Cardinia Planning Scheme C234
Pakenham East Precinct Structure Plan

Expert Witness Statement

Revision A
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Contents

1. Expert Witness Statement

I have been retained to prepare an expert witness statement which:

1. Provides a summary of the preferred drainage strategy and functional designs of required drainage assets for the exhibited Pakenham East PSP area, and
2. Considers the submissions made to the Amendment.

All matters raised by "Planning Panels Victoria, Guide to Expert Evidence" are detailed in Appendix A of this expert witness report.

In late 2012, Cardinia Shire Council (**Council**) engaged me (Valerie Mag, Principal of Stormy Water Solutions (**SWS**)) to develop a methodology and preliminary proposals for a drainage strategy to be applied within the Pakenham East Precinct Structure Plan **(PEPSP)** area. In February 2013, the methodology (summarised in Section 2 of this report) was presented to Council. In 2013 three options for development of the drainage strategy were presented. One additional option was added in 2014/2015. Subsequently, Council adopted Option 1 which located all drainage elements within the PEPSP boundary. Option 1 is the option reflected in the exhibited PEPSP.

The concept designs developed by 2015 were used to set the drainage reserve requirements as currently proposed within Amendment C234.

The required drainage elements were subsequently developed to a functional design (**FD**) standard as detailed in the reports listed in Table 1 below. This work was jointly funded by Melbourne Water Corporation (**MWC**) and Council. The FD process updated modelling and design requirements to the standard required by Melbourne Water under their "Constructed Waterways in Urban Developments Guidelines" and "Wetland Design Manual". The functional designs were adopted by MWC within the relevant Development Services Scheme (DSS).

The FD process was initiated to confirm that the drainage reserve areas as detailed in the PEPSP were sufficient to contain all required drainage elements given:

- Current MWC retarding basin and wetland design standards, and
- All other site constraints.

Table 1 Relevant Drainage Reports

Report	Report Title	Report Referred to as the following in this report
1	Pakenham East Precinct Structure Plan, Deep Creek Corridor Proposals, Stormy Water Solutions, 5 October 2014.	**2014 Deep Creek Report**
2	Pakenham East Precinct Structure Plan, Proposed Drainage Strategy, Draft Report, REVISION D, Stormy Water Solutions, 21 December 2017	**2017 Strategy Report**
3	Hancocks Gully Development Services Scheme, Functional Design of Two Wetland/Retarding Basins and Two Vegetated Channels, Revision B, Stormy Water Solutions, 12 December 2016	**2016 Hancocks Gully FD Report**
4	Dore Road Development Services Scheme, Functional Design of the Dore Road DSS, Wetland/Retarding Basin, Revision A, Stormy Water Solutions, 24 February 2017	**2017 Dore Road FD Report**
5	Ryan Road Development Services Scheme, Wetland/Retarding Basin Functional Design, Revision C, Stormy Water Solutions, 7 April 2017	**2017 Ryan Road FD report**
6	Dore Road Drainage Scheme (1606), Swale Functional Design, Stormy Water Solutions, 15 June 2017	**2017 Dore Road Swale FD Report**

Report 2 (the 2017 Strategy Report) is the ultimate revision of a 2015 Strategy Report which detailed the concept designs and reserve requirements of the PEPSP drainage elements.

I adopt this document, as my Expert Witness Statement for the purposes of the Planning Panels hearing in relation to amendment C234 to the Cardinia Planning Scheme commencing on the 19 February 2018.

My conclusions detailed in reports 1 – 6 have not changed in this Expert Witness Statement. The plans contained within Reports 1 to 6 are supported for the purposes of the statement as being appropriate for inclusion in the PEPSP.

My opinions regarding specific submissions are summarised in Section 3 below.

The specification of the PEPSP drainage proposals has been undertaken over many years.

I conclude that Amendment C234 is appropriate regarding allowing adequate drainage reserves to ensure enough space to develop the waterway, wetland and retarding basin functional designs to a detailed design standard, while ensuring all MWC, Council and other authority requirements are met going forward.

2. Summary of the Preferred Drainage Strategy and Drainage Asset Designs

2.1 Option Analysis

In early 2013 three options were formulated as possible drainage strategy solutions. A forth option was subsequently added.

By 2015 Stormy Water Solutions had produced four Drainage Strategy plans (1304/1-5) which detailed Options 1 to 4 and their proposed drainage strategy elements. These are presented in Appendix A of the 2017 Strategy Report.

Option 1 showed all required drainage elements within the PSP boundary. Option 2 detailed a possible alternative where some elements could be located directly downstream of the PSP boundary. Option 2 would have required agreement from affected landowners and the Department of Transport (DoT) on the land affected by potential future railway stabling infrastructure. Options 3 and 4 are variations on Option 2 which try to minimise drainage encumbrances on the land located between the Pakenham Bypass and the Railway (including DoT land).

Council ultimately adopted Option 1 for PSP formulation. The concept design of the drainage elements associated with Option 1 form the PEPSP drainage reserve requirements. The subsequent functional design process was initiated to ensure the defined spaces were adequate to meet all drainage requirements as defined by MWC. The functional design process has identified some areas where the reserve spaces could be reduced (e.g. in the Dore Road wetland/retarding basin site and in the Hancocks Gully South wetland/retarding basin site). This is further discussed in Section 2.3.

2.2 Drainage Strategy Requirements and Objectives

The general drainage strategy formulation considered:

- Allowance for development of small catchments individually (upstream of individual wetlands/retarding basins) without the requirements for drain cleanout/enlargement works downstream,
- Preferably not requiring the drainage crossing of any highway, bypass or railway culvert system to be required,
- Utilising 5 Year ARI pipe capacities in the developed areas (as required by Melbourne Water and Cardinia City Council),
- Accommodating all existing gas line alignments and levels (i.e. APA Group and Lattice Energy requirements),
- Allowing for piped catchments to discharge to regional WSUD elements,

- Accommodating space for some recreation initiatives within the creek/wetland corridors (such as paths etc.),
- Allow space for ecological initiatives such as frog ponds which (potentially) could be used as offset sites by developers,
- Ensuring the two outlets to Deep Creek to mimic existing hydrological conditions, and
- Ensuring local catchment diversion into Deep Creek at PSP northern boundary and at Princes Highway to separate PSP impact from rural impact in the Deep Creek Catchment.

Although allowing space for ecological initiatives such as frog ponds was a design constraint at the time of formulation of the original drainage strategy, I have been instructed that this consideration was subsequently not required because the Commonwealth referral indicated no controlled actions. I have been instructed that occurred after all reports were completed.

Other strategy details are discussed below.

2.2.1 Deep Creek

It was proposed to retain Deep Creek and its riparian zone. As per the existing reserve/easement between Princes Highway and Ryan Road, a 50-metre reserve either side of the creek was originally proposed in the PEPSP area. This was based on the 1990's work which the Dandenong Valley Authority (**DVA**) completed when the low-density Ryan Road subdivision occurred.

However, subsequent 2014 investigations detailed in the 2014 Deep Creek Report indicated a 100 m reserve on the eastern side of the creek was more appropriate.

This is further discussed in Section 3.2 below.

2.2.2 Hancocks Gully

The existing straight drain is proposed be remodelled as a 40-metre-wide vegetated channel meandering within a 65-metre reserve. It is understood that no significant existing vegetation is affected along the channel alignment.

The alignment shown in the 2016 Hancocks Gully FD Report can change slightly as required by the site development.

There is old course "flood plain" valley to the west of the proposed channel. The DSS pipeline alignment and associated valley floor will be required to follow this alignment when the land is developed.

The Princes Highway culvert, the Pakenham Bypass culvert and the railway culvert have enough capacity to convey the future and existing 1% Annual Exceedance Probability (**AEP**) flows at these points.

2.2.3 Retarding Basin Requirements

Four retarding basins are proposed at this stage. They are:

- Hancocks Gully North Wetland/Retarding Basin,
- Hancocks Gully South Wetland/Retarding Basin,
- Dore Road DSS Wetland/Retarding basin, and
- Ryan Road DSS Wetland/Retarding basin

As the catchment ultimately discharges to the Koo Wee Rup Flood Protection District (**KWRFPD**), the flood retarding basins have been designed to ensure:

- The peak 1% (Annual Exceedance Probability (**AEP**) flow from the future development does not exceed the predevelopment flow rate at all outfall points (retarding basin outlet points),
- The peak 24-hour 1% AEP flow from the future development does not exceed the predevelopment flow rate for a storm of this duration at all outfall points (retarding basin outlet points), and
- Each retarding basin can store at least the difference between the expected post development and predevelopment 24-hour 1% AEP flow volume to ensure no increased flood effect within the KWRFPD during a 24-hour 1% AEP flood event in the region.

In addition to the above, development of the functional design of these retarding basins included defining the current low flow regimes to the downstream receiving bodies. Frequent flow regimes are required to be maintained post development to protect the existing ecology and channel morphology of the downstream Deep Creek and Hancocks Gully creek systems. This is achieved in the functional designs via ensuring the 1 Exceedance Per Year (**EY**) post development flood flow is reduced to the predevelopment rate

2.2.4 Water Quality Requirements

All functional designs exceed best practice regarding water quality requirements. As such all wetlands are proposed to retain at least 80% Total Suspended Solids (TSS), 45% Total Phosphorus (TP) and 45% Total Nitrogen (TN).

In addition to stormwater pollutant retention, the wetlands will:

- Allow for a relatively deep inlet drainage pipe invert level at the Dore Road Wetland/retarding basin (as defined by the wetland normal water level) and thus allow for the upstream drainage pipes to be constructed under the existing gas infrastructure,

- Allow for a relatively high outlet drainage invert level at Hancocks Gully North Wetland/retarding basin W1 (as defined by the wetland normal water level) and thus allow for the outlet culvert to be constructed over the existing gas infrastructure,
- Consist of self-sustaining WSUD elements which, by definition, minimise the maintenance requirements of individual WSUD elements, and
- Supplement the social and landscape amenity of any future development.

Other WSUD initiatives can be considered by Council or individual developers. These elements would supplement the MWC system but are not strictly required to meet the objects of any future site drainage principles. Elements which could be considered are:

- Local melaleuca swamps possibly located in the extended base systems of the vegetated channels proposed,
- Rainwater Tanks,
- Incorporation of sustainable landscaping practices to minimise irrigation within the development,
- Stormwater reuse being collected stormwater (including runoff from roofs and roads),
- Grey water reuse within the development, and
- Use of recycled sewage water from the local South East Water sewage treatment plant.

The functional Design of the Hancocks Gully South Wetland Retarding/Basin and the Ryan Road DSS wetland/retarding basin allow for the provision of connecting wetland outflows to a feeder pipe to the stormwater harvesting initiatives advocated within the “Pakenham East stormwater Harvesting Investigation, Project Report, Dalton Consulting Engineers, May 2015”. If this occurs the pollutant reduction objectives are expected to be more than current best practice.

2.2.5 Ecological Requirements

The preliminary ecological advice which informed the development of the PEPSP drainage strategies indicated very little vegetation issues regarding drainage infrastructure apart from retention of the Deep Creek riparian zone and vegetation in road reserves.

At the present time, Hancocks Gully is just the straight drain the farmer originally cut with any vegetation present offering little ecological attributes.

The use of vegetated channel systems and wetland systems is expected to greatly enhance current ecological attributes along the local drainage lines.

2.2.6 Gas easements

Gas easements affect 3 of the 4 wetland/retarding basin sites. The relevant authority requirements have been included within the functional design formulation of the following assets:

- Hancocks Gully North Wetland Retarding Basin,

- Dore Road DSS wetland/retarding basin, and
- Ryan Road DSS wetland/retarding basin

Some minor changes to designs have occurred to address the gas easement requirements. For instance, the Hancocks Gully North Wetland Retarding Basin design was redesigned in 2017 to minimise impact on the existing gas asset at the outlet.

All wetland and retarding basin functional designs to date have been given approval in principle from APA Group and Lattice Energy.

2.3 Drainage Functional Designs

The functional design of the PEPSP drainage elements are detailed in the following drawing sets.

Dore Road DSS:
- DORERD_SWS_1_REV_A, 24 February 2017 (4 drawings)
- 1717_DORE_SWALE, 9 June 2017 (5 drawings)

Hancocks Gully DSS:
- HCGN_SWS_RevC, 23 August 2017 (7 drawings)
- HCGS_SWS, 5 September 2016 (5 drawings)

Ryan Road DSS:
- 1603_RYANRD_SWS_Rev_D, 9 June 2017 (7 drawings)

All the drawings above have been replicated in the relevant function design reports referred to in Table 1.

The functional design process has identified some areas where drainage reserve spaces could be reduced (e.g. in the Dore Road wetland/retarding basin site and in the Hancocks Gully South wetland/retarding basin site).

In addition, going forward, there may be some scope to reduce wetland/retarding basin reserve areas by optimising offsets to the required MWC minimum. These are:
- Normal water levels of wetlands and sediment ponds being no less than 15 metres from the site boundary, and
- Sediment dewatering areas being no less than 15 metres from the site boundary.

However, in addition to the above, I'd suggest site boundaries are also required to be at least 10 metres from the cut line or the 1% AEP flood line (whichever has the larger extent of site).

Offsets from drainage assets to site boundaries may also be required to be greater than required to meet MWC offset requirements due to landscape, ecological and/or social objectives of council/MWC.

3. Response to Submissions

I have reviewed the submissions and concentrated my responses in relation to drainage issues.

Submissions of relevance are:

- Submission 20 - Letter from Andrew and Suzanne Cleary (13 Ryan Rd. Pakenham), no date
- Submission 21 – Water Technology letter dated 23 February 2018
- Submission 28 - Letter from Phil Walton (XWB Consulting) dated 23 February 2018 to the VPA regarding the submission by Submission by Paul and Penny Carney and the accompanying Water Technology Pty Ltd letter to Paul and Penny Carney dated 22 February 2018 regarding drainage matters on the property.
- Submission 29 - An email from Department of Environment, Land, Water & Planning (DELWP) to VPA dated 23 February 2018
- Submission 36 – Plans in Motion letter dated 23 February 2018
- Submission 42 - An email from James Naylor (for Cedric Naylor) to the VPA dated 23 February 2018
- Submission 44 – Lendlease submission dated 23 February 2018
- Submission 49 - A letter from Laurack P/L to the VPA, no date
- Submission 71 - Cardinia Shire Council – Submission to Amendment C234 (Pakenham East Precinct Structure Plan)

My responses are summarised below.

3.1 Submission 20 – Ryan Road Flooding Issues

This submission states that “The land included in the proposal, on the east side of Ryan Rd, between Princes Hwy, and Canty Lane, is set on a flood plain, with a flood plain overlay, which is recognized as such in the document. Subsequently, these properties have a small building envelope because of this. We have witnessed significant flooding of the area, several times when that area did flood and come out onto Ryan Road. from overflow of Deep Creek. Many properties are known to be unable to use their land closest to Deep creek over the winter months as it’s too wet.”

These properties were considered in the original drainage strategy. However, it was assumed (by me) at the time that the density and form of development would not change from the existing situation. Provided flood levels did not increase due to adjacent PSP proposals (in the eastern flood plain), then the flood protection to these properties would not change.

Section 3.9 below discusses Council’s requirement for “a coordinated drainage plan, fill plan and concept plan” for this area.

I support this council requirement. A drainage strategy is required to ensure all flooding, fill, and stormwater quality issues are addressed due to the future development of this area.

The 2014 Deep Creek Report also details required upgrading of the Ryan Road culvert system at Deep Creek. I assume this work will occur when Ryan Road is reconstructed.

3.2 Submission 28 – Deep Creek Flood Plain North of Princes Hwy

This submission is detailed in a letter from XWB Consulting to the VPA regarding the submission by Paul and Penny Carney and the accompanying Water Technology Pty Ltd letter/advice in relation to the Deep Creek flooding issues.

This submission concerns the PEPSP requirements in the land generally contained between Deep Creek to the west, Dore Road to the east, Princes Highway to the south and the AusNet easement to the north.

In summary, the submitter contends that 50 metre drainage reserve to the east of Deep Creek would be more appropriate than a 100 metre corridor. The reasoning behind the adoption of a 100 metre corridor is discussed in Section 3.2.1 below and my responses to specific issues raised by the submitter are detailed in Section 3.2.2.

3.2.1 Strategy Methodology

The Deep Creek and Dore Road DSS drainage reserve requirements were developed giving considerations detailed within the 2017 Dore Road FD Report and the 2017 Dore Road Swale FD Report (Table 1). The drainage strategy formulation was based on the following considerations:

- Placing the Dore Road wetland between the gas easement and Princes Highway given that this is the lowest point in the contributing catchment area,
- Ensuring only one piped drainage crossing of the gas main to minimise DSS costs (to APA Group requirements),
- Minimising the Dore Road wetland/retarding basin size by diverting all flows from the west of the north-south Gas Main directly to Deep Creek,
- Setting the Dore Road wetland/retarding basin normal water level given the requirement to provide an outfall for the pipe under the gas easement (which is relatively deep), while still providing a gravity outfall at its downstream end to Deep Creek,
- Not requiring a drainage reserve though the middle of 95/65 Dore Road by directing the 37-ha external catchment around the potential development area to a swale in the reserve proposed east of Deep Creek or a DSS pipe in Dore Road,
- Proposing a swale within the reserve east of Deep Creek to provide:
    - An outfall as low as possible to minimise development fill requirements on 95 and 65 Dore Road

- Conveyance of local flows (up to the 1% AEP event) directly to Deep Creek (to bypass the Dore Road Wetland),
- No requirement for an additional gas easement crossing into the Dore Road wetland/retarding basin from land located north of the east west gas main,
- Supplement the stormwater treatment within the Dore Road DSS so that the total DSS provides the required pollutant reduction loads, and
- Convey the 1% AEP floodplain flow from Deep Creek when the creek overtops into its eastern flood plain in the 1% AEP event.

Figure 1 below is a replication of the existing flood plain extent upstream of Princes Highway. The plan clearly shows a natural valley though the proposed PEPSP proposed residential development and open space areas. The drainage strategy maximises development potential of this land by diverting the external catchment around the developable area (either to a pipe in Dore Road or the proposed swale in the reserve proposed east of Deep Creek). This negates the requirement for a drainage reserve through the residential area.

Significant fill will be required to develop the residential land in this area of the PSP. Essentially the area between the 100 m offset reserve boundary and the flood plain extent (detailed in Figure 1) is required to be filled. By incorporating the proposed swale at the 100 m offset location, the pipe outfall invert levels from the development can be in the order of 1 metre lower than if the reserve/swale were 50 metres away from Deep Creek. This saves the developer 1 metre of fill over the entire area requiring to be filled. This equates to in the order of a saving of $2 Million in filling costs.

More to the point though, the 100 m offset allows significant filling of a flood plain to facilitate development, while ensuring flow conveyance will still occur, as required, north to south though the site. The location of the land subject to inundation overlay line compared to the 100 metre offset line is shown in Figure 2 below.

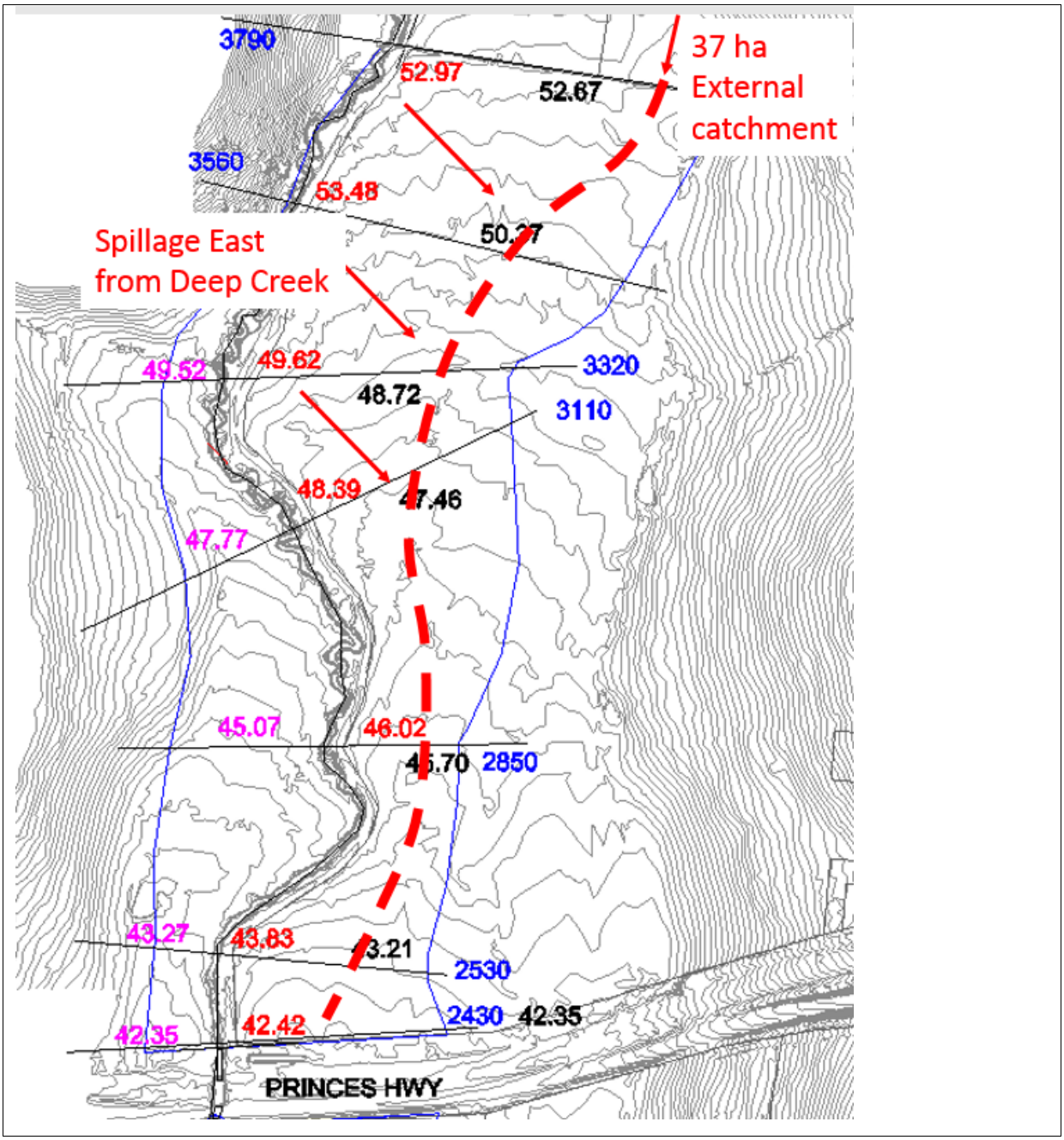


Figure 1 **Figure 5 From 2014 Deep Creek Report Showing natural flood plain valley east of Deep Creek**

Red Dashed Line – Denotes "Valley" through the area of interest

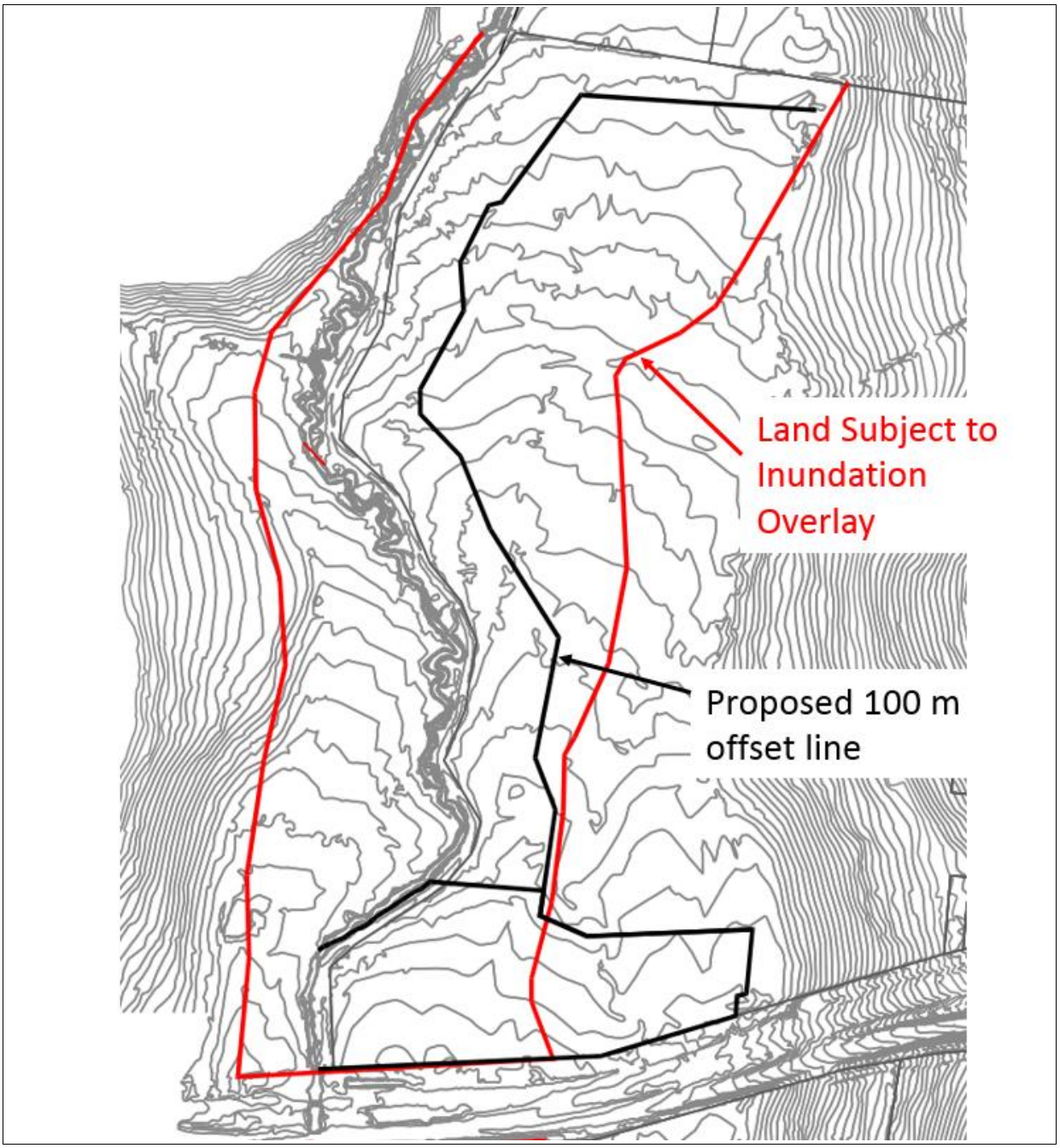


Figure 2 LSIO Compared to 100 Metre Offset Line

3.2.2 Response to Submission

Given the above, the issues raised in the submission are responded to as per the discussions below.

The submission states “As suggested in the majority of the plans above, the purpose of the 100 m reserve is for waterway and drainage purposes.” I would agree with this as the area is within areas either affected by sheet flow from breakaway flows from Deep Creek or flooding in the deeper areas closer to the eastern edge of the 100 m reserve boundary.

The submission states “it may be possible to modify the current 1% AEP Deep Creek channel, levees and floodplain to improve flood conveyance, reduce erosion within Deep Creek in the long-

term and maximise the land within the PSP (increase Net Developable Area)". The strategy developed for the PEPSP assumed that the existing riparian zone of Deep Creek, which encompasses conservation areas, cannot be modified. In addition, based on previous experience I think it is very unlikely that Melbourne Water would accept significant augmentation works to a natural waterway such as Deep Creek. As such, the "capacity" of Deep Creek itself cannot be augmented significantly.

The submission states "a 50 m corridor is likely to be sufficient, as this is what has been allowed for at the downstream end of Deep Creek within the PSP". The 2014 Deep Creek Report generally specifies a 100 metre offset to Deep Creek south of Princes Highway. As above, a 50 metre offset will significantly increase fill requirements of developable land.

The submission states "the retardation and water quality assets WI-05 is likely to be oversized given the proposed upstream land use". As per the 2017 Dore Road FD report, although appearing slightly oversized regarding water quality requirements, the site also provides a flood retention role and is required to be the size specified for this role.

The submission states "it may be possible to incorporate off stream wetlands and retarding basins with minimal or no loss of native vegetation". This is what the strategy achieves as there is NO loss within the Dore Road retarding basin/wetland site and minimal loss associated with the swale design within the 100 metre reserve.

The landowner asks "the VPA to allow flexibility for a developer, to reach a mutual agreement to design and construct the gateway site on more than the constrained "Slithers" that have been allowed." There may be scope (given planning and Gas Easement restrictions/requirements), to obtain more development space around the Dore Road Wetland/Retarding Basin site. The FD drawing does suggest this possibility.

The landowner seeks "clarification of the creek setback requirements: is this for conservation or drainage purposes only?". The 100 m offset is required for drainage purposes as described above, primarily to offset:

- Flood storage loss though filling of a significant flood plain,
- Allow for flood conveyance, and
- Ensure developable land can achieve piped outfalls to the flood plain, while minimising fill requirements within future development areas.

The WT letter states "we understand, based on correspondence from Melbourne Water, that the proposed waterway corridor setback has been determined by flood flows and flood levels within the 1% AEP floodplain." Yes, these were considerations, together with ensuring a balance of filling most

of the existing flood plain, protecting existing ecological features and reducing fill requirements within the future development.

The WT letter states “it may be possible to reduce the extent of the 1% AEP floodplain and therefore, reduce the waterway corridor width requirement”. The 100 m offset requirement is a significant reduction in the existing 1% AEP flood plain extent on the site. In my experience, the filling of the flood plain allowed by MWC in this case is much more than usually allowed in similar situations.

The WT letter states “it may be possible to modify the current 1% AEP Deep Creek channel, levees and floodplain to improve flood conveyance, reduce erosion within Deep Creek in the long-term”. I agree, in theory this could occur, but my experience with similar riparian zone areas is that the existing Deep Creek riparian zone will be required to be retained, and thus augmentation of Deep Creek itself is not an option.

WT describe that the “swale will convey local runoff from future development to the east and excess flow from Deep Creek”. The swale also ensures most of the 37-ha upstream (north) of the developable area is diverted around the future subdivision to negate the requirement for a floodway though the middle of the future residential area.

WT consider that “a 50 m corridor is likely to be sufficient, as this is what has been allowed for at the downstream end of Deep Creek within the PSP.” However, the PEPSP shows most of the eastern reserve downstream of Princes highway has been set at 100 metres.

WT state that “separate Hec Ras models were constructed to assess three reaches of Deep Creek within the PSP. Culvert influence on flood levels was assessed separately, to inform boundary conditions within each model. It is possible to model these reaches in one consolidated hydraulic model. We consider that this would provide a more accurate representation of interactions between the three reaches and influence from culverts.” Modelling as one system will not necessarily increase accuracy. There were three separate models, but the upstream water level in one was input into the culvert analysis at the relevant road crossing. This culvert analysis produced a flood level which was the downstream control on the next upstream model. Independently analysing each culvert system externally from the models can increase accuracy as the modeller knows the physical constraints of each system intimately.

WT state that “three separate Hec Ras models were built to assess conveyance capacities of the Deep Creek channel and its floodplain. Again, it is possible to model this reach in one consolidated hydraulic model, allowing for lateral weirs to represent the interaction between the floodplain and channel. We consider this approach (or the use of a 2D model package) would provide a more realistic and accurate representation of interactions between the channel and floodplain.” I undertook an iterative process to determine how much flow could be contained within Deep Creek and where flow would be side cast to

the relevant flood plain. Essentially the “lateral weir” calculation was done by me, by hand, outside of Hec Ras. In effect I used a 1D model to produce 2D results by considering the 2D effects external to the model. This is a valid technique and often gives the modeller a better understanding of flood plain interactions than just accepting a 2D model output as “true”.

WT state that “stormwater runoff from **catchment I** (about 6.9 m^3/s during the 9-hour event) is likely to be partly captured by the proposed drainage infrastructure under the development scenario and conveyed to the proposed retarding basin immediately upstream of the Princes Highway, effectively part by-passing Deep Creek. Consequently, reduced flows can be expected within Deep Creek and its eastern floodplain on the Subject Land.” I agree flows will be reduced from the 2014 analysis. The 2017 Dore Road Swale FD Report indicated flows from Catchment I will be more like 4.6 m^3/s, than 6.9 m^3/s. This combined with the Deep Creek overflow into the flood plain will reduce design flows in the flood plain from 24.1 m^3/s to 21.8 m^3/s. This reduction in flow rate may drop the flood level in the swale system order of 100 mm from those detailed in the 2017 Dore Road Swale FD Report. The reduction in flow rate will not alter the strategy proposals, which also consider pipe outfall and fill considerations etc.

WT state that “whilst Hec Ras is still currently used within industry, there are many 2D software packages available that are more appropriate to capture floodplain interactions. Melbourne Water generally recommends 2D models to be used for hydraulic impact assessment.” I deliberately used Hec Ras as this model:

- Can clearly show flood and fill levels so that development fill levels can be easily set, and
- Can be easily modified in house by MWC in the future to adapt to changes in development proposals etc.

A complex model is not necessarily the better model. I have seen many inaccurate model results from 2D models due to modeller input and understanding limitations. I have used a 1D model and replicated what can reasonably occur in a 2D sense by applying my modelling experience developed over 28 years in this field of expertise.

WT noted “that current Net Developable Area on the Subject Land is 57.98% however, fraction impervious was assumed to be 0.6 for the Subject Land and the wider catchment when designing drainage infrastructure.” SWS accounted for the development as per the PEPSP proposals and used MWC recommended fraction impervious values for the land use specified. As per the 2017 Dore Road FD Report (Figure 4 and Table 7), the subject site modelling incorporated a fraction impervious of 0.75 for PEPSP proposed residential areas and 0.1 for proposed parkland areas. These values are consistent with the recommendations in the Melbourne Water’s “Guidelines for the use of MUSIC”.

WT suggest that “a targeted planting program, promoting Swamp Paperbark within the waterway corridor and drainage reserves, including around the proposed water quality assets WI-05, may further improve water quality treatment performance within the PSP.” MWC require wetlands to be

designed to the current Melbourne Water Wetlands Design Manual. Wetland treatment as stated by Water Technology would have to be negotiated though with MWC and the treatment /infiltration mechanism fully understood. I have never seen an application like this adopted as the primary treatment mechanism within a MWC DSS to date. However, initiatives such as this are often encouraged to supplement DSS water treatment initiatives.

WT also suggest that "it may also be possible to create a series of linear wetlands within the Deep Creek Eastern Floodplain, similar to the proposed swale." I deliberately proposed a swale drain solution to keep the DSS costs as low as possible and implementation of DSS infrastructure for the developer as simple as possible (given the gas main constraints). Wetlands are much more expensive and certainly significantly more complex to design and implement in flood plain settings (where flow management is also a consideration).

Regarding linear wetland application in the Deep Creek floodplain, WT state "Whilst the design may need to comply with Melbourne Water's *Wetland Design Manual* and it would be appropriate to allow for design to be further refined at a later stage. Notwithstanding costs associated with crossing the existing gas mains, we consider this option merits consideration as an alternative to current Drainage Scheme proposals. It would maximise the land within the PSP available for development as the drainage reserve immediately north of Princes Highway would be reduced." This statement effectively negates the years of negotiation with the APA Group during the formulation of the PEPSP proposals. In addition, the design MUST comply with the Melbourne Water Wetland Design Manual, as has occurred in the FD process of this project. I believe that I have met all requirements regarding the above, while also suggesting a solution to:

- Ensure the DSS implantation as cost effective, easy and simple as possible upstream of Princes highway (given all the constraints in the project), and
- Maximise the developable land take by negating the requirement for a floodway though the natural valley which runs through the middle of the proposed residential land.

In summary, the drainage strategy and functional design developed for the PEPSP:

- Are to current MWC wetland design manual requirements,
- Consider all significant constraints (especially the gas main and ecological constraints),
- Have been formulated to keep the DSS infrastructure costs as low as possible,
- Reduce filling costs and volumes adjacent to Deep Creek as much as possible (given a significant portion of the floodplain is required to be filled),
- Have been formulated to aid the ease of implementation of the DSS requirements by the future developer by, as far as possible, specifying a simple swale drain solution in the flood plain (rather than a complex wetland solution) in the areas draining to Deep Creek north of the gas easement, and
- Provide flood conveyance.

3.3 Submission 21 – Deep Creek Flood Plain South of Princes Hwy

Submission 21 is detailed in a Water Technology letter dated 23 February 2018.

In summary, the submitter contends that 50 metre drainage reserve to the east of Deep Creek, south of Princes highway would be more appropriate than a 100 metre corridor.

In particular, the submitter suggests that:

- Modifying and augmenting the Deep Creek cross section could reduce the reserve requirements, and
- 2D modelling would be more appropriate than 1 D modelling in this situation.

Deep Creek is of similar form and depth as in this section as in the section upstream of Princes Highway. As such, my response to both these issues is discussed in Section 3.2 above.

The submitter states that "a 50 m corridor is likely to be sufficient to ensure waterway objectives are satisfied." No calculations are presented to support this statement. As per Table 8 in the 2014 Deep Creek Report, my calculations indicated that a 100 metre reserve (with some flood plain augmentation) would be required to retain the existing riparian zone adjacent to the creek, while not increasing local flood levels. I would assume that any proposed alternative would have to also show that these objectives can be met.

3.4 Submission 36 – West Deep Creek Flood Plain Upstream of Princes Highway

Submission 21 is detailed in a Plans in Motion letter dated 23 February 2018.

The submitters state that "Amendment C234 stipulates that land 50 – 100 metres on either side of Deep Creek, outside of the amendment area would be rezoned to RCZ2". The submitters oppose this rezoning.

Given the similar drainage issues and flood plain form on the western side of the creek as the eastern side of the creek, if the area is developed, protection of the creek and allowance for flood conveyance will be required adjacent to the western edge of the creek. Protection mechanisms over a 100 metre offset would probably be required due to the arguments in Section 3.2 for a 100 metre protection mechanism on the eastern flood plain.

Planning considerations are outside my area of expertise. As such I cannot comment on the appropriateness of applying RCZ2 to this area.

3.5 Submission 29 – DELWP Drainage Issues

DELWP have issues with Plan 3 of the amendment. They have interpreted that "There is vegetation to be retained that is in the middle of drainage locations. It is outlined within the NVPP that drainage cannot be altered to affect retained vegetation, while Plan 3 shows otherwise. The remnant vegetation in proposed drainage areas should be classified as lost vegetation as per the Guidelines (DELWP 2013)."

I assume the above relates to "conservation area" being shown to extend over the 100 metre drainage reserve north of Princes Highway.

It should ne noted, that although a flood plain, the only drainage work proposed in the location in the PEPSP is a 25 – 30 metre (at top width) swale running along the eastern boundary of the reserve. This swale can be aligned around almost all "conservation areas". In the worst case, a small section of piping could be incorporated to retain vegetation (if required).

3.6 Submission 42 – Impact of Properties south of the PEPSP

This submission concerns impacts at 655 Five Mile Road, Pakenham, part of which is located only about 2.4 km south of the southern PSP boundary.

The submitter objects to there having been no Environment Effects Statement (EES) concerning this PEPSP.

Specifically, it is stated in the submission that:

- "There has been inadequate consideration of the drainage impact generally of this project upon downstream properties, and in particular, the impact upon Hancocks Gully, which flows through the family farm, from north to south", and
- They are "witnessing more frequent episodes of Hancocks Gully being at, or near capacity, following significant rainfall events, and submit that it is not capable of handling likely increased flows, arising from the Pakenham East development. There will therefore likely be adverse consequences for the future agricultural productivity of downstream properties, including ours".

As per the 2016 Hancocks Gully FD report, the PEPSP drainage proposals have been formulated to ensure the requirements detailed in 2.2.3 and 2.2.4 are adhered to. In meeting these flood attenuation/storage and water quality requirements the issues above have been addressed.

3.7 Submission 44 – Hancocks Gully Drainage Reserves

The Lendlease submission dated 23 February 2018 requests "a more flexible approach to the drainage corridor to encourage increased water sensitive urban design, stormwater detention within the creek corridor and electrical easement and a more natural meandering creek corridor". In particular "A holistic

review of the Hancocks Gully drainage strategy may incorporate opportunities for Water Sensitive Urban Design throughout the masterplan, as well as options for retarding options in the north of the catchment."

The drainage strategy for the PEPSP was formulated with a holistic view and total catchment management methodology.

Distributed WSUD and stormwater detention was not proposed within the Hancocks Gully creek corridor to reduce ongoing ownership and maintenance responsibilities for Council, as larger, more robust systems will be the responsibility of Melbourne Water. In addition, in this case the steep nature of much of the landform north of Princes Highway results in limited opportunity for distributed asset creation.

Retarding basins north of the catchment were not considered as Option 1, referred to above, deliberately placed all drainage assets within the PSP area. The large dam located north of, and within, the electricity easement (at the northern extent of the PSP) was originally proposed to be included as a WSUD asset in the strategy. However, MWC was very clear that they would not take responsibility that this existing asset as part of the PSP proposals.

In addition, placing retarding basins at the lowest pint in the contributing catchments is best practice in regard to optimising asset size etc.

3.8 Submission 49 – Deep Creek Flood Plain South of Canty Lane

This submission states that "the area located south of Canty Lane in regard to the 1:100 flood level may not be correctly detailed. The site has had for over 12 years soil placed on the land which sits over the natural surface level" the submitter suggests this would alter the plans shown in the PEPSP reports.

The Lidar information used in the formulation of the PEPSP does not indicate significant fill in the area specified. No quantifiable difference from the expected natural valley form is observed. However, site observation by myself certainly show filling to protect house and shed assets etc. along Canty Lane.

Notwithstanding the above, the presence of fill will not change the formulation of the PEPSP in this area. 1% AEP flows are required to be conveyed in the Deep Creek corridor. Extreme flows (in excess of the 1% AEP will need to be catered for via the subdivision incorporating overland flow paths from Deep Creek to the Ryan Road wetland/retarding basin. Any existing fill which may be located in a future overland flow path can be removed as required during the future design/construction process.

3.9 Submission 71 - Cardinia Shire Council

10 properties north of Canty Lane, and east of Ryan Rd, were not originally included in the PSP but are shown in the current amendment.

These properties were considered in the original drainage strategy. However, it was assumed (by me) at the time that the density and form of development would not change from the existing situation. Provided flood levels did not increase due to adjacent PSP proposals (in the eastern flood plain), then the flood protection to these properties would not change.

The Council submission requests a change to requirement R14 being "A coordinated drainage plan, fill plan and concept plan is required to provide appropriate guidance on the development of Housing Area 2 and to confirm that decreasing the present lots from 4000 sqm to 800 sqm is appropriate and can be implemented without implications on adjoining properties."

Council's description of "why is change required?" in their submission is a summary of my advice to council in relation to this issue in February 2018. This is reiterated below.

The potential development of these lots falls outside existing defined Melbourne Water Catchment Development Services Schemes. As such, development of these lots has not been accounted for in the drainage strategies developed for the three DSS's proposed within the Precinct Structure Plan boundary.

There are usually four potential impacts of development being;

- Site outfall provisions,
- Increased stormwater pollutant loads,
- Increase flood flows to Deep Creek, and
- Flood protection of the development itself

Ideally it would be advantageous for all lots to develop as one uniform drainage strategy. However, this cannot be guaranteed, so it has to be assumed that each lot will develop individually. In a simple sense this is awkward, as potentially there will be at least 10 site outfalls required to be constructed to Deep Creek.

In regard to increased pollutant loads Council believes that each potential lot developer could pay the Melbourne Water Catchment water quality rate which would help fund the proposed wetlands proposed in the downstream Deep Creek retarding basin. However, as the area is not within a Development Services Scheme, Melbourne Water may require individual WSUD initiatives on each lot to meet Clause 56 requirements. Space definitions for these initiatives would need to be defined on each lot. In regard to increased flood flows Council believes that the peak flows from this small area would discharge to Deep Creek well before the peak discharge in Deep Creek occurs. As such, Council suspects that Melbourne Water would not require flood retardation provisions on each lot.

All of the above would be required to be confirmed by Melbourne Water

The increased development of these lots does not impact on the existing drainage scheme proposed for Pakenham East PSP and/or vice versa as these lots are not in any affected Development Services Scheme east of the creek. However, development of each individual lot will probably require an individual drainage strategy addressing the above issues and the filling issues discussed below.

Fill will be required for these properties. A 50 metre reserve on the west of Deep Creek and a 100 metre reserve of the east of Deep Creek between Princes Highway and Ryan Road was set assuming some simple flood plain augmentation (shaping) works were carried out in the flood plain to the east of Deep Creek as detailed in Figure 8 of the 2014 Stormy Water Solutions report. If these works occur, the properties to the west of the creek can be filled to the 50 m reserve boundary without increasing flood levels in the area.

Any future development must incorporate filling to required Melbourne Water catchment standards adjacent to the creek to ensure adequate flood protection. At this stage fill requirements are assumed to be 600 mm above the flood levels determined given ultimate reserve requirements. Fill requirements should be in the order of between 750 to 1100 mm adjacent to Deep Creek in the low density lots to the west of the creek. As discussed in the 2014 Stormy Water Solutions report, developers could probably grade the fill down to natural surface level over (say) 100 metres, creating, in effect, a very wide, flat levee adjacent to the creek.

It should be noted that the SWS 2014 report did indicate that further work required going forward in the design process should include:

- Ensuring the design of any future subdivision relies on detailed flood plain survey information, and updated flood levels to set adequate fill levels adjacent to the reserve, and
- Ensure the design of future reserve augmentation works meets the intent of the design as detailed in the Stormy Water Solutions 2014 report.

It may be difficult for an individual landowner to undertake this investigation/design work. Again if, all lots were part of one overall strategy this could occur easily, but this cannot be guaranteed. This may mean that the first developer may incur the cost to set fill requirements for all, unless Melbourne Water or VPA have undertaken (or have already undertaken) this analysis as an internal activity.

The uncoordinated development of this area could result in damming in some properties. An overall fill plan would assist with the development of this area. This should be done in conjunction with the updated flood analysis discussed above. Provided filling of a downstream lot incorporates an adequately graded catch drain (directed to Deep Creek) on the northern extent of the fill, flood levels on the lot to the north should not increase and nuisance flooding on this neighbour should not be too significant. Of course each catch drain will require space on the developing lot which may affect lot yield etc.

This will not be an easy area to ensure coordinated implementation of drainage and flood protection mechanisms. Melbourne Water and /or VPA/Council will probably be required to set an overriding drainage strategy for the area to ensure all landowners meet all requirements going forward without detrimental impacts on their direct neighbours or on the Deep Creek corridor.

Given the considerations described above, I support the Council submission regarding R14.

4. Conclusions

The specification of the PEPSP drainage proposals has been undertaken over many years.

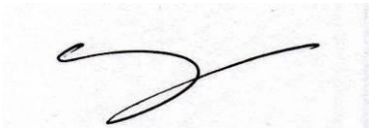
The concept design plans formulated in 2015 were used to set the drainage reserves detailed in the PEPSP. Further work to bring the drainage assets designs to the functional design standards (in 2016 and 2017) confirmed that enough space had been allocated in the PEPSP to ensure all drainage elements can meet all authority requirements going forward.

I conclude that Amendment C234 is appropriate having regard to allowing adequate drainage reserves to ensure enough space to develop the waterway, wetland and retarding basin functional designs to a detailed design standard, while ensuring all MWC, Council and other authority requirements are met going forward.

5. Declaration

I acknowledge that I have read the Expert Witness Code of Conduct and agree to be bound by it.

I have made all the inquiries that I believe are desirable and appropriate and that no matters of significance which I regard as relevant have to my knowledge been withheld from the panel.



Valerie – Joy S Mag
B.E. Civil (Hons), M. Eng. Sci.
Principal
STORMY WATER SOLUTIONS
1.26 202 Jells Road
Wheelers Hill 3150
May 2018

Appendix A Matters Raised by Planning Panels Victoria, Guide to Expert Evidence

1. The name and address of the expert.

Valerie – Joy S Mag
B.E. Civil (Hons), M. Eng. Sci.
Principal
STORMY WATER SOLUTIONS
1.26 202 Jells Road
Wheelers Hill 3150

2. The expert's qualifications and experience.

For qualifications and experience refer to Appendix B of this report.

3. Expert's area of expertise.

I am a hydrologist with 28 years' experience in hydrology and hydraulics and various applications of these fields. My educational qualifications are as follows:

- Bachelor of Civil Engineering, Monash University (1989)
- Master of Engineering Science (Water Resources and Environmental Engineering), Monash University (1993)

I have twenty eight years' experience and expertise in hydrologic and hydraulic engineering, particularly in the areas of:

- Preparing complex urban and rural flood plain strategies,
- Preparing Water Sensitive Urban Design Strategies,
- Major catchment analysis, including flood flow and flood level estimation,
- Planning and assessment of development within flood plain and overland flow path systems,
- Reviewing drainage strategies prepared by other consultants for Melbourne Water and various councils, and
- Regularly preparing and conducting training in drainage and WSUD for the Municipal Association of Victoria, Vic Roads, Melbourne Water, the Department of Tourism Arts and the Environment (Tasmania), ARRB Group and others.

My CV is attached as Appendix B.

4. Expert's expertise to make the report.

I have been involved in various drainage projects with in PEPSP area over almost all of my 28-year career, firstly during my time at the Dandenong Valley Authority and Melbourne Water and lately in my role as a consultant engineer.

5. Reference to any private or business relationship between the expert witness and the party for whom the report was prepared.

I have been the primary consultant responsible for developing the drainage strategies and designs within the PEPSP since 2013. Council and MWC commissioned me directly to undertake this work over this time.

In addition, I have completed many projects directly for MWC and Council since the inception of Stormy Water Solutions in 2003.

6. All instructions that define the scope of the report.

In a letter dated 8 May 2018, Harwood Andrews requested me to:

- Provide a summary of the preferred drainage strategy and concept and functional design of required drainage assets for the exhibited Pakenham East PSP area; and
- Consider the submissions made to the Amendment.

7. The facts matters and all assumptions upon which the report proceeds.

Refer to Section 1, Expert Witness Statement.

I have assumed that all submissions relevant to my area of expertise have been provided to me.

8. Documents and other materials the expert has been instructed to consider or take into account in preparing her report and the literature or other material used in making the report.

I have reviewed the following material in regard to the preparation of this statement of expert evidence:

- Submission 20 - Letter from Andrew and Suzanne Cleary (13 Ryan Rd. Pakenham), no date
- Submission 21 – Water Technology letter dated 23 February 2018
- Submission 28 - Letter from Phil Walton (XWB Consulting) dated 23 February 2018 to the VPA regarding the submission by Submission by Paul and Penny Carney and the accompanying Water Technology Pty Ltd letter to Paul and Penny Carney dated 22 February 2018 regarding drainage matters on the property.
- Submission 29 - An email from Department of Environment, Land, Water & Planning (DELWP) to VPA dated 23 February 2018
- Submission 36 – Plans in Motion letter dated 23 February 2018

- Submission 42 - An email from James Naylor (for Cedric Naylor) to the VPA dated 23 February 2018
- Submission 44 – Lendlease submission dated 23 February 2018
- Submission 49 - A letter from Laurack P/L to the VPA, no date
- Submission 71 - Cardinia Shire Council – Submission to Amendment C234 (Pakenham East Precinct Structure Plan)
- Planning Panels Victoria, Guide to Expert evidence

My report is also based on:

- Various site visits to the PEPSP area and drainage sites since 2013,
- My knowledge of the catchment through the many projects I have been involved with, both in my time at the Dandenong Valley Authority (DVA), Dandenong Valley and Westernport Authority (DVWPA), Melbourne Water and in consultancy (starting with mapping the Deep Creek flood plain in 1992 while at the DVA),
- Melbourne Water Corporation's Constructed Waterways in Urban Developments Guidelines, and
- Melbourne Water Corporation's Wetland Design Manual.

9. The identity of the person who carried out any tests or experiments upon which the expert relied in making the report and the qualifications of that person.

Expert Witness Statement rely on investigations and hydrological calculations carried out by myself and my project engineer (Michael Mag).

10. A summary of the opinion or opinions of the expert.

I conclude that Amendment C234 is appropriate having regard to allowing adequate drainage reserves to ensure enough space to develop the waterway, wetland and retarding basin functional designs to a detailed design standard, while ensuring all MWC, Council other authority requirements are met going forward.

11. Provisional opinions that are not fully researched for any reason (identifying the reason why such opinions have not been or cannot be fully researched).

I do not consider this Expert Witness Statement is incomplete or inaccurate in any respect. However, the flood hydrology (estimate of flood flows and volumes) has not been updated at this stage to reflect current changes in Australian Rainfall and Runoff 2016. Flood flows and models are as have been previously modelled in by myself and my project engineer. Notwithstanding the above, in other projects conducted in Melbourne during 2017/2018, flood flows have not varied significantly between ARR 1987 and ARR 2016 estimates.

12. Any questions falling outside the expert's expertise and whether the report is incomplete or inaccurate in any respect.

Planning, ecological and environmental issues fall outside my area of expertise.

Appendix B Valerie Mag – Curriculum Vitae

Bachelor of Engineering (Honours) 1989, Monash University
Master of Engineering Science 1992, Monash University

Mobile: 0412 436 021
Email: stormywater@optusnet.com.au

Personal Profile

Valerie prides herself on delivering good environmental engineering solutions, on time and within budget. She is an accomplished flood hydrologic and hydraulic modeller, with many years' experience applying models such as RORB, Hec Ras and MIKE 11 to complex urban and rural flood plain strategies.

Over the past twenty three years Valerie has been involved in (and been responsible for) many urban stormwater quality management projects, both in Victoria and interstate. She has a comprehensive understanding of the issues involved in developing water sensitive urban design (WSUD) strategies, including wetland and bioretention design, and is proficient in the application of stormwater pollutant models (such as MUSIC) to these applications.

Valerie was an independent reviewer of the 2010 Melbourne Water Corporation Wetland Design Guidelines and 2011 Melbourne Water Corporation MUSIC Guidelines.

Valerie has a Master's Degree in Water Resources and Environmental Engineering. She is passionate about providing transparent and clear environmental engineering directions in her products so that all stakeholders can fully embrace the exciting potential of water sensitive urban design.

Employment History

Stormy Water Solutions - Principal	**(2003 - present)**
Ecological Engineering Pty Ltd	(2001 - 2003)
Melbourne Water Corporation	(1991 - 2001)
Dandenong Valley Authority	(1989 - 1991)
Boral Johns Perry Power Projects	(1989)

Experience

TRAINING

In early 2004 Stormy Water Solutions developed the first of many courses and workshops which it subsequently offered to various organisations and individuals to supplement their knowledge of best practice drainage and WSUD requirements and engineering techniques. Over the thirteen years since inception, Stormy Water Solutions has conducted over 100 courses and workshops and trained approximately 2000 practitioners including engineers, mangers, planners and landscape architects.

Valatie has conducted training for Melbourne Water, the Clearwater Program, The Derwent Estuary Program (Tasmania), Vic Roads, and various councils and individual organisations.

Valerie has trained, engineers, managers, planners, maintenance personal, landscape architects, urban designers, ecologists and environmental scientists. The courses and workshops encourage participants to discuss issues relating directly to their project experience, thus enabling all participants to learn from each other.

WATER RESOURCES MANAGEMENT STORMWATER HARVESTING

Stormwater Harvesting

Valerie has conducted many detailed water balance analysis to ensure optimal sizing of various rainwater harvesting schemes. Analysis always includes a detailed assessment of demand (e.g. irrigation, toilet flushing, washing machine etc) and supply (i.e. available catchment and rainfall etc). Analysis performed includes the concept design of major initiatives proposed for Scotch College, irrigation pond sizing in various subdivisions throughout Melbourne and many projects requiring stormwater tanks sizing including the Dandenong Markets and Springers Leisure Centre in Cheltenham.

DSE Project Assessment

Valerie was part of the small SCA Consulting Team which assess over 60 water reuse and stormwater harvesting projects for the Department of Sustainability and Environment in 2007. These projects were those funded under the 2004 Stormwater and Urban Conservation Fund. This work included assessing probable potable water savings and making recommendations in regard to which projects provided the most benefits to the Victorian community and the cost effectiveness of each project. The work provided direction to the DSE in regard to future consideration of proposed stormwater and urban recycling projects.

WATER SENSITIVE URBAN DESIGN

Valerie was an independent reviewer of the 2010 Melbourne Water Corporation “Wetland Design Guidelines” and the 2010 Melbourne Water Corporation “MUSIC Guidelines” document.

Hume City Council WSUD Asset Audit and Rectification Project – 2015

In 2014 Optimal Stormwater and Stormy Water Solutions completed an audit of the WSUD assets within Hume City Council. The project consisted of auditing 55 projects including wetlands, bioretention systems, swales and ponds and recommending rectification works. Maintenance schedules for all assets were also prepared. This project won the Stormwater Victoria 2015 award for “Excellence in Asset Management”. The **Judges Citation is a follows:**

“Hume City Council, Optimal Stormwater and Stormy Water Solutions' WSUD Asset Audit and Rectification Project with support from Melbourne Water's Living Rivers Program, has brought real asset

management principles to the WSUD asset class with tangibility and affordability. The project was undertaken in a highly collaborative way from the get go, ensuring support and alignment across Council. The project was delivered with low cost and significant outcomes including a happy community and a safer place. Management of WSUD assets is an industry wide issue. This project provides a great low cost and attainable exemplar of how this can be done.

Major Wetland and WSUD Strategy Development, Wyndham City Council

Valerie worked on three major waterway rehabilitation projects within Wyndham City Council from 2004 to 2007. These projects required investigating possible application of WSUD to existing drainage assets within the area. The projects included the D1 Drainage Scheme WSUD Drain Rehabilitation Strategy, The Werribee Floodway WSUD Drain Rehabilitation Strategy and the Lollypop Creek WSUD Drain Rehabilitation Strategy. Following the successful adoption of the Lollypop Creek Strategy, Valerie completed the functional design and supported Council in the detailed design of 5 major wetland systems along Lollypop Creek. These wetlands will replace the existing concrete drain. These wetlands were constructed very successfully by Council in between 2005 and 2007. Council and Stormy Water Solutions were awarded the Stormwater Industry Award (both state and national awards) for this wetland design in late 2007.

Use of Class A Recycled Water – Hunt Club Estate Cranbourne

Recycled water has relatively high nutrient concentrations which can affect stormwater runoff characteristics. Valerie Mag was engaged to investigate the impact of a major initiative of the Hunt Club Estate to use utilise Class A recycled water (recycled water) within the development for residential and school garden watering and oval irrigation.

Valerie fully understood that a robust, clear and transparent investigation of this complex issue could clarify some of the myths and misgivings about this issue. All parties (including referral bodies) were shown that application of recycled water would not result in adverse stormwater impacts. This has resulted in the adoption of a scheme which will result in potable water saving within this site of over 150 ML/yr. However, the knowledge gained also facilitates easier application of this technique on other proposed large scale development projects in Victoria and therefore potentially help achieve in massive savings in portable water use within Victoria in the future.

Cardinia Industrial Area Drainage Strategy (Pakenham)

Valerie was jointly retained by both Cardinia Shire Council and Melbourne Water in late 2007 to develop a comprehensive drainage, flood mitigation and WSUD strategy for this major future development west of Pakenham. Her contribution included merging the environmental aspects of the development with the civil engineering, landscape, urban planning and council vision. She was involved in negotiations and workshops involving Council and all major stakeholders. She was the primary designer of the adopted WSUD strategy for the development, and developed the major wetland, pond and vegetated

channel designs which now form a major part of the adopted Melbourne Water Corporation Development Services Scheme (also developed by Stormy Water Solutions).

Afton Street Conservation Park Wetland Design (Mooney Valley)

The City of Mooney Valley engaged Valerie to complete all the hydrologic and hydraulic modelling required for the concept and functional design of the combined wetland/irrigation pond within this extremely high profile site. Stormy Water Solutions has also produced all functional design drawings for the asset. This design work was completed in July 2008, with detailed design and wetland construction completed (by Council) in 2010. Council and Stormy Water Solutions received a Merit award in 2009 from Stormwater Victoria in the "Master Planning and Design" category.

CATCHMENT AND FLOODPLAIN MANAGEMENT

Drainage Scheme Development (Metropolitan Melbourne)

Valerie has been responsible for developing many Melbourne Water drainage schemes. Work included undertaking hydrologic and hydraulic analysis, stakeholder consultation, multi-disciplinary team coordination including coordinating environmental input, determining cost estimates and drainage scheme rate recommendations and producing the functional design of major retarding basins and wetland systems required for the implementation of Drainage Schemes in Greenfield and developed areas. Drainage Schemes developed include Braeside South Drainage Scheme (Braeside), Braeside Drainage Scheme (Braeside), Collison Road Drainage Scheme (Cranbourne), Laurimar Drainage Scheme (Whittlesea), Shakespeare Grove Main Drain Drainage Scheme (St Kilda), and the Homestead Road Drainage Scheme (Berwick).

Urban and Rural Floodplain Studies (Metropolitan Melbourne and rural Victoria)

Valerie has completed numerous flood plain studies for Melbourne Water in both urban and rural areas. Development of hydrologic models (RORB) and hydraulic models (Hec Ras and MIKE 11) have been required. She has also been involved in the internal processing and public consultation required for major flood plain and overland flow path declaration projects such as Deep Creek Flood Plain (Pakenham), Grasmere Creek Flood Plain (Berwick), Merricks Creek Flood Plain (Hastings) and various overland flow path planning overlays within Melbourne.