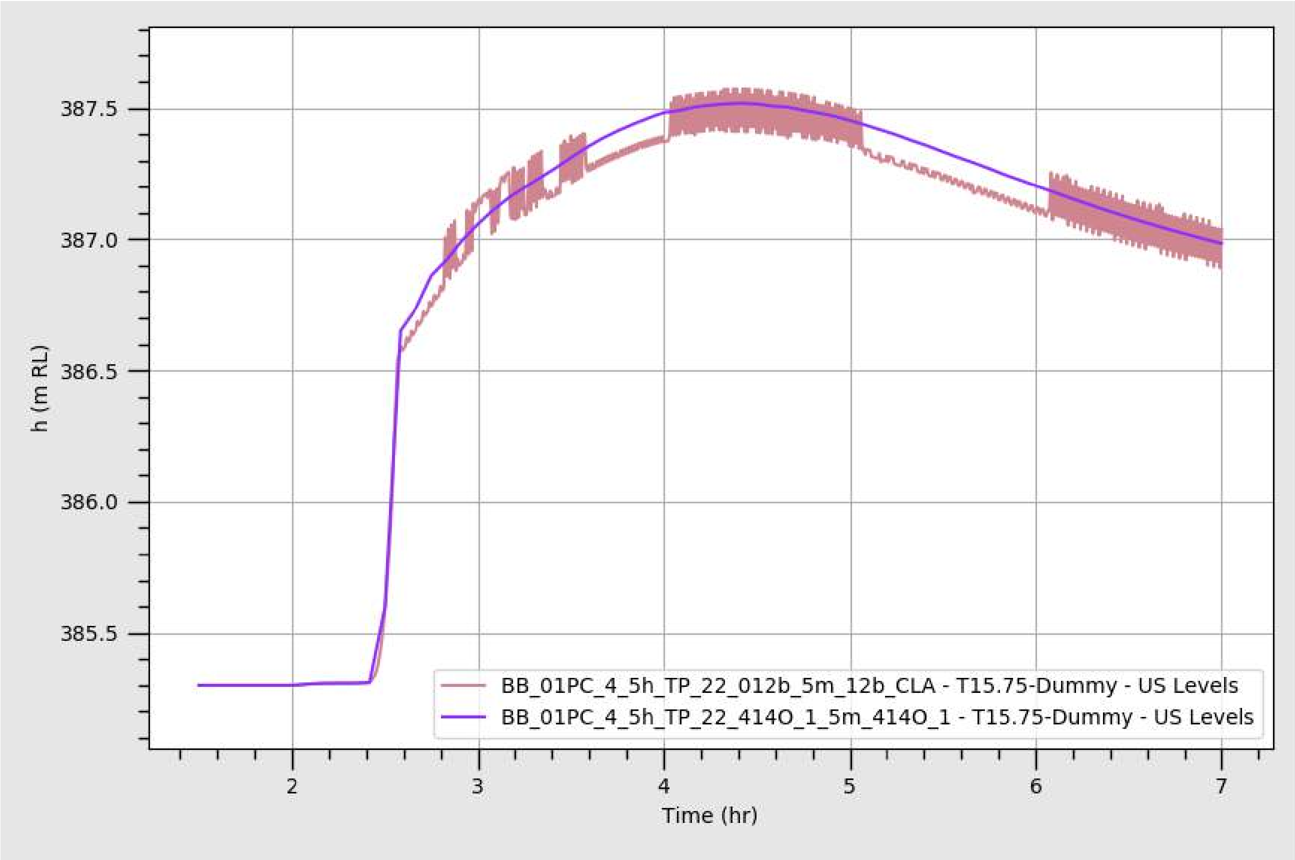

Figure 9.1 Example of existing conditions model instability in Garibaldi Creek through Beaufort

9.2.8 SUMMARY OF FLOOD IMPACTS

The impact mapping in Appendix F shows the detailed location and extent of impacts for each parameter (afflux, velocity change, duration change and hazard change). The maps show that the highest impacts (or change in parameters) occurs within the project boundary, with lesser impact and change outside the boundary. In addition, the mapping in Appendix F shows no significant new areas of land flooded outside the project boundary.

Outside the boundary the afflux is predominantly less than 100 mm with impacts localised to areas that experience significant depths of flooding in the baseline condition. Duration impacts are also localised, with flooding times in the affected areas increased by 2.5 hours or less. Changes to flood velocity and hazard are also minor and localised outside the project boundary, with the impact on these parameters occurring upstream of the Yam Holes Creek bridges.

Given that the majority of flood changes occur within the project boundary or within the existing floodplain, the impact on adjoining land uses is considered to be low, with the exception of impacts upstream of the Yam Holes Creek bridges and around Racecourse Road where some changes in flood behaviour are predicted upstream of the project boundary and along the road. At the next stage of design it is expected that these impacts can be reduced through a multi-disciplinary design approach to refining the design of the bridges and associated earthworks. Following further design optimisation of the bridges and reduction in impact, consultation with affected landowners on the impacts would then be undertaken to identify their sensitivities to changes in flood behaviour and the requirement to incorporate flood impact mitigation measures into the detailed design.

9.3 WATER QUALITY IMPACT ASSESSMENT FOR OPTION C2

A number of ecologically important wetlands are located around the project corridor and the road drainage system will drain either directly to or into the streams feeding some of these wetlands. Table 9.8 lists the discharge points from the road drainage system and the wetlands that will receive this road runoff either directly or indirectly.

Table 9.8 Road drainage discharge points and receiving wetlands

DISCHARGE POINT	ROAD CORRIDOR CATCHMENT AREA (HECTARES)	RECEIVING WETLAND
A	8.74	35597 (contains High Quality Wetland 7 identified on Figure 7.3)
B	3.70	35597 (contains High Quality Wetland 7 identified on Figure 7.3)
C	4.19	35595
D	8.66	35649 (contains High Quality Wetland 4 identified on Figure 7.3)
F	11.30	35649 (contains High Quality Wetland 4 identified on Figure 7.3)
G	7.82	35649 (contains High Quality Wetland 4 identified on Figure 7.3)
H	7.09	35649 (contains High Quality Wetland 4 identified on Figure 7.3)
I	15.98	35402 (contains High Quality Wetland 1 identified on Figure 7.3)
J	4.63	35402 (contains High Quality Wetland 1 identified on Figure 7.3)
K	3.61	35402 (contains High Quality Wetland 1 identified on Figure 7.3)
L	3.16	35402 (contains High Quality Wetland 1 identified on Figure 7.3)
M	9.87	35540 (contains High Quality Wetland 9 identified on Figure 7.3)
N	3.50	35540 (contains High Quality Wetland 9 identified on Figure 7.3)
O	6.36	35540 (contains High Quality Wetland 9 identified on Figure 7.3)

All discharge points were considered to drain runoff to sensitive receptors and stormwater treatment measures were therefore designed to protect the downstream receivers. MUSIC modelling was undertaken to determine the treatment requirements for the road runoff to meet the BPEMG performance criteria (see Table 4.3). Bioretention basins were found to be most effective in achieving the required pollutant load reductions. The resulting treatment measures for the road drainage system are summarised in Table 9.9 below.

Table 9.9 Proposed road drainage treatment measures

DISCHARGE POINT	ROAD CORRIDOR CATCHMENT AREA (HECTARES)	ROAD DRAINAGE TREATMENT MEASURES	POLLUTANT REDUCTIONS ACHIEVED BY PROPOSED TREATMENT MEASURES
A	8.74	35 m long swale Bioretention basin with surface area of 200 m^2	TSS 85%, TP 60%, TP 46%, Gross Pollutants 100%
B	3.70	200 m long swale Bioretention basin with surface area of 100 m^2	TSS 95%, TP 76%, TP 46%, Gross Pollutants 100%
C	4.19	Bioretention basin with surface area of 180 m^2	TSS 83%, TP 64%, TP 45%, Gross Pollutants 100%
D	8.66	Bioretention basin with surface area of 340 m^2	TSS 83%, TP 64%, TP 46%, Gross Pollutants 100%
F	11.30	Bioretention basin with surface area of 400 m^2	TSS 82%, TP 64%, TP 46%, Gross Pollutants 100%
G	7.82	Bioretention basin with surface area of 230 m^2	TSS 80%, TP 60%, TP 45%, Gross Pollutants 100%
H	7.09	Bioretention basin with surface area of 340 m^2	TSS 84%, TP 65%, TP 47%, Gross Pollutants 100%
I	15.98	Bioretention basin with surface area of 640 m^2	TSS 83%, TP 64%, TP 47%, Gross Pollutants 100%
J	4.63	Bioretention basin with surface area of 120 m^2	TSS 80%, TP 56%, TP 47%, Gross Pollutants 100%
K	3.61	Bioretention basin with surface area of 140 m^2	TSS 84%, TP 65%, TP 48%, Gross Pollutants 100%
L	3.16	Bioretention basin with surface area of 140 m^2	TSS 84%, TP 65%, TP 47%, Gross Pollutants 100%
M	9.87	Bioretention basin with surface area of 340 m^2	TSS 83%, TP 64%, TP 47%, Gross Pollutants 100%
N	3.50	Bioretention basin with surface area of 180 m^2	TSS 85%, TP 67%, TP 48%, Gross Pollutants 100%
O	6.36	Bioretention basin with surface area of 300 m^2	TSS 84%, TP 65%, TP 47%, Gross Pollutants 100%

The impact on water quality during the operational phase is low. At the detailed design stage these proposed treatment measures will be reviewed and optimised with the final design of the road drainage system, with basins rationalised by using additional lengths of swales as part of the treatment train to reduce land take and clearance requirements associated with basins.

9.4 WETLANDS IMPACTS ASSESSMENT FOR OPTION C2

The impacts of alignment C2 on the wetlands were assessed in terms of changes to the flooding regime and water quality for any of the wetlands affected by the project. The results of the assessment are summarised in Table 9.10. Water quality impacts assume specification of BPEMG as part of detailed design.

Table 9.10 Summary of flooding and water quality impacts on wetlands

WETLAND CURRENT ID	HIGH VALUE WETLAND NUMBER	FLOODING REGIME IMPACT	WATER QUALITY IMPACT
35402	Wetland 1	Minor increases in flood level of less than 20 mm over distances of up to 200 m downstream of Yam Hole Creek bridges. No significant velocity changes. Localised duration changes for higher order events 100 m beyond project boundary.	Pollutant loads from road drainage to be managed by treatment measures in accordance with BPEMG – no impact predicted.
35403	–	No surface water impacts – outside project area of influence.	No surface water impacts – outside project area of influence.
35404	–	No surface water impacts – outside project area of influence.	No surface water impacts – outside project area of influence.
35405	–	No surface water impacts – outside project area of influence.	No surface water impacts – outside project area of influence.
35539	–	No surface water impacts – outside project area of influence.	No surface water impacts – outside project area of influence.
35540	Wetland 5	No surface water impacts – outside project area of influence.	No surface water impacts – outside project area of influence.
35540	Wetland 9	No changes to flooding regime.	Pollutant loads from road drainage to be managed by treatment measures in accordance with BPEMG – no impact predicted.
35562	Wetland 3	No surface water impacts – outside project area of influence.	No surface water impacts – outside project area of influence.
35563	–	No surface water impacts – outside project area of influence.	No surface water impacts – outside project area of influence.
35564	–	No surface water impacts – outside project area of influence.	No surface water impacts – outside project area of influence.
35566	–	No surface water impacts – outside project area of influence.	No surface water impacts – outside project area of influence.

WETLAND CURRENT ID	HIGH VALUE WETLAND NUMBER	FLOODING REGIME IMPACT	WATER QUALITY IMPACT
35595	–	No changes to flooding regime.	Pollutant loads from road drainage to be managed by treatment measures in accordance with BPEMG – no impact predicted.
35596	Wetland 8	No surface water impacts – outside project area of influence.	No surface water impacts – outside project area of influence.
35597	Wetland 7	No changes to flooding regime.	Pollutant loads from road drainage to be managed by treatment measures in accordance with BPEMG – no impact predicted.
35649	Wetland 4	Increases in flood level of up to 300 mm mainly within project boundary with lesser increases extending up to 600 m upstream of Yam Hole Creek bridges. Localised velocity change within project boundary upstream of Yam Hole Creek bridges. Localised duration changes for higher order events 100 to 200 m beyond project boundary.	Pollutant loads from road drainage to be managed by treatment measures in accordance with BPEMG – no impact predicted.
35650	Wetland 2	No surface water impacts – outside project area of influence.	No surface water impacts – outside project area of influence.
35719	–	No surface water impacts – outside project area of influence.	No surface water impacts – outside project area of influence.
35735	–	No surface water impacts – outside project area of influence.	No surface water impacts – outside project area of influence.
–	Wetland 6	No surface water impacts – outside project area of influence.	No surface water impacts – outside project area of influence.

The table shows that the wetlands will be protected from water quality impacts by the proposed stormwater treatment measures. Only Wetlands 35402 and 35649 will experience changes in their flooding regimes but these changes are expected to be minimal and mainly occur at the high order events, with most significant impacts occurring within the project boundary. The impacts on the wetlands are therefore considered to be low.

10 MITIGATION

10.1 PLANNING AND DESIGN PHASE

10.1.1 MANAGEMENT AND MITIGATION MEASURES

Relevant planning and environmental legislation, including planning overlays, together with engineering guidelines were identified and reviewed for this project. The detailed design of the preferred bypass alignment option will adopt and implement the recommendations from the legislation and guidelines listed in Section 5 and any other requirements from the GHCMA.

The current functional design of Option C2 has sought to minimise impacts on flooding and water quality through the methods described in Section 4.5 and establish a basis for more detailed analysis and impact reduction at the detailed design phase. The detailed design phase will produce more developed flooding and water quality models and will demonstrate the performance of the design under present day and future climate scenarios for hydrological, hydraulic and water quality standards set by the legislation and guidelines. At the detailed design stage, a multi-disciplinary approach will be used to achieve the following refinements and improvements in the design with associated improvements in the flood impacts associated with the project:

- refined sizing and location of cross drainage structures (culverts and bridges), incorporating fauna passage requirements – refer to Section 10.3.1 for further details
- fully developed designs for channel realignments and associated environmental enhancements – refer to Section 10.3.2 for further details
- refined sizing, location and layout of stormwater treatment systems – refer to Section 10.3.3 for further details.

10.2 CONSTRUCTION PHASE

10.2.1 MANAGEMENT AND MITIGATION

All RRV maintenance and construction projects are required to develop a Construction Environmental Management Plan (CEMP) in accordance with the following guidelines:

- EPA Publication No. 275. Construction Techniques for Sediment Pollution Control (1991)
- EPA Publication No. 1834. Civil Construction, Building and Demolition Guide (2020).
- VicRoads Integrated Water Management Guidelines (2012).

The CEMP will outline how the contractor will comply with any environmental conditions for the project and provide a framework to ensure that environmental risks are properly managed. The CEMP will be approved by the Environmental Manager and Project Director from RRV/MRPV prior to construction commencing. Construction works will be carried out in consultation with GHCMA and Pyrenees Shire Council. The GHCMA is to review the CEMP prior to construction works commencing on site to ensure it is compliant with works on waterways guidelines. Regular supervision by the relevant authority (such as GHCMA, Pyrenees Shire Council and RRV) is needed to ensure the CEMP is being fully implemented and, reviews and improvements to the CEMP are being carried out when necessary.

Wherever possible temporary works required for the project should occur outside the extent of the 1% AEP floodplain, to reduce the risk of increased inundation of properties. Where construction is required within the 1% AEP floodplain the following activities will be managed and where possible minimised including:

- stockpiles
- location of equipment and plant
- formwork and temporary works
- temporary diversions or cofferdams
- access and/or working platforms
- modifications to banks and levees; and
- any temporary works that disturb or require clearance of existing native vegetation.

To minimise the impact of construction work on overland flow paths and floodplains, the works will be carried out in consultation with GHCMA and Pyrenees Shire Council.

10.2.2 WATER QUALITY

10.2.2.1 MANAGEMENT AND MITIGATION

Sediment laden runoff from construction sites can be managed by implementing appropriate engineering controls and staging rehabilitation of areas throughout the construction phase. Clause 42 of the SEPP requires construction works be managed to minimise land disturbance, soil erosion and the discharge of sediment and other pollutants to surface waters. Compliance with the SEPP, future Environmental Reference Standards and General Environmental Duty will be required by the Contractor to comply with EPA legislation. To achieve this, a stormwater management plan will be developed prior to construction works and will be consistent with guidance in the EPA publications Construction Techniques for Sediment Pollution Control (1991) and Civil Construction, Building and Demolition Guide (2020). Examples of typical construction water quality management are displayed in Photo 10.1 and Photo 10.2.

If stockpiling of material is necessary, runoff from these areas would need to be minimised and managed in accordance with Civil Construction, Building and Demolition Guide (2020) using techniques such as:

- minimise the storage volume and area of stockpiled material
- minimise the time construction materials are stockpiled on site
- covering materials that may have fine particles and are easily eroded
- diverting flow from external catchments away from the base of stockpiled material
- providing sediment control measures for runoff from stockpiled materials.

Photo 10.1 Example of construction phase sediment basin (source: VicRoads Integrated Water Management Guidelines, 2012)

Photo 10.2 Example of construction phase silt/sediment fence (source: AussieEnvironmental.com.au)

Prior to construction, the Contractor is to develop a CEMP, to be approved by the relevant authority, that identifies potential sources of contaminated runoff and procedures to treat and dispose of site runoff. The Contractor is responsible for implementing, maintaining and updating the CEMP throughout the construction period. If runoff from site occurs, it must meet SEPP requirements. The Contractor is to implement Integrated Water Management Guidelines during construction to manage water flows and quality. To assist with the design of temporary sediment basins, RRV has developed a Sediment Basin Design Tool.

During construction, water quality monitoring will be undertaken to assess the effectiveness of the above measures in protecting the receiving waterways and wetlands.

10.3 OPERATION AND MAINTENANCE PHASE

10.3.1 WATERWAY CROSSINGS

10.3.1.1 MANAGEMENT AND MITIGATION

The new road corridor crosses numerous waterways and associated habitats, which will be fragmented or disconnected as a result. The design currently includes 14 new waterway crossings consisting of 12 culvert crossings and 2 bridge crossings (see Table 9.1). At the detailed design stage refinements and enhancements of the waterway crossing design will be investigated to incorporate the following mitigation measures where possible to facilitate fauna passage through culverts:

- replacement of some culverts with bridge structures where technically and economically feasible
- realignment/repositioning of culverts to reduce culvert length in the direction of flow
- inclusion of light wells into long culverts (see Photo 10.3); and
- inclusion of low-level cells to promote permanent or regular wetting of culverts.

Photo 10.3 Example of light well in road culvert (source: Growling Grass Frog Crossing Design Standards, DELWP, 2017)

All refinements and enhancements would be developed in collaboration with the Biodiversity Team and relevant stakeholders.

10.3.2 CHANNEL REALIGNMENTS

10.3.2.1 MANAGEMENT AND MITIGATION

The road corridor intercepts a number of waterways and overland flow paths, requiring realignment of these channels and reconnection to a suitable point downstream and clear of the road corridor. These realignments will also fragment and disconnect habitats associated with the waterways and flow paths. The design currently includes 10 channel realignments to connect waterways across the alignment (see Table 9.2 and Appendix E which shows the mapped locations of the proposed channel realignments). At the detailed design stage the following design features will be investigated and implemented where possible to facilitate fauna passage and habitat creation/enhancement:

- robust engineering design to minimise channel velocities and scour/erosion risks within the channels and overbank areas
- transitions at the downstream ends of the channel realignments into the receiving stream lines that deliver flow at velocities similar to the existing conditions in the receiving streams
- incorporation of suitable aquatic and terrestrial planting within and along the channel realignments, maximising the use of native species and species resilient to the expected hydraulic and climatic conditions
- inclusion of pool and riffle features (see Figure 10.1), stilling areas and other similar features to provide habitat and refuge for aquatic species; and
- inclusion of other ecological and landscape design features in accordance with best practice guidelines such as the relevant parts of Melbourne Water's Constructed Waterway Design Manual (Melbourne Water, 2019) and DELWP's Growling Grass Frog Crossing Design Standards (DELWP, 2017).

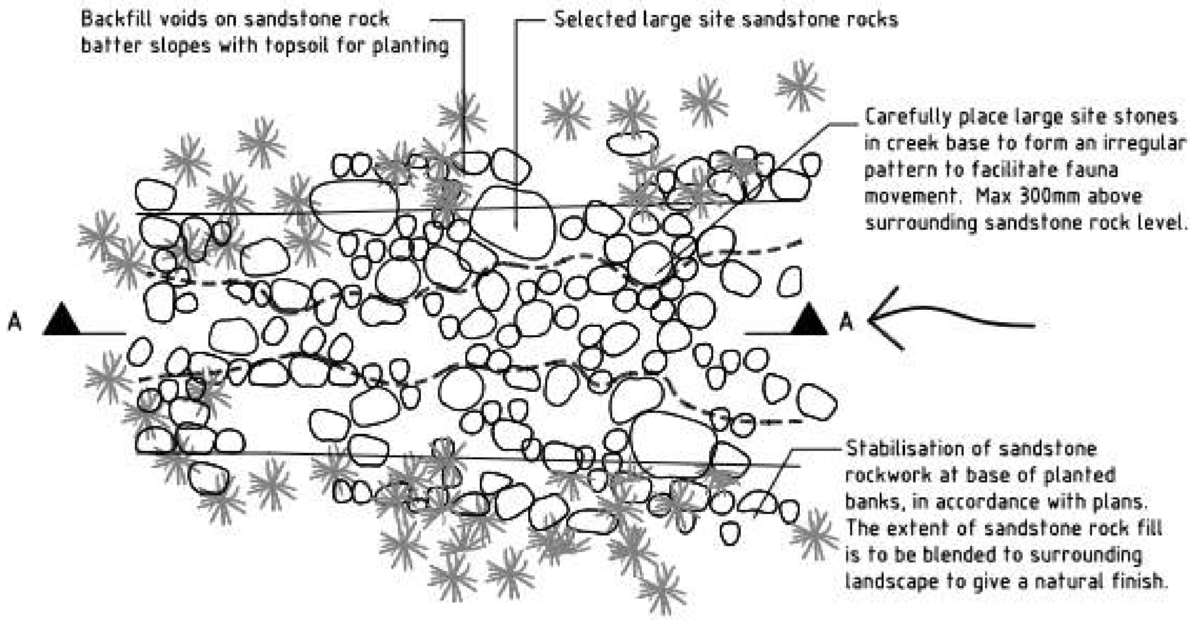

Figure 10.1 Example of meandering channel design to facilitate fauna movement (source: Sydney Water, 2020)

The flood modelling undertaken for this report indicates that, without the inclusion of formally designed channels, the 1% AEP flow widths at the locations of the channel realignments are approximately 20 m or less and velocities are 2 m/s or less, which is not an erosive velocity level for areas with established vegetation. Given that the project footprint extends at least 40 m from the toe of the road embankment in areas where realignment is proposed, there is adequate space to incorporate channel realignment designs that achieve low and non-erosive flow velocities and to accommodate ecological and landscape design features.

Designs would be developed in collaboration with the Biodiversity Team, RRV and stakeholders such as GHCMA, DELWP and Pyrenees Shire Council. Designs will be self-sustaining without imposing onerous or unusual maintenance requirements on RRV and will aim to minimise clearing of existing native vegetation.

10.3.3 WATER QUALITY

10.3.3.1 MANAGEMENT AND MITIGATION

Runoff from the road corridor will increase pollutant loads in receiving waterways and wetlands. Increases to pollutant loads need to be assessed and mitigated using WSRD elements, such as swales, bioretention systems, basins and wetlands, as part of the design phase.

A spill risk assessment will be conducted for each drainage outfall based on the likelihood of spill, which is estimated based on the road characteristics (geometry) of the drainage outfall catchment, and its proximity to the downstream water sensitive receptors (i.e. consequence of the spill) at detail design. This assessment will be included in the drainage design for the preferred bypass corridor.

Design measures to mitigate spill risk may include, extending and widening existing swales to provide additional storage and increase travel time for any spillage to discharge outside the project boundary. This will allow additional time for emergency crews to block the drainage system and additional volume for the spillage contained within the road drainage system. If as part of the spill risk assessment, the high-risk locations are identified, more rigorous mitigation measures such as the provision of spill containment may be required.

The design currently includes 14 stormwater treatment measures, primarily consisting of bioretention basins (see example in Figure 10.2), to remove pollutants from the road runoff prior to discharge to the receiving environment (see Table 9.9 for description and preliminary sizing of the proposed measures and Appendix E for the mapped location of the road drainage discharge points where these measures will be installed). Opportunities will be investigated at the detailed design stage to incorporate these treatment measures into the channel realignments where technically feasible, or to use similar design features (such as planting schemes) to integrate these elements of the water management system.

Figure 10.2 Example of a highway bioretention basin (source: UndercoverLandscapes.com.au)

The estimated surface areas of the bioretention basins range from 100 to 640 m^2. Given that the project footprint extends at least 40 m from the toe of the road embankment, there should be adequate space to locate the basins within the footprint and opportunities will be investigated to minimise basin size using a combination of measures such as Gross Pollutant Traps, swales and basins in a treatment train. The stormwater treatment system will be designed to achieve an appropriate balance between treatment outcomes and disturbance and clearing of existing land and vegetation.

10.3.4 CONSULTATION WITH FLOODING AND STORMWATER MANAGEMENT AUTHORITIES

GHCMA, DELWP and Pyrenees Shire Council will be consulted during the detailed design phase to get input on water sensitive and ecological design features and to understand if the water management system needs to accommodate any specific drainage requirements or future drainage scheme plans in the project area.

10.4 SUMMARY OF MITIGATIONS

A summary of mitigations is provided in Table 10.1 and will require incorporation into the EMF for the management of residual impacts.

Table 10.1 Summary of mitigations

NO.	MITIGATION	PROJECT PHASE
SW1	Undertake detailed drainage design that incorporates the functional design WSRD principles and includes features such as treatment swales and bioretention systems at all discharge points to protect the downstream water quality regime. Where possible integrate the treatment system within the required channel realignments and seek to achieve an appropriate balance between treatment outcomes and disturbance and clearing of existing land and native vegetation. Demonstrate through detailed water quality modelling that the treatment systems proposed to treat runoff from the road corridor will be effective at avoiding water quality impacts in receiving waterways and wetlands.	Design
SW2	Prepare spills risk assessment and incorporate spill containment into the road drainage/stormwater treatment system design where required to protect the downstream water quality regime.	Design
SW3	Refine the cross drainage design to further minimise and manage flooding impacts as far as practical around the main Yam Holes Creek crossing and floodplain in the vicinity of Racecourse Road, with a focus on reducing impact on the trafficability of Racecourse Road and any other sensitive land uses in the area. Consult with affected landowners on the flooding impacts and determine the need for further design refinements during the detailed design. Refine the design to facilitate fauna passage by shortening culverts, replacing culverts with bridges where feasible and inclusion of features such as light wells in long culverts.	Design
SW4	Channel realignments to be designed to avoid excessive velocities and depths and scour risk at transitions to downstream watercourses. Designs to incorporate ecological and landscape design principles to provide new or enhance existing aquatic and terrestrial habitats. Measures to be incorporated include structures/geometric design to limit velocities and avoid scour and erosion at transitions to receiving waterways, aquatic and terrestrial planting (maximising the use of native species) that is appropriate for the existing environment, pool and riffle features and other methods to provide stilling areas and other ecological and landscape design features in accordance with best practice guidelines such as the relevant parts of Melbourne Water's Constructed Waterway Design Manual (Melbourne Water, 2019) and DELWP's Growling Grass Frog Crossing Design Standards (DELWP, 2017)	Design

NO.	MITIGATION	PROJECT PHASE
	Demonstrate through detailed hydrological and hydraulic modelling that the hydraulic regimes within the channel realignments are such that scour, erosion and sedimentation will be avoided within the channel realignments and within the connecting waterways downstream. Designs to be sustainable without requiring onerous maintenance and minimising disturbance and clearing of existing land and native vegetation.	
SW5	Prepare a Construction Environmental Management Plan that includes best practice measures to manage sedimentation and erosion impacts and temporary flooding impacts during the construction phase in accordance with all relevant guidelines. The Plan will include a construction phase water quality monitoring plan to confirm effectiveness of established controls and where additional controls may be required in all receiving waterways and wetlands downstream of the construction area.	Construction

11 RESIDUAL IMPACTS

The water quality impacts of the project are considered to be minor provided sufficient measures are included in the design to treat runoff from the road corridor to meet best practice pollutant load reduction criteria.

The location of the project is such that some level of disturbance of the existing watercourses and floodplain processes is unavoidable, however, the assessment has demonstrated the basis for an effective cross drainage design incorporating channel realignments along the boundaries of the road corridor that can minimise impacts on the flooding regime, with relatively minor and localised increases in flood level and no significant changes to flood velocity, duration and hazard predicted to occur outside the project boundary. The detailed design phase will further refine the design of the cross drainage and channel realignments with the intent of minimising the impacts, particularly upstream of the Yam Hole Creek bridges and around Racecourse Road.

Residual impacts predicted by this assessment and requiring further consideration at detailed design are as follows:

11.1 FLOOD LEVEL IMPACTS

It is expected that the residual impacts on flooding and floodplain/waterway hydraulics will be low following the detailed design phase when the issues below are further addressed:

- The flooding impacts around the main Yam Holes Creek crossing and floodplain in the vicinity of Racecourse Road require additional investigations as part of the detailed design phase to finalise the specific crossing design, which will further minimise and manage afflux and flood hazard impacts on the floodplain and section of Racecourse Road local to the crossing.
- Potential for the waterway crossings, specifically long culverts, and channel realignments to obstruct or restrict fauna passage around the project footprint. Sections 10.3.1 and 10.3.2 identify measures to be investigated at the detailed design stage to address this residual impact.
- Potential for hazardous flow conditions to occur within the channel realignments due to the creation of new flow paths and potential for the channel realignments to introduce new scour, erosion and sedimentation problems within the channel realignments themselves and within the receiving streams downstream. Section 10.3.2 identifies measures to be investigated at the detailed design stage to address this residual impact.
- Consultation with landowners for affected areas of land will be undertaken at the detailed design stage to determine the acceptability of the predicted impacts to the landowner and if further design refinements are required to manage the impacts. Typical measures would include local road and property access raising, flood protection embankments, flood diversion channels and other similar measures to protect sensitive land uses.

11.2 FLOOD VELOCITY IMPACTS

Through further detailed modelling during the detailed design phase and mitigations prescribed in sections 10.1, 10.3.1, 10.3.2 and 11.1, flood velocity impacts during the operational phase for the 1 EY, 10% AEP and 1% AEP flood events will be low.

11.3 FLOOD DURATION IMPACTS

Through further detailed modelling during the detailed design phase and mitigations prescribed in sections 10.1, 10.3.1, 10.3.2 and 11.1, flood duration impacts during the operational phase for the 1 EY, 10% AEP and 1% AEP flood events will be low.

11.4 FLOOD HAZARD IMPACTS

Through further detailed modelling during the detailed design phase and mitigations prescribed in sections 10.1, 10.3.1, 10.3.2 and 11.1, flood hazard impacts during the operational phase for the 1 EY, 10% AEP and 1% AEP flood events will be low.

11.5 WATER QUALITY IMPACTS

The functional design incorporates best practice WSRD features such as bioretention basins to treat runoff from the road corridor prior to discharge to the receiving environment. These measures will ensure that the majority of the pollutant loads from the road corridor are removed prior to discharge consistent with best practice WSRD BPEMG, and the residual impact on water quality will be low due to the low pollutant loads in the discharged runoff. At the detailed design stage further mitigation measures will be investigated and implements consistent with the mitigations prescribed in sections 10.2.2 and 10.3.3 to address the following issues:

- The risk of contamination of the receiving environment as a result of spills is to be investigated through a spills risk assessment and spill containment measures may need to be incorporated into the stormwater management system to address this risk.
- All features of the water management system need to be designed to minimise impacts on existing native vegetation. The stormwater management and treatment system will be designed to achieve an appropriate balance between treatment outcomes and disturbance and clearing of existing land and vegetation.

11.6 WETLANDS IMPACTS

Section 9.4 demonstrates that the impacts on wetlands are low due to the WSRD measures proposed in the design to manage pollutants in road runoff; the low number of wetlands that will experience changes in flooding regime; the localised nature of the flooding impacts on the affected wetlands; and the low level of impact for more regular floods, such as the 1 EY event. Through further detailed modelling during the detailed design phase and mitigations prescribed in section 10.1, 10.2.2, and 10.3.3, wetland impacts during the construction and operational phase will continue to be assessed and managed to ensure that residual impacts remain low.

12 CONCLUSION

The study catchment is within the Hopkins River Basin in the eastern half of the Glenelg Hopkins Catchment Management Region. The flood risk for the project is associated with Yam Holes Creek and its tributaries. Yam Holes Creek flows east through Beaufort and comprises a catchment of approximately 70.1 km^2 to the confluence with Mount Emu Creek at Trawalla. All bypass alignment options intersect Yam Holes Creek and its tributaries within the FO and LSIO overlays. These overlays reflect the active waterway channels and floodplains for the 1% AEP respectively.

Water quality data assessing the environmental condition of Yam Holes Creek and its tributaries is limited. Pyrenees Shire Council monitor water quality data in Yam Holes Creek at Beaufort landfill as part of its due diligence environmental compliance. However, the data collected is not sufficient for commentary on water quality objectives. The environmental condition of the nearest watercourse, Mount Emu Creek, was rated poor to very poor.

The surface water assessment considered the performance of the bypass alignment options against the project objective for surface water:

To protect catchment values, surface water and ground water quality, stream flows and floodway capacity, and avoid impacts on protected beneficial uses.

A high level surface water impact assessment was undertaken for all four alignment options which identified Option A1 to have the least surface water impacts. However, Option C2 was subsequently found to be preferred when all environmental, social and economic disciplines were considered holistically.

Option C2 was subject to a more detailed impact assessment which examined the impacts of the option on the flooding regime (including flood level, velocity, duration and hazard), on the water quality in downstream receivers of runoff from the road corridor and on the wetlands adjacent to the project.

The outcomes of the flood impact assessment were that flood impacts are mainly concentrated around the main crossing of Yam Holes Creek near Racecourse Road, with impacts on flood level and hazard being of most significance. No buildings are affected but parts of the floodplain and Racecourse Road upstream of the crossing are predicted to experience increased flood levels and hazard.

The effects of climate change were modelled and found to not change the predicted impacts significantly.

The water quality assessment concluded that best practice stormwater treatment measures are required at all road drainage discharge points to protect downstream receivers such as wetlands. Concepts for bioretention systems are proposed to reduce pollutant loads in accordance with best practice.

The wetlands impact assessment identified that the flooding regime is only impacted at two wetlands, with the wetland upstream of the main Yam Holes Creek crossing most affected and subject to increased flood levels, particularly in moderate and major flood events. The impacts on this wetland are considered minor due to the low velocity and duration impacts and the localised flood level impacts that do not extend over the majority of the wetland.

The assessment identified the following aspects that require further investigation and optimisation at the detailed design stage to address residual risks associated with the project:

- The flooding impacts around the main Yam Holes Creek crossing and floodplain in the vicinity of Racecourse Road require additional investigations as part of the detailed design phase to finalise the specific crossing design, which will further minimise and manage afflux and flood hazard impacts on the floodplain and section of Racecourse Road local to the crossing.
- Waterway crossings will be designed to facilitate fauna passage through the following further design developments:
  - replacement of some culverts with bridge structures where technically and economically feasible
  - realignment/repositioning of culverts to reduce culvert length in the direction of flow
  - inclusion of light wells into long culverts; and
  - inclusion of low-level cells to promote permanent or regular wetting of culverts.

- The channel realignments will be carefully designed to ensure flow depths and velocities are minimised to avoid creation of new high hazard flow areas and transitions to the downstream watercourses are designed to avoid long term scour and erosion problems. Ecological and landscape design principles will be used in the design to facilitate fauna passage and the following specific measures will be included:
  - transitions at the downstream ends of the channel realignments into the receiving stream lines that deliver flow at velocities similar to the existing conditions in the receiving streams
  - incorporation of suitable aquatic and terrestrial planting within and along the channel realignments, maximising the use of native species and species resilient to the expected hydraulic and climatic conditions; and
  - inclusion of pool and riffle features, stilling areas and other similar features to provide habitat and refuge for aquatic species.
- The design currently includes bioretention basins to remove pollutants from the road runoff prior to discharge to the receiving environment. Opportunities will be investigated to incorporate these treatment measures into the channel realignments where technically feasible, or to use similar design features (such as planting schemes) to integrate these elements of the water management system.
- Opportunities will be investigated to minimise basin size using a combination of measures such as Gross Pollutant Traps, swales and basins in a treatment train. The stormwater treatment system will be designed to achieve an appropriate balance between treatment outcomes and disturbance and clearing of existing land and vegetation.
- A spills risk assessment will be undertaken and, where required, spill containment will be incorporated into the road drainage/stormwater treatment system design to protect the downstream water quality regime.

13 LIMITATIONS

This Report is provided by WSP Australia Pty Limited (*WSP*) for Regional Roads Victoria (*Client*) in response to specific instructions from the Client and in accordance with WSP's proposal dated 2 September 2020 and agreement with the Client dated 10 September 2020 (*Agreement*).

13.1 PERMITTED PURPOSE

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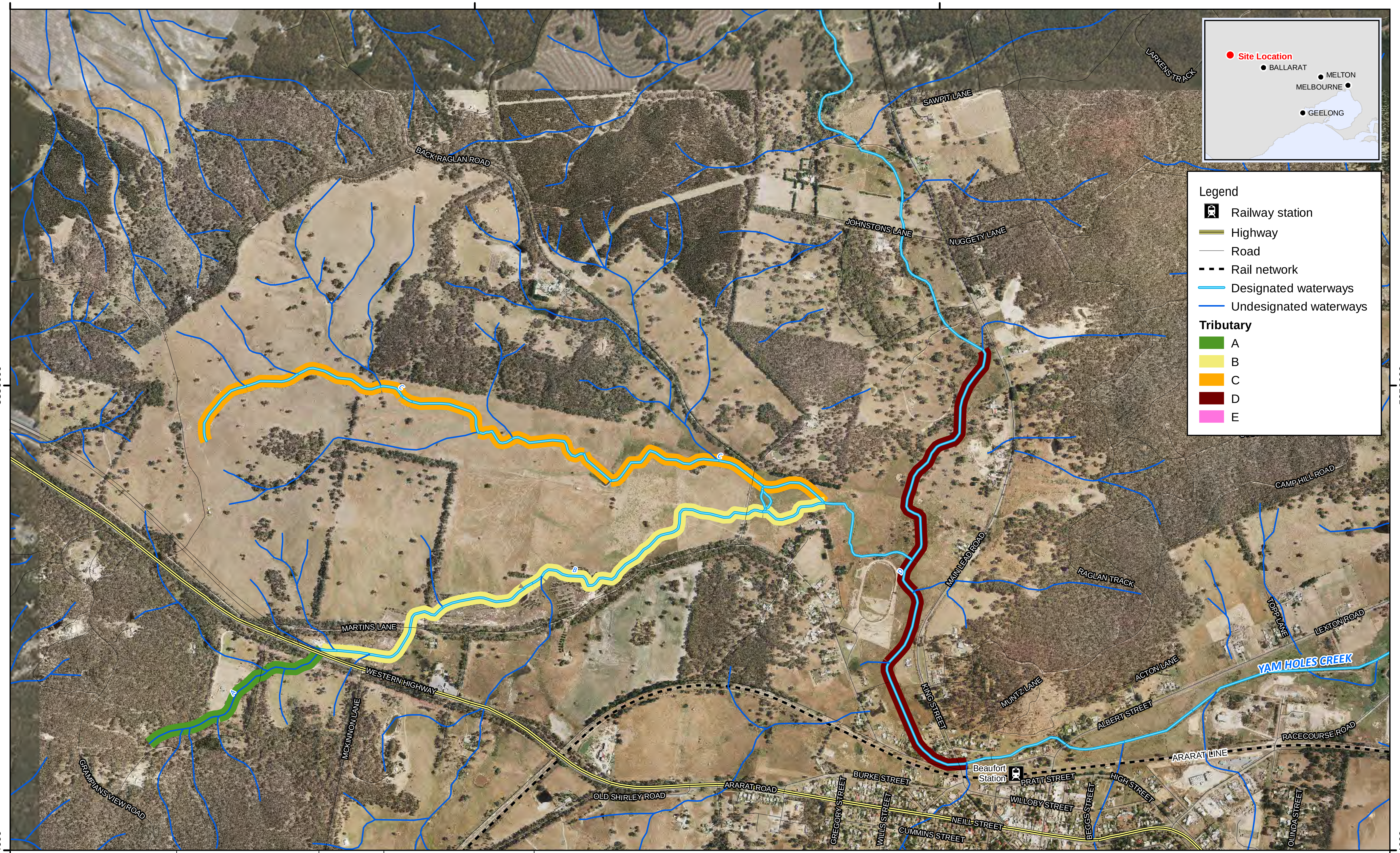
APPENDIX A

MAPS

Beaufort Bypass EES Surface Water Assessment

Map 1.1

Overview Map of Yam Holes Creek and its tributaries



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Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye,			Coordinate system: GDA 1994 MGA Zone 54 Scale ratio correct when printed at A3

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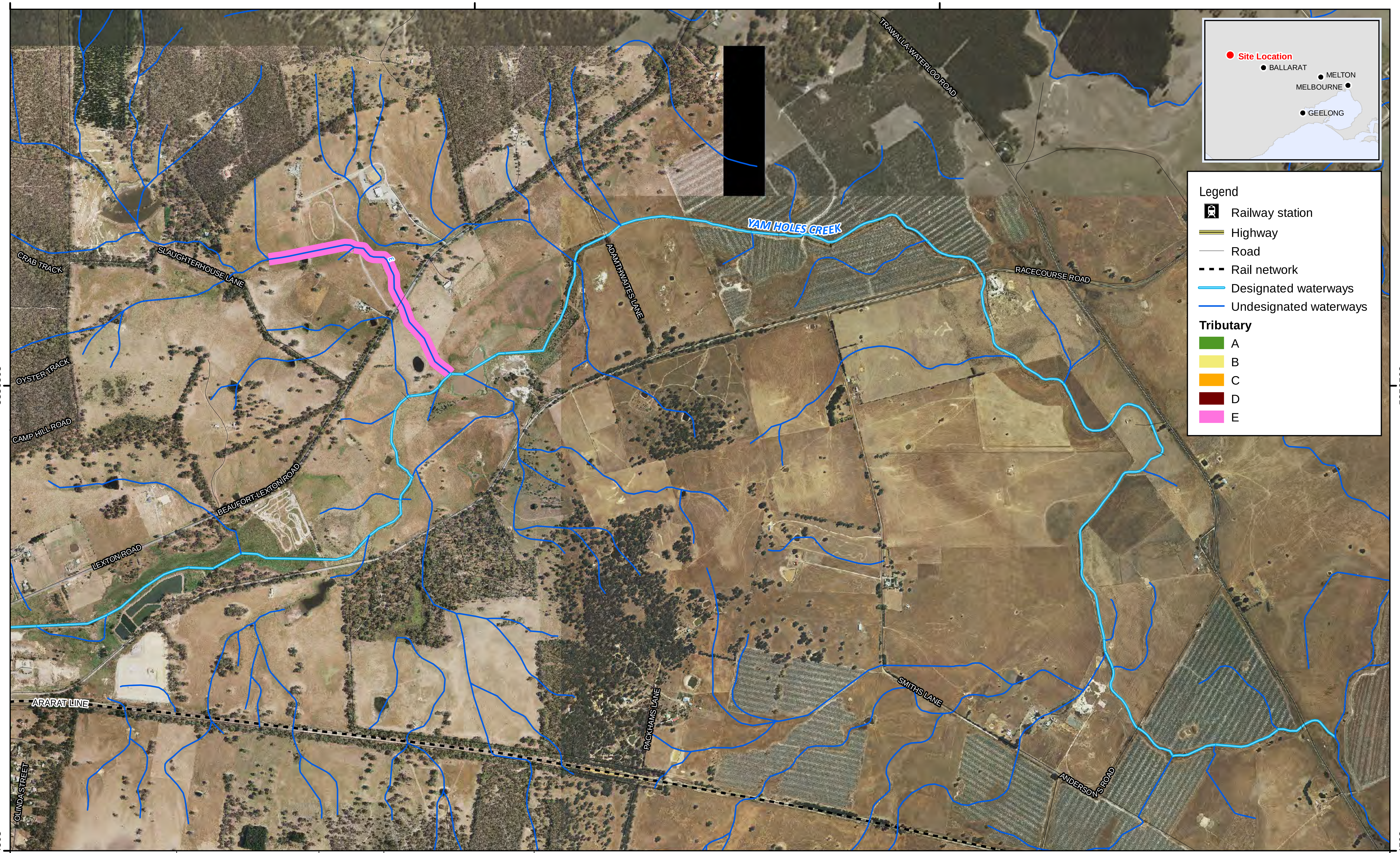

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Date: 21/06/2018 | Approved by: -

Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye.

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Scale ratio correct when printed at A3

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Beaufort Bypass EES Surface Water Assessment
Map 1.2
Overview Map of Yam Holes Creek and its tributaries

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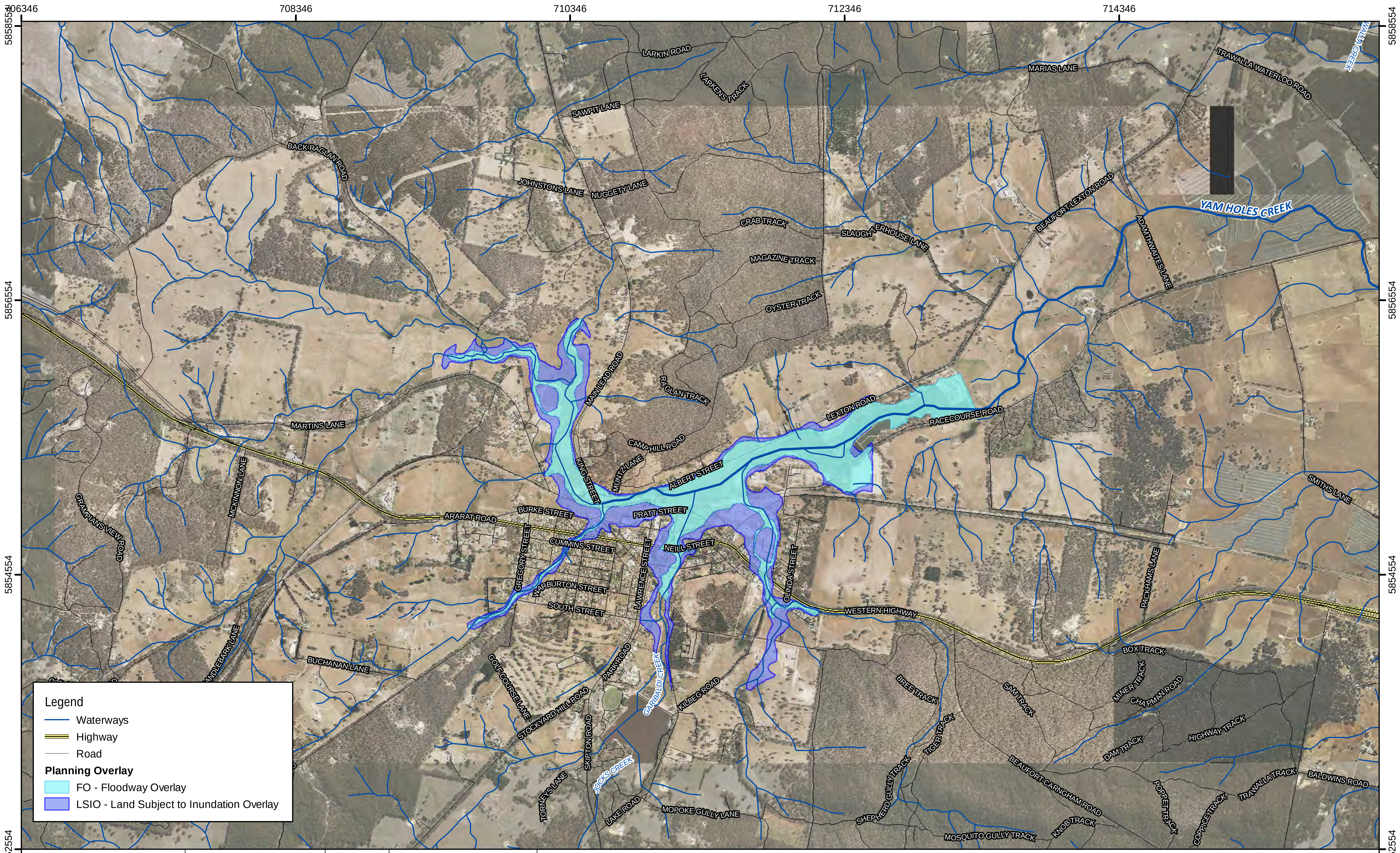

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Beaufort Bypass EES Surface Water Assessment
Map 2
Planning Surface Water Overlays

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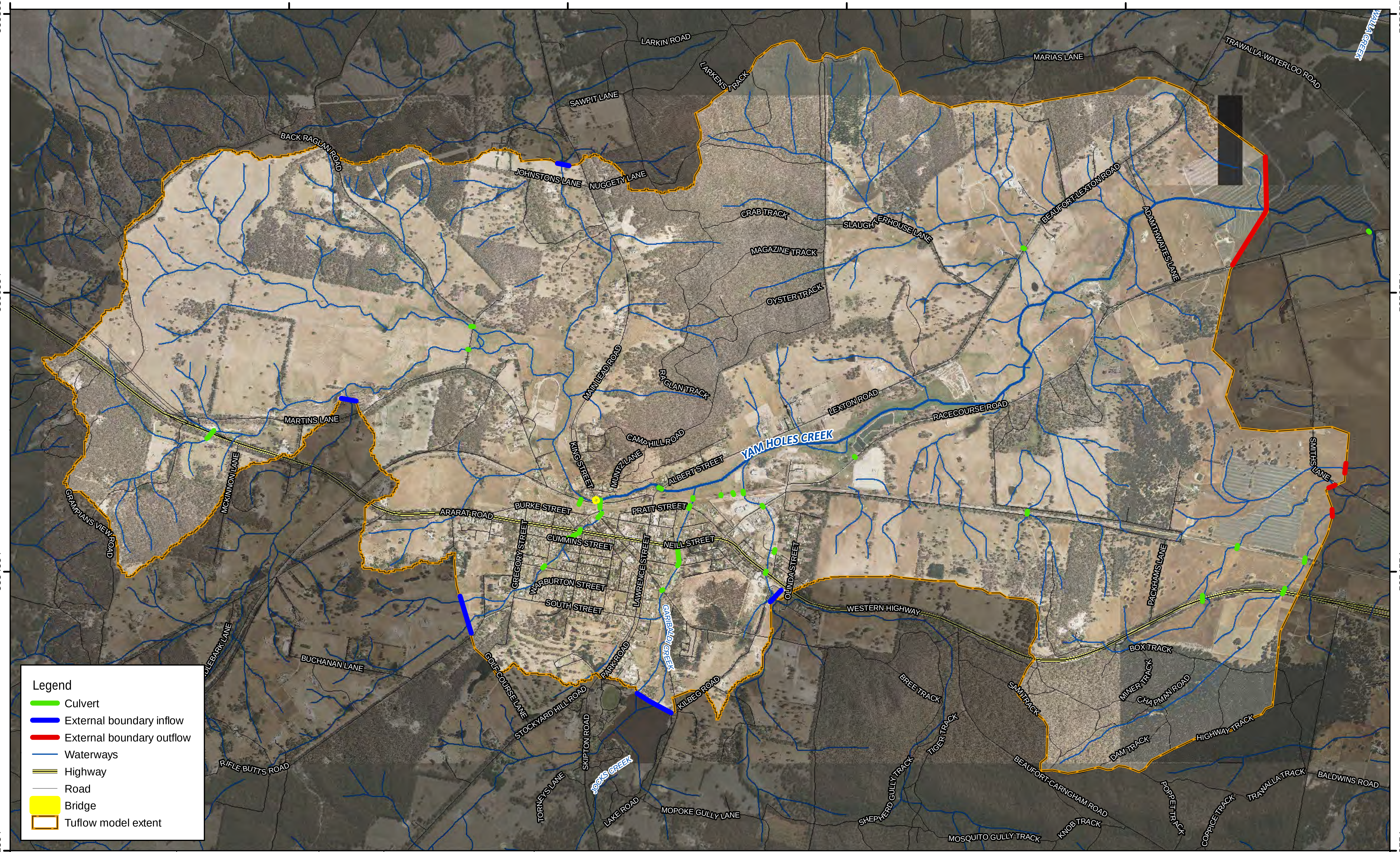

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Coordinate system: GDA 1994 MGA Zone 54
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Beaufort Bypass EES Surface Water Assessment
Map 3
Tuflow Model Setup

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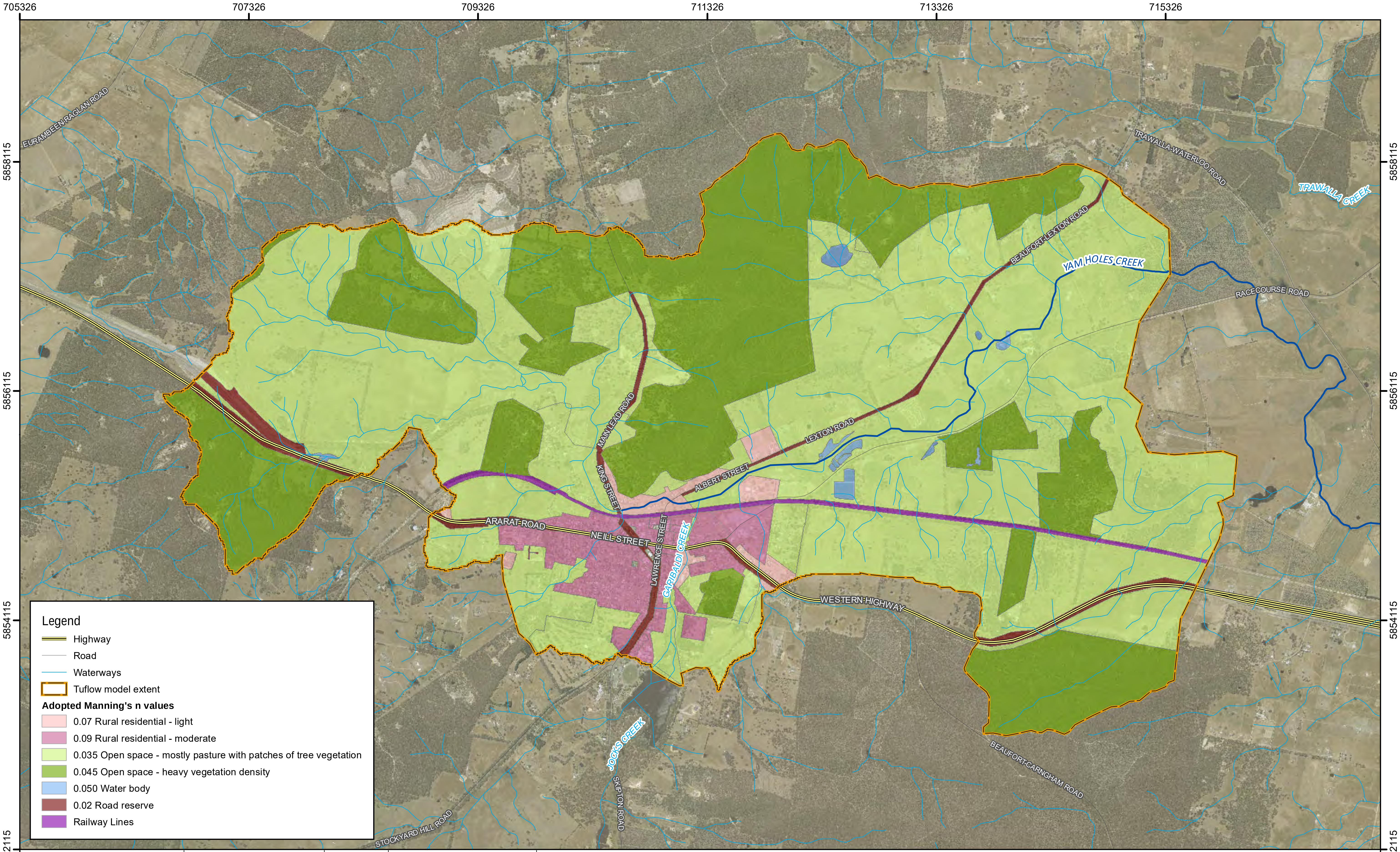

Legend
- Highway
- Road
- Waterways
- Tuflow model extent

Adopted Manning's n values
- 0.07 Rural residential - light
- 0.09 Rural residential - moderate
- 0.035 Open space - mostly pasture with patches of tree vegetation
- 0.045 Open space - heavy vegetation density
- 0.050 Water body
- 0.02 Road reserve
- Railway Lines

Map: 2270290A_GIS_090_A2	Author: VD/AS
Date: 12-Feb-21	Approved by: -

Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye.

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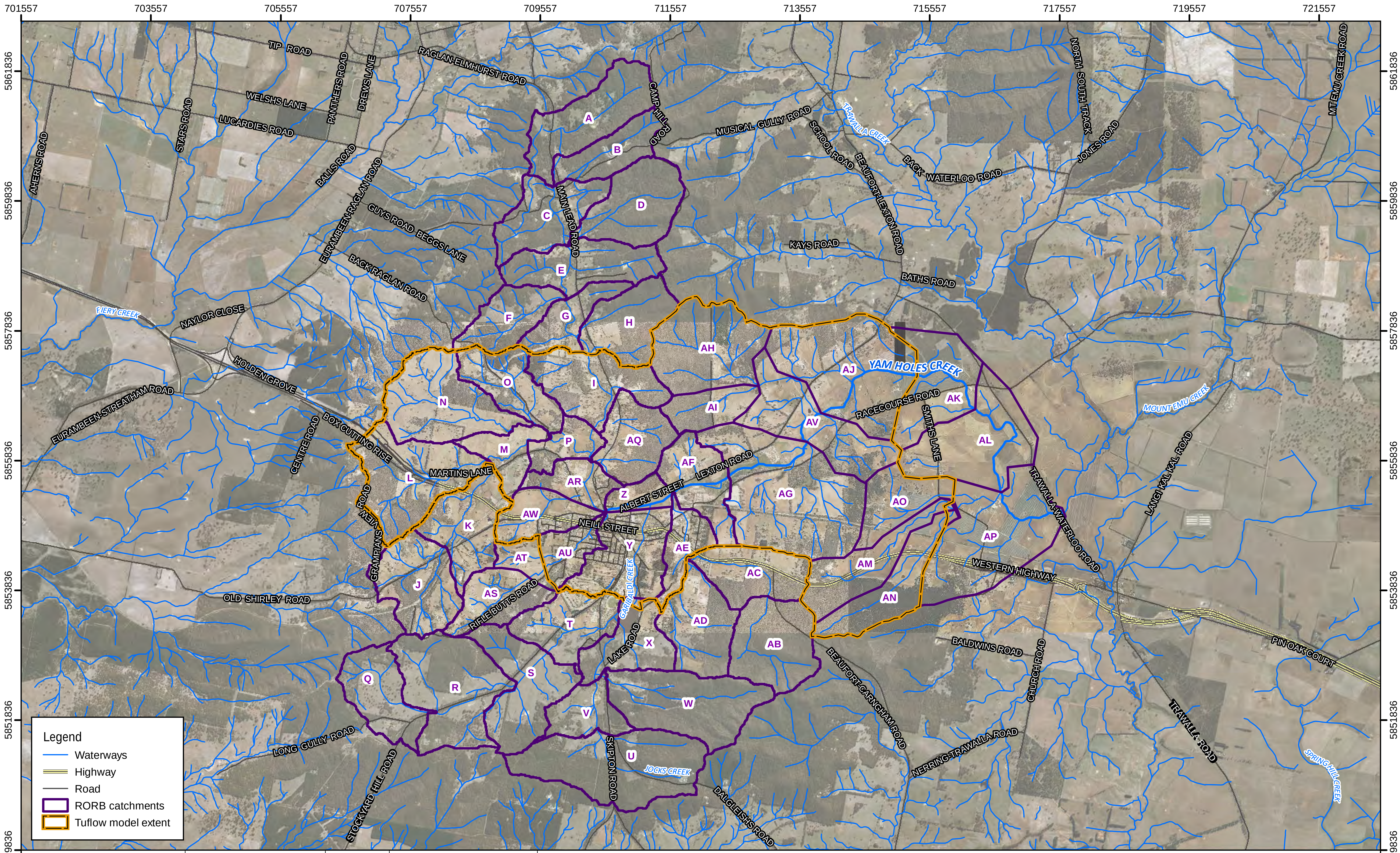
Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

Beaufort Bypass Environment Effects Statement Water Assessment

Figure 4
Adopted Manning's n values



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Author: VD

Date: 21/06/2018

Approved by: -

Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye,

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Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

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Beaufort Bypass EES Surface Water Assessment
Map 5
RORB Model Setup

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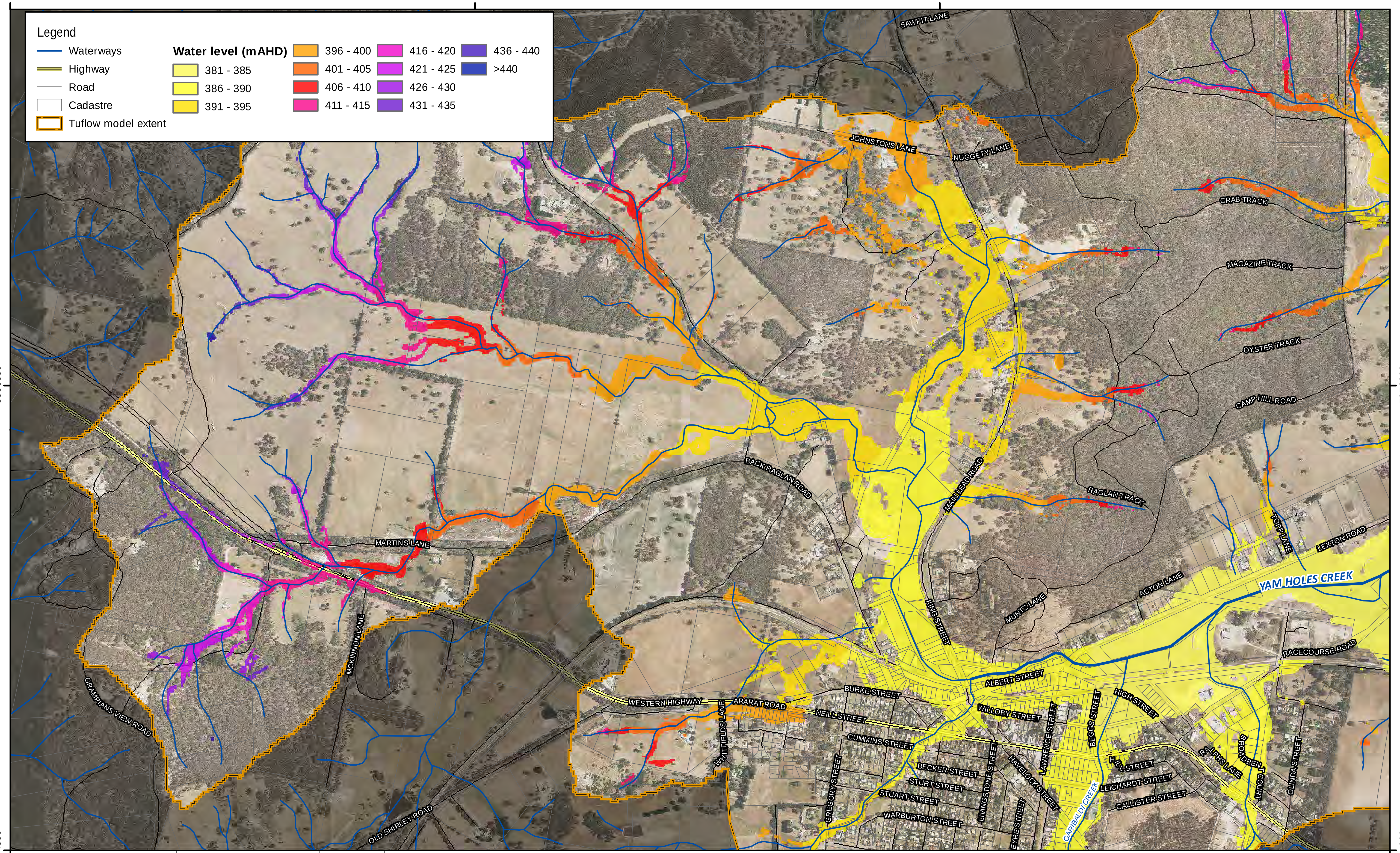

Map: 2270290A_GIS_091_A2	Author: VD
Date: 18/07/2019	Approved by: -

Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye.

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Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

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Beaufort Bypass EES Surface Water Assessment
Map 6.1
Existing Conditions
1% AEP base case flood level extent

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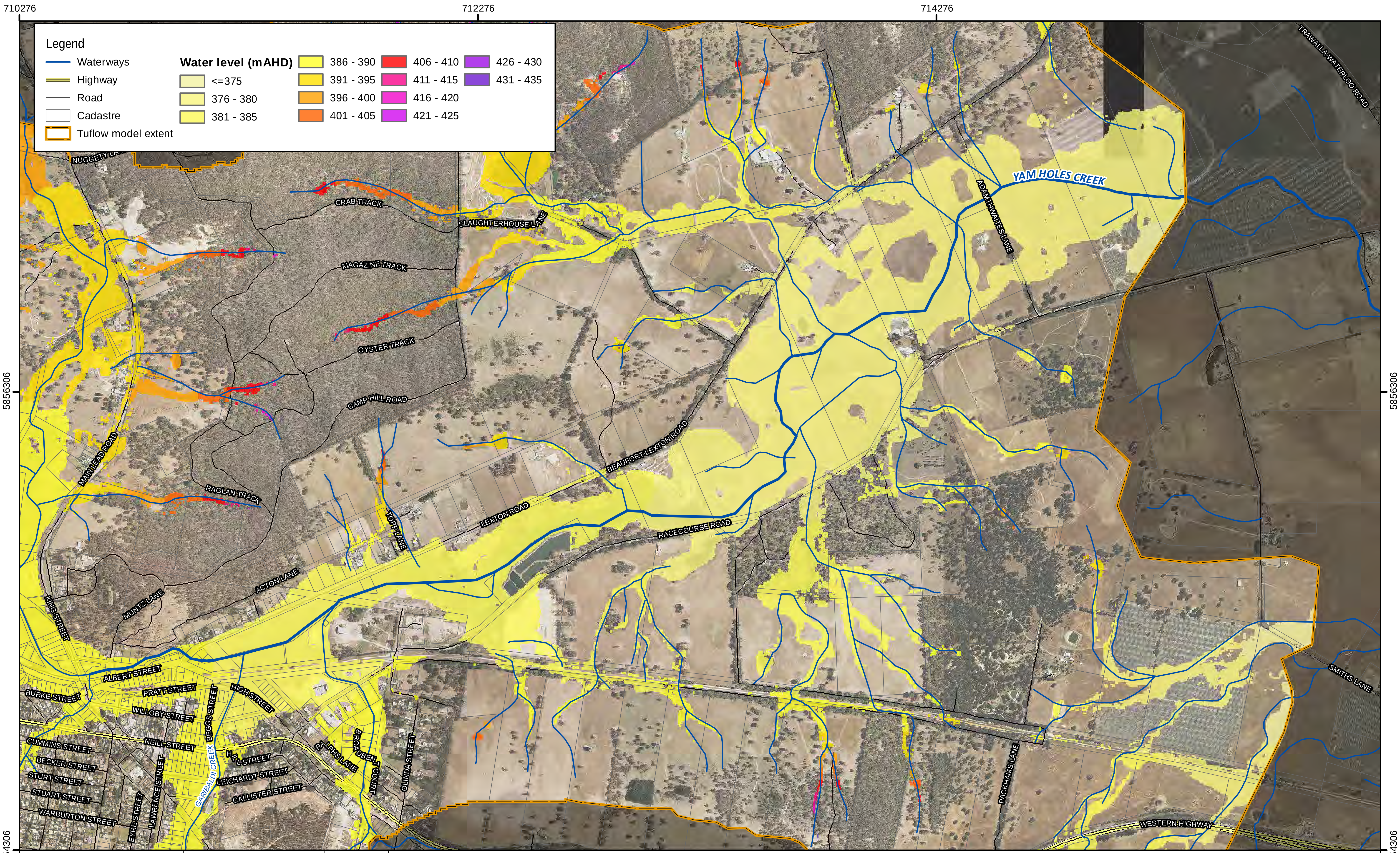

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Date: 18/07/2019	Approved by: -

Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye.

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Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

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Beaufort Bypass EES Surface Water Assessment
Map 6.2
Existing Conditions
1% AEP base case flood level extent

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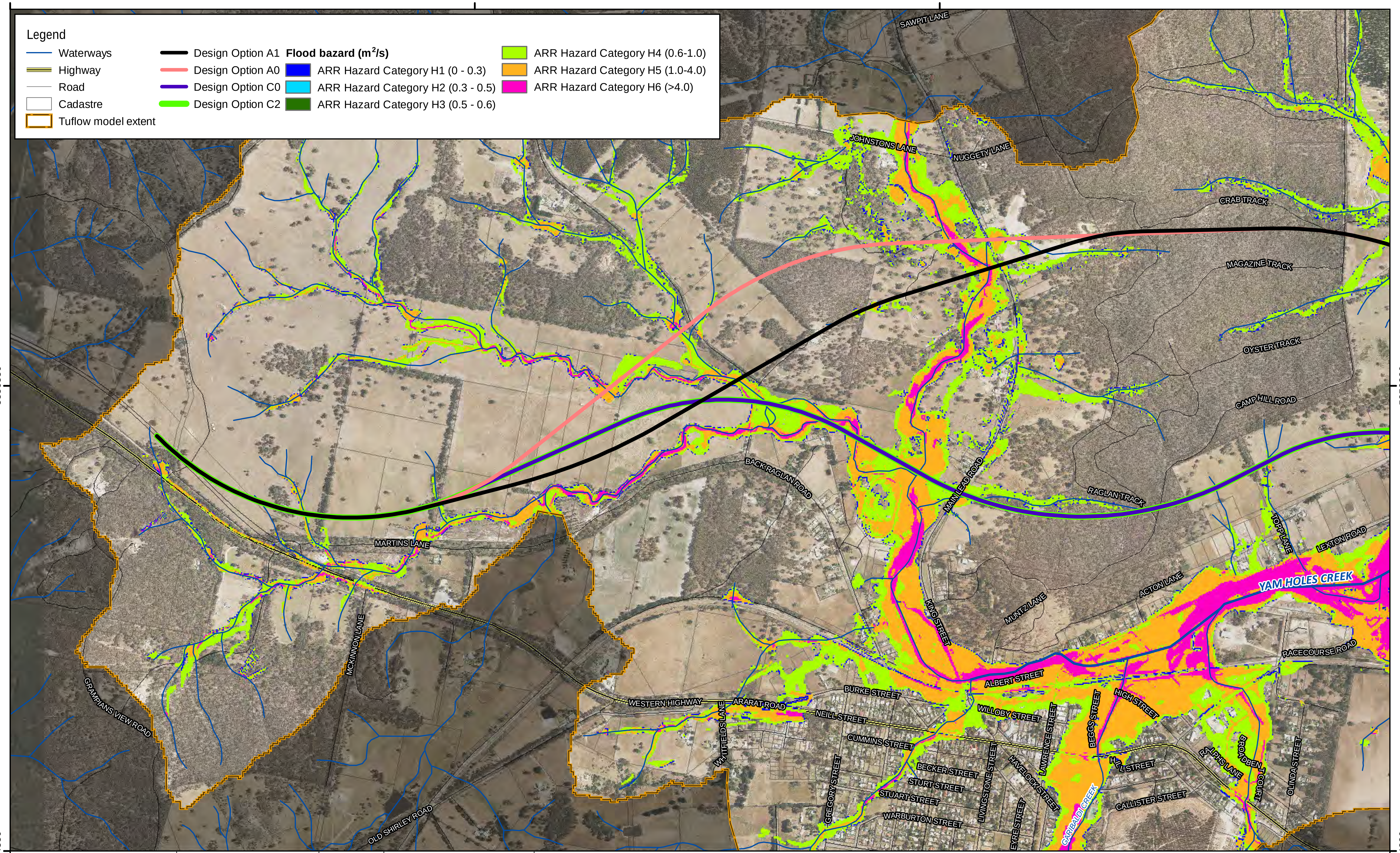

Legend

- Waterways
- Highway
- Road
- Cadastre
- Tuflow model extent
- Design Option A1
- Design Option A0
- Design Option C0
- Design Option C2

Flood bazard (m²/s)

- ARR Hazard Category H1 (0 - 0.3)
- ARR Hazard Category H2 (0.3 - 0.5)
- ARR Hazard Category H3 (0.5 - 0.6)
- ARR Hazard Category H4 (0.6-1.0)
- ARR Hazard Category H5 (1.0-4.0)
- ARR Hazard Category H6 (>4.0)

Map: 2270290A_GIS_093_A3	Author: VD/AS
Date: 6/08/2019	Approved by: -

Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye,

Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

Beaufort Bypass EES Surface Water Assessment

Map 7.1

Existing Conditions 1% AEP base case
Flood Hazard Map (Velocity x Depth)

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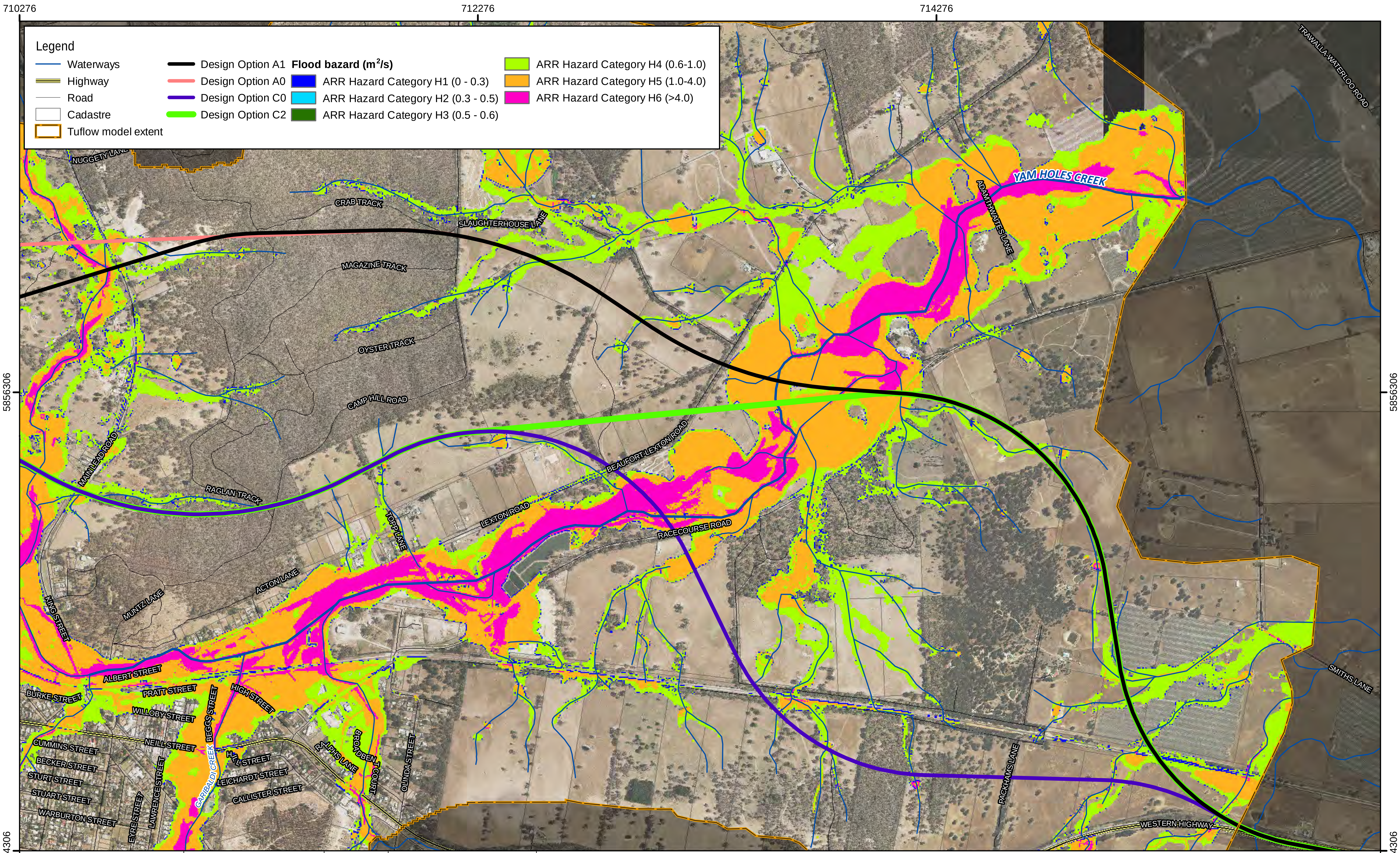

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Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye.

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Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

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Beaufort Bypass EES Surface Water Assessment
Map 7.2
Existing Conditions 1% AEP base case
Flood Hazard Map (Velocity x Depth)

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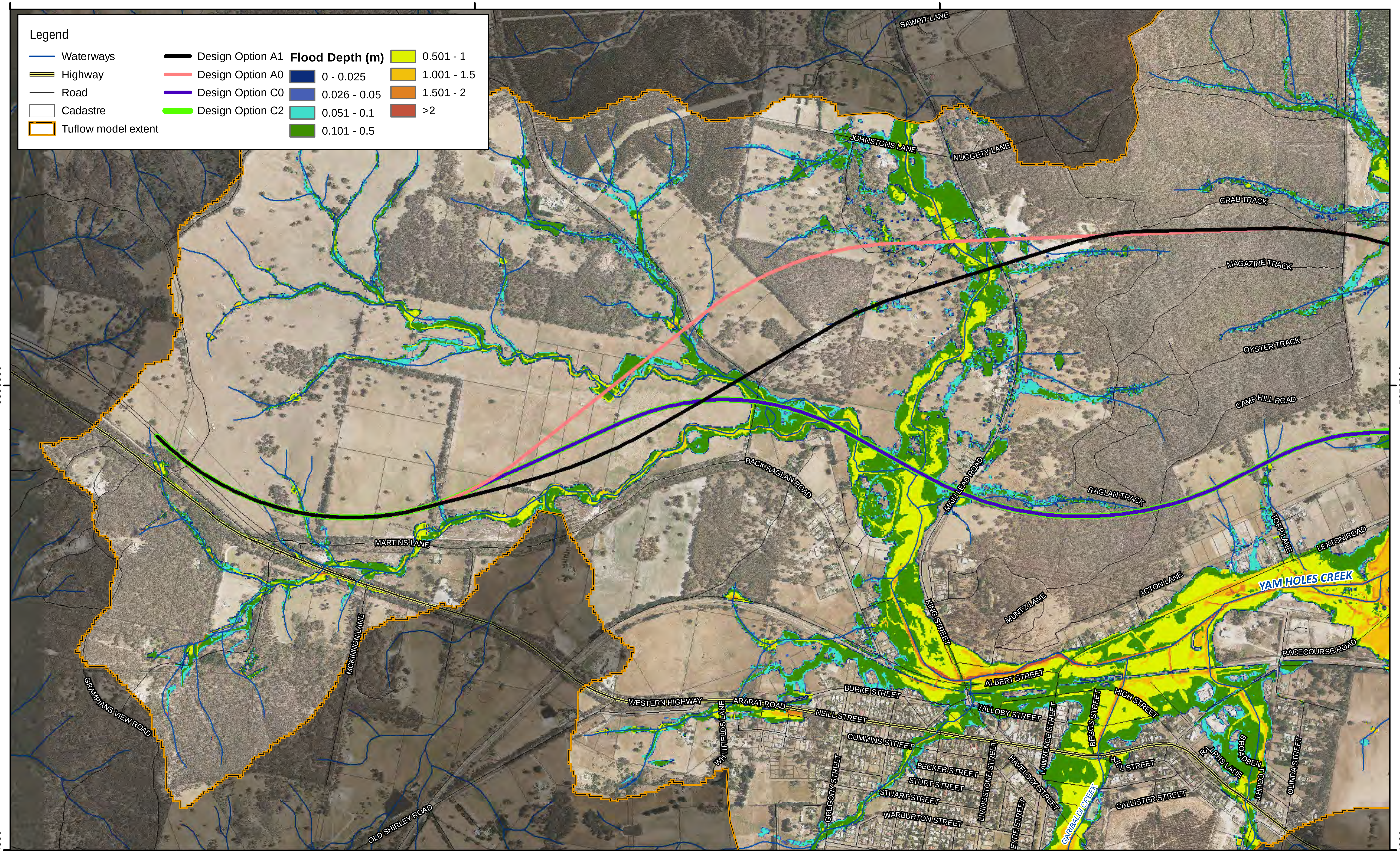

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Coordinate system: GDA 1994 MGA Zone 54
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Beaufort Bypass EES Surface Water Assessment
Map 8.1
Bypass Options with 1 % AEP base case flood depth

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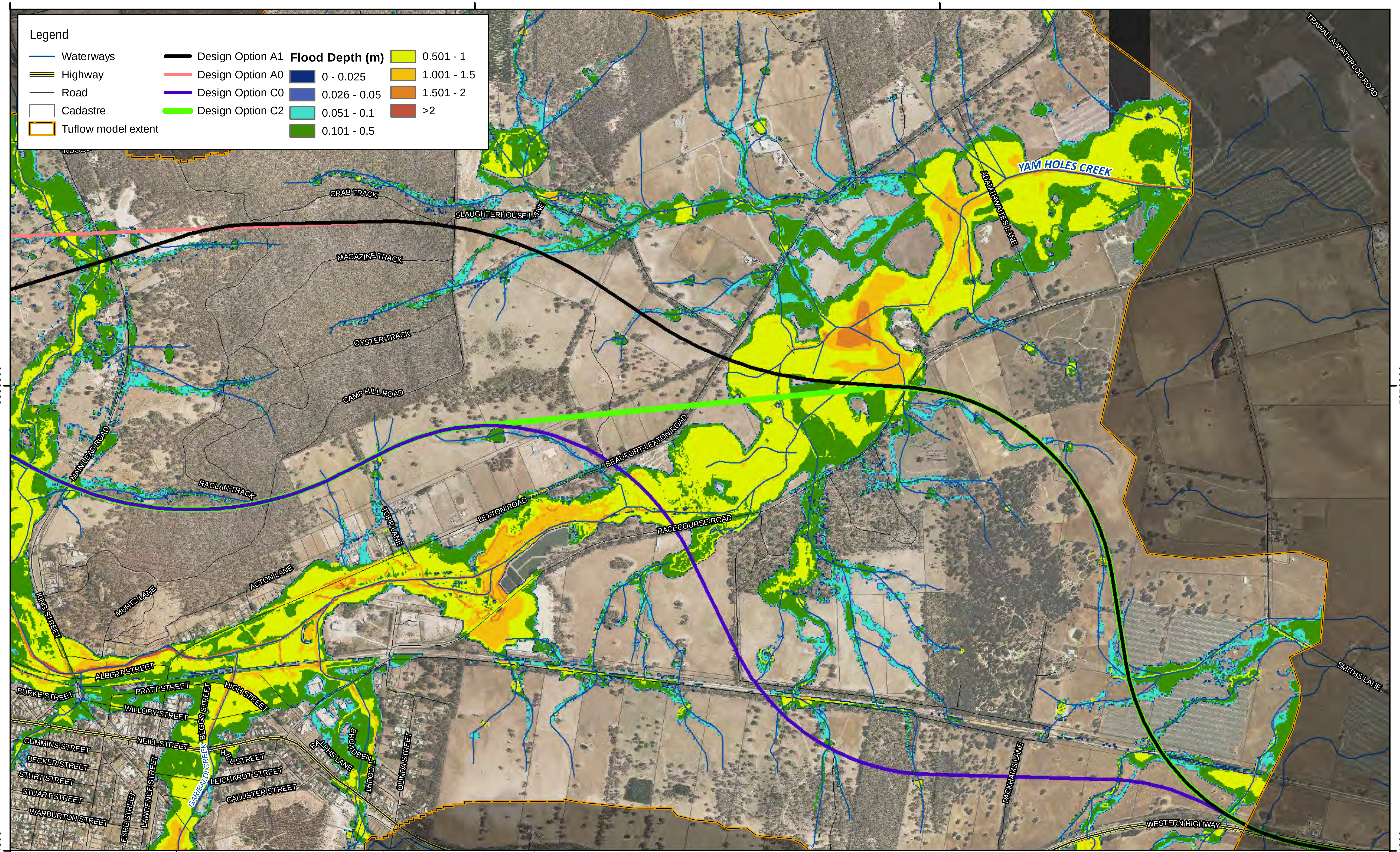

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Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye.

Beaufort Bypass EES Surface Water Assessment
Map 8.2
Bypass Options with 1 % AEP base case flood depth

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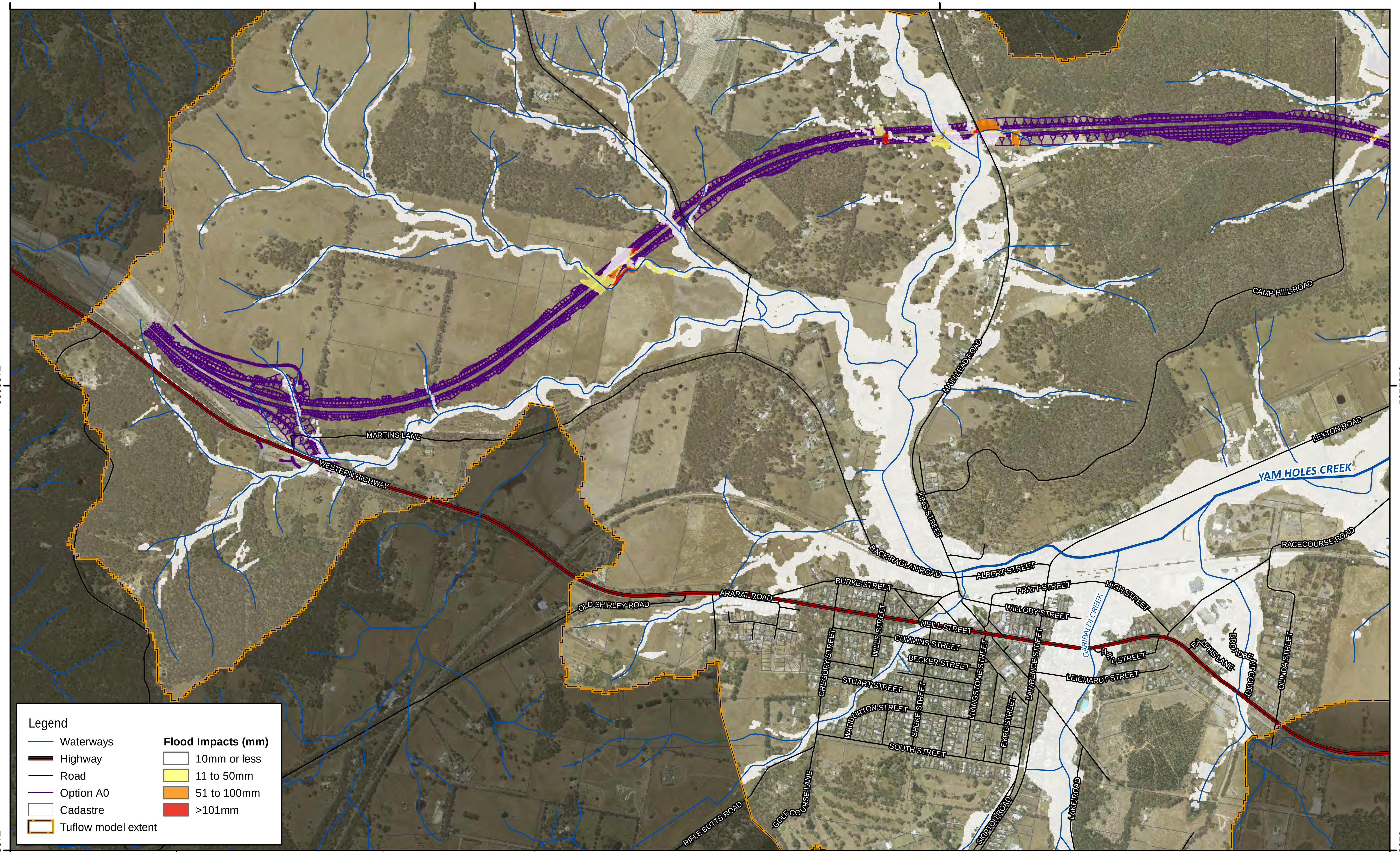

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Date: 6/08/2019	Approved by: -

Data source: VicRoads, Trimble.

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Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

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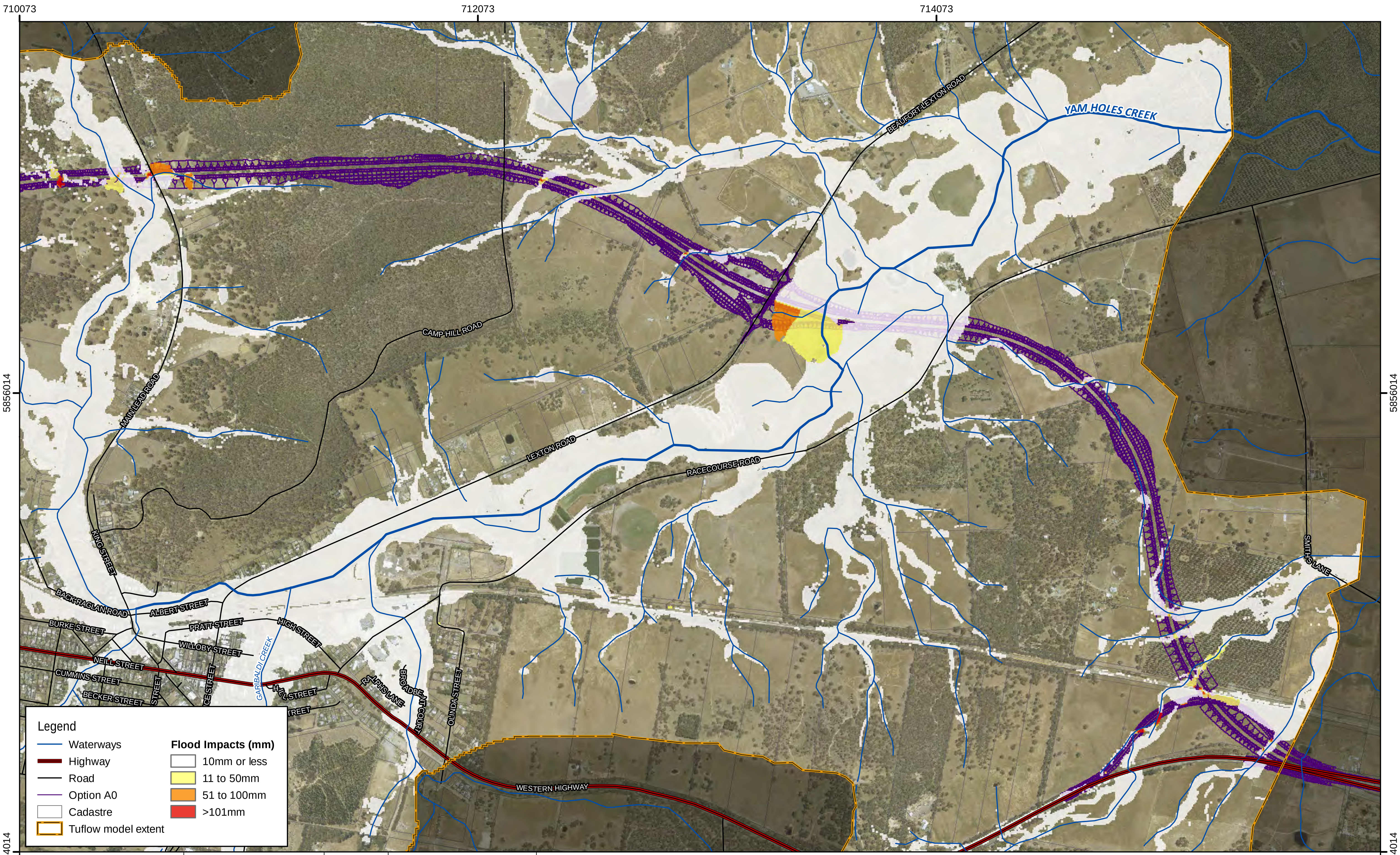
Beaufort Bypass EES Surface Water Assessment
Map 9.1
Beaufort Bypass Option A0 for 1% AEP
Difference between base case flood level and Option A0 flood level



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Data source: VicRoads, Trimble.

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Coordinate system: GDA 1994 MGA Zone 54
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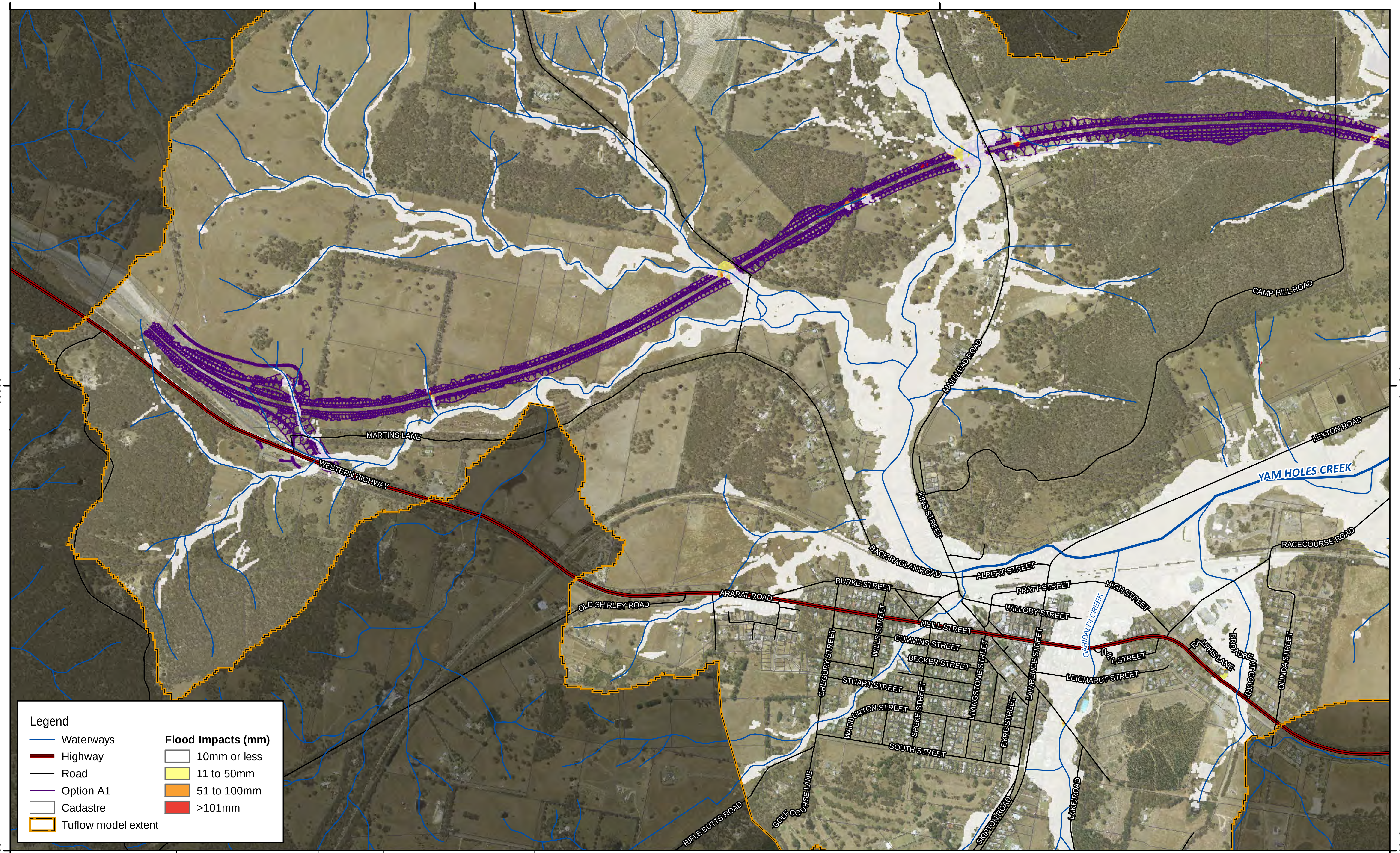
Beaufort Bypass EES Surface Water Assessment

Map 9.2

Beaufort Bypass Option A0 for 1% AEP

Difference between base case flood level and Option A0 flood level



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Data source: VicRoads, Trimble.

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Scale ratio correct when printed at A3

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Beaufort Bypass EES Surface Water Assessment
Map 10.1
Beaufort Bypass Option A1 for 1% AEP
Difference between base case flood level and Option A1 flood level

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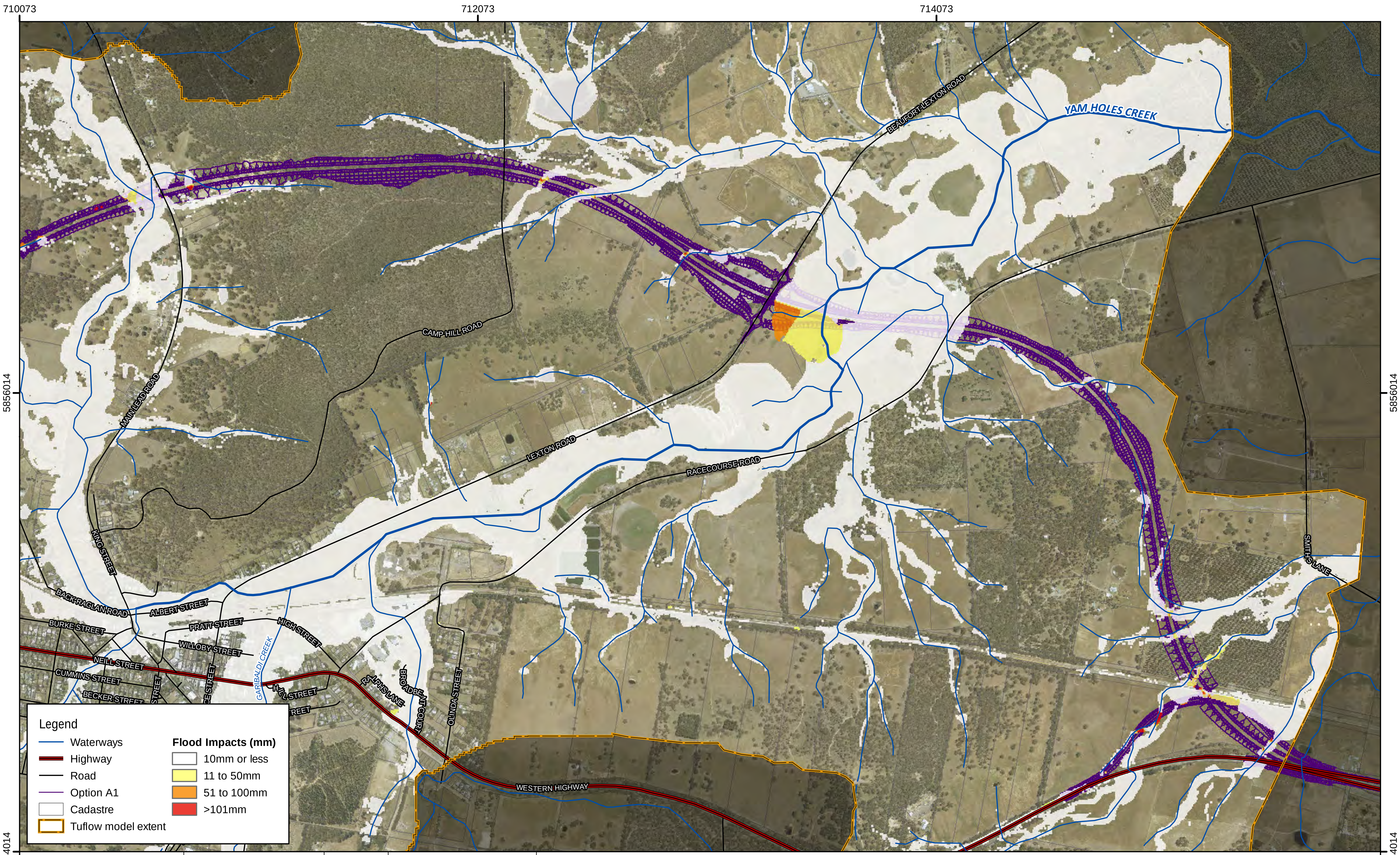

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Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

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Beaufort Bypass EES Surface Water Assessment
Map 10.2
Beaufort Bypass Option A1 for 1% AEP
Difference between base case flood level and Option A1 flood level

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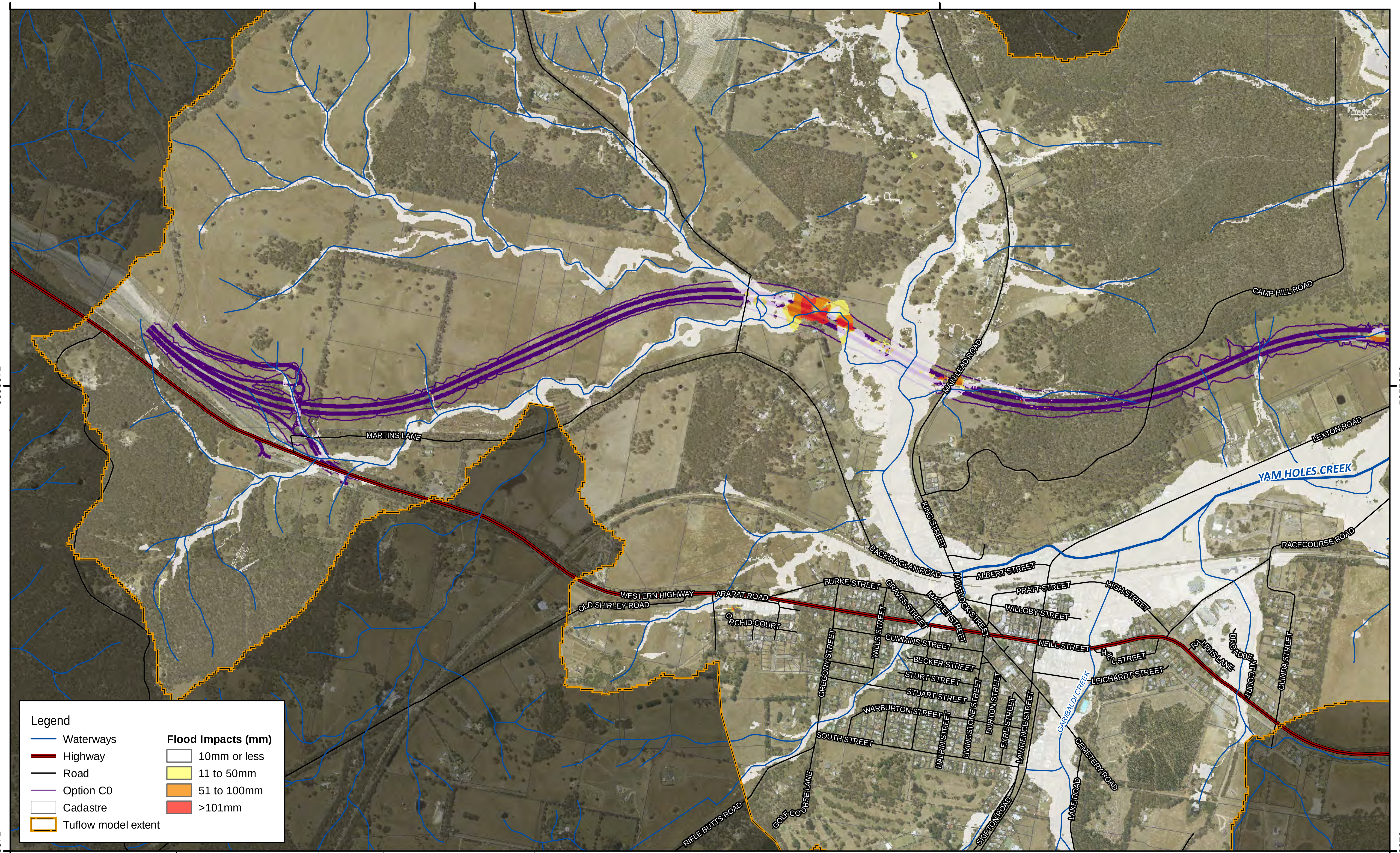

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Data source: VicRoads, Trimble.

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Coordinate system: GDA 1994 MGA Zone 54
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Beaufort Bypass EES Surface Water Assessment

Map 11.1

Beaufort Bypass Option C0 for 1% AEP

Difference between base case flood level and Option C0 flood level

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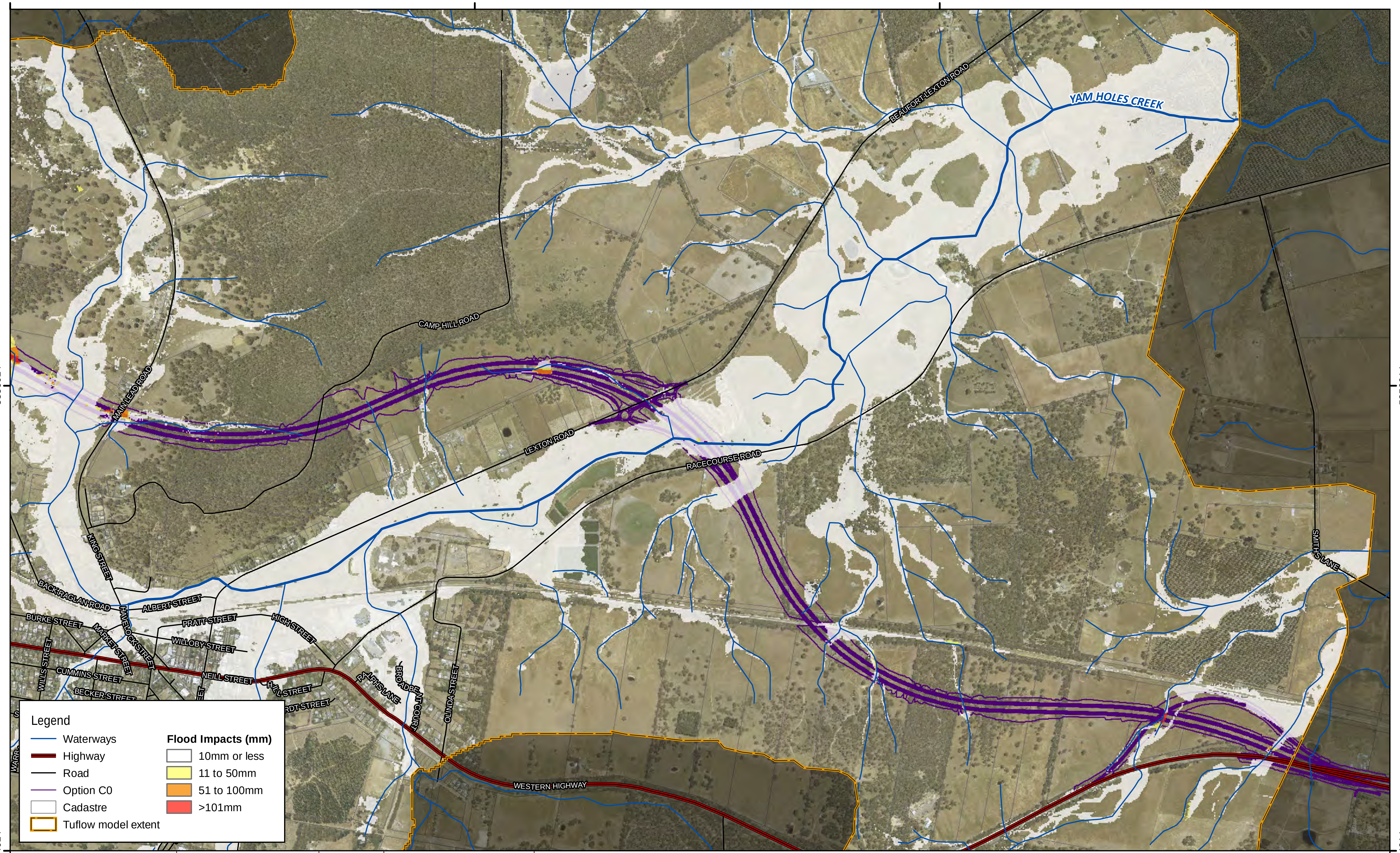

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Date: 6/08/2019	Approved by: -

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Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

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Beaufort Bypass EES Surface Water Assessment
Map 11.2
Beaufort Bypass Option C0 for 1% AEP
Difference between base case flood level and Option C0 flood level

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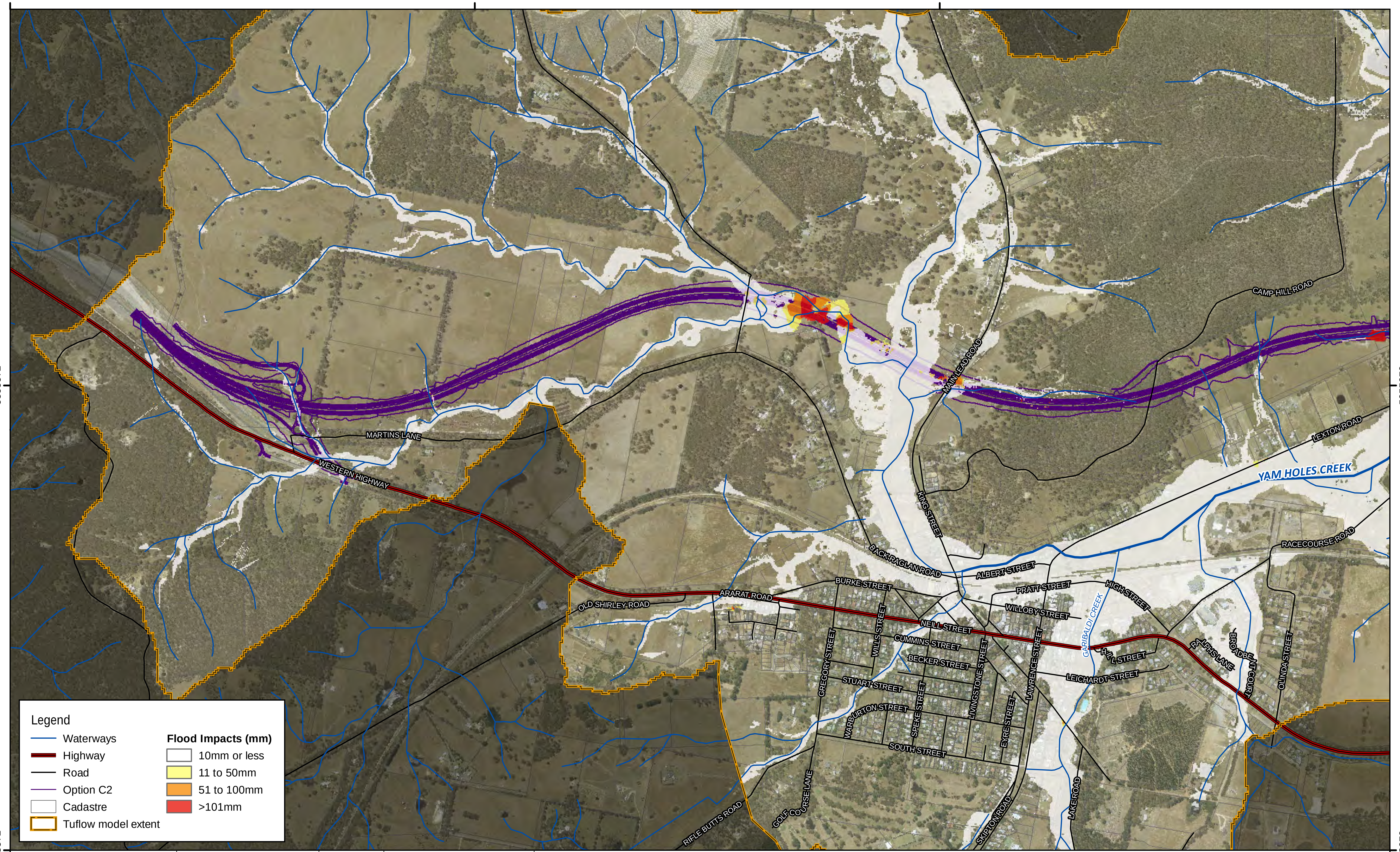

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Data source: VicRoads, Trimble.

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Beaufort Bypass EES Surface Water Assessment
Map 12.1
Beaufort Bypass Option C2 for 1% AEP
Difference between base case flood level and Option C2 flood level

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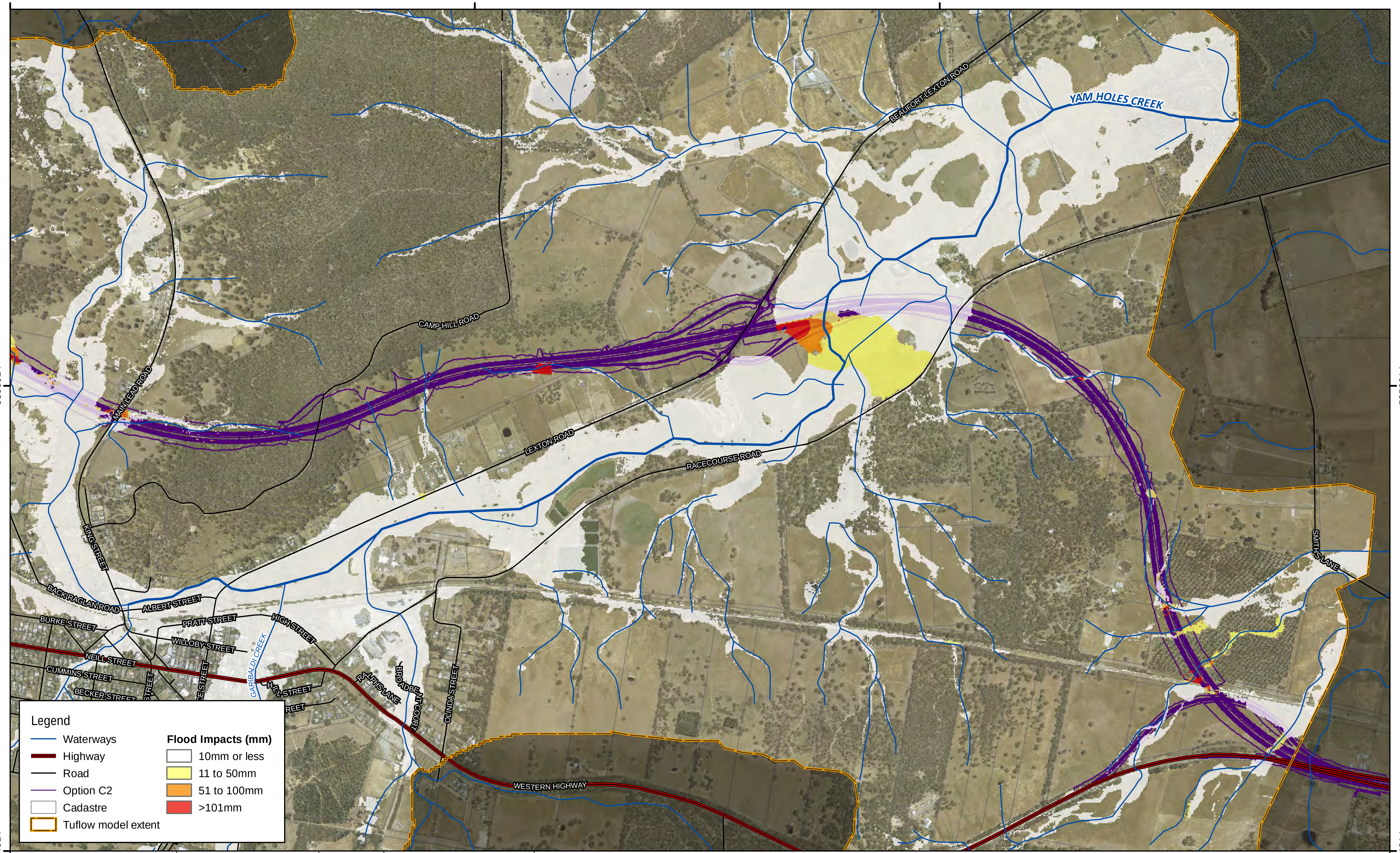

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Beaufort Bypass EES Surface Water Assessment

Map 12.2

Beaufort Bypass Option C2 for 1% AEP

Difference between base case flood level and Option C2 flood level

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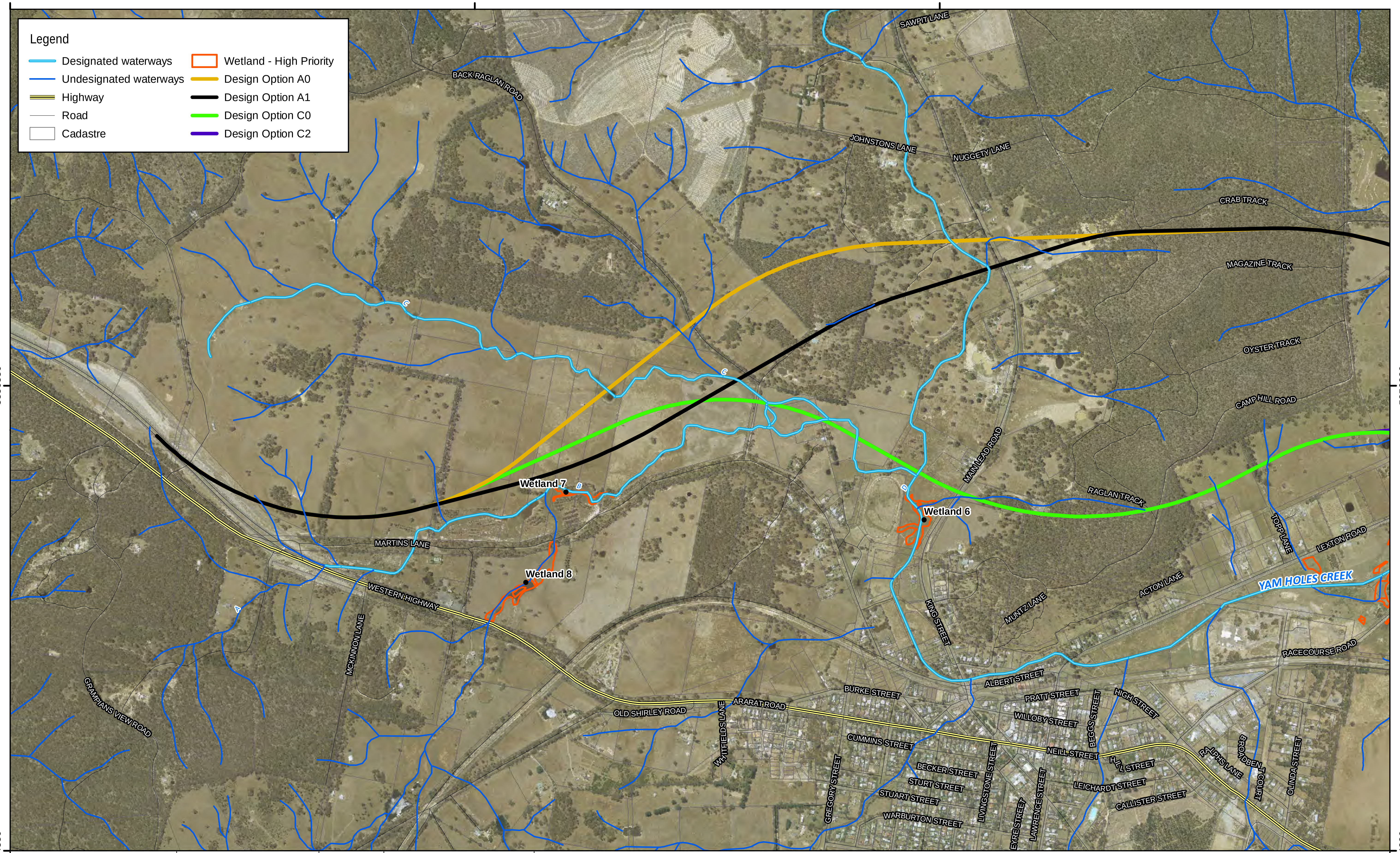

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Date: 6/08/2019	Approved by: -		
Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye,			

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Beaufort Bypass EES Surface Water Assessment
Map 13.1
Bypass Options with wetlands

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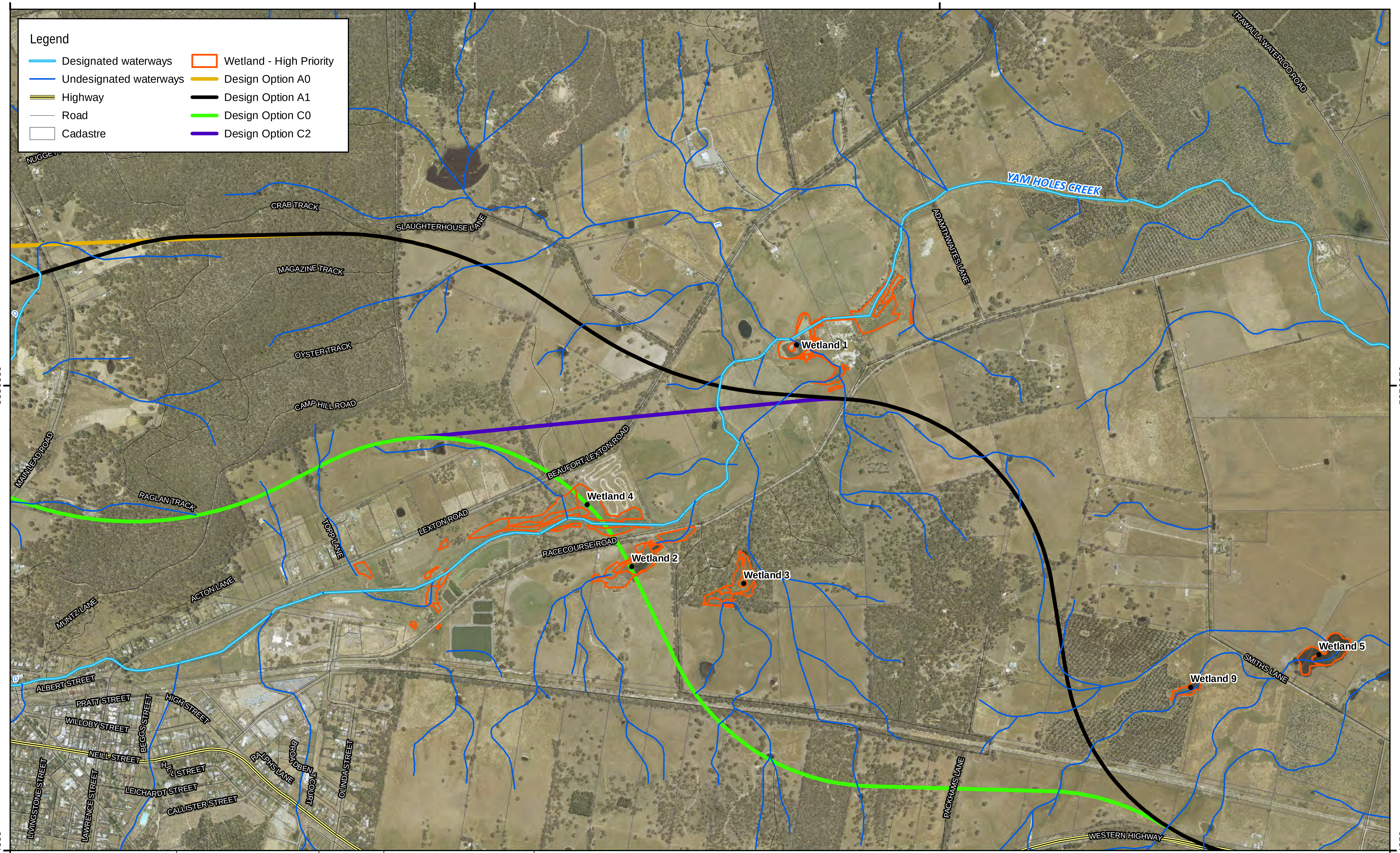

Map: 2270290A_GIS_114_A3

Author: VD/MB/AS

Date: 6/08/2019

Approved by: -

Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye,

0 150 300 m

1:15,000

Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

regional roads victoria

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Beaufort Bypass EES Surface Water Assessment
Map 13.2
Bypass Options with wetlands

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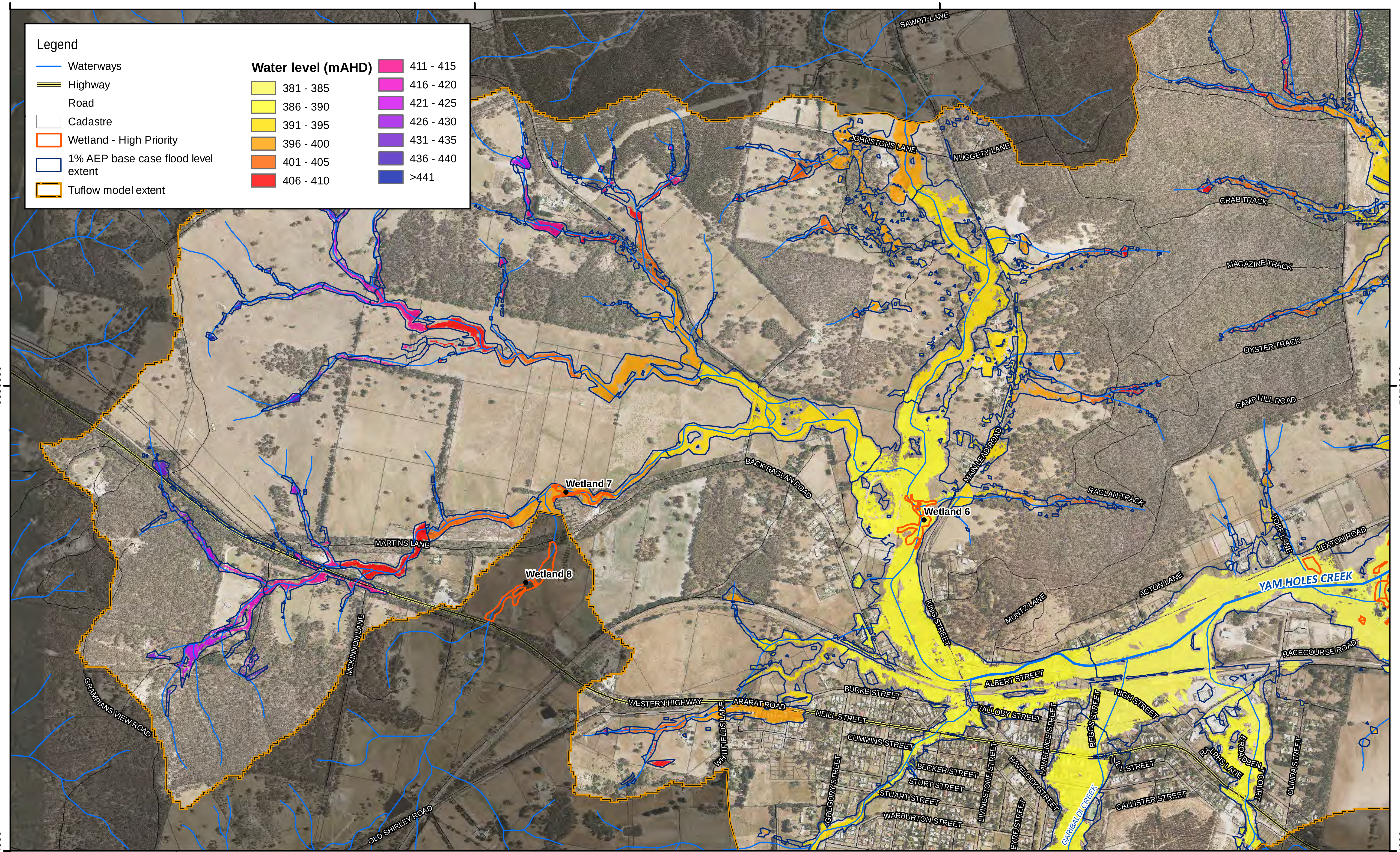

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Date: 6/08/2019	Approved by: -		
Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye,			Coordinate system: GDA 1994 MGA Zone 54 Scale ratio correct when printed at A3

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Beaufort Bypass EES Surface Water Assessment

Map 14.1

Existing Conditions

20% AEP (1 in 5 year ARI) base case flood level extent

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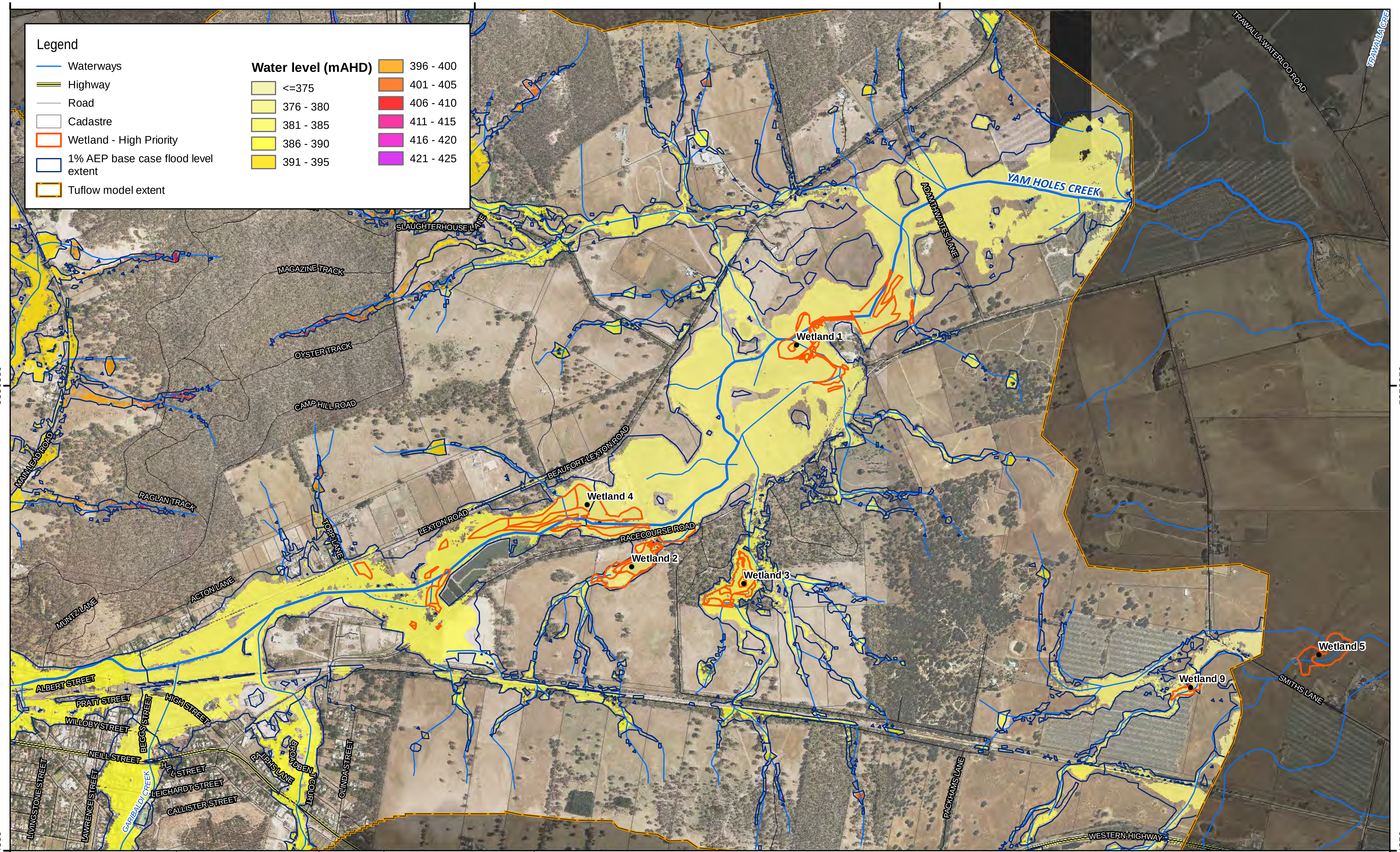

Map: 2270290A_GIS_123_A2	Author: VD/AS		0 150 300 m 1:15,000 Coordinate system: GDA 1994 MGA Zone 54 Scale ratio correct when printed at A3
Date: 6/08/2019	Approved by: -		

Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye.

Beaufort Bypass EES Surface Water Assessment
Map 14.2
Existing Conditions
20% AEP (1 in 5 year ARI) base case flood level extent

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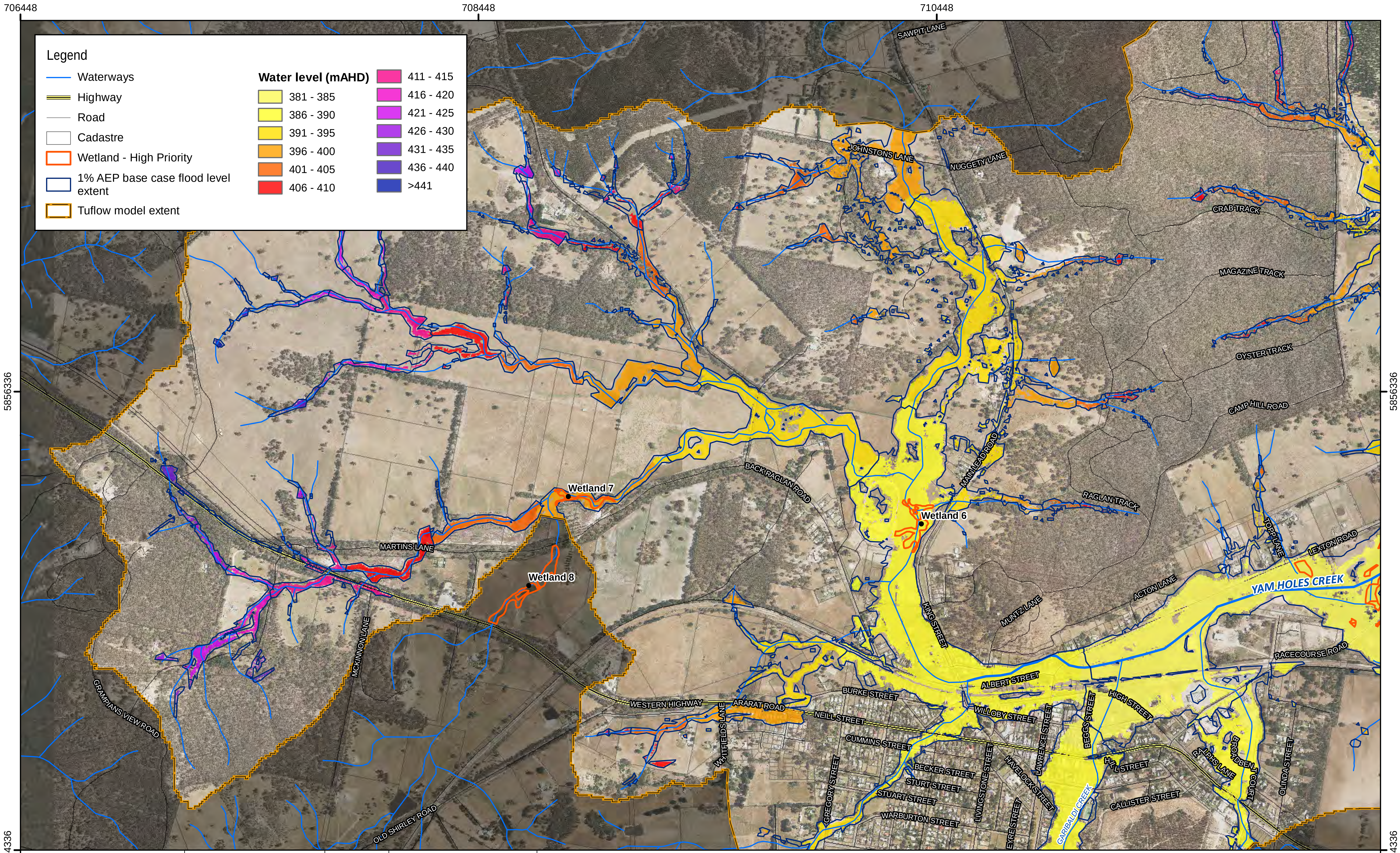

Map: 2270290A_GIS_124_A2

Author: VD/AS

Date: 6/08/2019

Approved by: -

Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye,

0 150 300 m

1:15,000

Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

Beaufort Bypass EES Surface Water Assessment
Map 15.1
Existing Conditions
10% AEP (1 in 10 year ARI) base case flood level extent

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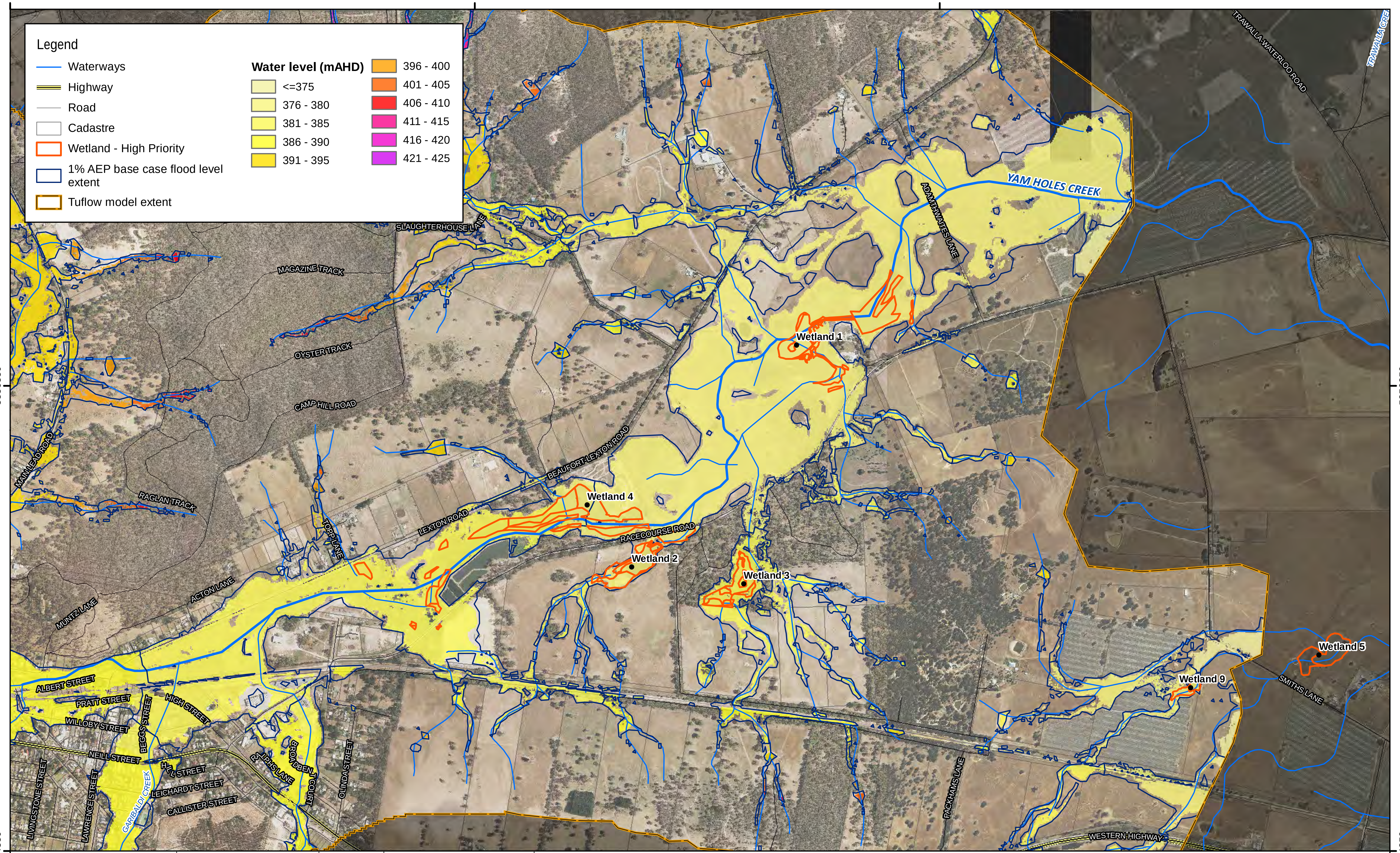

Map: 2270290A_GIS_124_A2	Author: VD/AS
Date: 6/08/2019	Approved by: -

Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye.

Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

Beaufort Bypass EES Surface Water Assessment
Map 15.2
Existing Conditions
10% AEP (1 in 10 year ARI) base case flood level extent

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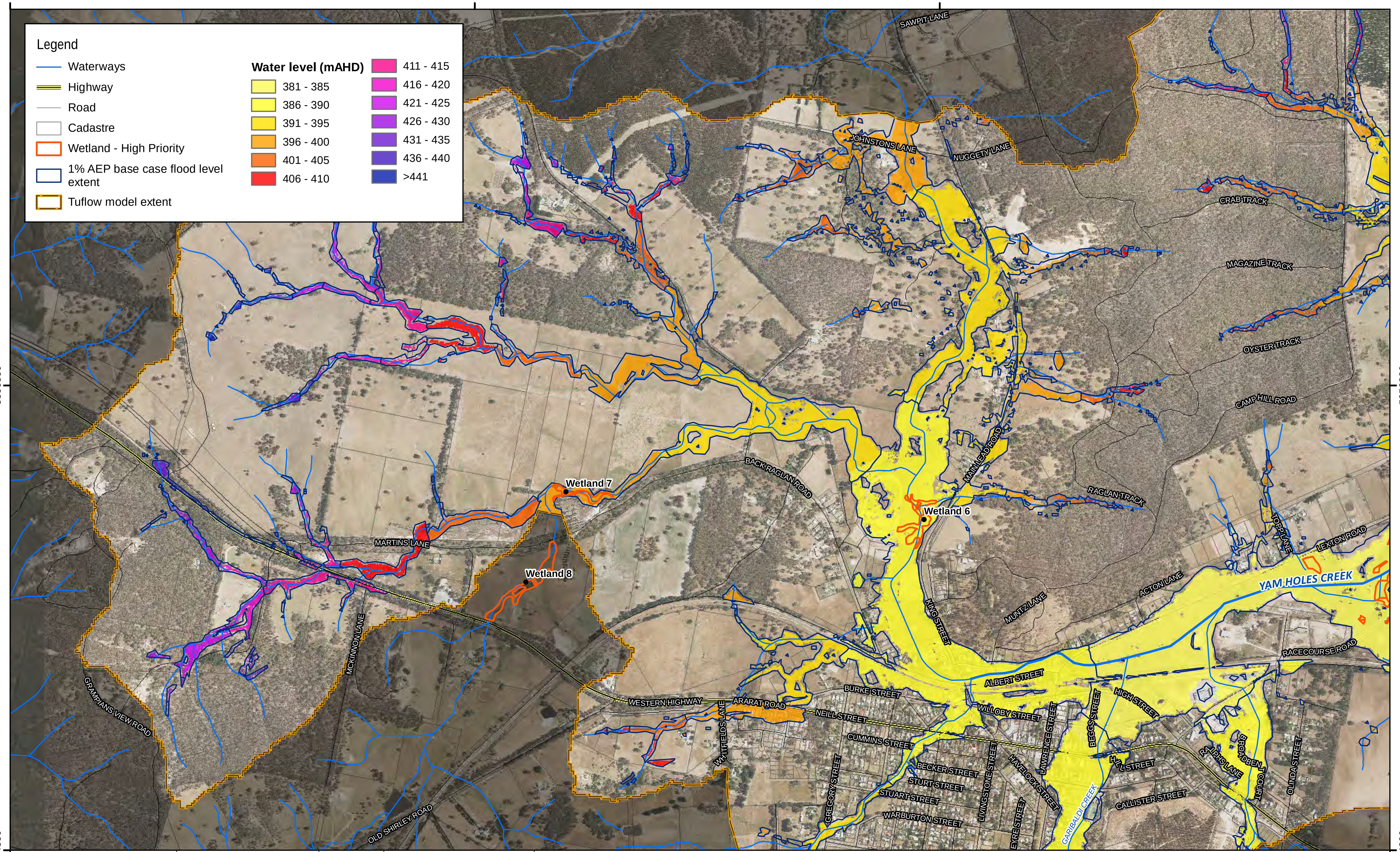

Map: 2270290A_GIS_125_A2 | Author: VD/AS

Date: 6/08/2019 | Approved by: -

Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye.

0 150 300 m

1:15,000

Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

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Beaufort Bypass EES Surface Water Assessment
Map 16.1
Existing Conditions
5% AEP (1 in 20 year ARI) base case flood level extent

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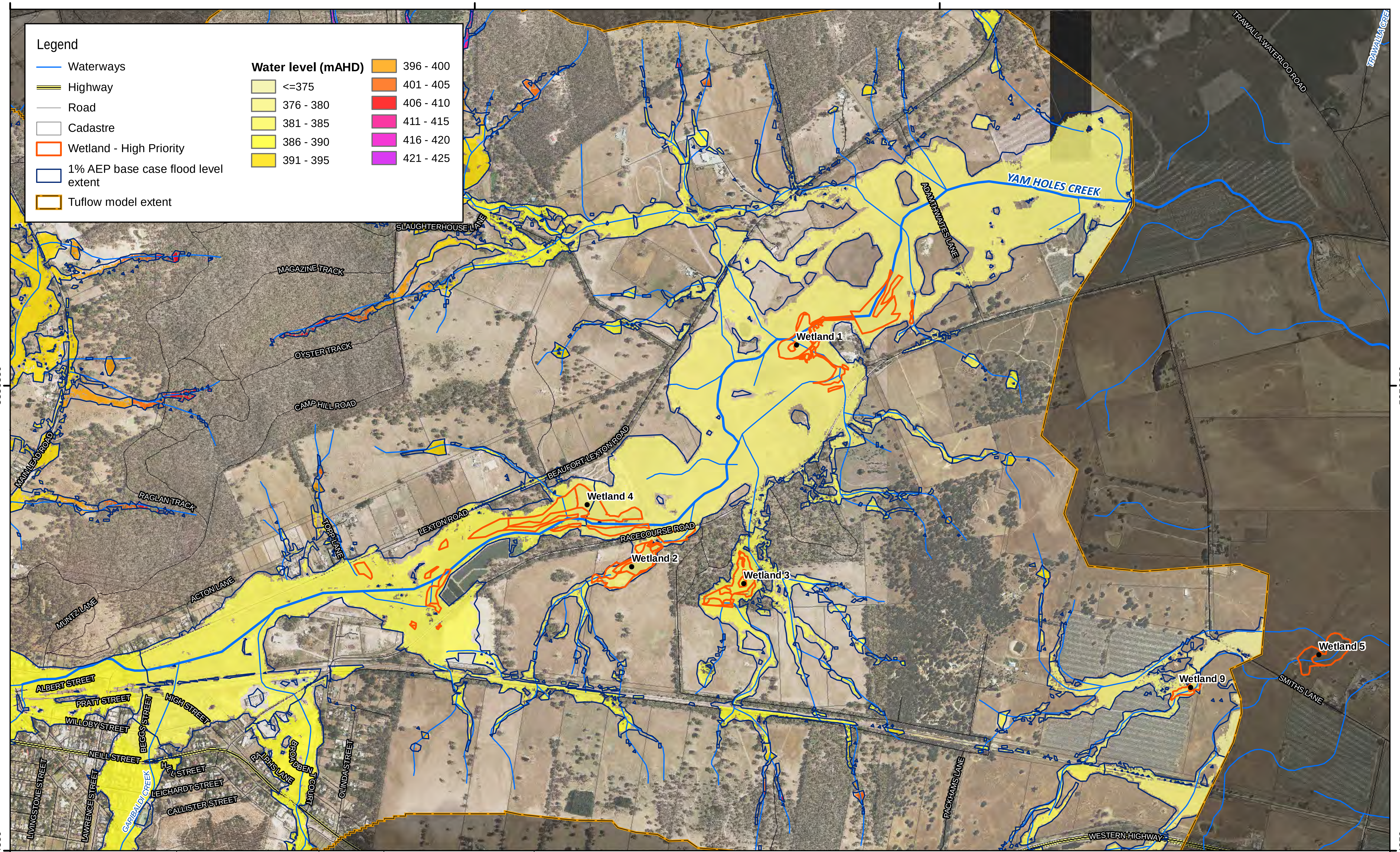

Map: 2270290A_GIS_125_A2	Author: VD/AS
Date: 6/08/2019	Approved by: -

Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye,

0 150 300 m

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Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

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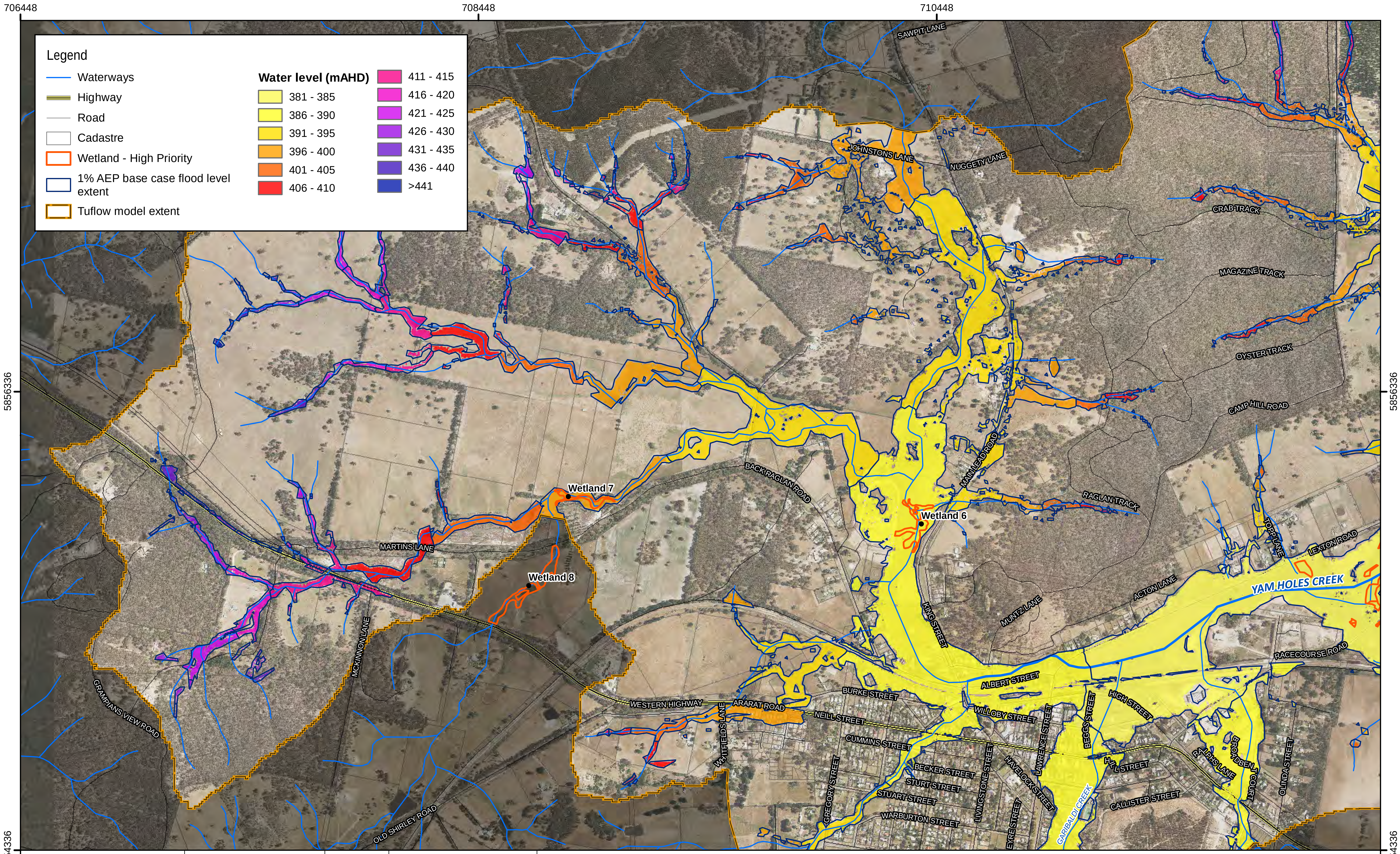
Beaufort Bypass EES Surface Water Assessment
Map 16.2
Existing Conditions
5% AEP (1 in 20 year ARI) base case flood level extent



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Date: 6/08/2019	Approved by: -

Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye,

0 150 300 m

1:15,000

Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

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Beaufort Bypass EES Surface Water Assessment
Map 17.1
Existing Conditions
2% AEP (1 in 50 year ARI) base case flood level extent

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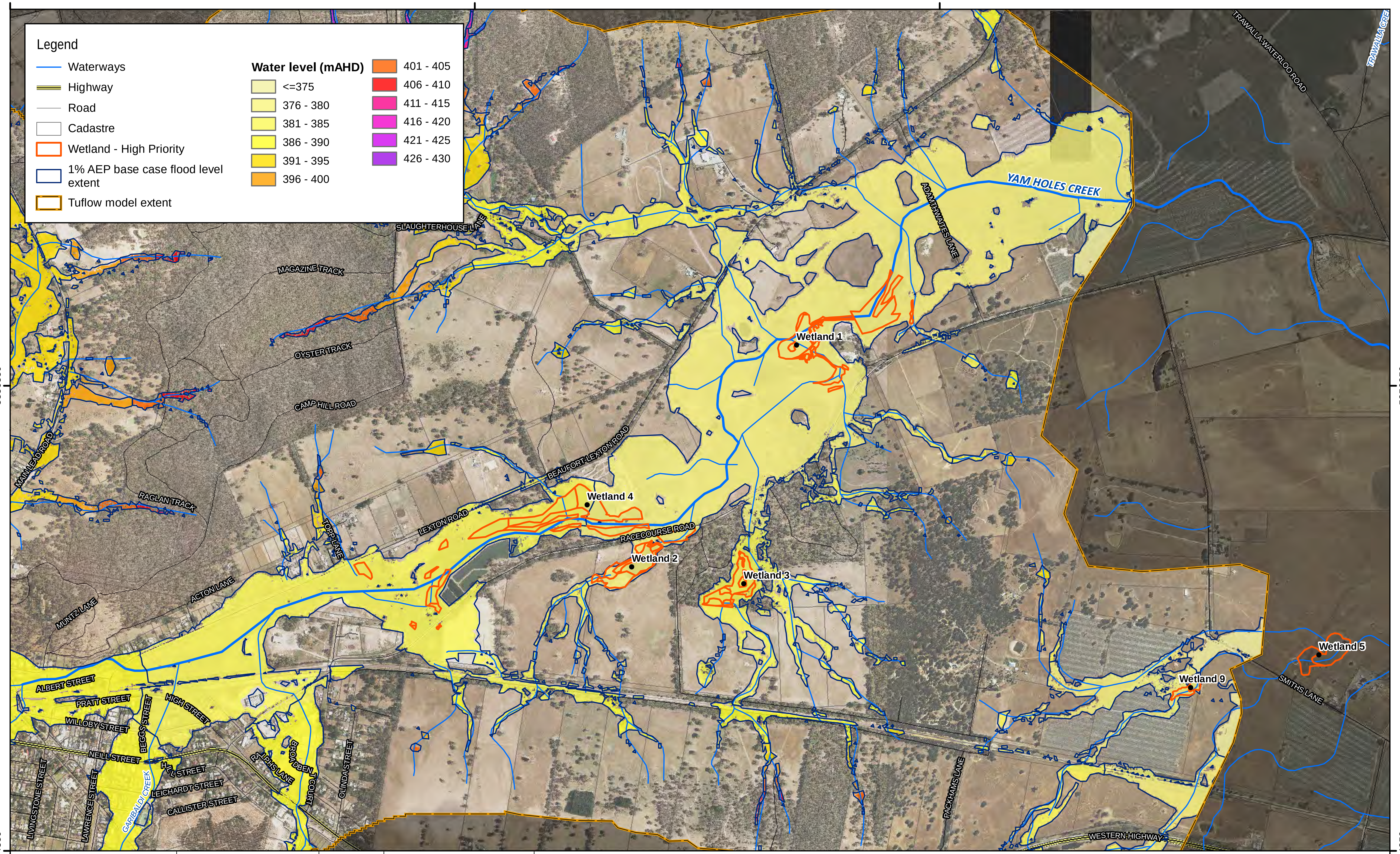


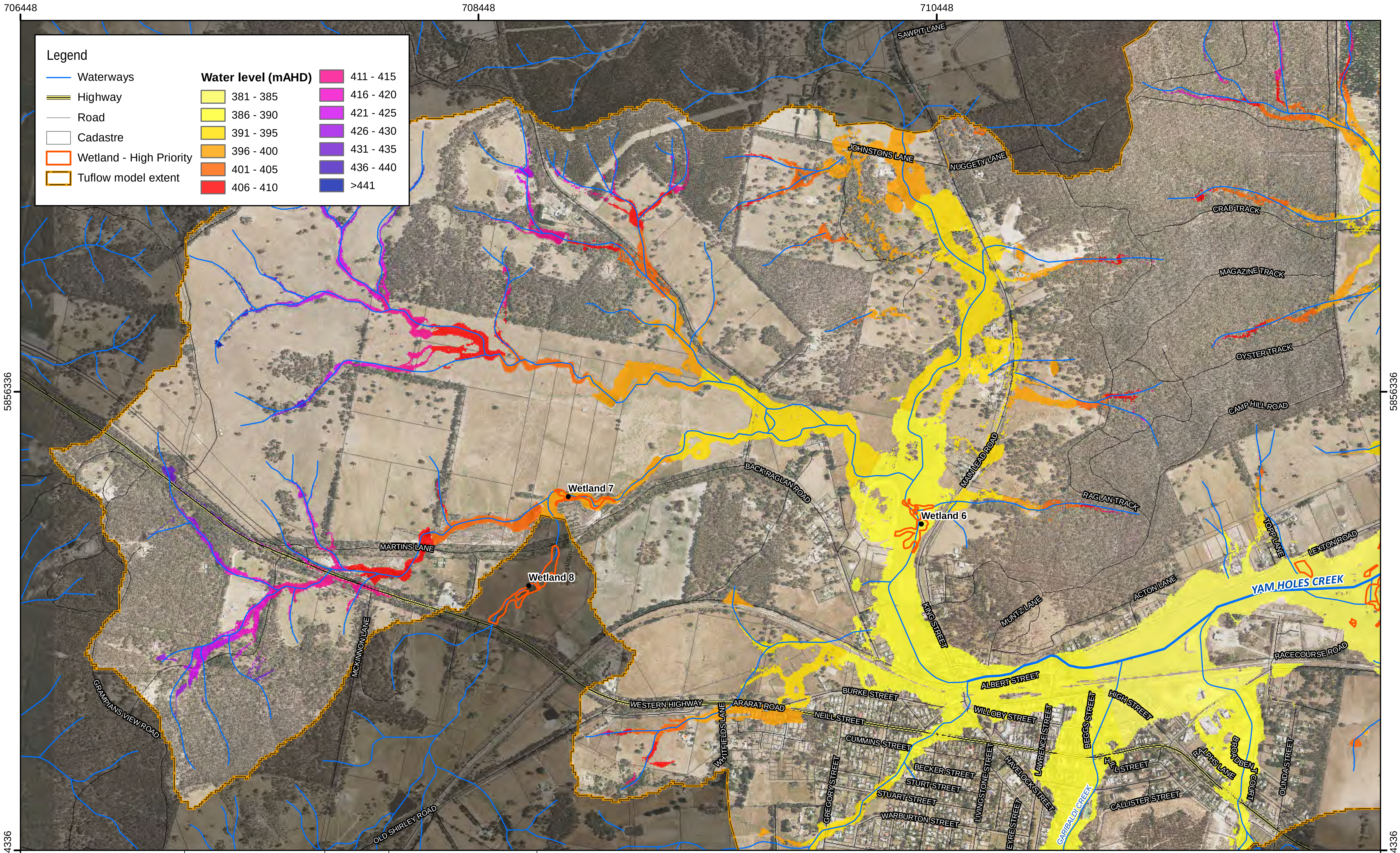
Map: 2270290A_GIS_126_A2	Author: VD/AS
Date: 6/08/2019	Approved by: -

Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye.

0 150 300 m
1:15,000

Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

Beaufort Bypass EES Surface Water Assessment
Map 17.2
Existing Conditions
2% AEP (1 in 50 year ARI) base case flood level extent



Map: 2270290A_GIS_127_A2	Author: VD/AS
Date: 6/08/2019	Approved by: -

Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye.

0 150 300 m
1:15,000

Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

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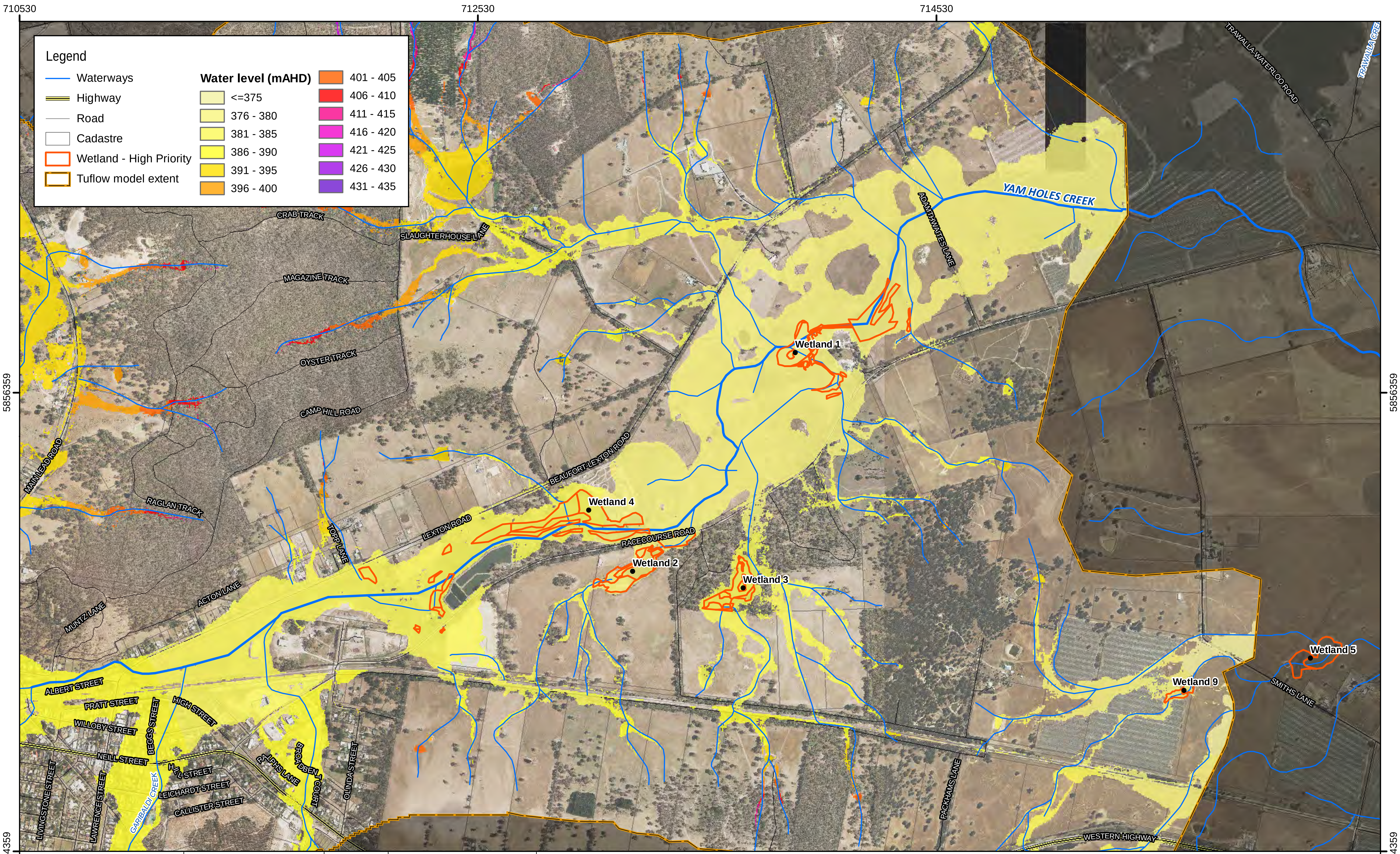
Beaufort Bypass EES Surface Water Assessment

Map 18.1

Existing Conditions

1% AEP (1 in 100 year ARI) Plus Climate Change base case flood level extent



Map: 2270290A_GIS_127_A2	Author: VD/AS	
Date: 6/08/2019	Approved by: -	

Data source: VicRoads, Trimble, ESRI, DigitalGlobe, GeoEye,

0 150 300 m

1:15,000

Coordinate system: GDA 1994 MGA Zone 54
Scale ratio correct when printed at A3

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Beaufort Bypass EES Surface Water Assessment
Map 18.2
Existing Conditions
1% AEP (1 in 100 year ARI) Plus Climate Change base case flood level extent