Flood Impact Assessment

Oakdale South Industrial Estate

59915094

Prepared for
Goodman Ltd

1 August 2016

Cardno
Shaping the Future

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Executive Summary

An updated flood impact assessment has been prepared to address the Oakdale South – Secretary's Environmental Assessment Requirements in relation to Soils and Water which require in part:

> *An assessment of flooding impacts associated with the proposal including details of any flood liability of the site and changes to flood behaviour.*

As part of the master planning for the precinct the existing flood modelling was reviewed, re-run and an assessment was undertaken of the impacts on flooding of the proposed earthworks and measures associated with the planned development of the Oakdale South Industrial Estate.

This flood impact assessment report should be read in conjunction with AT&L's Civil, Stormwater and Infrastructure Services Report.

100 yr ARI Flood

It is concluded that the proposed updated development will have a minor impact on 100 yr ARI flooding on the Ropes Creek floodplain which will not adversely impact on any adjoining property subject to Post-Development peak flows being limited to Pre-Development levels.

A zone of local increases in 100 yr ARI flood levels also occurs within the power line easement adjacent to the proposed development in an area already inundated in a 100 yr ARI flood under Existing Conditions. It is noted that within the easement the 100yr ARI flood extents are reduced, velocities maintained and that while the depth is locally increased (generally 0.1-0.2 m increase with local increases of 0.2-0.5 m) these local impacts are located around 60m from the existing transmission tower. It is concluded that these local flood impacts, which are confined close to the development, are expected to have negligible impact on the maintenance of TransGrid's easement and do not pose a risk to existing transmission stanchions.

It is further concluded that within the Ropes Creek floodplain that there are some zones with local increases in the 100 yr ARI velocities which is associated with local earthworks and /or due to the walls of local retarding basins; and these changes are confined within the 100 yr ARI flood extent which is not significantly changed by proposed earthworks.

The 100 yr ARI flood levels in the vicinity of the Warragamba Pipelines Corridor either do not increase or slightly decrease while the 100 yr ARI flood velocities in the vicinity of the Warragamba Pipelines Corridor are effectively unchanged.

PMF

As expected based on the severity of flooding, a number of flowpaths through the development would be activated by PMF flows discharged into the development along existing drainage lines. This includes a flowpath along the eastern boundary. A wall is located on the eastern boundary just south of the existing drainage line which flows between Basin E and Road 03 to contain within the site the flows which activate a flowpath along the eastern boundary in an event approaching the PMF.

It is concluded that under the proposed updated development that within the Ropes Creek floodplain that there are zones of both local reductions and local increases in the PMF levels. These minor changes in PMF levels do not significantly change the PMF extents on any adjoining properties. It is noted that there is a local small increase in the PMF level on a tributary of Ropes Creek which appears associated with the earthworks undertaken immediately north of the subject site.

It is further concluded that within the Ropes Creek floodplain that there are some zones with local increases in the PMF levels which is associated with local earthworks and /or due to the walls of local retarding basins; and these changes are confined within the PMF flood extent which is not significantly changed by proposed earthworks.

The PMF levels in the vicinity of the Warragamba Pipelines Corridor are largely unchanged or slightly reduce in level. It is noted that there are some local small increase in the PMF level adjacent to the corridor which appears associated with the earthworks undertaken immediately north of the subject site in Oakdale Central.

The PMF velocities in the vicinity of the Warragamba Pipelines Corridor are effectively unchanged

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1 Introduction

1.1 Purpose of this Report

This report details the updated flood impact assessment which has been prepared to address the Oakdale South – Secretary's Environmental Assessment Requirements in relation to Soils and Water which require in part:

> *An assessment of flooding impacts associated with the proposal including details of any flood liability of the site and changes to flood behaviour.*

As part of the master planning for the precinct an assessment was undertaken of the impacts on flooding of the proposed updated earthworks and measures associated with the planned development of the Oakdale South Industrial Estate.

This flood impact assessment report should be read in conjunction with AT&L's Civil, Stormwater and Infrastructure Services Report.

1.2 Location

The location of the Oakdale South precinct is indicated in **Figure 1**. The property is located in the upper reach of the Ropes Creek catchment.

1.3 Concept Stormwater Masterplan

The updated Oakdale Industrial Estate Stormwater Masterplan prepared in June 2016 is given in **Figure 3**.

1.4 Previous GHD Studies

In 2008 GHD undertook hydrological and hydraulic modelling of the upper Ropes Creek catchment including the overall Oakdale development.

Hydrological modelling was undertaken at the catchment and development scale. Results for the catchment hydrological modelling were not included in the 2008 report.

Hydraulic modelling was undertaken using a 1D/2D TUFLOW model. The 100 yr ARI flood extents and flood levels estimated in the 2008 floodplain modelling are given in **Figure 2.**

An addendum to this report was produced in 2013 as part of the detailed design of Oakdale Central (GHD, 2013). This report indicated that the adopted 2D grid size was 5 m x 5 m.

1.5 Previous Cardno Studies

Cardno prepared a flood impact assessments in September 2015 and May 2016 to address the Oakdale South – Secretary's Environmental Assessment Requirements in relation to Soils and Water.

As part of the master planning for the precinct the existing flood modelling was reviewed, re-run and an assessment was undertaken of the impacts on flooding of the proposed earthworks and measures associated with the planned development of the Oakdale South Industrial Estate.

It was concluded that the proposed development will have a minor impact on 100 yr ARI flooding on the Ropes Creek floodplain which will not adversely impact on any adjoining property subject to Post-Development peak flows being limited to Pre-Development levels.

2 Hydrology

Hydrological modelling of the upper Ropes Creek catchment was undertaken at the catchment and development scale using **xprafts**.

2.1 Existing (Pre-Development) Conditions

The subcatchment boundaries under Existing Conditions in the vicinity of the estate are given in **Figure 4**.

The **xprafts** link-node diagram for the Existing Conditions model is given in **Figure 6**.

2.2 Future (Post-Development) Conditions

The GHD Post-Development model was modified based on a Catchment Plan received on 24 August 2015. This required the creation of new subcatchments and adjustment of subcatchments N3, N4, N5 and N7. **Figure 3** details the modified subcatchment layout while **Figure 6** details the changes to the SSDA layout.

The impact of the modification of subcatchments and model layout was checked at Node N7 being the nearest mainstream node downstream of the proposed development. It was concluded that the modification has had minimal impact on the estimated 100 yr ARI peak flow.

3 Flooding Assessment

The updated assessment of the impact or otherwise of development was undertaken using a TUFLOW floodplain model of the upper Ropes Creek floodplain.

The model extent covers the subject site.

3.1 Existing Conditions

3.1.1 100 yr ARI

The locations at which100yr ARI hydrographs from the **xprafts** model were input into the TUFLOW floodplain model are identified in **Figure 7**. The TUFLOW floodplain model was run for a range of storm durations up to 9 hours. It was found that the critical storm burst duration varied depending on location as identified in **Figure 8**.

The estimated 100 year ARI flood levels and extent, depths and velocities under benchmark Existing Conditions are plotted in **Figures 9, 10** and **11** respectively.

When initially considering pedestrian and vehicular stability, three velocity x depth criteria were identified as follows:

Velocity x Depth	Comment
≤ 0.4 m^2/s	This is typically adopted by Councils as a limit of stability for pedestrians
0.4 – 0.6 m^2/s	Unsafe for pedestrians but safe for vehicles if overland flood depths do not exceed around 0.3 m
> 0.6 m^2/s	This is typically adopted by Councils as a limit of stability for vehicles

As part of the current revision of Australian Rainfall & Runoff (ARR) a series of research projects have been undertaken to inform the updating of the current edition of ARR. This includes ARR Project 10 Appropriate Safety Criteria for Vehicles. Most recently in December 2013 a draft version of Book 9 Chapter 6 Safety Design Criteria has been released by Engineers Australia for industry review (Download from: http://www.arr.org.au/downloads-and-software/chapters/).

In the draft Chapter 6 Book 9 *stability criteria based on the best available information for stationary small passenger cars, large passenger cars and large 4WD vehicles in various flow situations are presented in Figure 9.6.6 and Table 9.6.2* This Table and Figure are reproduced below.

In the draft Chapter 6 Book 9 it is further advised that:

> *Shand et al (2011) concludes that the available datasets do not adequately account for the following factors and that more research is needed in these areas:*
> - *Friction coefficients for contemporary vehicle tyres in flood flows;*
> - *Buoyancy changes in modern cars;*
> - *The effect of vehicle orientation to flow direction (including vehicle movement);*
> - *Information for additional categories including small and large commercial vehicles and emergency service vehicles*

Table 9.6.2. Interim Flow Hazard Regimes for Vehicles (Shand et al, 2011)

Class of vehicle	Length (m)	Kerb Weight (kg)	Ground clearance (m)	Limiting still water depth[1]	Limiting high velocity flow depth[2]	Limiting velocity[3]	Equation of stability
Small passenger	< 4.3	< 1250	< 0.12	0.3	0.1	3.0	$DV \leq 0.3$
Large passenger	> 4.3	> 1250	> 0.12	0.4	0.15	3.0	$DV \leq 0.45$
Large 4WD	> 4.5	> 2000	> 0.22	0.5	0.2	3.0	$DV \leq 0.6$

[1]At velocity = 0 ms^{-1}; [2]At velocity = 3.0 ms^{-1}; [3]At low depth

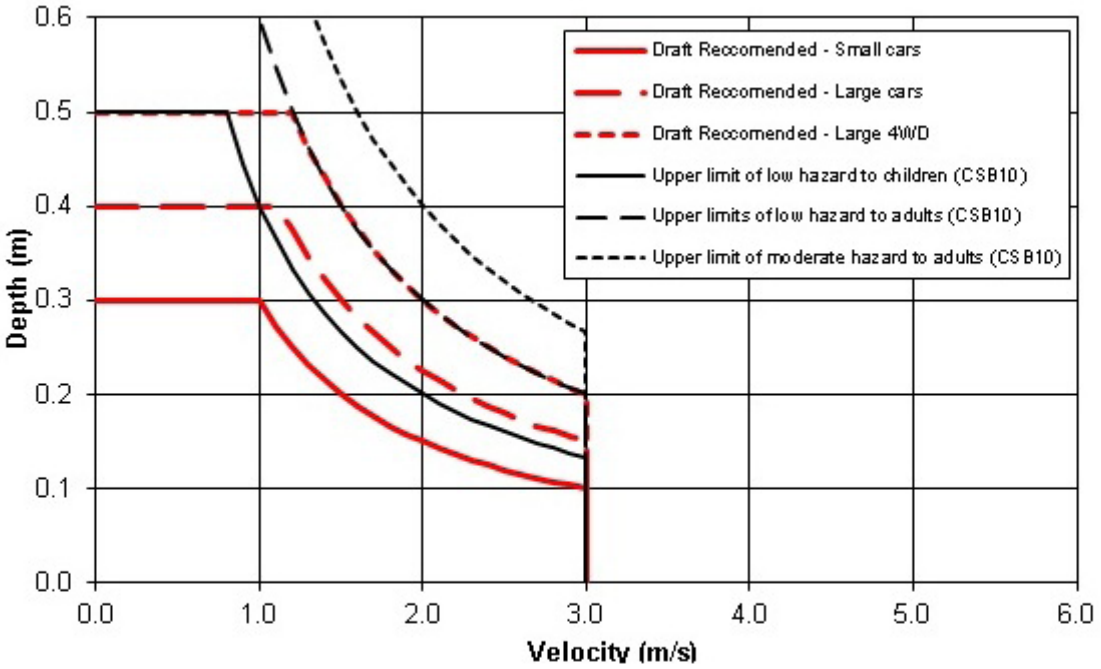
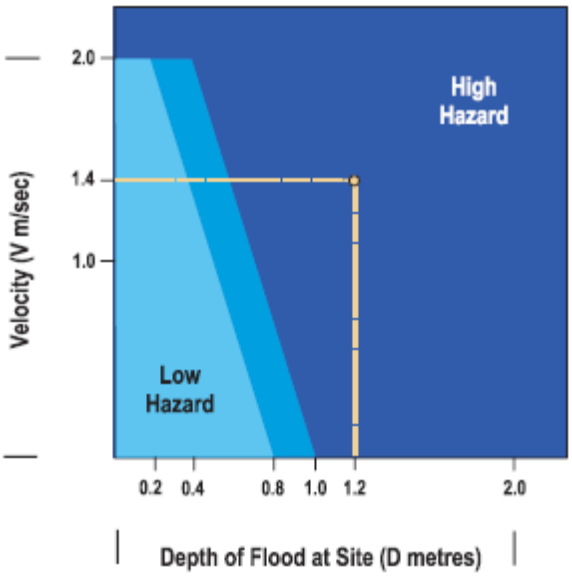


Figure 9.6.6. Interim Safety Criteria for Vehicles in Variable Flow Conditions (After Shand et al, 2011)

The estimated 100 year ARI velocity x depth under Existing Conditions is plotted in **Figure 12.**

Experience from studies of floods throughout NSW and elsewhere has allowed authorities to develop methods of assessing the hazard to life and property on floodplains. This experience has been used in developing the NSW Floodplain Development Manual to provide guidelines for managing this hazard. These guidelines are shown schematically below.

To use the diagram, it is necessary to know the average depth and velocity of floodwaters at a given location. If the product of depth and velocity exceeds a critical value (as shown below), the flood flow will create a high hazard to life and property. There will probably be danger to persons caught in the floodwaters, and possible structural damage. Evacuation of persons would be difficult. By contrast, in low hazard areas people and their possessions can be evacuated safely by trucks. Between the two categories a transition zone is defined in which the degree of hazard is dependent on site conditions and the nature of the proposed development.



Provisional Hazard Categories (after Figure L2, NSW Government, 2005)

This calculation leads to a provisional hazard rating. The provisional hazard rating may be modified by consideration of effective flood warning times, the rate of rise of floodwaters, duration of flooding and ease or otherwise of evacuation in times of flood. The estimated 100 year ARI provisional flood hazard under Existing Conditions is plotted in **Figure 13**.

3.1.2 PMF

The locations at which PMF hydrographs from the **xprafts** model were input into the TUFLOW floodplain model are identified in **Figure 14**. The TUFLOW floodplain model was run for a range of PMP storm durations up to 6 hours. It was found that the critical PMP storm duration varied depending on location as identified in **Figure 15**.

The estimated PMF flood levels and extent, depths and velocities under benchmark Existing Conditions are plotted in **Figures 16, 17** and **18** respectively.

The estimated PMF velocity x depth under Existing Conditions is plotted in **Figure 19.**

The estimated PMF provisional flood hazard under Existing Conditions is plotted in **Figure 20**.

3.2 Future Conditions

Prior to assessing flooding under future conditions the proposed development terrain was imported using a supplied TIN. The proposed updated development layout is given in **Figure 21**. Features of the proposed development include (refer **Figure 21**):

- The diversion of upstream 100 yr ARI runoff from Subcatchment N4b (refer **Figure 4**) immediately west to Ropes Creek;
- The proposed construction of Basins A, B, C, D and E comprising bio-retention in the base of the basin to achieve quality objectives and active basin storage to limit Post-Development peak flows to Pre-Development levels;
- Re-alignment of the Ropes Creek tributary upstream of Road 01 to direct flows into a 1 x 3.6 m (W) x 1.8 m (H) RCBC + 1 x 1.2 m (W) x 1.2 m (H) RCBC crossing under Road 01; and

- Re-alignment of a reach of the Ropes Creek tributary downstream of Road 01 to re-direct flows into an existing watercourse;
- Input of local runoff from within the easement at the downstream northern end of the easement (refer **Figure 22**);
- Inclusion of a wall on the eastern boundary just south of existing drainage line which flows between Basin E and Road 03 (refer **Figure 21**) to contain flows which activate a flowpath along the eastern boundary in an event approaching the PMF within the site.

3.2.1 100 yr ARI

The model was the run to estimate 100 yr ARI flooding under Future Conditions based on the approach adopted by GHD previously when assessing Future Conditions (as discussed in **Appendix B**).

The TUFLOW floodplain model was run for a range of storm durations up to 9 hours. It was found that the critical storm burst duration varied depending on location as identified in **Figure 23**.

The estimated 100 year ARI flood levels and extent, depths, velocities, velocity x depth and hazards under Future Conditions are plotted in **Figures 24, 25, 26, 27** and **28** respectively.

3.2.2 PMF

The model was the run to estimate PMF under Future Conditions based on the approach discussed in **Appendix B**.

While 100 yr ARI runoff from Subcatchment N4b (refer **Figure 4**) is proposed to be diverted immediately west to Ropes Creek, the local PMF runoff greatly exceeds the 100 yr ARI runoff. Accordingly the PMF runoff from Subcatchment N4b was input on the alignment of the current local watercourse (refer **Figure 31**)

The TUFLOW floodplain model was run for a range of PMP storm durations up to 6 hours. It was found that the critical PMP storm duration varied depending on location as identified in **Figure 32**.

The estimated PMF flood levels and extent, depths and velocities under benchmark Future Conditions are plotted in **Figures 33, 34** and **35** respectively.

The estimated PMF velocity x depth under Future Conditions is plotted in **Figure 36**.

The estimated PMF provisional flood hazard under Future Conditions is plotted in **Figure 37**.

4 Flood Impact Assessment

The estimated impact of Future Conditions on 100 year ARI flood levels and velocities are plotted in **Figures 29** and **30** respectively. The estimated impact of Future Conditions on PMF levels and velocities are plotted in **Figures 38** and **39** respectively.

100 yr ARI flood levels and PMF levels at 8 reference locations identified in **Figure 40** are summarised in **Table 1**.

Table 1 Estimated 100 yr ARI and PMF Levels at Reference Locations

	Existing Conditions			Future Conditions				Existing	Future
Location	100yr 2hr (m AHD)	100hr 9hr (m AHD)	Max WL (m AHD) (a)	100yr 2hr (m AHD)	100hr 9hr (m AHD)	Max WL (m AHD) (c)	Difference (cm) (c)-(a)	PMF (m AHD)	PMF (m AHD)
R1	62.97	62.79	62.97	62.72	62.65	62.72	-25	64.20	64.12
R2	60.96	60.84	60.96	60.86	60.84	60.86	-10	62.11	62.44
R3	60.02	59.94	60.02	60.07	60.05	60.07	4	60.97	61.21
R4	58.85	58.80	58.85	58.94	58.93	58.94	8	59.89	59.92
R5	58.31	58.25	58.31	58.20	58.18	58.20	-12	59.40	59.50
R6	57.47	57.43	57.47	57.43	57.43	57.43	-4	58.62	58.66
R7	56.62	56.64	56.64	56.65	56.66	56.66	2	57.57	57.68
R8	54.93	54.95	54.95	54.91	54.93	54.93	-2	56.20	56.18

It is noted from **Figure 29** that:

- within the Ropes Creek floodplain that there are zones of both minor reductions and minor increases in the 100 yr ARI flood levels;
- The reductions in flood levels are attributed primarily to the changes to a number of inflow locations under Future Conditions;
- the minor changes in flood levels do not change the flood extents on any adjoining properties;
- the 100 yr ARI flood levels in the vicinity of the Warragamba Pipelines Corridor either do not increase or slightly decrease;
- a zone of local increases in 100 yr ARI flood levels also occurs within the power line easement adjacent to the proposed development in an area already inundated in a 100 yr ARI flood under Existing Conditions;
- within the power line easement the 100yr ARI flood extents are reduced, velocities maintained and that while the depth is locally increased (generally 0.1-0.2 m increase with local increases of 0.2-0.5 m) these local impacts are located around 60m from the existing transmission tower.

It is noted from **Figure 30** that 100 yr ARI velocity impacts are primarily located within the middle reach of the development and where it is proposed to construct a new channel(s). The 100 yr ARI flood velocities in the vicinity of the Warragamba Pipelines Corridor are effectively unchanged.

As expected based on the severity of flooding, a number of flowpaths through the development would be activated by PMF flows discharged into the development along existing drainage lines. This includes a flowpath along the eastern boundary. A wall is located on the eastern boundary just south of the existing drainage line which flows between Basin E and Road 03 to contain within the site the flows which activate a flowpath along the eastern boundary in an event approaching the PMF.

The estimated PMF level differences under Future Conditions in comparison with Existing Conditions are plotted in **Figure 38**. It is noted from **Figure 38** that:

- within the Ropes Creek floodplain that there are zones of both local reductions and local increases in the PMF levels;
- the minor changes in PMF levels do not significantly change the PMF extents on any adjoining properties;
- PMF levels in the vicinity of the Warragamba Pipelines Corridor are largely unchanged or slightly reduce in level. It is noted that there are some local small increase in the PMF level adjacent to the corridor which appears associated with the earthworks undertaken immediately north of the subject site in Oakdale Central; and
- It is noted that there is a local small increase in the PMF level on a tributary of Ropes Creek which appears associated with the earthworks undertaken immediately north of the subject site.

The estimated PMF velocity differences under Future Conditions in comparison with Existing Conditions are plotted in **Figure 39**. It is noted from **Figure 39** that:

- within the Ropes Creek floodplain that there are some zones with local increases in the PMF velocities which is associated with local earthworks and /or due to the walls of local retarding basins;
- these changes are confined within the PMF flood extent which is not significantly changed by proposed earthworks;
- PMF velocities in the vicinity of the Warragamba Pipelines Corridor are effectively unchanged.

5 Conclusions

An updated flood impact assessment has been prepared to address the Oakdale South – Secretary's Environmental Assessment Requirements in relation to Soils and Water which require in part:

> *An assessment of flooding impacts associated with the proposal including details of any flood liability of the site and changes to flood behaviour.*

As part of the master planning for the precinct the existing flood modelling was reviewed, re-run and an assessment was undertaken of the impacts on flooding of the proposed earthworks and measures associated with the planned development of the Oakdale South Industrial Estate.

This flood impact assessment report should be read in conjunction with AT&L's Civil, Stormwater and Infrastructure Services Report.

5.1 100 yr ARI Flood

It is concluded that the proposed updated development will have a minor impact on 100 yr ARI flooding on the Ropes Creek floodplain which will not adversely impact on any adjoining property subject to Post-Development peak flows being limited to Pre-Development levels.

A zone of local increases in 100 yr ARI flood levels also occurs within the power line easement adjacent to the proposed development in an area already inundated in a 100 yr ARI flood under Existing Conditions. It is noted that within the easement the 100yr ARI flood extents are reduced, velocities maintained and that while the depth is locally increased (generally 0.1-0.2 m increase with local increases of 0.2-0.5 m) these local impacts are located around 60m from the existing transmission tower. It is concluded that these local flood impacts, which are confined close to the development, are expected to have negligible impact on the maintenance of TransGrid's easement and do not pose a risk to existing transmission stanchions.

It is further concluded that within the Ropes Creek floodplain that there are some zones with local increases in the 100 yr ARI velocities which is associated with local earthworks and /or due to the walls of local retarding basins; and these changes are confined within the 100 yr ARI flood extent which is not significantly changed by proposed earthworks.

The 100 yr ARI flood levels in the vicinity of the Warragamba Pipelines Corridor either do not increase or slightly decrease while the 100 yr ARI flood velocities in the vicinity of the Warragamba Pipelines Corridor are effectively unchanged.

5.2 PMF

As expected based on the severity of flooding, a number of flowpaths through the development would be activated by PMF flows discharged into the development along existing drainage lines. This includes a flowpath along the eastern boundary. A wall is located on the eastern boundary just south of the existing drainage line which flows between Basin E and Road 03 to contain within the site the flows which activate a flowpath along the eastern boundary in an event approaching the PMF.

It is concluded that under the proposed updated development that within the Ropes Creek floodplain that there are zones of both local reductions and local increases in the PMF levels. These minor changes in PMF levels do not significantly change the PMF extents on any adjoining properties. It is noted that there is a local small increase in the PMF level on a tributary of Ropes Creek which appears associated with the

earthworks undertaken immediately north of the subject site.

It is further concluded that within the Ropes Creek floodplain that there are some zones with local increases in the PMF levels which is associated with local earthworks and /or due to the walls of local retarding basins; and these changes are confined within the PMF flood extent which is not significantly changed by proposed earthworks.

The PMF levels in the vicinity of the Warragamba Pipelines Corridor are largely unchanged or slightly reduce in level. It is noted that there are some local small increase in the PMF level adjacent to the corridor which appears associated with the earthworks undertaken immediately north of the subject site in Oakdale Central.

The PMF velocities in the vicinity of the Warragamba Pipelines Corridor are effectively unchanged.

6 References

Cardno (2015) “Oakdale South Industrial Development, Flood Impact Assessment”, *Final Report*, prepared for Goodman, September, 9 pp + Apps.

GHD (2008) “Oakdale Concept Plan, Water Sensitive Urban Design Strategy”, *Final Report*, prepared for Goodman International Limited, May, 27 pp + Apps.

GHD (2013) “S75W Mod 5 Application, Oakdale Stage 1 Ropes Creek Flood Study”, *Addendum*, prepared for Goodman International Limited, July, 7 pp + Apps