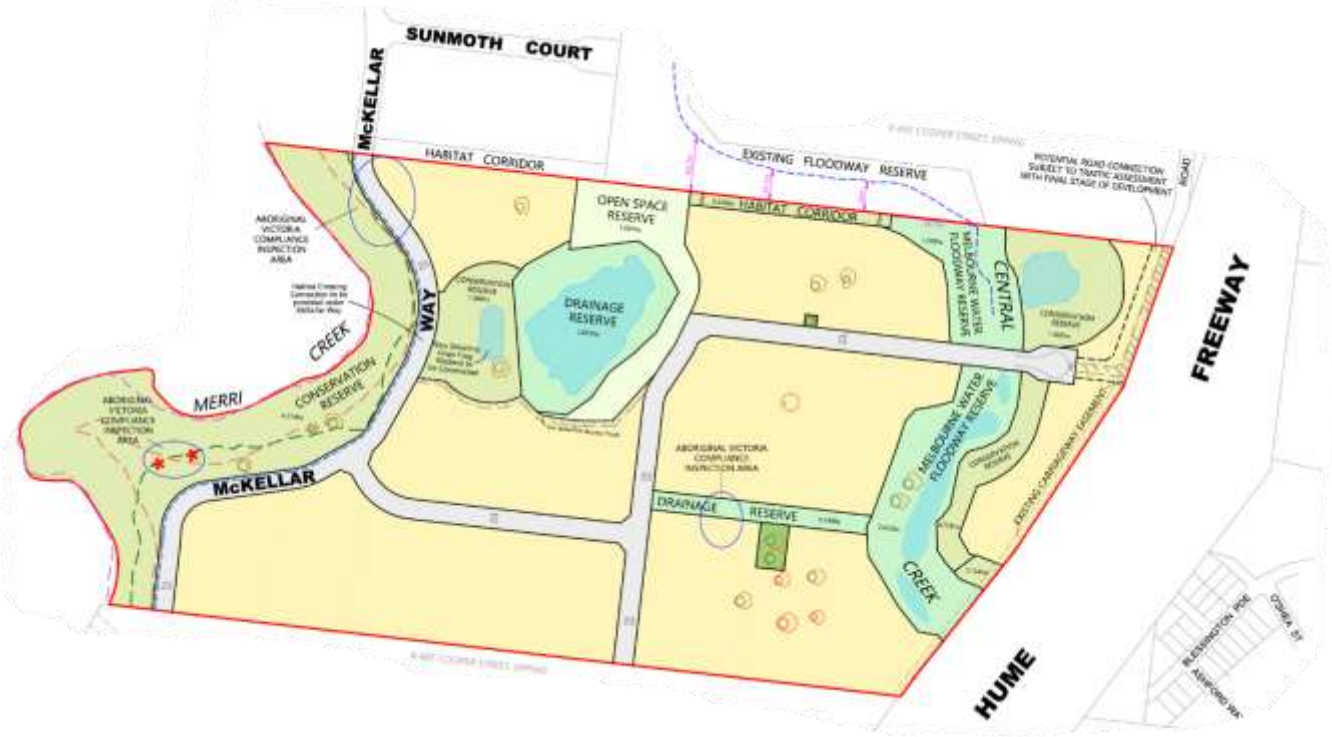

481 Cooper Street Epping

Stormwater Strategy

Vaughan Constructions

9 December 2021

Revision: 5

Reference: 1628

Document control

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- Using the documents or data in electronic form without requesting and checking them for accuracy against the original hard copy version.
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- Flows in this strategy have been calculated in accordance with ARR 2019, with the except of the RORB model, a Melbourne Water model which utilises ARR 1987 data.
- Whilst it is acknowledged that by many that global climate is changing, unless otherwise stated, this document has not considered the impacts of climate change

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1	23 June 2017	Amended per authority requirements	NJB	Reviewed 23.06.2017	NJB
2	14 March 2018	Amended development layout	NJB	Reviewed 14.03.2018	NJB
3	17 October 2018	Amended development layout	NJB	Reviewed 17.10.2018	NJB
4	23 June 2021	Amended development layout	NJB	Reviewed 23.06.2021	NJB
5	9 December 2021	Amended development layout	NJB	Reviewed 09.12.2021	NJB

Contents

1 Introduction

Vaughan Constructions has engaged Incitus to undertake a Stormwater Strategy for the subdivision and development of 481 Cooper Street Epping.

The 53 ha parcel of land is located approximately 18 km north of Melbourne in Epping. The site is bounded by existing and future industrial development to the north, the Hume Freeway to the east, future industrial development to the south and Merri Creek to the west. It is located approximately 1 km south of Cooper Street. The site is covered by the City of Whittlesea's Development Plan Overlay DPO33. The site is not located within Melbourne Water Development Services Scheme, however will be referred to Melbourne Water under the Planning and Environment Act (1987) and the Subdivisions Act (1988). The site is illustrated in **Figure 1.1** below.

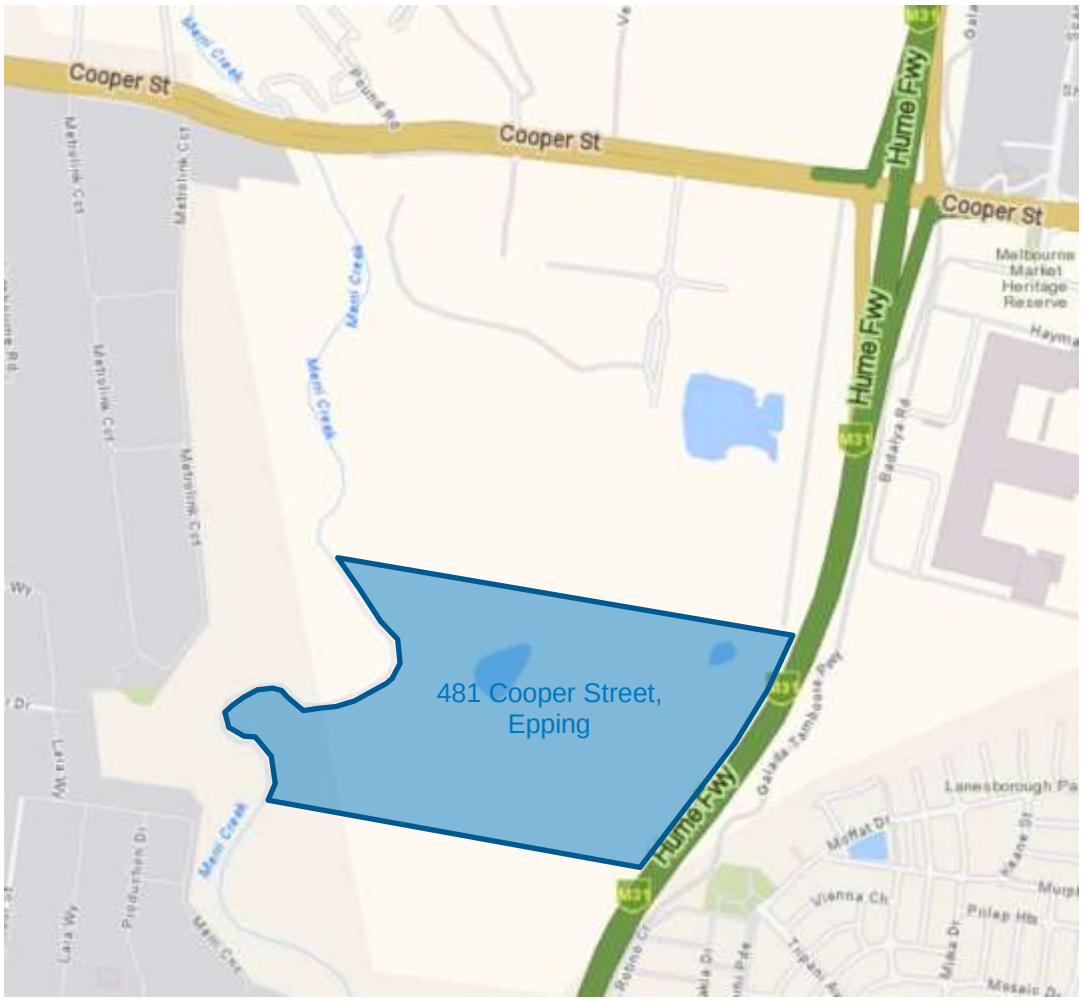

Figure 1.1 481 Cooper Street, Epping

Urbanisation leads to an increase in stormwater runoff and a subsequent increase in pollutant wash-off. It also has detrimental effects on the receiving waterways. In determining the urban structure, it is critical that assets required for drainage purposes are determined early so that the impacts from the increase of stormwater runoff due to urbanisation can be mitigated and all new development can proceed without the risk of flooding, of flooding neighbouring properties and without impacting on the natural environment, receiving waterways and ultimately, Port Phillip Bay.

Undertaking a drainage assessment of the catchment that identifies the quantity of runoff, the conveyance of this runoff, the need to retard the runoff and the treatment and / or reuse of the runoff will assist in determining the assets and / or land-take required for the stormwater management of this catchment. It will also identify the location of all stormwater assets.

Liveability and resilience should be incorporated into all new developments. With respect to stormwater management, this involves utilising the stormwater as an asset for the community whilst ensuring fundamentals such as flood protection, safety with respect to flow management and water supply security are maintained. This can be achieved through incorporation of best planning practices for stormwater management during the development of the urban structure.

This Stormwater Strategy for the development of 481 Cooper Street, Epping outlines a management plan for the stormwater that is generated from the urbanisation of the land. It identifies the assets required to manage the increased surface water runoff from urbanisation and sets a framework to achieve the intent of the stormwater assets. The surface water management for the site has been optimised and designed to achieve multiple benefits for the community and the environment.

2 Catchment Characteristics

The land at 481 Cooper Street Epping is located on the south side of Cooper Street, west of the intersection with the Hume Freeway, and is 53 ha in size. The average annual rainfall for the region is approximately 650 mm. The land is a disused quarry site and has had significant modification to the pre-European catchment form.

The site is bounded by Merri Creek to the west and traversed by Central Creek. Central Creek abuts the northern site boundary, prior to entering the site approximately 200 m west of the Hume Freeway and continues south until crossing the Hume Freeway approximately 100 m north of the southern boundary.

The topography is varied with a significant, extremely deep quarry hole located near the northern site boundary. The quarry hole currently exists as a pond and contains relatively clean water.

The site has a large external catchment of approximately 373 ha contributing to the site from Central Creek. Of this catchment, 307 ha is located north of Cooper Street and is not developed. The balance is located between Cooper Street and the northern boundary of the site and is zoned for industrial development. An additional 36 ha catchment is located immediately north of the site adjacent to the Hume Freeway which is utilised as a quarry and retains all runoff on-site. No catchment from Merri Creek contributes to the site. The site does not currently experience any flooding from Merri Creek.

Figure 2.1 depicts the general site characteristics.

Figure 2.1 Catchment Characteristics of 481 Cooper Street, Epping

3 Central Creek Waterway Corridor

The land at 481 Cooper Street Epping is traverse by Central Creek. Melbourne Water is committed to protecting the natural morphology of streams and its associated landscape form and values. Therefore, a waterway corridor has been allocated for Central Creek.

A waterway corridor is the area of land that is required to ensure an ecologically and socially resilient waterway system. The corridor is the waterway channel and its' associated vegetated riparian zones, as illustrated in **Figure 3.1**.

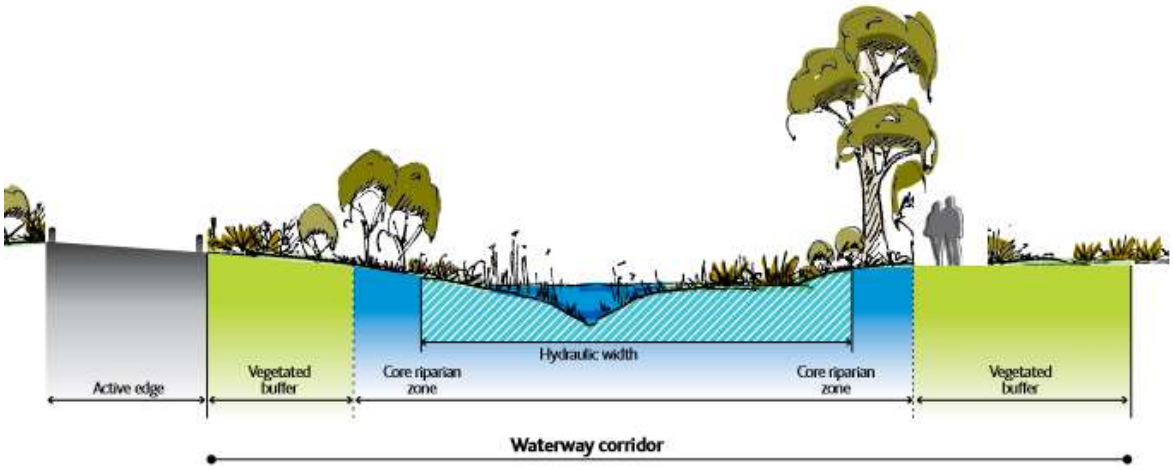

Figure 3.1 Waterway Corridor (Source: Melbourne Water's Waterway Corridors Guidelines, 2013)

The waterway corridor required for Central Creek has been defined by an Urban Floodway Zone which has been incorporated into the development layout. This waterway corridor is sufficient to convey flows and provide the required ecological and social values required. Central Creek has a constructed form upstream and is fragmented downstream of the Hume Freeway due to urbanisation. Thus, the development of 481 Cooper Street Epping will create a constructed waterway form for Central Creek to compliment the upstream form.

Melbourne Water's Waterway Corridor guidelines permit the inclusion of some shared paths and stormwater quality treatment assets within the waterway corridor, preferably to be located outside the core riparian zone.

A RORB model of the overall catchment indicates the peak 1% AEP design flow in Central Creek at Cooper Street is 14.88 m^3/s and the peak 1% AEP design flow in Central Creek at the Hume Freeway is 17.48 $m^3/$. Melbourne Water require the flow to be limited to the capacity of the downstream system thus the constructed waterway has been sized to convey a peak 1% AEP design flow not exceeding 12.5 m^3/s.

The waterway will have a compound form with a low flow channel inset into a high flow channel. The low flow channel will convey the regular flows. The high flow channel will convey the infrequent flow events which exceed the capacity of the low flow channel. The low flow channel will meander through the base of the waterway and contain rocks and

indigenous vegetation. The high flow channel base will be densely vegetated to control the velocities within the waterway.

The waterway will be sized to convey and contain the peak 1% AEP design flows. The waterway corridor will also contain freeboard above the 1% AEP flood level. The allotments abutting the waterway must achieve a 600 mm freeboard to the 1% AEP flood level. **Figure 3.2** illustrates a typical section of the constructed waterway form of Central Creek through the development of 481 Cooper Street Epping. Details of the waterway longitudinal section and variation of the cross sections will be provided during the detailed design phase.

Hydraulic modelling of the adopted profile resulted in a hydraulic width of the 1% AEP design flow within this waterway being less than 40 m. Based on the hydraulic width and no allowance for active edges in the development plan, a waterway corridor of 60 m is required in accordance with Table 4 from Melbourne Water's *Waterway Corridors* (October 2013) guidelines. The urban floodway zone provides a corridor width of not less than 60 m for Central Creek through the development of 481 Cooper Street Epping. The asset will be transferred to Melbourne Water upon completion.

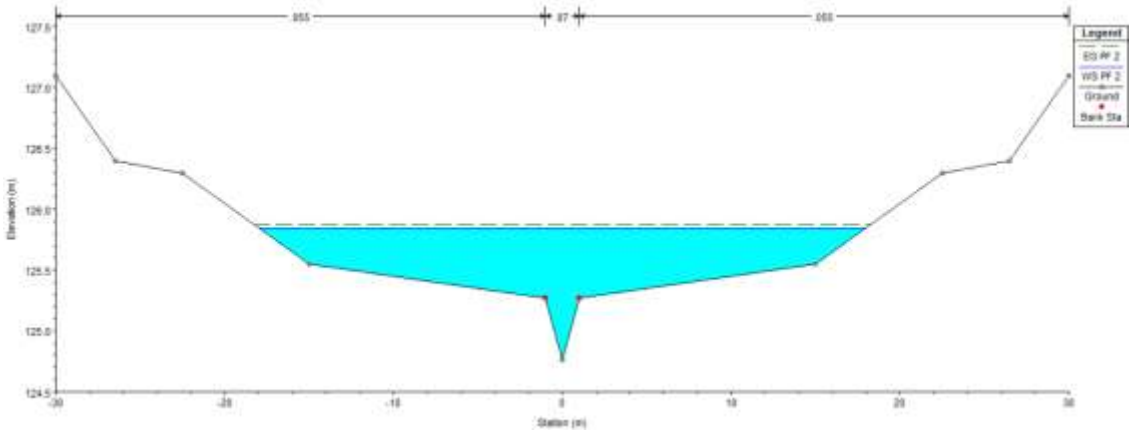

Figure 3.2 Typical Section of Central Creek in 481 Cooper Street Epping

The development of 481 Cooper Street Epping will include two connections to the Central Creek waterway corridor. The connection will be in accordance with Melbourne Water standards.

4 Stormwater Quantity

The drainage system for the development of 481 Cooper Street Epping will be designed to prevent property flooding occurring in a 1% Annual Exceedance Probability (AEP) storm event and the stormwater runoff can be safely conveyed through the development. To achieve this, the development will adopt a minor / major drainage system philosophy.

4.1 Minor Drainage System

The minor drainage system will consist of a subsurface pipe network designed to capture and convey all stormwater runoff generated from the catchment for rainfall events up to and including the 10% Annual Exceedance Probability (AEP) design storm for residential catchments.

As the localised catchments have an area less than 60 ha, the system will be designed in accordance with the Victorian Planning Authority's Engineering Design and Construction Manual.

4.2 Major Drainage System

The primary objective of the major drainage system is to provide flood protection for the allotments based on the 1% AEP storm event and to ensure the overland flow can be safely conveyed through the development. This will be via overland flow paths contained within road reserves.

The development is not located within a Melbourne Water Development Services Schemes (DSS) and no regional scale retardation has been provided for the development of this land. Therefore, the development must include on-site retardation to mitigate the stormwater runoff discharging from the site. Melbourne Water has specified the allowable discharge from the development as the capacity of the downstream pipe infrastructure and capacity of road reserve downstream of the Hume Freeway to convey the gap flows up to the 1% AEP design storm event.

The development of 481 Cooper Street Epping will be designed so that all road reserves will be set a minimum of 300 mm above the 1% AEP flood level in the drainage reserves. The allotments will be set a minimum of 600 mm above the 1% AEP flood level in drainage reserves, or 150 mm above the overland flow conveyed through the road reserves, whichever is greater.

4.2.1 On-site Retardation

Melbourne Water require the development of 481 Cooper Street Epping to limit the stormwater runoff discharging from the site to the capacity of the downstream drainage system and road reserve.

Melbourne Water has provided Incitus with the RORB model for the catchment. RORB was adopted as the design runoff routing model for generation of flows and simulation of storages catchment. RORB generates catchment runoff based on the selection of local rainfall intensity frequency duration data and appropriate loss models.

Interrogation of the supplied RORB model upstream of the Hume Freeway discovered that the sub area catchment boundaries did not match the topography and existing surrounding catchment boundaries. The reach lengths required amending to correlate to the modified sub area boundaries. There were also discrepancies in the fraction impervious values adopted for the existing development downstream of Cooper Street to the Hume Freeway. The model was updated to reflect the current existing conditions. The catchment plan indicating existing and amended boundaries and reach lengths is included in **Appendix A**. A summary of the modifications made to the RORB model is also included in **Appendix A**.

The amended RORB model indicated that the peak 1% AEP design flow for Central Creek at Cooper Street is 14.88 m^3/s. The peak 1% AEP design flow for Central Creek at the Hume Freeway prior to development of 481 Cooper Street is 17.08 m^3/s.

The model was then adapted to reflect the development of 481 Cooper Street Epping with an industrial land use. The peak 1% AEP design flow at the Hume Freeway for Central Creek with the development is 17.47 m^3/s.

Whilst the post development flow is only marginally higher than the pre-development flow at the Hume Freeway, Melbourne Water has expressed their desire for the development to retard the flows from Central Creek on-site utilising the existing quarry hole to the equivalent capacity of the downstream infrastructure.

Downstream of the Hume Freeway, Central Creek is converted into an urbanised drainage system utilising a pipe network with gap flows conveyed overland via the road reserves. The pipe drainage is a 1500 mm diameter RCP with a capacity of 6.45 m^3/s. The Tripani Avenue road reserve is 27 m. Based on the road profile and approximate longitudinal grade, it is anticipated the road reserve has the capacity to convey up to 6 m^3/s overland and comply with the floodway safety criteria.

Hence the maximum capacity of the downstream infrastructure to convey flows and the subsequent allowable discharge from Central Creek at the Hume Freeway is 12.45 m^3/s.

As the development of 481 Cooper Street Epping does not result in a sizable increase in the peak flow of Central Creek at the Hume Freeway and retardation could be provided by a structure limiting the discharge at the Hume Freeway; it is proposed to divert flows from Central Creek at the northern boundary into the existing quarry and utilise the public open space area for retardation purposes. The proposed diversion will occur immediately downstream of the existing wetland in Central Creek immediately north of the site; and allow for the regular flows to continue along Central Creek to maintain the biodiversity created within the creek corridor. The higher flows will divert from the creek corridor to the retarding basin located in the development. It is proposed to divert all flows from Central Creek exceeding 6 m^3/s up to 17 m^3/s into the retarding basin.

As only high flows will be diverted into the retarding basin, they will not receive specific treatment prior to diversion. However the flows will have some treatment through natural filtration within waterway corridor and passing through the upstream wetland.

The water level in the quarry taken at 6/08/16 is 121.59 m AHD. It is anticipated that the minimum outlet level for the basin to achieve a free draining outfall into the constructed waterway form of Central Creek is 126.0 m AHD. Hence the quarry will fill with the diverted water and will not discharge until the water level exceeds 126.0 m AHD. The existing quarry will be modified to ensure that batters to a level of 126.0 m AHD do no exceed a 1 in 5 slope.

The discharge from the basin will be a pipe outfall through a drainage reserve corridor and road reserve to the east; and discharging into the Central Creek corridor within the development. The road reserve at the east of the retarding basin connecting to Central Creek will be provided as a spillway in the event that the pipe outfall from the basin experiences any blockages.

A storage volume of 37,900 m^3 is required to retard the 1% AEP design flows from the Central Creek catchment upstream of the Hume Freeway to 12.11 m^3/s. The peak flood level in the retarding basin will be 127.4 m AHD. The allotments surrounding the retarding basin will achieve a minimum level at the drainage reserve boundary of 128.0 m AHD. The peak 1% AEP discharge at the Hume Freeway can be safely conveyed along the road reserve and in the existing 1500 mm diameter RCP drain.

Figure 4.1 depicts the intent for the retarding basin and catchment.

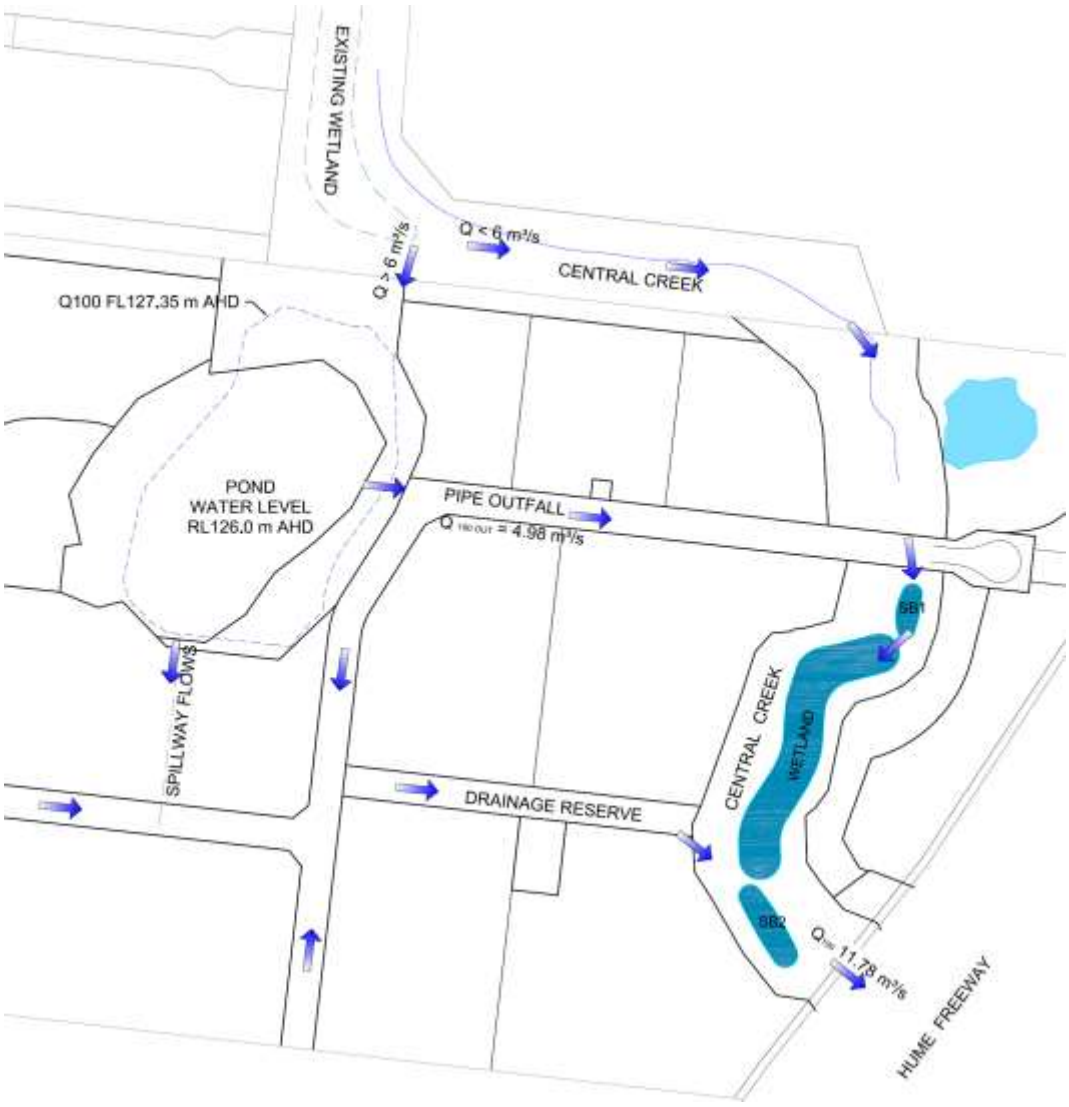

Figure 4.1 481 Cooper Street Epping Retarding Basin

4.2.2 Peak Development Flows

The peak development flows are generated from the development of the site. **Figure 4.2** illustrates the major catchments and flow paths for the development.

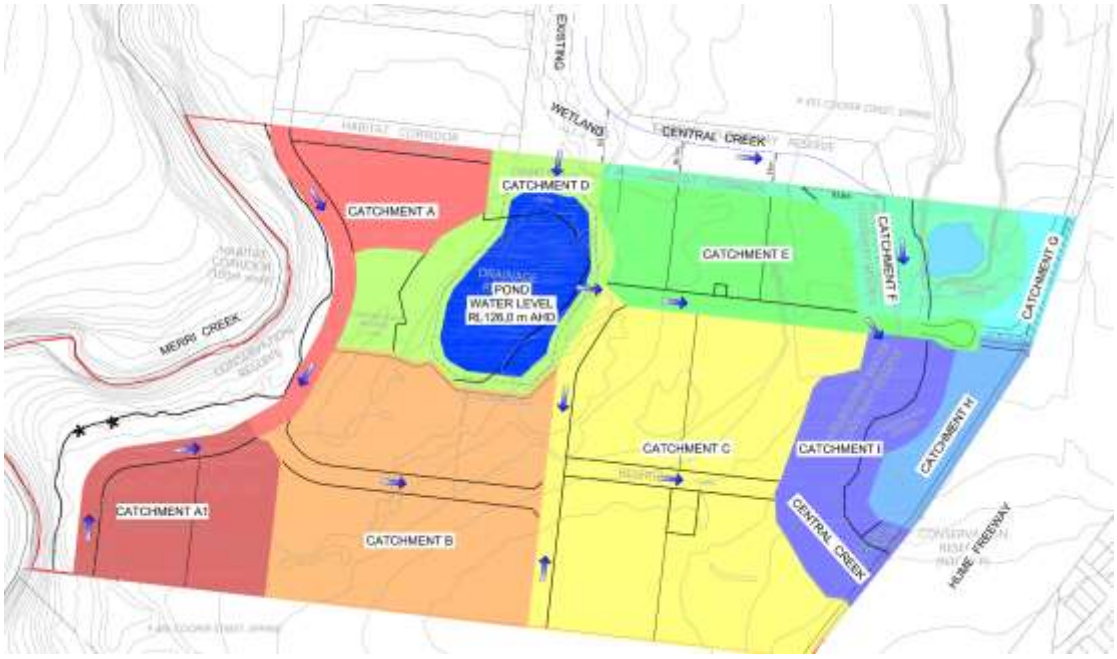

Figure 4.2 481 Cooper Street Epping Major Catchments

Table 4.1 outlines the runoff for the catchments and the anticipated overland flow conveyance.

Table 4.1 Major Drainage System Catchment Runoff

Catch	Area (ha)	AE (ha)	Additional catchment runoff	∑ae (ha)	Tc (mins)	$I_{1\% AEP}$ (mm/h)	$Q_{1\% AEP}$ (m^3/s)	Q_{GAP} (m^3/s)
A	3.13	3.10	-	3.10	15	121	1.04	0.52
A1	3.79	3.74	-	3.74	15	121	1.26	0.63
B	8.62	8.51	A, A1	15.35	19	106	4.52	2.26
C	12.01	11.87	A, A1, B	27.22	22	97	7.34	3.67
D	5.70	-	-	-	-		5.77	0.00
E	4.64	4.58	-	4.58	14	107	1.36	0.68
F	3.08	-	-	-	-		6.26	6.26
G	0.74	0.74	-	0.74	6	183	0.37	0.19
H	1.58	1.56	-	1.56	10	149	0.65	0.32
I	2.62	-	All	-	-		12.00	5.55

4.3 Drainage Reserve

A drainage reserve is required to convey the flows to Central Creek from Catchment A, Catchment A1, Catchment B and Catchment C. The reserve will adopt a pipe and high flow channel arrangement, where the pipe will convey the 10% AEP design flows as part of the minor drainage system, connecting to the proposed sediment pond; and the high flow channel will convey the gap flows between the 10% AEP design flow and the 1% AEP design flow.

It is estimated that the peak gap flow through this drainage reserve will be 3.67 m^3/s. **Figure 4.3** illustrates the proposed drainage reserve profile.

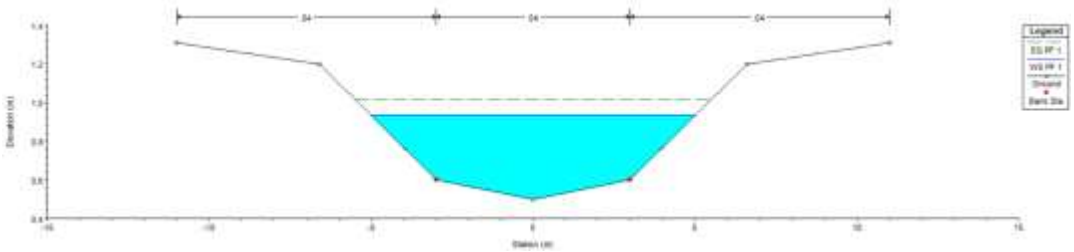

Figure 4.3 Proposed Drainage Reserve Profile

4.4 Overland Flow Safety

It is imperative that the development conveys the overland flows safely along road reserves. This requires ensuring the overland flow along major flow paths complies with floodway safety requirements. The recommended safety limits for residential developments are as follows (from the *Guidelines for Development in Flood Affected Areas* and adapted from Australian Rainfall and Runoff):

- V.dmax <= 0.4 m^2/s
- Vmax <= 2.0 m/s
- dmax <= 0.50 m

For the minimum road grades to comply with the engineering standards, the maximum overland flow which can be conveyed along a typical 22 m road reserve is 6 m^3/s. These figures have been based on 1 dimensional steady state hydraulic modelling using the software program HEC-RAS. The development is adopting 23 m road reserves and therefore can still convey 6 m^3/s overland safely. The maximum overland flow for the development is estimated to be 3.7 m^3/s, which can be fully contained within the road reserve and safely conveyed. **Figure 4.4** illustrates a typical 22m access road cross section for an industrial zone in the City of Whittlesea.

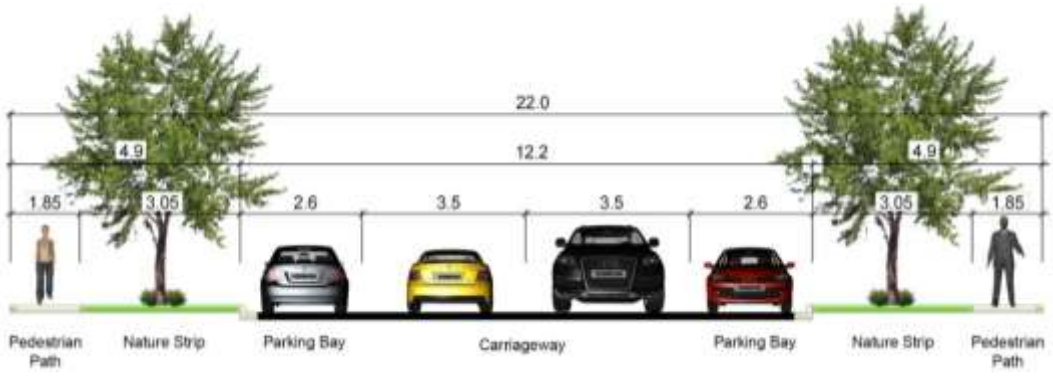

Figure 4.3 Typical Cross Section for an Industrial Zone Access Street

5 Stormwater Quality Treatment

The State Environment Protection Policy (Waters of Victoria) defines the required water quality conditions for urban waterways. The aim of stormwater quality treatment is to reduce typical pollutant loads from urban areas to Best Management Practices as defined in the following targets:

Table 5.1 Best Practice Pollutant Reduction Targets

Pollutant	Performance Objective
Total Suspended Solids (TSS)	80% reduction from typical urban load
Total Phosphorous (TP)	45% reduction from typical urban load
Total Nitrogen (TN)	45% reduction from typical urban load
Gross Pollutants (GP)	70% reduction from typical urban load

Source: Urban Stormwater: Best Practice Environmental Management Guidelines – Victorian Stormwater Committee, 1999.

There is no current planning provision that requires the treatment of stormwater runoff to best practice targets for industrial development. Typically, Melbourne Water would provide catchment scale treatment for industrial developments that are located within Development Services Schemes, however this catchment is not within a scheme.

The development can provide on-site treatment to achieve best practice pollutant reduction targets or pay Melbourne Water a stormwater quality offset contribution to help fund alternative treatment in the greater catchment. The current rate payable to Melbourne Water for offsetting stormwater quality treatment on-site in the City of Whittlesea is $ 32,846 per hectare of industrial development.

The provision of treatment on-site within a development where possible is preferable due to the environmental and community benefits derived from the reduction in pollutant loadings contributing to the receiving waterways. The development of 481 Cooper Street Epping proposes the inclusion of on-site treatment within the development.

The development will include two sediment ponds to provide pre-treatment to the stormwater runoff from the pipe drainage network prior to connection into Central Creek. These sediment ponds will be included within the Central Creek drainage reserve.

The development will also provide a constructed wetland within the Central Creek drainage reserve. It is proposed to divert flows from the creek through the constructed wetland for treatment. The pollutant loads attained from the treatment within the wetland will offset the required reduction in loads from the development.

Table 5.2 outlines the treatment parameters proposed.

Table 5.2 481 Cooper Street Epping Treatment Parameters

Pollutant	Sediment Basin 1	Wetland+	Sediment Basin 2*
Contributing Catchment (ha)	8	382	28
Area at NWL (m^2)	200	6,300	1,150
Permanent Pool Volume (m^3)	200	2,520	1,150
Extended Detention Depth (mm)	350	350	350
Approximate NWL (m AHD)	126.0	125.60	124.0

**Sediment pond sized to achieve 80% TSS load reduction, exceeds deemed to comply criteria for maximum size.*

+Wetland adopting a 24 hour EDT due to location in the waterway. Reduced EDT selected to minimise likelihood of drowning

Table 5.3 outlines the pollutant reduction target and the performance of the on-site treatment proposed.

Table 5.3 481 Cooper Street Epping Treatment Performance

Pollutant	Catchment Source Load (kg/yr)	Catchment Residual Load (kg/yr)	Load Reduction (kg/yr)	Target Load Reduction (kg/yr)	% Reduction for Site Pollutant Loads
Total Suspended Solids (TSS)	135,000	41,800	30,500	30,080	81.1%
Total Phosphorous (TP)	324	146	46	35	59.9%
Total Nitrogen (TN)	2,380	1,710	240	240	45%
Gross Pollutants (GP)	20,900	313	6,487	4,802	94.6%

The proposed inclusion of the treatment within the Central Creek drainage reserve is illustrated in **Figure 5.1**. The intent is to protect the treatment assets from velocities that will cause vegetation scour. Details will be included in the detailed design of the asset. The treatment assets will be transferred to Melbourne Water upon completion002E

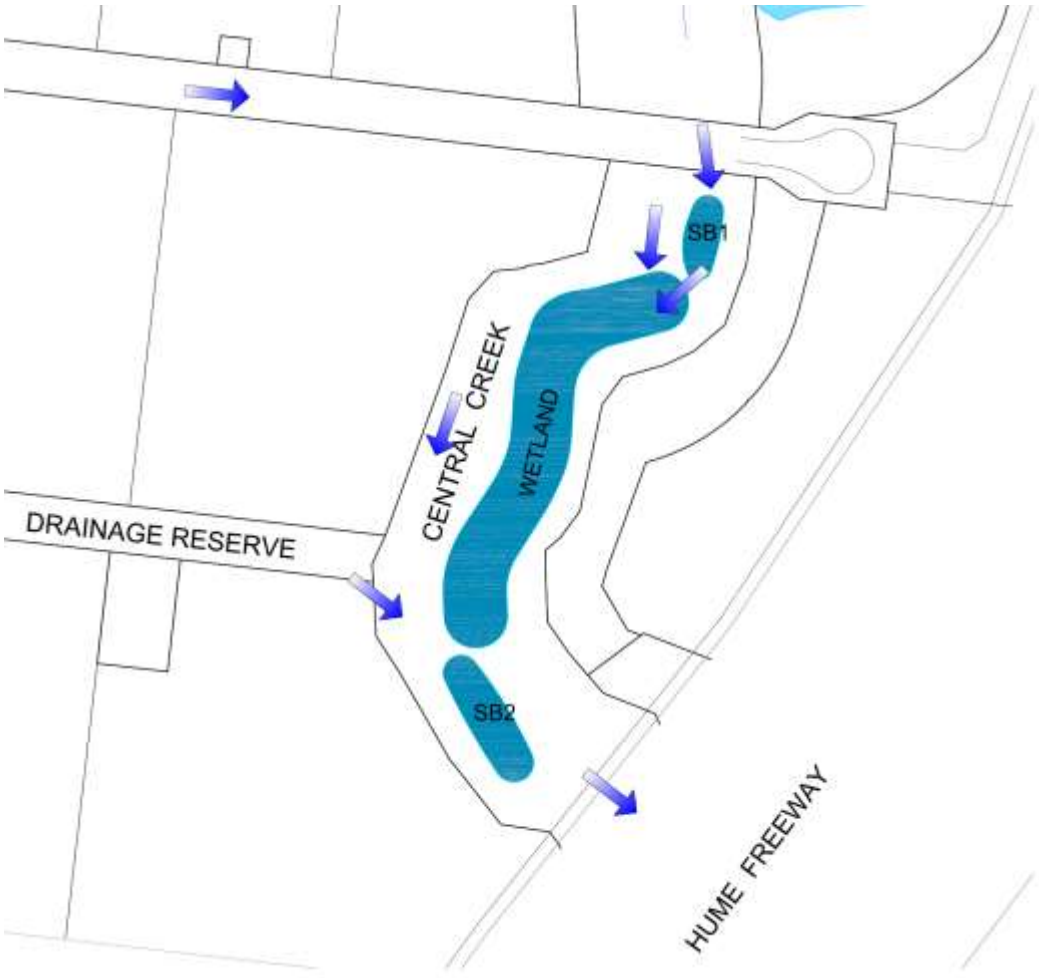

Figure 5.1 Proposed Treatment Layout for 481 Cooper Street Epping

6 Outfall Arrangement

The outfall for the development is Central Creek. The existing culverts under the Hume Freeway have capacity to convey the flows discharging from Central Creek at the site boundary. This provides the development with a free draining outfall.

As the permanent works will be constructed with the development, or are existing, no temporary outfall works are required for this development.

7 Conclusion

The development of 481 Cooper Street Epping is required to meet the drainage standards specified by the City of Whittlesea, Victorian Planning Authority and Melbourne Water.

The development will provide pipe drainage infrastructure to convey the 10% AEP design flows and minimise nuisance flooding occurrences in regular rainfall events. The gap flows, i.e. the difference between the 1% AEP design flows and the pipe flows, will be safely conveyed through the development along road reserve corridors.

Ultimate development of the overall catchment will include provision for conveyance of flows from the external catchment contributing via Central Creek. The profile of Central Creek will be modified to increase the flow capacity of the Creek corridor. The drainage reserve for the creek will be maintained in the Urban Floodway Zone.

As the existing road and drainage infrastructure downstream of the Hume Freeway does not have the capacity to safely convey the flows generated from the catchment with existing development conditions, the development of 481 Cooper Street Epping will provide for retardation of the catchment flows from a diversion on Central Creek. The retarding basin will be co-located with public open space area in the existing quarry location.

Allotments will achieve relevant freeboard from the 1% AEP flood levels associated the overland flows in road reserves or drainage reserves, whichever is greater.

The development will provide on-site treatment to achieve best practice pollutant reduction targets. The treatment assets include 2 sediment basins and a constructed wetland to be located within the Central Creek drainage reserve. These assets will be transferred to Melbourne Water upon completion.

The outlet for development is existing and free draining.

8 References

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Melbourne Water, December 2020, Constructed Wetlands Design Manual

Melbourne Water, 2018, Guidelines for the Use of MUSIC

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Melbourne Water, 2005, WSUD Engineering Procedures: Stormwater

Victorian Planning Authority, December 2019, Engineering Design and Construction Manual for Subdivision in Growth Areas

Appendix A – RORB Parameters

RORB File	DCENTRLCK Amend us Hume with RB diversion Mar18.cat
kc	7.93
m	0.8
IL	15 mm
RoC	0.6 (1% AEP)
Rainfall Location	EPPING
Temporal Pattern	Filtered
Aerial Pattern	Uniform
Aerial Reduction Factor	AR&R Bk II
Loss Factor	Constant Losses

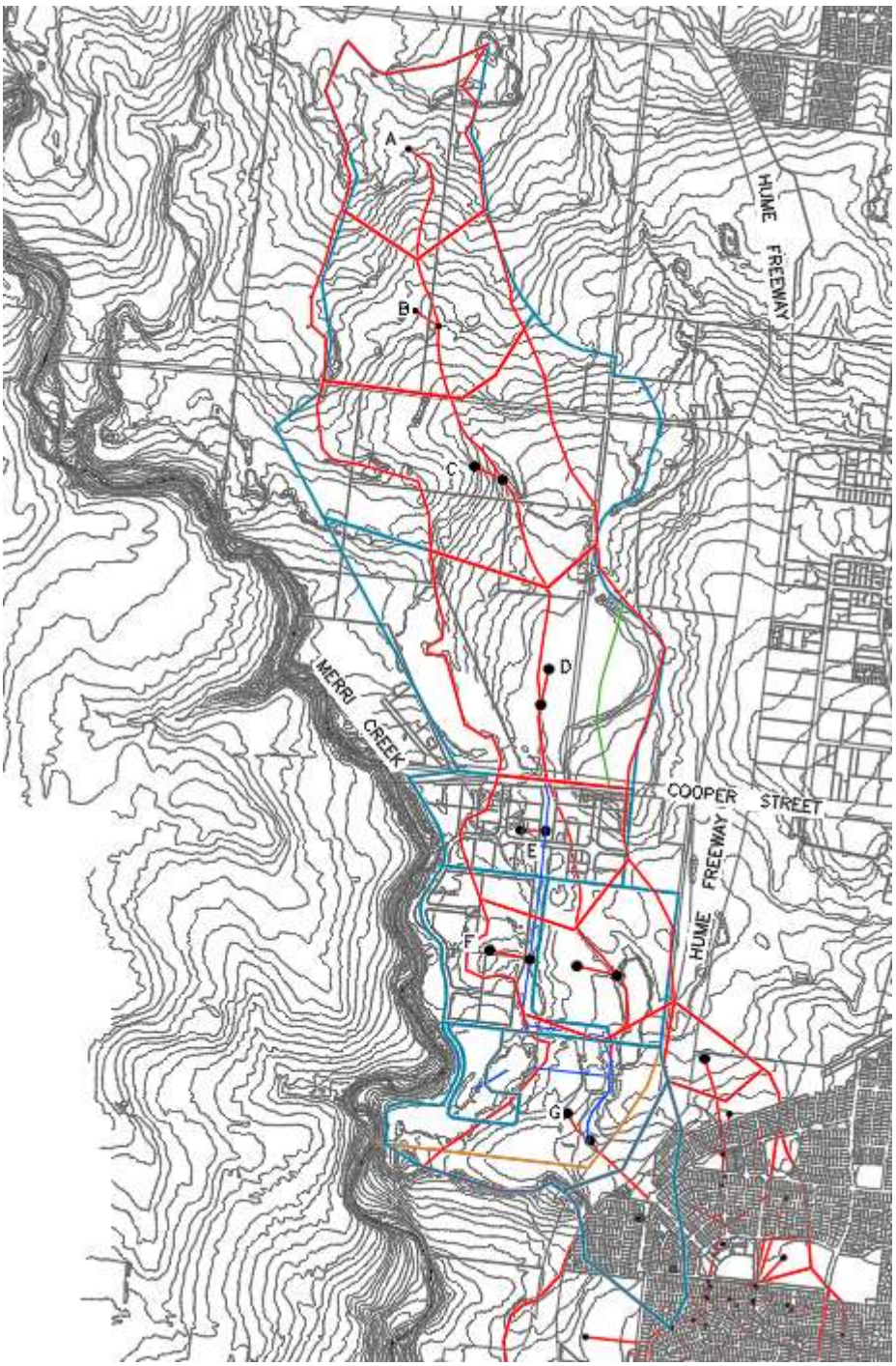
IFD Parameters

Location	EPPING
$^{2}I_{1}$	19.57
$^{2}I_{12}$	3.99
$^{2}I_{72}$	1.11
$^{50}I_{1}$	39.80
$^{50}I_{12}$	7.12
$^{50}I_{72}$	2.26
Skew	0.34
F2 Value	4.29
F50 Value	14.96
Zone	1

Amendments from Melbourne Water supplied file DCENTRLCK.catc:

- Sub area A, B, C, D, E, F & G catchment areas changed to reflect the geographic catchment
- Sub area A, B, C, D, E, F & G reach lengths and slopes changed to reflect the geographic conditions and amended catchment boundaries
- Sub areas E, F & G fraction impervious values changed to reflect the rezoning and development of the catchments
- Sub area G1 added – contributing to the RB
- Kc amended to maintain kc/Dav = 1.44. Previous kc value = 7.59

RORB Catchment Plan



Legend:

Red – Melbourne Water sub area boundary

Light Blue – Amended sub area boundary

Dark Blue – Amended Reach

RORB Modelling with 2016 IFD Data

An analysis of the peak flows has been undertaken with the application of the ARR2019. Since the kc value in model has been determined using the proportionate loss model, the assessment with the application of ARR2019 will continue to use the same loss model however apply the 2016 IFD data.

RORB File	DCENTRLCK Amend us Hume with RB diversion Mar18.cat
kc	7.93
m	0.8
IL	15 mm
RoC	0.6 (1% AEP)
Location	Latitude -37.661456; Longitude 144.987054
Temporal Pattern	ARR 2019 Point Temporal Patterns
Spatial Pattern	Uniform
Aerial Reduction Factor	Based on ARR 2019 (Book 2 Chapter 4)
Loss Factor	Constant with ARI

Table A1 shows the comparison of the ARR'87 peak 1% AEP design flows at critical locations with the ARR2019 peak 1% AEP design flows.

Table A1

Location	ARR'87 Peak 1% AEP Flow (m^3/s)	ARR2019 Peak 1% AEP Flow (m^3/s)
Cooper Street	14.47	14.92
Hume Freeway	12.11	11.82
Outlet of 4473	35.62	30.67

Table A2 shows the comparison of the ARR'87 peak values for the on-site retarding basin with the ARR2019 peak values.

Table A2

Retarding Baisn Parameter	ARR'87 Value	ARR2019 Vaue
Q_{IN} (m^3/s)	11.44	11.17
Q_{OUT} (m^3/s)	5.33	4.86
1% AEP Flood Level (m AHD)	127.4	127.32
Volume of Storage (m^3)	37,900	35,600

The results indicate that the relevant freeboard levels will still be achieved with the application of the current standards. It should be noted that adopting an initial loss / continuing loss model will yield different results to the proportionate loss model, however changing the loss model would require altering the kc value and potentially the m value for the loss model as well.

Appendix B – Intensity Frequency Duration Data

Epping Intensity Frequency Duration Table

Label: Epping
Latitude: Requested: -37.661455878 Nearest grid cell: 37.6625 (S)
Longitude: Requested: 144.987053843 Nearest grid cell: 144.9875 (E)

Duration	Average Exceedance Probability						
	63.20%	50%	20%*	10%	5%	2%	1%
1 min	86.6	98.4	140	172	208	260	306
2 min	72.7	81.9	114	139	167	210	246
3 min	65.5	73.9	104	127	152	190	224
4 min	60.2	68	95.8	117	141	177	208
5 min	55.8	63.2	89.3	110	132	165	194
10 min	41.7	47.4	67.7	83.5	101	126	149
15 min	33.8	38.5	55.1	68	82.1	103	121
20 min	28.7	32.7	46.7	57.7	69.6	87.4	103
25 min	25.2	28.6	40.8	50.3	60.8	76.3	89.8
30 min	22.5	25.6	36.4	44.8	54.1	67.9	79.9
45 min	17.4	19.7	27.9	34.3	41.3	51.9	61.1
1 hour	14.4	16.3	22.9	28.1	33.9	42.6	50.1
1.5 hour	11.1	12.5	17.4	21.3	25.6	32.1	37.9
2 hour	9.16	10.3	14.3	17.5	21	26.4	31.1
3 hour	7.04	7.89	10.9	13.3	16	20	23.6
4.5 hour	5.43	6.09	8.41	10.3	12.3	15.4	18
6 hour	4.53	5.08	7.02	8.56	10.2	12.8	15
9 hour	3.51	3.94	5.48	6.67	7.98	9.89	11.6
12 hour	2.92	3.3	4.6	5.61	6.7	8.27	9.61
18 hour	2.25	2.55	3.59	4.38	5.22	6.4	7.38
24 hour	1.86	2.12	2.99	3.65	4.35	5.3	6.08
30 hour	1.59	1.82	2.59	3.16	3.76	4.56	5.2

Duration	Average Exceedance Probability						
	63.20%	50%	20%*	10%	5%	2%	1%
36 hour	1.4	1.61	2.29	2.79	3.32	4.01	4.55
48 hour	1.14	1.31	1.87	2.28	2.7	3.24	3.65
72 hour	0.831	0.956	1.37	1.67	1.97	2.34	2.61
96 hour	0.658	0.755	1.08	1.3	1.54	1.82	2.02
120 hour	0.545	0.623	0.88	1.07	1.26	1.48	1.64
144 hour	0.466	0.53	0.741	0.896	1.06	1.24	1.38
168 hour	0.408	0.461	0.637	0.769	0.907	1.06	1.19

Appendix C – Flow Computations

Catchment	Tc (mins)	Area (ha)	C	Ae (ha)	ΣAe (ha)	I_{100} (mm/hr)	Q_{100} (m^3/s)
A	15	3.13	0.988	3.10	3.10	121	1.04
A1	15	3.79	0.988	3.74	3.74	121	1.26
B	19	8.62	0.988	8.51	15.35	106	4.52
C	22	12.01	0.988	11.87	27.22	97	7.34
D		5.70					5.77
E	14	4.64	0.988	4.58	4.58	107	1.36
F		3.08					6.26
G	10	0.74	0.988	0.74	0.74	183	0.37
H	10	1.58	0.988	1.56	1.56	149	0.65
I		2.62					12.00

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