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Mamre Road Precinct DCP – Discussion Paper

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1. Introduction

NSW Department of Planning, Industry and Environment has released the Mamre Road Precinct Draft DCP for comment. MIRVAC has engaged Tony Wong and Peter Breen to provide advice on the stormwater management conditions outlined in the draft DCP.

The draft report of the Stormwater and Water Cycle Management Study for the initial precincts of the Western Sydney Aerotropolis[1] espouses an integrated water servicing approach in setting infrastructure requirements for a series of precinct-scale servicing and water balance scenarios. The new water management criteria developed for the Aerotropolis precincts are focussed on promoting integrated water management and protection of waterway health, intended to foster broader "whole-of-precinct" and/or catchment-wide solutions. In relation to waterway health, the report sets out the key underlying principle for stormwater management objectives to "work towards managing waterway health within the Wianamatta-South Creek by capping the volume of erosive stormwater flows discharged from new development, as well as setting water quality requirements". The Mamre Road Precinct Stormwater Management objective generally follows the principles set out in this document.

Sydney Water (2020a)[2] undertook an analysis to explore possible water management solutions in the Mamre Road Precinct in support of the draft DCP. The stormwater management changes proposed in the DCP respond to the Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions and the Western Sydney Employment Area SEPP.

1.1 Background

Table 1 summarises the existing Penrith DCP (2014)[3] targets for stormwater management and those proposed in the new draft Mamre Road Precinct DCP.

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[1] Sydney Water (2020a) Draft Stormwater and Water Cycle Management Study supporting the draft Aerotropolis Precinct Planning Package https://shared-drupal-s3fs.s3-ap-southeast-2.amazonaws.com/master-test/fapub_pdf/00+-+Planning+Portal+Exhibitions/Western+Syd+Aero+Planned+Precincts+/WSAPP+/Draft+Stormwater+and+Water+Cycle+Management+Interim+Report.pdf

[2] Sydney Water (2020) Flood, Riparian Corridor and Integrated Water Cycle Management Strategy supporting the Mamre Road Precinct DCP https://shared-drupal-s3fs.s3-ap-southeast-2.amazonaws.com/master-test/fapub_pdf/00+-+Planning+Portal+Exhibitions/Mamre+Road+DCP/Mamre+Road+Flood+Riparian+and+Integrated+Water+Cycle+Management+Report.pdf

[3] https://www.penrithcity.nsw.gov.au/images/documents/building-development/development/Water_Sensitive_Urban_Design_Factsheet.pdf

Table 1. Stormwater management targets		
	Penrith 2014 DCP	Draft Mamre Road Precinct DCP(1)
Flow Volume Target (MARV reduction)	N/A	2.0 ML/ha/yr (~ 68%) >2nd order streams(3)
Stream Erosion Index (SEI)(4)	<3.5	
Flow Retardation	On Site Detention in any new developments is to be sized to ensure that for all rainwater events up to and including the 1:100 ARI event, do not increase stormwater runoff peak flows in any downstream areas	As for Penrith 2014 DCP
Total Nitrogen % annual load reduction	45	68(2)
Total Phosphorus % annual load reduction	60	75(2)
Total Suspended % annual load reduction	85	95(2)
Gross Pollutants % annual load reduction	90	100

1. To be consistent with Sydney Water Western Sydney Aerotropolis (Initial Precincts) Stormwater and Water Cycle Management Study Interim Report – October 2020.
2. Expected pollutant load reductions when developments comply with the proposed flow management target.
3. We understand it was determined that no 1st or 2nd order streams in the Mamre Road Precinct were worthy of protection.
4. The post development duration of stream forming flows shall be no greater than 3.5 times the pre-developed duration of stream forming flows. The comparison of post development and pre development stream forming flows is commonly referred to as the Stream Erosion Index (SEI).

We understand the objectives of the stormwater component of the DCP are:

1. Water quality and waterway health values are protected and enhanced through a risk-based approach that mitigates development impacts as documented in the NSW Government's Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions (2017).
2. Protect, maintain and restore the ecological condition of aquatic systems (including but not limited to wetlands and riparian lands) over time.
3. Retain and restore native vegetation to promote aquatic ecosystem functioning.
4. Ensure that waterways are protected in the design and management of the stormwater and wastewater management systems (*and that erosive flows are adequately managed*).
5. Effectively manage indirect and ongoing impacts of development on waterways to ensure the interim water quality and waterway health values as outlined in Table 6 of the draft DCP are maintained.

1.2 Prescribing MARV

The Mamre Road DCP adopts the interim objective of "*capping flow of 1.9 megalitres (ML) per hectare per annum, measured at any legal discharge point or estate boundary*". The introduction of prescribed mean annual runoff volume (MARV) would effectively require a significant component of stormwater harvesting and use, and infiltration – requirements that may be inconsistent with the proposed reticulated recycled water supply scheme.

The current requirements for reduction in stream erosion potential is largely inadequate in protecting the ecological health of high valued waterways and the SEI target could be strengthened from its current <3.5 to an SEI of between 1 and 2., The Draft DCP replaces the required reduction in stream erosion potential (SEI) with target reductions in the mean annual runoff volume for catchments discharging into (i) 1st and 2nd order streams; and (ii) 3rd or greater order streams to 0.9 ML/ha/yr and 2 ML/ha/yr respectively.

While presenting a simple deemed-to-comply performance metric, this broader requirement should not preclude more detailed, rigorous technical analysis and adaption of solution that would achieve the same outcome. There ought to be provision for a more scientific and rigorous multi-metrics approach to be adopted in place of the MARV approach should the development proponent chooses to pursue.

While not wanting to question the objectives of the draft DCP it is also important to recognise that South Creek and many of its tributaries have undergone significant historical degradation as a result of previous land-uses such as agriculture. This means that regardless of hydrologic management (eg reductions in MARV terms) flow characteristics in these waterways will remain significantly different, with flow volumes above the pre-developed land use conditions. So the existing in-channels environments will always experience flow disturbances far greater than pre-development conditions regardless of how flow is regulated. Therefore waterway environments in urbanising catchments that have undergone degradation due to pre-urbanisation land-use can only be expected to develop to some remediated health condition that represents new novel ecosystem. Such a condition can fulfill all the requirements of healthy waterway in the liveability and landscape sense, if not strictly in the waterway health sense, eg community composition of stream macroinvertebrates.

The analysis undertaken by Sydney Water[2] led to the observation that "this objective is more onerous to achieve than to simply apply stormwater pollution reduction and stream erosion index targets expressed in existing DCPs";

a. The analysis indicates that the cost increase in stormwater management required to achieve the volume reduction objective is 2.4 times the current NSW Stormwater Management objectives in existing DCP, i.e. "a notional (order of magnitude) cost of $120,000/Ha while business as usual approaches to stormwater management will achieve a notional residual discharge of 4.4 to5 ML/Ha/yr and cost $50,000/Ha to implement".

b. Sydney Water went on to recommend that stormwater management infrastructure such as wetlands and ponds for stormwater harvesting be located "in the floodplain where there is no net loss of developable area, floodplain storage and conveyance. To realise this, waterbodies must be integrated into the master planning for the Wianamatta South Creek precinct and within flood prone lands zoned as Private Recreation to the East of the Precinct". This is currently inconsistent with the Draft DCP for the Mamre Road Precinct.

2. Protecting Waterway Health

It is a well-accepted theory that waterway health is determined by both water quantity and quality conditions and the geomorphic structure of natural waterways. Mitigating the impact of land development on these waterways requires management of post-development stormwater runoff in terms of quantity and quality, and its potential to cause erosion in the receiving natural waterways.

2.1 Proposed Controls for the Mamre Road Precinct

In a letter dated 17 December 2020 from the Department of Planning Industry and Environment to MIRVAC it was advised that "*the interim objectives in Section 2.6 in exhibited draft Mamre Road Precinct DCP will be superseded by tables 1 and 2 below as follows*:"

- *Page 26, Section 2.6 Integrated Water Cycle Management: Following description of flow components the new Table 1 (below) will be added and referred to. Also, 'and baseflow requirements' in the last/following sentence will be deleted.*

- *Page 30, Section 2.6.2 Stormwater Quality: Table 6 of the draft DCP will be replaced with the new Table 2 below.*

These tables are presented in the next page.

Table 1 Ambient stream flows and requirements of waterways and water dependent ecosystems in the Mamre Rd Precinct

Flow Related Objectives		
	1-2 Order Streams	3rd Order Streams or greater
Median Daily Flow Volume (L/ha)	71.8 ± 22.0	1095.0 ± 157.3
Mean Daily Flow Volume (L/ha)	2351.1 ± 604.6	5542.2 ± 320.9
High Spell (L/ha) ≥ 90th Percentile Daily Flow Volume	2048.4 ± 739.2	10091.7 ± 769.7
High Spell - Frequency (number/y) High Spell - Average Duration (days/y)	6.9 ± 0.4 6.1 ± 0.4	19.2 ± 1.0 2.2 ± 0.2
Freshes (L/ha) ≥ 75th and ≤ 90th Percentile Daily Flow Volume	327.1 to 2048.4	2642.9 to 10091.7
Freshes - Frequency (number/y) Freshes - Average Duration (days/y)	4.0 ± 0.9 38.2 ± 5.8	24.6 ± 0.7 2.5 ± 0.1
Cease to Flow (proportion of time/y)	0.34 ± 0.04	0.03 ± 0.007
Cease to Flow – Duration (days/y)	36.8 ± 6	6 ± 1.1

Table 2 Ambient water quality of waterways and waterbodies in the Mamre Rd Precinct

Water Quality Objectives	
*Total Nitrogen (TN, mg/L)	1.72
Dissolved Inorganic Nitrogen (DIN, mg/L)	0.74
Ammonia (NH_3-N, mg/L)	0.08
Oxidised Nitrogen (NOx, mg/L)	0.66
*Total Phosphorus (TP, mg/L)	0.14
Dissolved Inorganic Phosphorus (DIP, mg/L)	0.04
Turbidity (NTU)	50
Total Suspended Solids (TSS, mg/L)	37
Conductivity (µS/cm)	1103
pH	6.20 - 7.60
Dissolved Oxygen (DO, %SAT)	43 - 75
Dissolved Oxygen (DO, mg/L)	8

* when showing compliance towards TN and TP through industry models, the DIN and DIP performance criteria should be instead to recognise that stormwater discharges of nutrients are mostly in dissolved form

2.2 Flow management for improved waterway health

Sydney Water[2] undertook an analysis of a number of water management scenarios in responding to the draft DCP for the Mamre Road Precinct. As described in Figure 7.6 of that report (see Figure 1) there are a number of flow characteristics desired in supporting the hydrology of natural waterways and these characteristics are described in Table 1 (see Section 2.1) above.

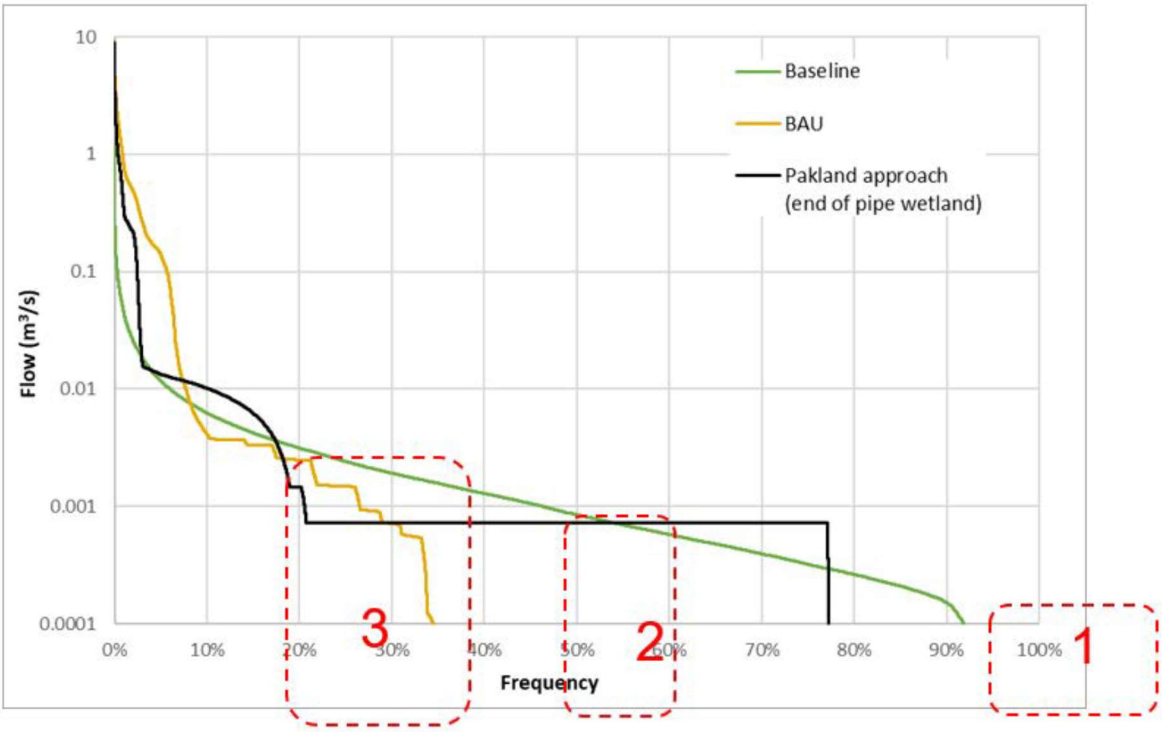

Figure 1 extracted Figure 7-6 from Sydney Water Report2 – Source modelled flow frequency curves comparing baseline, and hypothetical BAU and Parkland approaches to Precinct-scale water management at Mamre Road Precinct.

It is noted that:

a) the baseline flow characteristics depicted in Figure 1 are associated with a 3rd order or greater streams and it is assumed that the corresponding flow duration curves for the BAU and Parkland Approach are similarly for Precinct-scale solutions.

b) The flow duration curve for the Parkland Approach has a curious shape with constant controlled flow rate of 0.0008 m^3/s for flow frequency between 21% and 75%, which is abruptly terminated beyond the 75%tile.

c) The Parkland Approach presented does not deliver a rigorous attempt at mimicking the flow duration curve, merely force fitting to key points representing the cease-to-flow, median flow and freshes in the baseline curves.

d) As noted in the report, the near constant flow for such an extended period of the flow duration curve would require storage system (e.g. wetlands) with much longer detention period of over 3 times that of conventional approaches for best practice water quality outcomes.

As stated in the Sydney Water report "*Achieving a reduction in stormwater runoff volumes represents a shift in stormwater management that requires a combination of at-source controls, rainwater and stormwater harvesting and vegetated Water Sensitive Urban Design (WSUD) elements including biofiltration and wetlands, that can mimic the existing hydrologic characteristics of the rural catchment*"

As a deemed to comply condition, we understand satisfaction of the prescribed MARV reduction could satisfy development conditions. However, we also understand the MARV reduction is a very simple surrogate for a more sophisticated approach to matching the flow frequency curve at some identified points. We interpret this to be an alternative approach to satisfy the flow management requirements of new developments.

The intent to mimic the baseline flow characteristics as outlined in Figure 1 and broadly in the table of ambient stream flow presented by DPIE is supported. However, the range of flow duration characteristics can be achieved in many ways, not all of which need to be related to the reduction of mean annual flow prescribed in the table, and the industry should be given the opportunity to develop such options based on particular site and development context.

Together with mimicking the baseline flow duration curve is ensuring that increased flow erosion potential is mitigated. Achieving the prescribed MARV does not guarantee adequate mitigation of increased stream erosion potential associated with urban development. Not all flow conditions are stream erosive conditions. Replacing the current NSW Stream Erosion Index (SEI) approach to "*capping the volume of erosive stormwater flows discharged*" has removed the direct association of the flow management objective to reducing the exposure of greater erosive conditions attributed to urban development in the catchment. Flow management could be more targeted if the SEI requirement is more stringent with a revised target of between 1 to 2.

We understand eWater Source modelling has been used to determine three elements of the flow frequency curve that relate to the natural flow regime as shown in Figure 1:

a. Zero flow periods
b. Median flow
c. Seasonal pulses (three times median flow or 'freshes').

It is suggested these curves could be compared to those produced by MUSIC modelled solutions and this approach is demonstrated in the next chapter of the report.

2.3 Stormwater quality management for improved waterway health

DPIE advised that Page 30, Section 2.6.2 Stormwater Quality: Table 6 of the draft DCP will be replaced with the new Table 2 as set out previously. The table sets out ambient water quality objectives of the receiving water and it is not clear how individual parcels of development can demonstrate compliance to these objectives. These are precinct-scale concentration-based objectives and cannot be directly translated into site-based objectives.

It is inferred that pollutant load reductions presented in Table 7 (Page 31) of the draft DCP would apply as stormwater management targets at individual discrete allotment. While not confirmed, we envisaged that the load reductions presented in Table 7 of the Draft DCP are derived from modelling with a significant proportion of the load reductions attributed directly to the reduction in the MARV.

This approach to setting water quality management targets is not supported. With targets set with this approach, water quality improvement measures would pre-dominantly be tied to stormwater harvesting strategies, and in essence to the MARV targets.

Notwithstanding that stormwater harvesting often requires accompanying stormwater quality improvement, replacing direct reference to reduction targets of key stormwater pollutants has substantially downgraded the significance of adopting a stormwater treatment train approach – an approach involving many established stormwater treatment measures associated with removal of gross pollutants and the biophysical processes of sedimentation, filtration and biological uptakes associated with a whole family of stormwater quality measures such as gross pollutant traps, constructed wetlands, biofiltration etc. These systems are integrated into urban landscapes at a range of scales, retain water in the environment and contribute to urban liveability.

3. Mimicking the Flow Frequency Curves

3.1 Understanding the effect of urbanisation

The draft DCP for the Mamre Road Precinct stipulates a MARV of 1.9 (2.0) ML/ha/yr and this broadly corresponds to the flow volume for the protection of 3rd order or greater streams. Therefore, this target is applicable for the whole of Mamre Road Precinct and is optimally complied with through a whole-of-precinct strategy. It may not be appropriate for this to be applied for discrete assessment at a substantially smaller scale, such as the Aspect Development Estate as demonstrated in the following paragraphs.

An analysis was undertaken using the MUSIC model to describe the baseline hydrology of the 54.3 Ha Aspect Development Estate site. The result of this is shown in Figure 2 (compared against 1st & 2nd Order Streams) and Figure 3 (compared against 3rd Order or greater Streams). Key flow characteristics outlined in Table 1 of the DPIE advice are included in the figures for comparison. Key observations include:

a) The modelled baseline flow characteristics yield a MARV of approximately 1 ML/ha/yr, consistent with the prescribed MARV for 1st and 2nd order streams;
b) The flow duration curve derived from MUSIC for the baseline conditions reproduced the cease-to-flow conditions, the median flow, the freshes, but has over-estimated the high spells; considering the suite of flow characteristics, the results of the MUSIC modelling is considered to have reasonably represented the pre-development conditions;
c) The effect of urban development on flow characteristics is also shown in Figure 2, i.e.
    (i) If the development consists of 100% impervious surfaces, the flow duration curve exhibits a cease to flow condition at the 16%tile, i.e. flow only occurs during periods of rain with no "hydrological memory" or lag in runoff and subsurface flows that are often associated with detention of water on undulating surfaces and in the soil;
    (ii) A small proportion of pervious area restores the low flow hydrology to some degree, especially the cease-to-flow conditions, as shown by the flow duration curves for development layouts consisting of 90% impervious surface and 80% impervious surfaces; note that the flow magnitudes are represented in log scale and the seemingly small departures from baseline conditions do represent substantial percentage reductions;
    (iii) Post-development conditions would result in a reduction in median flow and freshes and significant increases in the high spells;
    (iv) The post-development scenarios report MARVs of 4.9 ML/ha/yr to 5.9 ML/ha/yr and all of the increases in flow volume occur during the period of rain as represented by the frequency of up to the 15%tile – it follows that, if mimicking the flow duration curve for protection of 1st and 2nd order stream is the principal management objective, a key flow management focus would be on mitigating the impact of development in the region between the 10%tile and the 15%tile;

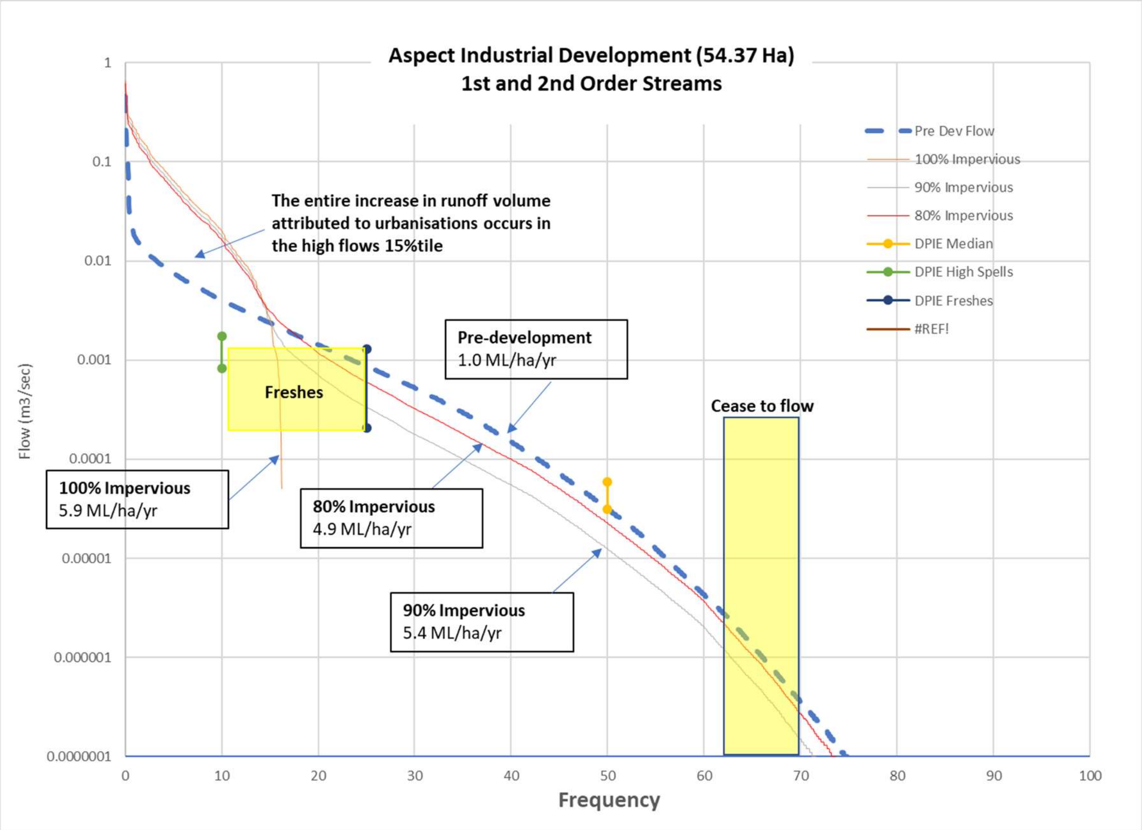

Figure 2 – Plots of simple MUSIC results for the 54.37 Ha Aspect Industrial Estate site against 1st and 2nd Order Streams flow characteristics

d) Comparison of the modelled baseline flow duration curve against desired flow characteristics for 3rd order or greater streams are shown in Figure 3, which clearly show a significant departure from the stipulated median flow and cease-to-flow conditions while maintaining the "freshes" and modelled flow being closer to the high spells.

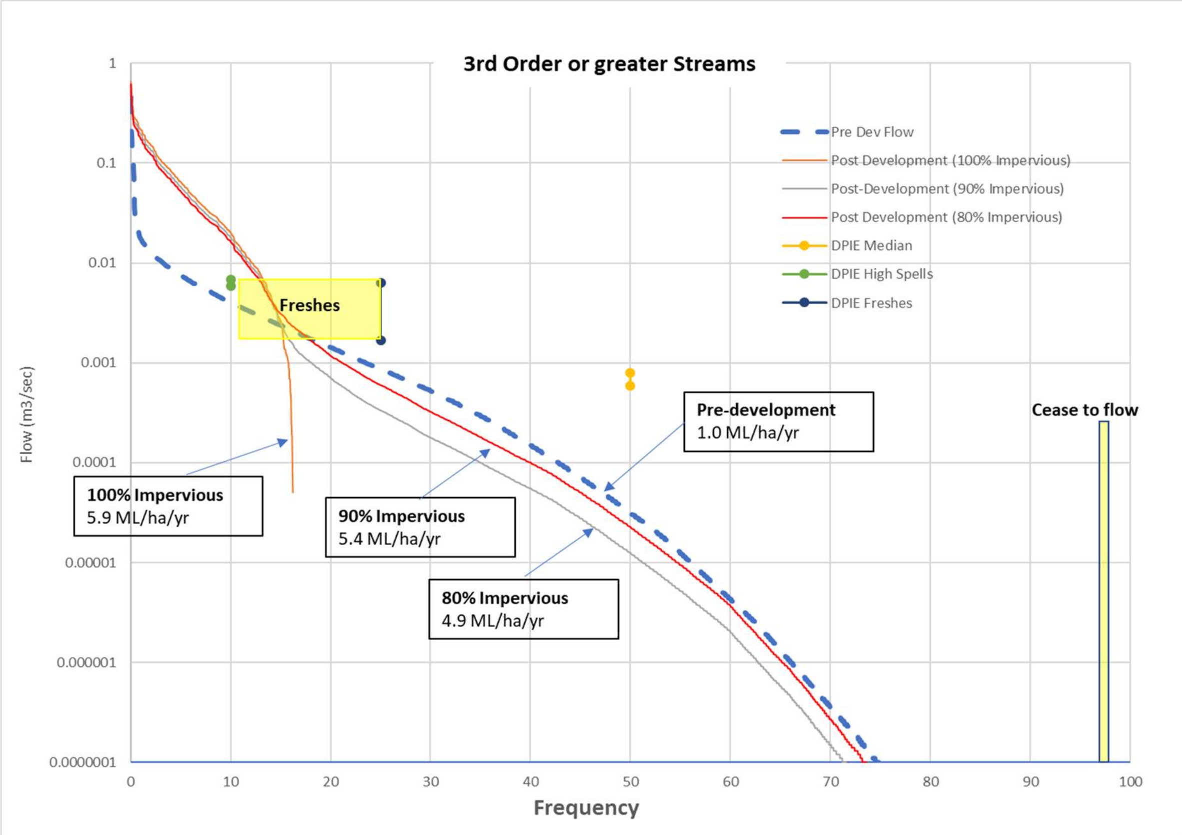

Figure 3 – Plots of simple MUSIC results for the 54.37 Ha Aspect Industrial Estate site against 3rd order and greater stream flow characteristics

3.2 Introducing WSUD measures

Figure 4 shows the results of introducing current WSUD measures that meets the Penrith 2014 DCP. The WSUD measures for current BAU development consist of rainwater tanks sized to meet 80% of the non-potable water demands, a bioretention basin to meet water quality pollutant load reduction, and an on-site 0.6Ha detention basin. Included in the development layout is the 4.5 Ha open space associated with the E2 Ecological Corridor, located inside the length of the northern property boundary.

Advanced WSUD initiatives included the provision of harvested water for landscape watering, the creating of an urban forest within the onsite detention basin, the use of a centralised stormwater storage constructed at the base of the OSD. The storage of approximately 2000 m^3 is to supply indoor non-potable use, landscape water including the E2 corridor within the property boundary, and water supply to the urban forest by a wicking bed system to optimise evapotranspiration.

- The resulting flow duration curve mimics the baseline curve very well from the 10%tile to the 50%tile.

- Further initiative may be required to reduce the SEI (currently 3.3) to between 1 and 2, through some further detention of peak storm discharges and external reuse of excess low flow. These initiatives would not significantly reduce the MARV but will better reproduce the baseline flow duration curve and reduce the stream erosion potential. Such initiatives could include high early discharge designs for the onsite detention basins.

Another analysis undertaken was to demonstrate the resulting flow duration curve for a solution that complies with the MARV of 1.9 ML/Ha/yr. This could only be achieved onsite through the construction of a 6.5Ha wetland serving largely as an evapotranspiration system with limited outflow. The resulting flow duration curve shown in Figure 4 is not considered to be an improvement to that for the "Advanced WSUD Initiatives" scenario without the associated increased land requirement.

> The analysis reported herein demonstrate that mimicking the key flow characteristics of baseline conditions can be undertaken through a range of innovative WSUD initiatives which does not necessarily need to reduce the MARV to the extent stipulated.

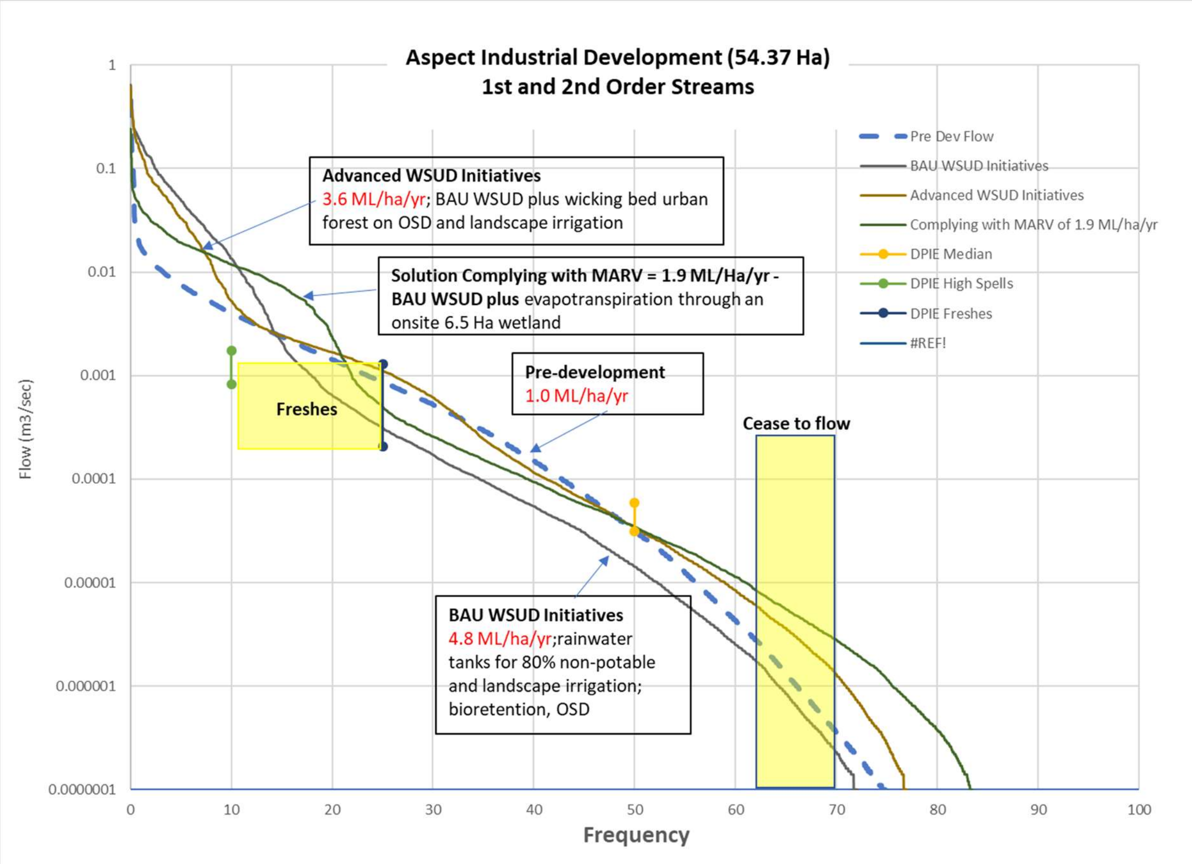

Figure 4 – Plots of simple MUSIC results for the 54.37 Ha Aspect Industrial Estate site with WSUD Initiatives against 1st and 2nd order stream flow characteristics

WSUD initiatives adopted that would comply with the 2014 Penrith DCP would not be able to mimic the flow characteristics of a 3rd order stream as shown in Figure 5.

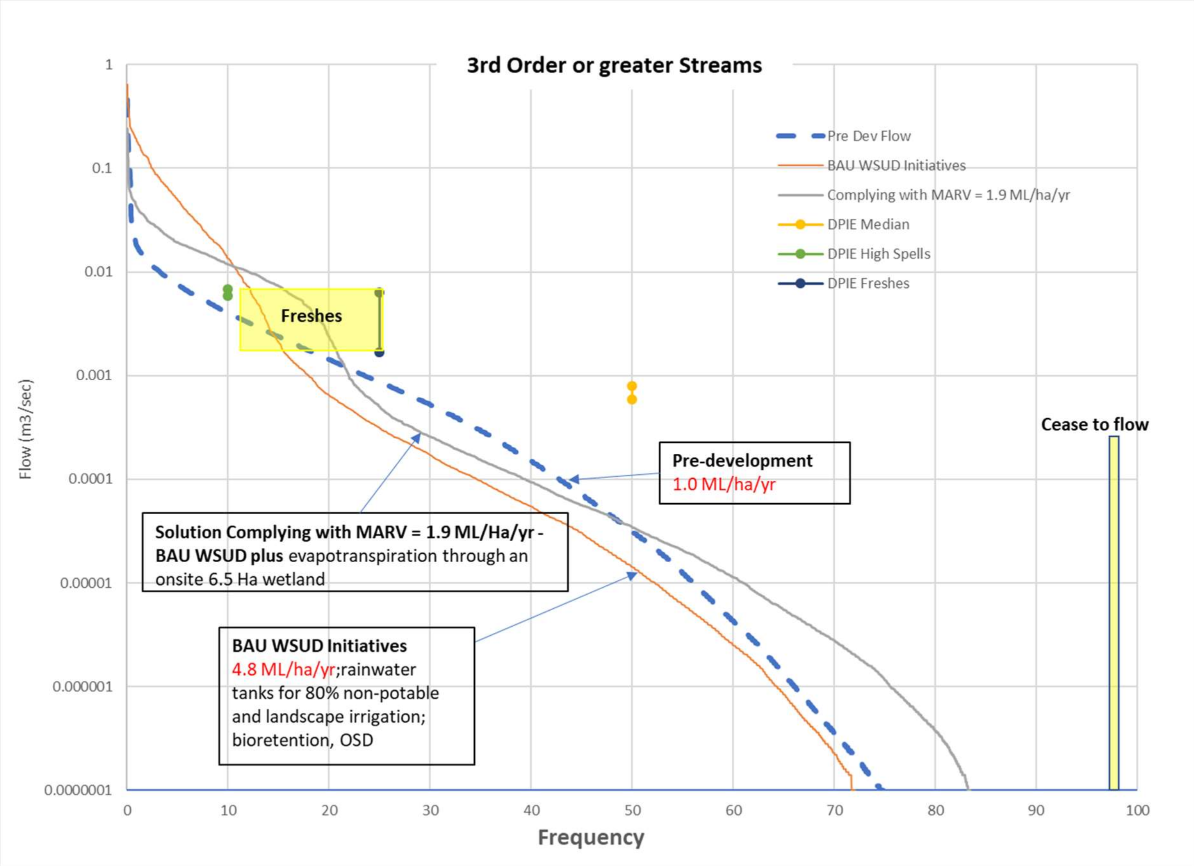

Figure 5 – Comparing MUSIC results against 3rd order or greater stream flow characteristics

4. Matching Flow Frequency Curve from Source and MUSIC

E2D experience in matching flows and pollutant loads from Source and MUSIC has proven difficult. Recent experience in Victoria on a major ICM project for Department of Environment Land Water and Planning has shown that significant changes to MUSIC guideline settings were required for:

1. Imperious fraction
2. Rainfall threshold
3. Soil moisture storage
4. Field capacity

The adoption of the same climate data period was crucial. It was found that on average Source predicted flow volumes approximately 47% of those predicted by MUSIC, and pollutant loads approximately 65% of those predicted by MUSIC.

We make these comments because the Mamre Road Flood Riparian and Integrated Water Cycle Management Report suggest the comparison of Source and MUSIC outputs. The models are quite different with Source being a fully calibrated model while MUSIC is generally not. The difficulty is that at the typical development approval scale MUSIC is currently the industry standard. We think there may be the need for guidance on how best undertake these comparisons.

5. Conclusions

1. We agree with improved development conditions to further protect waterways and receiving waters from the impacts of urban development.
2. However, the simple application of MARV target to achieve this, while attractive in an administrative sense, potentially has some significant practical issues and unintended outcomes that are less effective in waterway protection compared to a more rigorous approach of mimicking key flow characteristics of the natural waterway to be protected.
3. A significant practical issue is the potential conflict between the use of harvested stormwater and the use of recycled water in the broader Aerotropolis and Mamre Road Precinct areas.
4. We agree there are ecologically important points on catchment flow duration curves, as described in Table 1 (will be 2) and Figure 1.
5. We show a deemed to comply MARV reduction solution that is not an improvement to alternative approaches focused on mimicking the baseline flow duration curve. In the Mamre Road Precinct case presented in the report by Sydney Water, the proposed "Parkland Solution" shows a significant departure from the baseline curve. This suggests that a single compliance criteria may have unexpected waterway health results.
6. We also show a solution that can replicate the identified important segments (ceased to flow, median, freshes) of the predeveloped flow frequency reasonably up to the 10-15% flow range with the BAU WSUD development design in compliance with the 2014 Penrith Council DCP. A further refinement of the WSUD initiatives was shown to further improve the resulting flow duration curve in mimicking baseline conditions. But these solutions cannot achieve the proposed MARV reductions.
    a. Some further refinement of the advanced WSUD solution would result in a lower SEI values to further reduce excessive volume of erosive flows into the immediate receiving waterway (e.g. high early discharge OSD).
7. Our analysis suggests it is unreasonable to apply MARV reductions derived from the broad analysis of the Aerotropolis region and South Creek to individual allotments within the precincts of the region, including the Mamre Road Precinct. This analysis is consistent with the principal narrative, and we believe the intent, of the Draft Stormwater and Water Cycle Management Study supporting the draft Aerotropolis Precinct Planning Package and the Flood, Riparian Corridor and Integrated Water Cycle Management Strategy prepared by Sydney Water to guide the DCPs for the region.
    a. Large scale industrial developments such as the Mamre Road precinct simply don't have practical and sustainable demands to achieve the proposed MARV reductions without access to a broader regional stormwater harvesting or management scheme.

b. We note the draft DCP suggest applicants should plan for 35% pervious space in order to have sufficient space to be able to achieve the proposed stormwater volumetric reduction. Our experience is that large form industrial developments typically have about 10% on lot pervious areas. We show in our analysis that a substantial period of low flow conditions and cease-to-flow duration of the adjoining receiving waterway can be adequately mimicked by maintaining at least 10% open space.