



# Blockage in Drainage Structures

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ARR – Technical Committee

Australian Rainfall and Runoff  
A guide to runoff estimation



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- It is also the result of a significant amount of in-kind hours provided by Engineers Australia members.



## ARR Projects

- “Australian Rainfall & Runoff” is a valuable guide to flood estimation.
- Published in 1987.
- ARR due for updating.
- Projects for input to ARR are being funded by the Federal Department of Climate Change.
- This is one of these projects.



## Blockage Project

- One of the projects is concerned with blockage of drainage structures.
- This has not been considered in previous editions of ARR.
- Also poorly covered in other manuals and guidelines.
- Important impacts on performance of drainage systems.



## Culvert in Wollongong

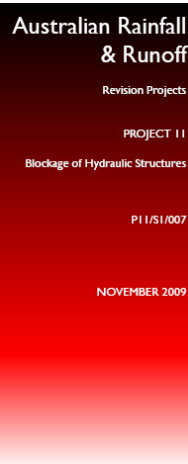


## Process

- Stage 1 – Provide background
  - Committee.
  - Workshop (March 2008).
  - Stage 1 report.
  - Stage 1 release.
- Stage 2 – Develop guidelines
  - Review committee and contributions.
  - Workshop (May 2010).
  - Stage 2 report and guidelines.



## Stage 1 report - ARR



- Stage 1 report can be downloaded from ARR website
- All ARR communications are available on this website.

[www.arr.org.au](http://www.arr.org.au)



## Blockage locations

- Cross drainage
  - Bridges or culverts across drainage paths.
- Drainage system inlets
  - Inlets to piped drainage systems.
- Open channels and swales
  - Where there is no cross drainage structure.
- Overland flow paths
  - Flow paths away from channels.
- Weirs and dams
  - Constricted spillways.



## Types of debris

- Litter
- Leaves
- Grass
- Garden mulch
- Reeds
- Woody debris
- Sediment
- Building material
- Cars
- Miscellaneous debris



## Debris classification

- Floating debris
  - Small, medium or large debris, mainly vegetation.



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## Non-floating debris

- Non-floating debris
  - Mainly sediment, from sand up to boulders.



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## Urban debris

- Urban debris
  - All types of material that can float.



## Debris availability

- Potential for soil erosion.
- Local geology.
- Catchment area.
- Amount and type of vegetation cover.
- Urban areas.
- Preceding rainfall.

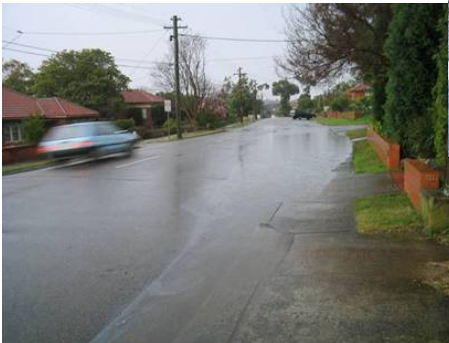


## Cross drainage structures



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## Inlet pits



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## Overland flow paths



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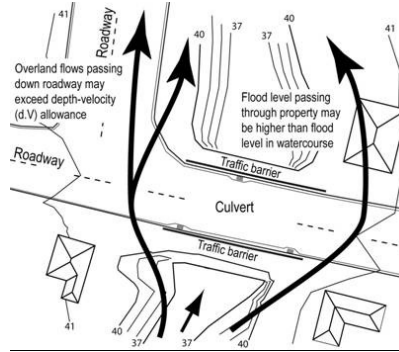
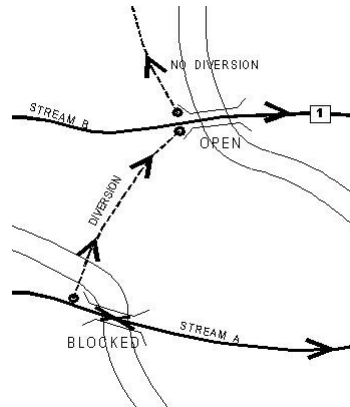
## Impacts of blockage

- Hydraulic.
  - Changes in flood levels and flow velocity.
  - Additional ponding.
  - Additional hazards (water over roads for example).
- Geomorphology.
  - Flow paths may be altered, perhaps permanently.



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## Flow diversions from blockage



## Impacts of blockage

- **Structural.**
  - Damage can occur to structures.
- **Economic.**
  - Blockage can increase already large damages.
- **Social.**
  - Blockage may increase social impacts of flooding.
- **Environmental.**
  - Changes in velocities or flow patterns may affect scour, vegetation or fish.



## Stage 2 outcomes

- Stage 2 of this project must provide results in three main areas.
  - Assessment of effects of blockage on drainage systems.
  - Appropriate design recommendations.
  - Recommendations for management measures.
- These are the difficult questions resulting from this project.



## Assessment of effects of blockage

- Assess probability of debris transport.
- Assess probability of debris deposition.
- Assess impacts of the blockage for the range of relevant aspects.
- Account for these in drainage system planning and design.



## Design recommendations

- Blockage should be considered in design guidelines.
  - Type of approach.
  - Simple, such as blockage factor.
  - Complex hydraulic analysis.
- Design guidelines needed for range of regions.
  - Rural, or different types of urban.



## Management measures

- Design drainage systems with appropriate allowance for blockage.
  - Need to understand processes and risks.
- Debris control structures.
  - Interception or diversion structures upstream of other structures.
- Structure modifications.
  - Improved inlets or increased sized structures to reduce risk.



## Control structures



## Management measures

- Debris reduction programmes.
  - Reduce the sources of debris, good but difficult to implement.
- Maintenance measures.
  - Ensure blockages are removed as soon as possible.
- Community awareness.
  - Education and awareness programmes in conjunction with other measures.



## Existing Guidelines

- Queensland Urban Drainage Manual (QUDM).
  - Good guidance based on experience, but limited factual data.
- Council guidelines.
  - Similar to QUDM.
- Wollongong City Council.
  - Suited to Wollongong, but perhaps less suited to other regions.



## Blockage risk

- Risk will vary greatly.
  - Catchment types, urban or rural for example.
  - Debris types expected.
  - Locations all around Australia.
  - Debris management measures may affect risk.
  - Variation from one event to another.



## Risk assessment

- Determine the expected risk level, maybe to three rating levels.
- Determine how this risk rating affects the drainage structures.
- Determine blockage impacts, again perhaps for a small number of levels.
- A single allowance for blockage may be too simple.



## Assess blockage impact

- How does risk rating affect the performance of the structure.
- Determine the performance of the drainage system as a whole.
- Analyse the hydraulic performance of the system.
- Provide appropriate statistical assessment for design floods.



## Analysis requirements

- Design of new or revised drainage systems.
  - Incorporate blockage into initial planning and design.
  - Incorporate specific probability.
- Assessment of existing systems.
  - Review performance of systems.
  - Understand blockage that may occur.



## Design floods

- Need to incorporate blockage into design of drainage systems.
- Allow for appropriate level of risk and blockage quantity to ensure the probability is assessed correctly.
- Provide design flood levels and other hydraulic issues with appropriate allowance for blockage.





## Design approaches

Hydraulic structure	Analysis methodology
On-site detention systems	<ul style="list-style-type: none"><li>• Adoption of an appropriate blockage factor<sup>[1]</sup></li></ul>
Overland flow paths	<ul style="list-style-type: none"><li>• Adoption of an appropriate blockage factor for screened barriers</li></ul>
Stormwater inlets (kerb and field inlets)	<ul style="list-style-type: none"><li>• Adoption of an appropriate blockage factor</li></ul>
Stormwater pipes	<ul style="list-style-type: none"><li>• Adopt a pipe roughness slightly larger than 'smooth pipe' conditions</li></ul>
Stormwater outlets (screened) including surcharge chambers	<ul style="list-style-type: none"><li>• Adoption of an appropriate blockage factor, plus</li><li>• Adjustment to design tailwater conditions</li></ul>
Stormwater outlets not screened	<ul style="list-style-type: none"><li>• Adjustment to design tailwater conditions</li></ul>
Energy dissipaters	<ul style="list-style-type: none"><li>• Assess on a case-by-case basis</li></ul>
Detention/retention basins	<ul style="list-style-type: none"><li>• Adoption of an appropriate blockage factor for the outlet structure</li></ul>
Stormwater infiltration systems	<ul style="list-style-type: none"><li>• Adoption of an appropriate blockage factor</li></ul>
Fishways	<ul style="list-style-type: none"><li>• Assess on a case-by-case basis</li></ul>
Waterway bridges and culverts	<ul style="list-style-type: none"><li>• Adoption of an appropriate blockage factor (non-critical structures)</li><li>• Adjustment to entry, friction and exit loss coefficients (critical structures)</li></ul>



## Drainage system planning

- Need to plan for blockage in system.
- Ensure that the appropriate ARI is adopted with allowance for blockage.
- Ensure that design is not too conservative.
- Design must make suitable allowance for blockage but not to an extreme level.



## Management

- Management measures may affect the risk rating and performance.
- Incorporate these changes in risk and blockage into design assessment.
- Drainage system should be designed with appropriate allowance for blockage and management.



## Other management

- Can management measures be recommended to reduce impacts.
- What are these measures and can they operate effectively.
- Will they be effective in the long term.
- How do these measure affect the design flood levels.



## Other issues

- Discussion above refers mainly to cross drainage structures and system inlets.
- Blockage of other drainage system components.
- These need different recommendations.
- Open channels, swales and overland flow paths.
- Planning review and recommendations.



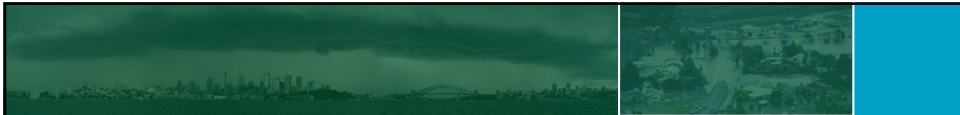
## Next processes


- Publicise Stage 1 report
  - This paper.
- Gather more data
  - Any other data, especially quantitative information will be welcomed.
- Review policies
  - Some policies have been reviewed, but others will be welcomed.
- Prepare recommended procedures.





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