

Barwon River Urban Renewal Area Implementation Plan

Prepared for City of Greater Geelong

Image shows flooding of Landy fields and
Barwon Terrace, October 2022
(Photo source: from City of Greater Geelong)

Quality Assurance

Implementation Plan

Barwon River Urban Renewal Area

Prepared for

City of Greater Geelong

Project Number

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1 Introduction

1.1 Project Overview

The City of Greater Geelong (Council), in partnership with the Corangamite Catchment Management Authority (CCMA) has undertaken a scenario-based investigation into the development potential of land severely constrained by flooding from the Barwon River in South Geelong.

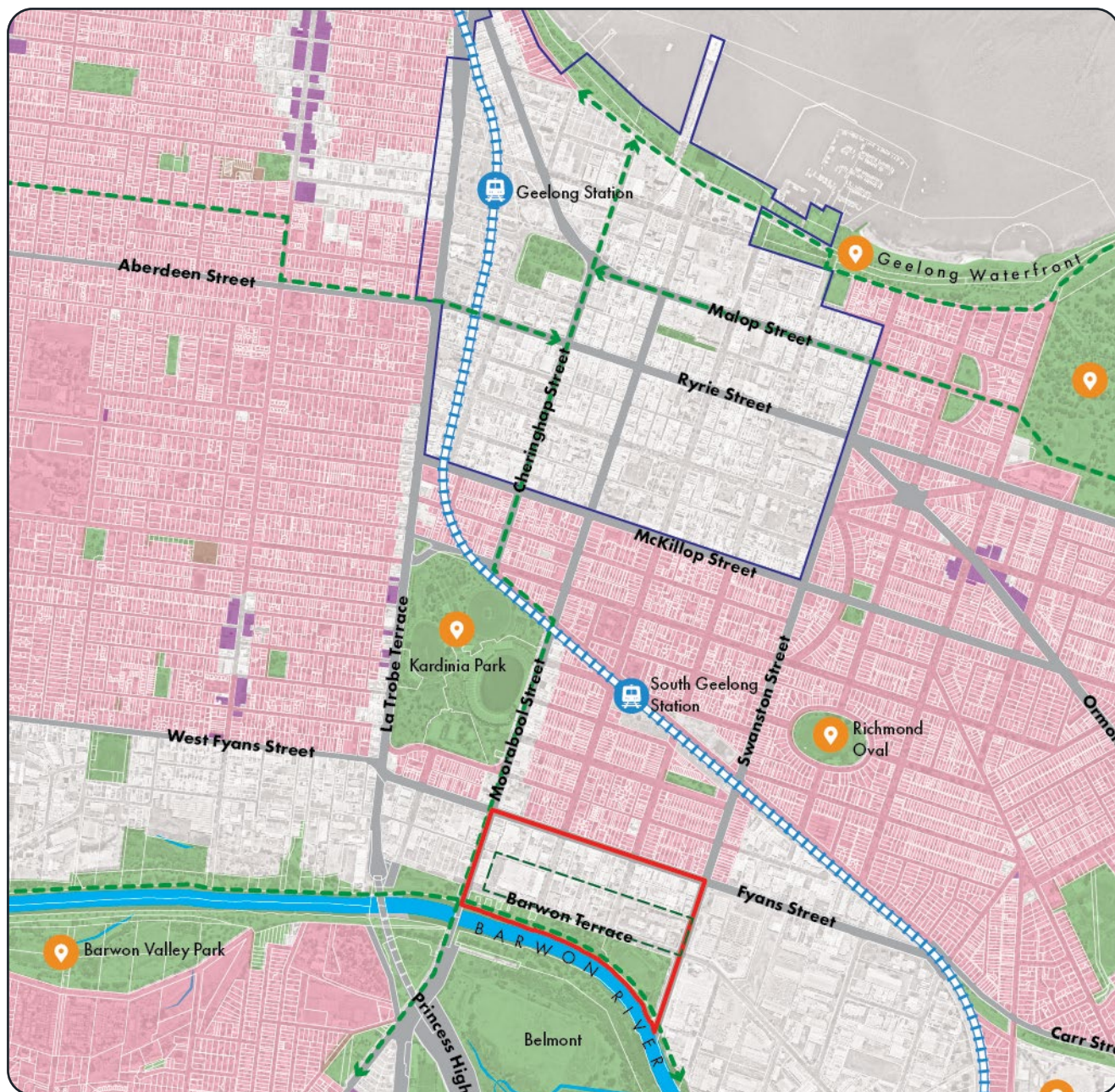
The land covered by the Fyans-West Fyans Structure Plan (2009) has seen minimal development since the adoption of the Structure Plan over a decade ago. In particular, the area east of Moorabool Street has seen limited development interest aligned with the proposed outcomes from the structure plan.

The purpose of this project is to prepare a suitable development outcome that responds to a flood strategy supported by the Council and CCMA whilst incentivising landowners to work collaboratively to undertake high-quality urban renewal.

A Background Report was prepared in 2021 assessing the study area for three different development scenarios. These scenarios are summarised in Section 2.2 of this document.

This Implementation Plan is designed to synthesise the outcomes from the Background Report, undertake a deeper dive into development feasibility and make recommendations about how planning controls can be modified to incentivise development to occur in a coordinated and well-planned manner.

This Implementation Plan will inform a review of the Fyans-West Fyans Street Precinct Structure Plan 2009.



Legend

	Study Area		Water Course
	Investigation Area		Central Geelong Boundary (Regional Retail Centre)
	Major Roads		Neighbourhood Retail Centre
	Train Line & Train Station		Residential Area
	Public Open Space		Destinations

Figure 1. Geelong Context Plan

1.2 Key Issues

Flooding & Developable land

Extensive flooding limitations to development means that consideration needs to be given to how development potential for the precinct can be facilitated including a holistic approach to floodplain management and collaborative development strategies amongst landowners in the precinct.

Height Limits and Setbacks

Height limits specified in the Structure Plan limit development to 2-5 stories, however based on the lack of development activity to date it appears that these heights either constrain viable development.

Active Frontages

There are challenges in achieving activated frontages to Barwon Terrace given that the Flood Overlay dictates that development must be significantly setback from the road.

Vehicle Access

Significant depth of flooding prevents access to some properties fronting Barwon Terrace during a flood event. There is a need to consider how consolidated access from Little Fyans Street can be encouraged to create flood resilient development.



Figure 2. Extensive Flooding of Landy fields and Barwon Terrace, October 2022 (Photo source: from City of Greater Geelong)

1.3 Key Opportunities

Access & Movement

- Potential to resolve pedestrian access and connectivity issues along Barwon Terrace.
- Potential to slow the speed of vehicle movements across and through the study area.
- Potential to increase car parking capacity/bus waiting areas for rowing/athletics events.

Developable land

- Potential to maximise developable land through collaborative development strategies amongst landowners in the precinct to create larger sites and better facilitate development.

Built Form

- Provide a high-quality mixed use, residential, retail, and commercial offering in a unique location, proximate to the CBD.
- Potential to increase development height limits to respond to land lost for flood storage.
- Formulate clear guidance for street wall heights and setbacks for built form above the street wall, to ensure a good streetscape outcome.
- Potential to use the natural topography to create a unique, site responsive development that supports views to the Barwon River.

Land Use & Open Space

- Create a distinct open space interface between future development and Barwon Terrace, adjacent to the Barwon River environs.
- Potential uses for the set back open space between future development and Barwon Terrace must be temporary and not contain permanent builtform due to flooding risk. These may include uses such as:
 - alfresco dining areas associated with hospitality uses.
 - landscaped open space,
 - shared path connection adjacent to Barwon River.

2 What Has Informed This Implementation Plan?

2.1 Background Studies

Background technical studies including consideration of:

- Review of relevant State and Local legislation, strategies and planning policies that inform, govern or influence infrastructure provision.
- Detailed analysis of the strategic and on-the-ground context of the study area.
- Technical studies focusing on traffic and flood impact to determine what upgrades or improvements may be necessary to support desired development outcomes.
- Background research focusing on urban design, open space and landscape.

2.2 Development Scenarios

Critical to any development on the sites is an understanding of the Flood Overlay (FO) and Land Subject to Inundation Overlay (LSIO) and how they affect the land.

Water Technology tested development scenarios (refer to Appendix) based on landform manipulation that corresponds to flood water storage requirements. The three preliminary scenarios were scored against the below categories:

- Movement and Access
- Cut and Fill
- Streetscape/Landscape
- Built Form, and
- Land Use

Preliminary Scenario 01

considered the current/proposed flood controls as the basis on which to assess development potential.

Preliminary Scenario 02

speculatively considered that all flooding issues could be managed off-site, and considered the entire sites as developable.

Preliminary Scenario 03 managed all flood water on-site through a cut and fill outcome which maintained the storage requirement but considered what development yield changes would need to occur to offset the loss in developable land.

2.3 Stakeholder Consultation

Stakeholder consultation was undertaken with Council, CCMA, as well as landowners.

At the conclusion of this work it was agreed that Preliminary Scenario 03 was the preferred option to be explored further.

The reasons for discounting Preliminary Scenarios 01 and 02 are as follows:

Preliminary Scenario 01

Adoption of Scenario 1 would largely be adopting the status quo and would potentially miss the benefits that can come from encouraging a more coordinated approach to the delivery of development within the study area.

Preliminary Scenario 02

Scenario 2 was confirmed to be unviable by the CCMA given it would displace flood water from within the study area to other nearby private properties or worsen flood conditions on the surrounding road network.

Preliminary Scenario 03

Preliminary Scenario 03 investigated development for the land involving a staged approach to cut and fill to facilitate development of the Study Area whilst also addressing flood storage and volume on site.



Legend

	Study Area		Ownership
	Investigation Area		Crown Land*
	50cm Contours		Development Area
	Proposed LSIO - Land Subject To Inundation Overlay (safe for vehicle)		* Managed by land owner &
	Proposed FO - Flood Overlay (unsafe for vehicle)		

Figure 3. Preliminary Scenario 3 Development Extent

2.4 Preferred Scenario

The proposed development outcome is based on a coarse flooding assessment by Water Technology, which has evaluated the appropriate areas of cut and fill that can be manipulated without having a detrimental impact on existing flood storage.

The outcome of this modelling supported the staged approach to landform manipulation, allowing smaller portions of the study area to develop ahead of other properties, whilst maximising the potential developable footprint.

It also demonstrated the benefit of parcel consolidation between Yarra and Bellerine Streets given the severity of flood constraints along Barwon Terrace which prevent the safe provision of vehicle access.

Land consolidation facilitates activation of the properties fronting Barwon Terrace by utilising Yarra, Bellerine or Little Fyans Streets for safe vehicle access. Consolidation of land and a coordinated approach to cut/fill to create more development friendly footprints in the north of Module 2 are also crucial to achieve maximised outcomes for all land owners.

It is noted that Properties 1 & 7 in Module 2 have limited development potential under the preferred scenario however this is an improved outcome compared to the current scenario whereby Property 1 has no development potential and Property 7 has an existing building that is at risk from flood events.

2.5 Capacity Study

Scenarios

The development model identifies 3 'modules' for development to indicate the different land parcel blocks being delivered.

This includes:

- Module 1: Western
- Module 2: Central
- Module 3: Eastern

The scenarios assume that the development would be delivered based on property ownership.

- Module 2 lots 4&7 are under one ownership and therefore expected to be delivered together.
- Module 2 lot 6 is also expected to be delivered with the crown land to allow for the highest and best use of the site.

General Assumptions

For the purposes of testing the following best use assumptions where made to guide the built form:

- Residential towers - 20m deep footprint to allow for double loaded central access corridor layout.
- Minimum 9m width between above podium towers.
- Office/Commercial - 10m deep footprint wrapped around podium level parking.
- Where built form above podium does not provide efficient residential footprints, it is assumed that this will provide for commercial uses.

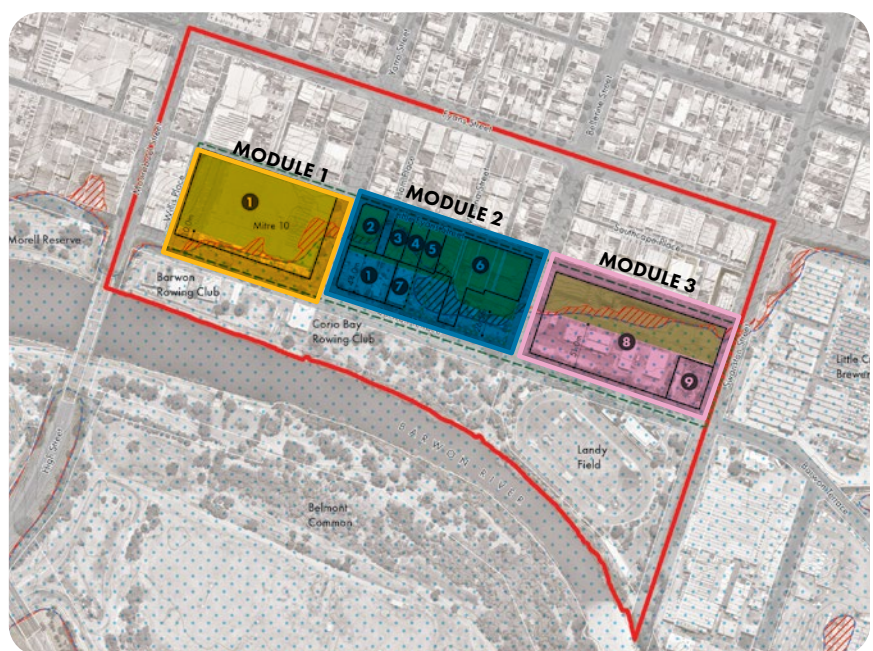


Figure 4. Precinct Modules used for Capacity Study

Scenario 1 — Base Case

Scenario 1 is tested as a 'base case' development outcome on the basis of maximum building height achievable under the current Design and Development Overlay – Schedule 26 (DDO26).

Assumptions

Scenario 1 specifically assumes:

- 5-storey built form:
 - 3-storey podium
 - 2-storey upper levels
- 80/20 split for residential/commercial uses
- 80% delivery of statutory car parking requirements for
 - Modules 1 (Western)
 - Module 2 (Central)

Two development options were tested for Module 3 (Eastern):

1. mixed-use residential
2. light industrial and office

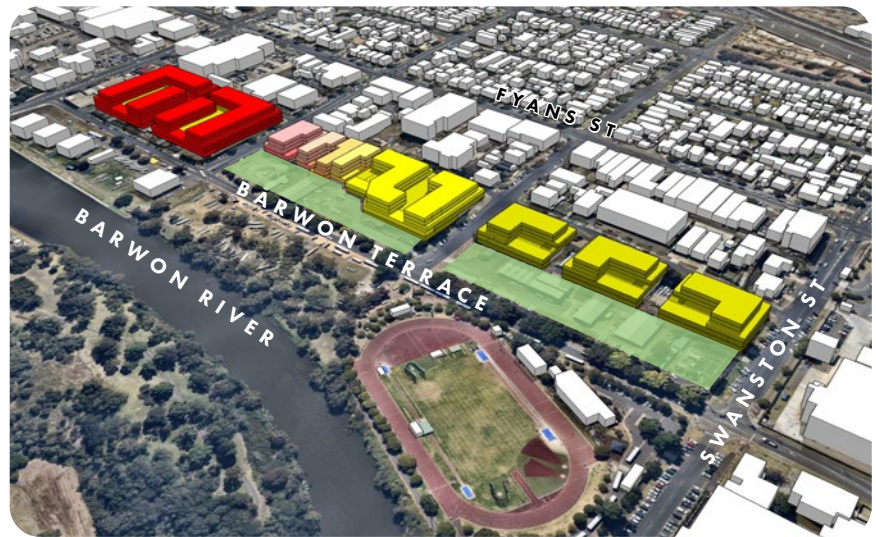


Figure 5. Base case - North-western view



Scenario 2 — Base Case+

On the basis that Scenario 1 may not be viable for all parcels, a second variant, Scenario 2 was tested as a modified 'base case +' scenario. This scenario explored opportunities to increase viability beyond the current constraints of DDO26.

Scenario 2 assumes the same land use split, car parking delivery and development options tested for Module 3 but envisages an increased height of 7-storey built form, made up of:

- 3-storey podium
- 4-storey upper levels

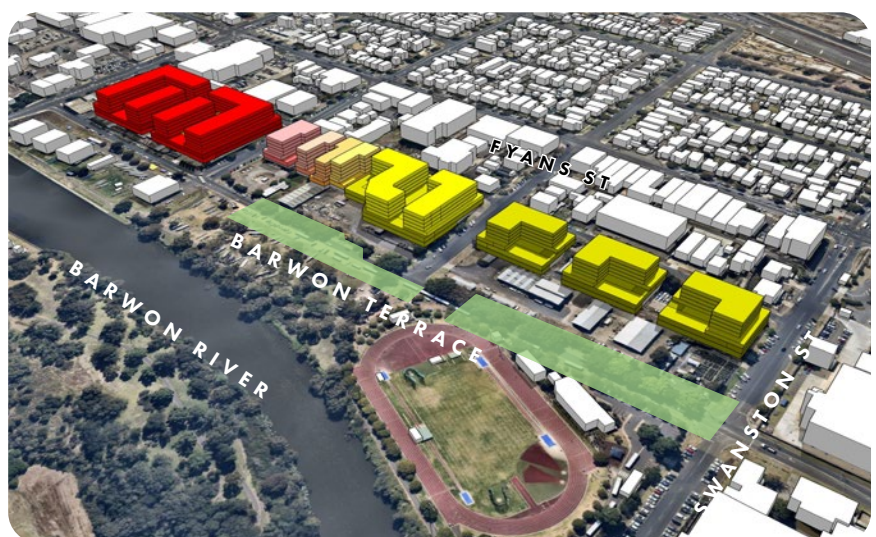


Figure 6. Base case+ - North-western view

Option Testing — Eastern Site

The Study also tests the different building heights (Base Case and Base Case +) for yield outcomes, as well as different land uses within the eastern block, which indicates potential rezoning.

The option testing for the Eastern module looks at options for:

1. Mixed-use residential
2. Light industrial and office

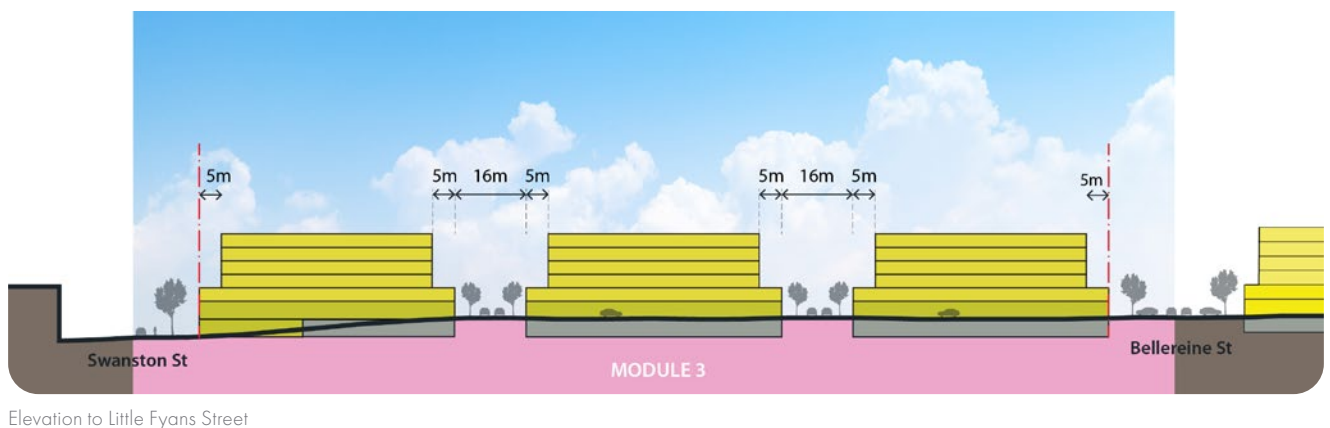
The models tested exhibit a variation in built form in order to maximise development potential for the differing uses.

Option 1 — Mixed Use & Residential

Under this option, Module 3 was modelled to facilitate a mixed use development higher residential yield with an additional street to facilitate extra street-facing built-form.



Figure 7. Option 1 - Mixed Use Residential

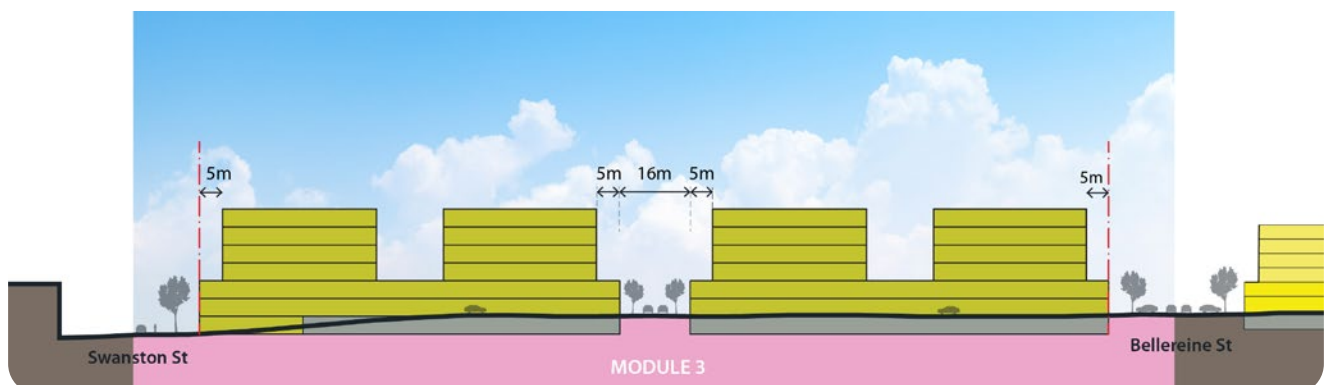


Option 2 — Light Industrial & Office

Under this option, Module 3 has reduced breaks in the built-form and one less access street. This takes advantage of the larger permissible floor plates and facilitates a greater parking capacity to meet the requirements of the commercial/ industrial uses.



Figure 8. Option 2 - Light Industrial & Office



Elevation to Little Pyans Street

2.6 Builtform Directions

In order to provide a clear long-term vision for the precinct, the development potential of the land parcels in the 3D Development Capacity Study was fully tested.

The Study tested options for the maximum potential yield and examined best case scenarios for movement and access, built form and setbacks, and land use.

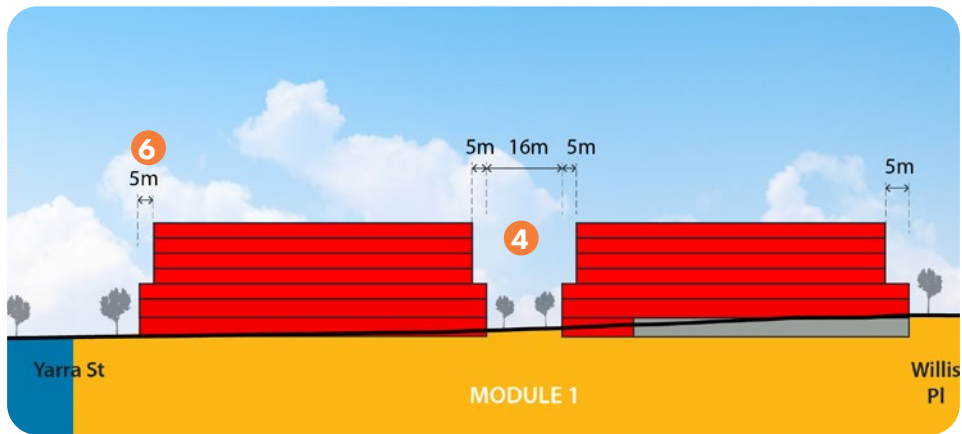
The Study has provided general built-form directions including:

- 1 3-storey podium addressing the riverside open space (undevelopable space),
- 2 3-storey podium from Swanston Street, Bellerine Street and Yarra Street, in part where there is a steep drop in the landform.
- 3 2-storey street wall from Little Fyans Street.
- 4 16m building gaps to break up built forms on Module 1 and Module 3, potential for internal road/laneway/open space.
- 5 6m building gaps between Site 3 and 4, as well as site 5 and 6 for light, amenities and mid-block connections. This means 3m setbacks from one side boundary on Site 3,4, 5, and 6.
- 6 5m upper-level setback from Little Fyans Street, Swanston Street, Bellerine Street, Yarra Street and Willis Place.
- 7 3m upper-level setback from Barwon Terrace.

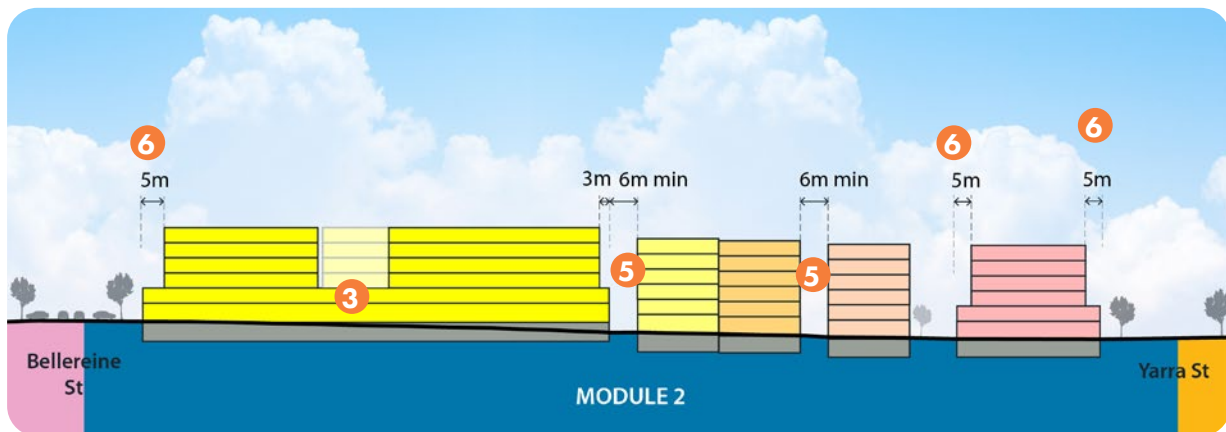
The Study also tested different building heights (Base Case and Base Case +) for yield outcomes, as well as different land uses within the eastern block, which indicates potential rezoning.



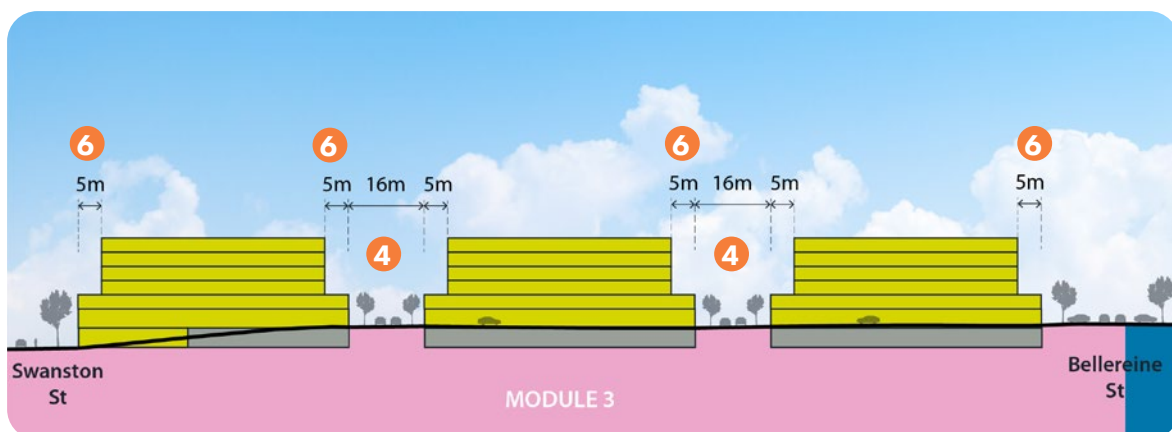
Figure 9. Base case - Plan



Module 1: Western



Module 2: Central



Module 3: Eastern

Figure 10. Massing elevation from Little Fyans Street

2.7 Conditions of Development

Further to the Builtform Guidelines outlined in section 2.6 that have been developed as part of the study, additional guidance is given below with regard to future development in the study area.

These conditions are based on direction from the CCMA.

Residential

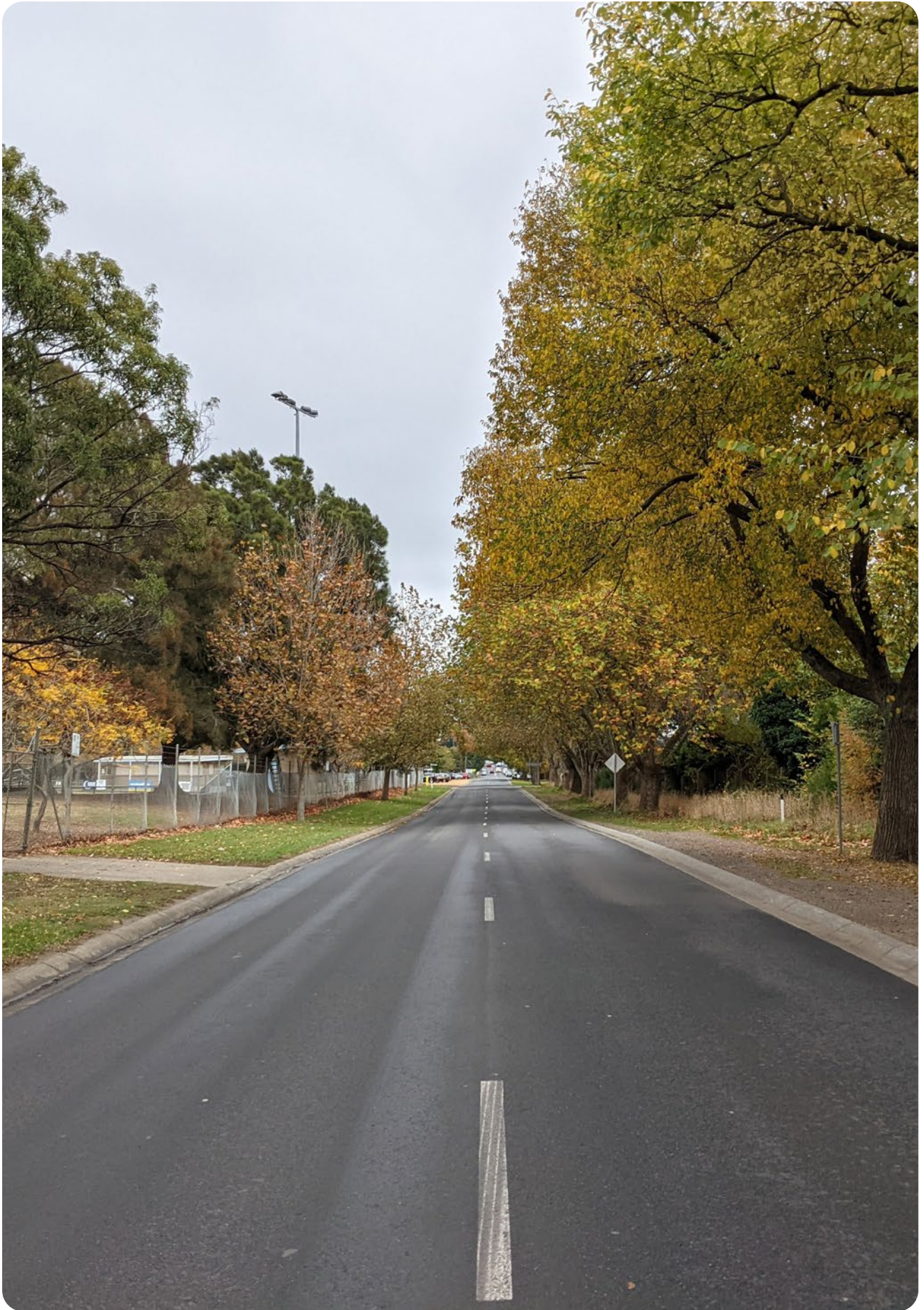
All residential buildings must meet the following minimum conditions:

- No residential buildings are to be constructed within the Floodway Overlay as defined by the new mapping associated with amendment C339 (i.e., only within the LSIO).
- The finished floor level of any residential buildings must be constructed no lower than 300 mm above the 1% AEP flood level.
- New residential buildings and carparks provided for residential purposes must have safe egress/ access routes meeting the applicable flood hazard safety criteria during a 1% AEP flood event to flood free land where emergency facilities are located.
- Any development within the floodplain must be designed to ensure a philosophy of 'zero adverse impacts' to surrounding areas for all flood events up to and including the 1% AEP event, including flood flow and flood storage.

Commercial, Retail and Non-Residential Buildings

The Authority notes that existing building footprints are located in areas of the floodplain identified as floodway overlay. The Authority would strongly discourage buildings in the flood overlay and strongly encourage buildings at the northern end of the precincts, with cut and fill balance used to maximise development footprints in the north. The Authority would accept development if the following minimum conditions are met:

- Development must not be constructed within areas of the pre-developed 1% AEP floodplain greater than 1 metre deep.
- The finished floor level of any development must be constructed no lower than the nominal flood protection level (i.e., a minimum of 300 mm above the 1% AEP flood level).
- Any car parking for commercial or retail purposes must not be constructed within areas of the floodplain greater than 1 metre deep.
- Existing buildings are to be demolished prior to works commencing on any new development in accordance with this Implementation Plan.



3 Development Viability Assessment

3.1 Overview

To ensure this Implementation Plan is responsive to the economic reality of development delivery, a preliminary financial assessment was undertaken by Urban Enterprise to confirm viability.

The financial analysis was undertaken on the basis of the two key development scenarios outlined previously and three development 'modules' based on the existing street blocks. This includes:

- Module 1 - Western,
- Module 2 - Central and
- Module 3 - Eastern

which comprise allotments in various ownership configurations.

The analysis assumes that development would be delivered by a profit-seeking developer/investor, and in accordance with existing ownership structures. For example Module 2 - lots 4 and 7 are in joint ownership and will be delivered concurrently).

3.2 Methodology & Assumptions

Urban Enterprise has specifically utilised a residual land value (RLV) analysis which is a valuation method commonly relied upon by developers to determine the viability of a development.

Calculating the RLV

The RLV is calculated by estimating the total revenue from the development of the land, and then subtracting all costs associated with the development, including an allowance for profit and risk but excluding the cost of the land.

$$\begin{array}{rcl} \text{Total} & & \text{Residual} \\ \text{Development} & - & \text{Land Value} \\ \text{Revenue} & & \text{(RLV)} \\ & - & \\ & \text{Development} & \\ & \text{Costs} & \\ & \text{(inc profit \& risk)} & \end{array} =$$

The amount left over is the RLV, or a final amount the developer is able to pay for the land given the assumed value of the development, projects costs and required profit and risk allowance. Projects which demonstrate a higher RLV than the Capital Improved Value (CIV) of the land are considered viable developments.

Assumptions

The financial analysis is subject to a set of high-level assumptions which are set out in detail throughout section 1.4.1 and Appendix A of the accompanying Memo. These assumptions include financial considerations, development costs and estimated income.

3.3 Financial Viability Analysis



Base case - SE View

Scenario 1 — Base Case

The RLV analysis for Scenario 1 demonstrates a positive outcome and project viability for only four of seven developable parcels:

- Module 1
 - Lot 1
- Module 2
 - Lot 2
 - Lot 6 (including Crown land)
- Module 3
 - Lot 8 (for mixed-use residential outcome)

Conversely, the light industrial and office option for Module 3 yields a negative outcome which significantly reduces the viability. This was attributed to the low selling price for industrial properties within South Geelong and current high construction prices.

3.4 Conclusion



Base case+ - SE View Showing extra storeys

Scenario 2 — Base Case+

Under these conditions, the RLV analysis demonstrates a positive outcome for the majority of the developable parcels, with six of the seven lots demonstrating project viability.

It is noted that the RLV of Lot 4 & 7 is circa \$16,000 less than the CIV which suggests that if efficiencies in the assumed development proposal could be achieved that a viable development could be undertaken.

Module 3 Options 1 & 2

The light industrial and office option for Module 3 continues to yield a negative outcome for the same reasons explained under Scenario 1.

Under both Scenario 1 (Base Case) and Scenario 2 (Base Case+), the financial analysis indicates Lots 1, 2, 6 and 8 (mixed use option) are all viable urban renewal projects that would be expected to be delivered by a profit-seeking developer.

The increased height uplift tested under Scenario 2 provides an improved viability outcome and allows for Lots 3 and 5 to be considered a feasible development option.

In both scenarios, Lots 4, 7 and 8 (light industrial and office options) are considered unviable. The light industrial and office option for Module 3 is considered unfeasible due to the lack of sale revenue to cover current construction.

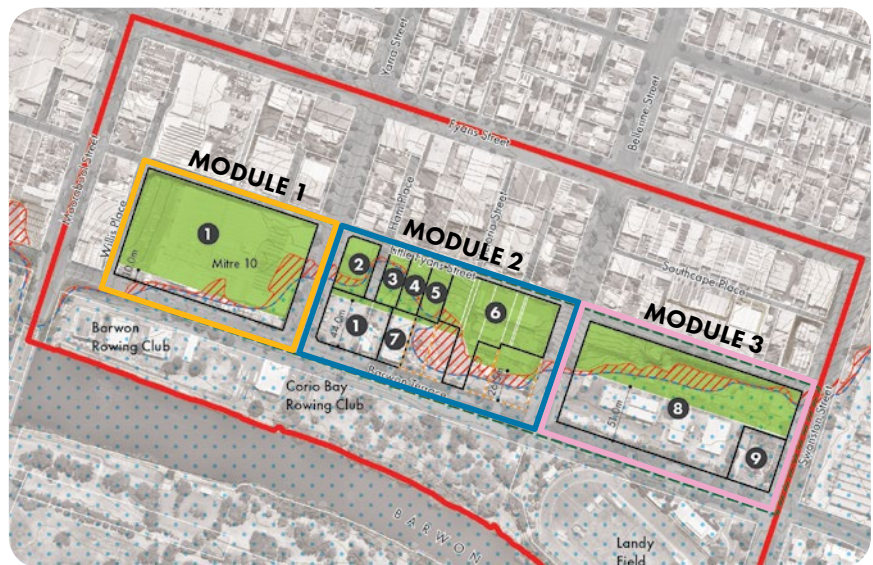


Figure 11. Precinct Modules

4 Planning Scheme Amendment Recommendations

4.1 Overview

As demonstrated by the preceding sections of this report, this investigation has produced a development scenario for the urban renewal of the precinct that responds to existing strategic direction and key site constraints, including significant flood hazard. In order to achieve commercially viable development prospects, the accompanying financial analysis tested a 'Base Case +' scenario which supports increased building height beyond current approvable maximum limits to compensate for net developable area lost to flood constraints.

Accordingly, this section of the report considers the necessity for changes to the current planning policies and controls impacting the Study Area to facilitate development outcomes tested under the 'Base case +' Scenario.

4.2 Zone

The Study Area currently consists of the Mixed Use Zone (MUZ) which applies to Module 1 - Western and Module 2 - Central and the Industrial 3 Zone (IN3Z) which applies to Module 3 - Eastern.

Broadly speaking, the MUZ facilitates mixed-use development outcomes at higher densities that are responsive to existing or preferred neighbourhood character attributes.

Notably, the existing MUZ controls do not invoke a maximum building height requirement in the schedule, nor have localised objectives. Therefore, the retention of this standard MUZ provision over Modules 1 and 2 provides sufficient scope to deliver increased building height to ensure viability for future urban renewal.

The IN3Z is broadly supportive of light industry and associated uses that provide a buffer between more intensive industrial activities and local

communities. The use of land for residential or other sensitive purposes are prohibited under the IN3Z or highly constrained and therefore does not facilitate genuine mixed-use development outcomes.

Whilst supportable under the IN3Z, it is noted the Urban Enterprise financial analysis determined that a light industrial and office development outcome on land within Module 3 - Eastern would not be economically viable.

Given the current IN3Z zoning is unlikely to facilitate commercially viable development opportunities within Module 3, secondary strategic work should be undertaken by the Council to determine the most appropriate zoning in order to activate the land as part of the broader urban renewal precinct whilst considering adjoining and surrounding land uses and potential associated impacts on encroaching sensitive land uses.

4.3 Design & Development Overlay

The Study Area is currently subject to the Design and Development Overlay – Schedule 26 (DDO26) which applies to Module 1- Western and Module 2 - Central and the Schedule 20 (DDO20) which applies to Module 3 - Eastern.

Generally speaking, the Design and Development Overlay (DDO) is principally intended to implement requirements based on a demonstrated need to control built form and the built environment. The intended built form outcome must be clearly stated, and must demonstrate the way in which the imposed requirements will bring this about. Where possible, performance-based requirements should be used rather than prescriptive requirements.

Based on the analysis conducted, it is clear that built form outcomes need to be refined for the Study Area to encourage innovative urban renewal while also strongly discouraging at-grade car parking and removing built form from the southern interface to mitigate flooding risks.

DDO26 relates to the 'West Fyans-Fyans Street Precinct Structure Plan Area' and generally sets out design objectives that encourage contemporary, adaptable design and built form outcomes that are sympathetic to the Barwon River corridor, topography, heritage sites and public realm interfaces. Consideration is also given to the further fragmentation of land which may inhibit the ability to deliver coordinated development outcomes.

While the existing design objectives set out in Clause 1.0 of DDO26 remain sufficiently broad to achieve the urban design ambitions for the Study Area, it is suggested that the Study Area is unique in the context of such a large precinct that a new specific DDO is warranted.

It is recommended that the existing buildings and works requirements set out in Clause 2.0 and Table 1 of DDO26 be retained in the new DDO Schedule. The sub-headings utilised across Clause 2.0 remain highly relevant and should be retained for consistency purposes. Under these sub-headings, the following changes and/or additions are recommended to further align the buildings and works requirements with the overarching design objectives:

Design and Built Form

- Redraft the first bullet point to require a high level of articulation and visual interest for all buildings, while also encouraging high density built form outcomes generally consistent with the preferred maximum building heights.
- Build in scope to allow for exceeding preferred height limits where there is a demonstrated commitment to design excellence and environmentally sustainable design.
- Provide further direction to encourage highly permeable fencing, where fencing is required.

Car Parking and Vehicle Access

- Redraft the fourth bullet point to remove the directive for vehicle access to locations other than Little Fyans Street, or Yarra and Bellarine Streets where flood impacts are less severe.
- Provide stronger emphasis on car parking within basement levels that are accessed from the northern side of the Study Area.
- Provide equally strong discouragement of at-grade car parking in the flood-prone areas of the Study Area.

Traffic and Pedestrian Movements

- Provide specific reference to Little Fyans Street for vehicle access, with Yarra and Bellarine Streets as secondary options where flood impacts are less severe.
- Encourage a shared path and open space connection along with the southern interface adjacent to the Barwon Terrace to account for flood-impacted areas.

Public Spaces

- Provide further direction to ensure public spaces are designed to withstand flood hazard.

Table 1

Consider amalgamating Precincts 6 and 7 to provide consistency across the Study Area, noting that Precinct 6 does not currently specify design objectives, preferred building height and preferred setback and landscaping.

Additionally, we suggest the following updates to Table 1:

Design objectives

- Ensure the third point does not place undue emphasis on the existing amenity of surrounding properties, having regard to the high-density aspirations for the Study Area.
- Emphasise the need to consider flood hazards and develop innovative mitigation measures in order to deliver context-responsive, high-density built form.
- Encourage collaborative outcomes between landowners to consolidate development sites and ensure vehicular access can be achieved via Little Fyans Street, or Yarra and Bellarine Streets.
- Encourage adaptive reuse of larger format industrial buildings within flood extents.

Preferred building height

- Encourage built form between 5 and 7 storeys, and provide performance-based requirements, rather than a prescriptive requirement for height.

Preferred setback and landscaping

- Provide emphasis on setbacks derived from flood hazards and pedestrianised activation and open space interventions that are able to withstand flood risk.
- Include direction to exclude at-grade car parking and vehicular access within setback to Barwon Terrace.

Map 1

Update the Access and Amenity Improvement Plan to include the Little Fyans vehicle access and the shared path/open space connection sought adjacent to the Barwon Terrace interface. Where Precincts 6 and 7 are amalgamated, include a new map to differentiate between each Module.

DDO20 relates to 'Industrial 1, 2 and 3 Zones' and broadly seeks to improve the visual appearance and amenity for industrial areas, while also mitigating negative off-site impacts and promoting best practice stormwater quality.

Should it be determined that Module 3 will transition away from its industrial functions to facilitate commercially viable urban renewal, it is recommended that DDO20 be removed and the bespoke DDO schedule described above be applied in conjunction with the broader Study Area.

4.4 Local Planning Policy

Strategic direction for the West Fyans-Fyans Street Precinct Structure Plan Area is also enshrined within the Local Planning Policy Framework set out in the Greater Geelong Planning Scheme at Clause 21.17.

Similar to the findings for DDO26, Clause 21.17 provides a broad direction that supports medium and high-density development outcomes, strong ground floor activation, the reuse of existing buildings and enhanced relationships with public open space. To provide tailored support for the outcomes required for the Study Area, the following recommendations are made:

- Include objective that relates to flood hazard and encourages design solutions that mitigate risk to life and property, while also providing appropriate activation.
- Expand key issues and influences to include commentary on flood hazards and work to date.
- Consider amalgamation of Precincts 6 and 7 in accordance with the DDO recommendations and provide strategic support for residential/mixed land use in Precinct 6.
- Remove emphasis on higher density housing being located adjacent to Barwon Terrace. Instead, encourage high density mixed-use development located adjacent to Little Fyans Street, and sufficiently set back from flood hazardous land adjacent to Barwon Terrace.
- Continue to support commercial uses to activate the ground and first floors. Expand this to capture more broad 'mixed use' land uses where flood mitigation is provided and remove reference to restrict these to a 'limited number', as economic viability is contingent on this.
- Revise the Access and Amenity Improvement Plan to match new setbacks from Barwon Terrace as a result of flood modelling.

4.5 Conclusion

The existing content within DDO26 and Clause 21.17 currently embeds substantial strategic support that aligns with this Study as the policy framework broadly encourages mixed-use, high-density development outcomes with an exception for Module 3.

Having regard to the unique site constraints and built form parameters required to achieve commercial viability and flood risk mitigation, it is recommended that a bespoke DDO schedule be prepared in line with the recommendations above to ensure these localised considerations are adequately captured. It is recommended that this new schedule be applied over the entire Study Area and the existing DDO26 and DDO20 controls are removed.

The retention of the MUZ over Modules 1 and 2 provides sufficient scope to deliver increased building height which is the primary factor in ensuring economic viability for future urban renewal. It is recommended that Council undertake secondary strategic work to determine the most appropriate zoning to facilitate urban renewal for Module 3, noting commercial realities for light industrial and office development in this location at this point in time.

Appendices

Appendix A	Barwon River Feasibility Memo — Urban Enterprise
Appendix B	Flooding and Drainage Report — Water Technology

MEMO

Project	Barwon River Urban Renewal
Client	Tract (on behalf of City of Greater Geelong)
Date	20 June 2022
Subject	Development Feasibility

1.1. INTRODUCTION

This memo provides a preliminary financial assessment for urban renewal scenarios in the Barwon River Urban Renewal Precinct, prepared by Tract on behalf of the Greater City of Geelong (Council).

Council seeks to investigate appropriate built form outcomes and the economic reality of development delivery within the Barwon River Renewal Precinct. Urban Enterprise has been engaged to undertake a preliminary development feasibility of the renewal precinct.

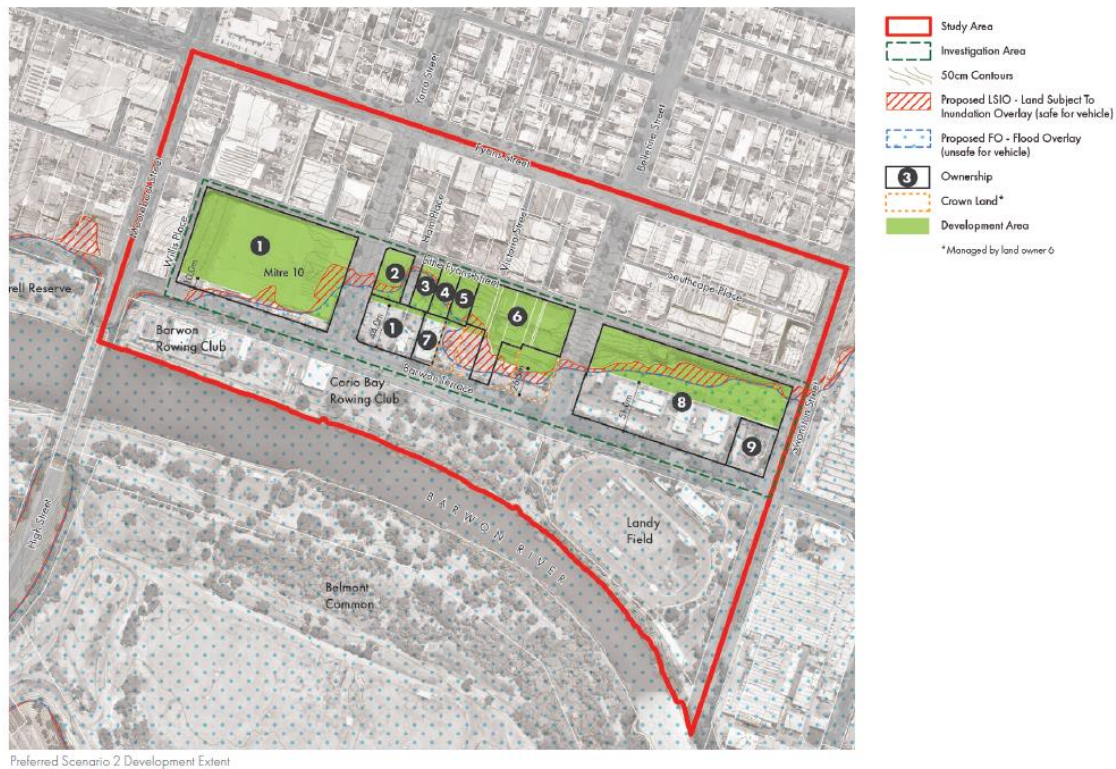
The aim of this project is to understand the financial viability of development options for landowners and developers to realistically deliver renewal. This involves investigating different scenarios to identify the plausibility of development based on various built form outcomes.

1.2. SITE CONTEXT

The area of investigation is located in South Geelong along the Barwon River, approximately 1.5kms from Geelong CBD and 0.5km south of South Geelong train station. There are 11 individual lots (including crown land) which serve the focus of investigation. These study areas are located between Barwon Terrace and Little Fyans Street, bound by Willis Place to the West, and Swanston Street to the east (Figure 1).

The investigation area is subject to an Inundation Overlay which significantly affects the developable area of these properties. It is assumed earthworks will be undertaken to create viable development outcomes that are engineered to safeguard against the effects of inundation.

F1. SUBJECT SITE AND DEVELOPEABLE AREA



Source: Tract, 2022

1.3. DEVELOPMENT SCENARIOS

The development model identifies 3 'modules' for development to indicate the different land parcel blocks being delivered. This includes:

- Module 1: Western Case
- Module 2: Central Case
- Module 3: Eastern Case

The scenarios assume that the development would be delivered based on property ownership. Module 2 lots 4&7 are under one ownership and therefore expected to be delivered together. Module 2 lot 6 is also expected to be delivered with the crown land to allow for the highest and best use of the site.

Built form modelling provided by Tract identified two key scenarios for development and thus the focus for financial modelling.

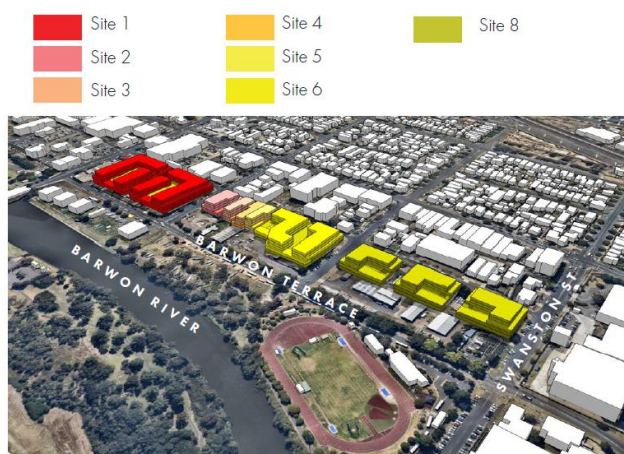
1.3.1. SCENARIO 1: BASE CASE

- A 3-storey podium + 2 storey upper levels
- A 80/20 split for residential/ commercial uses
- Reduced car parking compliance to 80%
- Two development options for Module 3 (Eastern Block) which include mixed use residential or a commercial option (light industrial + office)

T1. SCENARIO 1 BUILT FORM SUMMARY

Base Case	Module 1 Eastern	Module 2 - Central					Module 3 (Western)	
Lot Number	1	2	3	4+7	5	6+ Crown land	8 (Mixed Use)	8 (Industrial)
Developable Area via Cut and Fill (sqm.)	14,856	1516	1014	2288	1040	7045	9130	9130
Dwelling Yield (Total)	311	33	20	22	20	129	184	N/A
1 Bedroom	31	3	2	2	2	13	18	N/A
2 Bedroom	217	23	14	16	14	90	129	N/A
3 Bedroom	62	7	4	4	4	26	37	N/A
Commercial (GFA)	8337	1,516	863	973	887	4090	3086	22,462
Car Parks Provided	576	74	47	53	48	252	280	595

F2. S1: BASE CASE NORTH-WESTERN VIEW



Source: Tract, 2022

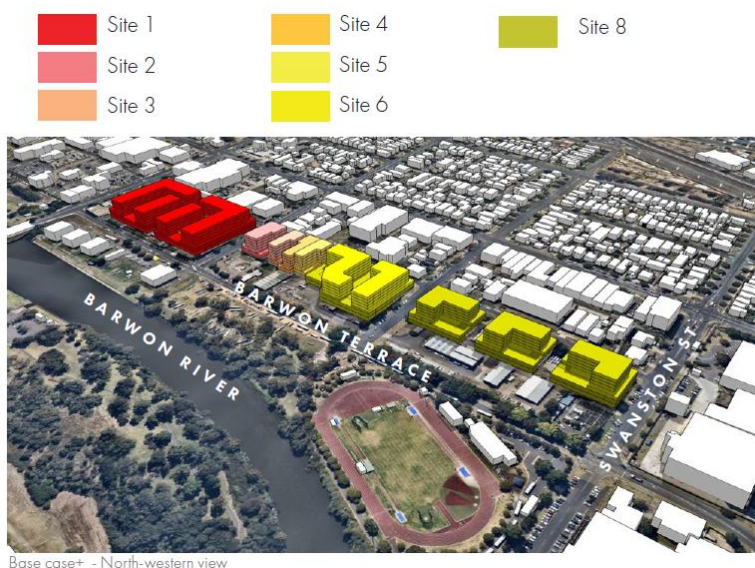
1.3.2. SCENARIO 2: BASE CASE +

- A 3-storey Podium + 4 storey upper levels
- Reduced car parking compliance to 80%
- A 80/20 split for residential/ commercial uses
- Two development options for Module 3 (Eastern Block) which include mixed use residential or a commercial option (light industrial + office)

T2. SCENARIO 2 BUILT FORM SUMMARY

Base Case +	Module 1 Eastern	Module 2 - Central					Module 3 (Western)	
Lot Number	1	2	3	4+7	5	6 + Crown land	8 (Mixed Use)	8 (Industrial)
Developable Area via Cut and Fill (sqm.)	14,856	1516	1014	2288	1040	7045	9130	9130
Dwelling Yield (Total)	399	52	33	36	33	191	212	N/A
1 Bedroom	40	5	3	4	3	19	21	N/A
2 Bedroom	280	36	23	25	23	134	149	N/A
3 Bedroom	80	10	7	7	7	38	42	N/A
Commercial (GFA)	14,814	1,516	863	973	887	5,216	5,681	32115
Car Parks Provided	800	95	59	67	61	353	387	835

F3. S2: BASE CASE + NORTH-WESTERN VIEW



Source: Tract, 2022

Table 1&2 illustrates the details of the options, including developable area and lot yield to underpin the preliminary financial assessment of the options.

1.4. FINANCIAL ANALYSIS

To test the viability of the development proposal, a residual land analysis has been undertaken. A residual land analysis (RLV) is a valuation method that is commonly used by developers to provide a preliminary estimate of the price that they could afford to pay for land in order to achieve a viable development. This is done by estimating the total revenue from the development of the land, and then subtracting all costs associated with the development, including an allowance for profit and risk but excluding the cost of the land. The amount left over is the residual land value, or a final amount the developer is able to pay for the land given the assumed value of the development, projects costs and required profit and risk allowance.

This analysis is based on the information detailed in the built form outcomes prepared by Tract and also a set of assumptions in relation to development costs and sales income.

1.4.1. METHODOLOGY AND ASSUMPTIONS

This section provides an overview of assumptions adopted for the residual land value analysis. A complete list of assumptions is provided in Appendix A.

It is assumed the development of the site would be undertaken by a developer/ investor who would seek a commercial return on the investment.

Typically, in a residual land value analysis, a profit and risk allowance of 20% is used.

1.4.2. FINANCIAL MODEL & DEVELOPMENT ASSUMPTIONS ADOPTED

The following high-level financial assumptions have been adopted for the model:

- The residual land value analysis is based on the preliminary built form outcomes prepared by Tract.
- For Module 1&3, the assumed development period is 36 months for planning/design and 24 months construction. This includes the industrial option for Module 3 except the construction period is 18 months.
- For properties in Module 2, planning/design is assumed to be 24 months and 24 months for construction.
- The development is assumed to be funded by a mix of debt and equity with debt being used to fund development and equity being used to fund the land acquisition. This is typical for this type of development and is generally a requirement of the major banks.
- Construction costs are based on current unit rates detailed in the Rawlinsons Construction Handbook (2022).
- The adopted sales rate for commercial and retail floorspace is \$5,833 psm and \$3,083 psm respectively. This is an assumption based on comparable sales within the vicinity of the development.
- Current property value is derived from valuation data (site value and capital improved value) provided by the City of Greater Geelong (Council).
- The development model assumes a profit and risk allowance of 20%. This is a typical allowance in a RLV analysis but also reflects that this development would be the first of its kind outside of the Geelong CBD. Other potential risk factors include confidence around staging and delivery of development, the need for detailed technical studies to support the cost estimates/ infrastructure requirements, the nature of the planning controls and planning process and the need for a detailed market assessment to validate demand and pricing.

1.4.3. DEVELOPMENT COSTS

Construction Costs

Construction costs have been estimated using Rawlinsons Construction Handbook (2022). The total construction costs for the development include the following:

- Demolition of existing buildings on the site
- Site work and preliminaries (excavation/fill, civil works)
- Construction of car parking, residential apartments, commercial floorspace and light industrial floorspace.
- Fit-out of commercial floorspace.

Australia's construction market is currently experiencing unprecedented shortages in raw materials and labour, coupled with high building demand. To factor in significant price increases in construction and delays, a contingency allowance of 10% has been applied to the construction costs.

Other Costs

Other project costs include the following:

- Professional fees
- Authority fees
- Marketing and selling fees; and
- Open space contributions (these contributions are assumed to be applied to public realm improvements).

Finance Costs

It is assumed that the development would be funded by equity and debt. Equity would be used to fund the land acquisition. The remaining development costs would be funded by debt. The adopted interest rate for the life of the development is 6% p.a.

1.4.4. ESTIMATED INCOME

It should be noted that a detailed market assessment has not been undertaken to inform the analysis. Rather, recent sales/rents for residential apartments and commercial floorspace in Geelong have been collated and analysed. Comparable sales/rents have been used as an indicator of the likely income for this development.

It is recommended that a detailed market assessment be undertaken to validate the revenue assumptions prior to any development proceeding.

Residential Sales

Residential (dwelling) sales are based on an average selling price per dwelling. The adopted sales rates are based on recent and comparable sales evidence in Geelong. The adopted sales rates for dwellings are as follows:

- 1 bedroom - \$500,000
- 2 Bedroom - \$700,000
- 3 Bedroom - \$900,000

It is assumed that the apartments are pre-sold prior to construction commencing and that the commercial spaces are sold on completion.

Commercial Income

The analysis assumes that the property will be sold in its entirety including all commercial lots.

The adopted sales rate for commercial and retail floorspace is \$5,833 and \$3,083 per sqm respectively. This is derived from market evidence and validated by current rents/yields.

1.5. FINANCIAL OUTCOMES

The following tables summarise the results of the RLV analysis.

A residual land value that exceeds the current capital improved value of the property indicates that the development would be viable, based on the assumptions adopted.

1.5.1. SCENARIO 1: BASE CASE

T3. RLV S1: BASE CASE

Base Case	Module 1 Eastern		Module 2 - Central			Module 3 (Western)		
Lot Number	1	2	3	4+7	5	6 + Crown land	8 (Mixed Use)	8 (Industrial)
Net Sales Revenue	\$221,224,325	\$26,337,220	\$15,817,226	\$17,688,177	\$15,971,005	\$94,596,687	\$122,222,040	\$77,840,594
Development Cost	\$212,987,463	\$25,520,763	\$15,686,280	\$18,012,079	\$15,804,879	\$88,596,253	\$114,869,425	\$108,224,813
Residual Land Value (RLV)	\$8,236,862	\$816,457	\$130,947	-\$520,124	\$166,126	\$5,163,898	\$7,352,615	-\$30,384,219
Capital Improved Value (CIV)	\$3,020,000	\$620,000	\$560,000	\$475,000	\$460,000	\$2,320,000	\$3,020,000	\$3,020,000

Scenario 1 assumes the development proposal will deliver 5 levels based on an 80/20 split for residential and commercial uses respectively including an industrial option for Module 3.

The RLV analysis in Table 3 illustrates a positive outcome for six developable parcels. The larger the land size the higher the residual value as dwelling yield amortises initial costs across the life of the development.

Projects which demonstrate a higher RLV than the CIV are considered viable developments. In this scenario, Lots 1-1, 2-2, 2-6 and 3-8 demonstrate project viability.

A second option was tested for an industrial/ commercial mix development located on Site 3-8. The RLV calculated is -\$30,384,219. This is primarily due to the low selling price for industrial properties within the South Geelong vicinity (based on market comparables). Current high construction prices coupled with a 10% contingency significantly reduces the viability of an industrial option.

1.5.2. SCENARIO 3: BASE CASE+

T4. RLV S2: BASE CASE+

Base Case+	Module 1 Eastern			Module 2 - Central			Module 3 (Western)	
Lot Number	1	2	3	4+7	5	6 + Crown land	8 (Mixed Use)	8 (Industrial)
Net Sales Revenue	\$303,798,809	\$37,497,470	\$23,146,573	\$25,917,840	\$23,329,867	\$136,691,993	\$151,189,165	\$123,592,550
Development Cost	\$294,055,100	\$35,839,378	\$22,314,992	\$25,458,989	\$22,482,399	\$128,831,527	\$137,730,553	\$157,182,983
Residual Land Value	\$9,743,709	\$1,658,092	\$831,581	\$458,851	\$651,383	\$7,024,572	\$13,458,612	-\$33,590,434
Capital Improved Value	\$3,020,000	\$620,000	\$560,000	\$475,000	\$460,000	\$2,320,000	\$3,020,000	\$3,020,000

Scenario 2 assumes the development proposal will deliver 7 levels based on an 80/20 split for residential and commercial uses respectively. This Scenario assumes an additional 2 stories will be built to allow for greater dwelling yield.

Scenario 2 demonstrates a positive RLV for all mixed use developments. This is expected given the allowance for extra lot yield across all renewable lots

Six of the seven mixed-use developments demonstrated project viability as the RLV is higher than the CIV.

The industrial option for Lot 3-8 still presents a negative RLV for the same reasons explained in Scenario 1.

1.6. CONCLUSION

Under both scenarios, the financial analysis indicates lots 1-1, 2-2, 2-6 and 3-8 (mixed use) are all viable renewable projects that would be expected to be delivered by a profit-seeking developer. In both cases, Modules 2-4 and 3-8 (industrial) are considered unviable.

The addition of two stories in Scenario 2 allows for lots 2-3 and 2-5 to be considered a feasible development option. As a result, planning controls could potentially permit smaller land parcels to have greater building height to achieve realistic development delivery.

The industrial based-option for the eastern site is considered unfeasible due to the lack of sale revenue to cover current construction prices for their respective development.

APPENDIX A – ADOPTED ASSUMPTIONS

Component	Assumption		Source
Revenue Income	1 bedroom	\$500,000	Urban Enterprise, 2022
	2 Bedroom	\$700,000	
	3 Bedroom	\$900,000	
	Commercial & Retail	\$5833	
	Industrial	\$3083	
	Demolition Costs	\$73 (per sqm)	
Construction Costs	Cut and Fill	\$90 (per cubic m)	Rawlinson's Construction Handbook (2022) derived by Urban Enterprise Comparable Development Projects UE
	Civil Works and Amenity Improvements	\$325 (per sqm)	
	Residential Apartments	\$3,425	
	Balcony	\$1070 (per sqm)	
	Underground Parking	\$1863 (per sqm)	
	Aboveground Parking	\$1142	
	Commercial & Retail	\$2725 (per sqm)	
	Light Industrial	\$1,705 (per sqm)	
Development Costs	Marketing and Selling Fees	2.75%	State Revenue Office Victoria Urban Enterprise, 2022
	Authority Charges	1.5%	
	Stamp Duty and Legal Fees	6%	
	Professional Fees	10%	
	Public Open Space	5%	
	Contingency	10%	
	Profit & Risk	20%	
	Finance	6%	
Timing	Planning + Design		Construction
Module 1	36		24
Module 2	24		24
Module 3 – Mixed Use	36		24
Module 3 - Industrial	36		18

APPENDIX B RESIDUAL LAND VALUE ANALYSIS SCENARIO 1: BASE CASE

Summary Table

Module 1 (West)		Module 2 (Central)					
	1	1	2	3	4	5	6
Land Purchase Costs	\$5,100,000.00	\$490,000	\$620,000	\$560,000	\$475,000	\$460,000	\$2,320,000
Construction Costs	\$180,744,341.95	\$150,146	\$21,717,741	\$13,364,618	\$15,377,587	\$13,463,090	\$75,203,883
Excavation+ Demolition	\$880,560.00	\$18,376	\$128,891	\$125,580	\$183,178	\$52,574	\$603,148
Building construction	\$158,604,437.91	\$0	\$19,121,949	\$11,694,429	\$13,098,911	\$11,848,649	\$66,004,351
Civil	\$4,828,040.23	\$118,121	\$492,560	\$329,644	\$697,535	\$337,950	\$1,759,667
Contingency	\$16,431,303.81	\$13,650	\$1,974,340	\$1,214,965	\$1,397,962	\$1,223,917	\$6,836,717
Fees and Charges	\$19,001,999.39	\$40,197	\$2,297,991	\$1,419,210	\$1,626,407	\$1,430,505	\$7,978,224
Professional	\$16,431,303.81	\$13,650	\$1,974,340	\$1,214,965	\$1,397,962	\$1,223,917	\$6,836,717
Public Open Space	\$106,000	\$24,500	\$27,500	\$22,000	\$18,750	\$23,000	\$116,000
Authority Charges	\$2,464,696	\$2,047	\$296,151	\$182,245	\$209,694	\$183,588	\$1,025,507
Marketing/Selling Costs	\$7,487,592.54	\$0	\$891,414	\$535,352	\$598,677	\$540,557	\$3,201,734
Financing Costs	\$12,715,364.46	\$10,045	\$1,452,917	\$894,093	\$1,028,761	\$900,681	\$5,031,140
Gross Revenue	\$272,276,092	\$0	\$32,415,040	\$19,467,355	\$21,770,063	\$19,656,621	\$116,426,692
Net Profit (Loss)	\$47,226,794.03	-\$690,388	\$5,434,978	\$2,694,082	\$1,568,518	\$2,861,789	\$21,902,526

Residual Land Value Analysis							
	1	1	2	3	4	5	6
Gross Sales Revenue	\$272,276,092	\$0	\$32,415,040	\$19,467,355	\$21,770,063	\$19,656,621	\$116,426,692
Less Selling/Marketing Expenses	\$7,487,593	\$0	\$891,414	\$535,352	\$598,677	\$540,557	\$3,201,734
Less Profit and Risk (at 20%)	\$43,564,175	\$0	\$5,186,406	\$3,114,777	\$3,483,210	\$3,145,059	\$18,628,271
Equals Net Sales Revenue	\$221,224,325	\$0	\$26,337,220	\$15,817,226	\$17,688,177	\$15,971,005	\$94,596,687
Less Excavation Costs	\$880,560	\$18,376	\$128,891	\$125,580	\$183,178	\$52,574	\$603,148
Less Civil Works Costs	\$4,828,040	\$118,121	\$492,560	\$329,644	\$697,535	\$337,950	\$1,759,667
Less Building Construction Costs	\$175,035,742	\$13,650	\$21,096,289	\$12,909,395	\$14,496,874	\$13,072,566	\$72,841,068
Less Fees/ Charges	\$19,001,999	\$40,197	\$2,297,991	\$1,419,210	\$1,626,407	\$1,430,505	\$7,978,224
Less Financing Costs	\$12,715,364	\$10,045	\$1,452,917	\$894,093	\$1,028,761	\$900,681	\$5,031,140
Equals Funds Available for Land P	\$8,762,619	-\$200,388	\$868,571	\$139,305	-\$344,577	\$176,729	\$6,383,440
Less Stamp Duty/ Legal Fees (at 6	\$525,757	\$12,023	\$52,114	\$8,358	-\$20,675	\$10,604	\$383,006
Residual Land Value	\$8,236,862	-\$212,412	\$816,457	\$130,947	-\$520,124	\$166,126	\$5,163,898

Crown Land	7
\$0	\$910,000
\$673,685	\$143,083
\$82,450	\$84,024
\$0	\$0
\$529,991	\$46,052
\$61,244	\$13,008
\$70,431	\$32,459
\$61,244	\$13,008
\$0	\$17,500
\$9,187	\$1,951
\$0	\$0
\$45,070	\$9,572
\$0	\$0
-\$789,185	-\$1,095,114

Module 3 (East) Mixed use	
8	9
\$3,020,000	
\$97,313,432	
\$1,408,410	
\$84,091,091	
\$2,967,256	
\$8,846,676	
\$10,240,677	
\$8,846,676	
\$67,000	
\$1,327,001	
\$4,136,746	
\$6,846,000	
\$150,427,126	
\$28,870,271	

Module 3 (East) Industrial	
8	9
\$3,020,000	
\$90,593,551	
\$1,408,410	
\$77,982,108	
\$2,967,256	
\$8,235,777	
\$9,538,144	
\$8,235,777	
\$67,000	
\$1,235,367	
\$2,634,605	
\$6,373,256	
\$95,803,808	
-\$16,355,748	

Crown Land	7
\$0	\$0
\$0	\$0
\$0	\$0
\$0	\$0
\$82,450	\$84,024
\$529,991	\$46,052
\$61,244	\$13,008
\$70,431	\$32,459
\$45,070	\$9,572
-\$789,185	-\$185,114
\$47,351	\$11,107
-\$836,536	-\$196,221

8	9
\$150,427,126	
\$4,136,746	
\$24,068,340	
\$122,222,040	
\$1,408,410	
\$2,967,256	
\$92,937,766	
\$10,240,677	
\$6,846,000	
\$7,821,931	
\$469,316	
\$7,352,615	

8	9
\$95,803,808	
\$2,634,605	
\$15,328,609	
\$77,840,594	
\$1,408,410	
\$2,967,256	
\$86,217,885	
\$9,538,144	
\$6,373,256	
-\$28,664,358	
\$1,719,861	
-\$30,384,219	

APPENDIX C RESIDUAL LAND VALUE ANALYSIS SCENARIO 2: BASE CASE+

Summary Table

Module 1 (West)		Module 2 (Central)				
	1	1	2	3	4	5
Property Purchase Cost	\$5,100,000	\$490,000	\$620,000	\$560,000	\$475,000	\$460,000
Construction Costs	\$249,949,552	\$150,146	\$30,503,764	\$18,999,615	\$21,708,641	\$19,140,910
Demolition & Excavation	\$880,560	\$18,376	\$128,891	\$125,580	\$183,178	\$52,574
Building construction	\$221,518,266	\$0	\$27,109,244	\$16,817,153	\$18,854,415	\$17,010,303
Civil	\$4,828,040	\$118,121	\$492,560	\$329,644	\$697,535	\$337,950
Contingency	\$22,722,687	\$13,650	\$2,773,069	\$1,727,238	\$1,973,513	\$1,740,083
Fees and Charges	\$26,237,090	\$40,197	\$3,216,530	\$2,008,323	\$2,288,290	\$2,024,095
Professional	\$22,722,687	\$13,650	\$2,773,069	\$1,727,238	\$1,973,513	\$1,740,083
Public Open Space	\$106,000	\$24,500	\$27,500	\$22,000	\$18,750	\$23,000
Authority Charges	\$3,408,403	\$2,047	\$415,960	\$259,086	\$296,027	\$261,012
Marketing/Selling Costs	\$10,282,421	\$0	\$1,269,145	\$783,422	\$877,219	\$789,626
Financing Costs	\$17,246,519	\$9,910	\$2,013,248	\$1,253,975	\$1,432,770	\$1,263,300
Gross Revenue	\$373,906,227	\$0	\$46,150,733	\$28,488,090	\$31,898,880	\$28,713,682
Net Profit (Loss)	\$65,090,645	-\$690,253	\$8,528,045	\$4,882,755	\$4,021,974	\$3,940,765

Residual Land Value Analysis						
	1	1	2	3	4	5
Gross Sales Revenue	\$373,906,227	\$0	\$46,150,733	\$28,488,090	\$31,898,880	\$28,713,682
Less Selling/Marketing Expenses	\$10,282,421	\$0	\$1,269,145	\$783,422	\$877,219	\$789,626
Less Profit and Risk (at 20%)	\$59,824,996	\$0	\$7,384,117	\$4,558,094	\$5,103,821	\$4,594,189
Equals Net Sales Revenue	\$303,798,809	\$0	\$37,497,470	\$23,146,573	\$25,917,840	\$23,329,867
Less Excavation Costs	\$880,560	\$18,376	\$128,891	\$125,580	\$183,178	\$52,574
Less Civil Works Costs	\$4,828,040	\$118,121	\$492,560	\$329,644	\$697,535	\$337,950
Less Building Construction Costs	\$244,240,952	\$13,650	\$29,882,313	\$18,544,391	\$20,827,928	\$18,750,386
Less Fees/ Charges	\$26,237,090	\$40,197	\$3,216,530	\$2,008,323	\$2,288,290	\$2,024,095
Less Financing Costs	\$17,246,519	\$9,910	\$2,013,248	\$1,253,975	\$1,432,770	\$1,263,300
Equals Funds Available for Land Purchase	\$10,365,648	-\$200,253	\$1,763,927	\$884,661	\$488,139	\$901,562
Less Stamp Duty/ Legal Fees (at 6% of Land Cost)	\$621,939	-\$12,015	\$105,836	\$53,080	\$29,288	\$54,094
Residual Land Value	\$9,743,709	-\$212,268	\$1,658,092	\$831,581	\$458,851	\$651,383

			Module 3 (East) Mixed use		Module 3 (East) Industrial	
6	Crown Land	7	8	9	8	9
\$2,320,000	\$0	\$910,000	\$3,020,000		\$3,020,000	
\$109,533,376	\$673,685	\$143,083	\$116,573,663		\$136,757,267	
\$603,148	\$82,450	\$84,024	\$1,408,410		\$1,408,410	
\$97,212,981	\$0	\$0	\$101,600,392		\$119,949,122	
\$1,759,667	\$529,991	\$46,052	\$2,967,256		\$2,967,256	
\$9,957,580	\$61,244	\$13,008	\$10,597,606		\$12,432,479	
\$11,567,217	\$70,431	\$32,459	\$12,254,247		\$14,364,351	
\$9,957,580	\$61,244	\$13,008	\$10,597,606		\$12,432,479	
\$116,000	\$0	\$17,500	\$67,000		\$67,000	
\$1,493,637	\$9,187	\$1,951	\$1,589,641		\$1,864,872	
\$4,626,498	\$0	\$0	\$5,117,172		\$4,183,132	
\$7,229,203	\$44,463	\$9,444	\$8,043,583		\$8,205,436	
\$168,236,299	\$0	\$0	\$186,078,972		\$152,113,908	
\$32,171,426	-\$788,579	-\$1,094,986	\$41,070,308		-\$14,416,279	

6	Crown Land	7	8	9	8	9
\$168,236,299	\$0	\$0	\$186,078,972		\$152,113,908	
\$4,626,498	\$0	\$0	\$5,117,172		\$4,183,132	
\$26,917,808	\$0	\$0	\$29,772,636		\$24,338,225	
\$136,691,993	\$0	\$0	\$151,189,165		\$123,592,550	
\$603,148	\$82,450	\$84,024	\$1,408,410		\$1,408,410	
\$1,759,667	\$529,991	\$46,052	\$2,967,256		\$2,967,256	
\$107,170,561	\$61,244	\$13,008	\$112,197,997		\$132,381,601	
\$11,567,217	\$70,431	\$32,459	\$12,254,247		\$14,364,351	
\$7,229,203	\$44,463	\$9,444	\$8,043,583		\$8,205,436	
\$8,362,198	-\$788,579	-\$184,986	\$14,317,672		-\$35,734,504	
\$501,732	-\$47,315	-\$11,099	\$859,060		-\$2,144,070	
\$7,024,572	-\$835,894	-\$196,085	\$13,458,612		-\$33,590,434	



Flooding and Drainage Report

Investigating the Development Potential of the
Barwon River Urban Renewal Area, South
Geelong

City of Greater Geelong

6 December 2022



Document Status

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1 INTRODUCTION

Water Technology was engaged as part of a multidisciplinary project team to undertake a scenario-based investigation into the development potential of flood prone land in South Geelong.

The City of Greater Geelong (The City), in partnership with the Corangamite Catchment Management Authority (CCMA), is undertaking the study that will inform a future update to the 'West Fyans - Fyans Street Precinct Structure Plan' (adopted June 2009) (Structure Plan).

The investigation builds on previous work and policy guidance for Geelong South and the Barwon River Precinct. Modelling of two preferred development scenarios along with targeted stakeholder engagement and broader consultation with the community has been undertaken.

The flood modelling and drainage component undertaken by Water Technology forms one of several investigation reports for the broader project.

1.1 Flooding and Drainage Overview

The following report provides responses to the objectives relative to Water Technology's skills and expertise listed in the consultancy brief.

- Land use
- Flood protection options and flood protected access routes
- Park areas and public open spaces
- Infrastructure and green infrastructure
- Impacts (including any potential cumulative impacts assessment) from development on the flood plain.
- An assessment of proposed development potential against the relevant clauses of the planning scheme.
- Implementation options with a key focus on flood protection options and impacts from development of the floodplain.



2 BACKGROUND

The Fyans-West Fyans Precinct study area is located in South Geelong, bounded by the Barwon River to the south, Shannon Avenue to the west, Swanston Street to the east and West Fyans and Fyans Street to the north (**Error! Reference source not found.**). The study area was subject to a Precinct Structure Plan in 2009 which resulted in the implementation of Amendment C205 to the City of Greater Geelong Planning Scheme in 2011. The amendment is to be implemented in 2 stages, the majority (stage 1) has been rezoned to Mixed Use Zone with a small area zoned Commercial 2. Stage 2 is located in the western half of the precinct. The area has a varied history of land use including residential, industrial, commercial, landfill and recreation. As a result of previous land use, several legacy issues relating to contaminated land and landfill sites exist throughout the study area.

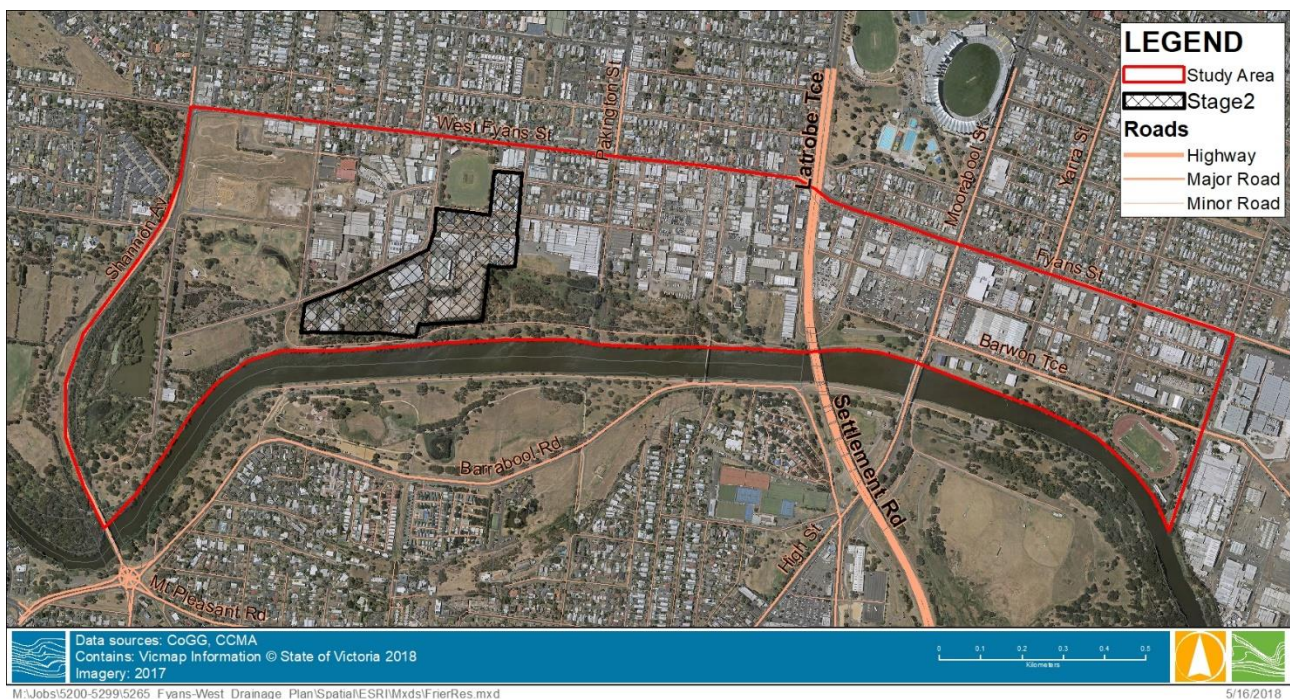


Figure 2-1 Fyans-West Fyans Precinct Study Area

The area has a long history as a mixed-use precinct from the mid-19th century following European settlement. Initially used for industrial uses including wool scouring and cleaning, the area now consists of residential pockets including several heritage listed homes. There are also several industrial businesses as well as offices, car yards and homemaker uses. The area is located along the Barwon River, which is an important local destination for recreation and sports. There are formal and informal open space areas including an athletics track, river trails, oval and a mountain bike track.

A Structure Plan was developed for the area in 2009. The Structure Plan sought to convert the area over time from an industrial precinct to a mixed-use precinct with a strong focus on residential development up to 5 stories in height, whilst maintaining a mix of complementary commercial and employment land uses. A copy of the Structure Plan map is shown in Figure 2-2 noting that this report only responds to a small section within this structure plan area..

The Corangamite Catchment Management Authority (CCMA) manage a large portion of the Barwon River floodplain and southern boundary of the study area as part of the “Barwon through Geelong Management Plan”. The management of the waterway and riparian zone of the Barwon River by public agencies offers

opportunities for recreation, amenity, connectivity and water quality treatment for the study area. These are discussed throughout the report.

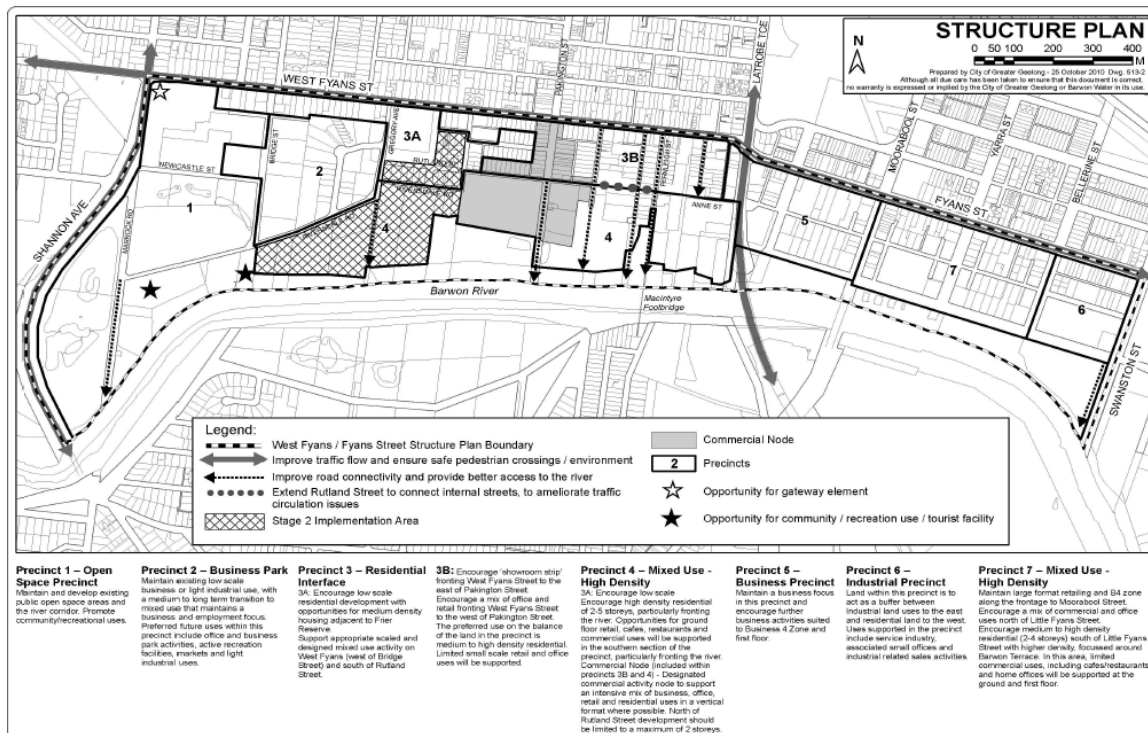


Figure 2-2 Fyans- West Fyans Structure Plan Map

2.1 Flooding

As part of the Lower Barwon and Lower Moorabool River Flood Study, a hydraulic flood model was developed using a flexible grid modelling approach. The model was calibrated to several historic floods (including 1952, 1995 and 2001 flood events) to a high degree of accuracy and is considered fit for the production of design mapping and future flood controls within the planning scheme. The updated 1% AEP design flood extent matches the existing LSIO well for much of the study area with several minor changes within the study area. The updated results appear to show a small section of the floodplain is now cut off. At the eastern end of the study area, there is a minor reduction in the flood extent for several properties along Barwon Terrace (Figure 2-3). Flood Depth results for the 1% AEP are shown in Figure 2-4, while the design flood extents for the Barwon River are shown in Figure 2-5.

Error! Reference source not found. shows the variation in site topography across the site as well as the natural slope and man-made steep escarpments along the northern edge of the floodplain. This also highlights the need to address cut-fill scenario in three stages/ modules (i.e. Moorabool Street to Yarra Street, Yarra Street to Bellerine Street and Bellerine Street to Swanston Street).

Appendix A contains six sections through the site providing further information on the existing topography and variation of the northern slope. Each section begins at Little Fyans Street and heads south across the Barwon River.

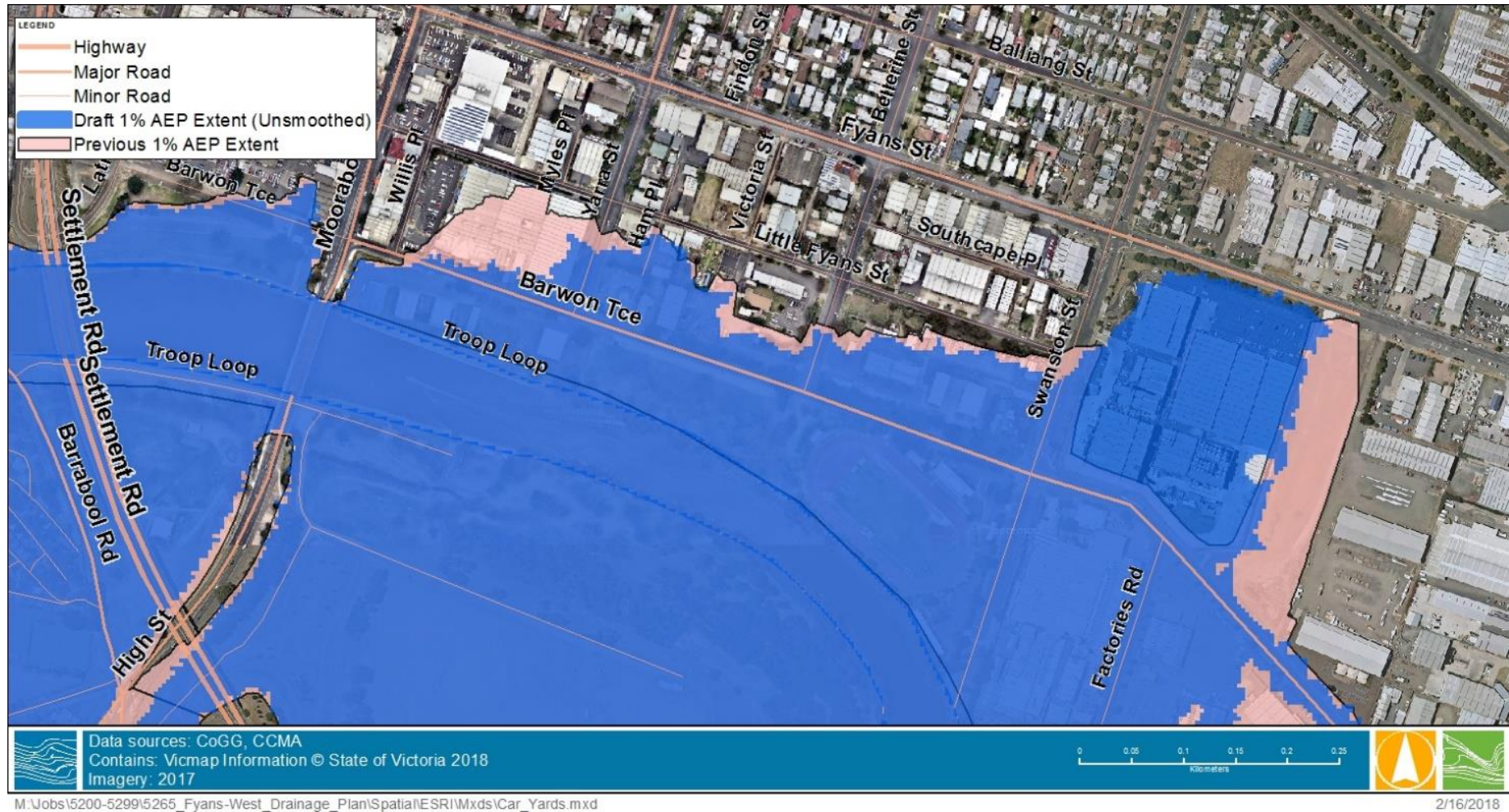


Figure 2-3 Existing Extent (GHD, 1997) and Updated 1% AEP Flood Extent (WT, 2018)

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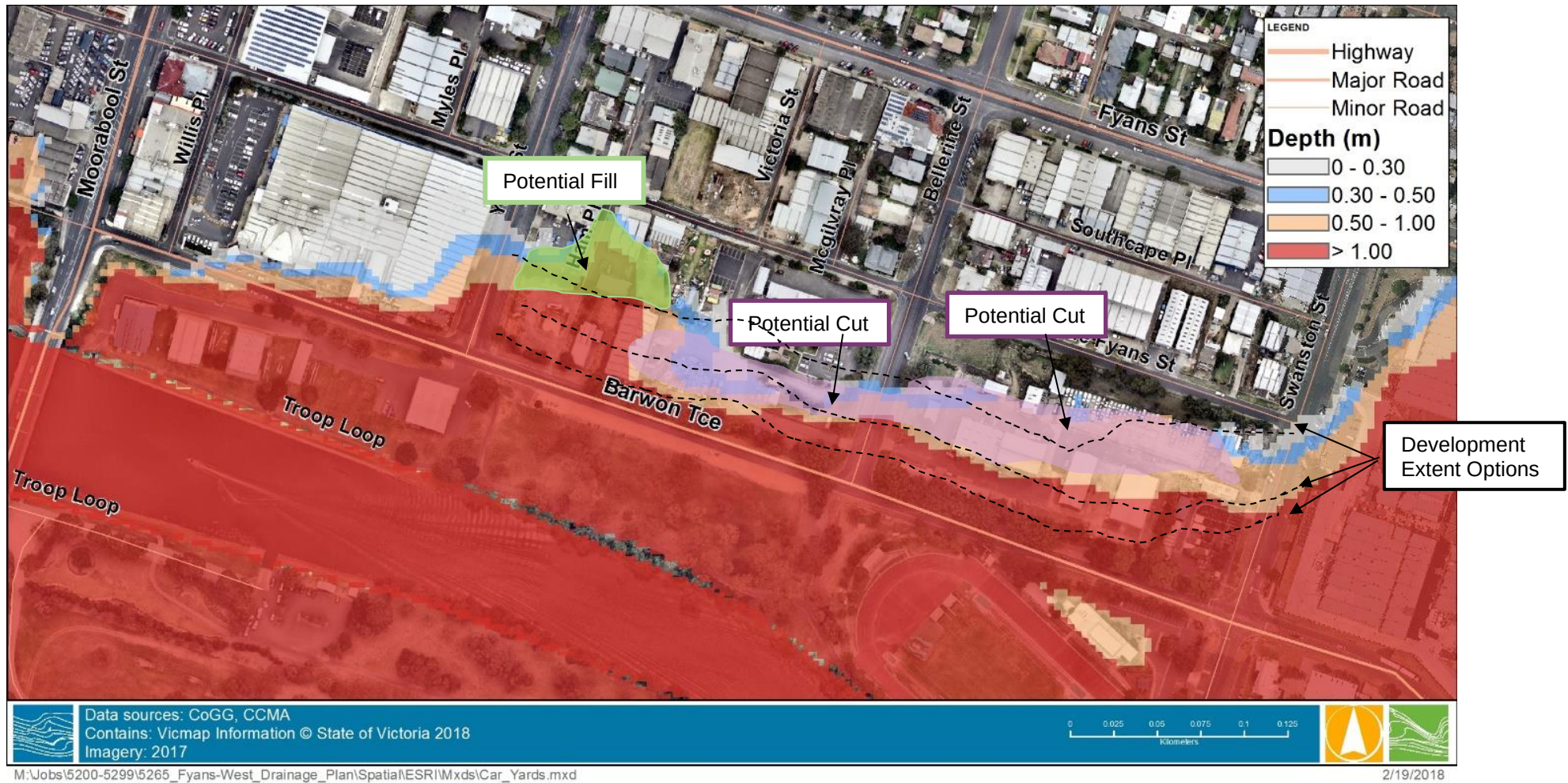


Figure 2-4 1% AEP Barwon River Flood Depth Plot

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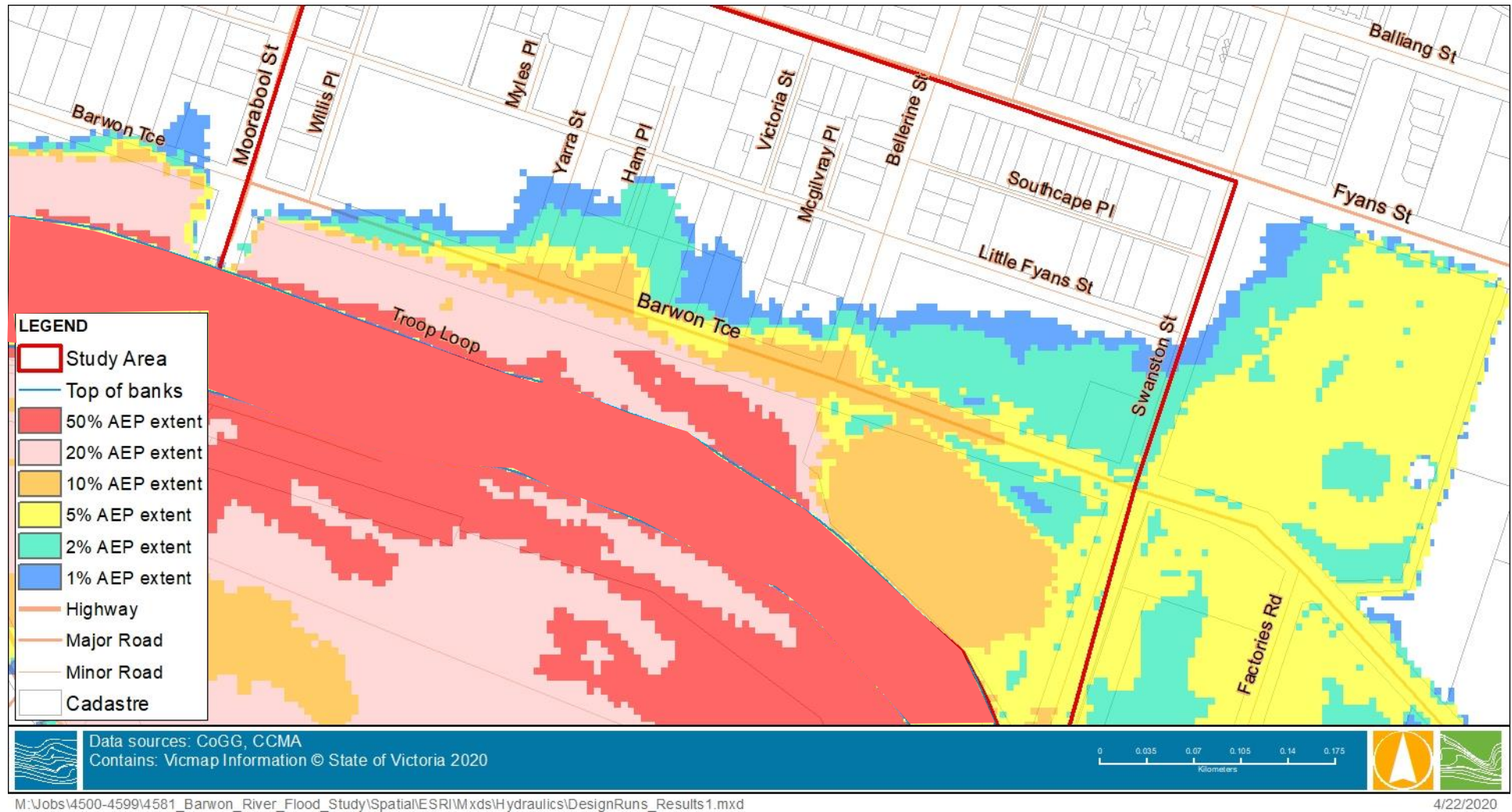


Figure 2-5 DESIGN AEP FLOOD EXTENT

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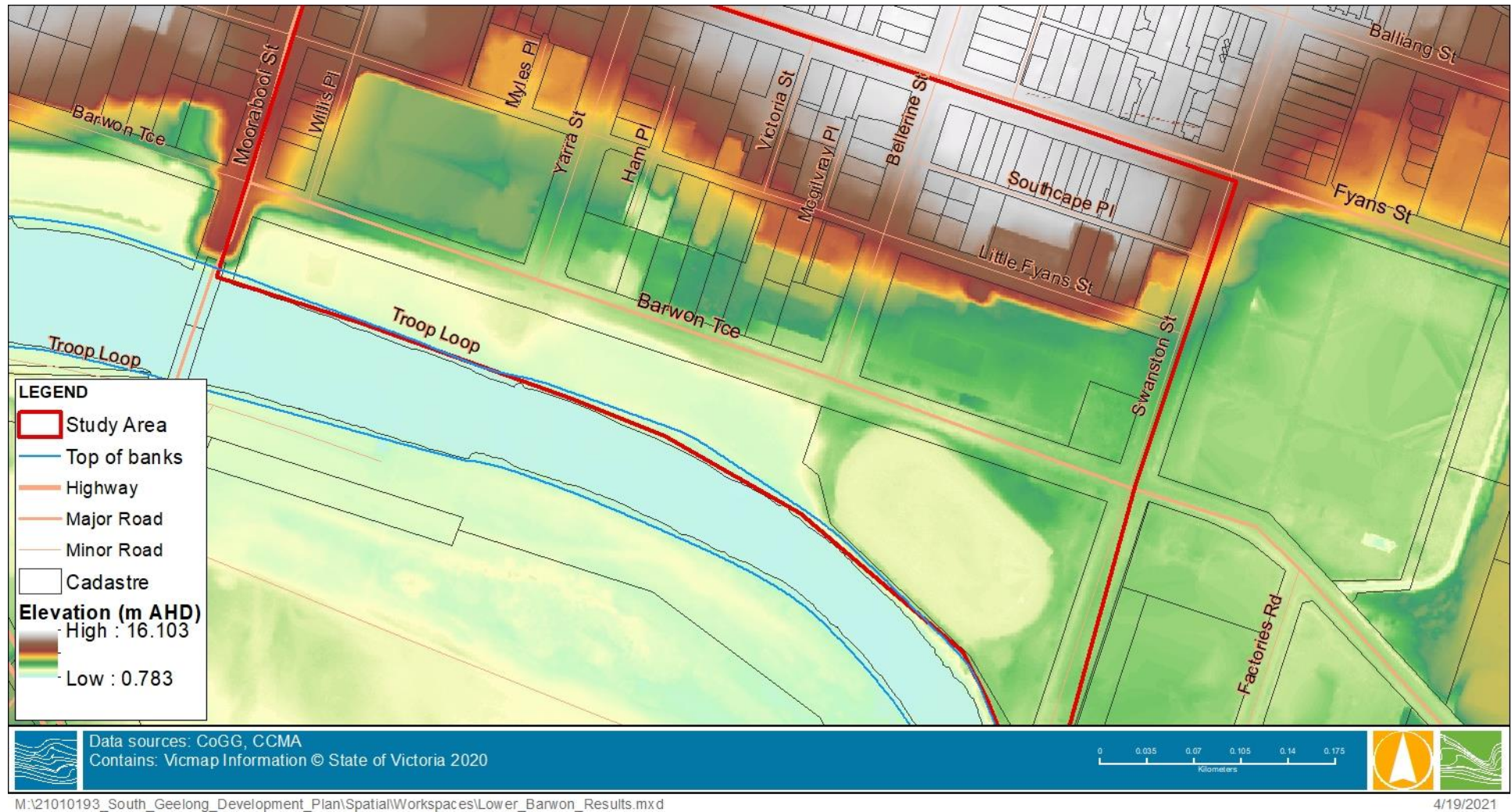


Figure 2-6 Existing Site Topography

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2.2 Floodplain Development Controls

Under current planning arrangements in Victoria, Catchment Management Authorities (CMA's) are the relevant Floodplain Management agencies outside of Melbourne Water's area of responsibility. CMA's are referral authorities under the Victorian planning regime, but not Determining Authorities and hence Council is not bound to refuse a permit on their advice, however it is unlikely that this would occur.

Any developments located within the current LSIO defining the 1% AEP flood extent from the Barwon River, will trigger a planning permit and referral to the CCMA. The CCMA do not currently support the development of new buildings within the Floodway Overlay (depths greater than 300 mm), however development within the Land Subject to Inundation (depths 0 – 300 mm) may be achievable through consultation with the CCMA. Discussions with the CCMA to date have identified potential cut-fill opportunities to develop within areas with depth greater than 300mm.

In responding to such referrals, the CCMA would be expected to take into account standard floodplain principles such as:

- Flood impacts on adjoining land;
- Any impacts on the waterway or floodplain environmental assets (such as wetlands);
- Erosion potential;
- Any impact of flood conveyance and flood storage;
- Potential for flood damage; and
- Safety and access.

Planning Scheme amendment C339 is expected to update existing flood related overlays through this area in line with the finding of the Lower Barwon and Lower Moorabool Flood Study (2019).

2.2.1 Guiding Principles and Assessment Criteria

Based on the Department of Environmental, Land, Water and Planning (DELWP) Floodplain Development Guidelines, there are a number of key principles that underpin the CCMA requirements. These include:

- Flood Storage
- Site Safety
- Access Safety
- Flood Damage
- Waterway and Floodplain – Conveyance and Function of the Floodplain
- Cumulative Impact of Development

A copy of the current DELWP development in flood prone land guidelines is available from the link below:

https://www.water.vic.gov.au/_data/assets/pdf_file/0025/409570/Guidelines-for-Development-in-Flood_finalAA.pdf



3 RIVERINE FLOOD MODELLING

The southern portion of the study area sits within the Barwon River 1% AEP floodplain. A previous flood study of the Barwon River known as the Lower Barwon and Lower Moorabool River Flood Study was carried out by Water Technology in 2018. The outputs from the study form the basis of future riverine flood planning controls in the area.

Assessing the flood behaviour from the Barwon River is a major component of understanding the potential development of the precinct. The nature of flooding and long lead time along the Barwon may lend the site to development within the current 1% AEP flood extent. Understanding the three scenarios for development, the requirements for development within the floodplain and the expected land use will help establish a preferred scenario to assess. Key to the analysis will be the existing design flood model results from the Lower Barwon and Moorabool Study, which highlight the risk and frequency of flooding within the precinct.

The existing MIKE Flexible Mesh Hydraulic model was re-established to existing conditions and ensured the inclusion of all existing building footprints within the subject area to provide a more detailed assessment of riverine flood behaviour. The 4 required design events (10%, 5%, 2% and 1% AEP) were simulated and the results used to undertake a SWOT (Strengths, opportunities, weaknesses and threats) analysis.

3.1 Existing Conditions

Detailed modelling undertaken as part of the Lower Barwon and Lower Moorabool Flood study has been used to define the existing flood risk at this location for the purposes of understanding if and how development can progress within the precinct. Modelling has been undertaken for a range of flood magnitudes.

Flood modelling results shown in the section below represent the existing flooding risk at the site for the range of AEPs in relation to flood depth, flood level and velocity.

A table displaying the particulars of the area is shown in Table 3-1 and provides an overview across the three module areas (Figure 3-1).

In assessing the site against the development requirements around site safety, access safety and floodplain storage, the following were identified:

Site Safety – Under existing 1% AEP flood modelling a significant portion of module 1-3 would be considered unsafe for development. This is based on the hazard of the southern portion of the lot where flooding depths exceed 300 mm. The land within each of the respective modules fronting Little Fyans Street is considerably higher than the Barwon Terrace frontage and given its height is located outside the extent of the mapped flood extent, they would be suitable for development.

Access Safety – Under existing 1% AEP flood modelling Barwon Terrace is likely to experience significant flooding in excess of 1 m. Flooding to this depth is considered to be unsafe and would not be trafficable. Having regard to this development which relies on access via Barwon Terrace, it would not be considered suitable based on the requirements of access safety in this location.



Table 3-1 Module One – Flood Information

	1% AEP	2% AEP	5% AEP	10% AEP	20% AEP
Flood Depth	0 – 1.45 m	0 – 0.93 m	0 – 0.31 m	Not Impacted	Not Impacted
Flood Level	5.37 – 5.44 m AHD	4.85 – 4.89 m AHD	4.23 – 4.24 m AHD	Not Impacted	Not Impacted
Flood Velocity	Up to 0.69 m/s	Up to 0.54 m/s	Up to 0.23 m/s	Not Impacted	Not Impacted

Table 3-2 Module Two – Flood Information

	1% AEP	2% AEP	5% AEP	10% AEP	20% AEP
Flood Depth	0 – 2.14 m	0 – 1.62 m	0 – 1.00 m	0 – 0.60 m	Not Impacted
Flood Level	5.31 – 5.38 m AHD	4.80 – 4.86 m AHD	4.20 – 4.23 m AHD	3.81 – 3.84 m AHD	Not Impacted
Flood Velocity	Up to 0.67	Up to 0.60	Up to 0.26	Up to 0.25	Not Impacted

Table 3-3 Module Three – Flood Information

	1% AEP	2% AEP	5% AEP	10% AEP	20% AEP
Flood Depth	0 – 1.43 m	0 – 0.91 m	0 – 0.31 m	0 – 0.29 m	Not Impacted
Flood Level	5.27 – 5.31 m AHD	4.75 – 4.80 m AHD	4.16 – 4.19 m AHD	3.79 – 3.80 m AHD	Not Impacted
Flood Velocity	Up to 0.58 m/s	Up to 0.47 m/s	Up to 0.24 m/s	Up to 0.17 m/s	Not Impacted



Figure 3-1 Module Layout

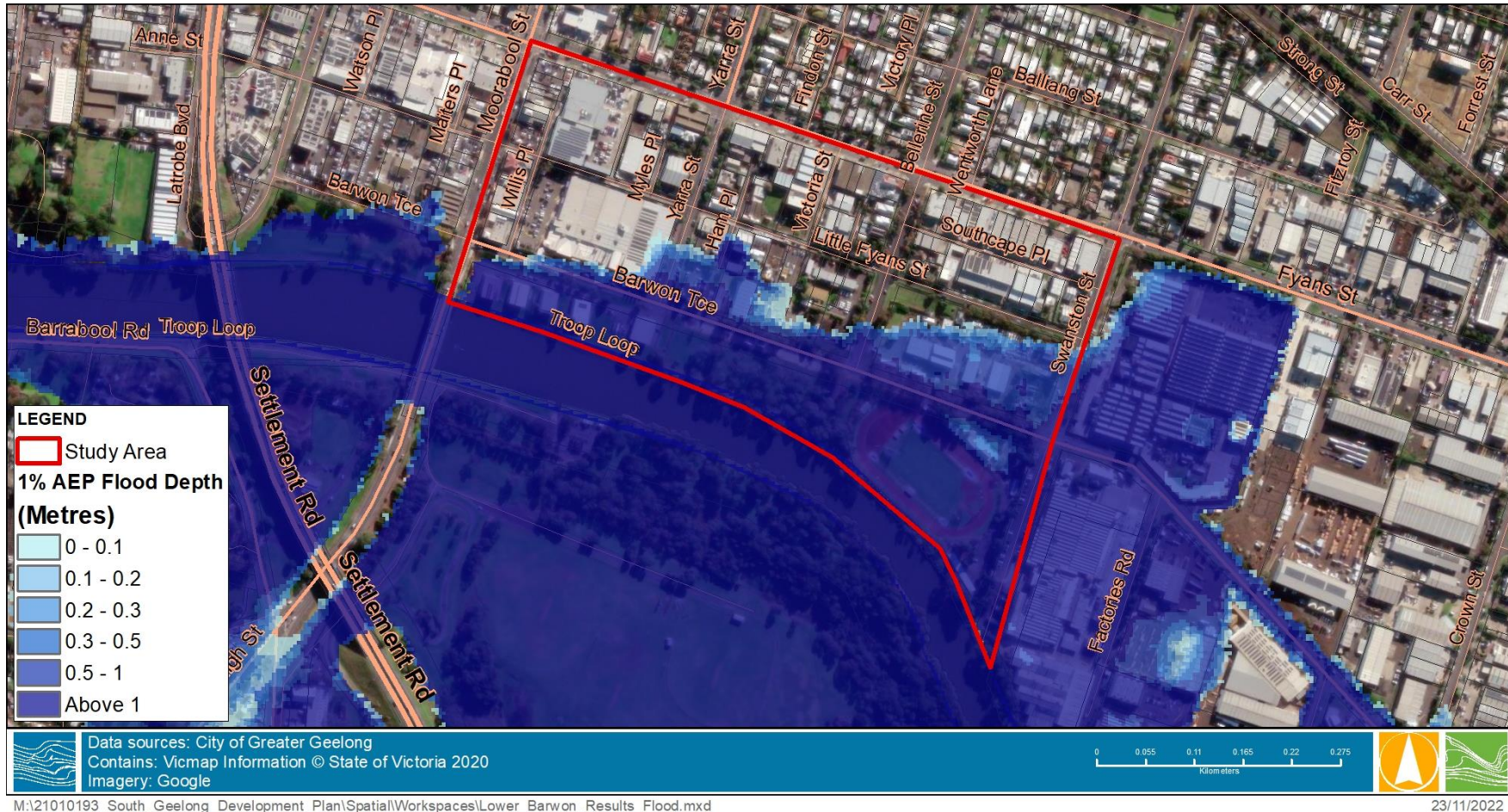


Figure 3-2 1% AEP Flood Depth



Figure 3-3 1% AEP Flood Velocity

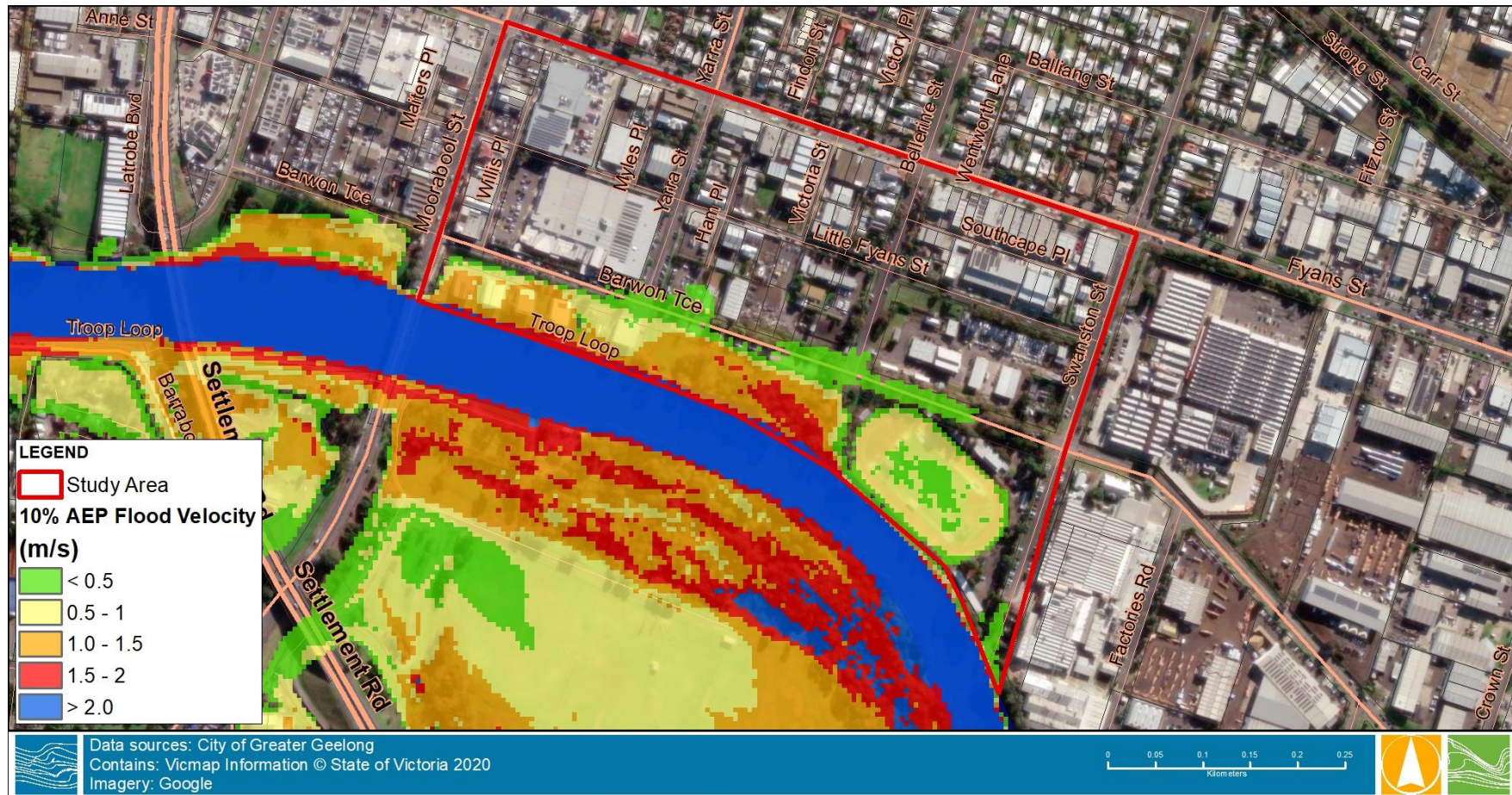


Figure 3-4 1% AEP Vehicle Hazard



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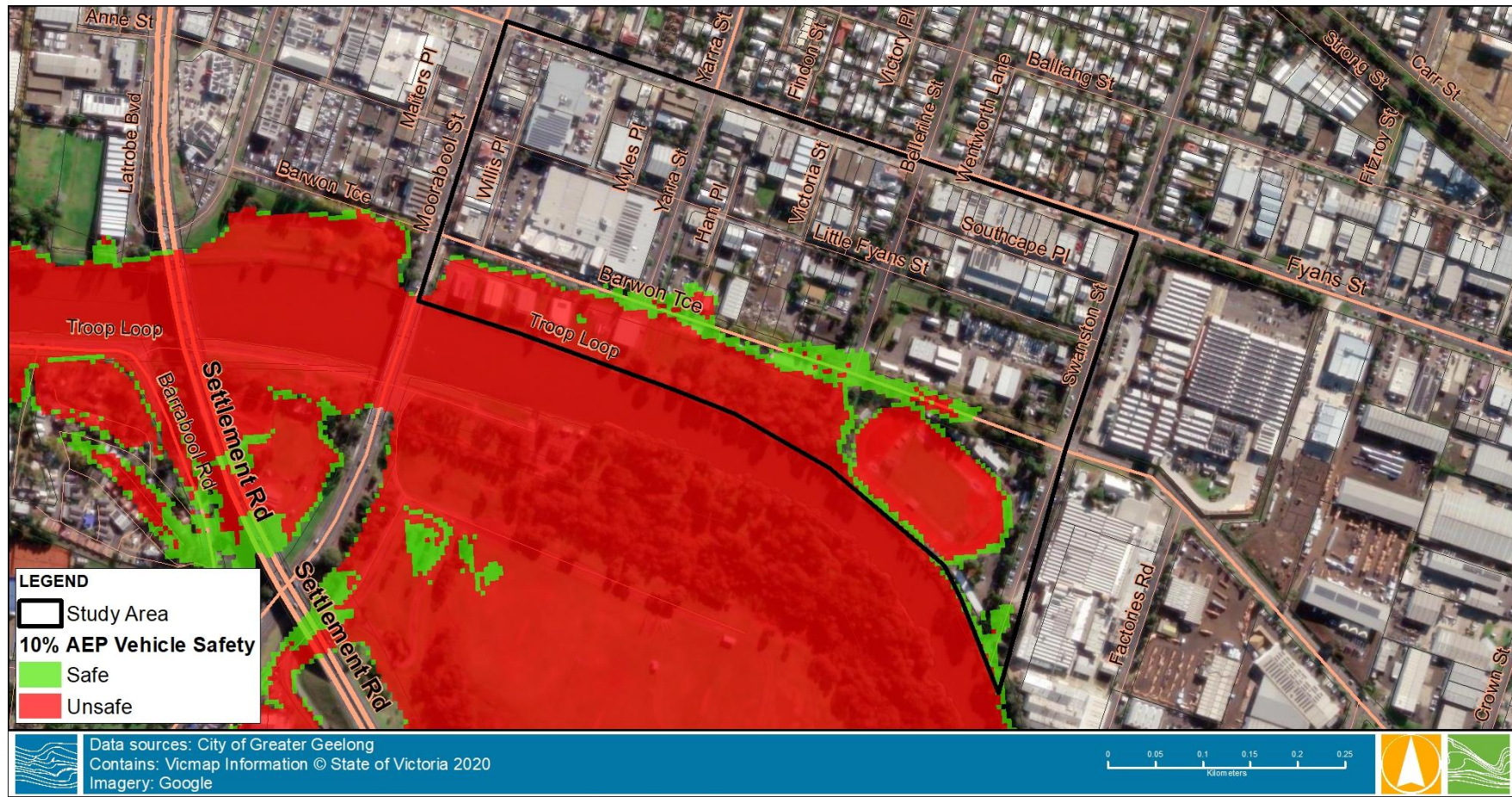
Figure 3-5 10% AEP Flood Depth



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Figure 3-6 10% AEP Flood Velocity



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Figure 3-7 10% AEP Vehicle Safety



3.2 Cut and Fill Analysis

A cut and fill assessment for the three respective development areas within the precinct has been undertaken to identify the potential for topography changes within the precinct to accommodate development without increasing flood risk. The site has been delineated into three block areas (modules) based on the roadways running north/south through the area (i.e. Moorabool Street – Yarra Street, Yarra Street – Bellerine Street and Bellerine Street – Swanston Street).

The cut and fill volumes have been calculated on the following assumptions:

- Only the area within the current 1% AEP flood extent (on each respective ‘Module’) has been assessed to be included in the ‘cut’ area.
 - As cut and fill volumes onsite are to be balanced, we have assumed that only the land within the known flooding extent of the 1% AEP event will need to be manipulated. With the exception of the assessment for Module 2B, which seeks to adjust the land already outside the 1% AEP flood extent.
- Developable land shall be filled to a level equal or above the 1% AEP flood level.
 - The land will be assumed safe and free from flooding at topographic levels above the 1% AEP flood event. Further to this, the volumes of fill required to create level building areas above the 1% AEP flood event are not regarded to impact flood storage and therefore are not considered (Figure 3-8).
- The upper limit of the applicable 1% AEP level was used as the fill target level within each area.
 - Flood levels within each of the respective “Modules” vary from west to east due to the natural floodplain slope. The maximum of the flood levels across the lot will be used for this assessment to achieve the highest level of applicable protection across the lot.
- A nominal minimum ground level for the low-lying land of 4.2 m AHD has been adopted consistent with levels abutting Barwon Terrace and in line with the southern property frontages.
 - There are parts of each respective lots which are below the ground levels at the Barwon Terrace property frontages. For the purposes of this assessment a nominal lowest land level was adopted. This was set at 4.2 m AHD to enable efficient drainage where current stormwater may pool without the ability to freely drain.
- No level for level cut and fill balance is required, a site volume balance for each of the three areas has been used in this case.
 - Corangamite CMA cut and fill guidelines level for level volumetric balances would typically be required. In this case only net site (Module) balances will be assessed; no consideration has been made for level for level (at interval levels).
- The area within the flood extent but situated above the nominated 4.2 m AHD minimum ground level is available for filling to achieve developable areas.
 - In line with the approach shown in Figure 3-9, cut and fill within the site has adopted minimum ground levels which ensures that a flat usable space is provided within the flood prone portion of the lot. provision of a minimum level also ensures that any cutting used to create the developable areas is reasonable, kept above adjacent street levels and is part of the connected floodplain area.

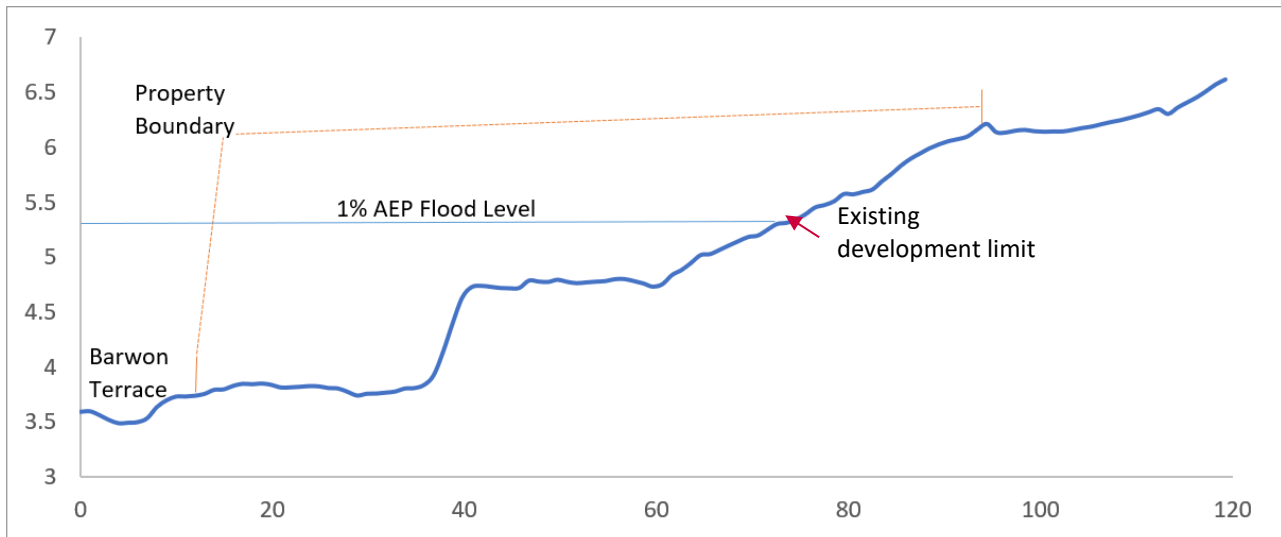


Figure 3-8 Example module cross-section (from Barwon Terrace to Little Fyans Street)

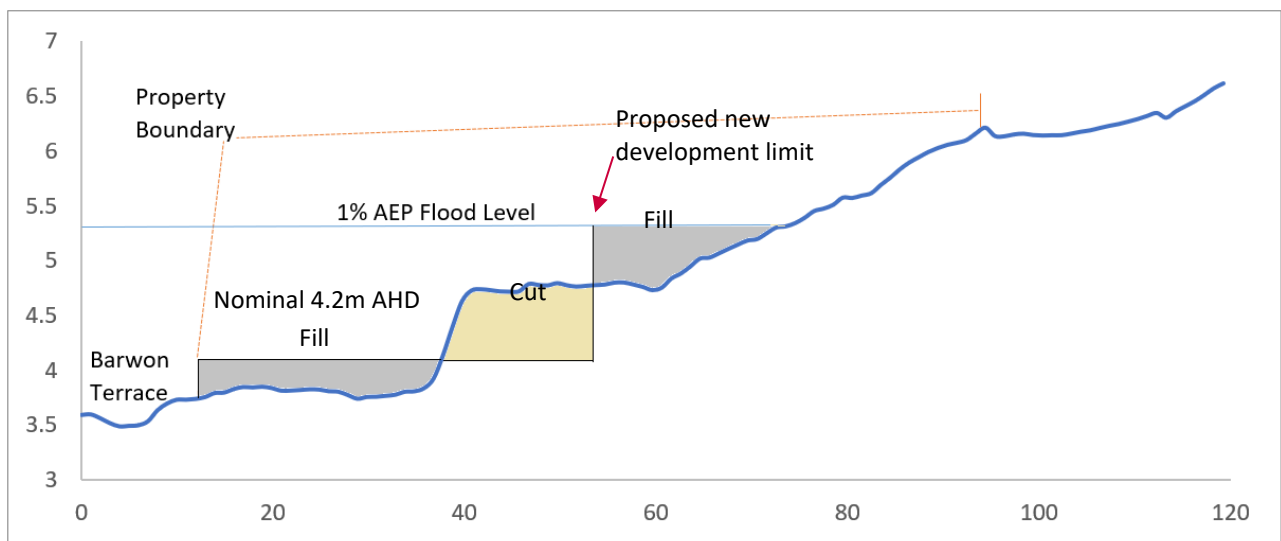


Figure 3-9 Example module cross-section showing proposed cut and fill approach.



3.2.1 Module 1 (Between Moorabool Street and Yarra Street)

Module 1 covers the area between Willis Place and Yarra Street. The existing topography of this area is shown in Figure 3-10. A summary of the existing topography and 1% AEP flood levels is provided in Table 3-4.

Table 3-4 Site Levels – Module 1

Module 1	Topography (m AHD)		1% AEP Flood Level (m AHD)	
	Max	Min	Max	Min
	10.99	3.83	5.44	5.37

An indicative set back of 10 metres from Barwon Terrace road reserve was used as a starting point. Cut and fill volumes were estimated in order to provide a safe and developable area north of the development line shown on Figure 3-11 Developable Area - Module 1. The balance of cut and fill within this location is shown in Table 3-5.

Table 3-5 Cut and Fill – Module 1

Module 1	Floodplain Storage Volume - Balance	
	Cut (m³)	Fill (m³)
	535	465

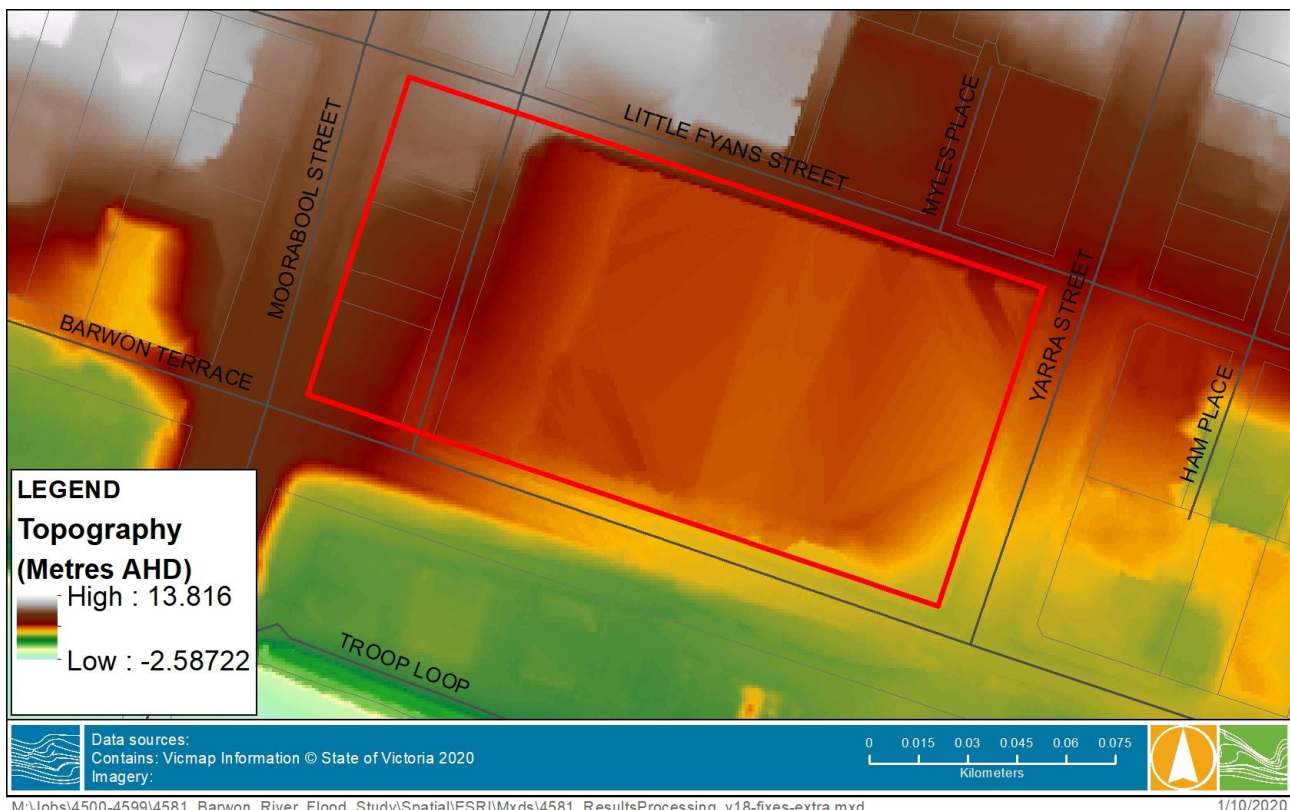


Figure 3-10 Site Topography – Module 1



Figure 3-11 Developable Area - Module 1

3.2.2 Module 2 (Between Yarra Street and Bellerine Street)

Module 2 is the area located between Yarra Street and Bellerine Street. The existing topography of this area is shown in Figure 3-12. Surface topography and 1% AEP flood levels are shown in Table 3-6 below.

Table 3-6 Site Levels – Module 2

Module 2	Topography (m AHD)		1% AEP Flood Level (m AHD)	
	Max	Min	Max	Min
	10.25	2.98	5.38	5.31

For module 2 (scenario A), the assessment indicates available cut which slightly exceeds the required fill, with ground levels below the development line indicated on Figure 3-12. Site Topography - Module 2, approximately 43 m from the southern boundary for the lots in the western half of the module and ~27.5 metres for the VicRoads site. The 1% AEP floodplain storage volume balance based on cut and fill within the existing flood extent is summarised in Table 3-7.

Table 3-7 Cut and Fill – Module 2 (Scenario A)

Module 2 (Scenario A)	Floodplain Storage Volume – Balance	
	Cut (m³)	Fill (m³)
	3731	3642

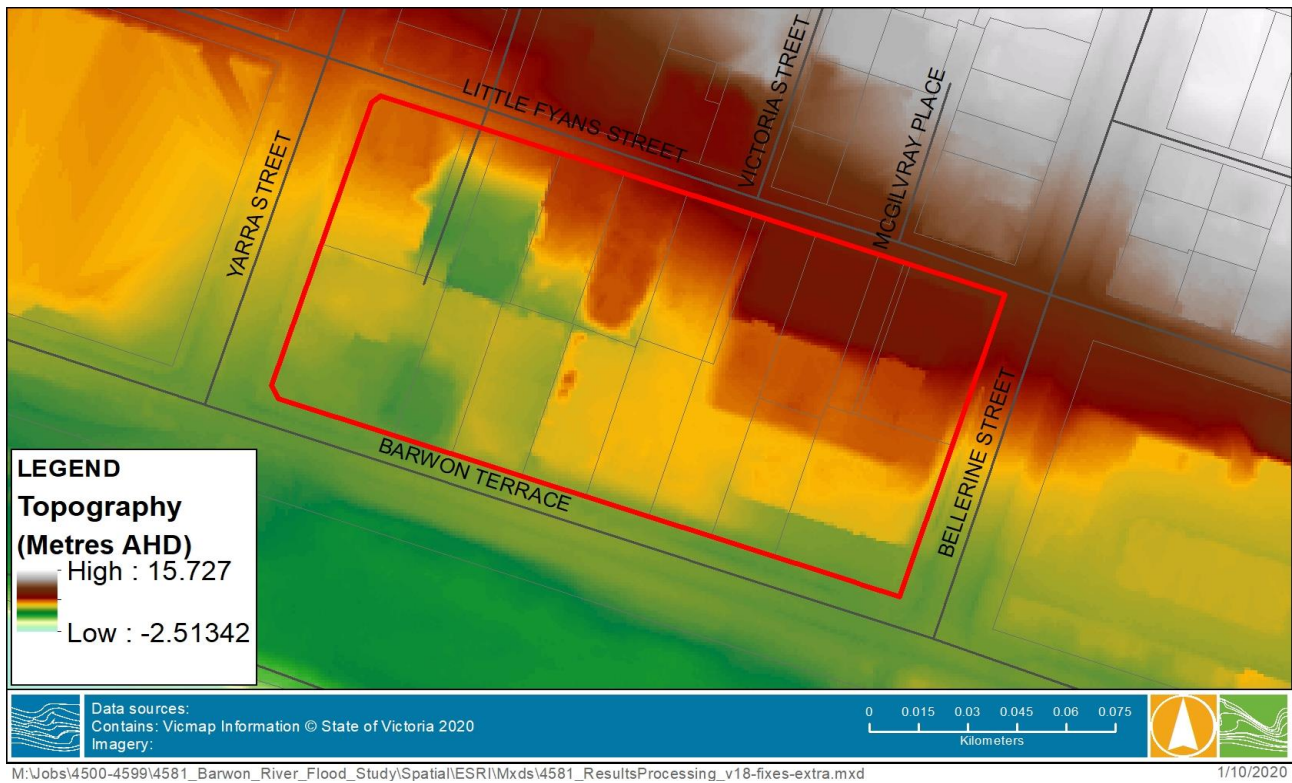


Figure 3-12 Site Topography - Module 2



Figure 3-13 Developable Area - Module 2 (Scenario A)

A second scenario for Module 2 to investigate manipulation of the existing area outside the flood extent within the VicRoads land was also undertaken (Scenario B). The focus of this assessment was to facilitate a consistent development line across the module to create more developable land within the western properties fronting Barwon Terrace within Module 2 to allow for a larger development footprint across the precinct.

The assessment was able to move the development line further towards Barwon Terrace by approximately 5-6 metres as shown in Figure 3-14 with the corresponding site cut and fill balance shown in Figure 3-8.

Table 3-8 Cut and Fill – Module 2 (Scenario B)

Module 2 (Scenario B)	Floodplain Storage Volume - Balance	
	Cut (m³)	Fill (m³)
	4296	4206



Figure 3-14 Developable Area - Module 2 (Scenario B)

3.2.3 Module 3 (Between Bellerine St and Swanston St)

Module 3 area is the land between Yarra Street and Bellerine Street. The existing topography of this area is shown in Figure 3-15. Applicable topographic and 1% AEP flood levels are shown in Table 3-9 below.



Table 3-9 Site topography - Module 3

Module 3	Topography (m AHD)		1% AEP Flood Level (m AHD)	
	Max	Min	Max	Min
	10.53	3.74	5.31	5.27

The cut and fill balance of the development area was set based on achieving a relative volume balance. In this case the required fill is slightly lower than the available cut as indicated in Table 3-10. The development line is shown to be approximately 51 metres from the southern boundary (Figure 3-16).

It is important to note that the assessment provided above considers only a single terraced approach where the areas north of the development line are at or above the respective 1% AEP flood level and the areas below are at 4.2 m AHD. This equates to approximately a 1.2 metre difference between the two terraces.

Table 3-10 Cut and Fill – Module 3

Module 1	Floodplain Storage Volume – Balance	
	Cut (m³)	Fill (m³)
	2720	2681

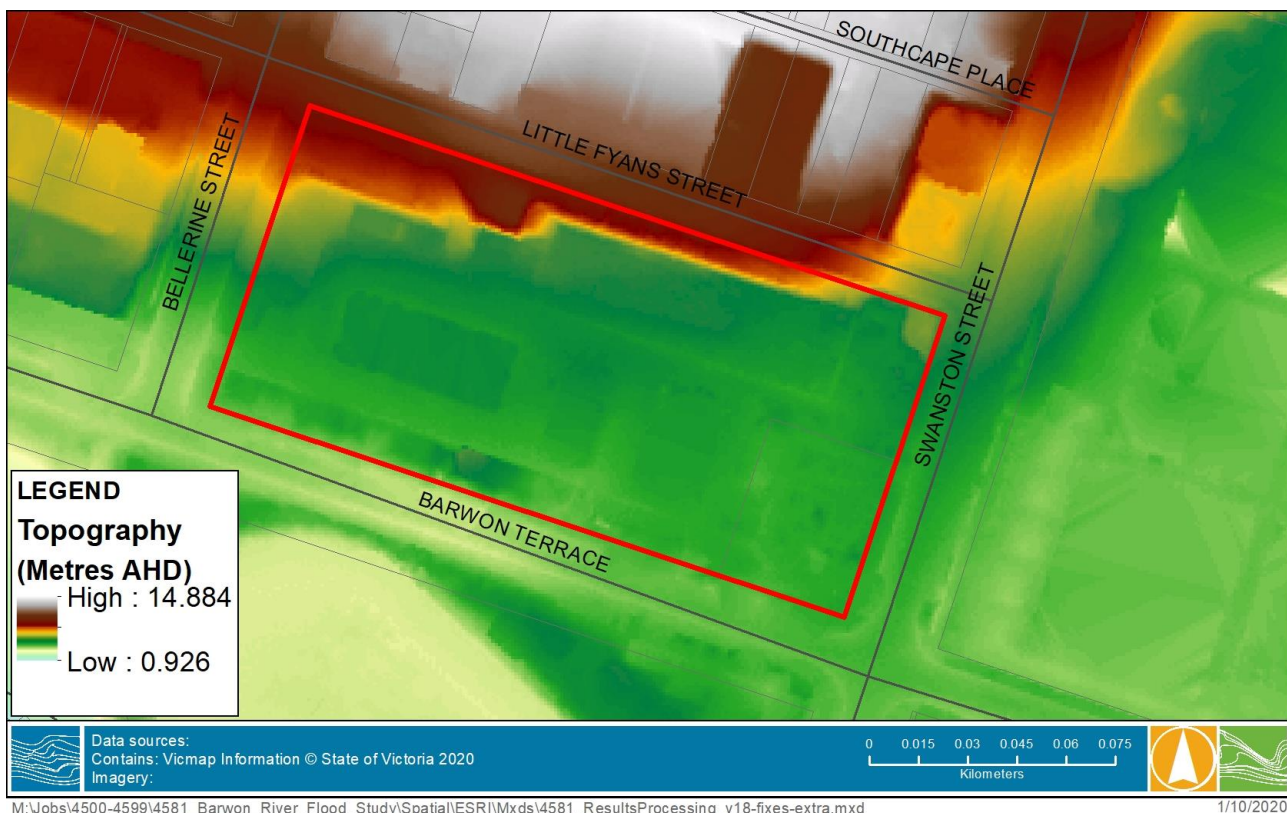


Figure 3-15 Site Topography – Module 3



Figure 3-16 Developable Area – Module 3

3.2.4 Floodplain Terracing

An alternative approach which was not considered as part of this assessment, but which could be undertaken at the site is further terracing of the cut and fill within the respective lots. This would vary from the current approach by providing some land within the flood extent which has development potential due to levels being sited to a specific depth resulting in a designed low flood risk area.

Flood depths within the low flood risk portion of the site would need to be kept within reasonable limits (0.15 – 0.3 metres to facilitate low risk use of the floodplain. In which case the site may facilitate flood free, low hazard and high hazard floodplain land (within the 1% AEP flood extent), as per Figure 3-17.

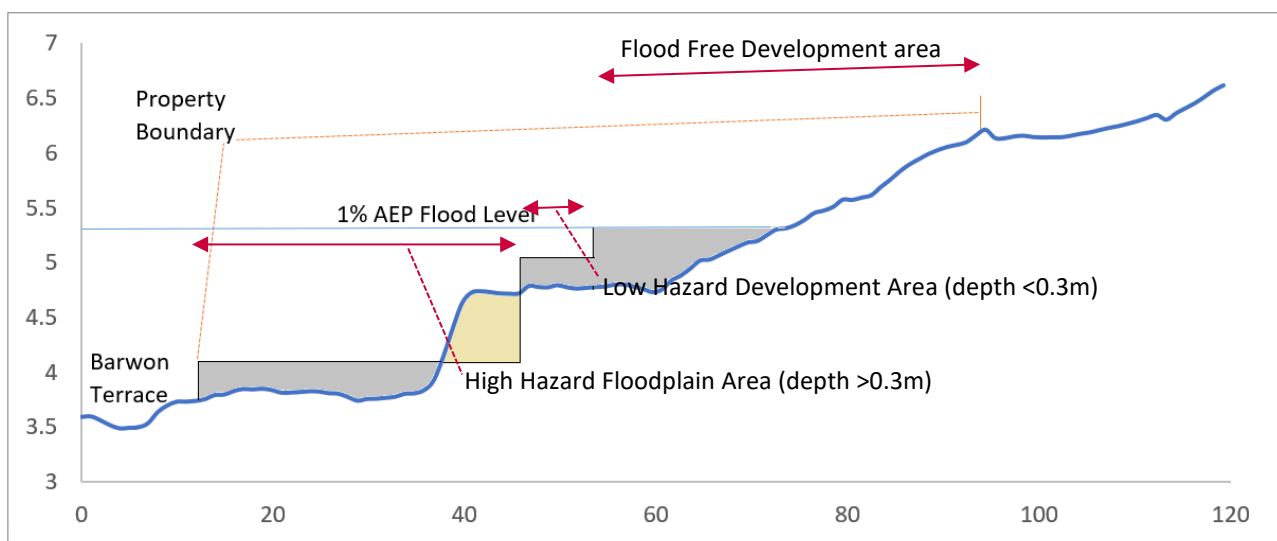


Figure 3-17 Terraced floodplain development cross-section



3.3 Impact Assessment

Modelling of the 1% and 10% AEP riverine flood event was simulated based on the proposed cut and fill of the respective modules. This was undertaken in order to understand if any impact is associated within changes to the topographic features within the precinct

The modelling utilised the existing MIKE flood model developed for the Lower Barwon and Lower Moorabool Flood Study (Water Technology, 2018).

The impact assessment was completed for the two proposed development options as assessed as part of the cut and fill assessment. The difference between the 2 scenarios is related to the different options around module 2, with the cut and fill option for module 1 and 3 the same for Scenario A and B.

Modelling of both the 1% AEP and 10% AEP was completed for the 2 development scenarios.

The results from the proposed development options were compared to existing condition results and difference plots produced which show the change in flood level.

The results for the 1% AEP event Scenario A and Scenario B show small areas of localised flood level increases and decreases. The pink shading in both



Figure 3-19

and



Figure 3-20 shows areas which were previously identified as being inundated in the 1% AEP flood event which are now dry as a result of filling. Areas shaded blue show locations which were not previously flooded in the 1% AEP event and which are now wet.

Where proposed cutting has created the lower terraced area on the site there has been a minor reduction in peak flood levels, which is likely a reflection of a smoother uniform floodplain area.

Within Scenario A there is an area of identified increase in flood level within the VicRoads site and immediately south of the filled area. The flood level within this area is shown to increase by up to 0.02 m during the 1% AEP flood event. The area of increase extends into the road reserve south of the property where the level difference decreases to less than 0.005 m.

This occurs in Scenario B also, however the area of increased difference is smaller and largely confined to within the VicRoads property itself. In this scenario the area of high ground within the site is moved further north which does appear to offset the impact of the filling required within the low areas within and adjacent to Hams Place.

Assessment of the impact of the cut and fill during the 10% AEP does not show any impact for either Scenario A or B. This is due to the minor impact of flooding generally across the development sites in the 10% event. During the 10% AEP event flooding is largely confined to the Barwon Terrace frontage of the 3 modules and as such the areas which are proposed to be filled, which sit along the northern boundary of the modules, are not impacted. Small areas within each module are now shown to be inundated during the 10% AEP as indicated by the blue shading. This is caused by the leveling of the lower terrace which reduces the ground levels within the parts of the properties fronting Barwon Terrace.

It is important to note that an equitable development option at this location will require an area (module) based approach. The approach is required in order to meet both site and access safety requirements for development within flood prone land, and ensure flood storage and cumulative impacts are adequately managed. Site by site cut and fill assessments and or small scale mitigation options do not provide a solution which ensures a safe and sustainable development outcome at this location and which is able to meet the strategic needs of the structure plan. Given the distributed land holdings within Module 2 and 3 a broader flood risk and development outcome is essential. This will enable a larger development area within the northern

section of the modules whilst providing land within the lower floodplain areas for passive use which incorporate into the river corridor and adjoining recreational areas.



Figure 3-18 1% AEP Developed Conditions Flood Depth – Scenario 2A



Figure 3-19 1% AEP Developed Conditions Difference Plot – Water Level (Scenario 2A)



Figure 3-20 1% AEP Developed Conditions Flood Depth – Option 2B



Figure 3-21 1% AEP Developed Conditions Difference Plot Water Level



Figure 3-22 10% AEP Developed Conditions Flood Depth – Option 2A



Figure 3-23 10% AEP Developed Conditions Difference Plot Water Level



Figure 3-24 1% AEP Developed Conditions Flood Depth – Option 2B



Figure 3-25 10% AEP Developed Conditions Difference Plot Water Level

4 STORMWATER AND DRAINAGE ANALYSIS

Similar to the above riverine flood modelling assessment, existing flood modelling (rain on grid) results developed as part of the drainage report for the Fyans-West Fyans Precinct were used for an assessment of existing stormwater flooding risk. No major overland flow paths were identified within previous modelling, however the nature of the catchment with a short and steep slope from Fyans Street down to the Barwon River floodplain does present some risks. Namely the risk for overland flowpaths to escape from the confines of open drains and roadways as well the potential for a high Barwon River level in the receiving outfall of the drainage network to limit the capacity of the drainage system.

As part of the initial assessment regarding Water Quality within the Fyans West-Fyans Precinct Drainage Report (Water Technology, 2018) recommendations aimed at improving overall quality of stormwater runoff from the upstream catchment were provided. These were focussed on end of line treatment measures that treat the broader catchment upstream of the study area. Due to the nature of the long linear catchments and multiple outfalls into the Barwon River within the study area, the use of proprietary treatment measures may offer additional benefits outside of the current best practice requirements. The use of Gross Pollutant Traps (GPT's) and educational signage around water quality and the water cycle along the Barwon corridor provide multiple benefits to water quality of the Barwon River as well as offer learning opportunities for the community.

Key locations of trunk drainage and Barwon River outfall locations are shown in **Error! Reference source not found..** Consideration should be given to the incorporation of integrated water outcomes which contribute to improved water quality where possible as part of overall development outcomes in this area. There may be opportunities to incorporate water quality (WSUD & IWM) features into the landscape through the use of encumbered open space provided these features 'fit' within the final topography layout and do not restrict the conveyance of the floodplain.

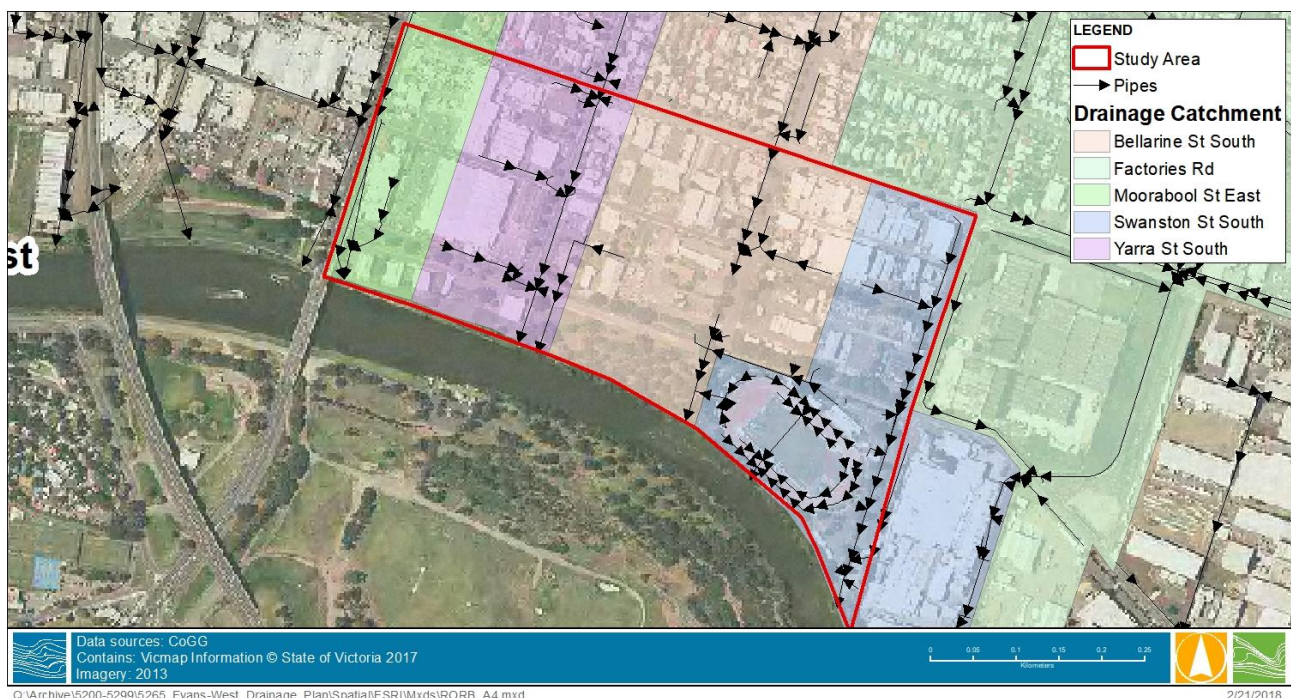


Figure 4-1 Stormwater Outlets to Barwon River





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Figure 4-2 1% AEP Stormwater Flood Depth



Figure 4-3 10% AEP Stormwater Flood Depth

4.1 Stormwater Flooding Risk

Available stormwater flood modelling for the 1% AEP and 10% AEP flood events indicates a flash flooding risk within a number of locations across the precinct. Two key areas within the precinct are identified to have unsafe areas, these include a section of Barwon Terrace adjacent to Landy Field and within the low depression within Han Place.

Flooding depths within Barwon Terrace during both a 1% AEP and 10% AEP are considered to be hazardous and not safe for vehicles with depths during both events shown to exceed 0.3 m. A number of small areas within the 3 modules are also shown to store stormwater during significant rainfall events. These areas are relatively localised. Future development of these areas must consider improved onsite drainage. It is noted that existing onsite drainage across the three areas is limited, likely a reflection of the age of development in the area and the drainage regulations at the time.

Renewal and upgrade of council drainage in this location may also need to consider increases in trunk drainage size from Fyans Street to the river outlet as a result of incremental catchment intensification which would have cumulatively increased runoff within the area over time.

4.2 Stormwater Quality Assessment

The Fyans-West Fyans Precinct drainage report highlighted the difficulty in achieving significant water quality objectives with the use of end of line treatment measures within the subject site. The elongated and narrow catchments that lead to the precinct and out fall to the Barwon River limit the potential to obtain catchment wide benefits from end of line treatment options (i.e. Gross Pollutant Traps).

Based on the learnings of the precinct scale drainage assessment it is understood that a number of limitations exist in relation to achieving meaningful water quality improvements with end of line treatment. Options to incorporate water quality treatment measures to improve the quality of runoff from the three module areas is possible by incorporating site based WSUD and or IWM. In doing so this will enable the reduction in current annual pollutant loads discharging from the local catchment. Existing pollutant load estimates draining to the stormwater outfalls within the catchment are available from the existing precinct MUSIC model, which also includes the upstream catchment.

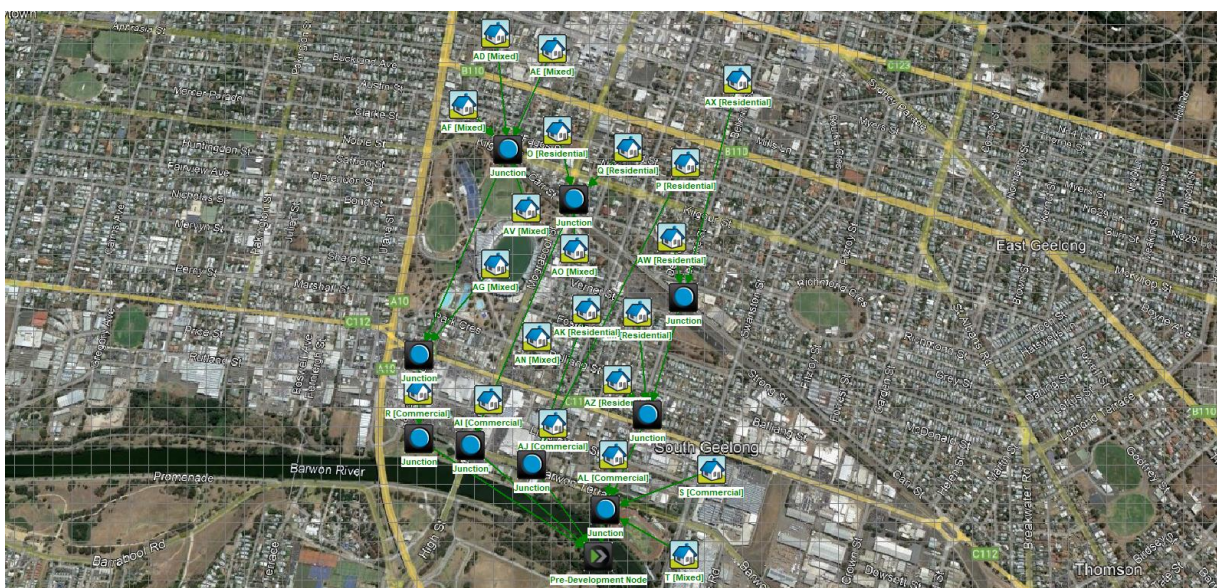


Figure 4-4 Music Model – Fyans Street Catchment



Current modelling indicates high sediment and gross pollutant loads which discharge directly into the Barwon River at this location as indicated by the table below. In lieu of this, any retrofit treatment measures within the precinct and/or within the proposed development modules will assist in reducing current pollutant loads.

Table 4-1 Fyans Catchment Mean Annual Loads

	Inflow
Flow (ML/yr)	301
Total Suspended Solids (kg/yr)	53.0E3
Total Phosphorus (kg/yr)	9.8
Total Nitrogen (kg/yr)	693
Gross Pollutants (kg/yr)	13.6E3

4.2.1 Site Based IWM and Treatment Options

The subject site is located within a number of small catchments which drain from north to south towards the Barwon River. The South Geelong area in which the site is located is well established and, as a result of its age, has very little by way of water quality treatment and/or integrated water management.

Previous assessments undertaken by Water Technology as part of the Fyans – West Fyans Precinct Drainage Report 2018 outline a number of potential retrofit options to manage water quality within this precinct. This included the construction of a wetland within open space between Barwon Terrace and the river. Additionally, the installation of additional gross pollutant traps within the lower areas of the catchment adjacent to the river were recommended.

In relation to the three modules which form the basis of this study area, there are a number of limitations relating to the likely timing of development and network connections within the sites which lend themselves to future site-based water quality treatment measures being the most effective use of space and most practical treatment option. Options which would be suitable to consider at a site (module) scale and which have the potential to meet both water quality treatment and integrated water management standards may include:

- Proprietary treatment products (ie. SPEL- Ecoceptor)
- Gross Pollutant Trap – CDS Units
- Rain Water Tanks
- Rain Gardens
- Bio-retention system

A main drainage outfall passes along Yarra, Bellerine and Swanson Street which enable easy connection into the existing network from each of the respective modules. Further to the above, the identified high flooding risk within the southern area of the sites provides opportunities to install more extensive water treatment or IWM assets amongst public or private open space.



5 SUMMARY

Located within the floodplain of the Barwon River, existing conditions flood modelling indicates the precinct is subject to significant flood depths during a 1% AEP flood event. Within the 3 development areas (modules), flood depths are shown to range up to 2.14 metres, with a significant portion of each of the respective modules considered unsuitable for development. These areas do not meet the access safety requirements outlined in the DELWP Guidelines for Development in Flood Affected Areas.

Access to these areas via Barwon Terrace is also considered to be unsafe during flood events up to and including the 1% AEP.

As part of this analysis, Two options were assessed in order to understand the development potential for the area based on alterations of the site topography to both provide a reasonable development area whilst complying with the DELWP Guidelines for Development in Flood Affected Areas and further advice provided by Corangamite CMA.

In considering options for cut and fill within this area, an approach which broke up the precinct into modules was undertaken. This was recommended to provide a reasonable and practical approach to both the calculation of cut and fill within the precinct and to ensure an equitable development solution within individual parcels of land. It is noted that a considerable proportion of a number of the lots within Module 2 and 3 are owned separately. If development was to occur on a site by site basis in this area, it is unlikely that a meaningful development footprint with sufficient flood free land and access could be provided. Calculating cut and fill options at this level also enables for works within the lower lying land to occur as a means of facilitating the filling of the lots fronting Little Fyans Street. This also enables the potential passive use of the flood prone area for open space, WSUD, parkland and or recreational use. The proposed terracing of the modules also supports a greener interface with the existing river corridor and adjoining recreational areas.

An assessment of the two cut and fill options discussed above was undertaken for both the 1% and 10% AEP flood events. The results indicate that the proposed works have a minor and localised impact on flood levels within this area with impacts largely contained within the development areas.

An assessment of the existing stormwater network at this location indicates limited opportunity for a consolidated water treatment asset in this area. Given the limitations around the numerous main drains which flow in a north-south direction discharging to the Barwon River, it is recommended that future development consider site-based water quality treatment and or integrated water management. Options which are likely to be more suitable in this area include proprietary products which will enable adequate treatment of runoff within the site whilst minimising the required footprint and impacts associated within being located within the floodplain.



APPENDIX A SITE SECTIONS (TOPOGRAPHY AND DESIGN FLOOD LEVELS)

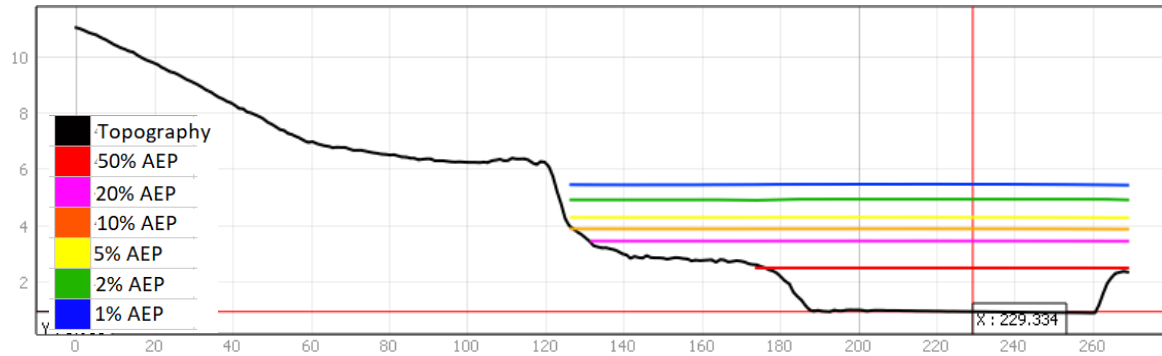




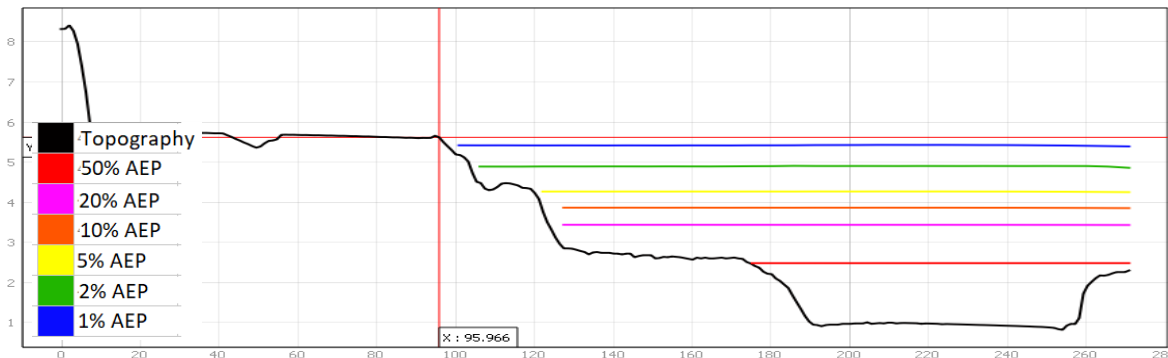
Figure A-1 Site Cross-section



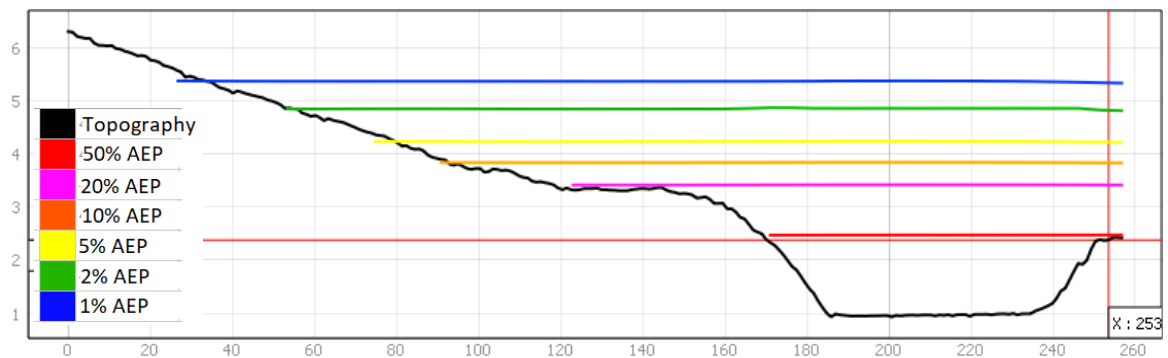
Section 1



Section 1A

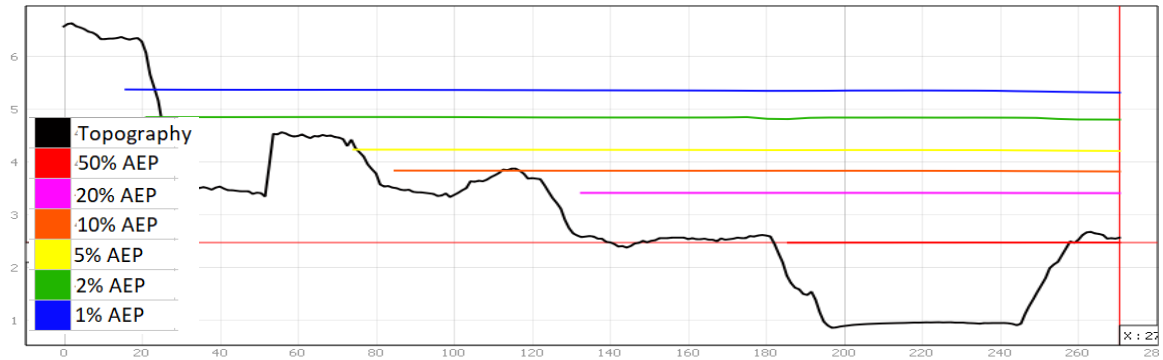


Section 2

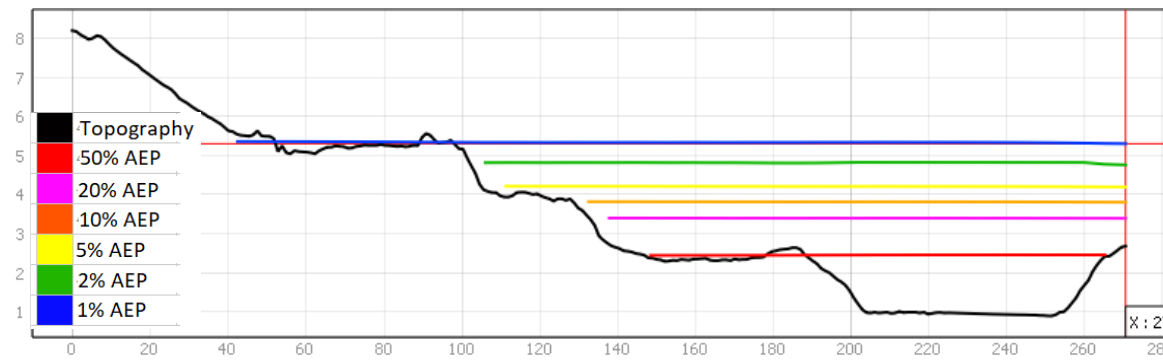




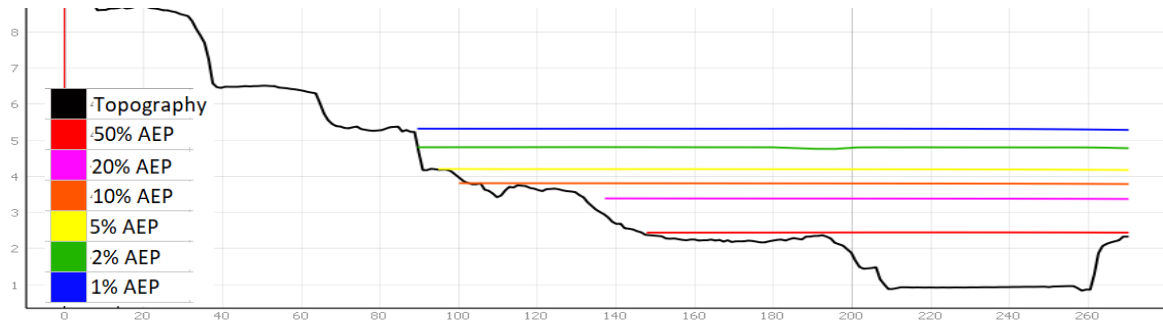
Section 2A



Section 3

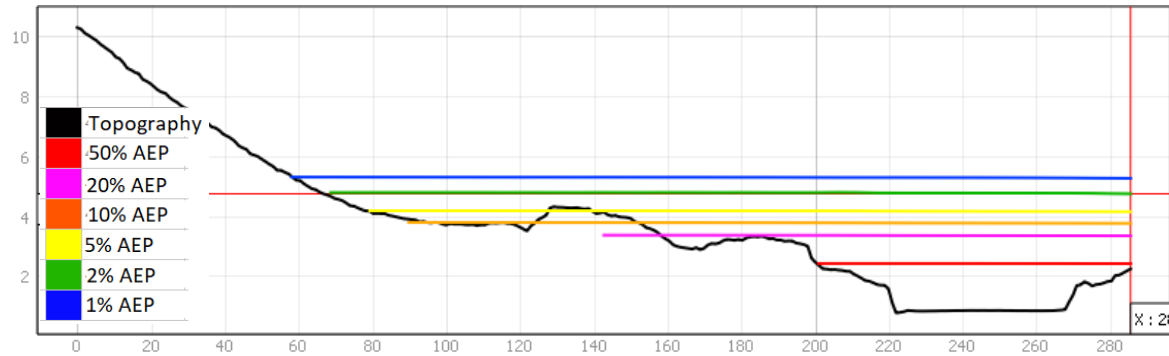


Section 3A

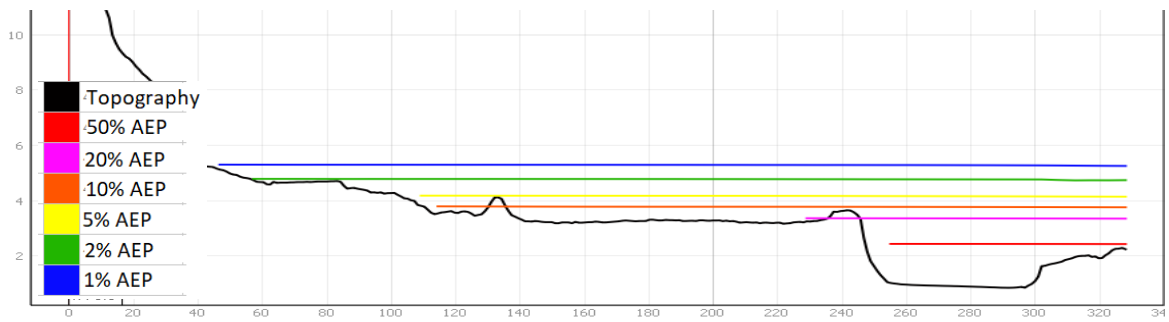




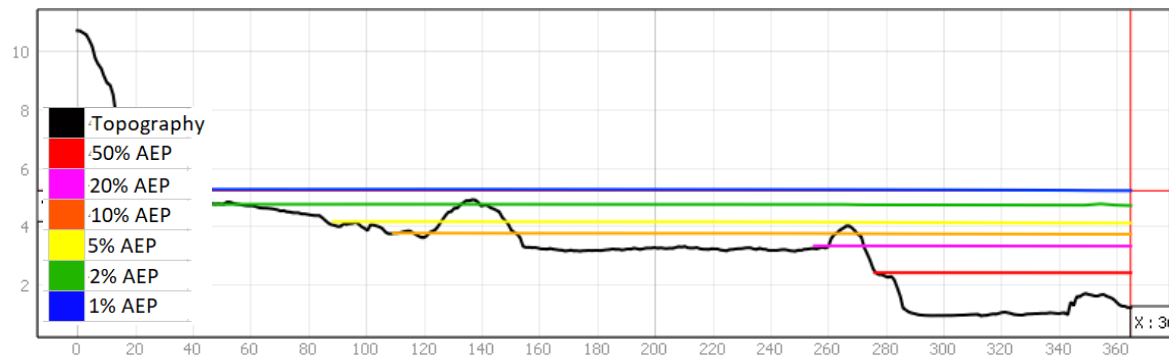
Section 4



Section 4A

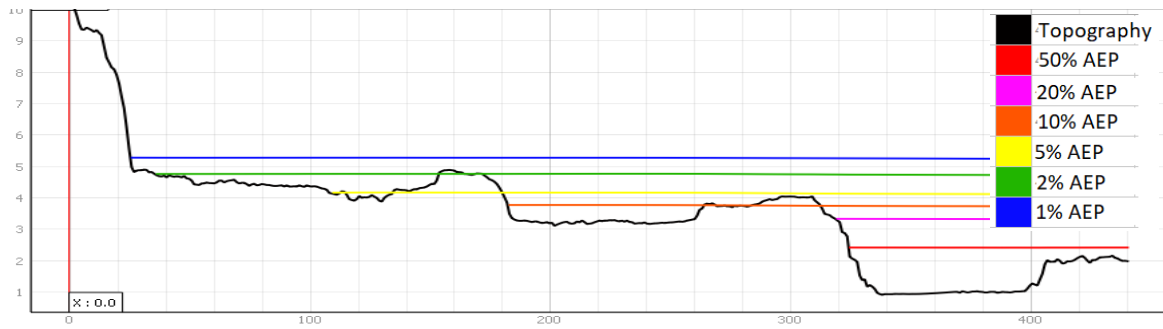


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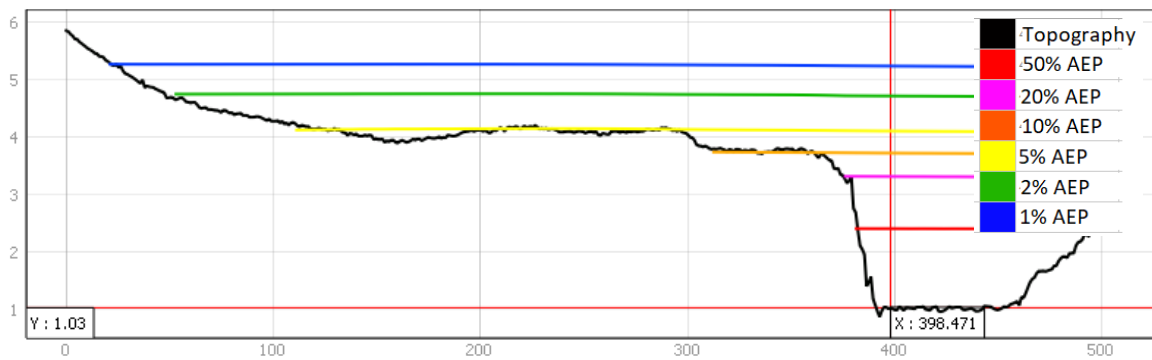




Section 5A



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