APPENDIX B

REVIEW OF PREVIOUS STUDIES

B1 BEAUFORT FLOOD STUDY (WATER TECHNOLOGY, 2008)

B1.1 BACKGROUND

The Beaufort Flood Study (Water Technology, 2008) was undertaken in 2008. The study was initiated by the Glenelg Hopkins CMA and Pyrenees Shire Council in response to concern over uncertainties in understanding and definition of flood risk for the Beaufort township. The study provided information on flood levels and flood risk within the Beaufort township.

There were no formal records of flooding either in authority archives or gained through community consultation efforts carried out by Water Technology consultants in 2008 as part of the Beaufort Flood Study. Three flood marks were identified in community consultations carried out by Water Technology as part of their study which were found to be either the result of localised flash flooding or related to unknown flood events.

The Beaufort Flood Study (Water Technology, 2008) was based on survey data gathered using aerial photogrammetry and land based techniques. The photogrammetry provided a base digital terrain model (DTM) for the Yam Holes Creek catchment to Beaufort, with the land based survey used to define existing critical hydraulic structures in the township (bridges and culverts) as well as key waterway cross sections.

B1.2 MODELLING METHODOLOGY

A RORB hydrologic model was developed as part of the Beaufort Flood Study (Water Technology, 2008) to estimate design flood flows for Yam Holes Creek to Beaufort (refer Section 7.4). A detailed two-dimensional hydraulic model was developed using MIKE FLOOD (DHI Software) to investigate the extent of flooding, flood height and flood velocities. MIKE FLOOD is a comprehensive modelling package for modelling of complex flow paths encountered on floodplain. It consists of a two-dimensional model (MIKE 21) linked to a one-dimensional model (MIKE 11). Detailed calibration of the MIKE FLOOD model was not possible because of the absence of formal records on flooding. In lieu of calibration, anecdotal evidence on flooding gained from the community consultation was used to verify the MIKE FLOOD model. The Beaufort Flood Study considered 5, 10, 20, 50, 100 ARI design flood events and the probable maximum flood (PMF).

The 100 year ARI flood inundation map for existing conditions, in the absence of any flood mitigation measures, is provided in Figure 11-1. The number of properties in the Beaufort township impacted by flooding for different recurrence intervals for existing conditions is provided in Table B1 (Water Technology, 2008).

B1.3 RESULTS

The Beaufort Flood Study (Water Technology, 2008) results indicated that the area south of the railway line in the Cemetery Creek and Cumberland Creek catchments is the most flood-affected area within Beaufort. A large amount of water pools in this area due to the limited culvert and bridge structures that restrict water movement through the railway line. There is a difference in water surface in the 100 year ARI event of approximately 0.5 m at the railway bridge on Cemetery Creek, and approximately 0.8 m difference though the culverts on Cumberland Creek. These results are considered reasonable due to the limited size of the structures at the railway line and the potential for them to become blocked from debris during large flows. It may be possible to reduce water levels in this area by upgrading the structures underneath the railway line (Water Technology, 2008).

The Cemetery Creek catchment contributes most of the flows upstream of the railway line and contributes the greatest potential damage to property, which predominantly occurs along its channel. Lake Beaufort was assumed to be full at the beginning of the design storm events, based on the assumption that large events are likely to occur during the wet winter-spring period (Water Technology, 2008).

Ding Dong Creek, due to its relatively small catchment size, was mostly contained within its drainage channel and poses little threat to property. The downstream end of Cumberland Creek breaches its channel considerably, however this is mostly due to the large backwater pool caused by flows down Cemetery Creek (Water Technology, 2008).

The constructed channel on Yam Holes Creek has insufficient capacity to convey 100 year ARI flows, hence water breaks out upstream of Beaufort-Amphitheatre Road. The large floodplain downstream of the Beaufort township on Yam Holes Creek becomes significantly inundated for all design events (Water Technology, 2008).

The railway embankment significantly impedes floodwaters flowing into Yam Holes Creek and is a major cause of flooding in Beaufort (Water Technology, 2008).

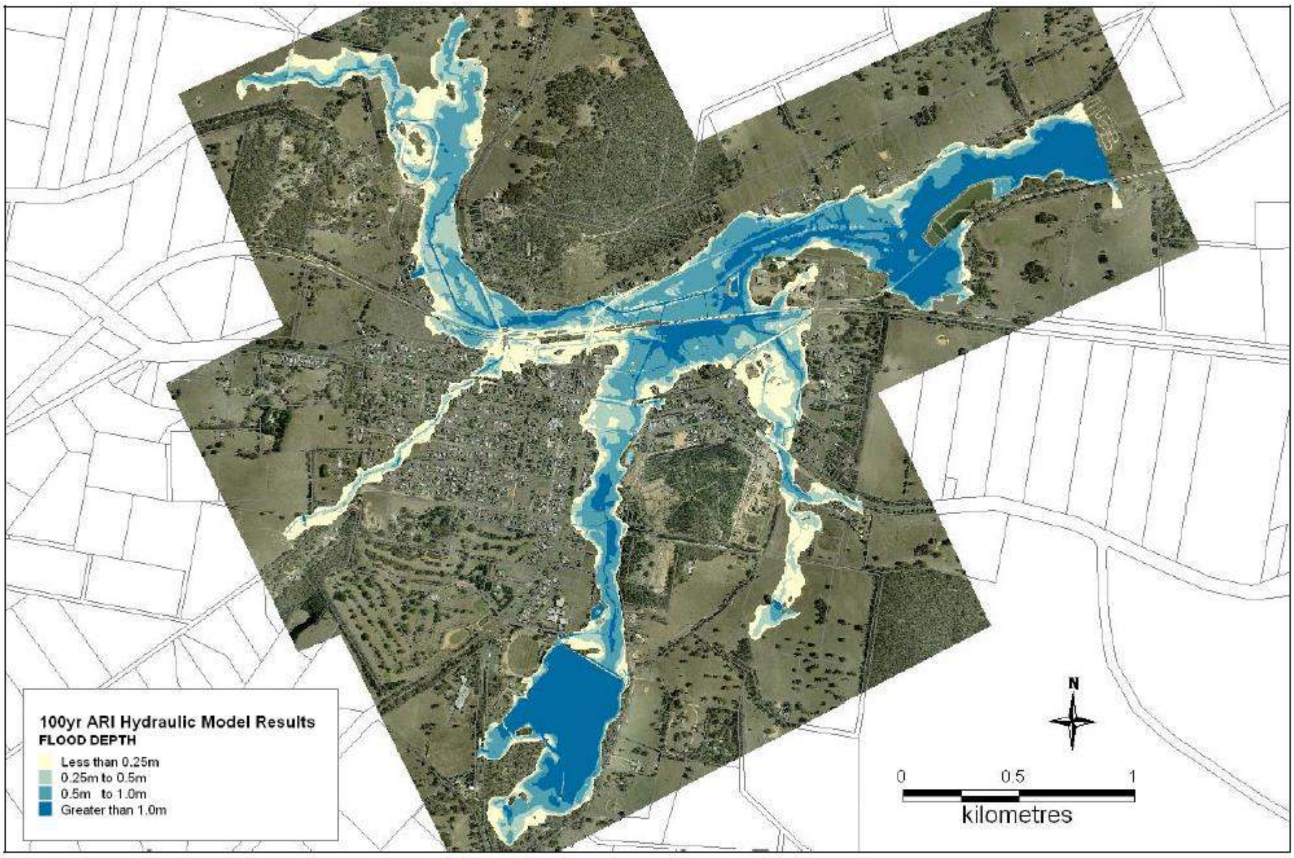

Figure 11-1 100 year ARI flood inundation map - unmitigated scenario (Water Technology, 2008)

Table A.1 Estimated number of flooded properties - unmitigated scenario (Water Technology, 2008)

	DESIGN FLOOD (ARI (YEARS)					
	5	10	20	50	100	PMF
Properties flooded above floor	12	21	31	32	41	211
Properties flooded below floor	169	176	178	179	173	50

	DESIGN FLOOD (ARI (YEARS)					
	5	10	20	50	100	PMF
Total flooded properties	**181**	**197**	**209**	**211**	**214**	**261**

In a later study by Water Technology in 2011, a number of possible structural flood mitigation options were investigated for the Beaufort township.

B2 RAILWAY LINE CULVERT UPGRADE (WATER TECHNOLOGY 2012)

In February 2012, the Pyrenees Shire Council provided a set of design drawings for proposed culvert upgrades for the railway line as well as a proposed floodway and culvert for Cumberland Creek at Racecourse Road. These structures were assessed by Water Technology to determine their effectiveness in reducing flood levels upstream of the railway. In 2012 Pyrenees Shire Council requested that the existing hydraulic model for Beaufort be used to test a changed culvert arrangement at Racecourse Road as well as the railway culverts proposed during modelling completed during February 2012. The performance of the proposed works was modelled by Water Technology in the same year using the 100 year ARI event and the maximum Water Surface Elevations observed during 9 and 36 hour events. Following communication with the Pyrenees Shire council it was confirmed that the culverts under the rail alignment have been built, and an alternate large-span culvert structure was built at Racecourse Road.

The MIKE FLOOD model developed by Water Technology for the February 2012 work, incorporating the proposed railway culvert upgrades and proposed floodway and culvert for Cumberland Creek at Racecourse Road, was made available for the Beaufort Bypass EES. The MIKE FLOOD model ends just past the township of Beaufort and does not cover the Yam Holes Creek waterway crossings of the proposed alignment options downstream of Beaufort. The current MIKE FLOOD model will be used as the basis of the flood modelling analysis for this EES for the portion of the alignment that it covers. For the remainder of the alignment outside the current model extent, either a new model or extension of the existing model will be required.

APPENDIX C

HYDROLOGIC AND HYDRAULIC MODEL DETAILS

C1.1 INTRODUCTION

A summary of the hydrology and hydraulic modelling undertaken for the Beaufort Bypass project surface water impact assessment is included in this appendix.

A hydrology modelling was required to estimate the magnitude of runoff from the catchments within the project area for a range of storm events. The estimated flows from the hydrologic model (RORB) were used to inform a two-dimensional hydraulic model (TUFLOW) established for the floodplain within the extent of the proposed project, to estimate the direction, depth and velocity of flood flows resulting from each storm event.

Hydraulic modelling for performed for both baseline and proposed conditions to identify the existing flooding conditions and the potential impacts which is likely to occur on those conditions as a result of the project.

C1.2 HYDROLOGIC MODELLING

A hydrologic model was established for the catchments within the project study area to simulate the hydrologic regime of local watersheds. The model was built on RORB platform, which is a runoff routing software originally developed by Eric Laurenson and Russell Mein in the Civil Engineering Department of Monash University. The RORB hydrologic model was used to calculate flood hydrographs from rainfall data and local catchment and waterway characteristics, by subtracts losses from rainfall to produce rainfall-excess and routes this through catchment storage to produce the flood hydrographs corresponding to each storm event.

RORB's standard GIS plug-in (miRORB) was used to breakdown the total catchment into smaller subareas and derive the physiographic characteristics of each subarea including area, impervious fraction, slope and length of waterways within each subarea with high accuracy. The catchment parameters used in the RORB model are listed in Table C.1, which are based on the calibration undertaken by Water Technology in Beaufort Flood Study (Water Technology, 2008). A large part of the proposed project is located within the catchment area in that study; as such, it was considered necessary to adopt the same model parameters in current hydrologic modelling.

Table C.1 RORB model parameters

PARAMETER	CALIBRATED VALUE
m	0.80
kc	8.80
Initial Loss (I.L.)	19.80mm
Continuing Loss (C.L.)	1.00mm

The latest version of RORB was used, which had built-in capabilities for utilisation of the Australian Rainfall & Runoff 2016 Guidelines in the simulation. The rainfall intensity-frequency-duration curve for the study area is presented in Figure 11-2.

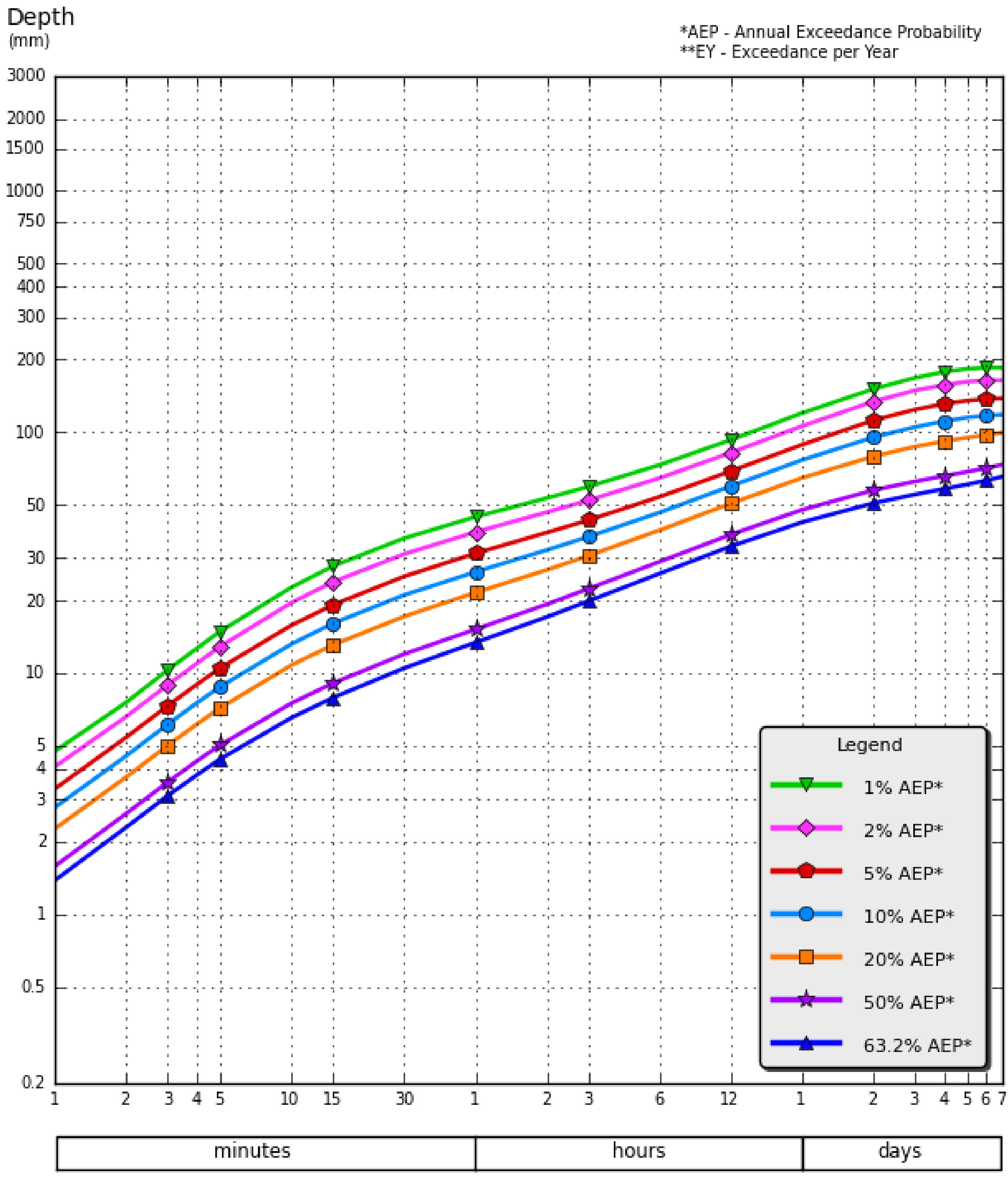

Figure 11-2 Rainfall intensity-frequency-duration curves for Beaufort area

To save in time and cost of the hydraulic modelling, the minimum required extent of the hydraulic model was selected to include all critical project components, existing roads and drainage infrastructure and other important features. Parts of the catchment outside the extent of the hydraulic model were included in the hydrologic model and results from the hydrologic model were used to inform the hydraulic model in form of local Discharge-Time (Q-T) boundary conditions at the interface locations.

The extents of the hydrologic and hydraulic model, and the interface nodes where flood hydrographs from the hydrologic model were exported to the hydraulic model are shown in Figure 11-3.

The estimated 1% AEP peak flows at the interface nodes shown in Figure 11-3 are presented in Table C.2.

Table C.2 The estimated 1% AEP peak flows from the RORB model

LOCATION	1% AEP PEAK FLOW (m^3/s)
N1	31.16
S1	9.54
S2	6.54
S3	40.99
S4	15.94

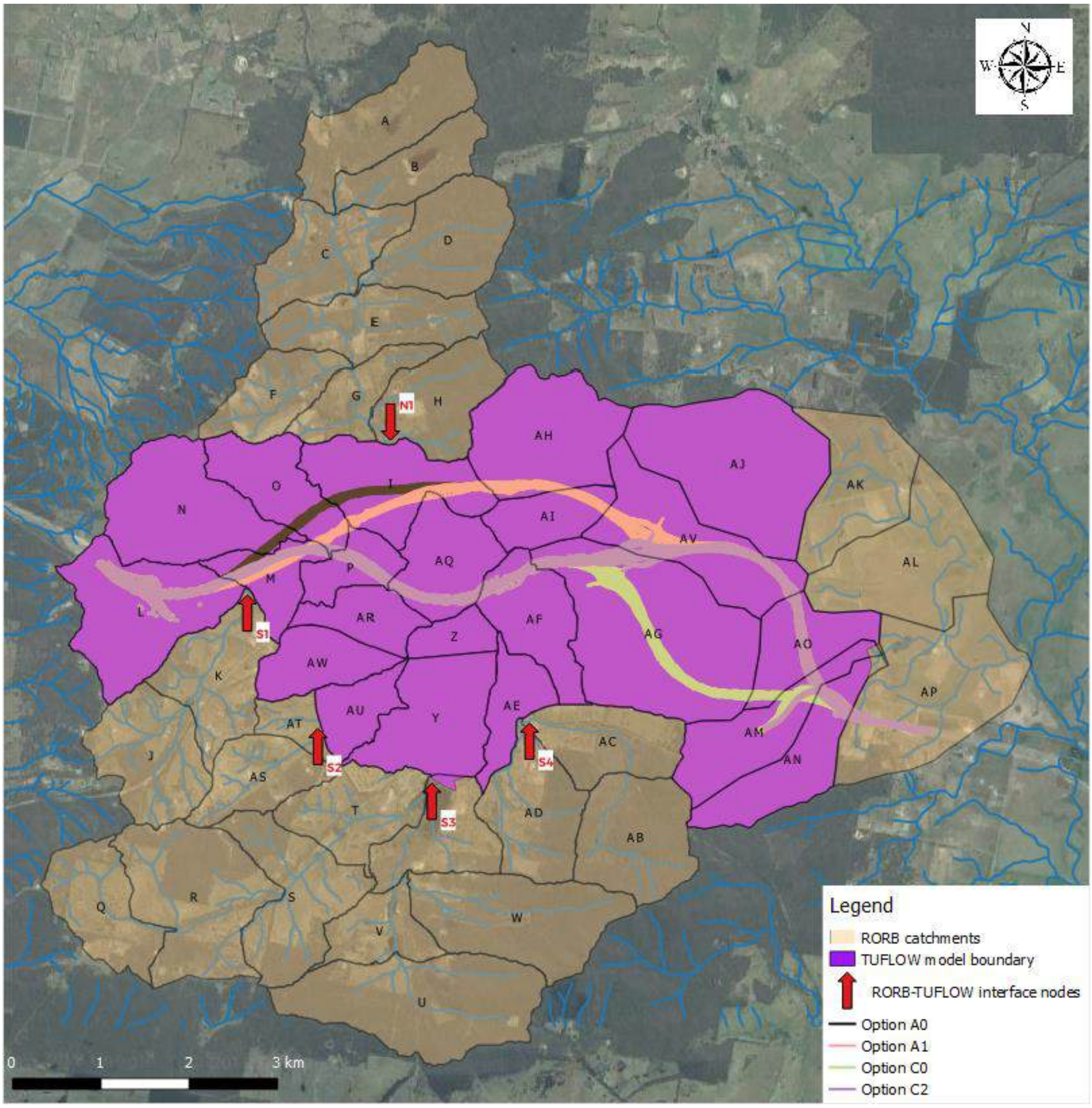

Figure 11-3 The extent of the hydrologic (RORB) and hydraulic (TUFLOW) models and the interface nodes.

C1.3 HYDRAULIC MODELLING

A two-dimensional hydraulic model was developed for the area shown in Figure 11-3, to identify the baseline flooding conditions under storm events with different recurrence intervals, and investigate the post-developed flooding conditions. The hydraulic modelling was undertaken in TUFLOW, which is a powerful software for solution of unsteady shallow water equations.

The details of the hydraulic model are summarised in Table C.3.

Table C.3 Details of the hydraulic model (TUFLOW)

PARAMETER	VALUE
Software release version	2018-03-AA w64
Solution scheme	HPC
Ground elevation data	LiDAR: - Water Technology (2018) - VicRoads (2016) - Within Mike Flood model (2008)
Grid resolution	5m
Solution time step	2 seconds
1D/2D Scheme	2D only
Model area	29.7 km^2
External inflows	RORB-generated hydrographs
Rainfall-runoff engine	On-grid excess rainfall (SA)
Upstream boundary conditions	None
Downstream boundary conditions	Normal flow

Due to the poor quality and insufficient coverage of the supplementary LiDAR data supplied from Water Technology, the boundary of the hydraulic model was selected to the minimum extent required to include the key features required for modelling. The parts of the catchment located outside of the hydraulic model boundary were included in the hydrologic model.

The existing infrastructure data such as the elevation and dimensions of road and railway embankments, bridges and culverts were derived from VicRoads' database, feature survey, data embedded in the Beaufort flood model (Water Technology, 2008) and the data surveyed during site visits.

The hydraulic model was used to investigate flooding conditions for 1hr, 2hr, 3hr, 6hr, 9hr, 12hr, 24hr and 36hr storm events. It was evident that the 6-hour storm resulted in highest flood levels.

For the purpose of the bypass alignment options assessment only and as discussed with the Glenelg Hopkins Catchment Management authority, the maximum allowable afflux was set to 100mm. Once a preferred alignment option is selected by RRV, GHCMA will not accept afflux exceeding 10 mm, unless formal agreements are made with potentially affected landholders.

To compare the flooding conditions associated with each alignment option, individual "design" hydraulic models were developed for each of the alignment options, in which the proposed road embankment for that alignment option was added to the model. To allow the flow of water across the proposed road, the embankment for each alignment option was cut to the minimum required length to limit the afflux in the floodplain to 50mm. While, the absence of a designed cross-drainage structure at the waterway crossings may not yield an accurate representation of the final developed conditions, it will yield sufficiently accurate results to compare the impacts associated with the alignment options.

APPENDIX D

SURFACE WATER RISK ASSESSMENT AND RISK REGISTER

Project	Beaufort Bypass	Lead	WSP
Description	EES Environmental Risk Register	Last Updated	Dec-20

				Impact Pathway					Initial Risk				Residual Risk		
Risk No.	Alignment Option	Discipline	Project Phase	Project Activity / Aspect	Primary Environmental Impact	Secondary Environmental Impact (if applicable) (further details provided in column V)	Description of risk and impact	Standard Controls (i.e. VicRoads Contract Specification e.g. Section 177, Section 720, Section 750; EPA Environmental Guidelines for Civil Construction, building and demolition and other relevant industry standards) (please detail)	Consequence	Likelihood	Risk Rating	Additional Controls (recommended to further reduce risk)	Consequence	Likelihood	Risk Rating
SW1a	A0	Surface Water	Initial	Design	Changes Hydrology		The final design alters local hydrology regime and negatively impacts on flooding, water quality and / or habitat.	Use hydrologic and hydraulic numerical modelling to inform the functional design of the bypass corridor. Consultation with CMA and Council to confirm surface water performance criteria (flood risk and drainage) for detail design. Preferred bypass alignment to be modelled to meet CMA and Council criteria. For preferred option, impacts on wetlands from road drainage discharge to be assessed by developing road drainage design concepts and water quality modelling using MUSIC.	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low
SW1b	A1	Surface Water	Initial	Design	Changes Hydrology		The final design alters local hydrology regime and negatively impacts on flooding, water quality and / or habitat.	Use hydrologic and hydraulic numerical modelling to inform the functional design of the bypass corridor. Consultation with CMA and Council to confirm surface water performance criteria (flood risk and drainage) for detail design. Preferred bypass alignment to be modelled to meet CMA and Council criteria. For preferred option, impacts on wetlands from road drainage discharge to be assessed by developing road drainage design concepts and water quality modelling using MUSIC.	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low
SW1c	C0	Surface Water	Initial	Design	Changes Hydrology		The final design alters local hydrology regime and negatively impacts on flooding, water quality and / or habitat.	Use hydrologic and hydraulic numerical modelling to inform the functional design of the bypass corridor. Consultation with CMA and Council to confirm surface water performance criteria (flood risk and drainage) for detail design. Preferred bypass alignment to be modelled to meet CMA and Council criteria. For preferred option, impacts on wetlands from road drainage discharge to be assessed by developing road drainage design concepts and water quality modelling using MUSIC.	Major	Likely	High	None identified	Major	Likely	High
SW1d	C2	Surface Water	Initial	Design	Changes Hydrology		The final design alters local hydrology regime and negatively impacts on flooding, water quality and / or habitat.	Use hydrologic and hydraulic numerical modelling to inform the functional design of the bypass corridor. Consultation with CMA and Council to confirm surface water performance criteria (flood risk and drainage) for detail design. Preferred bypass alignment to be modelled to meet CMA and Council criteria. For preferred option, impacts on wetlands from road drainage discharge to be assessed by developing road drainage design concepts and water quality modelling using MUSIC.	Minor	Unlikely	Low	None identified	Minor	Unlikely	Low
SW2a	A0	Surface Water	Initial	Planning	Statutory planning and environmental approval non-compliances		Unable to meet the Permit and Approval requirements	Planners, designers and managers review Legislation and Policies throughout the design process to ensure the design is compliant with legislation and approvals. Relevant legislation and strategies include: - Environmental Protection Act 1970 - State Environment Protection Policy (SEPP) (Waters) - Planning and Environment Act (1987) - Victorian Planning Policy (VPP) Framework - VPP Overlays - Water Act 1989 - Catchment and Land Protection Act 1994 - Local Planning Policy Framework - Glenelg Hopkins CMA relevant catchment management strategies and guidelines. Comprehensive understanding of applicable legislation and policy requirements to align construction activities and final design carefully with the applicable requirements. Effective communication with stakeholders to identify potential departures in early phases	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low

				Impact Pathway					Initial Risk				Residual Risk		
Risk No.	Alignment Option	Discipline	Project Phase	Project Activity / Aspect	Primary Environmental Impact	Secondary Environmental Impact (if applicable) (further details provided in column V)	Description of risk and impact	Standard Controls (i.e. VicRoads Contract Specification e.g. Section 177, Section 720, Section 750; EPA Environmental Guidelines for Civil Construction, building and demolition and other relevant industry standards) (please detail)	Consequence	Likelihood	Risk Rating	Additional Controls (recommended to further reduce risk)	Consequence	Likelihood	Risk Rating
SW2b	A1	Surface Water	Initial	Planning	Statutory planning and environmental approval non-compliances		Unable to meet the Permit and Approval requirements	Planners, designers and managers review Legislation and Policies throughout the design process to ensure the design is compliant with legislation and approvals. Relevant legislation and strategies include: - Environmental Protection Act 1970 - State Environment Protection Policy (SEPP)(Waters) - Planning and Environment Act (1987) - Victorian Planning Policy (VPP) Framework - VPP Overlays - Water Act 1989 - Catchment and Land Protection Act 1994 - Local Planning Policy Framework - Glenelg Hopkins CMA relevant catchment management strategies and guidelines. Comprehensive understanding of applicable legislation and policy requirements to align construction activities and final design carefully with the applicable requirements. Effective communication with stakeholders to identify potential departures in early phases	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low
SW2c	C0	Surface Water	Initial	Planning	Statutory planning and environmental approval non-compliances		Unable to meet the Permit and Approval requirements	Planners, designers and managers review Legislation and Policies throughout the design process to ensure the design is compliant with legislation and approvals. Relevant legislation and strategies include: - Environmental Protection Act 1970 - State Environment Protection Policy (SEPP)(Waters) - Planning and Environment Act (1987) - Victorian Planning Policy (VPP) Framework - VPP Overlays - Water Act 1989 - Catchment and Land Protection Act 1994 - Local Planning Policy Framework - Glenelg Hopkins CMA relevant catchment management strategies and guidelines. Comprehensive understanding of applicable legislation and policy requirements to align construction activities and final design carefully with the applicable requirements. Effective communication with stakeholders to identify potential departures in early phases	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low
SW2d	C2	Surface Water	Initial	Planning	Statutory planning and environmental approval non-compliances		Unable to meet the Permit and Approval requirements	Planners, designers and managers review Legislation and Policies throughout the design process to ensure the design is compliant with legislation and approvals. Relevant legislation and strategies include: - Environmental Protection Act 1970 - State Environment Protection Policy (SEPP)(Waters) - Planning and Environment Act (1987) - Victorian Planning Policy (VPP) Framework - VPP Overlays - Water Act 1989 - Catchment and Land Protection Act 1994 - Local Planning Policy Framework - Glenelg Hopkins CMA relevant catchment management strategies and guidelines. Comprehensive understanding of applicable legislation and policy requirements to align construction activities and final design carefully with the applicable requirements. Effective communication with stakeholders to identify potential departures in early phases	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low
SW3a	A0	Surface Water	Development	Clearing	Impacts on surface water quality		Destruction of vegetation results in changes to water quality and/or flooding conditions such as frequency and duration of flooding and increases to flood levels or flow velocities. The extent of ground disturbance within 50 m of Designated Waterways is 11.6 hectares.	Implementation of VicRoads Specification (Section 177 Part B - Water Quality and Section 177D (sediment and erosion control)). Implementation of other guidelines including: - EPA Publication No. 275. Construction Techniques for Sediment Pollution Control (1991) - EPA Publication No. 1834, Civil construction, building and demolition guide (2020) Works to be carried out in consultation with Glenelg Hopkins CMA and Pyrenees Shire Council. The CMA to approve the CEMP prior to construction works commencing on site. Regular supervision to ensure the CEMP is being full implemented and, reviews and improvements to the EMP are being carried out when necessary.	Minor	Possible	Low	Appropriately manage sediment control where highly dispersive soils and high erosion potential have been identified	Minor	Unlikely	Low

				Impact Pathway					Initial Risk				Residual Risk		
Risk No.	Alignment Option	Discipline	Project Phase	Project Activity / Aspect	Primary Environmental Impact	Secondary Environmental Impact (if applicable) (further details provided in column V)	Description of risk and impact	Standard Controls (i.e. VicRoads Contract Specification e.g. Section 177, Section 720, Section 750; EPA Environmental Guidelines for Civil Construction, building and demolition and other relevant industry standards) (please detail)	Consequence	Likelihood	Risk Rating	Additional Controls (recommended to further reduce risk)	Consequence	Likelihood	Risk Rating
SW3b	A1	Surface Water	Development	Clearing	Impacts on surface water quality		Destruction of vegetation results in changes to water quality and/or flooding conditions such as frequency and duration of flooding and increases to flood levels or flow velocities. The extent of ground disturbance within 50 m of Designated Waterways is 12.4 hectares.	Implementation of VicRoads Specification (Section 177 Part B - Water Quality and Section 177D (sediment and erosion control)). Implementation of other guidelines including: - EPA Publication No. 275. Construction Techniques for Sediment Pollution Control (1991) - EPA Publication No. 1834, Civil construction, building and demolition guide (2020) Works to be carried out in consultation with Glenelg Hopkins CMA and Pyrenees Shire Council. The CMA to approve the CEMP prior to construction works commencing on site. Regular supervision to ensure the CEMP is being full implemented and, reviews and improvements to the EMP are being carried out when necessary.	Minor	Possible	Low	Appropriately manage sediment control where highly dispersive soils and high erosion potential have been identified	Minor	Unlikely	Low
SW3c	C0	Surface Water	Development	Clearing	Impacts on surface water quality		Destruction of vegetation results in changes to water quality and/or flooding conditions such as frequency and duration of flooding and increases to flood levels or flow velocities. The extent of ground disturbance within 50 m of Designated Waterways is 19.5 hectares.	Implementation of VicRoads Specification (Section 177 Part B - Water Quality and Section 177D (sediment and erosion control)). Implementation of other guidelines including: - EPA Publication No. 275. Construction Techniques for Sediment Pollution Control (1991) - EPA Publication No. 1834, Civil construction, building and demolition guide (2020) Works to be carried out in consultation with Glenelg Hopkins CMA and Pyrenees Shire Council. The CMA to approve the CEMP prior to construction works commencing on site. Regular supervision to ensure the CEMP is being full implemented and, reviews and improvements to the EMP are being carried out when necessary.	Minor	Possible	Low	Appropriately manage sediment control where highly dispersive soils and high erosion potential have been identified	Minor	Unlikely	Low
SW3d	C2	Surface Water	Development	Clearing	Impacts on surface water quality		Destruction of vegetation results in changes to water quality and/or flooding conditions such as frequency and duration of flooding and increases to flood levels or flow velocities. The extent of ground disturbance within 50 m of Designated Waterways is 24.5 hectares.	Implementation of VicRoads Specification (Section 177 Part B - Water Quality and Section 177D (sediment and erosion control)). Implementation of other guidelines including: - EPA Publication No. 275. Construction Techniques for Sediment Pollution Control (1991) - EPA Publication No. 1834, Civil construction, building and demolition guide (2020) Works to be carried out in consultation with Glenelg Hopkins CMA and Pyrenees Shire Council. The CMA to approve the CEMP prior to construction works commencing on site. Regular supervision to ensure the CEMP is being full implemented and, reviews and improvements to the EMP are being carried out when necessary.	Minor	Possible	Low	Appropriately manage sediment control where highly dispersive soils and high erosion potential have been identified	Minor	Unlikely	Low
SW4a	A0	Surface Water	Development	Construction	Changes Hydrology		Temporary works during the construction period alters existing waterway regimes in form of: - changes to flooding conditions such as frequency and duration of flooding, increased flood levels or flow velocities - reduction of floodplain storage or other changes to flow regimes leading to increases to peak flows or floodwater volumes. The length of the bypass alignment located within the 1% AEP flood extent is approximately 1.3 km.	Works shall be carried out in accordance with: - VicRoads Contract Specification Section 177.B in relation to environmental management plans. - CMA requirements, permits will be required for works on designated waterways. VicRoads maintenance and construction projects are required to develop a Construction Environmental Management Plan (CEMP). The CEMP should outline how the contractor will comply with any environmental conditions for the project and provide a framework to ensure that environmental risks are properly managed. Temporary works that impact the floodplain should be modelled The CMA to approve the CEMP prior to construction works commencing on site. Regular supervision to ensure the CEMP is being full implemented and, reviews and improvements to the CEMP are being carried out when necessary. Wherever possible construction works required for the project should occur outside the extent of the 1% AEP floodplain, to reduce the risk of increased inundation of properties.	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low

				Impact Pathway					Initial Risk				Residual Risk		
Risk No.	Alignment Option	Discipline	Project Phase	Project Activity / Aspect	Primary Environmental Impact	Secondary Environmental Impact (if applicable) (further details provided in column V)	Description of risk and impact	Standard Controls (i.e. VicRoads Contract Specification e.g. Section 177, Section 720, Section 750; EPA Environmental Guidelines for Civil Construction, building and demolition and other relevant industry standards) (please detail)	Consequence	Likelihood	Risk Rating	Additional Controls (recommended to further reduce risk)	Consequence	Likelihood	Risk Rating
SW4b	A1	Surface Water	Development	Construction	Changes Hydrology		Temporary works during the construction period alters existing waterway regimes in form of: - changes to flooding conditions such as frequency and duration of flooding, increased flood levels or flow velocities - reduction of floodplain storage or other changes to flow regimes leading to increases to peak flows or floodwater volumes. The length of the bypass alignment located within the 1% AEP flood extent is approximately 1.1 km.	Works shall be carried out in accordance with: - VicRoads Contract Specification Section 177.B in relation to environmental management plans. - CMA requirements, permits will be required for works on designated waterways. VicRoads maintenance and construction projects are required to develop a Construction Environmental Management Plan (CEMP). The CEMP should outline how the contractor will comply with any environmental conditions for the project and provide a framework to ensure that environmental risks are properly managed. Temporary works that impact the floodplain should be modelled The CMA to approve the CEMP prior to construction works commencing on site. Regular supervision to ensure the CEMP is being full implemented and, reviews and improvements to the CEMP are being carried out when necessary. Wherever possible construction works required for the project should occur outside the extent of the 1% AEP floodplain, to reduce the risk of increased inundation of properties.	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low
SW4c	C0	Surface Water	Development	Construction	Changes Hydrology		Temporary works during the construction period alters existing waterway regimes in form of: - changes to flooding conditions such as frequency and duration of flooding, increased flood levels or flow velocities - reduction of floodplain storage or other changes to flow regimes leading to increases to peak flows or floodwater volumes. The length of the bypass alignment located within the 1% AEP flood extent is approximately 1.5 km.	Works shall be carried out in accordance with: - VicRoads Contract Specification Section 177.B in relation to environmental management plans. - CMA requirements, permits will be required for works on designated waterways. VicRoads maintenance and construction projects are required to develop a Construction Environmental Management Plan (CEMP). The CEMP should outline how the contractor will comply with any environmental conditions for the project and provide a framework to ensure that environmental risks are properly managed. Temporary works that impact the floodplain should be modelled The CMA to approve the CEMP prior to construction works commencing on site. Regular supervision to ensure the CEMP is being full implemented and, reviews and improvements to the CEMP are being carried out when necessary. Wherever possible construction works required for the project should occur outside the extent of the 1% AEP floodplain, to reduce the risk of increased inundation of properties.	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low
SW4d	C2	Surface Water	Development	Construction	Changes Hydrology		Temporary works during the construction period alters existing waterway regimes in form of: - changes to flooding conditions such as frequency and duration of flooding, increased flood levels or flow velocities - reduction of floodplain storage or other changes to flow regimes leading to increases to peak flows or floodwater volumes. The length of the bypass alignment located within the 1% AEP flood extent is approximately 2.0 km.	Works shall be carried out in accordance with: - VicRoads Contract Specification Section 177.B in relation to environmental management plans. - CMA requirements, permits will be required for works on designated waterways. VicRoads maintenance and construction projects are required to develop a Construction Environmental Management Plan (CEMP). The CEMP should outline how the contractor will comply with any environmental conditions for the project and provide a framework to ensure that environmental risks are properly managed. Temporary works that impact the floodplain should be modelled The CMA to approve the CEMP prior to construction works commencing on site. Regular supervision to ensure the CEMP is being full implemented and, reviews and improvements to the CEMP are being carried out when necessary. Wherever possible construction works required for the project should occur outside the extent of the 1% AEP floodplain, to reduce the risk of increased inundation of properties.	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low

				Impact Pathway					Initial Risk				Residual Risk		
Risk No.	Alignment Option	Discipline	Project Phase	Project Activity / Aspect	Primary Environmental Impact	Secondary Environmental Impact (if applicable) (further details provided in column V)	Description of risk and impact	Standard Controls (i.e. VicRoads Contract Specification e.g. Section 177, Section 720, Section 750; EPA Environmental Guidelines for Civil Construction, building and demolition and other relevant industry standards) (please detail)	Consequence	Likelihood	Risk Rating	Additional Controls (recommended to further reduce risk)	Consequence	Likelihood	Risk Rating
SW5a	A0	Surface Water	Development	Construction	Impacts on surface water quality		Construction activities leads to erosion and sedimentation in existing waterways or hazardous spills impact downstream waterways. The bypass alignment intersects existing waterways at 16 locations.	In accordance with VicRoads Contract Specification: - Section 177.B Water Quality and 177.D in relation to sediment and erosion control, - Section 177.1 in relation to environmental management plans and EPA Publications: - Construction Techniques for Sediment Pollution Control (1991) - Civil construction, building and demolition guide (2020) The CMA to approve the CEMP prior to construction works commencing on site. Regular supervision to ensure the CEMP is being full implemented and, reviews and improvements to the CEMP are being carried out when necessary.	Minor	Possible	Low	Not required	Minor	Possible	Low
SW5b	A1	Surface Water	Development	Construction	Impacts on surface water quality		Construction activities leads to erosion and sedimentation in existing waterways or hazardous spills impact downstream waterways. The bypass alignment intersects existing waterways at 16 locations.	In accordance with VicRoads Contract Specification: - Section 177.B Water Quality and 177.D in relation to sediment and erosion control, - Section 177.1 in relation to environmental management plans and EPA Publications: - Construction Techniques for Sediment Pollution Control (1991) - Civil construction, building and demolition guide (2020) The CMA to approve the CEMP prior to construction works commencing on site. Regular supervision to ensure the CEMP is being full implemented and, reviews and improvements to the CEMP are being carried out when necessary.	Minor	Possible	Low	Not required	Minor	Possible	Low
SW5c	C0	Surface Water	Development	Construction	Impacts on surface water quality		Construction activities leads to erosion and sedimentation in existing waterways or hazardous spills impact downstream waterways. The bypass alignment intersects existing waterways at 14 locations.	In accordance with VicRoads Contract Specification: - Section 177.B Water Quality and 177.D in relation to sediment and erosion control, - Section 177.1 in relation to environmental management plans and EPA Publications: - Construction Techniques for Sediment Pollution Control (1991) - Civil construction, building and demolition guide (2020) The CMA to approve the CEMP prior to construction works commencing on site. Regular supervision to ensure the CEMP is being full implemented and, reviews and improvements to the CEMP are being carried out when necessary.	Minor	Possible	Low	Not required	Minor	Possible	Low
SW5d	C2	Surface Water	Development	Construction	Impacts on surface water quality		Construction activities leads to erosion and sedimentation in existing waterways or hazardous spills impact downstream waterways. The bypass alignment intersects existing waterways at 16 locations.	In accordance with VicRoads Contract Specification: - Section 177.B Water Quality and 177.D in relation to sediment and erosion control, - Section 177.1 in relation to environmental management plans and EPA Publications: - Construction Techniques for Sediment Pollution Control (1991) - Civil construction, building and demolition guide (2020) The CMA to approve the CEMP prior to construction works commencing on site. Regular supervision to ensure the CEMP is being full implemented and, reviews and improvements to the CEMP are being carried out when necessary.	Minor	Possible	Low	Not required	Minor	Possible	Low

Risk No.	Alignment Option	Discipline	Project Phase	Impact Pathway Project Activity / Aspect	Primary Environmental Impact	Secondary Environmental Impact (if applicable) (further details provided in column V)	Description of risk and impact	Standard Controls (i.e. VicRoads Contract Specification e.g. Section 177, Section 720, Section 750; EPA Environmental Guidelines for Civil Construction, building and demolition and other relevant industry standards) (please detail)	Initial Risk Consequence	Likelihood	Risk Rating	Additional Controls (recommended to further reduce risk)	Residual Risk Consequence	Likelihood	Risk Rating
SW6a	A0	Surface Water	Development	Construction	Impacts on Surface Water Quality at MNES		Runoff during construction negatively impacts on water quality at sensitive MNES habitats. Flora and Fauna assessment identified within the project area: - 0.06 ha of seasonal wetlands (unlikely to have significant impact), - 2.64 ha of woodland and Derived Native Grassland within construction footprint (likely to have significant impact) - 1 threatened flora species (likely occurrence) - 3 threatened fauna species (low likelihood to moderate likelihood of occurrence)	Implementation of VicRoads Specification (Section 177 Part B - Water Quality and Section 177D (sediment and erosion control)). Implementation of other guidelines including: - EPA Publication No. 275. Construction Techniques for Sediment Pollution Control (1991) - EPA Publication No. 1834, Civil construction, building and demolition guide (2020) Works to be carried out in consultation with Glenelg Hopkins CMA and Pyrenees Shire Council. The CMA to approve the CEMP prior to construction works commencing on site.	Minor	Possible	Low	Not required	Minor	Possible	Low
SW6b	A1	Surface Water	Development	Construction	Impacts on Surface Water Quality at MNES		Runoff during construction negatively impacts on water quality at sensitive MNES habitats. Flora and Fauna assessment identified within the project area: - 0.06 ha of seasonal wetlands (unlikely to have significant impact), - 0.06 ha of woodland and Derived Native Grassland within construction footprint (unlikely to have significant impact) - 1 threatened flora species (likely occurrence) - 2 threatened fauna species (low likelihood to moderate likelihood of occurrence)	Implementation of VicRoads Specification (Section 177 Part B - Water Quality and Section 177D (sediment and erosion control)). Implementation of other guidelines including: - EPA Publication No. 275. Construction Techniques for Sediment Pollution Control (1991) -EPA Publication No. 1834, Civil construction, building and demolition guide (2020) Works to be carried out in consultation with Glenelg Hopkins CMA and Pyrenees Shire Council. The CMA to approve the CEMP prior to construction works commencing on site.	Minor	Possible	Low	Not required	Minor	Possible	Low
SW6c	C0	Surface Water	Development	Construction	Impacts on Surface Water Quality at MNES		Runoff during construction negatively impacts on water quality at sensitive MNES habitats.	Implementation of VicRoads Specification (Section 177 Part B - Water Quality and Section 177D (sediment and erosion control)). Implementation of other guidelines including: - EPA Publication No. 275. Construction Techniques for Sediment Pollution Control (1991) - EPA Publication No. 1834, Civil construction, building and demolition guide (2020) Works to be carried out in consultation with Glenelg Hopkins CMA and Pyrenees Shire Council. The CMA to approve the CEMP prior to construction works commencing on site.	Major	Likely	High	Water discharge at sensitive habitat/wetland locations will be designed to -maintain existing flow into those areas -not detrimentally impact water quality in these areas Contractor to consult with flora and fauna specialists to confirm water discharge quality requirements at sensitive habitat / wetlands	Minor	Likely	Medium
SW6d	C2	Surface Water	Development	Construction	Impacts on Surface Water Quality at MNES		Runoff during construction negatively impacts on water quality at sensitive MNES habitats. Flora and Fauna assessment identified within the project area: - 0.06 ha of seasonal wetlands (unlikely to have significant impact), - 3 threatened fauna species (low likelihood to moderate likelihood of occurrence)	Implementation of VicRoads Specification (Section 177 Part B - Water Quality and Section 177D (sediment and erosion control)). Implementation of other guidelines including: - EPA Publication No. 275. Construction Techniques for Sediment Pollution Control (1991) - EPA Publication No. 1834, Civil construction, building and demolition guide (2020) Works to be carried out in consultation with Glenelg Hopkins CMA and Pyrenees Shire Council. The CMA to approve the CEMP prior to construction works commencing on site.	Minor	Possible	Low	Not required	Minor	Possible	Low
SW7a	A0	Surface Water	Operation/Maintenance	Operation	Impacts on surface water quality		Traffic accidents resulting in contamination of waterways.	Carry out an accident and spills risk assessment at detailed design stage and provide spill containment at high risk areas where required Coordination with EPA on spill response	Moderate	Rare	Low	Not required	Moderate	Rare	Low
SW7b	A1	Surface Water	Operation/Maintenance	Operation	Impacts on surface water quality		Traffic accidents resulting in contamination of waterways.	Carry out an accident and spills risk assessment at detailed design stage and provide spill containment at high risk areas where required Coordination with EPA on spill response	Moderate	Rare	Low	Not required	Moderate	Rare	Low
SW7c	C0	Surface Water	Operation/Maintenance	Operation	Impacts on surface water quality		Traffic accidents resulting in contamination of waterways.	Carry out an accident and spills risk assessment at detailed design stage and provide spill containment at high risk areas where required Coordination with EPA on spill response	Moderate	Rare	Low	Not required	Moderate	Rare	Low
SW7d	C2	Surface Water	Operation/Maintenance	Operation	Impacts on surface water quality		Traffic accidents resulting in contamination of waterways.	Carry out an accident and spills risk assessment at detailed design stage and provide spill containment at high risk areas where required Coordination with EPA on spill response	Moderate	Rare	Low	Not required	Moderate	Rare	Low
SW8a	A0	Surface Water	Operation/Maintenance	Maintenance	Impacts on surface water quality		Maintenance activities have the potential to generate pollutants such as dust, herbicides, cleaning agents or spillages of diesel / petrol fuel spillages from maintenance plant.	Maintenance Management procedures are to be developed and approved by VicRoads.	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low

				Impact Pathway					Initial Risk				Residual Risk		
Risk No.	Alignment Option	Discipline	Project Phase	Project Activity / Aspect	Primary Environmental Impact	Secondary Environmental Impact (if applicable) (further details provided in column V)	Description of risk and impact	Standard Controls (i.e. VicRoads Contract Specification e.g. Section 177, Section 720, Section 750; EPA Environmental Guidelines for Civil Construction, building and demolition and other relevant industry standards) (please detail)	Consequence	Likelihood	Risk Rating	Additional Controls (recommended to further reduce risk)	Consequence	Likelihood	Risk Rating
SW8b	A1	Surface Water	Operation/Maintenance	Maintenance	Impacts on surface water quality		Maintenance activities have the potential to generate pollutants such as dust, herbicides, cleaning agents or spillages of diesel / petrol fuel spillages from maintenance plant.	Maintenance Management procedures are to be developed and approved by VicRoads.	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low
SW8c	C0	Surface Water	Operation/Maintenance	Maintenance	Impacts on surface water quality		Maintenance activities have the potential to generate pollutants such as dust, herbicides, cleaning agents or spillages of diesel / petrol fuel spillages from maintenance plant.	Maintenance Management procedures are to be developed and approved by VicRoads.	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low
SW8d	C2	Surface Water	Operation/Maintenance	Maintenance	Impacts on surface water quality		Maintenance activities have the potential to generate pollutants such as dust, herbicides, cleaning agents or spillages of diesel / petrol fuel spillages from maintenance plant.	Maintenance Management procedures are to be developed and approved by VicRoads.	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low
SW9a	A0	Surface Water	Operation/Maintenance	Operation	Impacts on surface water quality		Increase in pollutant loads as a result of untreated and undiluted road runoff into nearby waterways.	For preferred option, impacts on wetlands from road drainage discharge to be assessed by developing road drainage design concepts and water quality modelling using MUSIC. Where modelling identifies unacceptable impacts, develop concepts for mitigation measures including water sensitive road design elements such as treatment swales and water quality basins.	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low
SW9b	A1	Surface Water	Operation/Maintenance	Operation	Impacts on surface water quality		Increase in pollutant loads as a result of untreated and undiluted road runoff into nearby waterways.	For preferred option, impacts on wetlands from road drainage discharge to be assessed by developing road drainage design concepts and water quality modelling using MUSIC. Where modelling identifies unacceptable impacts, develop concepts for mitigation measures including water sensitive road design elements such as treatment swales and water quality basins.	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low
SW9c	C0	Surface Water	Operation/Maintenance	Operation	Impacts on surface water quality		Increase in pollutant loads as a result of untreated and undiluted road runoff into nearby waterways.	For preferred option, impacts on wetlands from road drainage discharge to be assessed by developing road drainage design concepts and water quality modelling using MUSIC. Where modelling identifies unacceptable impacts, develop concepts for mitigation measures including water sensitive road design elements such as treatment swales and water quality basins.	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low
SW9d	C2	Surface Water	Operation/Maintenance	Operation	Impacts on surface water quality		Increase in pollutant loads as a result of untreated and undiluted road runoff into nearby waterways.	For preferred option, impacts on wetlands from road drainage discharge to be assessed by developing road drainage design concepts and water quality modelling using MUSIC. Where modelling identifies unacceptable impacts, develop concepts for mitigation measures including water sensitive road design elements such as treatment swales and water quality basins.	Minor	Unlikely	Low	Not required	Minor	Unlikely	Low