Review of Allans Creek Flood Study

Review of Fairy & Cabbage Tree Creeks Flood Study

Floodplain Management Committee Meeting

Leon Collins, Senior Engineer

17th April 2018

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Advisian (Worley Parsons Group)

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Who we are

- Advanced Analysis
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- Decommissioning and Restoration
- Environment and Society
- Energy Services
- Investment Options Analysis, StepWise
- Operational Excellence
- People and Organisation
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- Production Asset Value Enhancement
- Project Delivery Services
- Safety Consulting
- Strategy
- Innovation Workshops
- Transport Specialist Services
- Water Specialist Services
Advisian – Water Resources

- **Modelling**
  - Hydrologic, hydraulic, estuarine process, dispersion, nutrients, water balance, scour, sediment transport

- **River Engineering**
  - Geomorphology, scour, stream rehabilitation & bank stabilisation

- **Estuaries**
  - Estuary process & management studies
  - Effluent disposal, dredging & disposal, salinity (including climate change)

- **Hydraulic Structures**
  - Bridges, spillways, basins & small dams, trunk drainage

- **Water Resources**
  - Surface & groundwater, water balance (mines, urban, rural), environmental flows, yield, re-use

- **Water Sensitive Urban Design**
  - MUSIC nutrient modelling & concept design

- **Flooding**

![Concept & Detail Design](image1)

![Creek Stabilisation](image2)
Advisian - Flooding

waterRIDE™

(Figure: Profile and Time Series Plots at any location in the model)

(Figure: Flood Impact Assessment - Major Infrastructure)

(Figure: Flood Mitigation)

Advisian–Flooding

• NSW Floodplain Management Program
  • Flood Studies
  • Flood Risk Management Studies
  • Mitigation Investigation & Design

• Infrastructure & Development
  • Flood Impact Assessment
  • Emergency Response Plans

• WaterRIDE software
  • Visualisation & interrogation of model results
  • Flood Forecasting Tools

• Other
  • Planning measures
  • Climate Change Assessments
  • Entrance Management Plans
  • Court Related
## Advisian - Project Team

### Overview

- Team manager / Principal for over 15 years
- Over 30 years' experience in Australia and overseas in environmental assessment and water resources management
- Specialist in the fields of hydrology, floodplain management, stormwater management, estuary management, environmental impact assessment and risk assessment.
- Project Director and author responsible for the preparation of over 40 government funded Flood Studies and Floodplain Risk Management Studies for rivers and streams in NSW.

### Qualification & Affiliations

- Bachelor of Engineering (Civil) (Hons), University of Newcastle
- Master of Engineering Science, University of New South Wales (candidate)
- Member, Engineers Australia, CPEng, NPER
- Member, Water Panel Sydney Division, Engineers Australia (current Chair)
- Sternbeck Medalist 2010 for best paper and presentation at the 30th NSW Floodplain Management Authorities Conference, Gosford, February 2010

### Awards

- Bachelor of Engineering (Civil) (Hons), University of Newcastle
- Bachelor of Engineering (Environmental) (Hons), University of Newcastle
- Member, Engineers Australia (MIE Aus)
Presentation Outline

Review of Allans Creek Flood Study

1. The Study Area
2. Background
3. Previous Study vs. Review
4. Hydrology: RAFTS vs. WBNM
5. Hydraulics: 1D vs. 2D
6. Progress Update
7. Next Steps

Review of Fairy & Cabbage Tree Creeks Flood Study

1. The Study Area
2. Background
3. Previous Study vs. Review
4. Progress Update
5. Next Steps
1. The Study Area

**Catchment size**
- Allans Creek: 45 km²
- Study area: 50 km²

**Major tributaries**
- Byarong Creek
- American Creek

**Hydraulic controls**
- M1 Motorway
- Princes Highway
- Illawarra Railway

**Historic floods**
- 17 August 1998
- 23 October 1999
2. Background

The Floodplain Risk Management Process

“A Flood Study is a comprehensive technical investigation of flood behaviour that defines the variation over time of flood levels, extent and velocity for flood events up to and including the PNF.”

2. Background

17 August 1998

Byarong Creek at Koloona Ave

Byarong Creek at The Avenue

23 October 1999

Arrow Ave, adjacent Byarong Creek

Overland flows at Koloona Ave
3. Comparison of Previous & Current Studies

**Lawson and Treloar 2006/2008**

**Extent**
Main tributaries to elevations of ~50m AHD

**Hydrologic Model**
XP-RAFTS, 93 sub-catchments

**Hydraulic Model**
MIKE-11 one-dimensional model

**Topographic Data**
Cross-sectional survey of channel & floodplain at 40 to 400m intervals

**Design Rainfall**
ARR 1987

**Structural Blockages**
WCC Blockage Policy, 2002

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**Extent**
Additional tributaries & overland flow paths
Extent of existing & future development (e.g. Mt Keira, Kembla Hts)

**Hydrologic Model**
WBNM 2017, ~600 sub-catchments
(to resolve local overland flow)

**Hydraulic Model**
TUFLOW two-dimensional model
Linked 1D culverts, pits & pipes

**Topographic Data**
2013 LiDAR (1m DEM) supplemented by cross-sectional survey, Works As Executed plans, 2005

**LiDAR**

**Design Rainfall**
Revised Illawarra IFDs and ARR 2016 procedures

**Structural Blockages**
WCC Revised Blockage Policy, 2016
4. XP-RAFTS vs. WBNM2017

XP-RAFTS, 2006/2008

Differences in runoff & stream routing procedures

BUT

Same purpose & objective

β 93 sub-catchments
β ARR 1987

WBNM2017, 2018

β ~600 sub-catchments
β Revised Illawarra IFDs & ARR 2016
5. 1D vs. 2D Hydraulic Model

MIKE-11 1D, 2006/2008

TUFLLOW 2D, 2018

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**Schematisation**

- MIKE-11: 1D, 2006/2008
  - Stream reach
  - X-sections
  - Over-bank split

- TUFLOW 2D, 2018
  - 2D grid cells (elevation, hydraulic roughness, etc.)
  - Linked 1D: pits, pipes, culverts, channels (if req'd)

**Terrain**

- MIKE-11: Generally simplified floodplain at surveyed XS
  - Simplification of channel changes between XS (esp. bends)
  - Highly simplified floodplain between XS

- TUFLOW 2D: Far superior in overbank/floodplain areas
  - Potentially equal in-channel at surveyed XS
  - Superior resolution of channel changes (esp. bends)

**Hydraulics**

- MIKE-11: One-dimension!
  - Constant WL
  - Loss coeff's
  - Interaction with over-bank?
  - Alternative flow-paths?

- TUFLOW 2D: Two-dimensions!
  - Alternative flow-paths
  - Interaction of multiple flow paths, floodplain, etc.
5. 1D vs. 2D Hydraulic Model

Cross-section of American Creek upstream of Princes Highway

- Improved overbank / floodplain
- Channel section & conveyance well-represented
5. 1D vs. 2D Hydraulic Model

MIKE-11 1D, 2006/2008

TUFLOW 2D, 2018
7. Next Steps

Stage 2 - Model Update / Development
August 2018

- Acquire additional survey data
- Develop detailed WBNM hydrologic model
- Develop detailed TUFLOW hydraulic model
- Calibrate to August 1998 event
  - Input: recorded rainfall, recorded ocean levels
  - Flood data: Byarong Creek gauge, 99 surveyed flood levels
- Verify to October 1999 & March 2011 events
- Develop design flood hydrographs (Revised IFDs & ARR2016)
# 1. The Study Area

<table>
<thead>
<tr>
<th>Catchment size</th>
<th>Historic floods</th>
<th>Hydraulic controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fairy/Cabbage: 21 km²</td>
<td>17 August 1998</td>
<td>M1 Motorway</td>
</tr>
<tr>
<td>Smith Street: 0.6 km²</td>
<td>23 October 1999</td>
<td>Memorial Drive</td>
</tr>
</tbody>
</table>

- Entrance berm
- Detention basins
- Illawarra Railway
- Brokers Road - constructed ~March 2000
- Foothills Road
- M1 Motorway
- Memorial Drive
2. Background

The Floodplain Risk Management Process (3rd iteration)

“A Flood Study is a comprehensive technical investigation of flood behaviour that defines the variation over time of flood levels, extent and velocity for flood events up to and including the PMF.”


Previous Studies

- Cabbage Tree Creek Flood Study (PWD 1991)
- Fairy Creek Floodplain Management Study (Kinhill 1996)
- Cabbage Tree Creek Floodplain Management Study (Willing & Partners 1997)
- Fairy Lagoon Entrance Management Policy (Cardno Lawson Treloar 2007)
  - Mechanical breakout at water level of 1.6 mAHD
- Fairy & Cabbage Tree Creeks Flood Study (BMT WBM 2009)
  - WBNM hydrologic model & 1D/2D TUFLOW hydraulic model
- Fairy & Cabbage Tree Creeks Floodplain Risk Management Study & Plan (Bewsher 2010)
3. Comparison of Previous & Current Studies

**BMT WBM 2009**

- **Extent**

**Advisian 2018**

- **Extent**
  - Additional tributaries & overland flow paths
Review of Allans Creek Flood Study

4. Progress

Data Collection & Review
- LiDAR (2005, 2013)
- Past studies
- WAE / design plans

Preliminary Model
- TUFLOW direct rainfall model
- Inform flow paths & review data adequacy

5. Next Steps

Additional Survey
- Survey brief: cross-sectional, structural, detention basin, and ground survey

Stage 2 – Model Update / Development
- Develop detailed WBNM hydrologic model
- Develop detailed TUFLOW hydraulic model
- Calibrate to August 1998 event
  - Input: recorded rainfall, recorded ocean levels
  - Flood data: Byarong Creek gauge, surveyed flood levels
- Verify to October 1999 & February 2012 events
- Develop design flood hydrographs (Revised IFDs & ARR2016)
Discussion
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