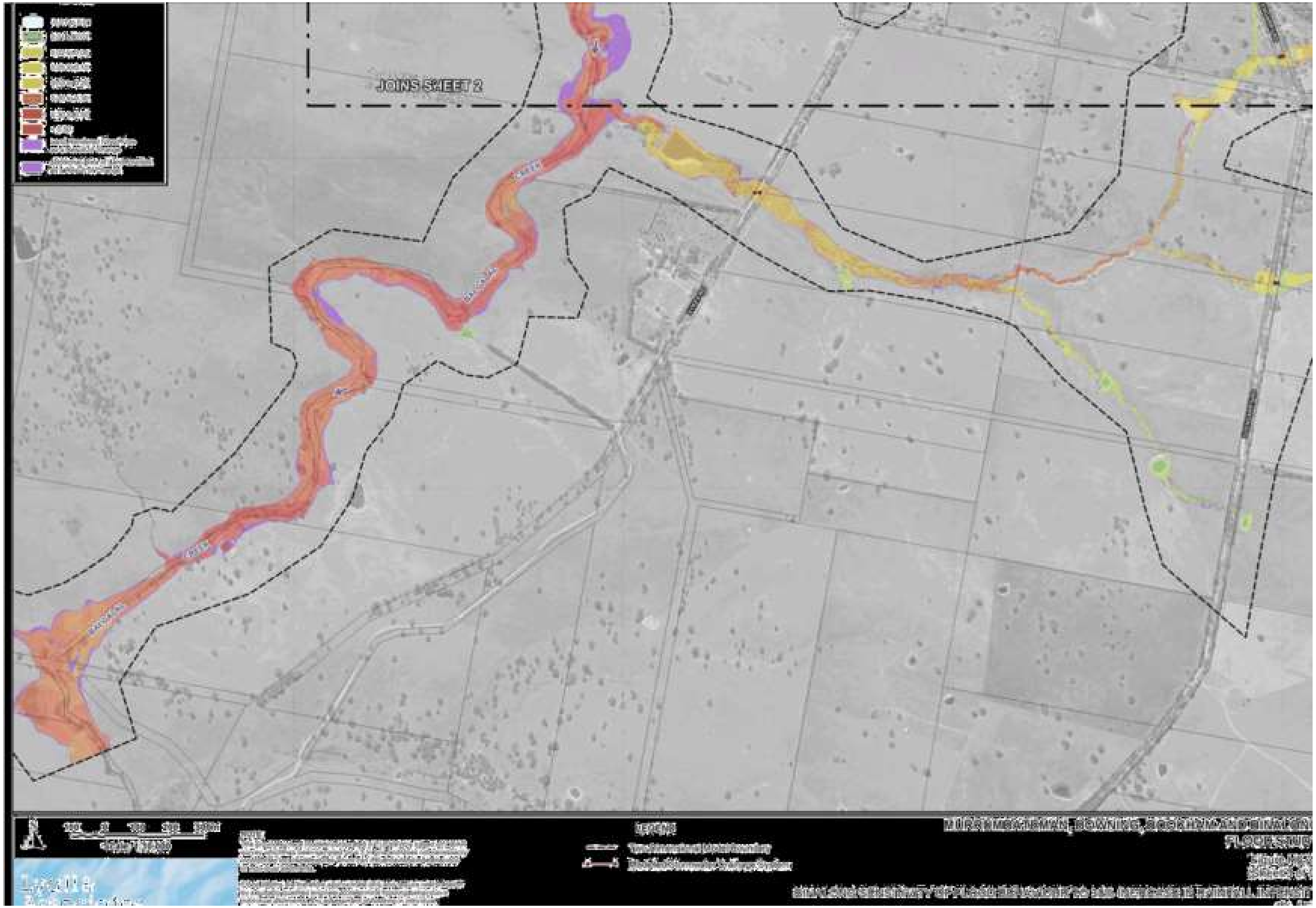
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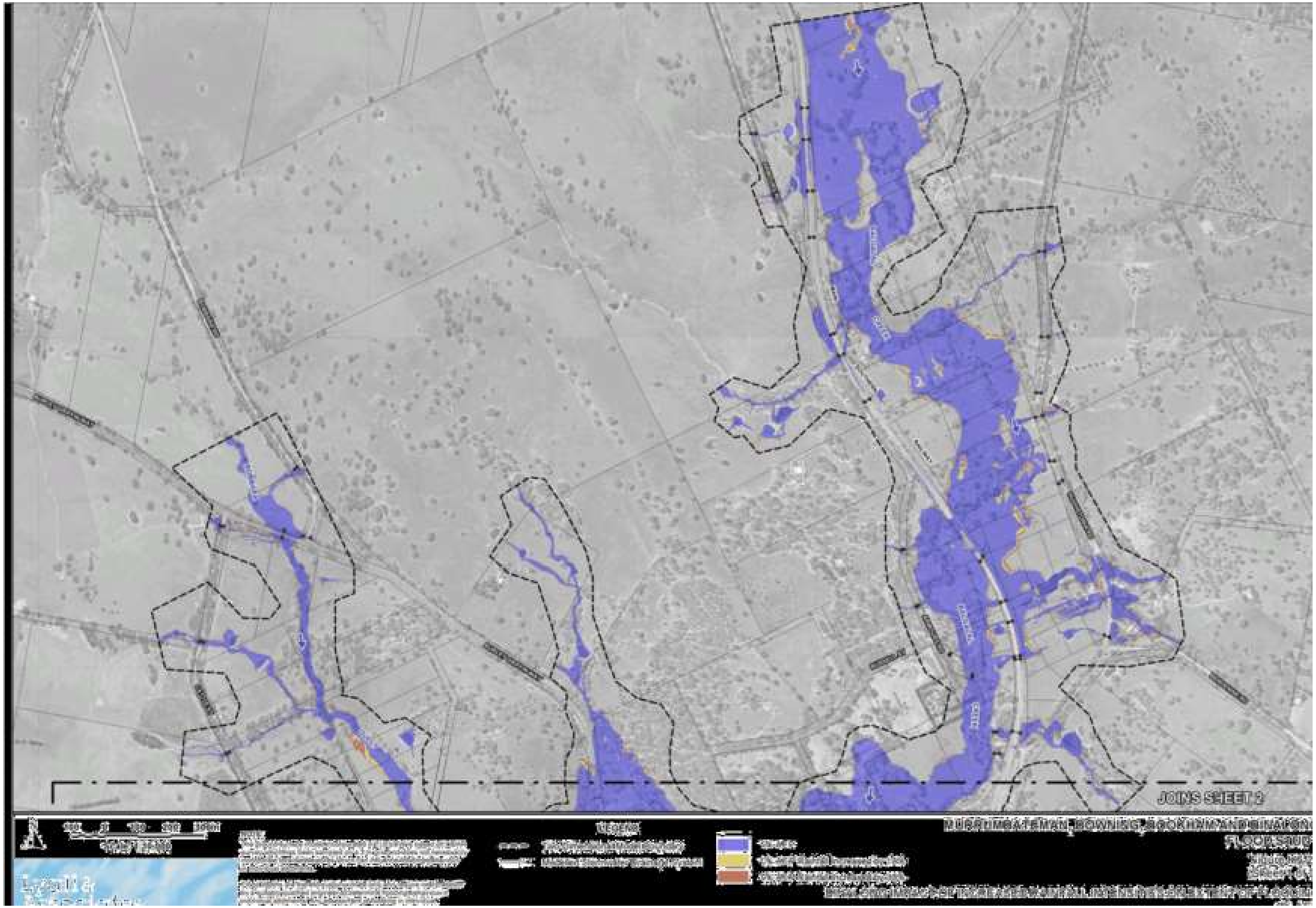
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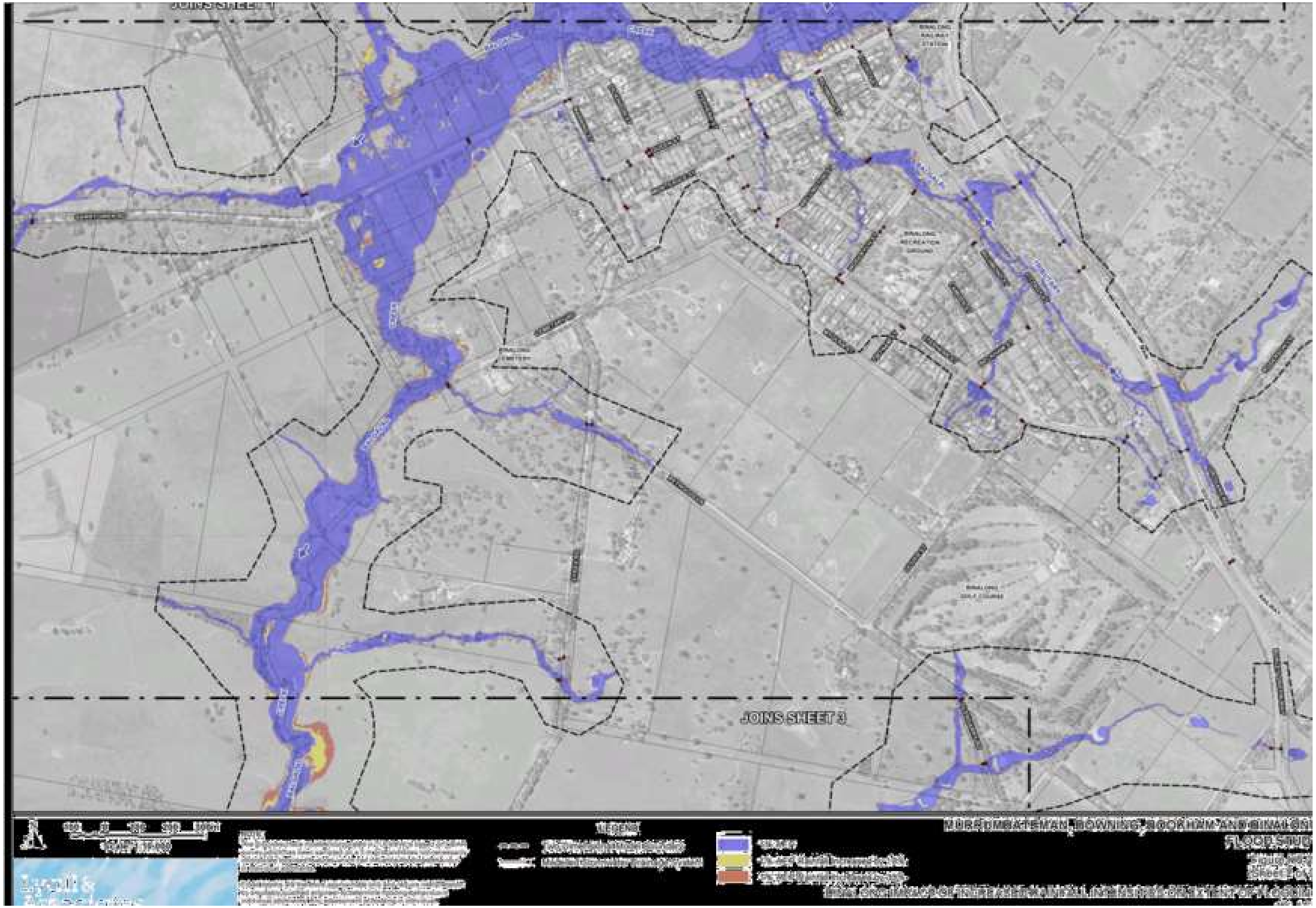
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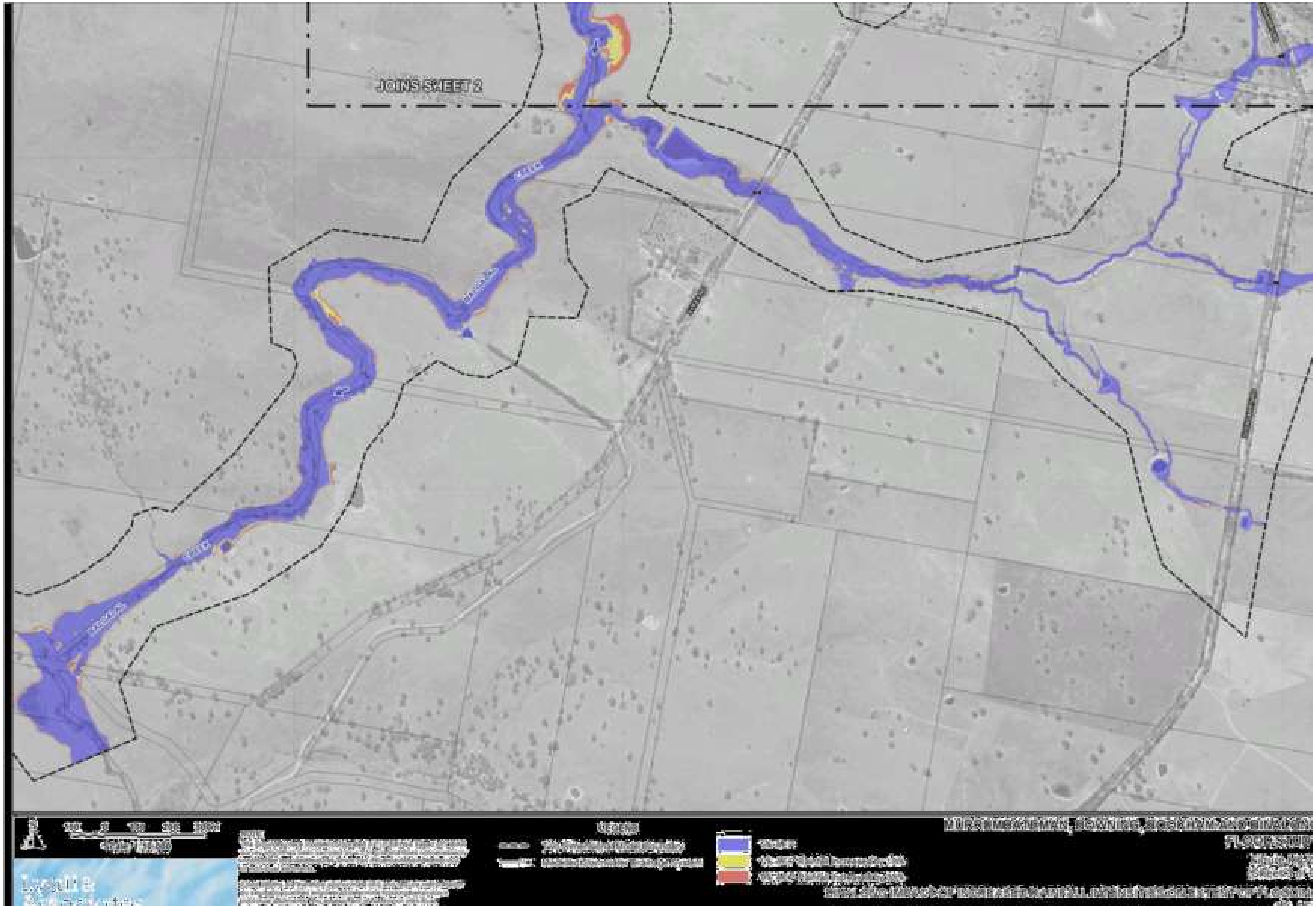
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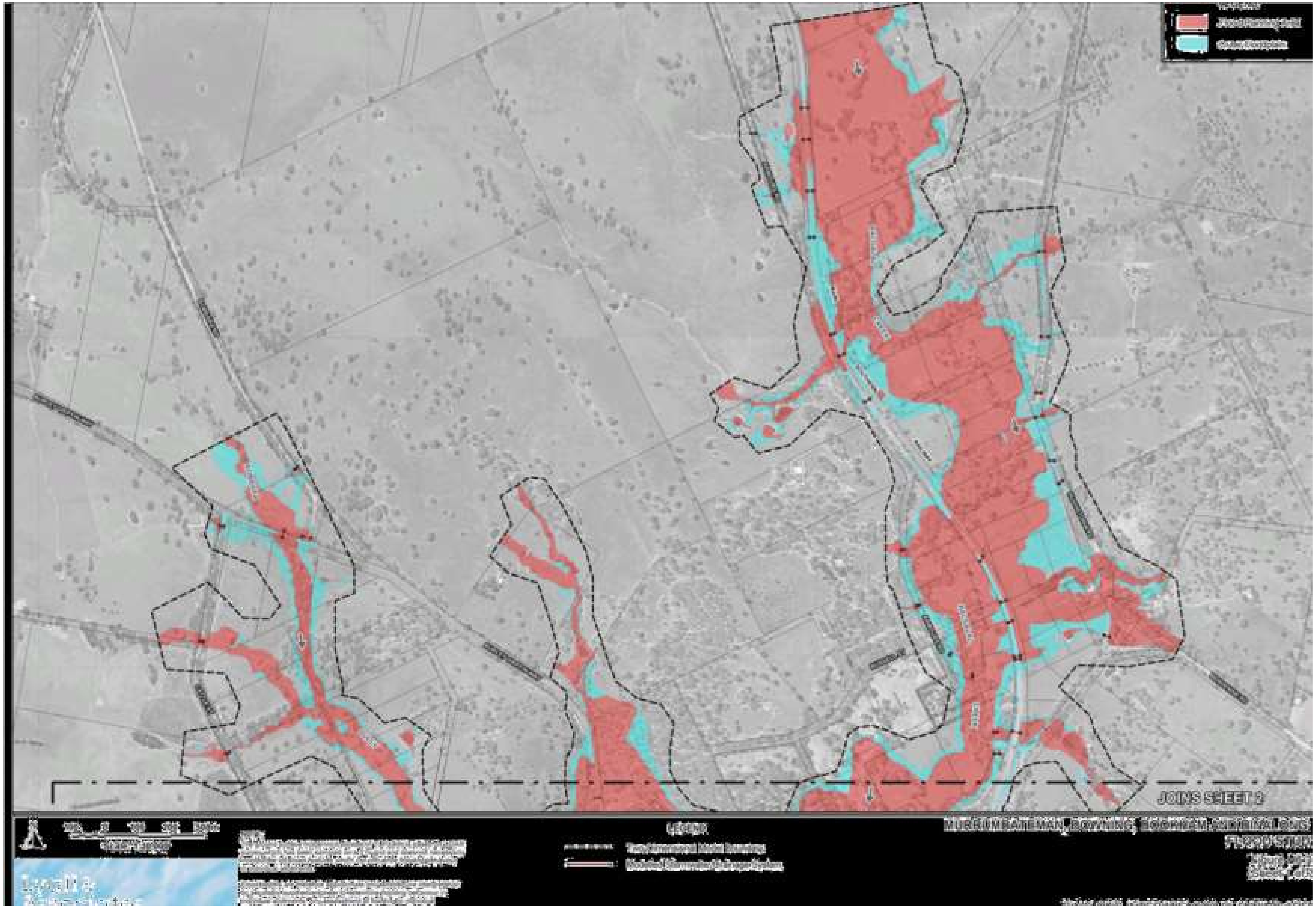
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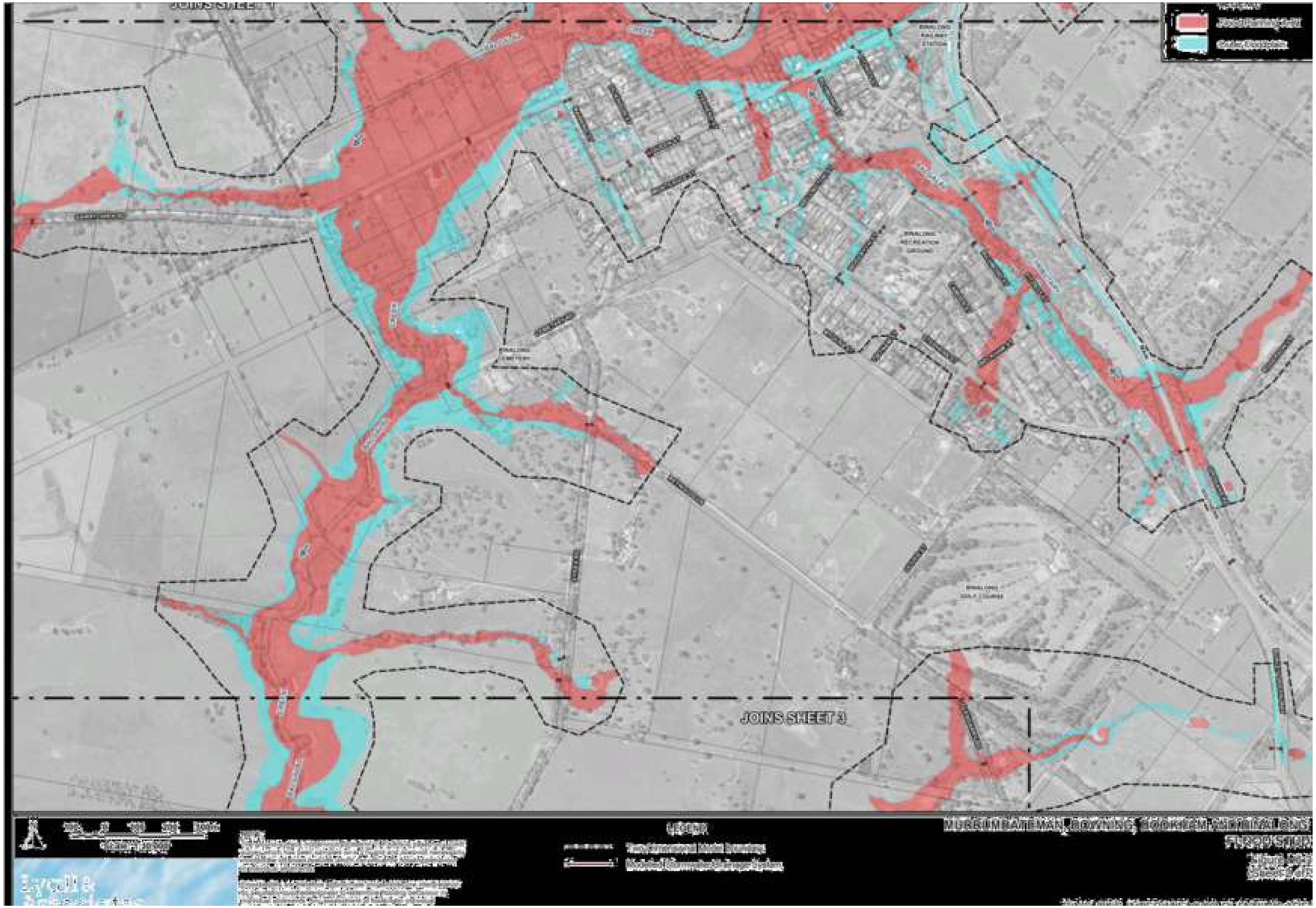
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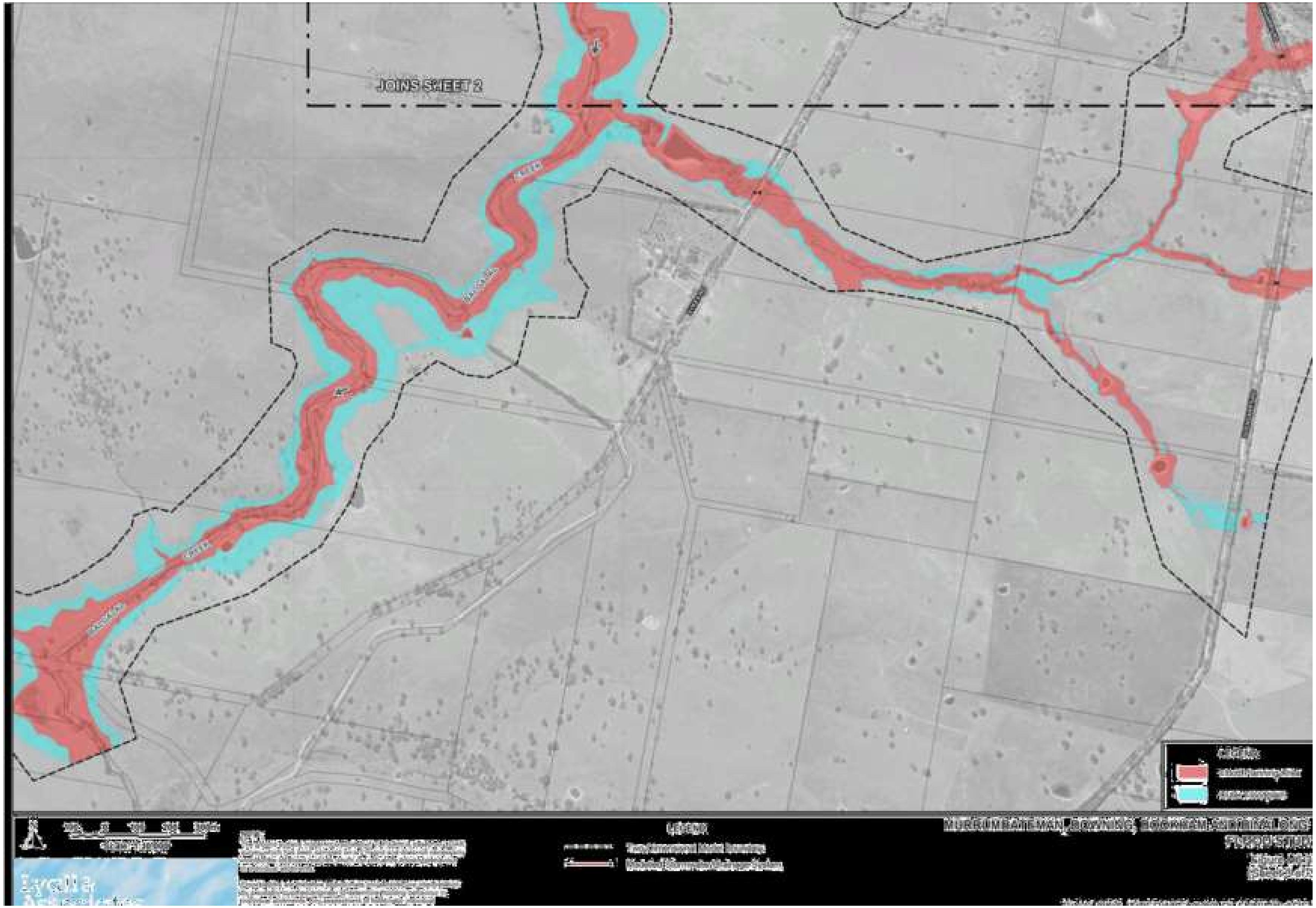
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Lyall & Associates

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

21 July 2021

The General Manager
Yass Valley Council
PO Box 6
YASS NSW 2582

Attention: Ms Kellie Jones

RE: Murrumbateman, Bowning, Bookham and Binalong Flood Study – Addendum Report

Dear Madam,

This letter forms an addendum to the *Murrumbateman, Bowning, Bookham and Binalong Flood Study* (***Four Villages Flood Study***) (Lyall & Associates, 2020) and deals with the development of flood planning constraint category mapping for the four villages. This addendum report also deals with the preparation of similar flood mapping for the villages of Gundaroo and Sutton.

1. Background

Following the completion of the *Four Villages Flood Study*, Yass Valley Council (**Council**) commissioned Lyall & Associates to prepare the *Yass Floodplain Risk Management Study and Plan* (***Yass FRMS&P***), a draft of which will be placed on public exhibition alongside this addendum report. The scope of the *Yass FRMS&P* included the development of an approach to best manage future development on the floodplain at Yass. The approach, details of which are set out in Appendix E of the draft *Yass FRMS&P* report, included the development of a series of maps which enable Council to apply a specific set of flood related controls to future development based on the existing flood risk and the proposed land use.

Following a review of the approach set out in the *Yass FRMS&P*, both Council and the Department of Planning, Industry and Environment (**DPIE**) determined that it was necessary to develop a similar approach for the villages of Murrumbateman, Bowning, Bookham, Binalong, Gundaroo and Sutton (**the six villages**) so that a consistent set of flood related planning controls can be applied to future development in the local government area.

The flood mapping that has been developed as part of this addendum report relies on the results of detailed flood modelling that was undertaken as part of the *Four Villages Flood Study*, as well as similar flood modelling that was undertaken as part of the *Gundaroo Flood Study* (WMAwater, 2016a) and the *Sutton Flood Study* (WMAwater, 2016b). In order to compile the necessary flood mapping for the villages of Gundaroo and Sutton, it was necessary to run the flood models that were developed as part of the respective flood studies for a storm which has an Annual Exceedance Probability (**AEP**) of 0.2% (1 in 500).

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Similar to Yass, the six villages are affected by the following two types of flooding:

- **Main Stream Flooding**, which occurs when floodwater surcharges the inbank area of the existing river and creek systems. Main Stream Flooding is typically characterised by relatively deep and fast flowing floodwater, but may be shallower and slower moving in flood fringe areas.
- **Major Overland Flow** which occurs during storms which result in the surcharge of the existing stormwater drainage system. It is also present in the upper reaches of the study catchments.

The following sections of this addendum report set out the methodology which was adopted for developing the flood mapping for the six villages, noting that is consistent with the methodology which is set out in the *Yass FRMS&P*. **Table 1** below lists the figures that are included in a separate A3 volume (**Volume 2**) which forms part of this addendum report and should be referred to when reading the following discussion.

TABLE 1
LIST OF FIGURES BOUND IN VOLUME 2 OF ADDENDUM REPORT

Village	Annexure	Figure No.	Figure Title
Murrumbateman	A	A1	Extract of Yass Valley Flood Planning Area Map at Murrumbateman
		A2	Extract of Yass Valley Flood Planning Constraint Category Map at Murrumbateman
Bowning	B	B1	Extract of Yass Valley Flood Planning Area Map at Bowning
		B2	Extract of Yass Valley Flood Planning Constraint Category Map at Bowning
Bookham	C	C1	Extract of Yass Valley Flood Planning Area Map at Bookham
		C2	Extract of Yass Valley Flood Planning Constraint Category Map at Bookham
Binalong	D	D1	Extract of Yass Valley Flood Planning Area Map at Binalong
		D2	Extract of Yass Valley Flood Planning Constraint Category Map at Binalong
Gundaroo	E	E1	Gundaroo Flood Hazard Vulnerability Classification – 1% AEP
		E2	Gundaroo Flood Hazard Vulnerability Classification – 0.2% AEP
		E3	Gundaroo Flood Hazard Vulnerability Classification – PMF
		E4	Gundaroo Hydraulic Categorisation of Floodplain – 1% AEP
		E5	Gundaroo Flood Emergency Response Classification – 1% AEP
		E6	Extract of Yass Valley Flood Planning Area Map at Gundaroo
		E7	Extract of Yass Valley Flood Planning Constraint Category Map at Gundaroo
Sutton	F	F1	Sutton Flood Hazard Vulnerability Classification – 1% AEP
		F2	Sutton Flood Hazard Vulnerability Classification – 0.2% AEP
		F3	Sutton Flood Hazard Vulnerability Classification – PMF
		F4	Sutton Hydraulic Categorisation of Floodplain – 1% AEP
		F5	Sutton Flood Emergency Response Classification – 1% AEP
		F6	Extract of Yass Valley Flood Planning Area Map at Sutton
		F7	Extract of Yass Valley Flood Planning Constraint Category Map at Sutton

2. Freeboard Considerations

Unlike flooding on the Yass River at Yass, an inspection of the design water surface profiles that are presented in the three flood study reports highlights that the flood range along the main arms of the watercourses which traverse the six villages is relatively narrow for storm events with AEPs of between 1% (1 in 100) and 0.2% (1 in 500) in intensity. The studies also show that the uncertainty in the peak 1% (1 in 100) AEP flood level estimate is also not as great as that on the Yass River at Yass. As a result, the traditional 0.5 metres freeboard is considered appropriate for deriving the *Flood Planning Level* (**FPL**) in areas affected by Main Stream Flooding.[1] For the same reasons, a 0.5 metres freeboard has also been applied to peak 1% (1 in 100) AEP flood levels for setting the minimum habitable floor level in future development that is located in an area that is subject to Main Stream Flooding.

Similar to the approach set out in the *Yass FRMS&P*, the extent of the *Flood Planning Area* (**FPA**) in areas affected by Major Overland Flow has been defined as areas where the depth of inundation would exceed 0.1 metres in a 1% (1 in 100) AEP storm event. Similar to the approach adopted in the *Yass FRMS&P*, a 0.3 metres freeboard has been applied to peak 1% (1 in 100) AEP flood levels for setting the minimum habitable floor level in future development that is located in an area that is subject to Major Overland Flow.

Volume 2 of this addendum report contains extracts from the *Yass Valley Flood Planning Area Map* showing the extent of the Main Stream Flooding and Major Overland Flow FPAs at the six villages. Also shown on the extracts is the extent of the Main Stream Flooding and Major Overland Flow Outer Floodplain, which is defined as the area of land which lies between the extent of the FPA and the Probable Maximum Flood (**PMF**).

3. Flood Planning Constraint Category Mapping

As mentioned, Appendix E of the *Yass FRMS&P* sets out the proposed approach to managing future development on the floodplain at Yass. In order to apply the same approach at the six villages, it was necessary to develop a set of maps which enable appropriate flood related development controls to be applied to future development based on the existing flood risk and the proposed land use. Similar to the approach that was adopted at Yass, the floodplain at the six villages was divided into the following four categories:

- **Flood Planning Constraint Category 1 (FPCC 1)**, which comprises areas where factors such as the depth and velocity of flow, time of rise, and evacuation problems mean that the land is unsuitable for most types of development. The majority of new development types are excluded from this zone due to its potential impact on flood behaviour and the hazardous nature of flooding.
- **Flood Planning Constraint Category 2 (FPCC 2)**, which comprises areas which lie within the extent of the FPA where the existing flood risk warrants careful consideration and the application of significant flood related controls on future development.
- **Flood Planning Constraint Category 3 (FPCC 3)**, which comprises areas which lie within the extent of the FPA but outside areas designated FPCC1 and FPCC2. Areas designated FPCC3 are more suitable for new development and expansion of existing development provided it is carried out in accordance with the controls set out in Appendix E of the *Yass FRMS&P*.

[1] The Main Stream Flooding FPL at the six villages has been set equal to the peak 1% (1 in 100) AEP flood level plus a freeboard allowance of 0.5 metres. The Main Stream Flooding Flood Planning Area (**FPA**) is the area which lies at or below the Main Stream Flooding FPL.

- **Flood Planning Constraint Category 4 (FPCC 4)**, which comprises the area which lies between the extent of the FPA and the PMF. Flood related controls in areas designated FPCC4 are typically limited to flood evacuation and emergency response, although additional controls apply to essential community facilities and utilities that are critical for response and recovery, as well as community hospitals, residential care facilities and group homes.[2]

The derivation of the four FPCCs firstly involved the derivation of a number of sub-regions which were based on the nature of flooding at the six villages, the sub-categories of which are set out in **Table 2** over.[3] These sub-regions were then combined, with the resulting extents further refined in order to improve the area over which each FPCC applied. **Volume 2** of this addendum report contains extracts of the *Yass Valley Flood Planning Constraint Category Map* which show the subdivision of the floodplain at the six villages into the four FPCCs.

A *Special Flood Consideration Zone* has also been included which relates to areas where the flood risk is considered to be high enough to require additional controls to be applied to future development that is located on land which lies between the Main Stream Flooding FPA and the PMF. The *Special Flood Consideration Zone*, the extent of which is shown on extracts of the *Yass Valley Flood Planning Area and Flood Planning Constraint Category Maps* for each village, has been defined as the extent of land where the flood hazard vulnerability classification for the PMF is H3 or higher, noting that the resulting extent was further refined in order to improve its definition in a number of places. The additional controls in this area relate to the safe and timely evacuation of people who would be occupying the floodplain at the time of a flood event and only apply in areas that are subject to Main Stream Flooding and categorised as FPCC4.

4. Village Specific Flood Related Development Controls

While the flood range at Yass is significantly greater than in the six villages, especially for the PMF event, the *Yass FRMS&P* recommended the design and implementation of an integrated flood warning system for the Yass Valley which would provide sufficient warning to enable people housed in sensitive use type development to be evacuated from the floodplain in a safe and orderly manner. While the implementation of this measure would permit development of this type to be built on the floodplain at Yass, the same warning time is not available at the six villages. As a result, it is necessary to adopt a slightly different set of controls to future development of this type.

Schedules 2A and **2B** in **Annexure A** of this letter set out the prescriptive controls which apply to development that is affected by Main Stream Flooding and Major Overland Flow, respectively in the six villages.

Based on the above, it will be necessary to incorporate two sets of schedules in the Development Control Plan that Council is presently in the process of preparing, one set that relates to future development in Yass and the other set which relates to future development in the six villages.

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[2] Note that for the reasons set out in **Section 4** of this letter this definition differs from the definition given in the *Yass FRMS&P* for FPCC 4.

[3] It is noted that it was necessary to prepare additional flood mapping for the villages of Gundaroo and Sutton in order to derive several of the sub-categories set out in **Table 2**. **Volume 2** of this addendum report contains several figures showing the flood hazard vulnerability and flood emergency response classification, as well as the hydraulic categorisation of the floodplain at the two villages as derived as part of this addendum report. The methodology that was adopted for deriving the information that is shown on these figures is set out in the *Yass FRMS&P*.

TABLE 2
KEY ELEMENTS COMPRISING FLOOD PLANNING CONSTRAINT CATEGORIES

Flooding	FPCC	Sub-category	Constraint
Main Stream Flooding	1	a	1% AEP Main Stream Flooding Floodway
		b	1% AEP Main Stream Flooding Flood Hazard Vulnerability Classification H6
	2	a	1% AEP Main Stream Flooding Flood Storage
		b	1% AEP Main Stream Flooding Flood Hazard Vulnerability Classification H5
		c	0.2% AEP Main Stream Flooding Flood Hazard Vulnerability Classification H5 and H6
		d	1% AEP Flood Emergency Response Classification (Flooded - Isolated - Submerged)
		e	1% AEP Flood Emergency Response Classification (Flooded - Isolated - Elevated)
	3	-	Flood Planning Area
	4	-	Extent of PMF
Major Overland Flow	1	-	1% AEP Floodway AND Flood Hazard Vulnerability Classification H4 - H6
	2	a	1% AEP Floodway AND Flood Hazard Vulnerability Classification H1 - H3
		b	1% AEP Flood Storage Area
		c	0.2% AEP Flood Hazard Vulnerability Classification H5 and H6
		d	1% AEP Flood Emergency Response Classification (Flooded - Isolated - Submerged)
		e	1% AEP Flood Emergency Response Classification (Flooded - Isolated - Elevated)
	3	-	Flood Planning Area
	4	-	Extent of PMF

We trust that the information set out in this addendum report will assist Council in better managing the flood risk at the six villages. However, please do not hesitate to contact the undersigned should you wish to discuss any aspect of this addendum report.

Yours faithfully
Lyall & Associates Consulting Water Engineers

Scott Button
Principal

ANNEXURE A

SCHEDULE 2A

PRESCRIPTIVE FLOOD RELATED DEVELOPMENT CONTROLS – MAIN STREAM FLOODING AT SIX VILLAGES

Planning considerations	Flood Planning Constraint Category 1 (FPCC 1)						
	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions
Minimum Habitable Floor Level						A1	A2 A4
Building Components						B2	B2
Structural Soundness						C2	C2
Flood Affectation						D1	D1
Emergency Response						E4	E2 or E3
Management and Design						F2 F8	F2 F8
[illegible]							G2
Parking and Driveway Access						H2 H4 H5 H7	H3 H7 H8

Planning considerations	Flood Planning Constraint Category 2 (FPCC 2)						
	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions
Minimum Habitable Floor Level				A2	A3	A1	A2 A4
Building Components				B2	B2	B2	B2
Structural Soundness				C2	C2	C2	C2
Flood Affectation			D1	D1	D1	D1	D2
Emergency Response			E4 E5	E3 E4	E3 E4	E4	E2 or E3
Management and Design			F1	F2	F2 F3 F4	F2 F8	F2 F8
[illegible]			G1 G2	G1 G2	G1 G2		G2
Parking and Driveway Access			H1 H3 H5 H6 H7	H1 H3 H5 H6 H7	H1 H3 H5 H6 H7	H2 H4 H5 H7	H3 H7 H8

Planning considerations	Flood Planning Constraint Category 3 (FPCC 3)						
	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions
Minimum Habitable Floor Level				A2	A3	A1	A2 A4
Building Components				B2	B2	B2	B2
Structural Soundness				C2	C2	C2	C2
Flood Affectation			D1	D1	D1	D1	D2
Emergency Response			E4 E5	E3 E4	E3 E4	E4	E2 or E3
Management and Design			F1	F2	F2 F3 F4	F2	F2 F8
[illegible]			G1 G2	G1 G2	G1 G2		G2
Parking and Driveway Access			H1 H3 H5 H6 H7	H1 H3 H5 H6 H7	H1 H3 H5 H6 H7	H2 H4 H5 H7	H3 H7 H8

Planning considerations	Flood Planning Constraint Category 4 (FPCC 4)						
	Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions
Minimum Habitable Floor Level	A3	A3					
Building Components	B3	B3					
Structural Soundness	C1	C1					
Flood Affectation							
Emergency Response	E2 or E3	E3 E4	E4 E5	E2 E4	E2 E4		E2 E4
Management and Design	F2 F8	F2 F3 F4	F1	F2	F2 F3 F4	F2	F2
[illegible]	G1	G1	G1		G1		
Parking and Driveway Access	H3	H3					

(green)	Not Relevant	(purple)	Unsuitable Land Use	(orange)	Control only applies to development that is proposed on land which lies within the extent of the "Special Flood Considerations Zone" as defined on the Flood Planning and Flood Planning Constraint Category Maps

Page 8

SCHEDULE 2B

PRESCRIPTIVE FLOOD RELATED DEVELOPMENT CONTROLS – MAJOR OVERLAND FLOW AT SIX VILLAGES

Planning considerations	Flood Planning Constraint Category 1 (FPCC 1): Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions
Minimum Habitable Floor Level						A4	A3 A6
Building Components						B4	B1
Structural Soundness						C1	C1
Flood Affectation						D1	D1
Emergency Response						E4	E1
Management and Design						P2	P2
Stormwater							
Parking and Driveway Access						H2 H4 H6 H7	H3 H7 H8

Planning considerations	Flood Planning Constraint Category 2 (FPCC 2): Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions
Minimum Habitable Floor Level				A2	A4	A1	A2 A4
Building Components				B1	B1	B1	B4
Structural Soundness				C1	C1	C1	C1
Flood Affectation			D1	D1	D1	DX	DX
Emergency Response			E3				
Management and Design			P4 P6	P2	P2 P4	P2	P2
Stormwater			Q1	Q1	Q1		
Parking and Driveway Access			H1 H3 H4 H6 H7	H1 H3 H4 H6 H7	H1 H3 H5 H6 H7	H2 H4 H6 H7	H3 H7 H8

Planning considerations	Flood Planning Constraint Category 3 (FPCC 3): Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions
Minimum Habitable Floor Level	A3	A3		A2	A4	A1	A2 A4
Building Components	B3	B3		B1	B1	B1	B1
Structural Soundness	C4	C4		C1	C1	C1	C5
Flood Affectation							
Emergency Response	E2 or E3	E2 E4	E3				
Management and Design	P3 P6	P2 P5 P4	P4 P6		P4		
Stormwater	Q1	Q1	Q1	Q1	Q1		
Parking and Driveway Access			H1 H3 H4 H8	H1 H3 H4 H8	H1 H3 H4 H8	H2 H4 H8	H3 H8

Planning considerations	Flood Planning Constraint Category 4 (FPCC 4): Critical Uses and Facilities	Sensitive Uses and Facilities	Subdivision	Residential	Commercial and Industrial	Recreational and Non-Urban	Alterations and Additions
Minimum Habitable Floor Level	A3	A3					
Building Components	B3	B3					
Structural Soundness	C4	C4					
Flood Affectation							
Emergency Response	E2 or E3	E2 E4	E3				
Management and Design	P3 P6	P2 P5 P4	P3 P6				
Stormwater	Q1	Q1	Q1				
Parking and Driveway Access	H3	H3					

(green)	Not Relevant
(purple)	Unsuitable Land Use

Page 9

Prescriptive controls for associated planning considerations under each FPCC		
Minimum Habitable Floor Level A1 [illegible] A2 [illegible] A3 [illegible] A4 [illegible] A5 [illegible]	Building Components & Method B1 [illegible] B2 [illegible] B3 [illegible]	Structural Soundness C1 [illegible] C2 [illegible] C3 [illegible] C4 [illegible]
Flood Affectation D1 [illegible] D2 [illegible] [illegible]	Emergency Response E1 [illegible] E2 [illegible] E3 [illegible] E4 [illegible] E5 [illegible]	Management and Design F1 [illegible] F2 [illegible] F3 [illegible] F4 [illegible]
Stormwater G1 [illegible] G2 [illegible]	Parking and Driveway Access H1 [illegible] H2 [illegible] H3 [illegible] H4 [illegible] H5 [illegible] H6 [illegible] H7 [illegible] H8 [illegible] H9 [illegible]	

1. [illegible]
2. [illegible]

Lyall & Associates

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the country the people

YASS VALLEY COUNCIL

MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALONG FLOOD STUDY

ADDENDUM REPORT

JULY 2021

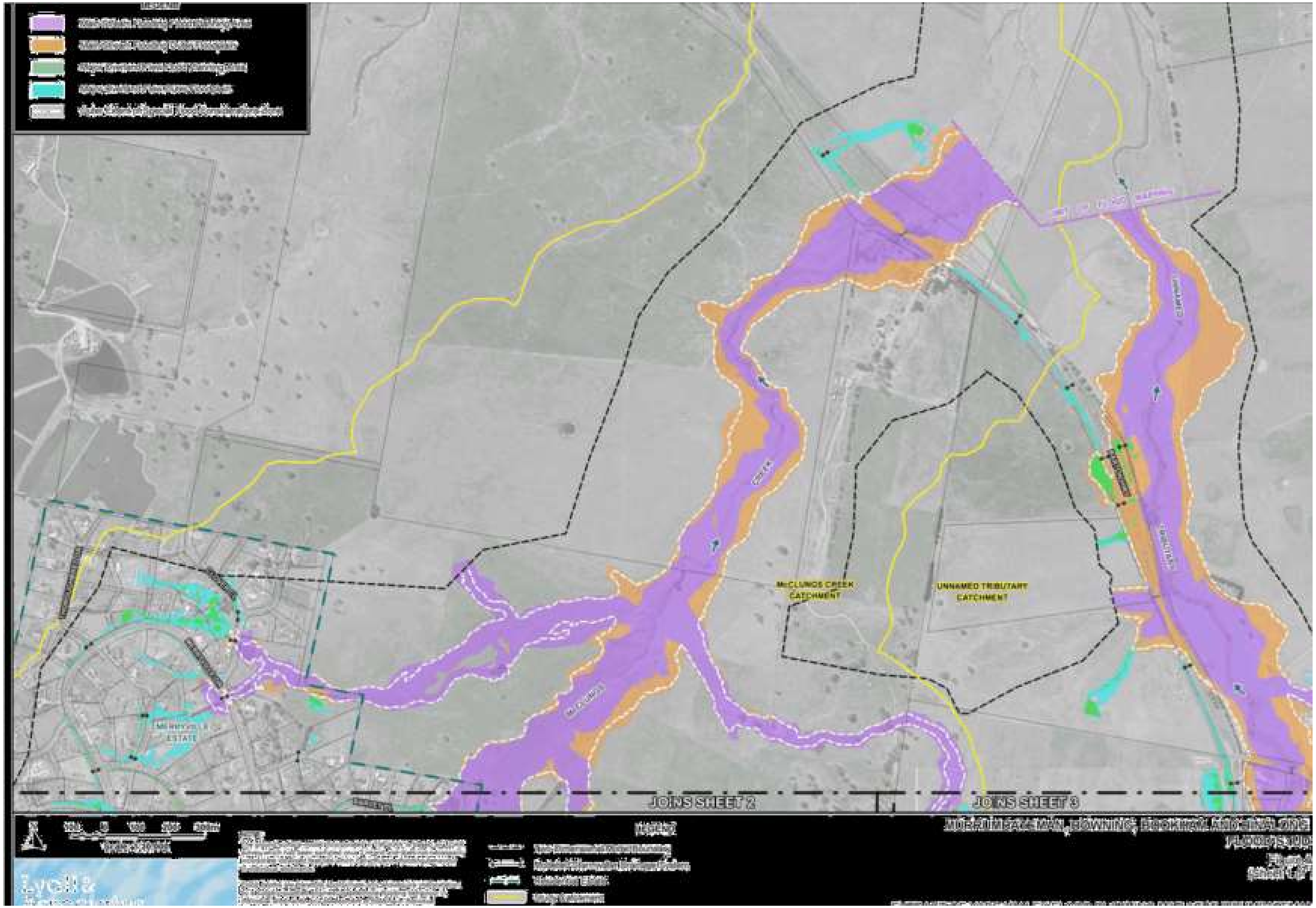
VOLUME 2 – FIGURES

Job No: ES454.001 File: MBBBFS_AR_Figures_[Rev 1.2].docx	Date: July 2021 Rev No: 1.2	Principal: SAB Author: SAB

ANNEXURE A

FIGURES RELATING TO THE VILLAGE OF MURRUMBATEMAN

LIST OF FIGURES (ANNEXURE A)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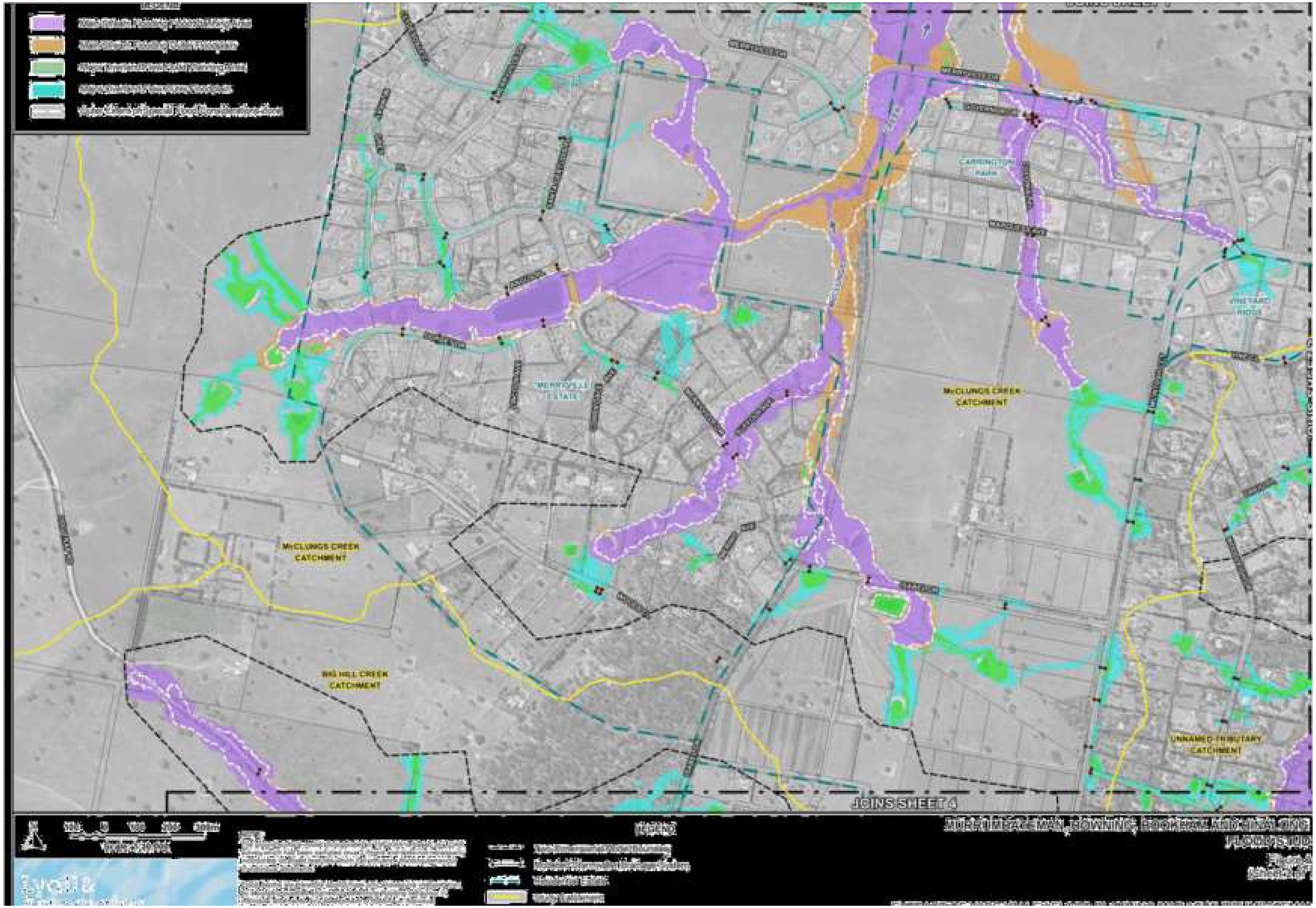
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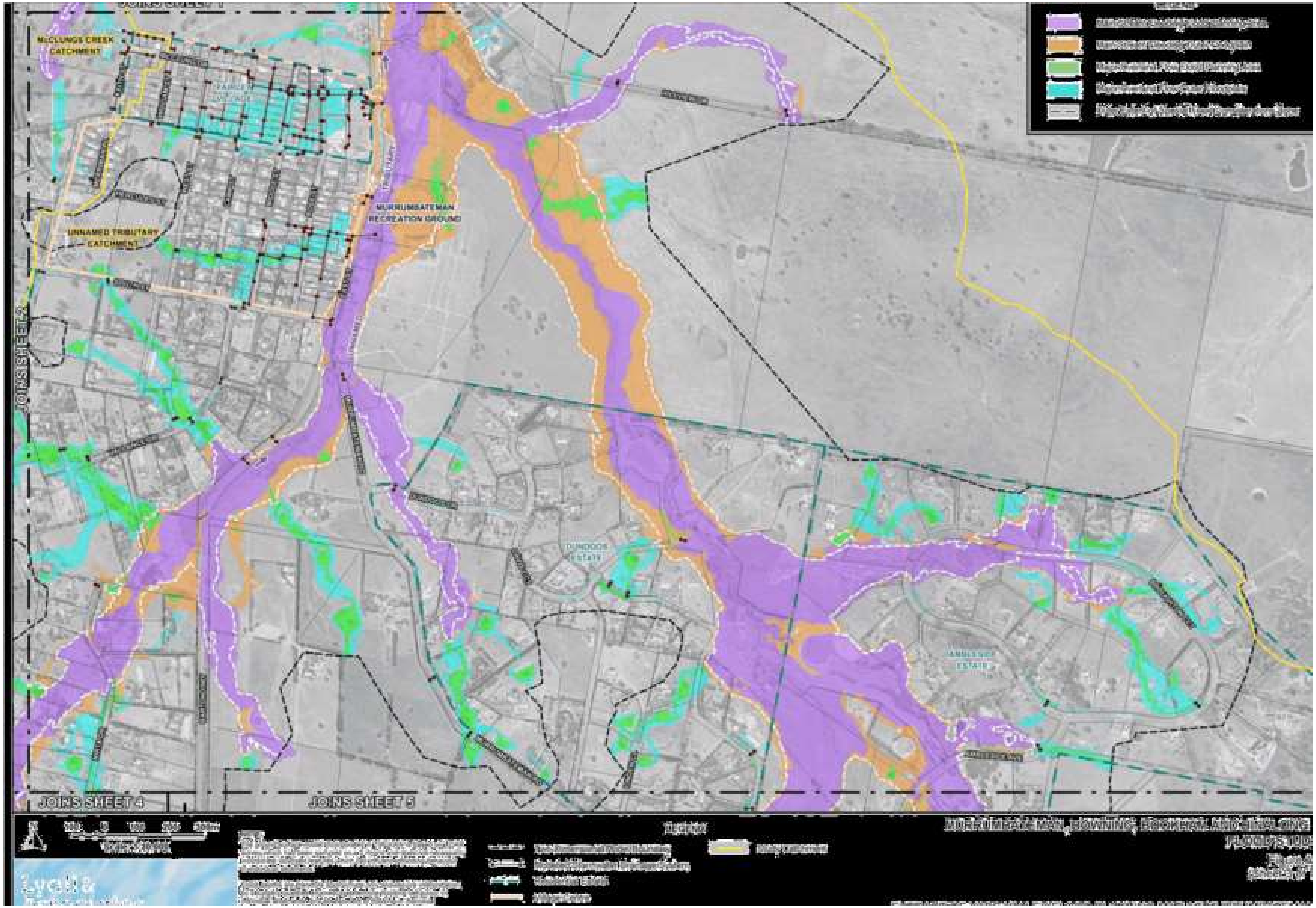
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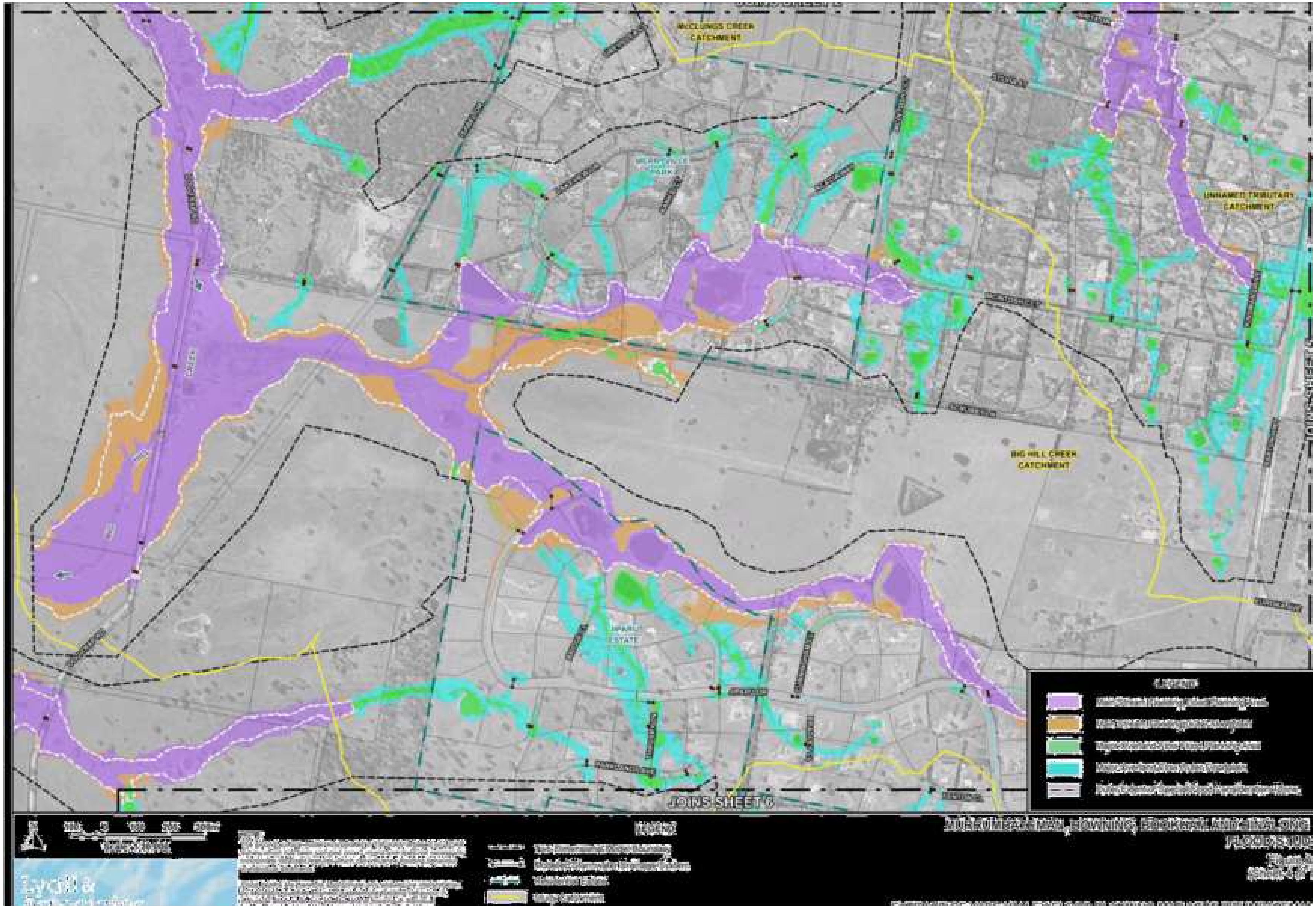
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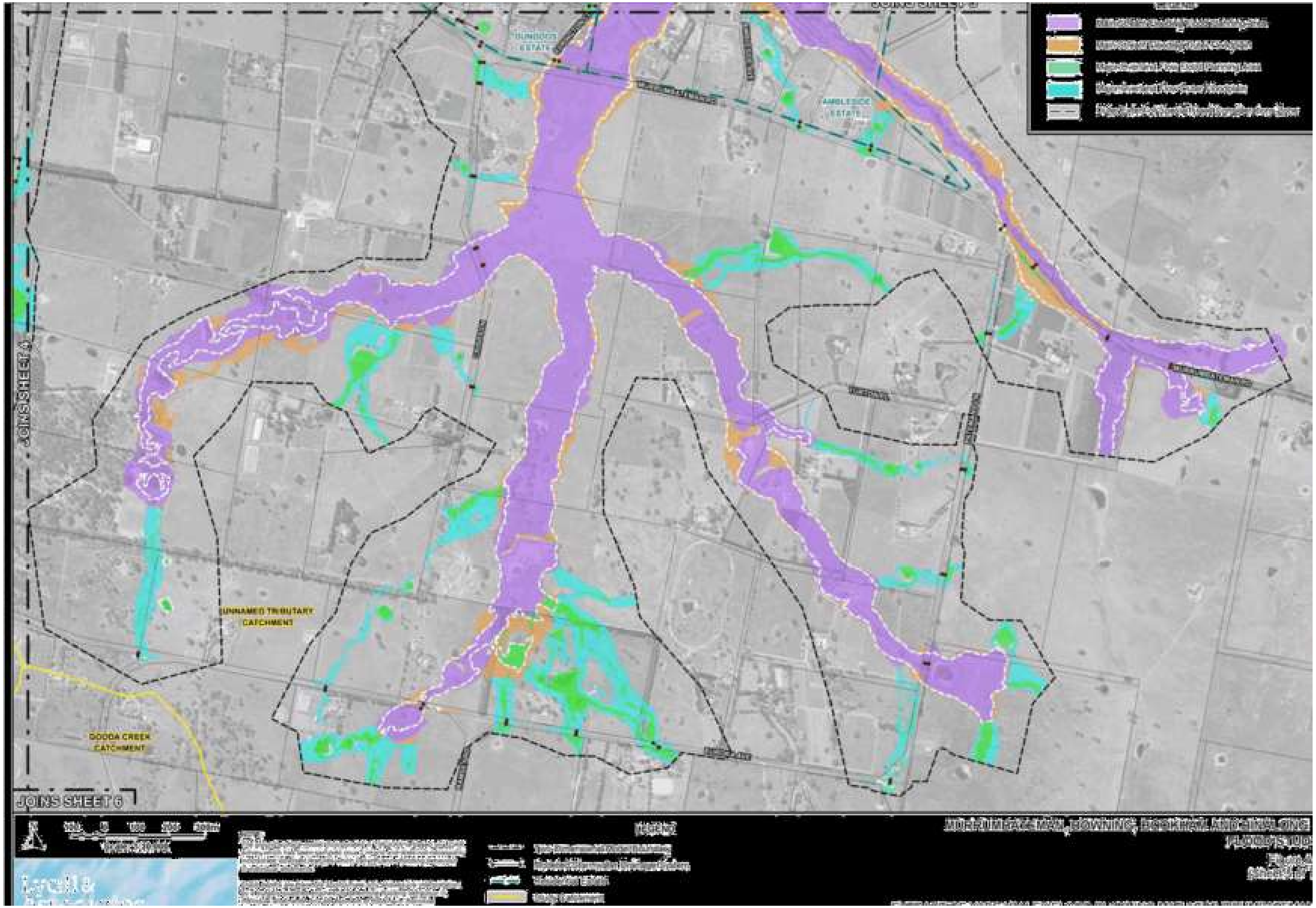
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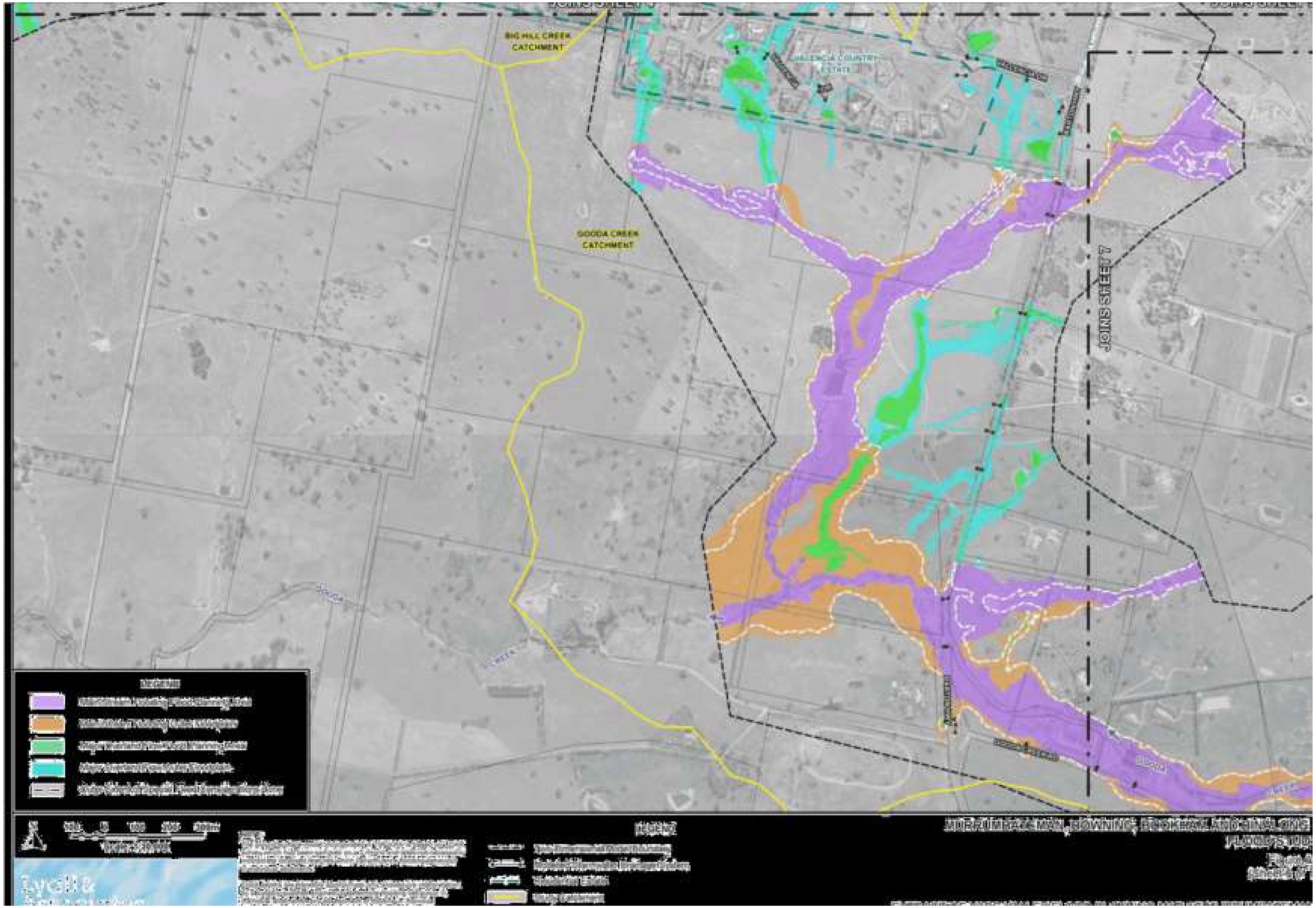
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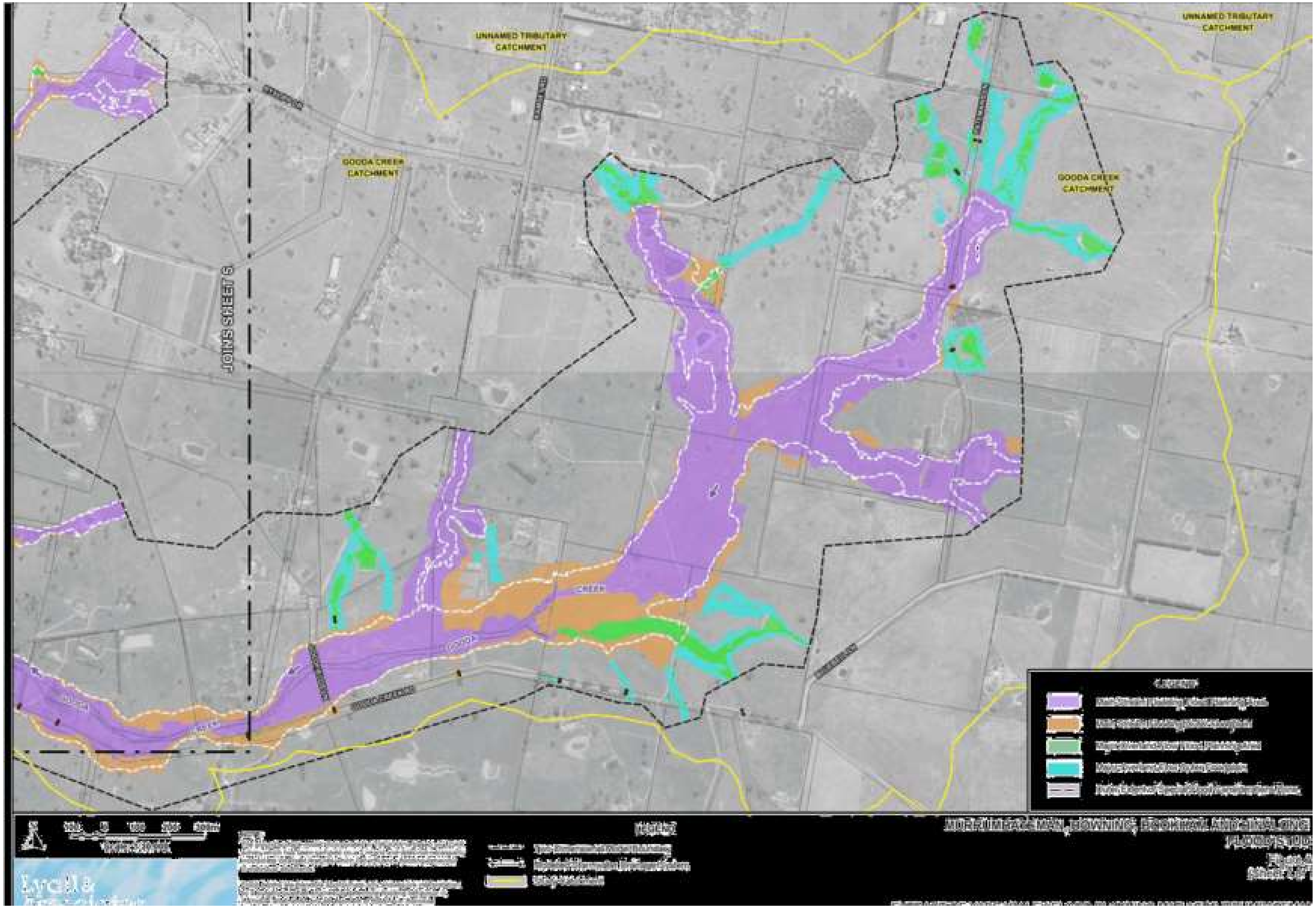
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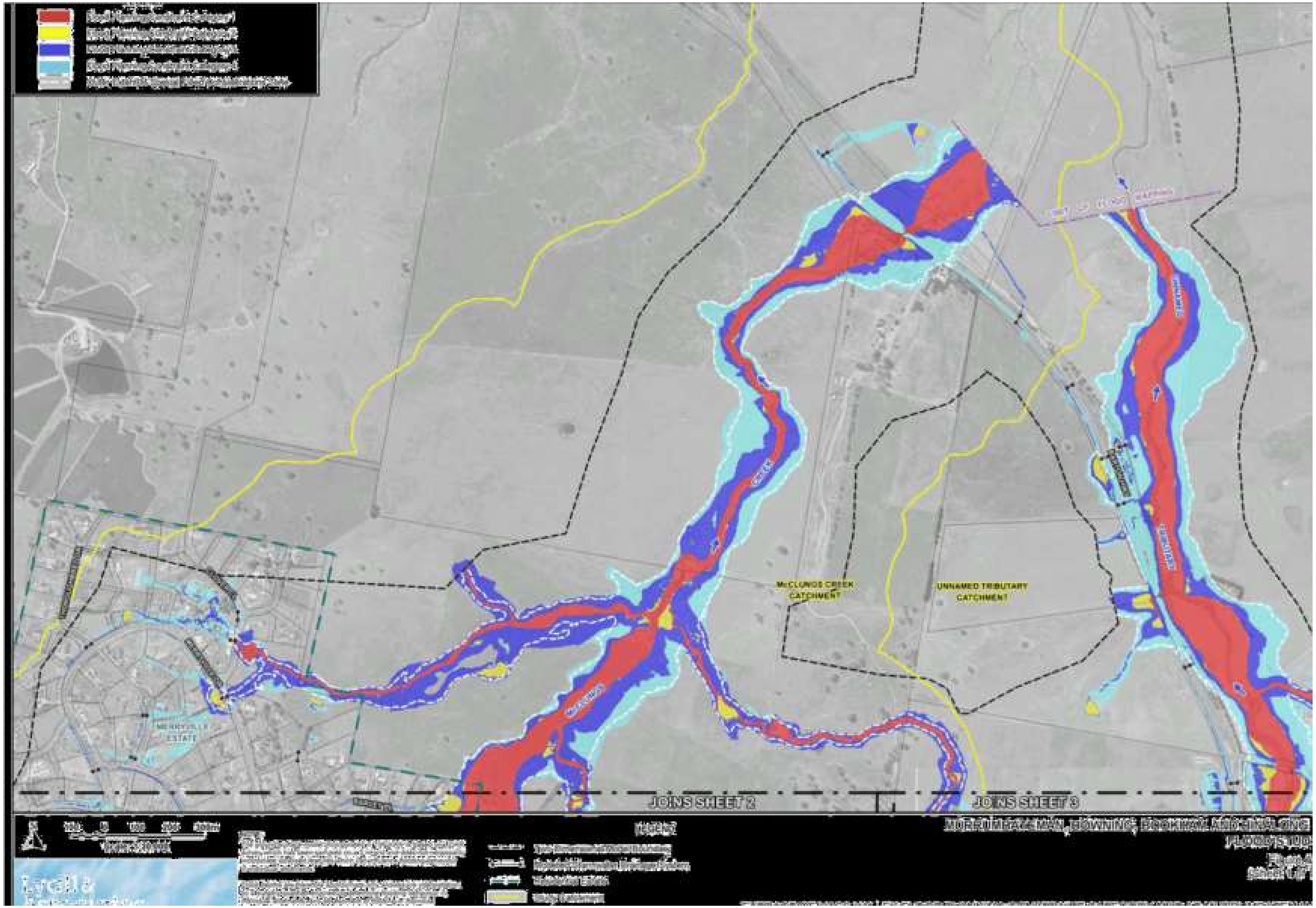
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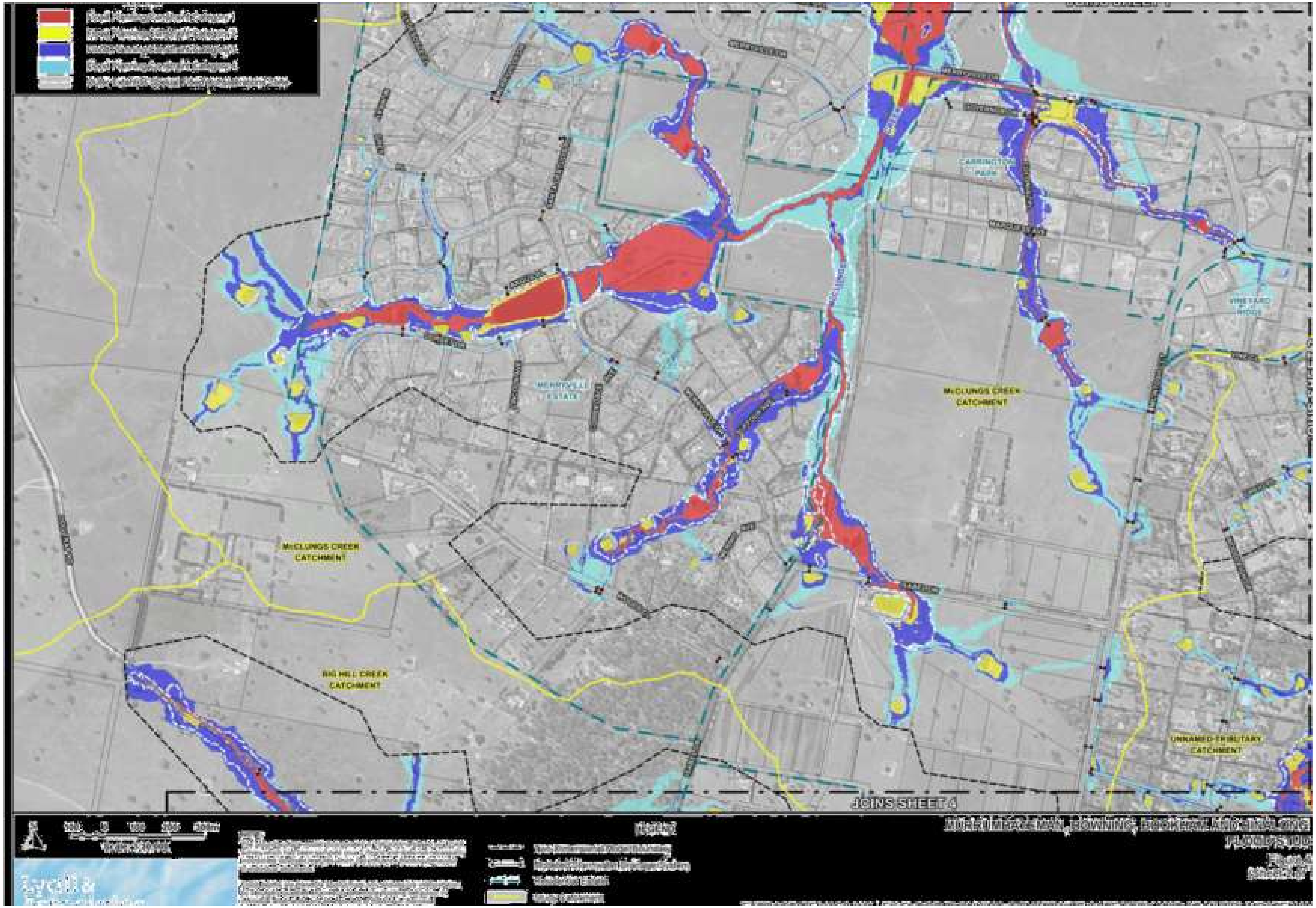
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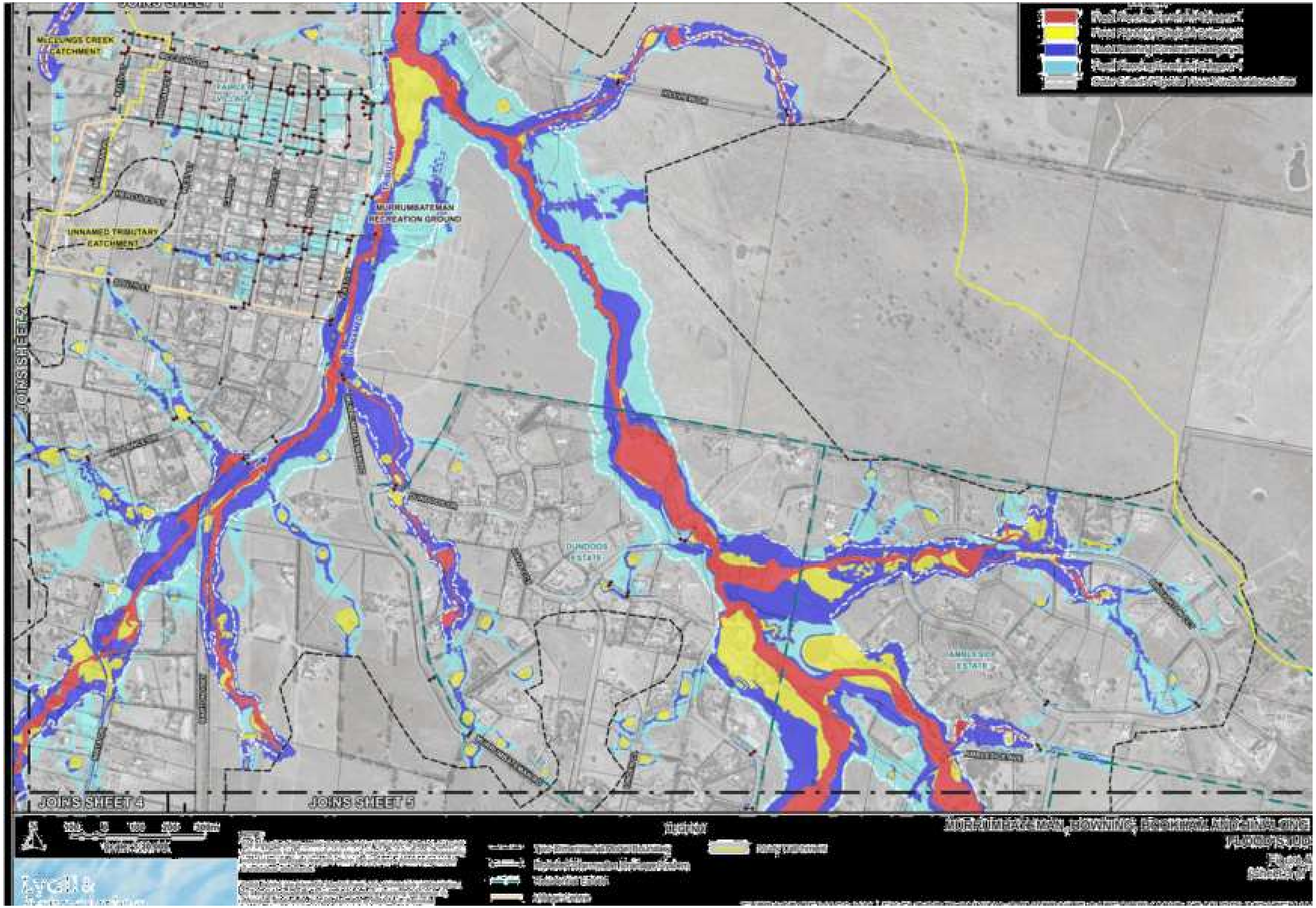
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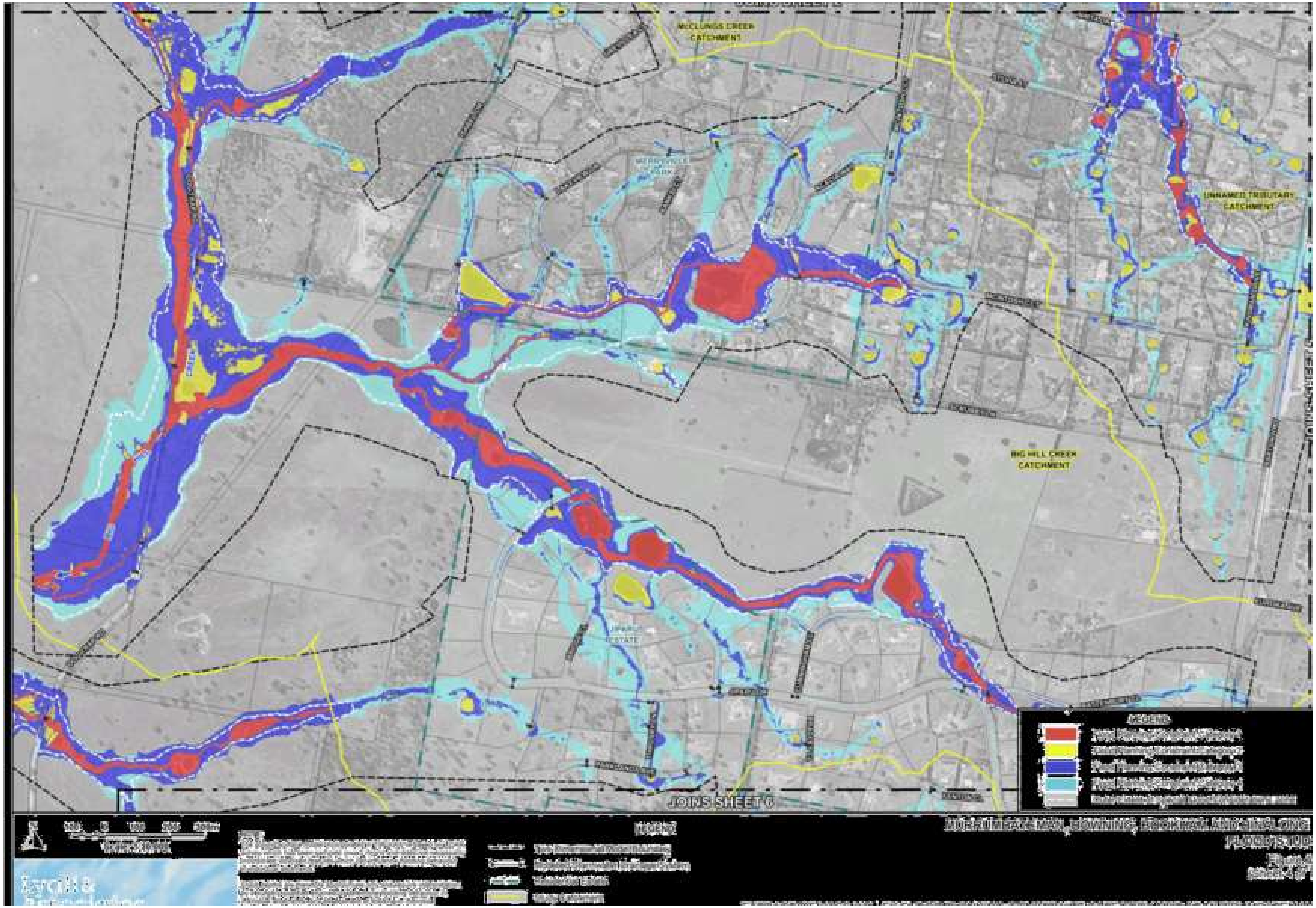
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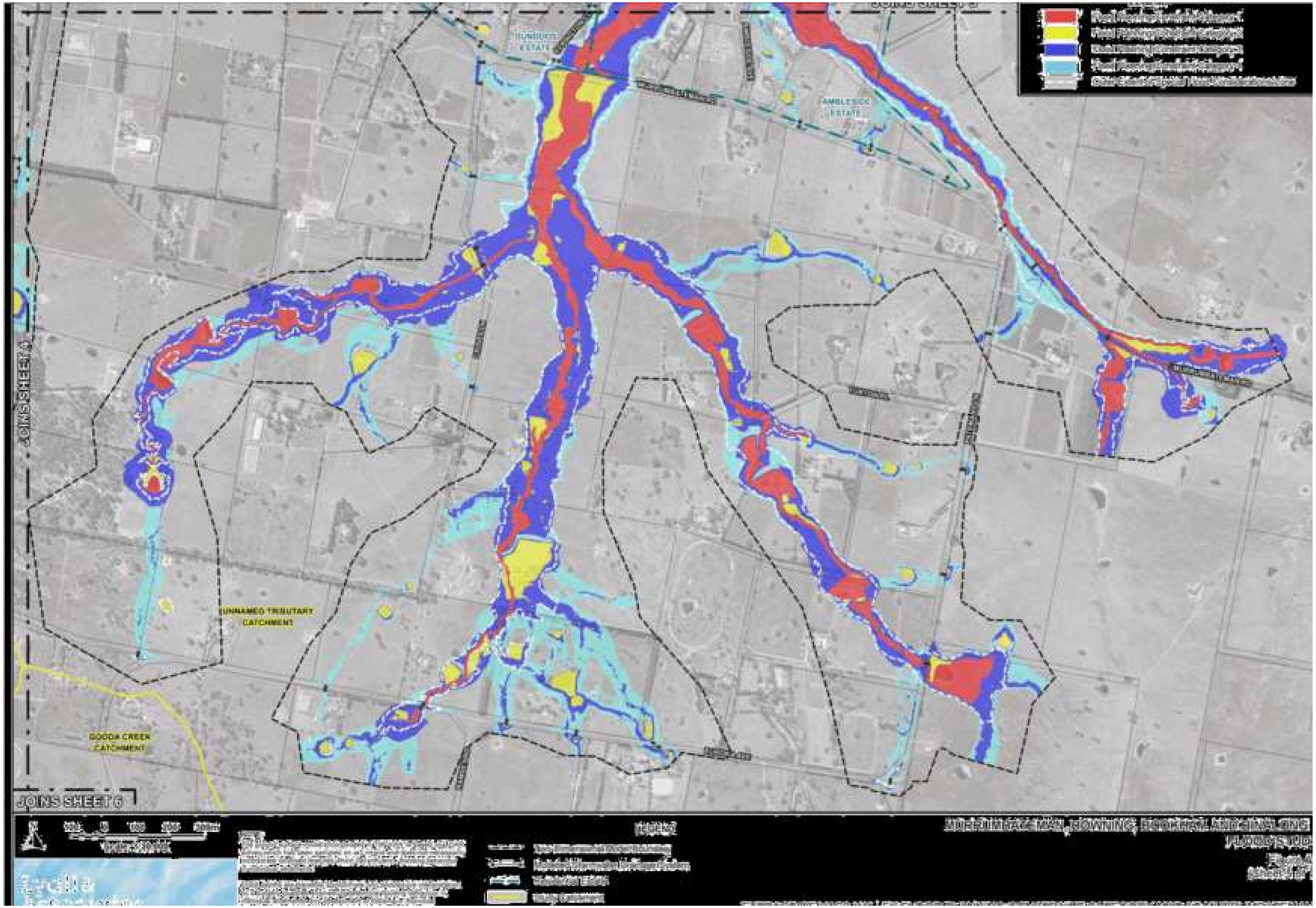
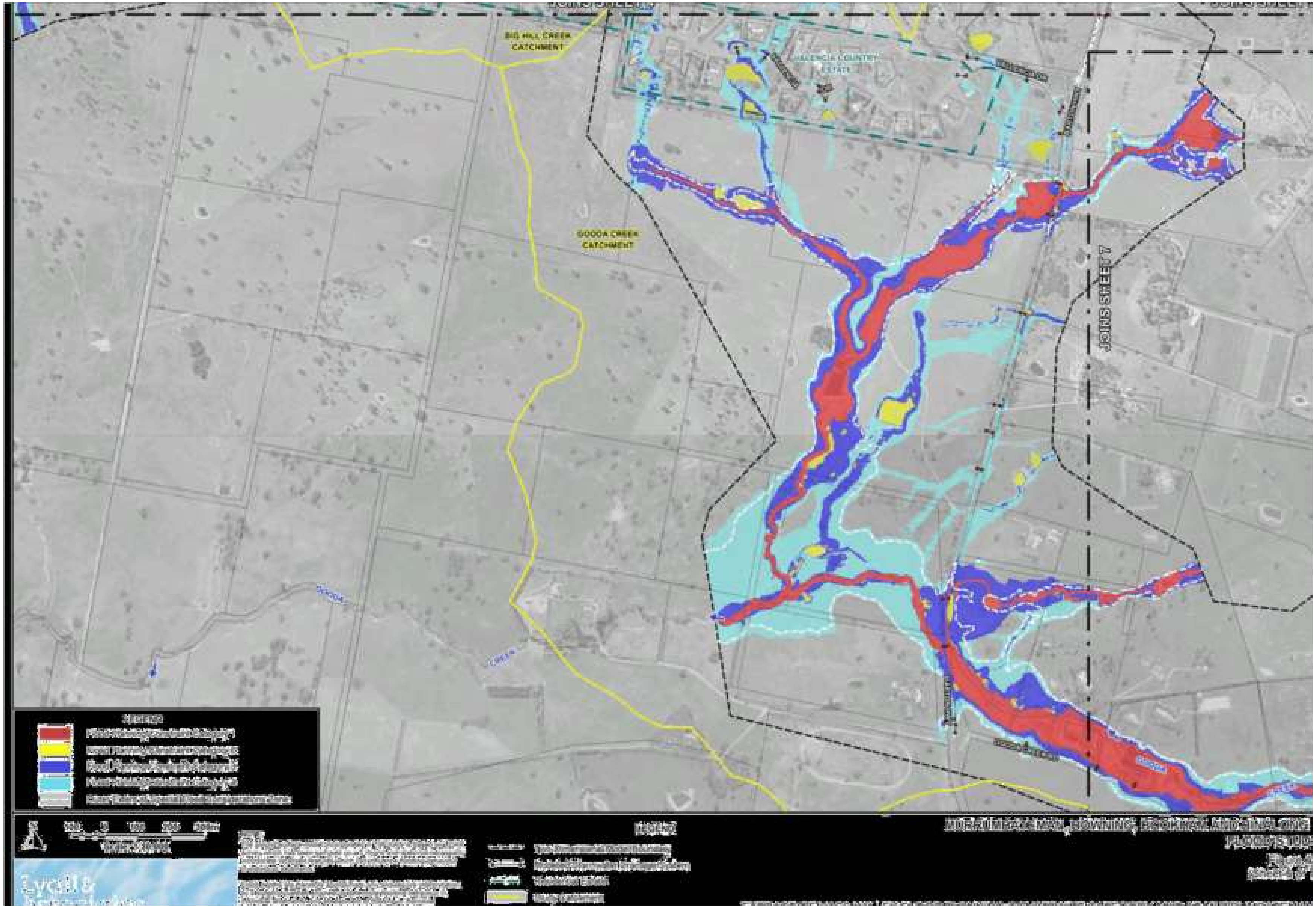
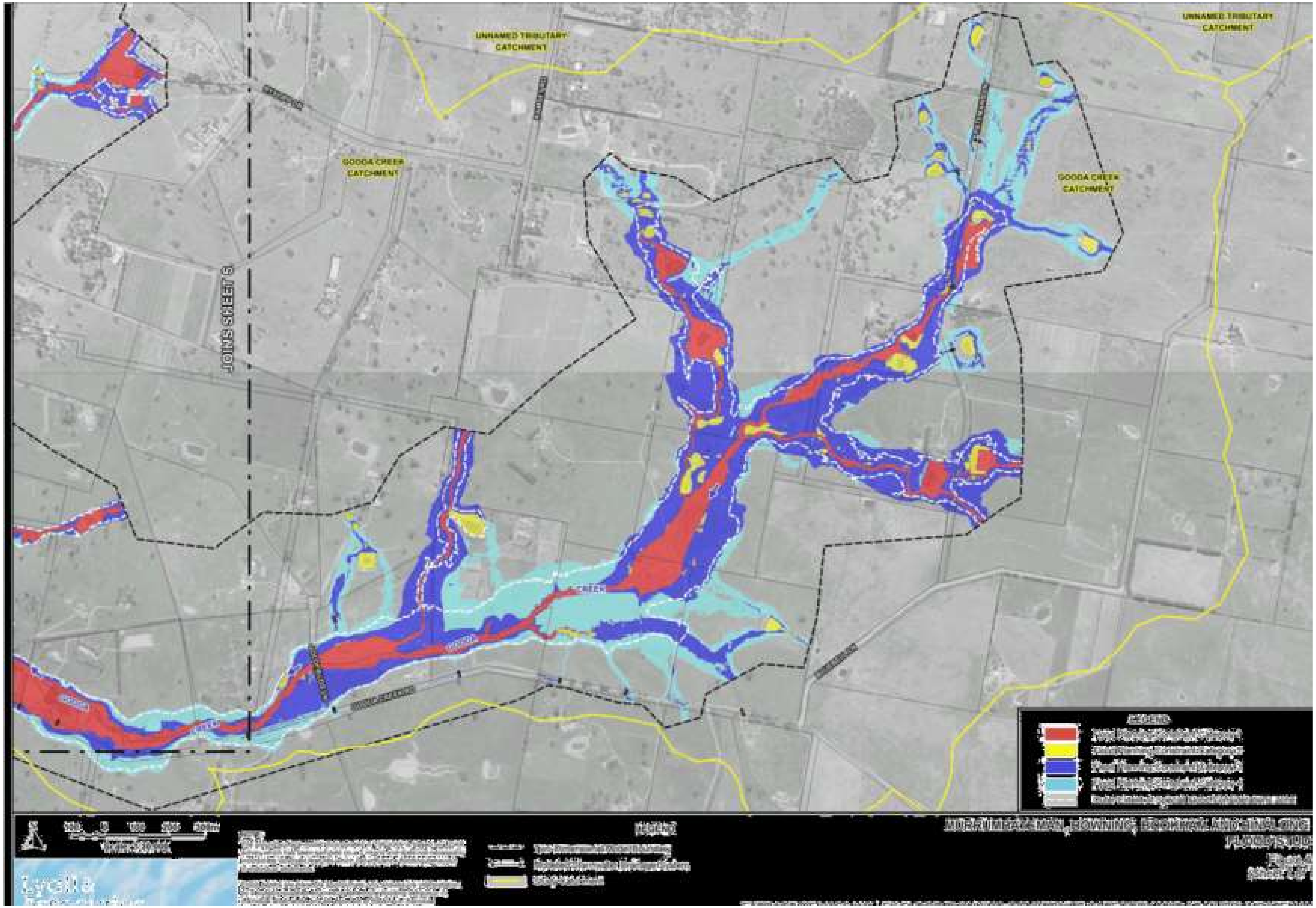
BIG HILL CREEK CATCHMENT
JOINS SHEET 6


JOINS SHEET 4
JOINS SHEET 6
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
AMBLESIDE ESTATE

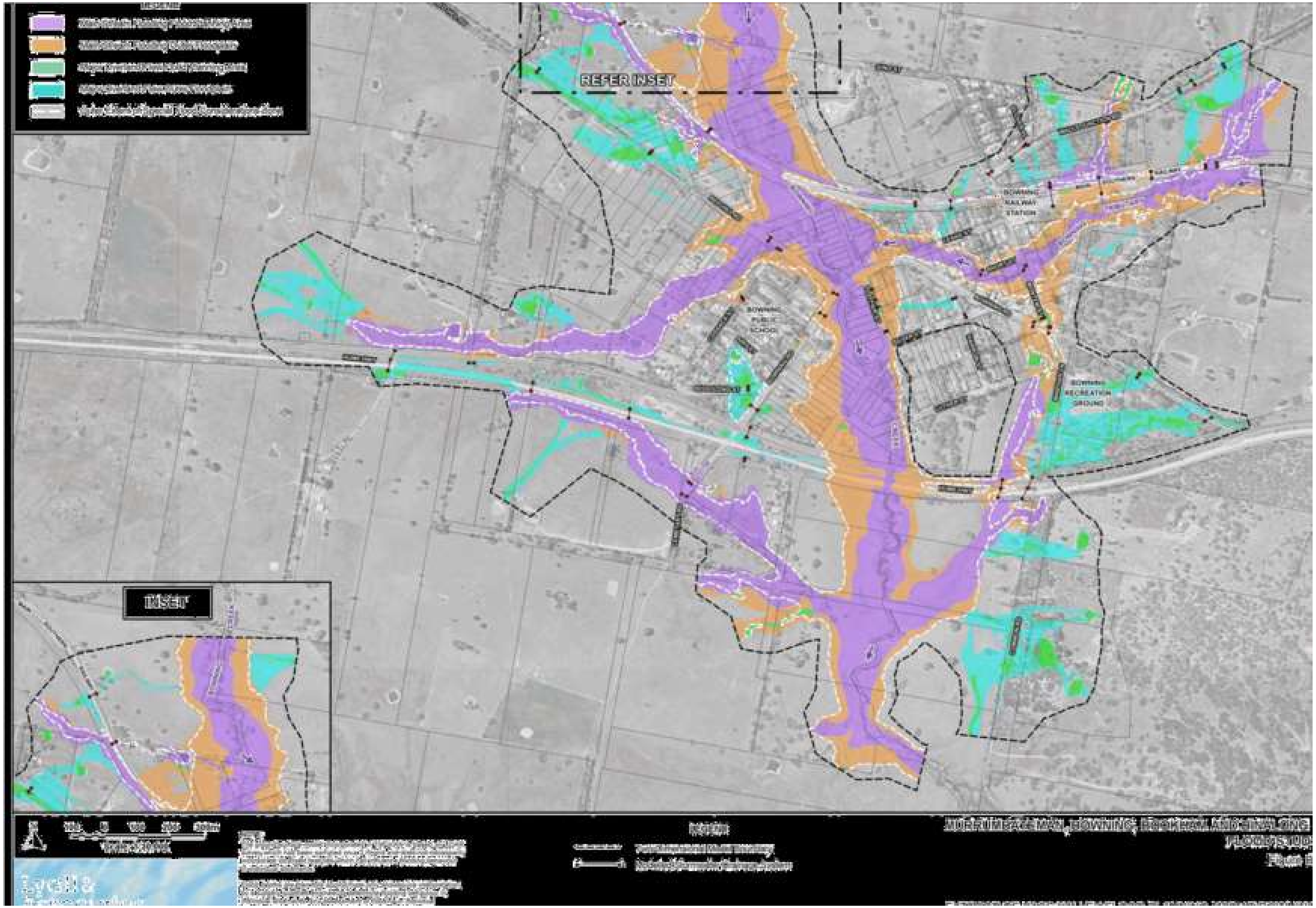

BIG HILL CREEK
CATCHMENT
GOODA CREEK
CATCHMENT
JOINS SHEET 7


UNNAMED TRIBUTARY CATCHMENT
UNNAMED TRIBUTARY CATCHMENT
GOODA CREEK CATCHMENT
GOODA CREEK CATCHMENT
JOINS SHEET 5
LEGEND

ANNEXURE B

FIGURES RELATING TO THE VILLAGE OF BOWNING

LIST OF FIGURES (ANNEXURE B)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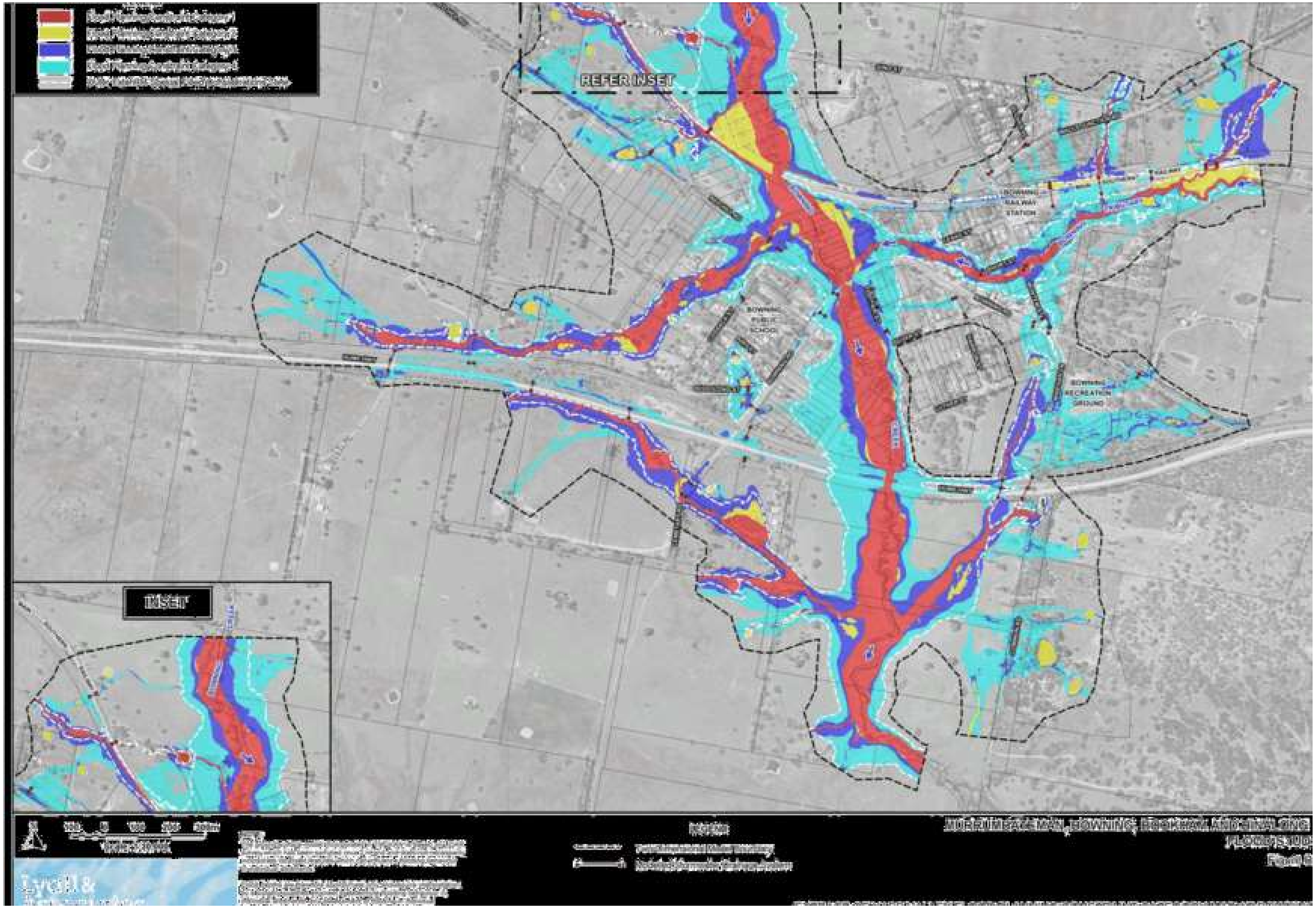
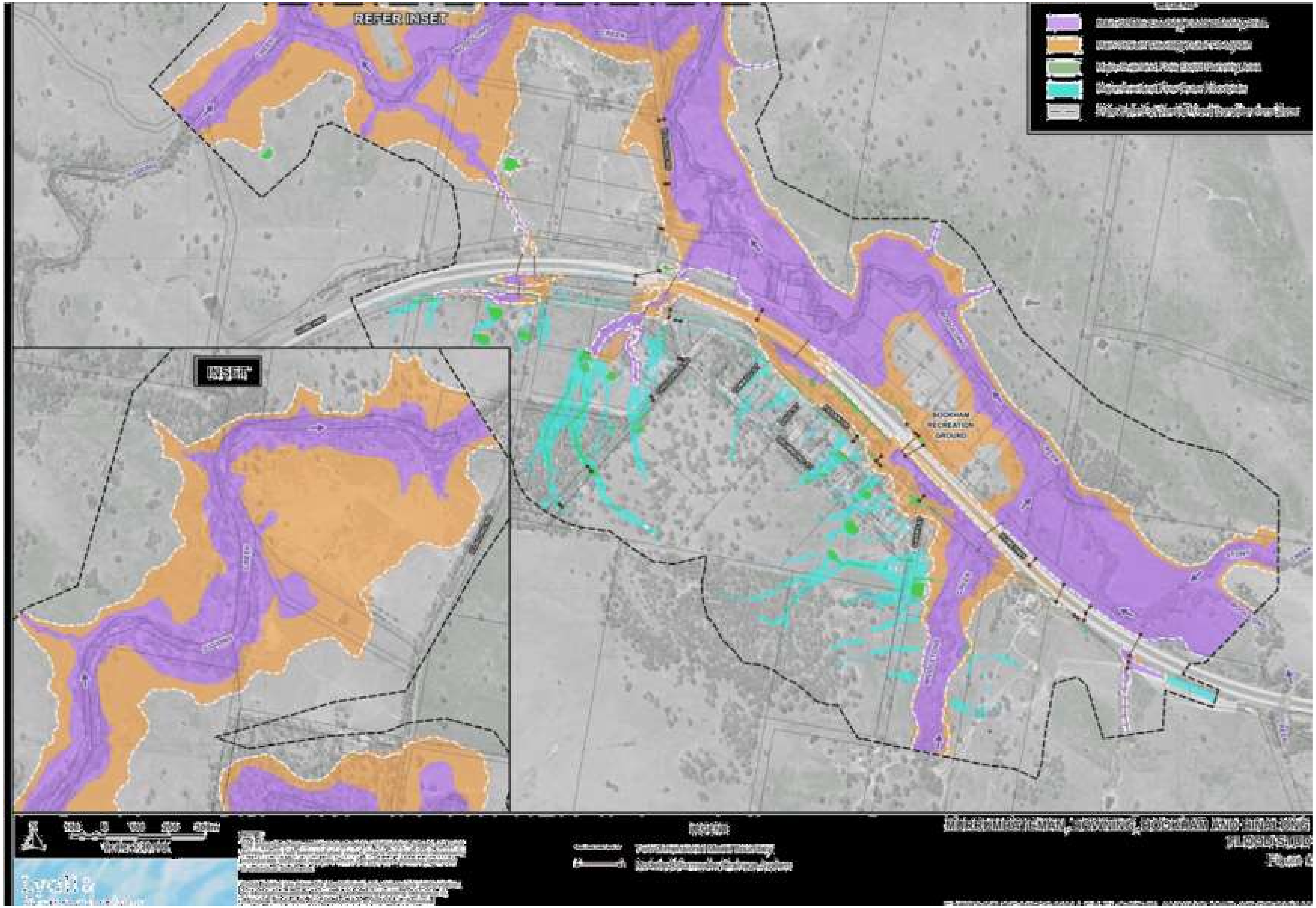
BOWNING RAILWAY STATION
BOWNING PUBLIC SCHOOL
BOWNING RECREATION GROUND
INSET

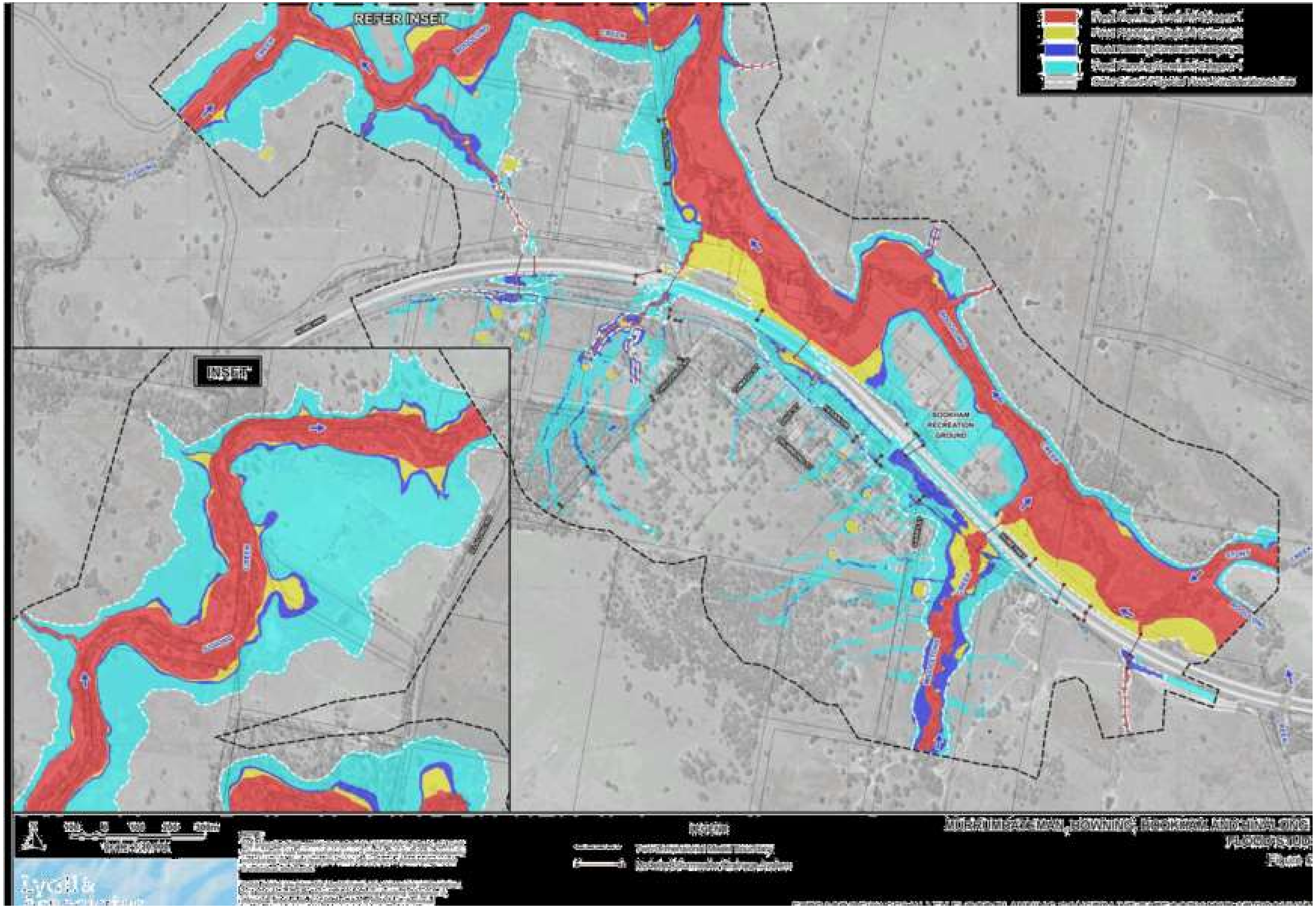

REFER INSET
INSET
BOWNING RAILWAY STATION
BOWNING PUBLIC SCHOOL
BOWNING RECREATION GROUND

ANNEXURE C

FIGURES RELATING TO THE VILLAGE OF BOOKHAM

LIST OF FIGURES (ANNEXURE C)

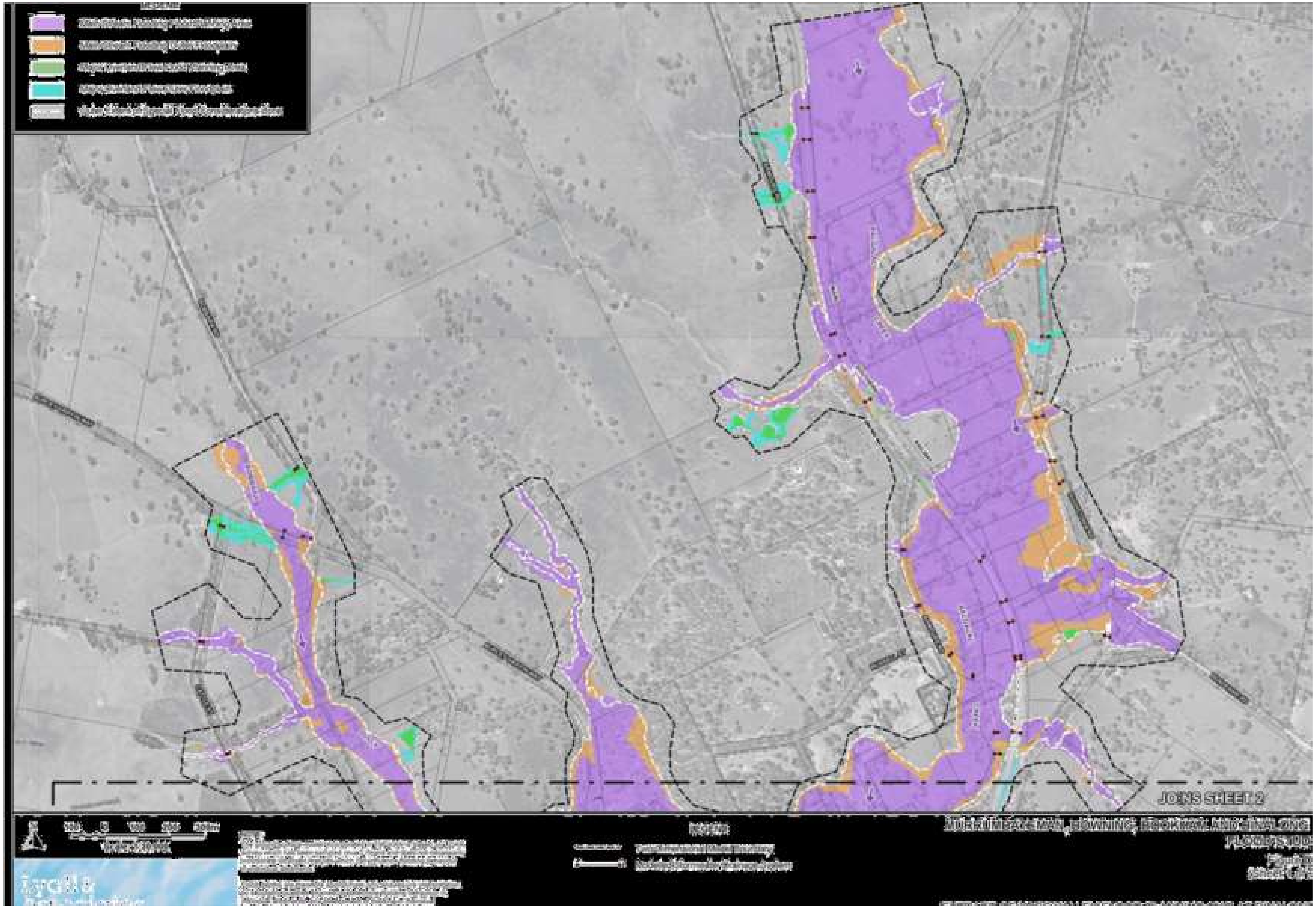

REFER INSET
INSET
BOOKHAM
RECREATION
GROUND


REFER INSET
INSET
BOOKHAM
RECREATION
GROUND

ANNEXURE D

FIGURES RELATING TO THE VILLAGE OF BINALONG

LIST OF FIGURES (ANNEXURE D)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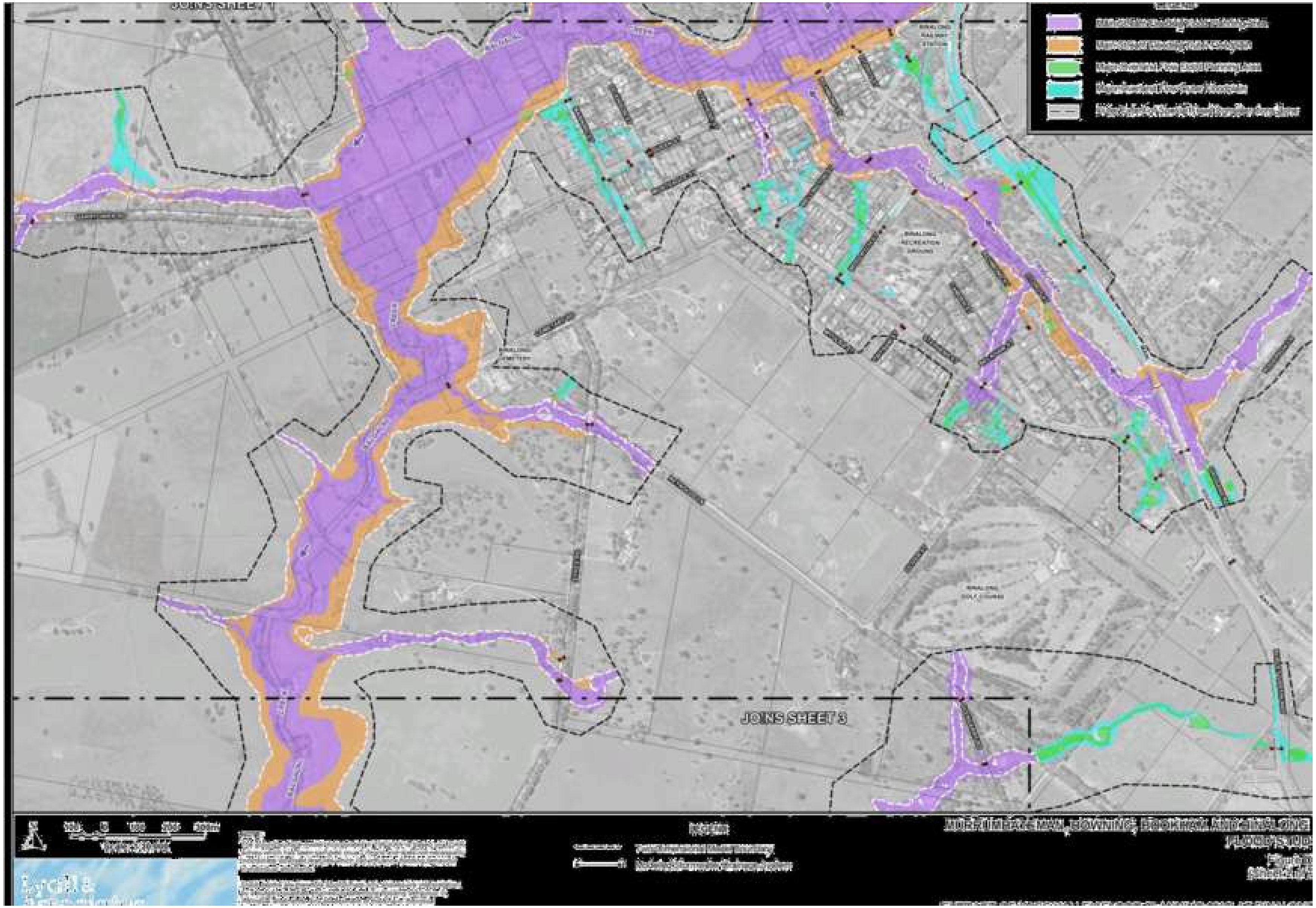
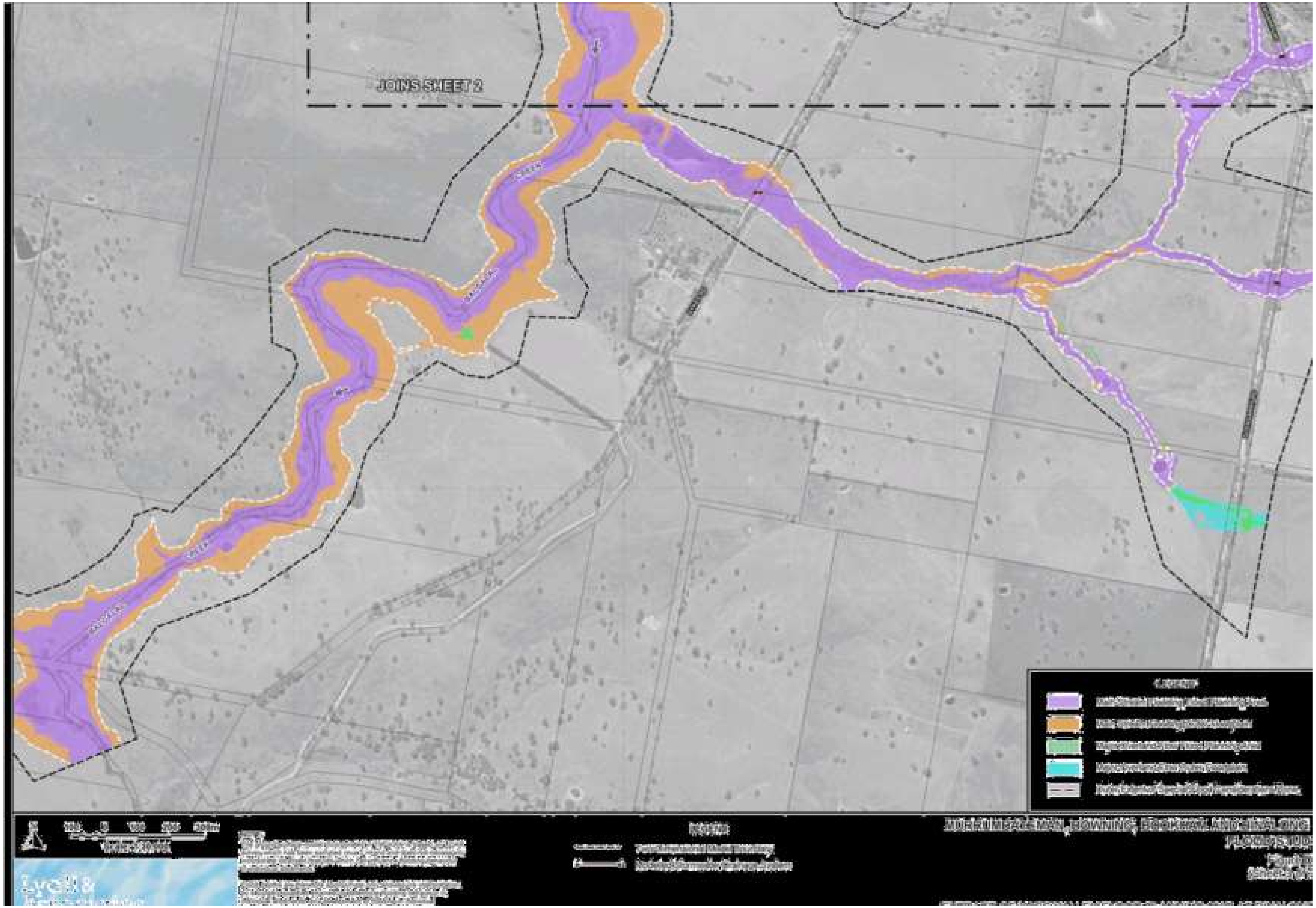

JOINS SHEET 3
BINALONG RECREATION GROUND
BINALONG GOLF COURSE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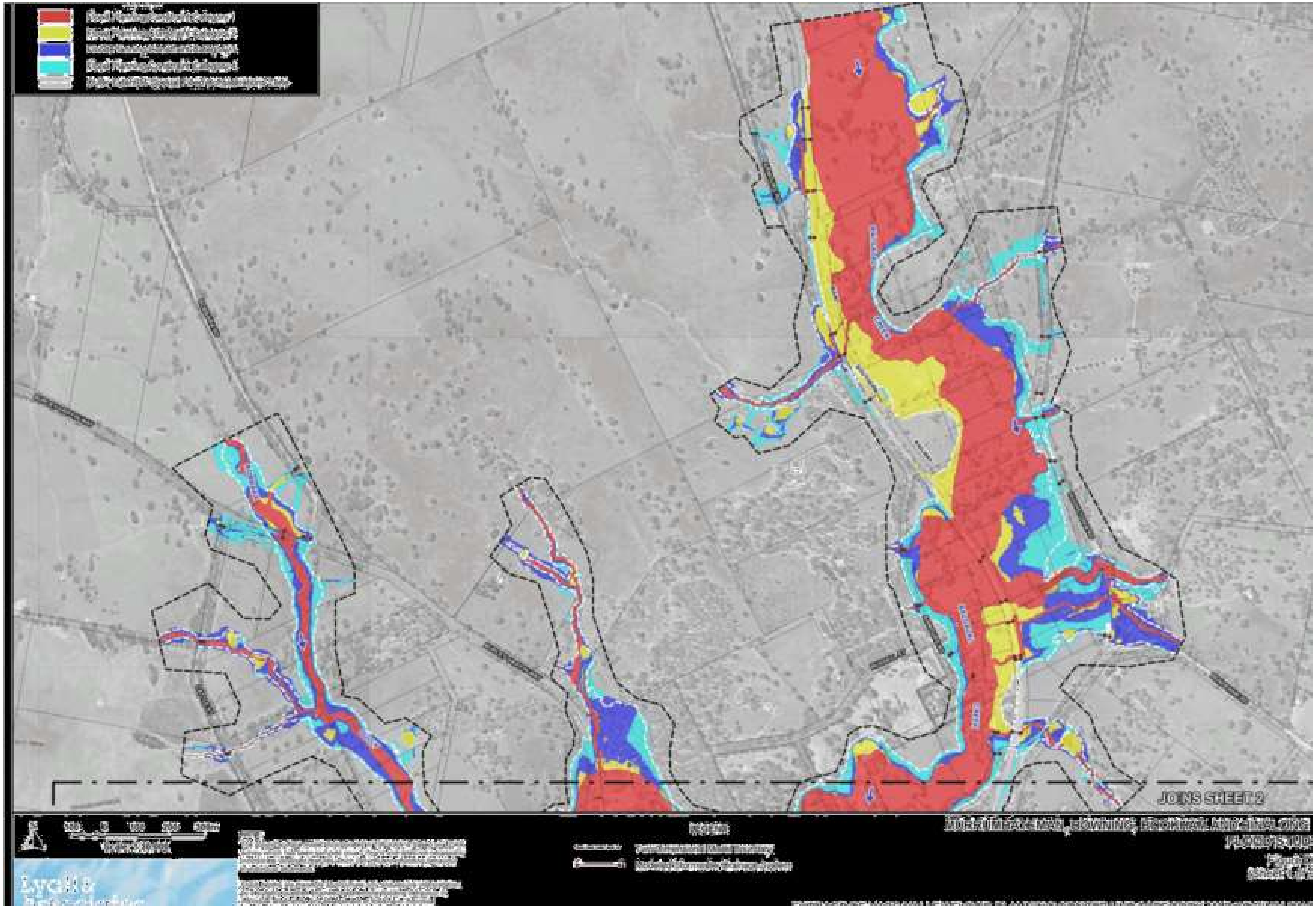
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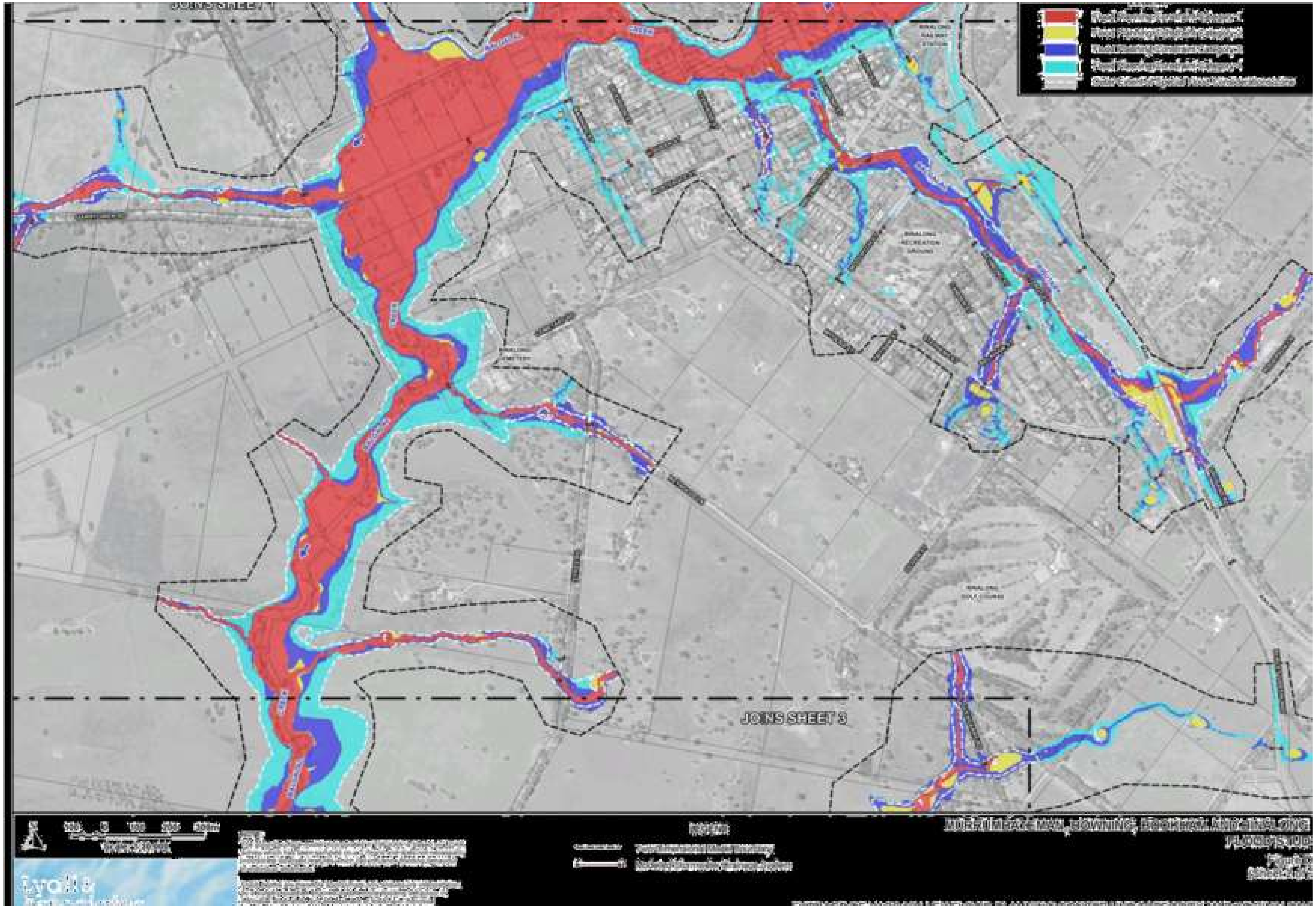
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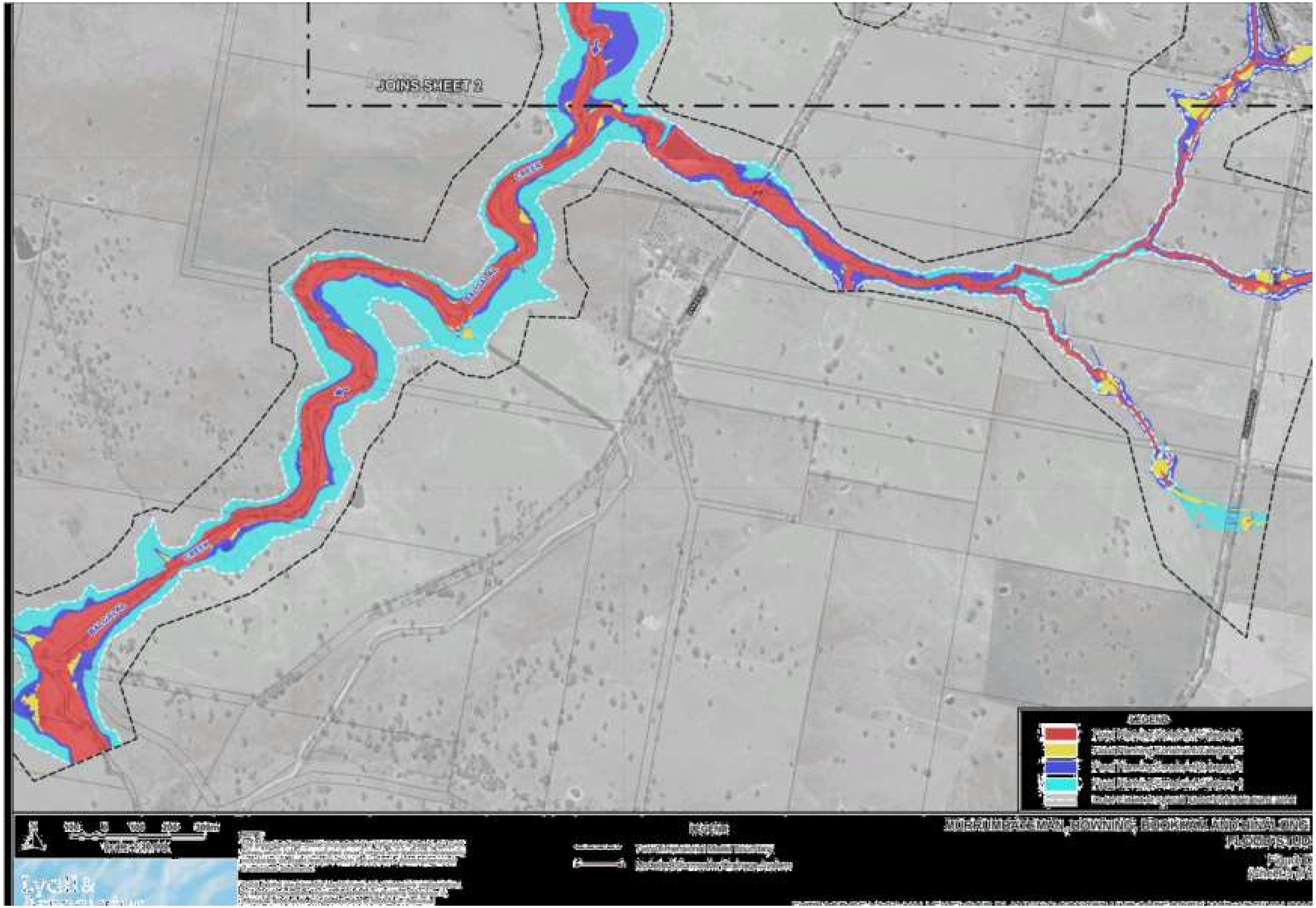
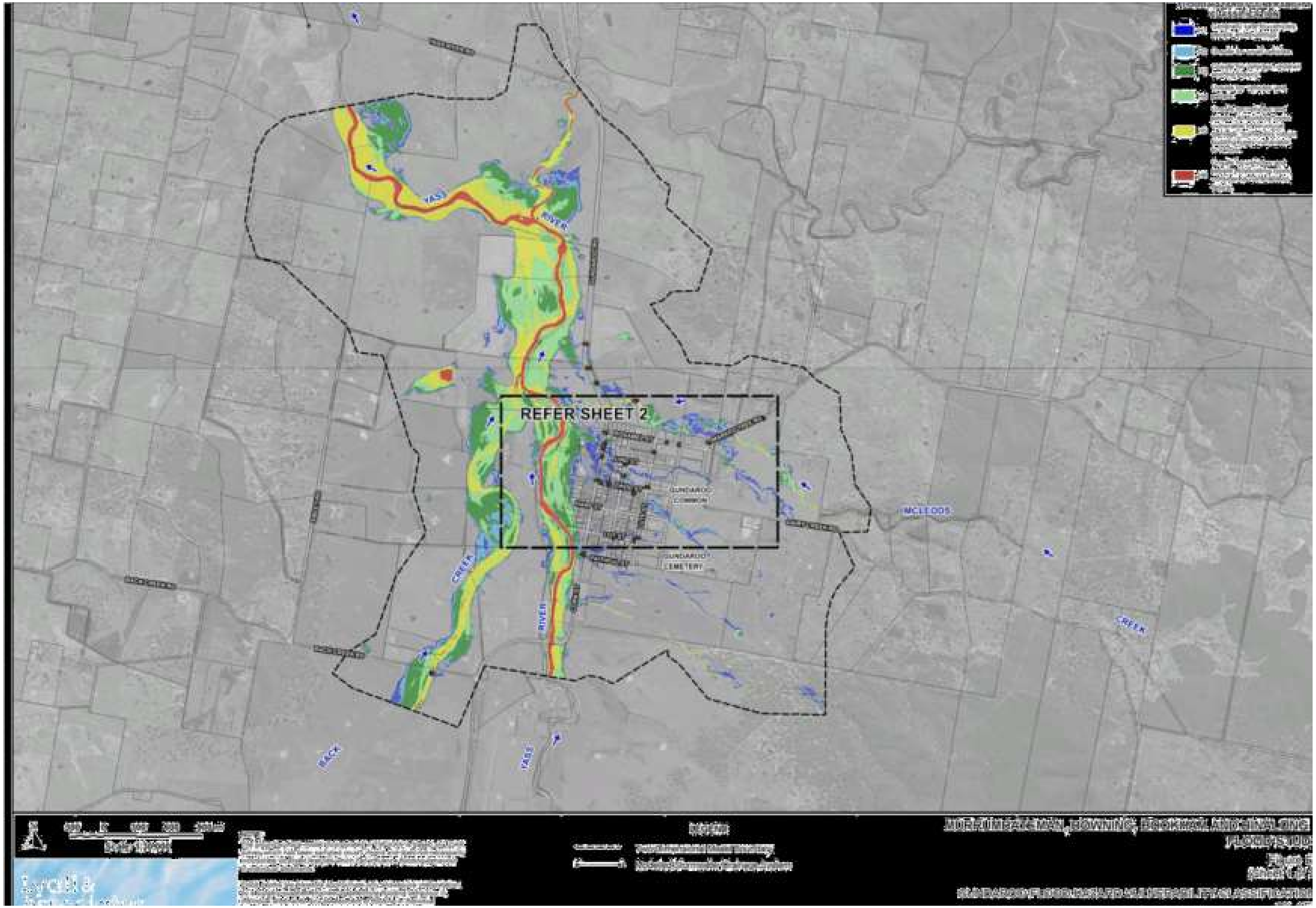

JOINS SHEET 2

ANNEXURE E

FIGURES RELATING TO THE VILLAGE OF GUNDAROO

LIST OF FIGURES (ANNEXURE E)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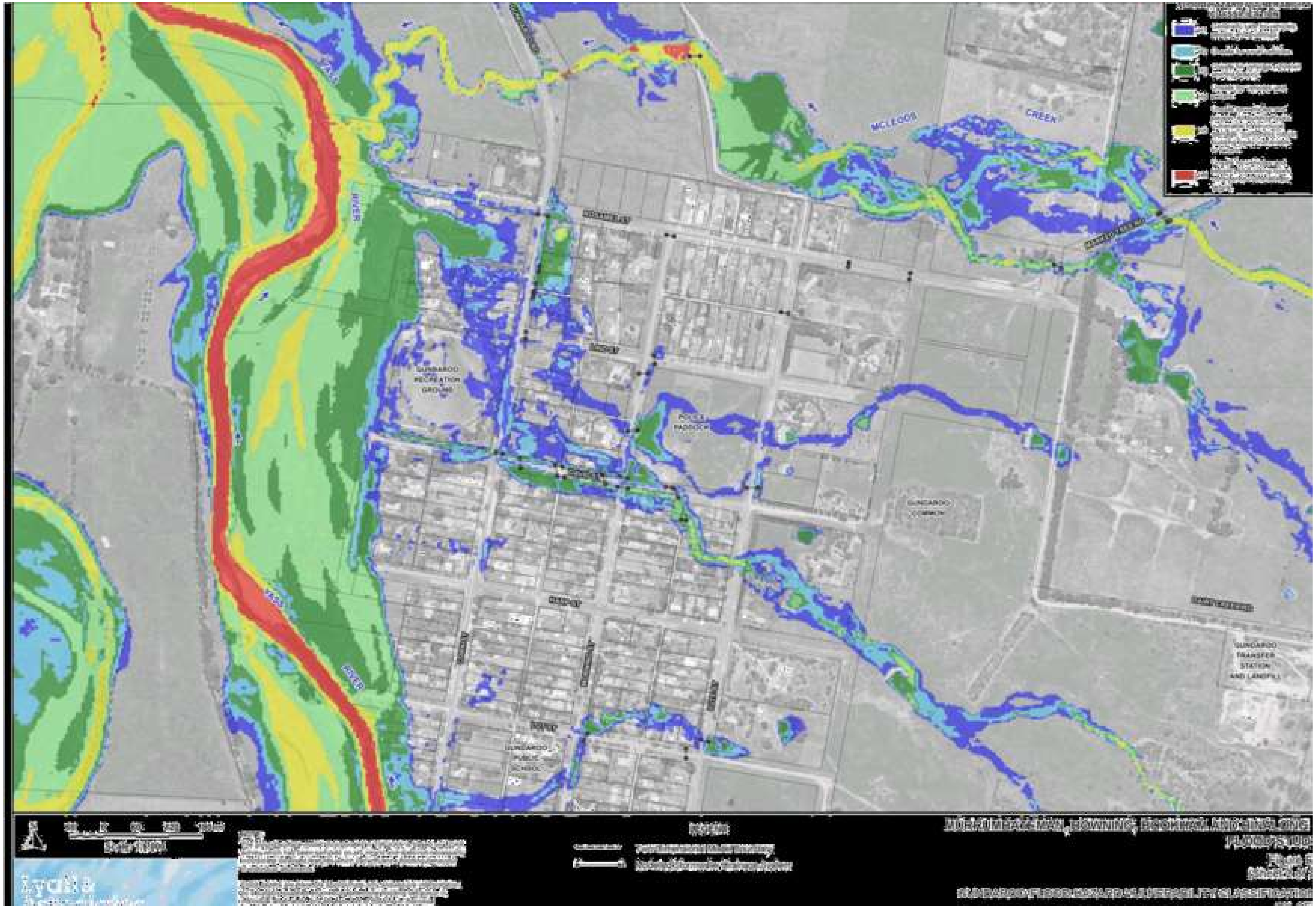
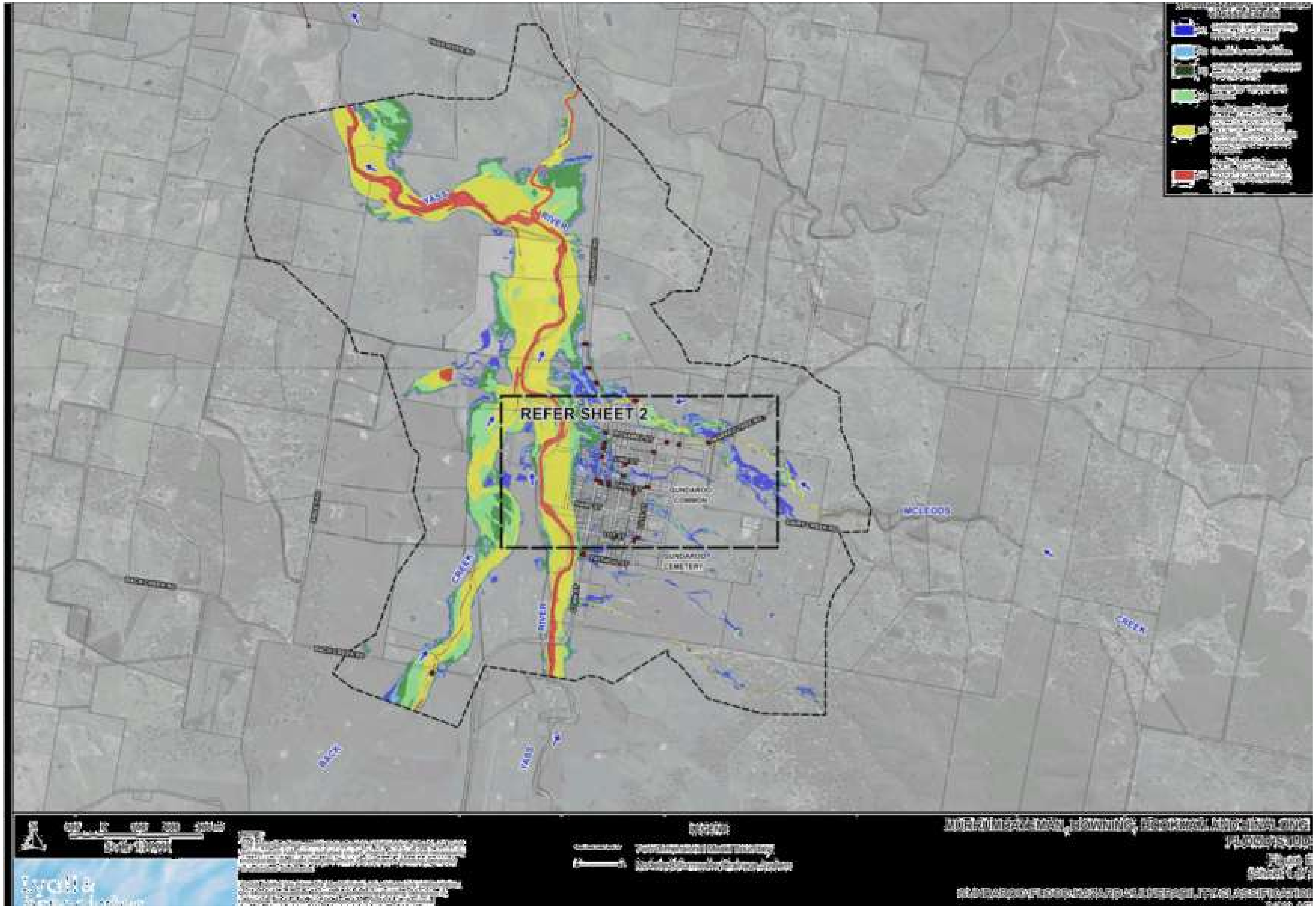
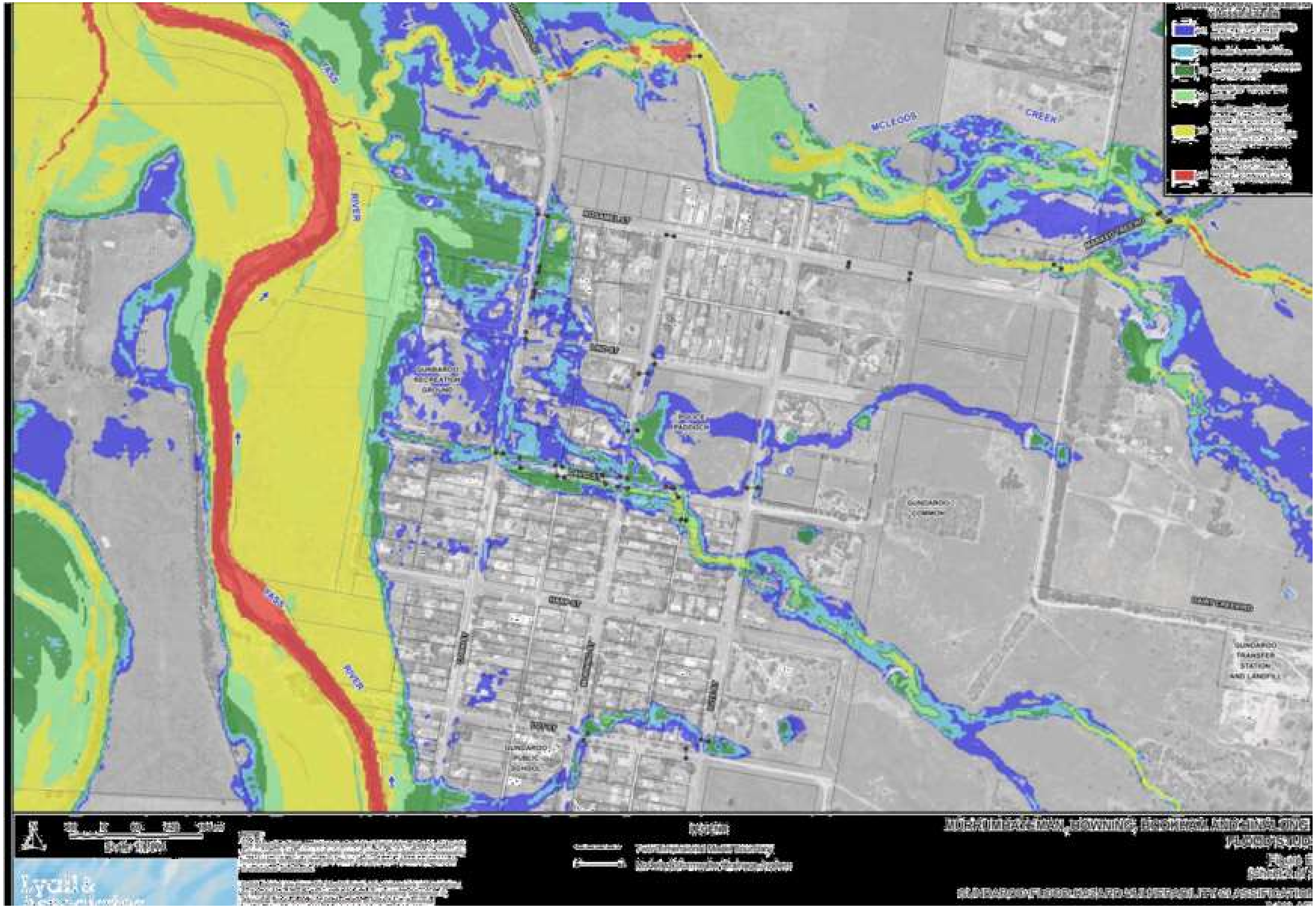
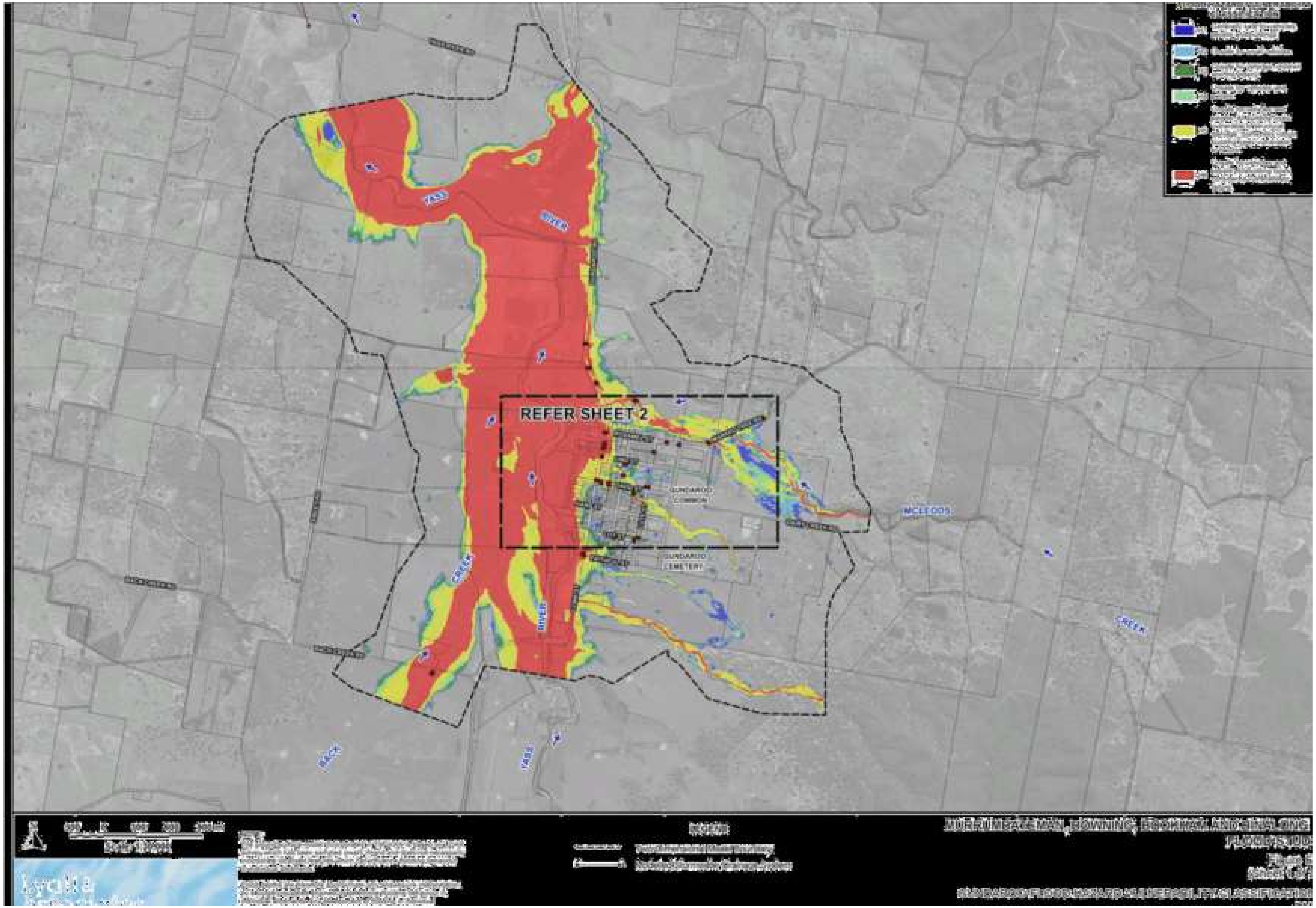
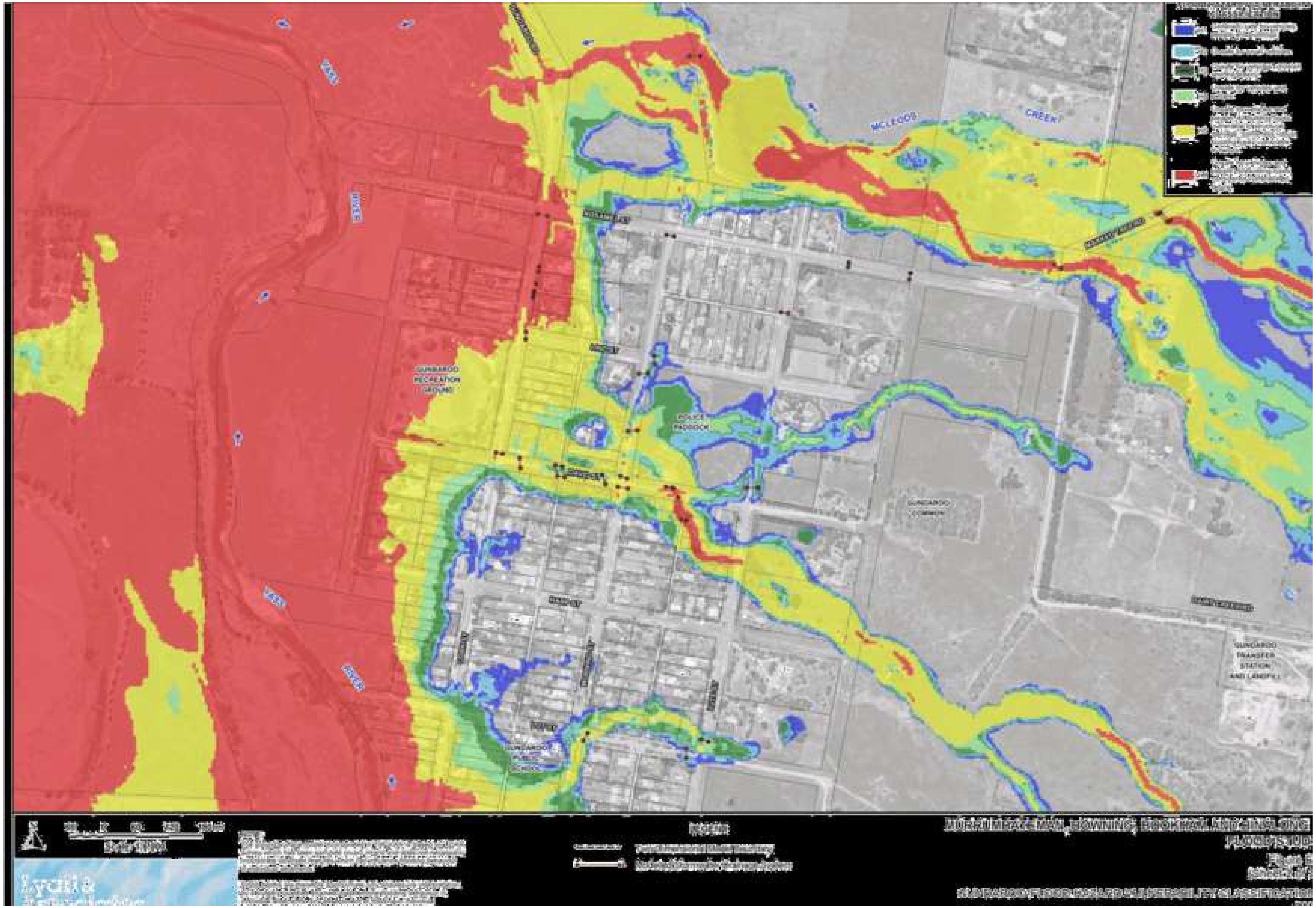
YASS
RIVER
CREEK
MCLEODS
BACK
GUNDAROO COMMON
GUNDAROO CEMETERY

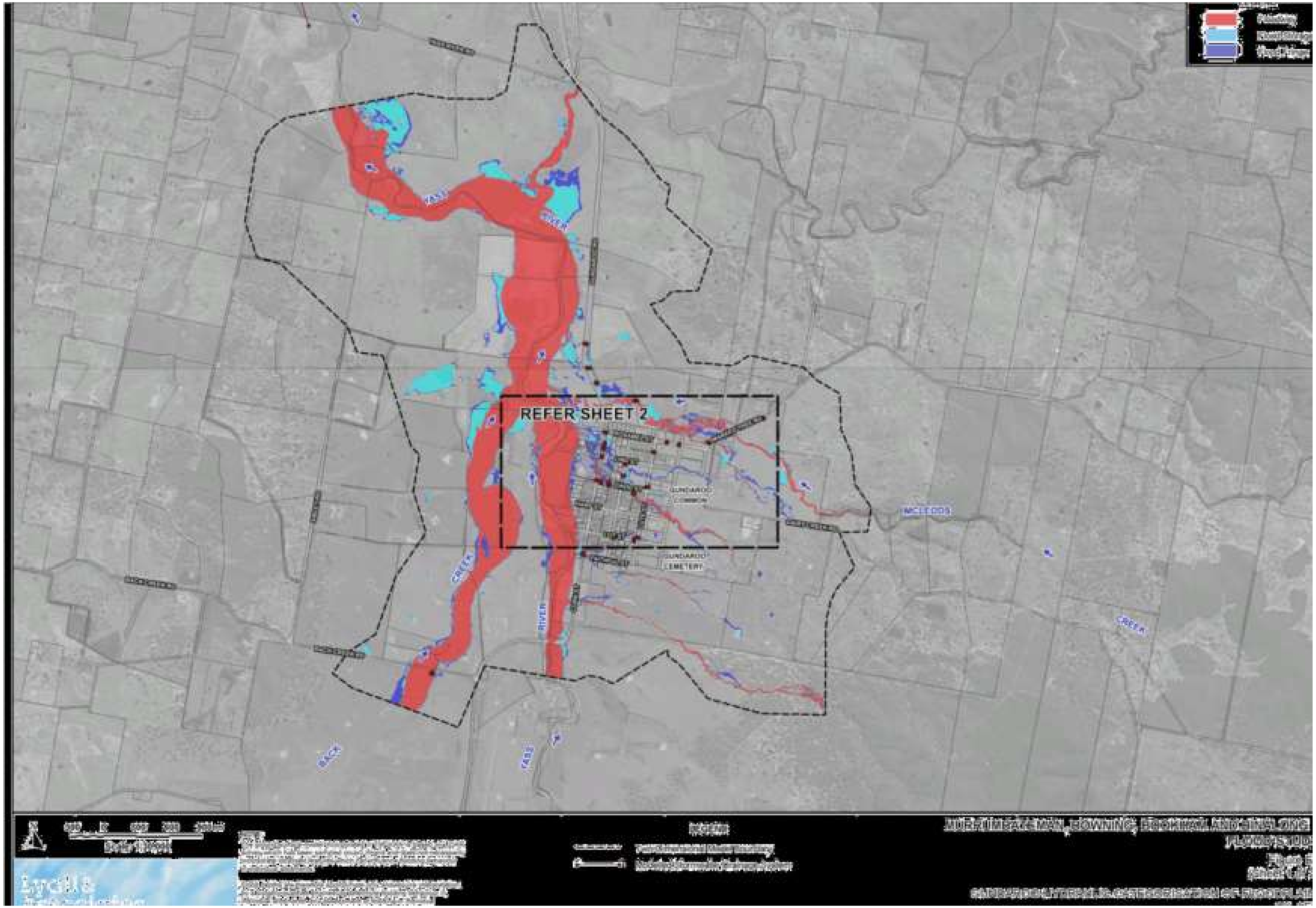

MCLEODS
CREEK
RIVER
GUNDAROO
RECREATION
GROUND
POLICE
PADDOCK
GUNDAROO
COMMON
GUNDAROO
TRANSFER
STATION
AND LANDFILL
GUNDAROO
PUBLIC
SCHOOL

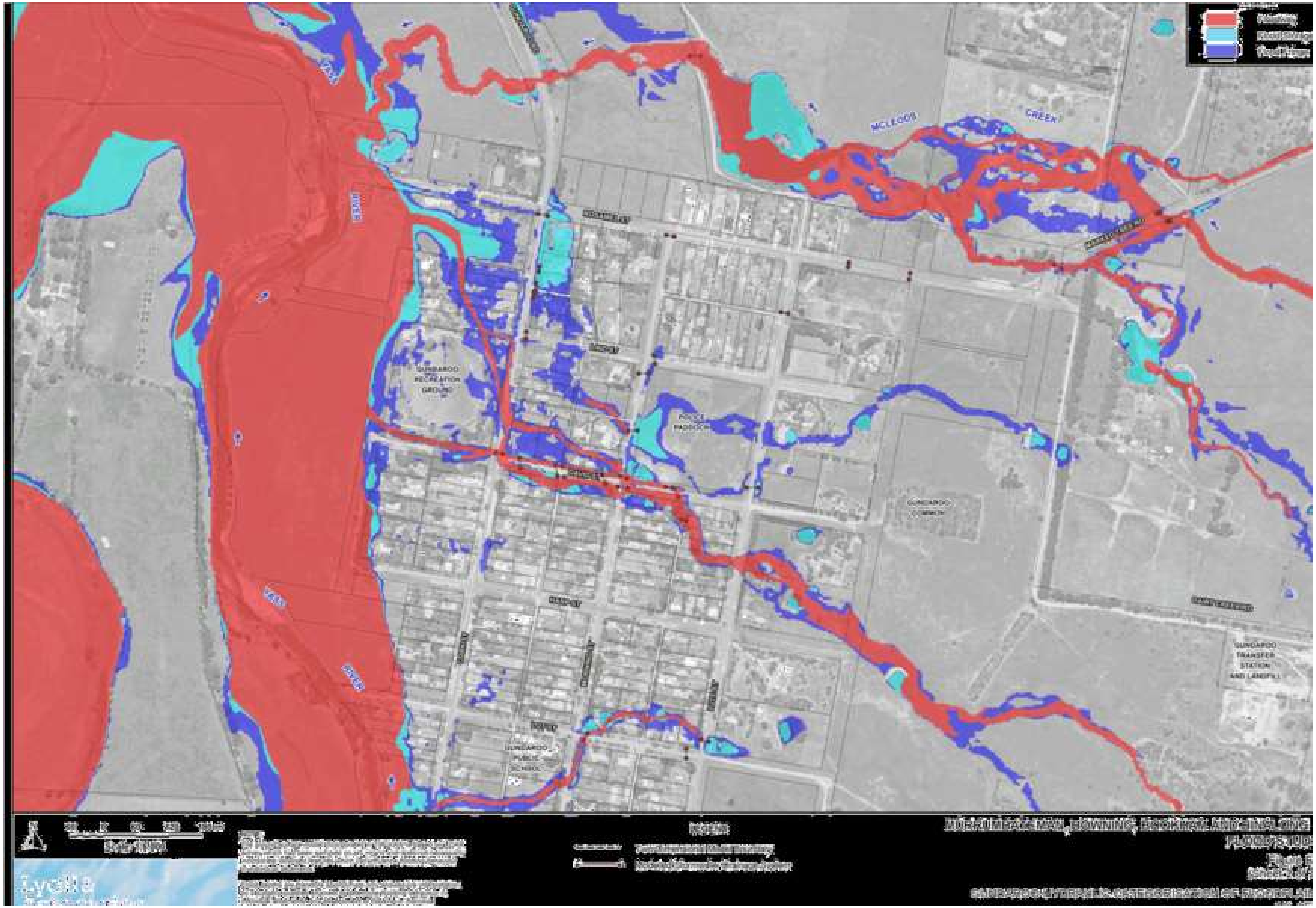

REFER SHEET 2
YASS
RIVER
CREEK
GUNDAROO COMMON
GUNDAROO CEMETERY
MCLEODS
CREEK
BACK
YASS

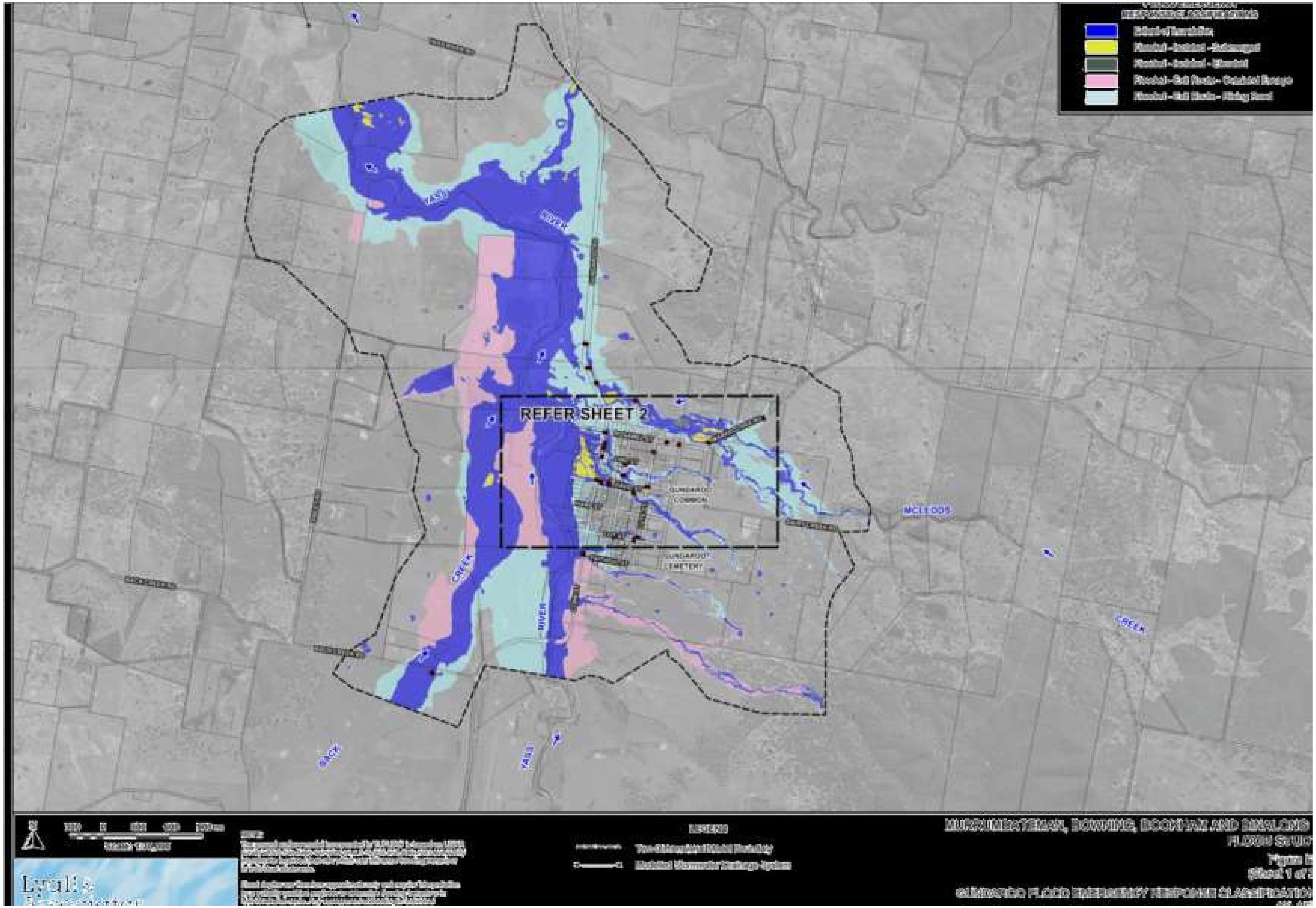

MCLEODS
CREEK
RIVER
RIVER
GUNDAROO
RECREATION
GROUND
GUNDAROO
COMMON
GUNDAROO
TRANSFER
STATION
AND LANDFILL
GUNDAROO
PUBLIC
SCHOOL

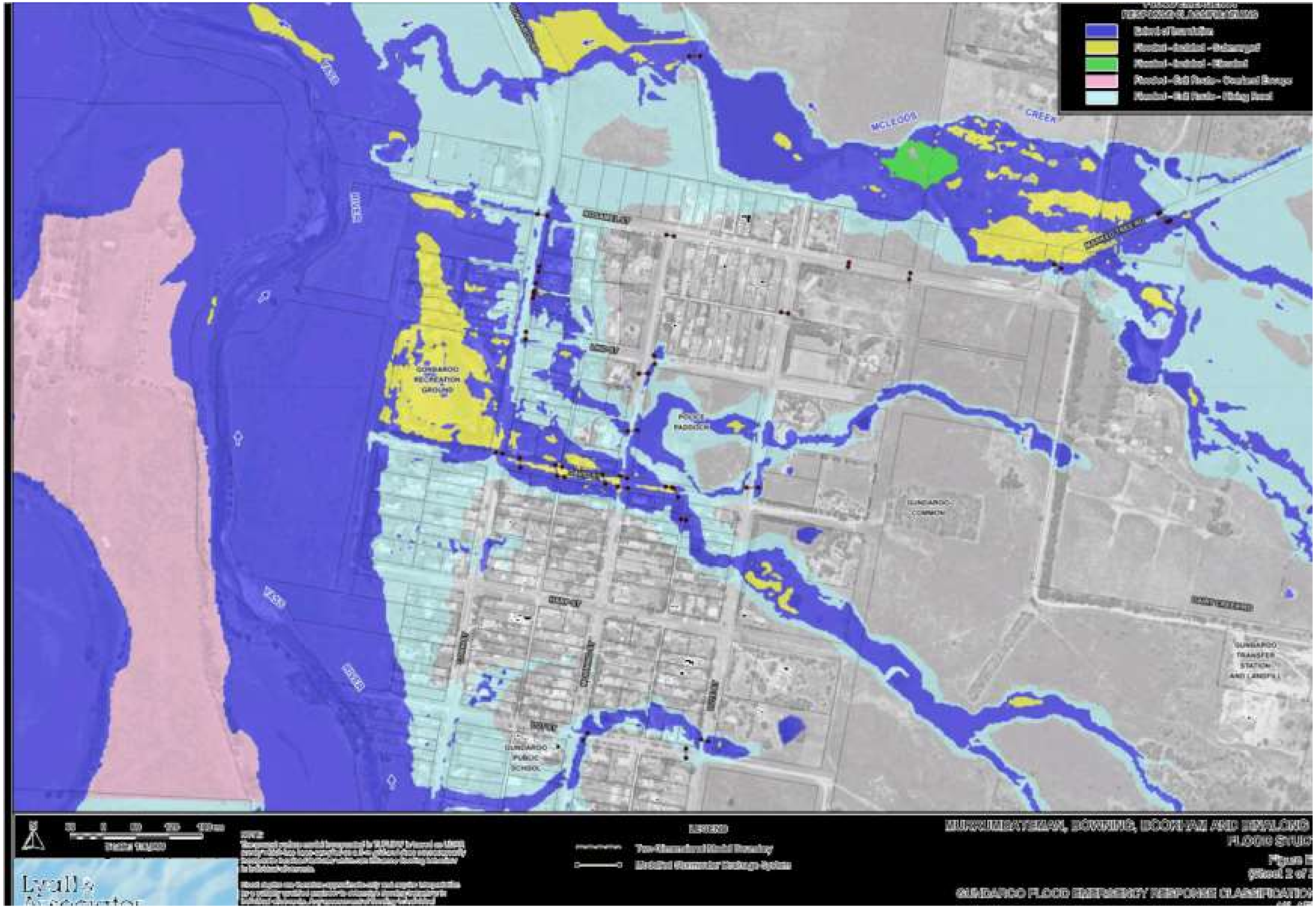

REFER SHEET 2
YASS
RIVER
CREEK
MCLEODS
BACK
GUNDAROO COMMON
GUNDAROO CEMETERY

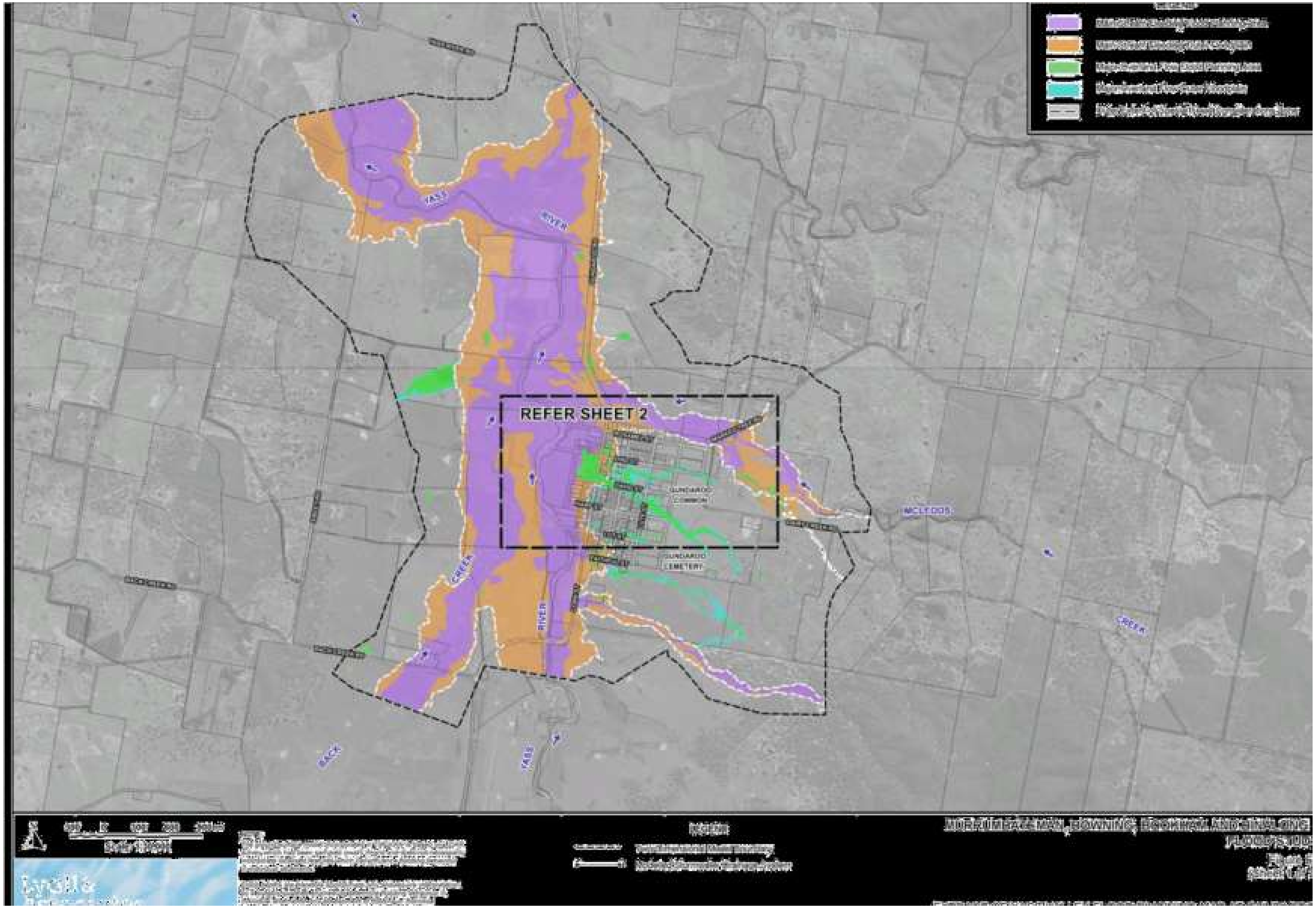

MCLEODS
CREEK
GUNBAROO RECREATION GROUND
POLICE PADDOCK
GUNDAROO COMMON
GUNDAROO TRANSFER STATION AND LANDFILL
GUNDAROO PUBLIC SCHOOL
MURRUMBATEMAN, BOWNING, BOOKHAM AND BINALONG FLOOD STUDY

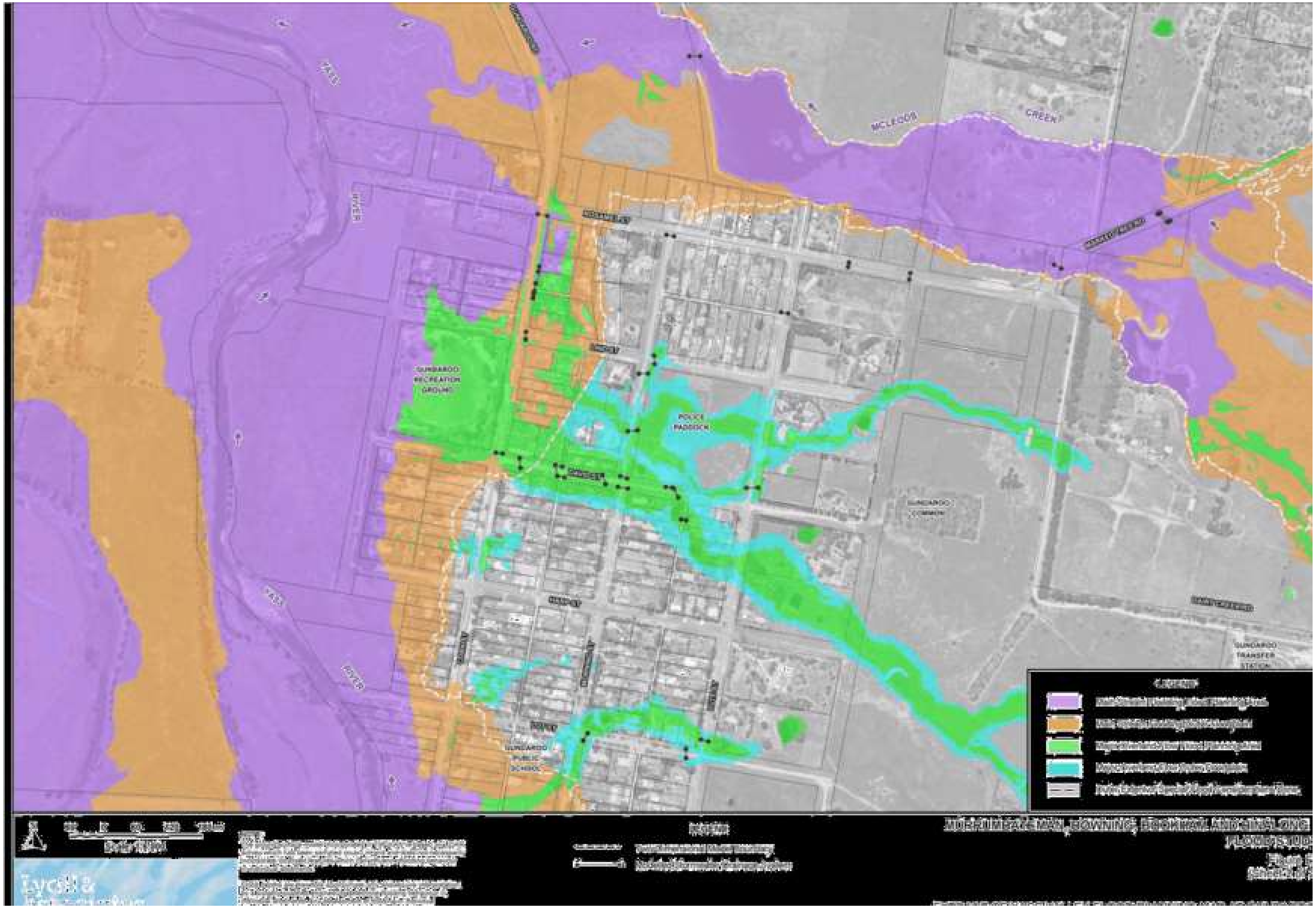

REFER SHEET 2
GUNDAROO COMMON
GUNDAROO CEMETERY
RIVER
CREEK
MCLEODS
CREEK
BACK
YASS

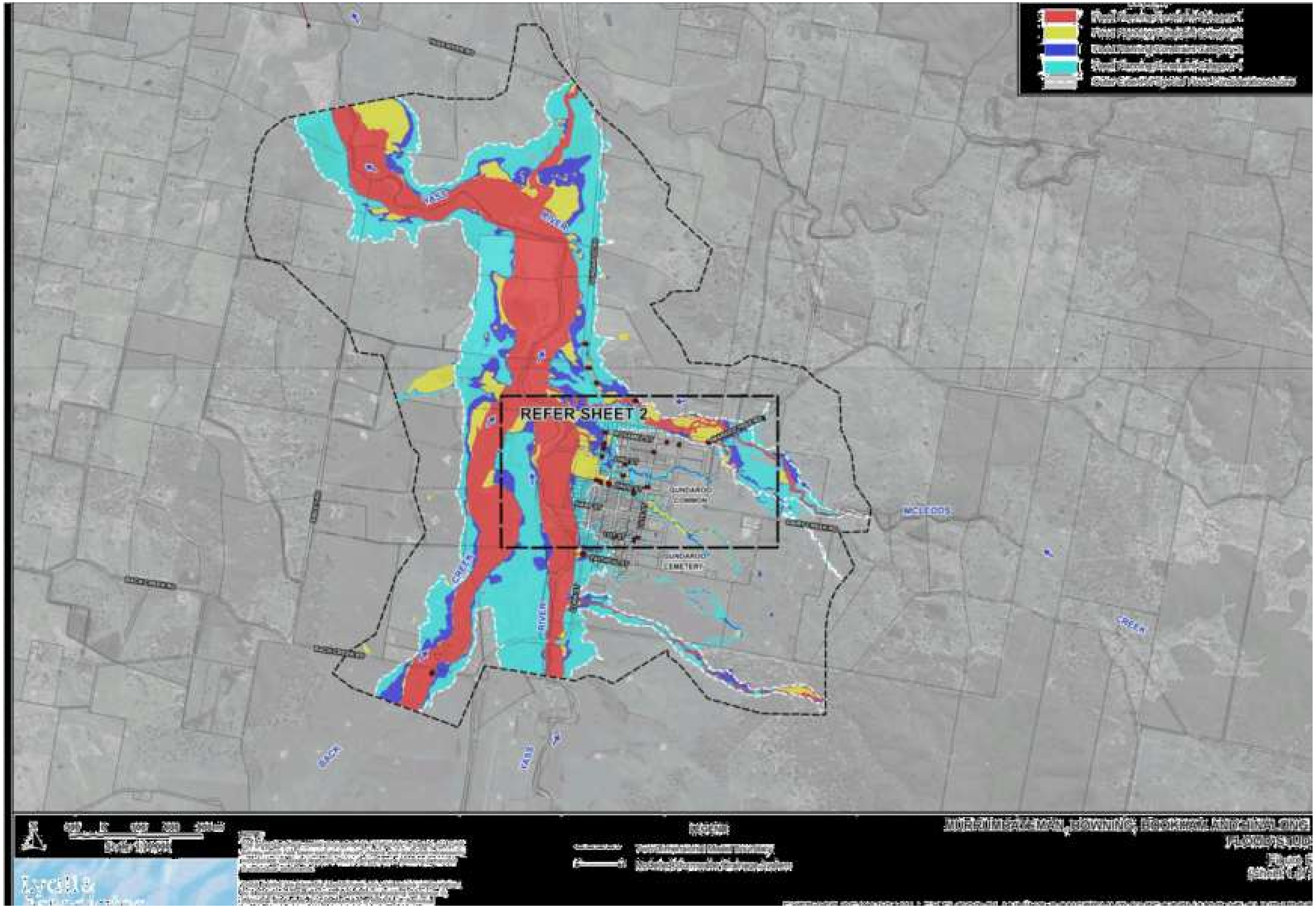

MCLEODS
CREEK
RIVER
GUNDAROO
RECREATION
GROUND
POLICE
PADDOCK
GUNDAROO
COMMON
GUNDAROO
TRANSFER
STATION
AND LANDFILL
GUNDAROO
PUBLIC
SCHOOL

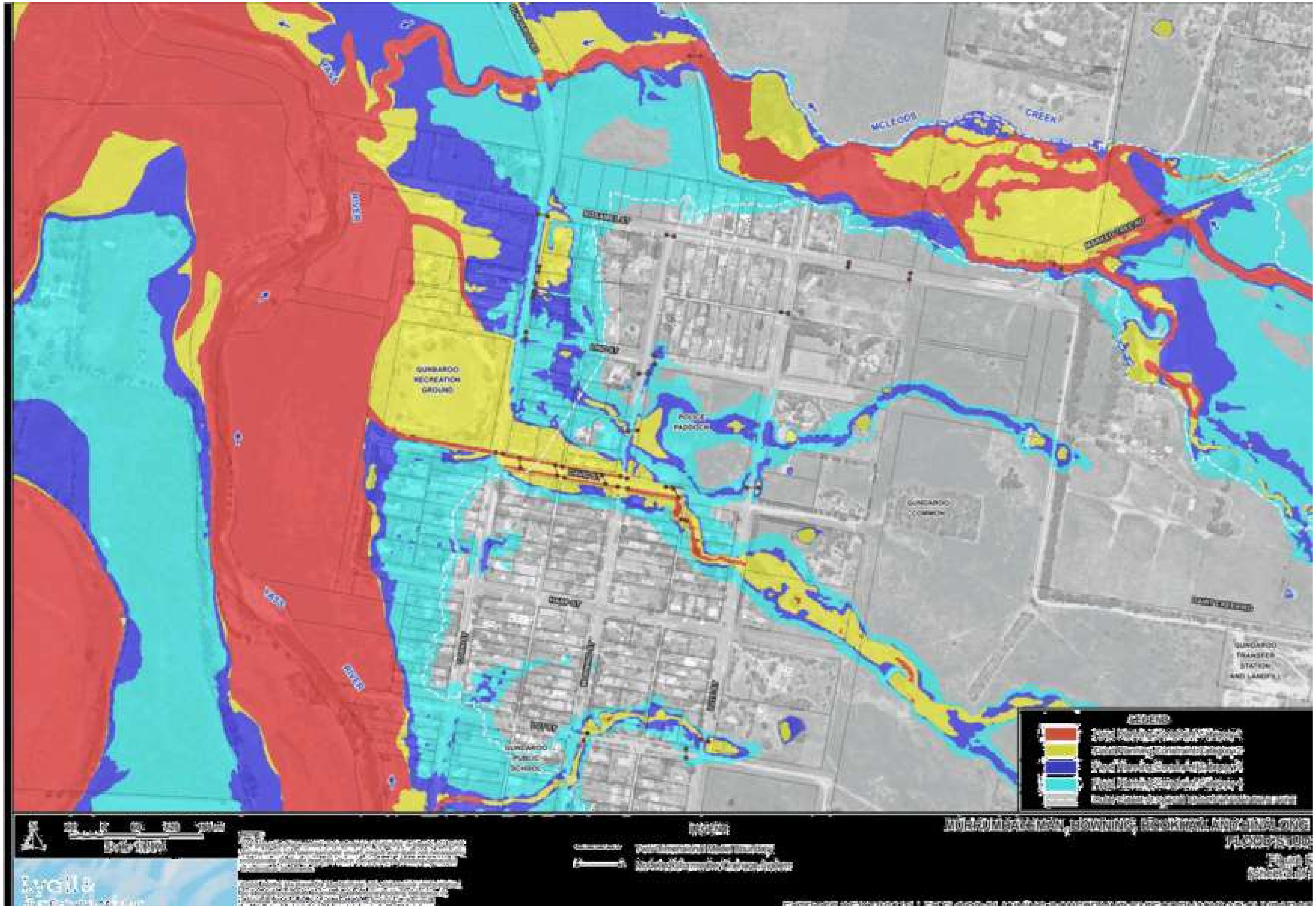

REFER SHEET 2
YASS
RIVER
CREEK
MCLEODS
GUNDAROO COMMON
GUNDAROO CEMETERY
BACK
LEGEND


MCLEODS
CREEK
GUNDAROO
RECREATION
GROUND
POLICE
PADDOCK
GUNDAROO
COMMON
GUNDAROO
TRANSFER
STATION
AND LANDFILL
GUNDAROO
PUBLIC
SCHOOL


REFER SHEET 2
RIVER
CREEK
GUNDAROO COMMON
GUNDAROO CEMETERY
MCLEODS
CREEK
BACK
YASS


MCLEODS
CREEK
GUNDAROO
RECREATION
GROUND
POLICE
PADDOCK
GUNDAROO
COMMON
GUNDAROO
TRANSFER
STATION
GUNDAROO
PUBLIC
SCHOOL

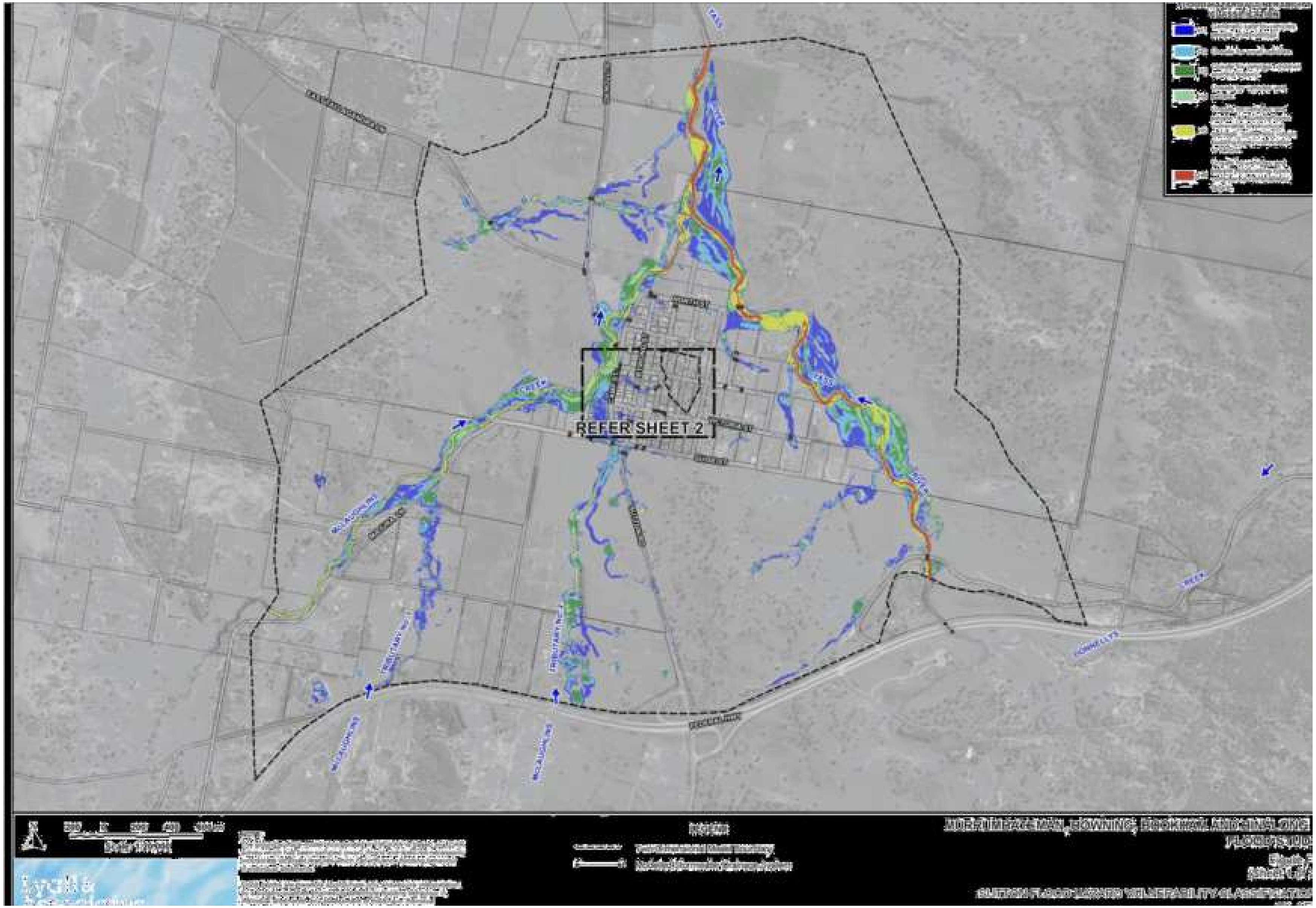

REFER SHEET 2
YASS
RIVER
CREEK
MCLEODS
GUNDAROO COMMON
GUNDAROO CEMETERY


MCLEODS
CREEK
GUNDAROO
RECREATION
GROUND
POLICE
PADDOCK
GUNDAROO
COMMON
GUNDAROO
TRANSFER
STATION
AND LANDFILL
GUNDAROO
PUBLIC
SCHOOL
LEGEND

ANNEXURE F

FIGURES RELATING TO THE VILLAGE OF SUTTON

LIST OF FIGURES (ANNEXURE F)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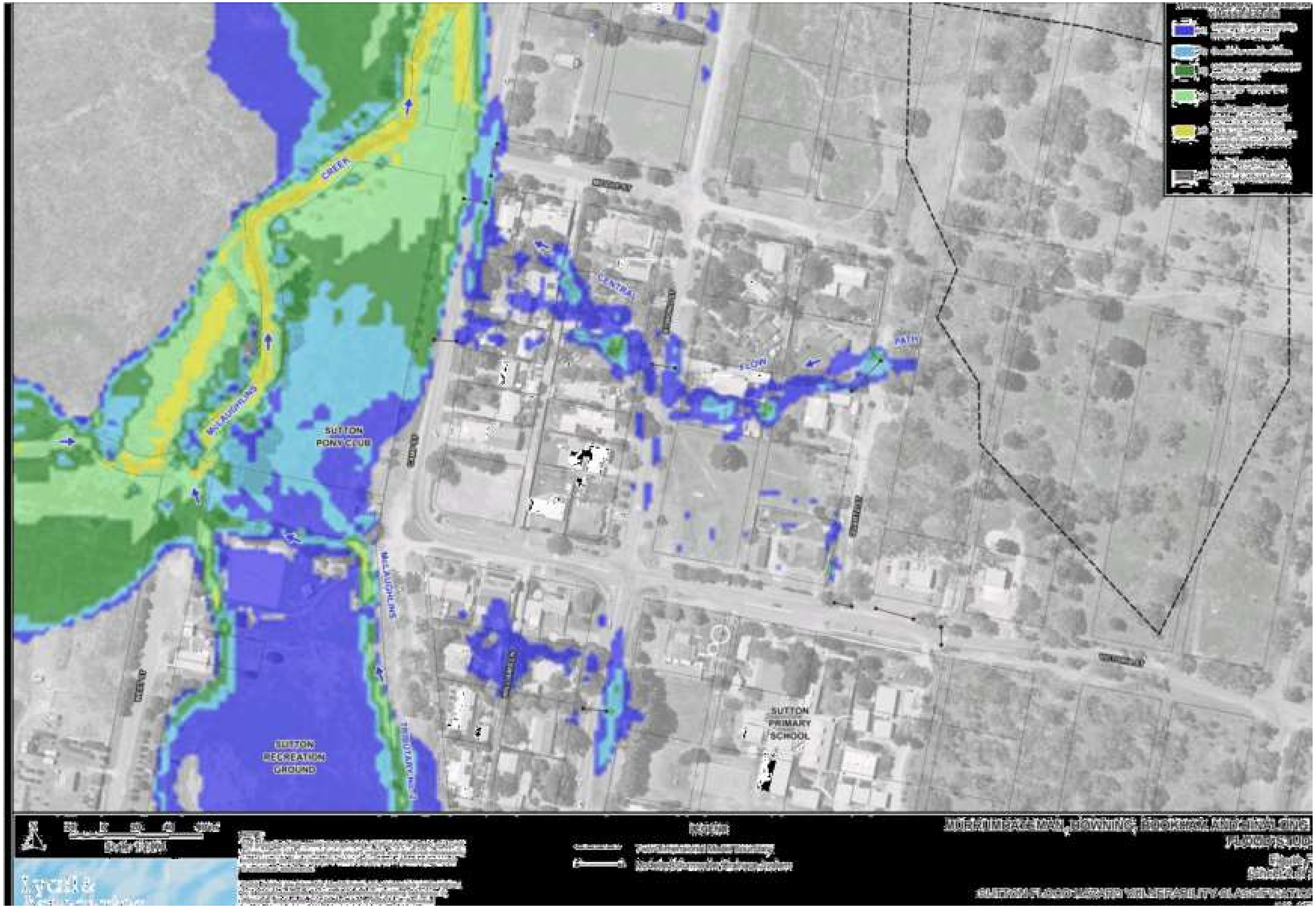
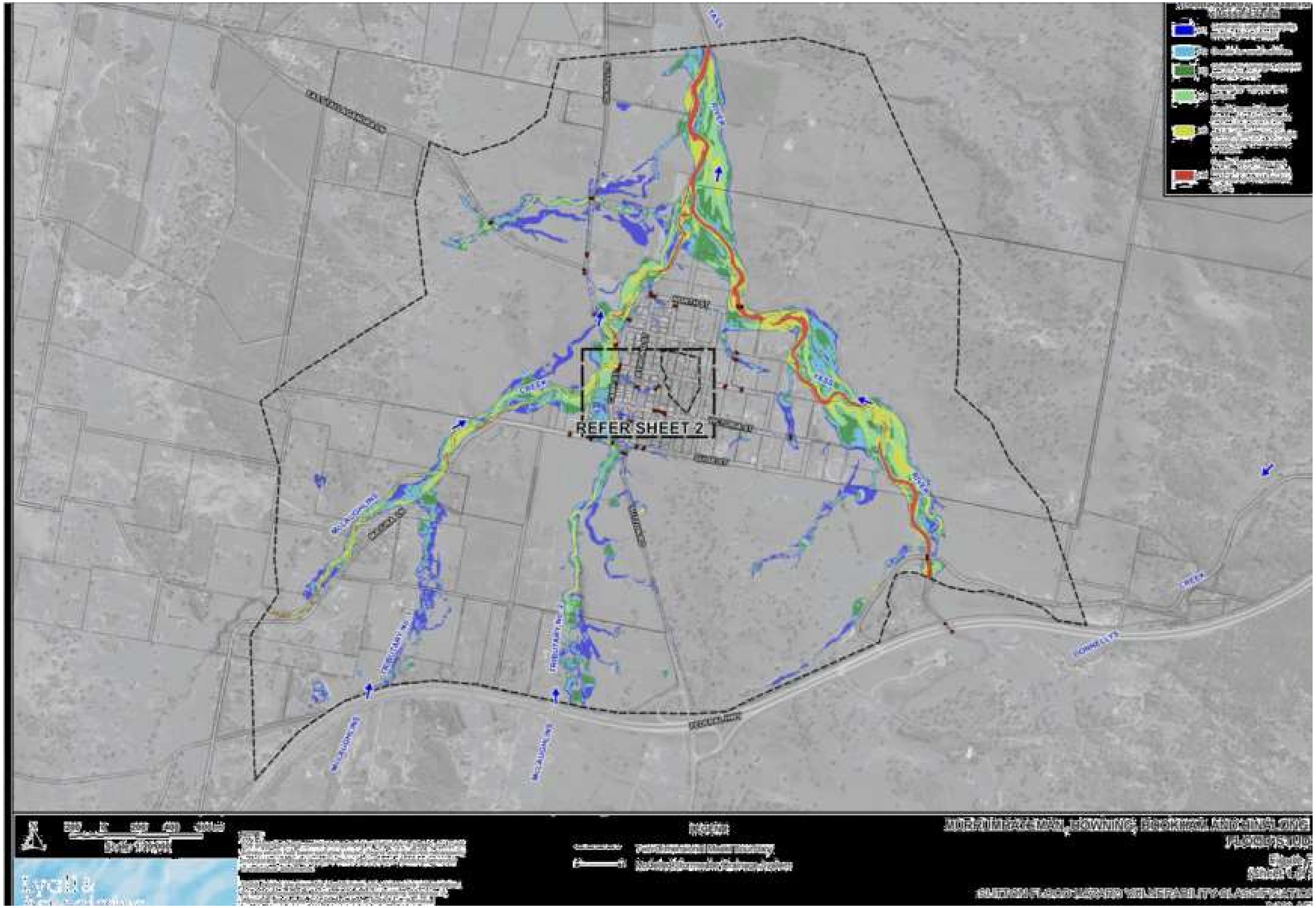

CREEK
CENTRAL
FLOW
PATH
McLAUGHLINS
SUTTON
PONY CLUB
SUTTON
RECREATION
GROUND
SUTTON
PRIMARY
SCHOOL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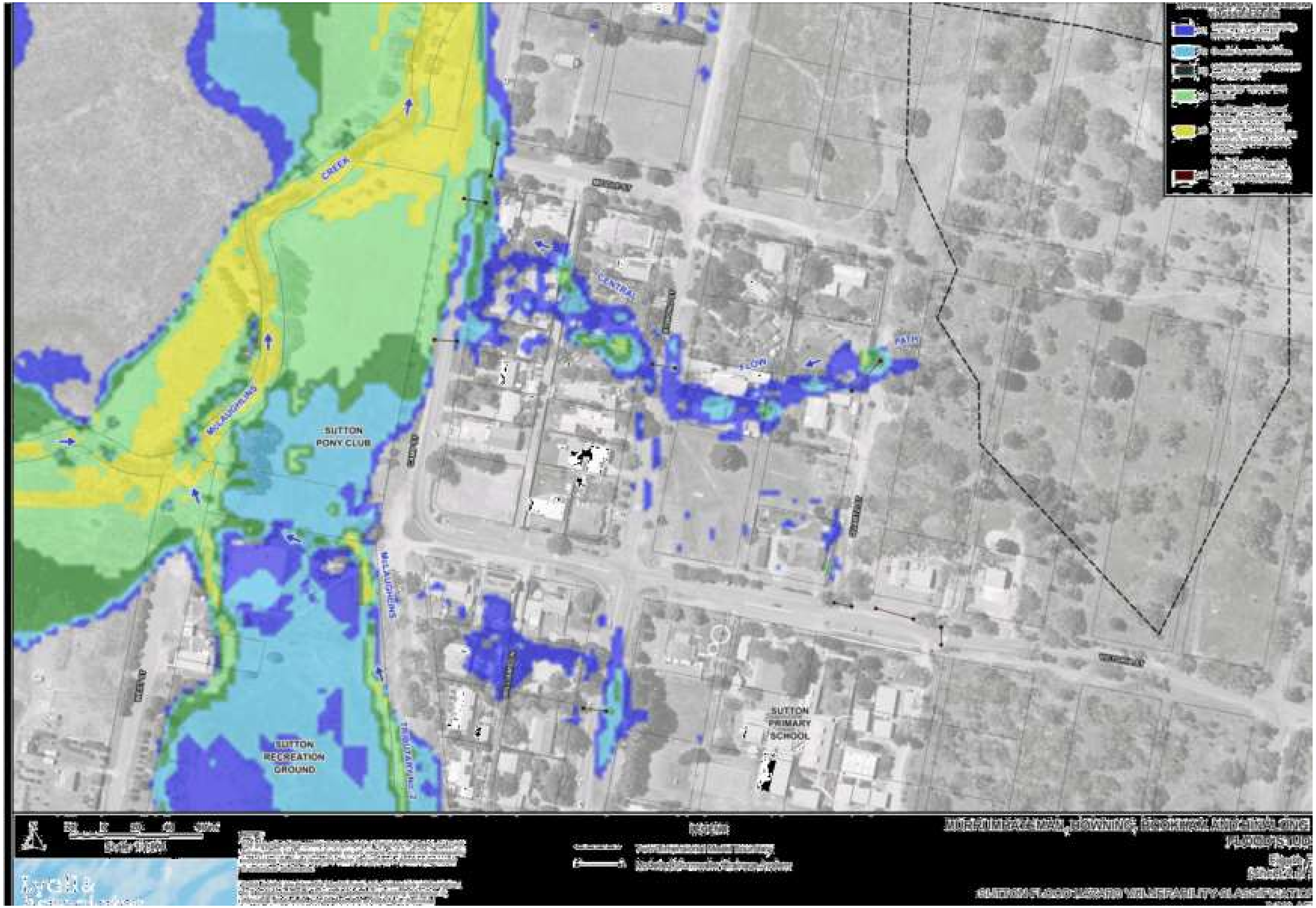
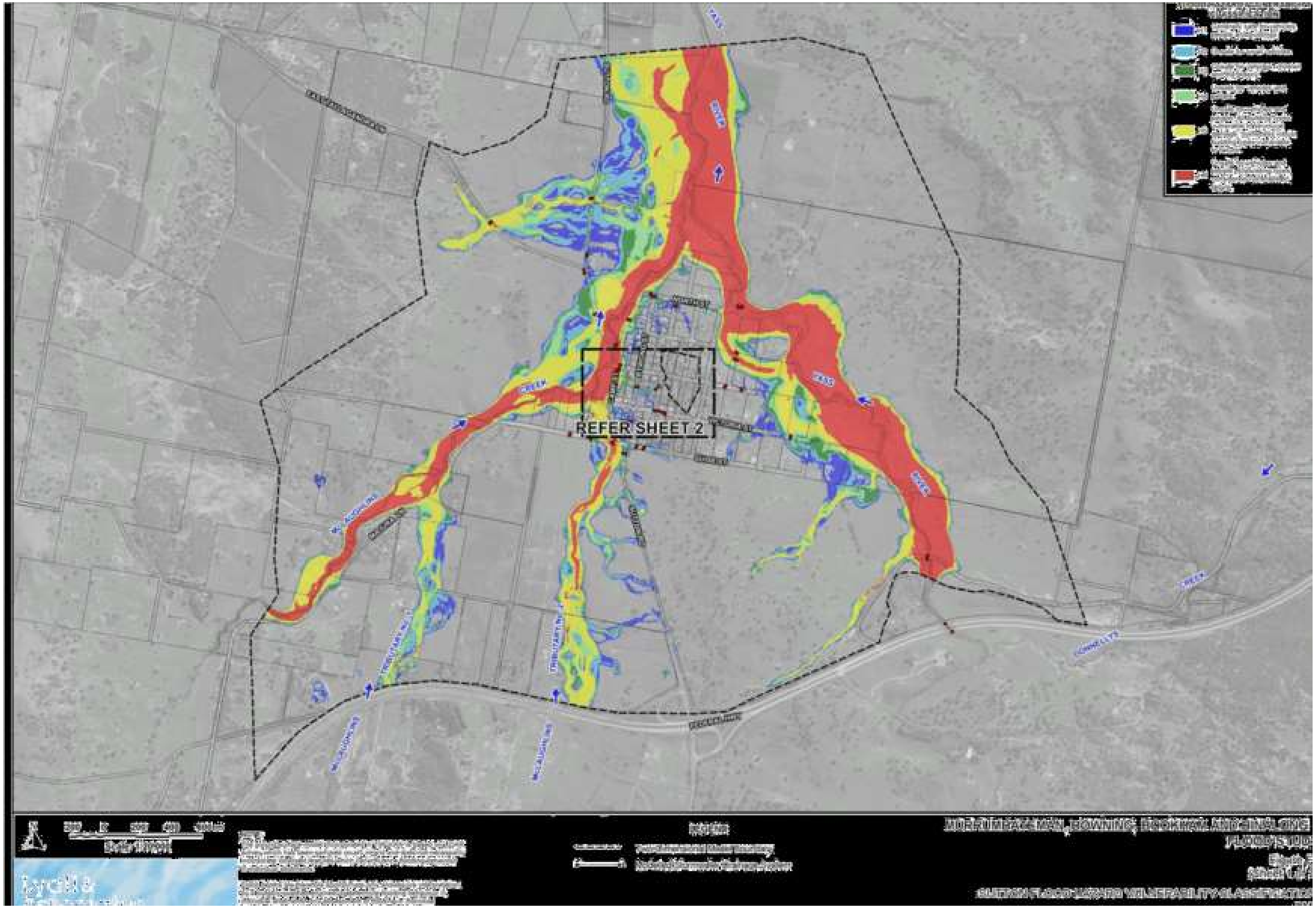

CREEK
CENTRAL
FLOW
PATH
SUTTON
PONY CLUB
McLAUGHLINS
SUTTON
RECREATION
GROUND
TRIBUTARY No. 2
SUTTON
PRIMARY
SCHOOL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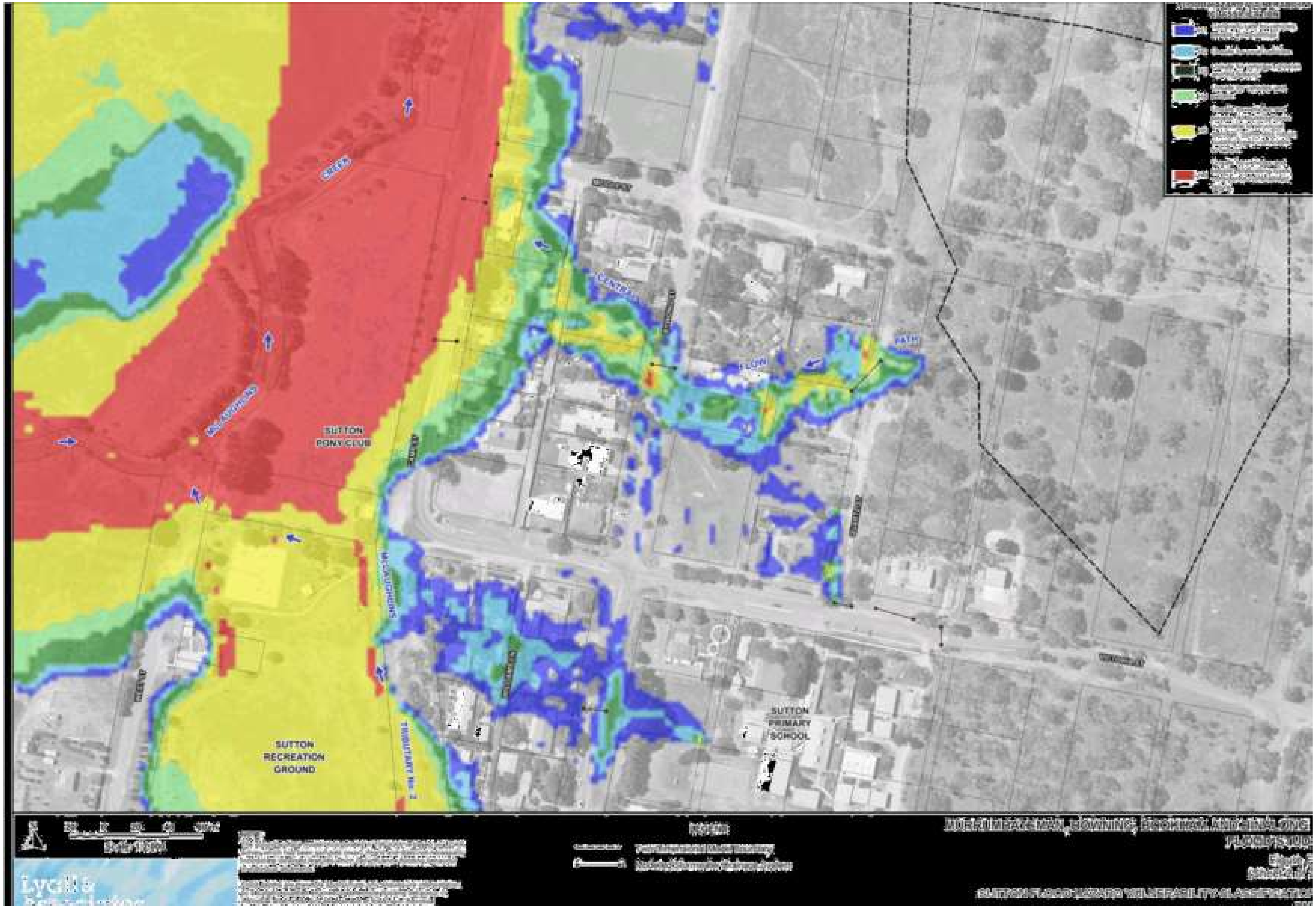
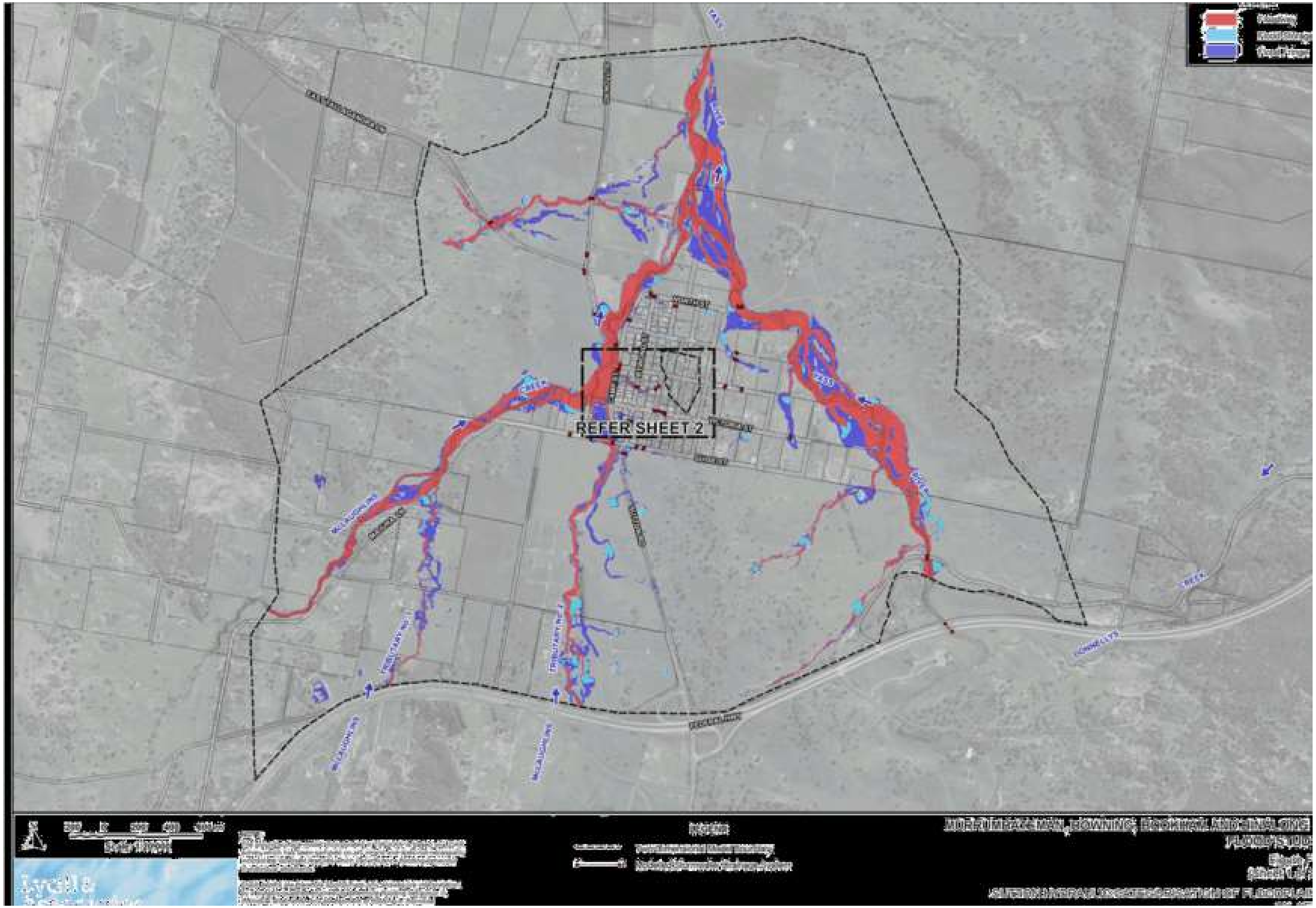

CREEK
SUTTON
PONY CLUB
SUTTON
RECREATION
GROUND
TRIBUTARY No. 2
SUTTON
PRIMARY
SCHOOL
FLOW
PATH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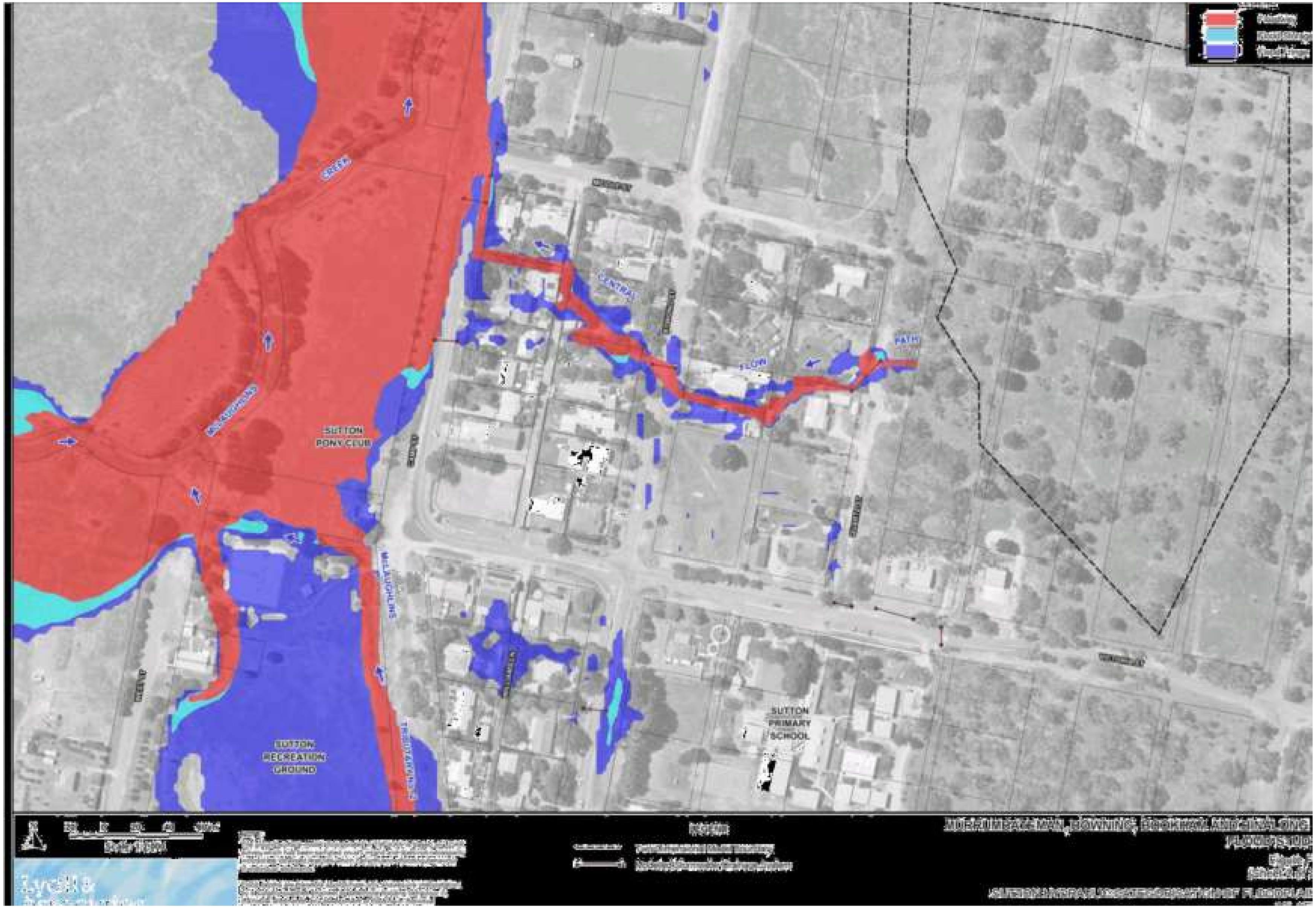
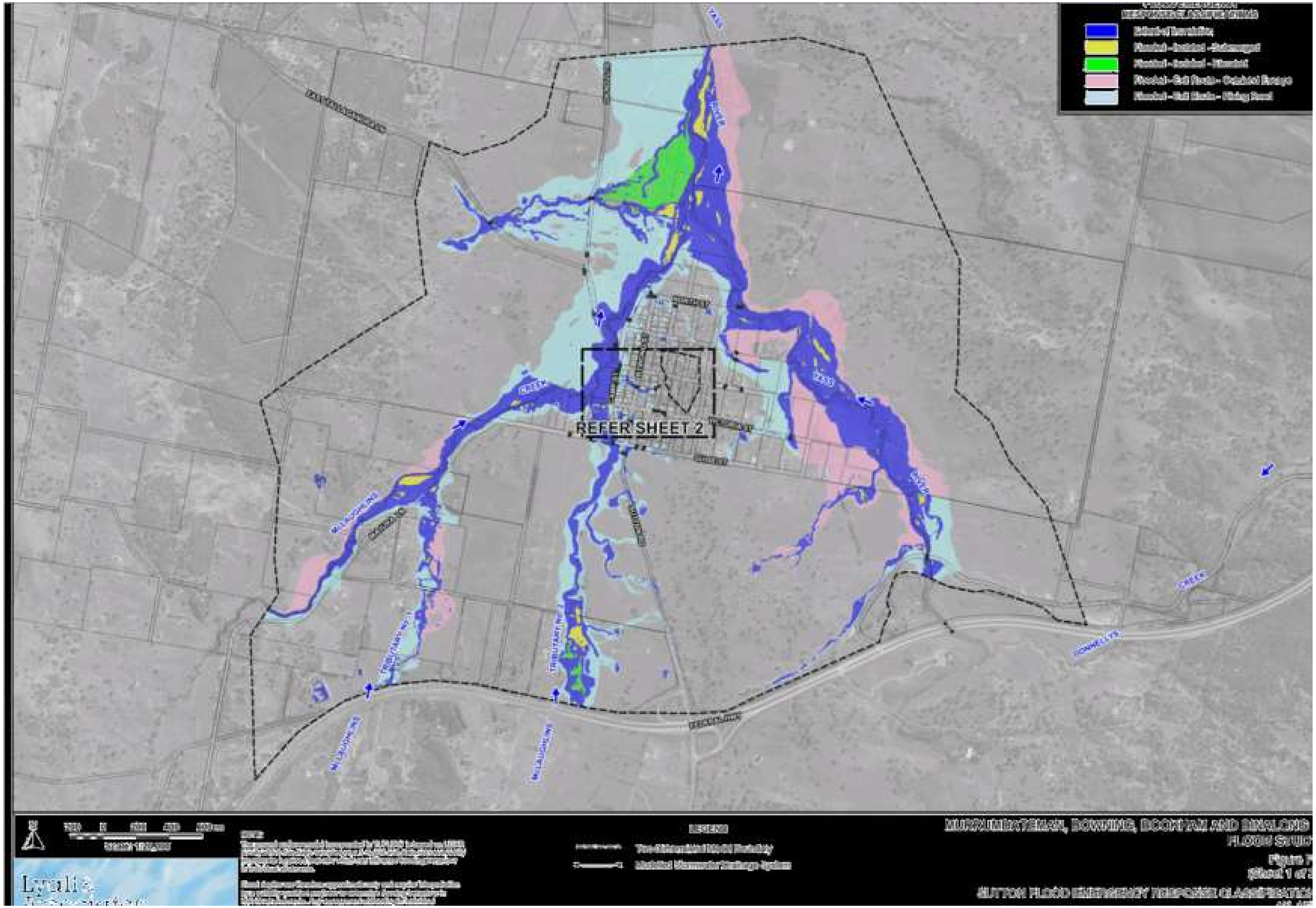
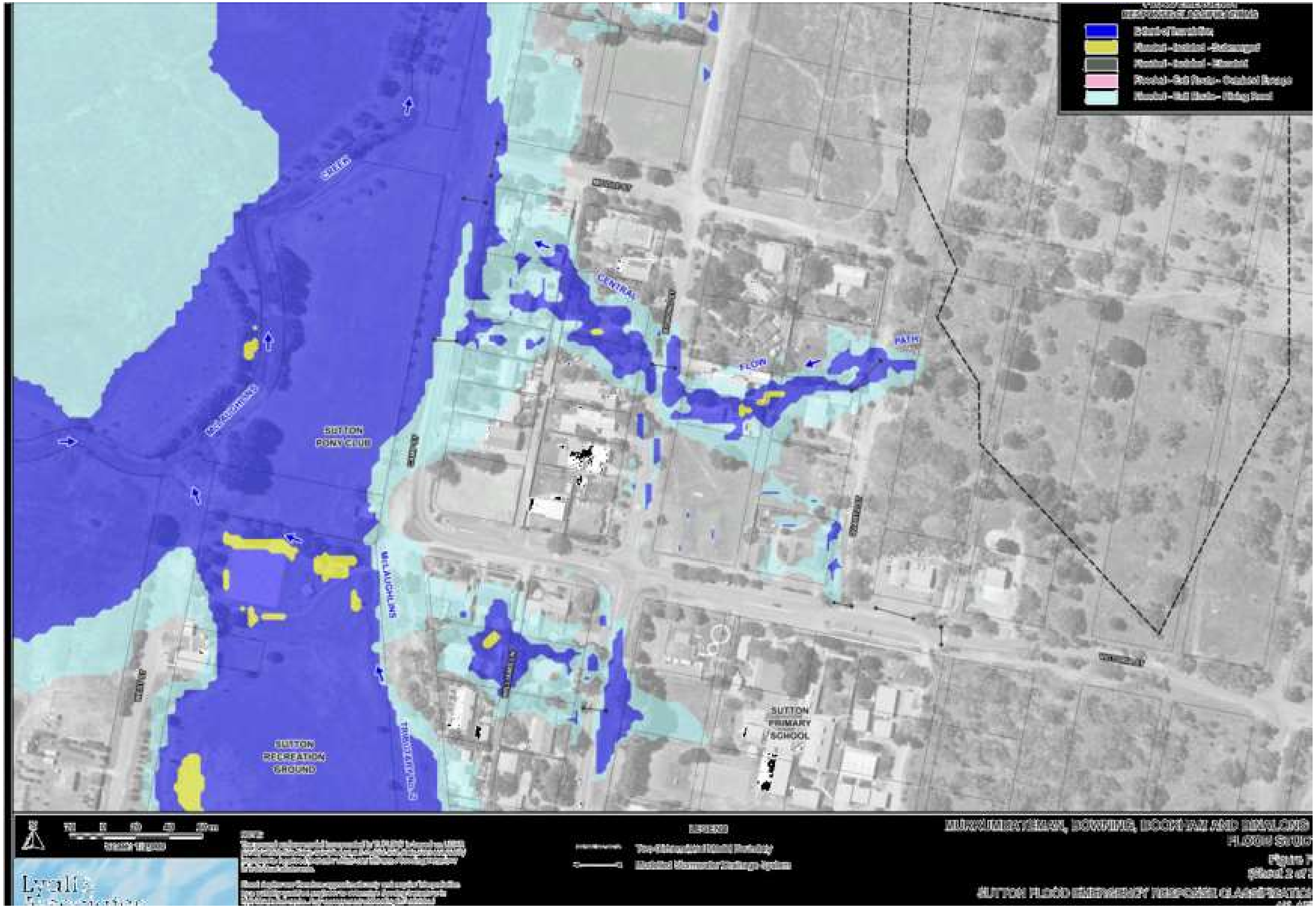
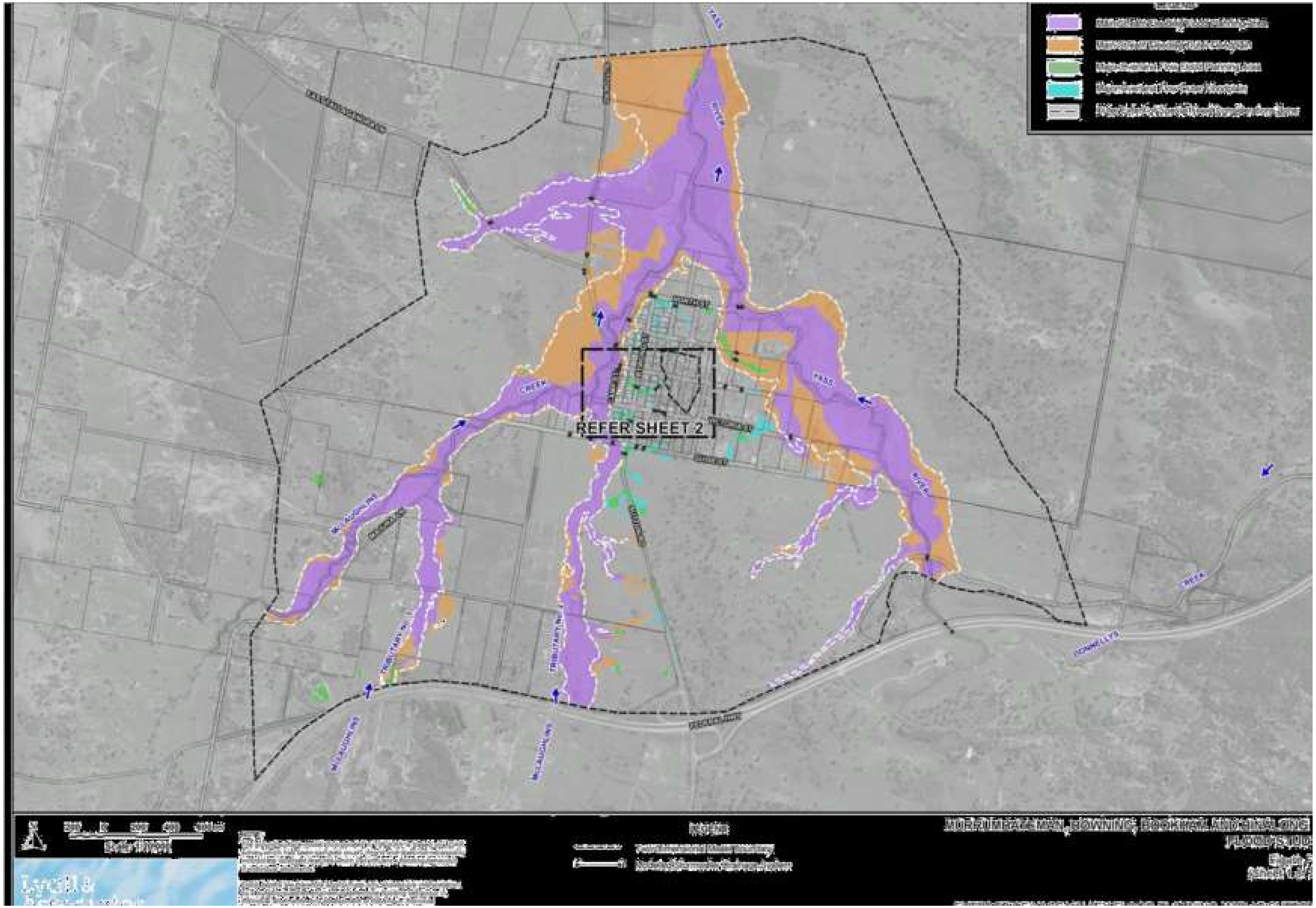

CREEK
CENTRAL
FLOW
PATH
SUTTON
PONY CLUB
SUTTON
RECREATION
GROUND
SUTTON
PRIMARY
SCHOOL


REFER SHEET 2
LEGEND


SUTTON
PONY CLUB
SUTTON
RECREATION
GROUND
SUTTON
PRIMARY
SCHOOL
CENTRAL
FLOW
PATH
MCLAUGHLINS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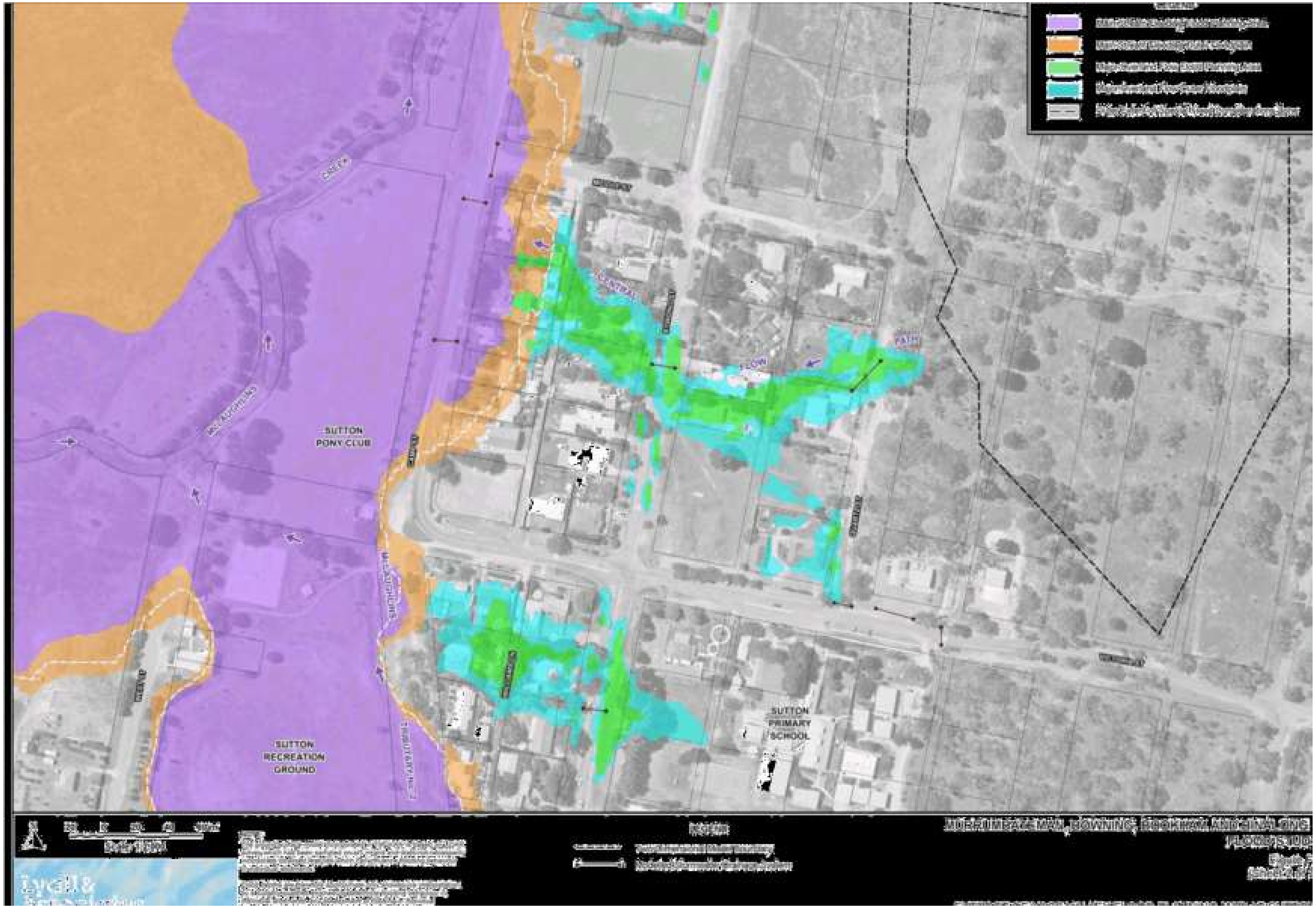
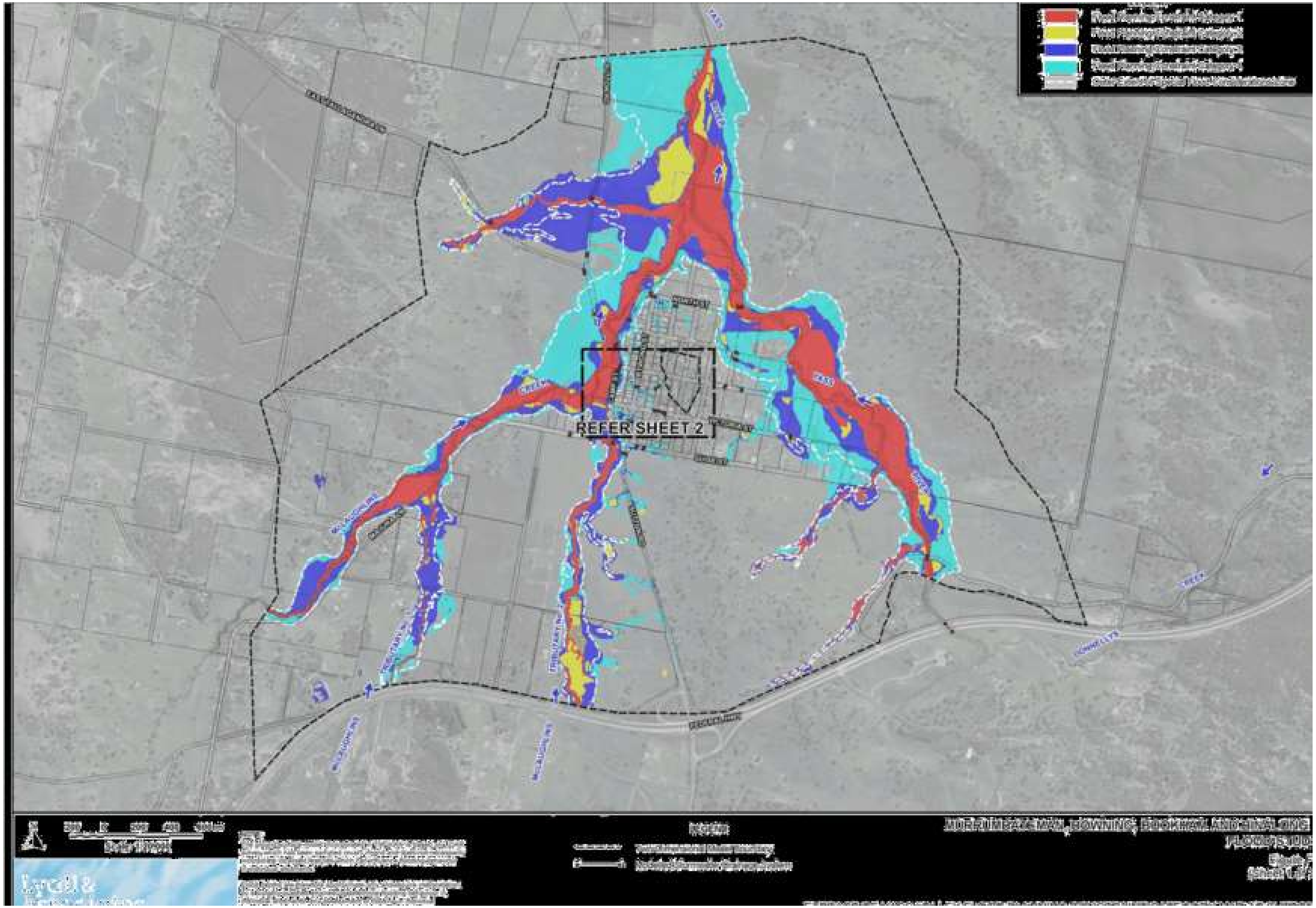

SUTTON
PONY CLUB
SUTTON
RECREATION
GROUND
SUTTON
PRIMARY
SCHOOL
CENTRAL
FLOW
PATH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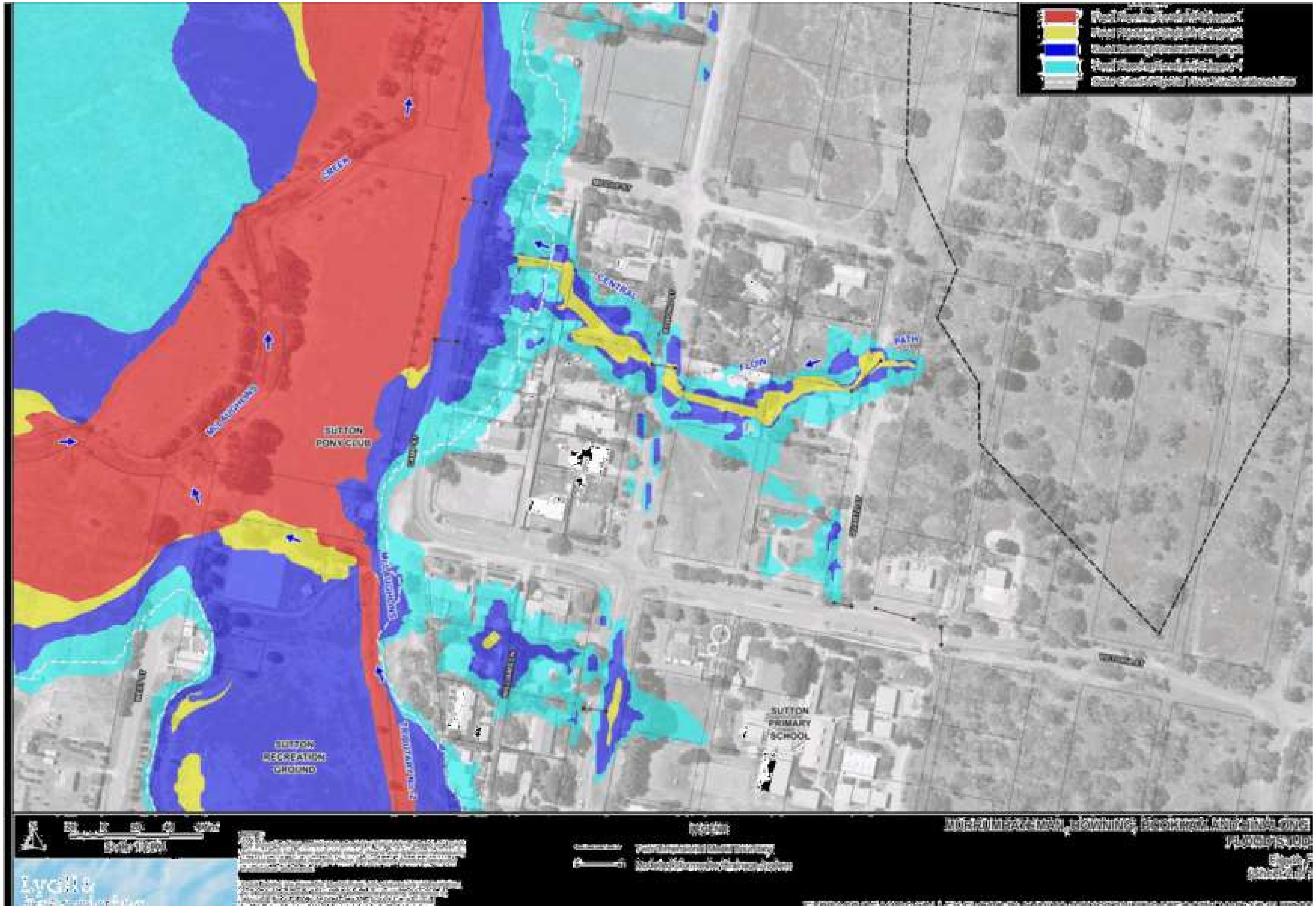
CREEK
CENTRAL
FLOW
PATH
SUTTON
PONY CLUB
SUTTON
RECREATION
GROUND
SUTTON
PRIMARY
SCHOOL