Flooded? Forget it!

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Agenda

1. Definition
2. Current guidelines in QLD
3. Design
4. Resilience
5. Serviceability
6. Other considerations

Definition

Floodways are road sections designed to be overtopped by floodwaters

Source: Road Drainage Manual: TMR, 2019

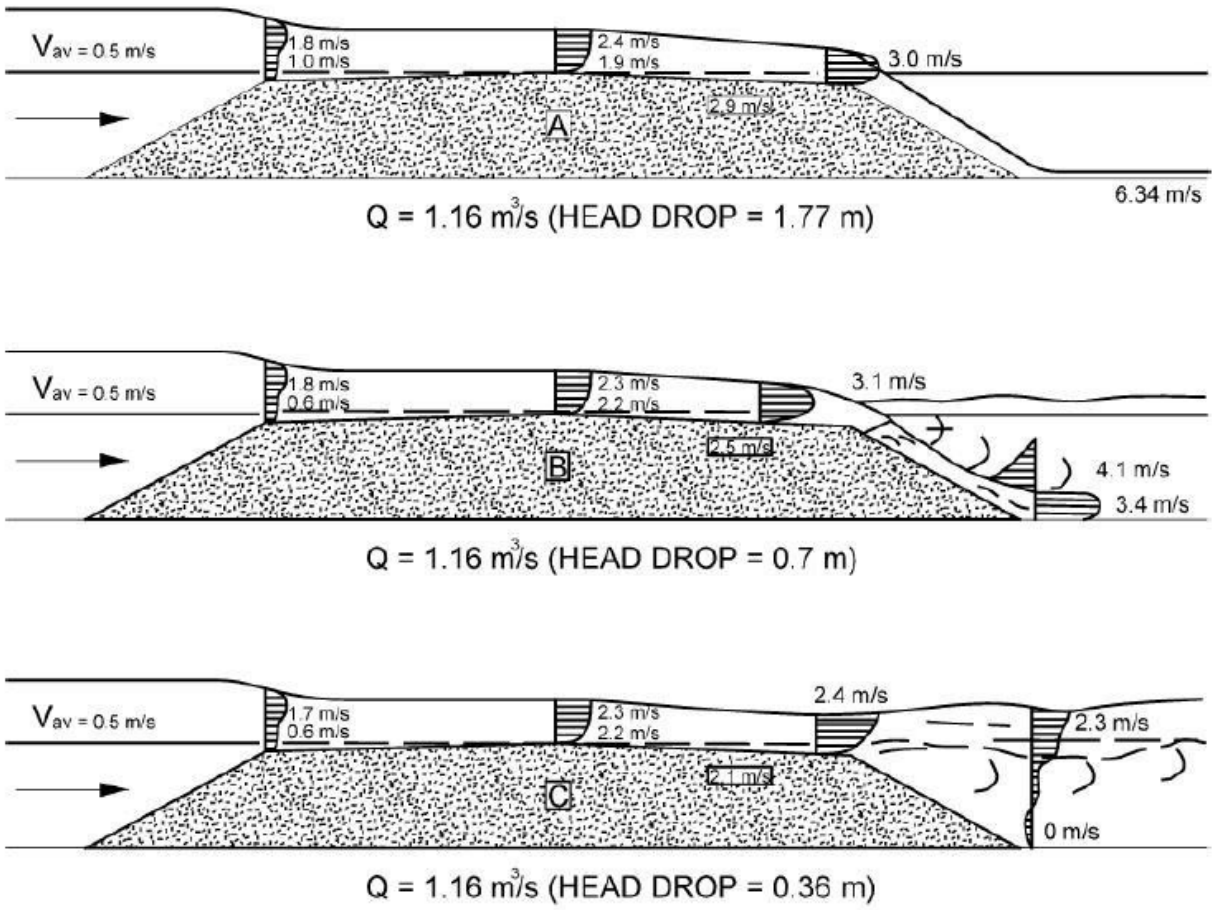
Immunity usually 5% Annual Exceedance Probability (AEP) or higher (20 ARI or lower), but any crossing can be designed as a floodway. At

Current guidelines in QLD

1. Austroads (2013)
2. QUDM (IPWEA, 2017)
3. Road Drainage Manual (TMR, 2019)
4. ARR19 (Section 3.7)
5. Local council guidelines
6. MRWA 2006 (for scour remediation/rock protection)

Design

1. Can be done using first principles (weir/culvert equations), as in guidelines
2. Can be also done using either 1D (depth/width averaged) and 2D models (depth averaged)
3. Better representation of over bank, multidirectional or skewed flows
4. Adjusting for variations in velocities
5. Serviceability
6. Resilience



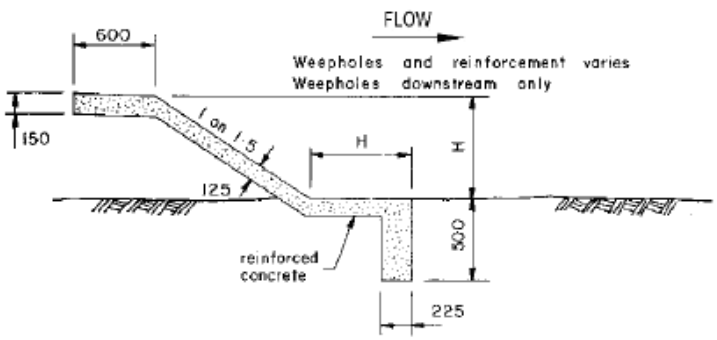
Source: Road Drainage Manual: TMR, 2019, after Cameron and Mcnamara 1966

Resilience

Floodway scour protection

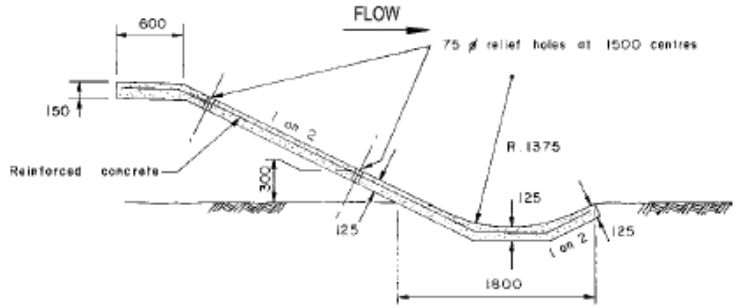
1. Minimum protection – grassed batters
2. Five types of floodway design
3. Free flowing/plunging/submerged

TYPE 1 – Concrete protection



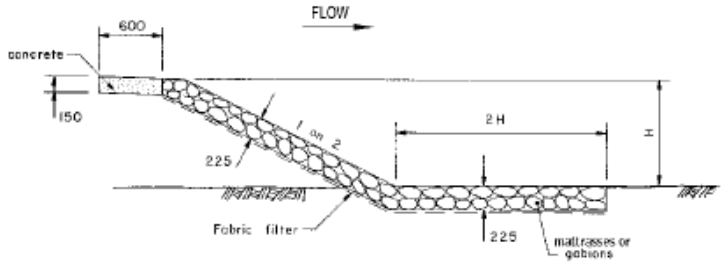
Most common type. Widely used.

TYPE 2 – Concrete protection



Type performs well, but need to justify cost. Requires specialist design.

TYPE 3 – Rock mattress protection



Mattresses must be pinned/anchored. Consider a cut-off wall.
Cut off walls may not be necessary as mattresses, usually achieve their optimum position with a little scour by dropping into a scour proof position

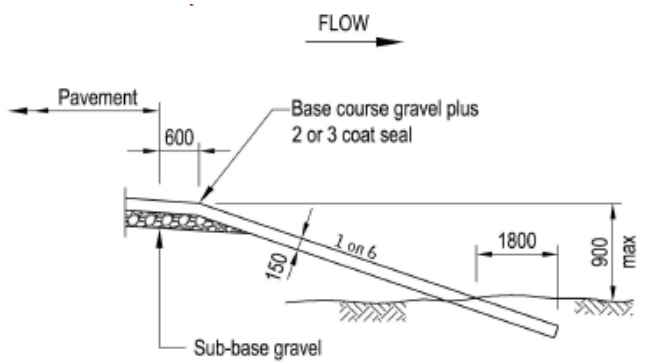
Source: Road Drainage Manual: TMR, 2010

Resilience

Floodway scour protection

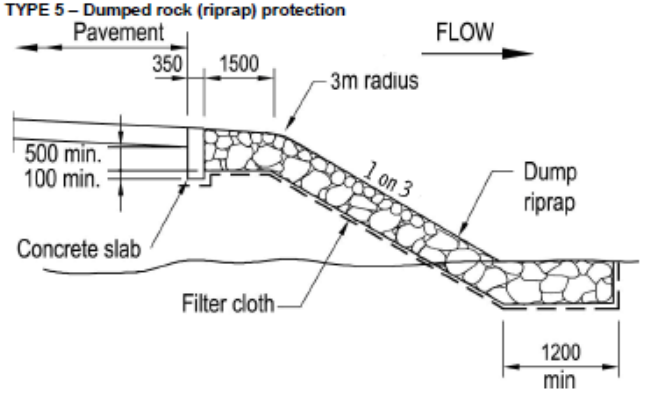
1. Rock protection sizing based on velocities in accordance with MRWA 2006.
2. Different sizing methods and engineering judgement should be used depending on model used (1D/2D) (TMR Bridge scour manual, 2019)

Velocity (m/s)	Class of rock protection (tonne)	Section thickness (m)
< 2	None	–
2.0–2.6	Facing	0.5
2.6–2.9	Light	0.75
2.9–3.9	¼	1.00
3.9–4.5	½	1.25
4.5–5.1	1.0	1.60
5.1–5.7	2.0	2.00
5.7–6.4	4.0	2.50
> 6.4	Special	–



Common, low cost type. Suitable for low velocities over floodway situations only.

TYPE 5 – Dumped rock (riprap) protection



Variation to Type 3 where mattresses are not readily available. Consider a cut-off wall.

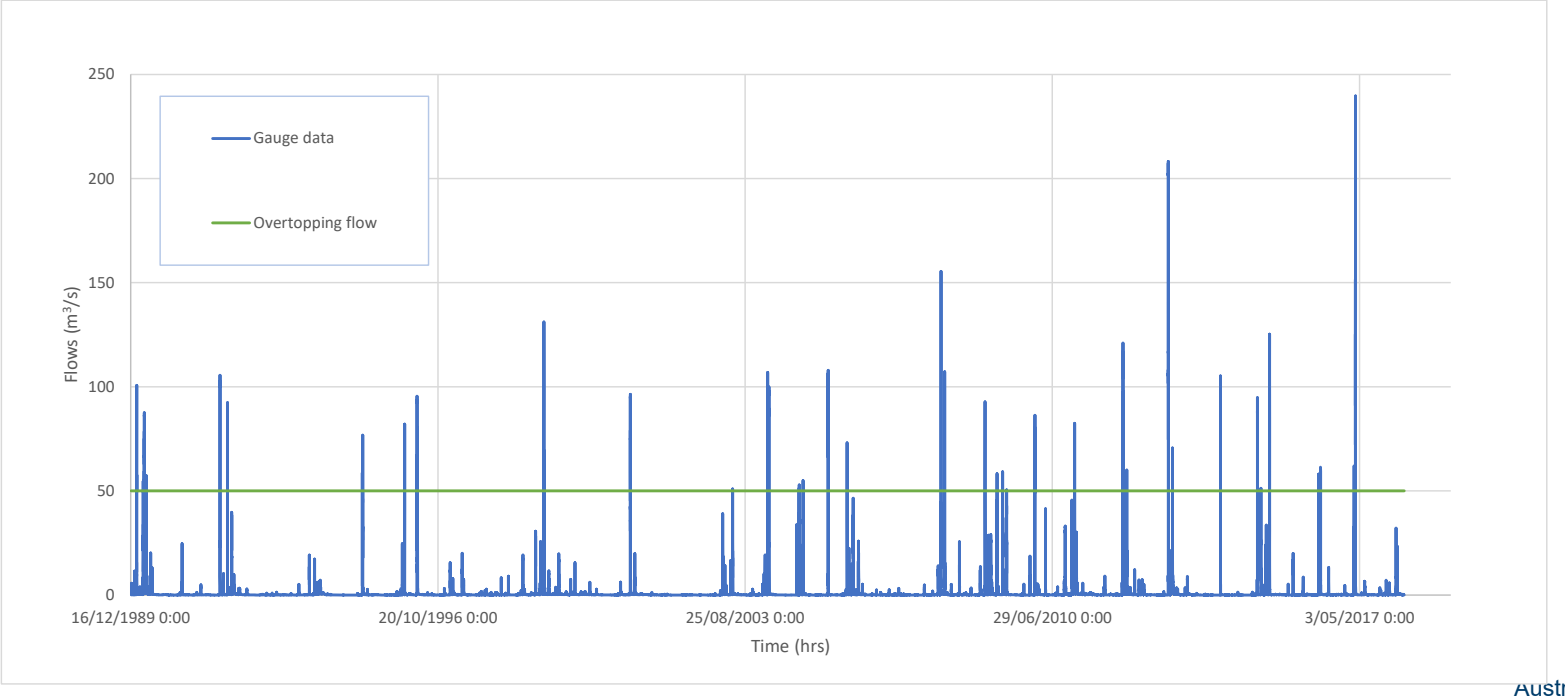
Source: Road Drainage Manual: TMR, 2010

Serviceability

1. The time of submergence (ToS) is the period of time that the road is inundated during a flood event, no matter the depth, it is expressed in hours or days.
2. The Average Annual Time of Submergence (AAToS), is the average time per year that the road is submerged, expressed as hours or days per year.
3. These factors are of importance with respect to stability of embankments and pavements and consequent maintenance costs.
4. They are also of importance in consideration of acceptable delays to traffic,
5. They are important for defining the disruption to transport and its associated cost due to floods.

Serviceability

- Some roads in QLD get inundated for weeks/months at a time during the wet season and/or may be inundated by tides.
- Calculations of ToS for these cases is very difficult and should use either a stream gauge or continuous simulation techniques

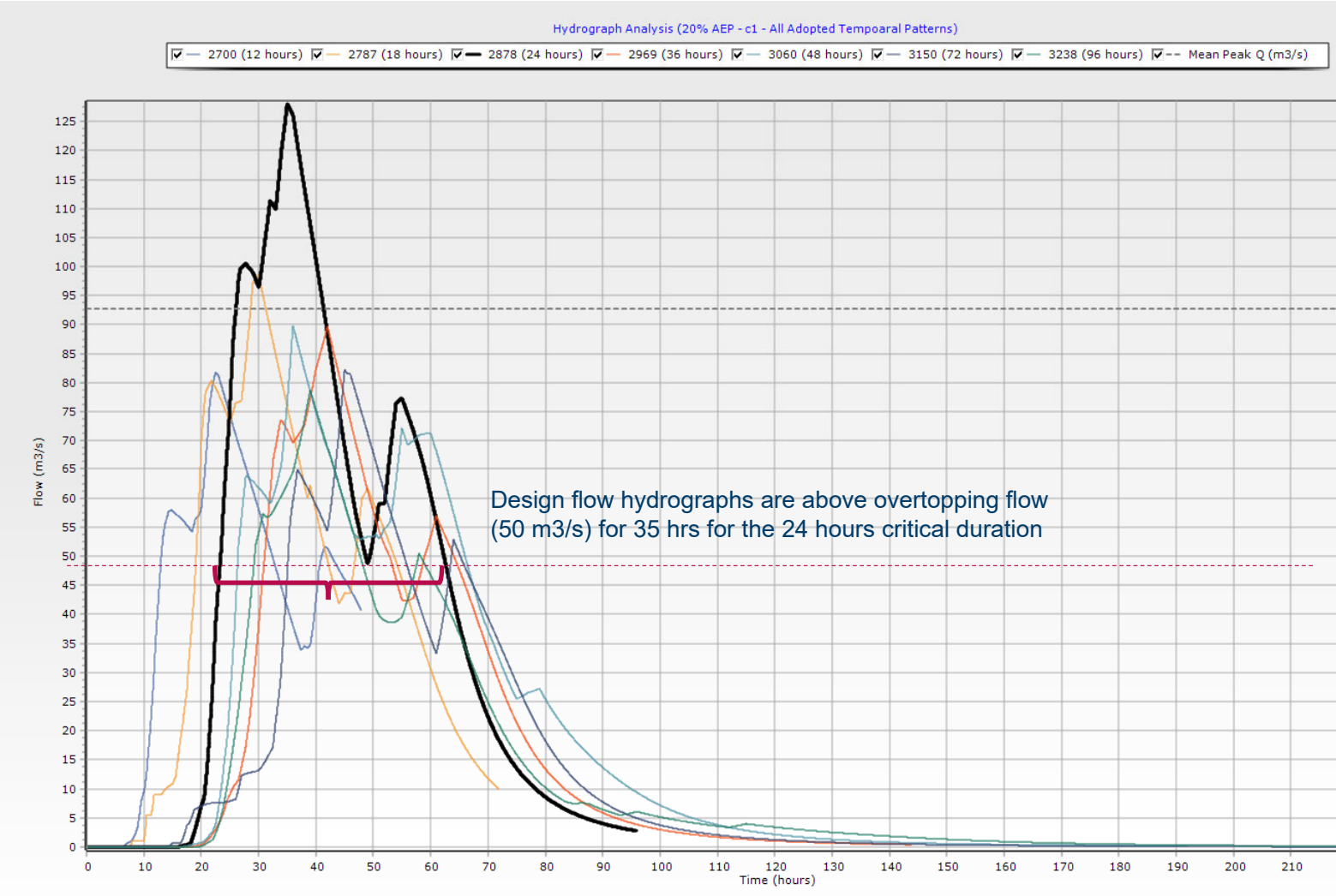


Serviceability

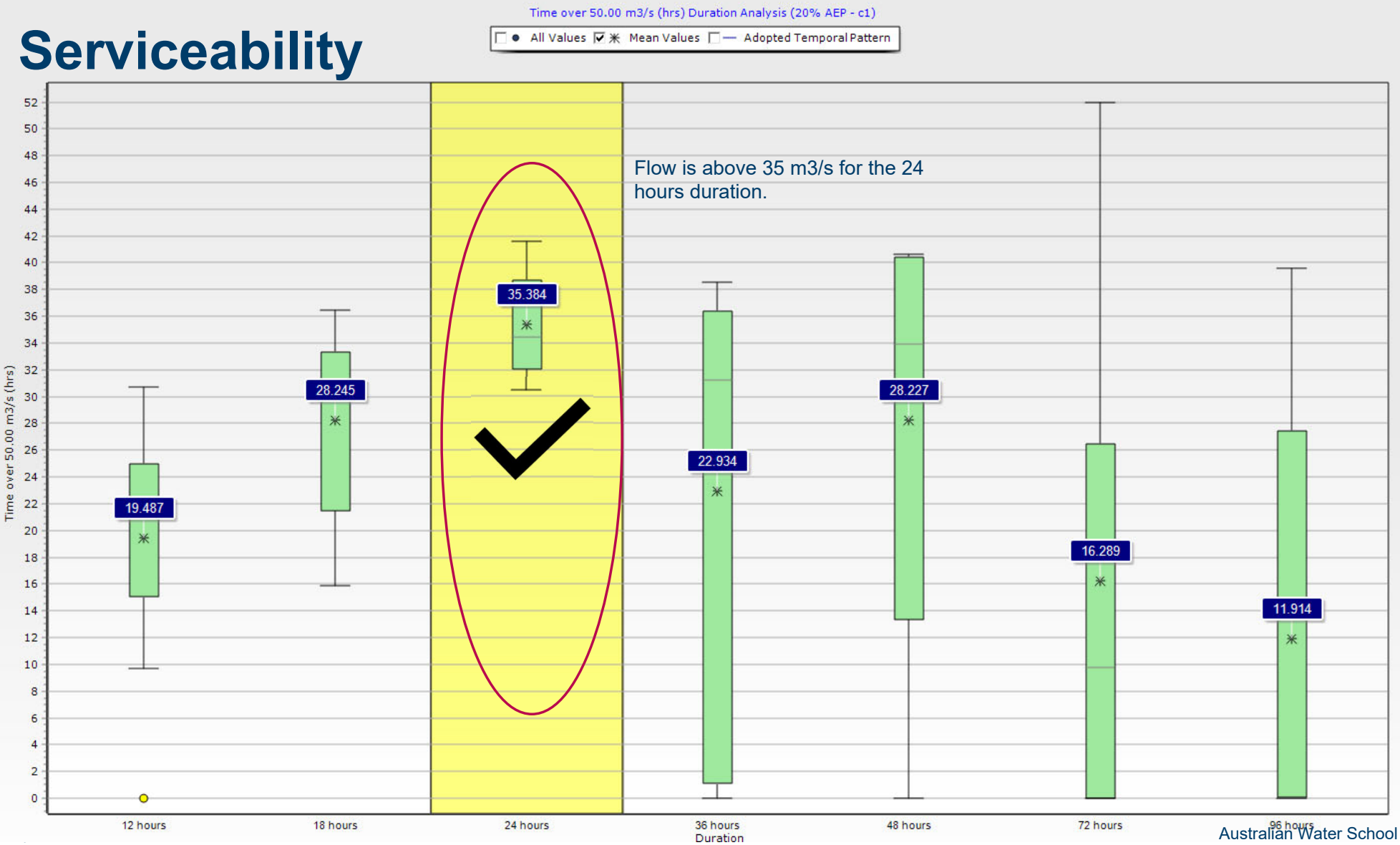
Where no gauges exist, ToS/AAToS can be calculated based on design events including PMF.

In line with ARR, using ensembles and different durations

Source: Road Drainage Manual: TMR, 2010



Serviceability



Serviceability

$$F_T(t) = 1 - AEP \qquad \Delta p \times \bar{t}(i) = \left(\frac{(t_i + t_{i-1})}{2}\right) \times \left(F_T(i) - F_T(i-1)\right)$$

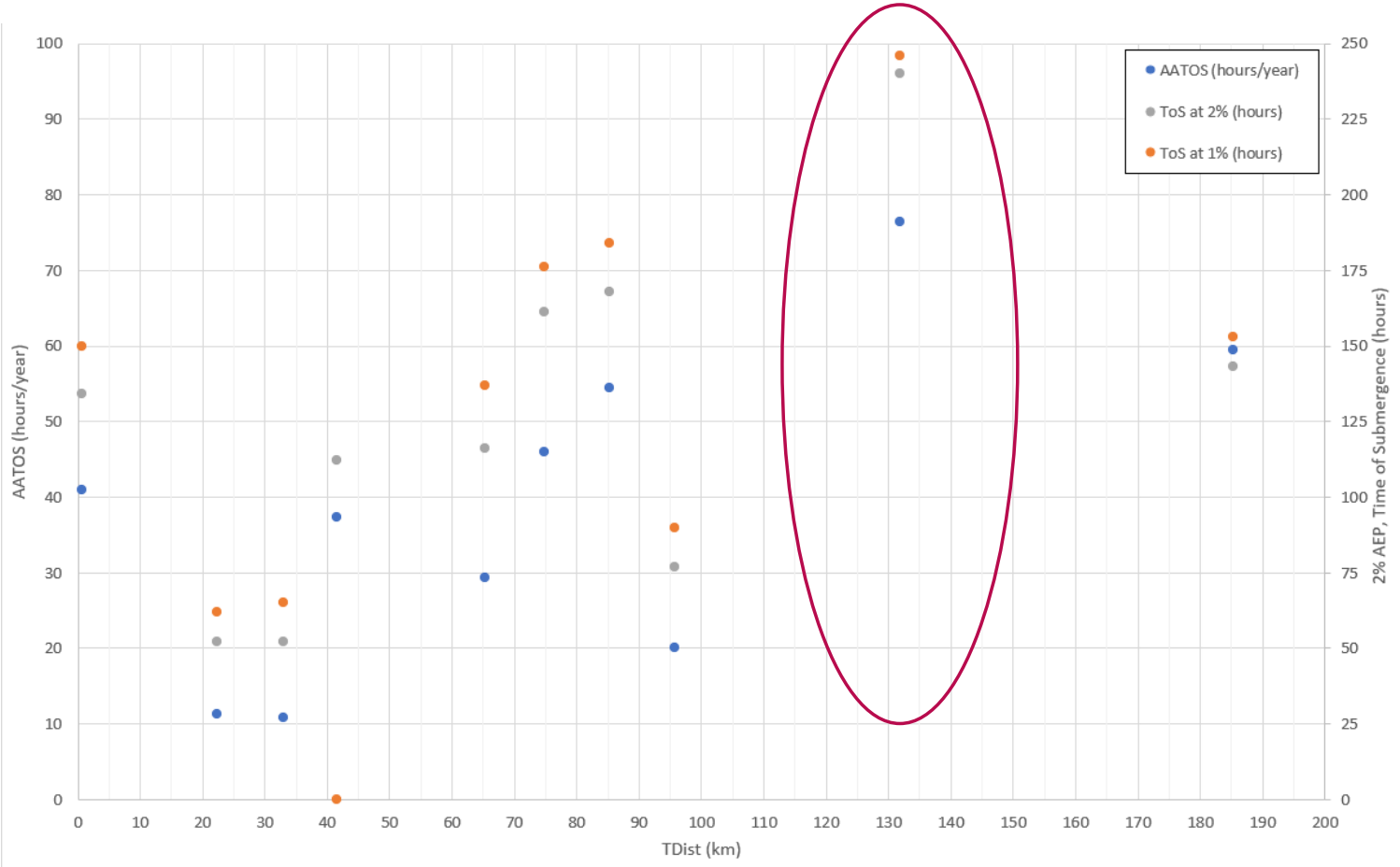
Table 10A-4 – AATOS Simplified Tabulated Calculation

AEP (%)	TOS (hours) [t]	$F_T(t)$	$\Delta p \times \bar{t}$
74	0	0.26	
63.2	15.2	0.37	0.818
50	23.2	0.50	2.532
20	26.0	0.80	7.375
10	29.8	0.90	2.792
5	32.5	0.95	1.558
2	35.0	0.98	1.013
1	36.7	0.99	0.358
1×10^{-6} (tmax)	65.0	1.00	0.508
$AATOS = \sum_{t=0}^{t=tmax} \Delta p \times \bar{t}$ (hours per year)			17.0

Source: Road Drainage Manual: TMR, 2010

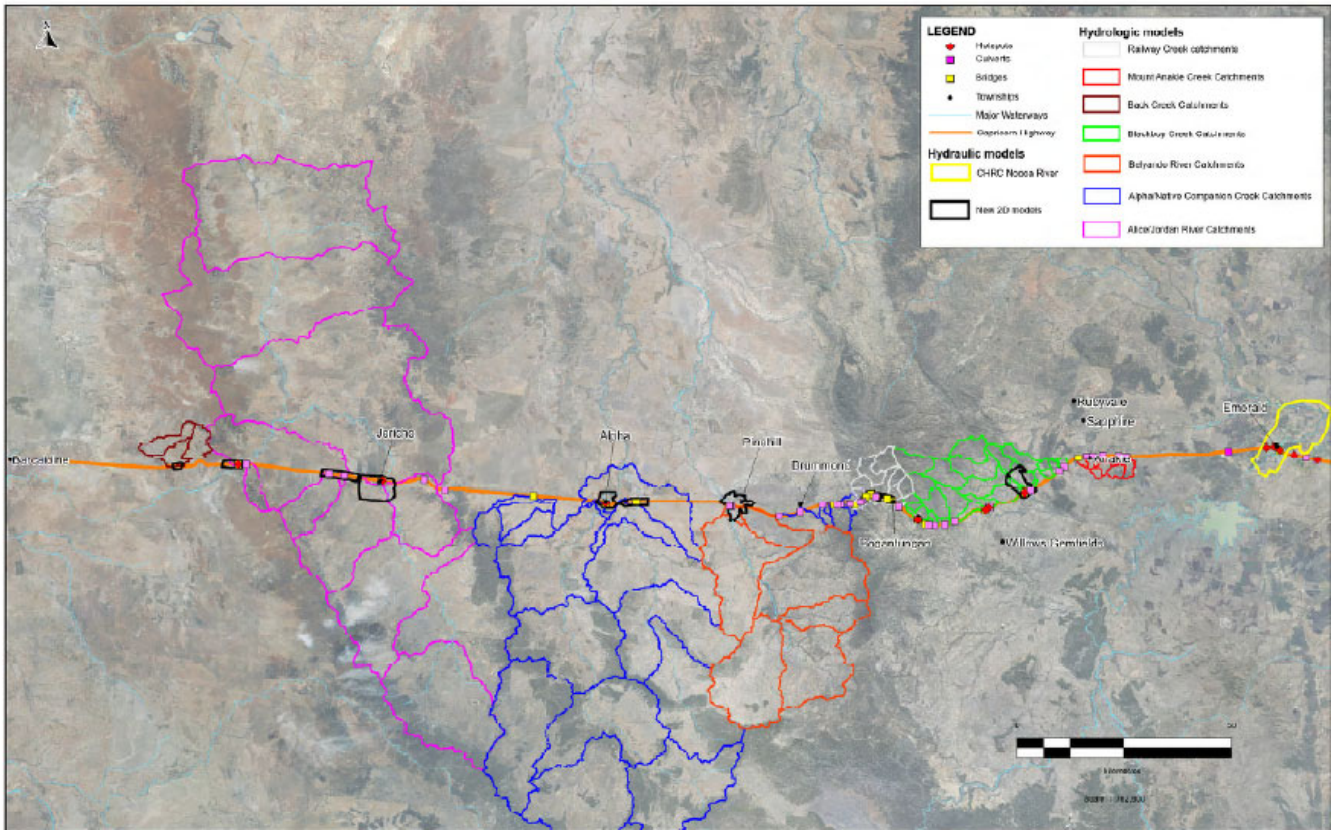
Serviceability

1. ToS and AAToS can be calculated simultaneously along stretches of road containing several floodways of low immunity crossings (flood link studies)



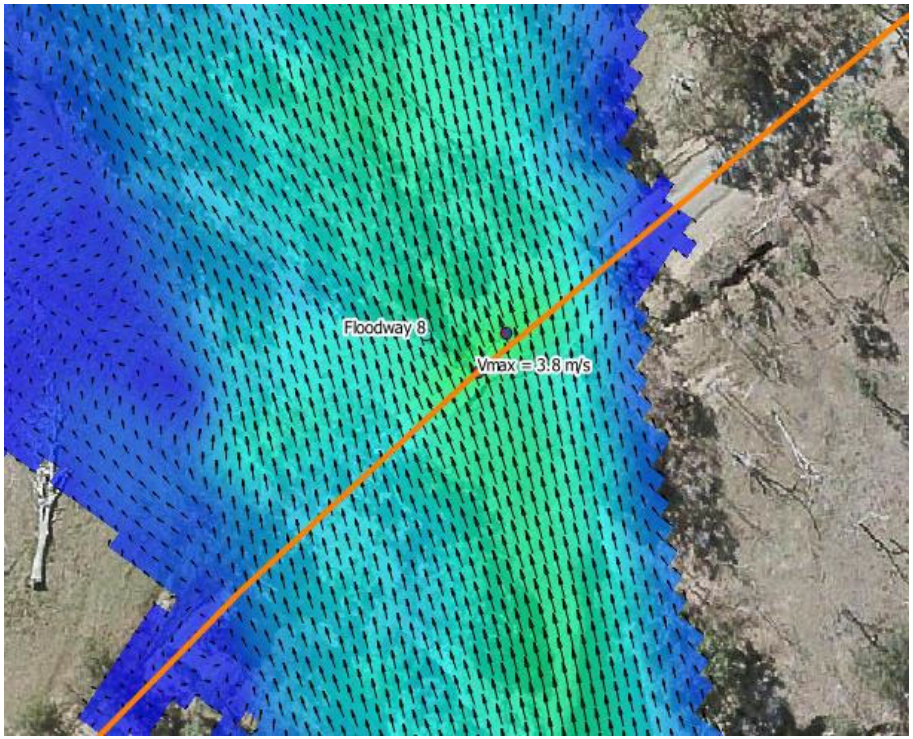
Serviceability

1. Identify impacts and cost of flooding to low-lying road
2. Cost and benefit of proposed road upgrades, set immunity criteria (best value for money to achieve immunity/connectivity)



Example

- Focus on resilience
- Flows, non-perpendicular to road alignment
- Maximum Velocity (3 m/s – 4 m/s) 2d model



- Road embankment scoured and concrete slab destroyed

Example

Remediation

- Improved immunity
- Shorter ToS/AAToS
- Concrete floodway (Type 1)
- Scour protection (1/4 Ton rock)
- Foamed bitumen (approaches)

Example

Other Considerations

Environmental

- River geomorphology (banks)
- Fish Passage

Design

- Remediation measures (extent)
- Approaches (large to extreme events)
- Climate change

Safety

- Safety first (design and operation)
- Safety media campaign

Thank you

Western Queensland

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Drone Footage by Boulia Shire Council

Marion Downs 11/2/22 Drone footage - YouTube