KUR-World

Appendix 7

Hydrology

Environmental Impact Statement

Cairns Office:
Level 1, 320 Sheridan Street,
PO Box 5678 Cairns QLD 4870
P: 61 7 4034 5300 F: 61 7 4034 5301

Townsville Office:
Suite 2A, Level 1, 41 Denham Street,
PO Box 539 Townsville QLD 4810
P: 61 7 4796 9444 F: 61 7 4796 9410

Environmental Approval & Compliance Solutions
www.natres.com.au

Technical Note

To	Mark Lawson, Develop North
Job no.	424103.01
Author	Andrew Butler, Fiona Butler
Technical Review	Tim Anderson
Date	17 November 2017

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KUR-World Surface Water Hydrology Technical Note

Introduction

The background to the project is provided in detail in the *KUR-World Water Quality and Aquatic Ecology Technical Report* (NRA 2017a).

Scope

The scope of works for the Surface Water Hydrology Technical Note is based on the requirements outlined in the letter *Request for an expanded fee proposal to address additional elements in relation to the Terms of reference for an environmental impact statement: KUR-World Integrated Eco-Resort, October 2016* of 24 October 2016. The work in this technical note addresses aspects of the following item from the terms of reference (TOR).

11.24: Describe the hydrology within the study area and the adjoining waterways in terms of water levels, discharges and freshwater flows. Detail the interaction of groundwater and surface water.

Methods

Desktop

Catchment analysis

Topographical analysis was conducted as part of the *KUR-World Geology and Soils Technical Report* (NRA 2017b). Briefly, contour data (generated from LiDAR survey data referred to in USPD 2016) at 1 m intervals produced for the project was used to generate slope analysis and relief mapping for the project area. Supplementary information included in the topographic maps was derived from the following sources.

- DNRM *Watercourse lines – Queensland*. Spatial data layer (DNRM 2014).
- DNRM *Drainage 25k – Queensland*. Spatial data layer (DNRM 2016).

Discharge characteristics relating to flooding hazards and stormwater drainage planning and design have been prepared by others (Arup) and are presented here for information.

Details of the interaction of groundwater and surface water are presented in the groundwater hydrology technical report (RLA 2017).

Field investigations

Creek cross-sections were described based on relative measurements of height above the bed base level made at 0.5-1 m horizontal intervals depending on the size and topographical complexity of the channel.

Water depth was recorded from a gauge (with 10 cm increments) installed at each of the water quality sampling points. The gauges were installed at the water's edge on the first monitoring event in the expectation that the water level would rise above this point during the remainder of the wet season. However, the water levels receded after this initial event at some locations, and the bases of the gauges were above the water mark on some occasions. When this occurred, field staff used the base of the gauge as a datum and measured the water level relative to the lowest mark on the post in centimetre increments.

Depth at peak discharge (*ie* peak discharge for the 2016/17 wet season, which occurred on approximately 8-9 February 2017) was estimated based on levels of storm flow debris visible at the sites. The Q2 depths were estimated based on the level below which vegetation does not occur (*ie* the most common flood event). For initial flow events, flow velocity was estimated (up to 21 February) and thereafter flow velocity was measured with a global water flow probe FP111.

Results and Discussion

Catchment descriptions

The project area is in the Barron River catchment. The topography of the project area (described in NRA 2017b) includes distinct ridgelines separated by deeply incised, steep-sided creek channels as shown on **Figure 1** and **Figure 2**.

Figure 1: Site topography showing deeply incised creek channels

Project: KUR-World Surface Water Hydrology Technical Note

KUR-World project area

Proposed access road

Drainage

Contours - 1m interval

- 490 to 509
- 472 to 490
- 454 to 472
- 436 to 454
- 418 to 436
- 400 to 418
- 382 to 400
- 364 to 382
- 346 to 364
- 328 to 346

N

0 0.5 1

Kilometres

Source:
Reever and Ocean Pty Ltd, © State of Queensland (Department of Natural Resources and Mines) 2017

NRA Ref: 424103.01
Date: November 2017

NRA

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Recommended print size: A3

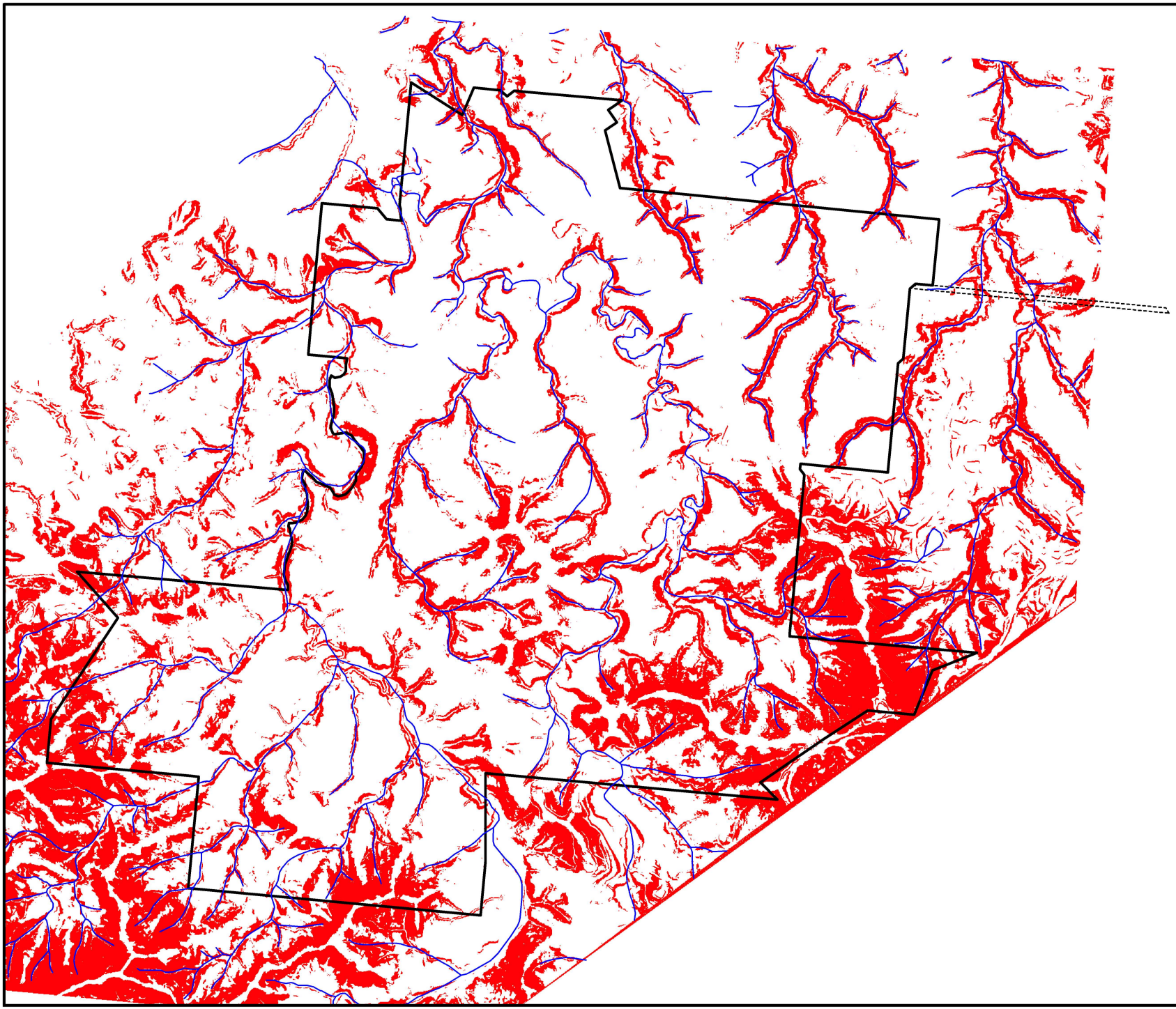

Figure 2: Slope analysis showing slopes >32% coinciding with deeply incised channels

Project: KUR-World Surface Water Hydrology Technical Note

KUR-World project area

Proposed access road

Drainage

Slope class

>32 % - steep or very steep

N

0 0.5 1

Kilometres

NRA Ref: 424103.01
Date: November 2017

Source:
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NRA

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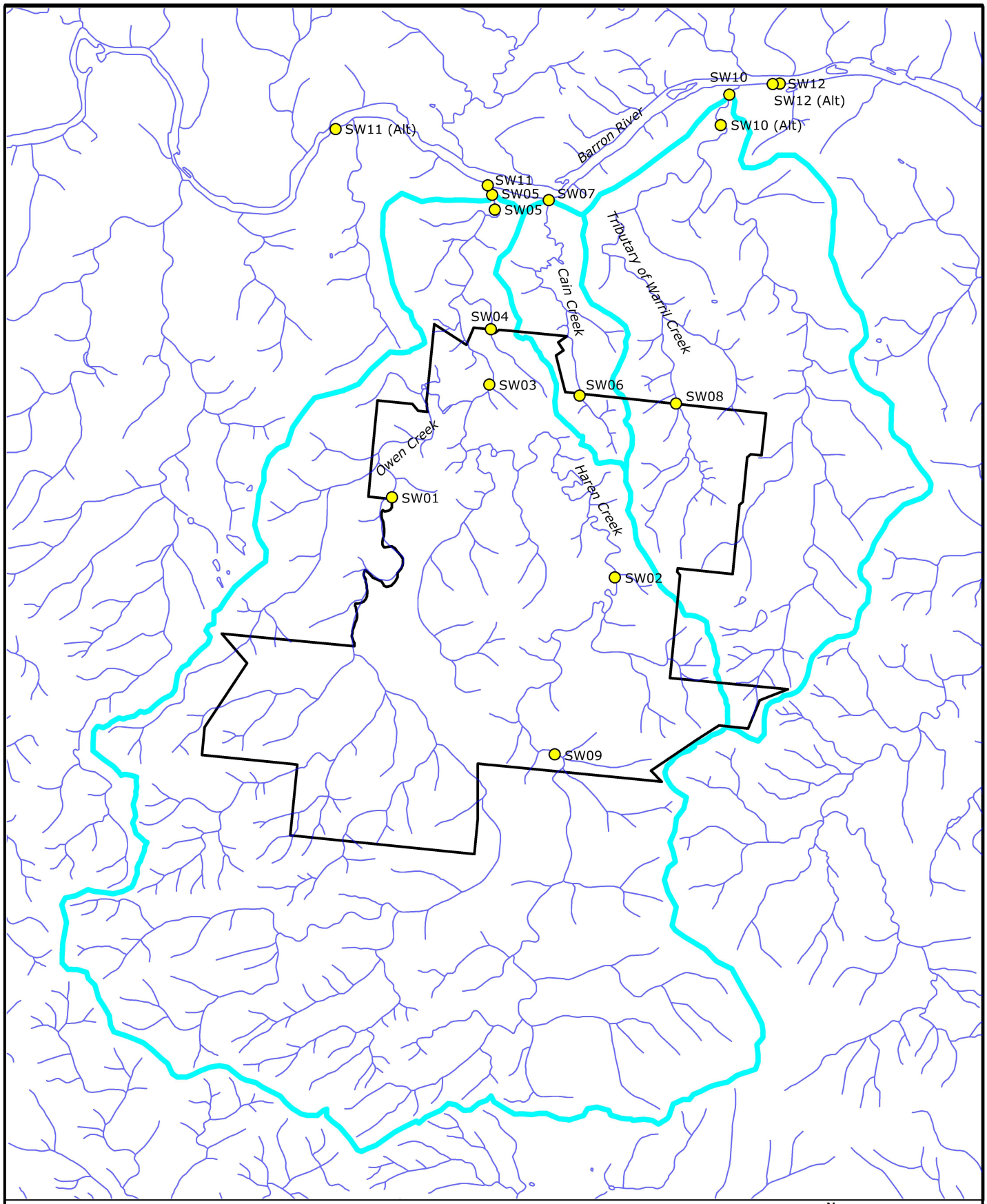

Figure 3: Catchment areas
Project: Kur-World Surface Water Hydrology Technical Note

KUR-World project area
Sub-catchments
Surface water monitoring sites

N

0 500 1000
metres

Source:
© State of Queensland (Department of Natural Resources and Mines) 2017, © State of Queensland (Department of Environment and Resource Management) 2010, Reever & Ocean Developments Pty Ltd

NRA Ref: 424103.01
Date: November 2017

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Three local catchments are recognised, and these are shown on **Figure 3**. Descriptions of each catchment are provided separately below.

All water depth measurements or estimations referred to in the following sections are relative to the height above the creek bed. Cross-section figures show flow rates on 16 March 2017 that were typical of base flows recorded at sites during field investigations throughout the wet season.

Owen Creek catchment description

Owen Creek catchment (approximately 1,625 ha overall) dominates the site, occupying approximately three quarters of the project area (**Figure 3**). This includes a major tributary, Haren Creek, which occupies the central section of the project area. Owen Creek is located along the western boundary of the project area. Owen Creek and Haren Creek are predominately rocky creeks with a number of closely spaced, moderately to deeply incised tributaries in a convergent tributary channel pattern. The steep-sided nature of the creeks can be seen on **Figure 1** and **Figure 2**. **Figure 1** shows the overall site topography and **Figure 2** shows only areas with slopes >32%. The deeply incised channels are more prominent in the areas with generally lower relief through the central and northern parts of the site where the majority of the development will occur.

Owen Creek becomes a third order stream when it meets Haren Creek (that is, both Haren and Owen Creeks are second order streams upstream of their confluence). The Owen Creek catchment flows north and joins the Barron River approximately 900 m from the northern boundary of the project area. Both Owen and Haren Creeks were observed to flow all year in 2016, although flow in both was reduced to a near trickle in the mid-dry season.

Cross-sections of Owen Creek and Haren Creek at different locations are presented on **Figures 4** and **5** and **Figures 6** and **7**, respectively. The cross-section for the on-site dam drainage line (that flows into Owen Creek) is presented on **Figure 8**. The water depths and observed or estimated flow regimes are provided in the tables accompanying each cross-section figure.

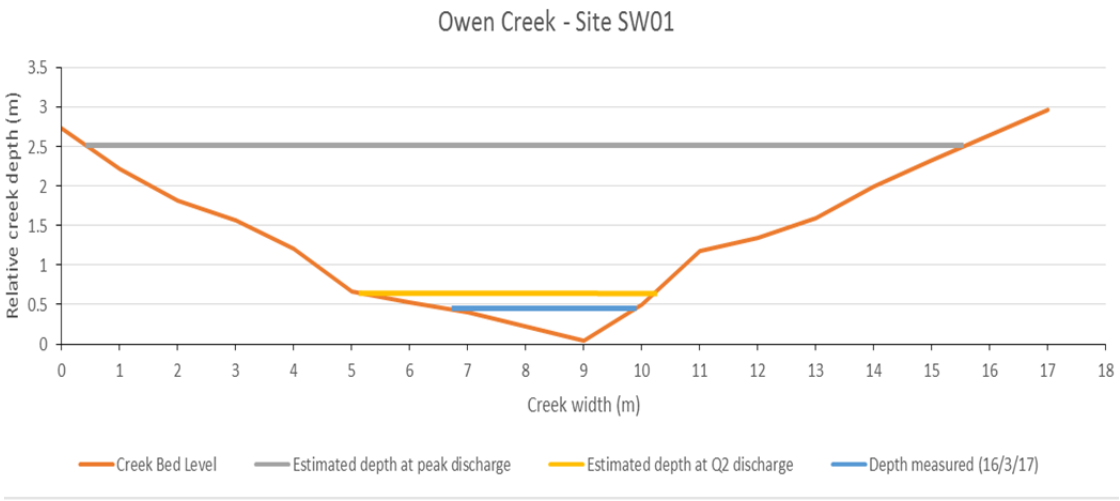

Figure 4: Owen Creek – Site SW01 cross-section

Table 1: Owen Creek – Site SW01 cross-section and estimated or measured depths under different flow conditions

Parameter	Relative depth (m)	Measured velocity (m/s)	Estimated discharge (m^3/s)
Q2 discharge	0.65	-	-
Maximum discharge (2016/17 wet season)	2.52	-	-
20 year ARI 60 min. peak discharge *	-	-	43.1
20 year ARI 24 hr. peak discharge *	-	-	75.3
50 year ARI 60 min. peak discharge *	-	-	65.5
50 year ARI 24 hr. peak discharge *	-	-	112.0
100 year ARI 60 min. peak discharge *	-	-	75.6
100 year ARI 24 hr. peak discharge *	-	-	132.4
Field measurements			
01/02/2017	0.51	0.1	0.09
21/02/2017	0.51	<0.1	<0.087
16/03/2017	0.45	<0.1	<0.06
04/04/2017	0.51	<0.1	<0.087
20/04/2017	0.43	<0.1	<0.06

* Data provided by Tomoko Shimamoto, Arup, 26 September 2017.

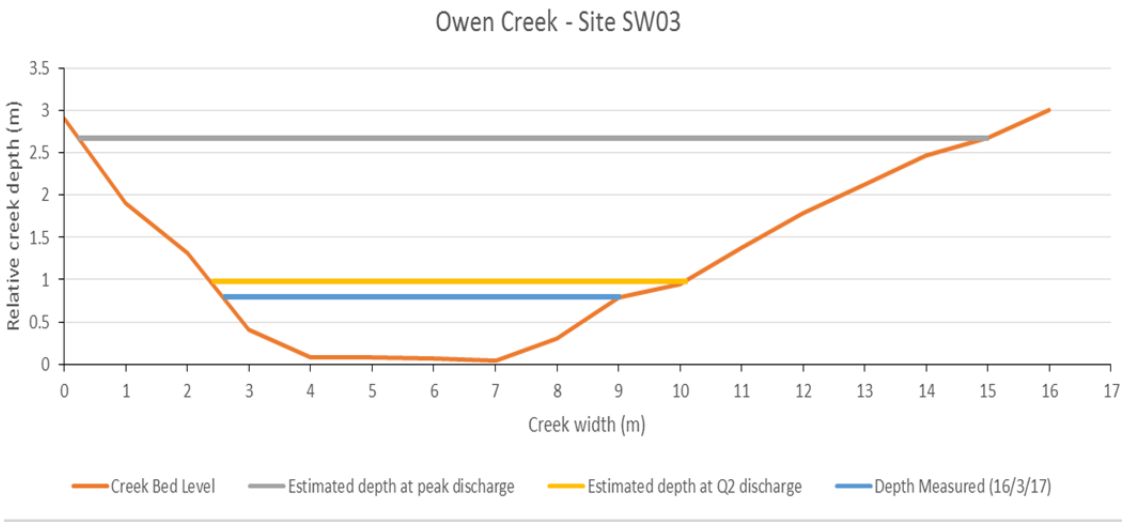

Figure 5: Owen Creek – Site SW03 cross-section

Table 2: Owen Creek – Site SW03 cross-section and estimated or measured depths under different flow conditions

Parameter	Relative depth (m)	Measured velocity (m/s)	Estimated discharge (m^3/s)
Q2 discharge	0.99	-	-
Maximum discharge (2016/17 wet season)	2.68	-	-
20 year ARI 60 min. peak discharge *	-	-	74.1
20 year ARI 24 hr. peak discharge *	-	-	163.9
50 year ARI 60 min. peak discharge *	-	-	119.4
50 year ARI 24 hr. peak discharge *	-	-	254.0
100 year ARI 60 min. peak discharge *	-	-	137.1
100 year ARI 24 hr. peak discharge *	-	-	301.3
Field measurements			
01/02/2017	0.83	0.1	0.40
21/02/2017	0.73	<0.1	<0.34
16/03/2017	0.79	<0.1	<0.375
04/04/2017	0.91	<0.1	<0.46
20/04/2017	0.78	<0.1	<0.37

* Data provided by Tomoko Shimamoto, Arup, 26 September 2017. The location used in flood modelling is at the confluence of Owen and Haren Creeks, approximately 130 m upstream of SW03.

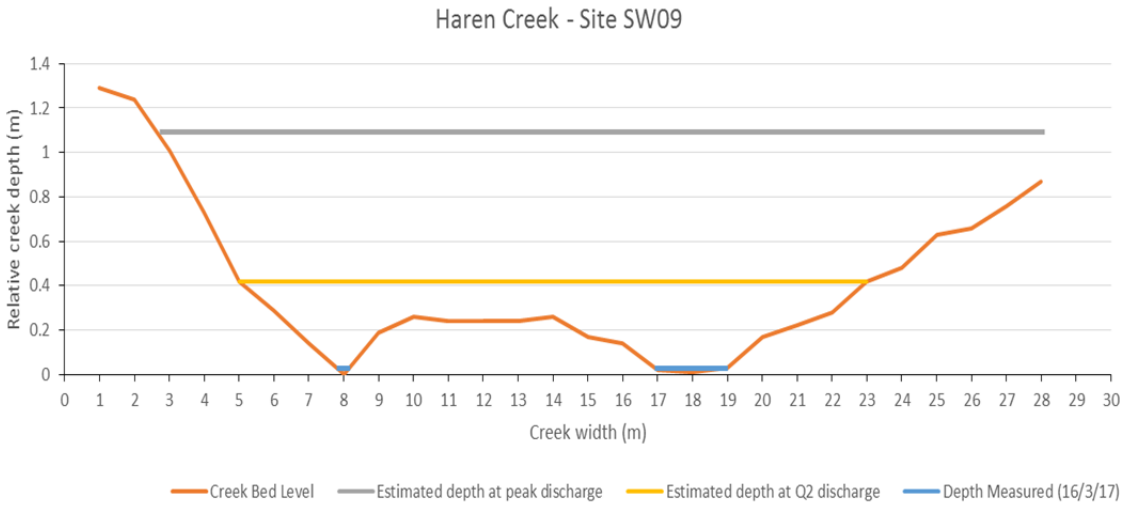

Figure 6: Haren Creek – Site SW09 cross-section

Table 3: Haren Creek – Site SW09 cross-section and estimated or measured depths under different flow conditions

Parameter	Relative depth (m)	Measured velocity (m/s)	Estimated discharge (m^3/s)
Q2 discharge	0.42	-	-
Maximum discharge (2016/17 wet season)	1.09	-	-
Field measurements			
01/02/2017	0.14	0.2	0.10
21/02/2017	No water present	No water present	No water present
16/03/2017	0.03	<0.1	<0.006
04/04/2017	0.07	0.3	0.07
20/04/2017	0.08	<0.1	<0.026

Note: no peak discharge data prepared for this location.

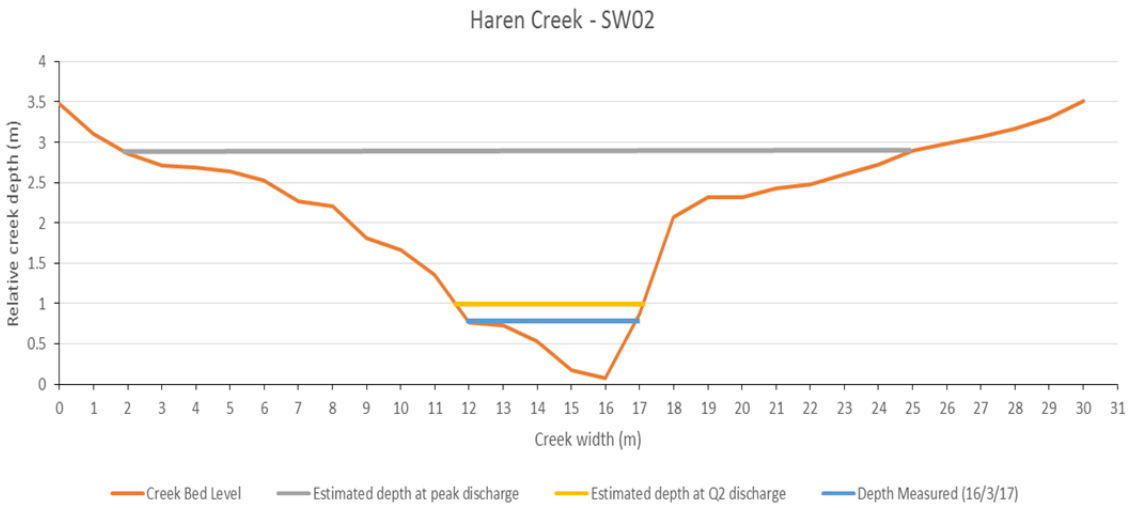

Figure 7: Haren Creek – Site SW02 cross-section

Table 4: Haren Creek – Site SW02 cross-section and estimated or measured depths under different flow conditions

Parameter	Relative depth (m)	Measured velocity (m/s)	Estimated discharge (m^3/s)
Q2 discharge	0.97	-	-
Maximum discharge (2016/17 wet season)	2.885	-	-
20 year ARI 60 min. peak discharge *	-	-	38.7
20 year ARI 24 hr. peak discharge *	-	-	63.8
50 year ARI 60 min. peak discharge *	-	-	59.6
50 year ARI 24 hr. peak discharge *	-	-	93.5
100 year ARI 60 min. peak discharge *	-	-	68.3
100 year ARI 24 hr. peak discharge *	-	-	109.4
Field measurements			
01/02/2017	0.85	0.2	0.40
21/02/2017	0.75	<0.1	<0.15
16/03/2017	0.77	<0.1	<0.16
04/04/2017	0.93	0.2	0.49
20/04/2017	0.81	<0.1	<0.18

* Data provided by Tomoko Shimamoto, Arup, 26 September 2017. The location used in flood modelling is at the confluence of two tributaries on Haren Creeks, approximately 300 m upstream of SW02.

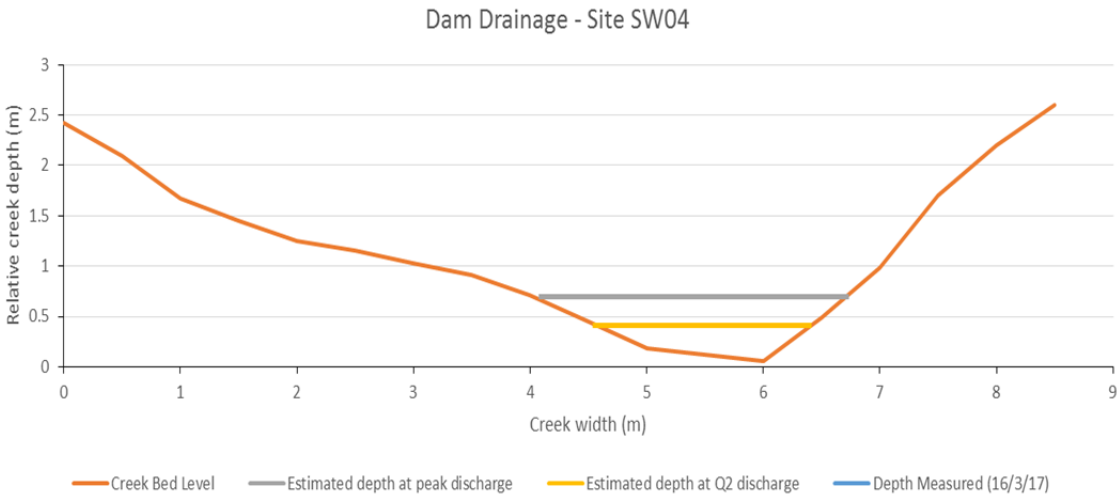

Figure 8: Dam Drainage – Site SW04 cross-section

Table 5: Dam Drainage – Site SW04 cross-section and estimated or measured depths under different flow conditions

Parameter	Relative depth (m)	Measured velocity (m/s)	Estimated discharge (m^3/s)
Q2 discharge	0.41	-	-
Maximum discharge (2016/17 wet season)	0.69	-	-
Field measurements			
01/02/2017	0.2	0.3	0.04
21/02/2017	No water present	No water present	No water present
16/03/2017	No water present	No water present	No water present
04/04/2017	No water present	No water present	No water present
20/04/2017	No water present	No water present	No water present

Note: no peak discharge data prepared for this location.

Warril Creek catchment description

Warril Creek catchment (approximately 505 ha overall) occupies the majority of the remaining one quarter of the project area. Warril Creek, a second order stream for most of its length, is east of the eastern boundary of the project area.

A first order tributary of Warril Creek flows through the far north-eastern corner of the project area. Within the project area, this first order tributary is predominately a deeply incised sandy creek with a number of closely spaced drainage lines/gullies forming a convergent tributary channel pattern. It did not hold water in the dry season of 2016, and was only observed to flow after the first wet season storms. It converges with the main Warril Creek channel approximately 2 km after leaving the northern project area boundary.

The cross-section of the Warril Creek tributary is presented on **Figure 9**.

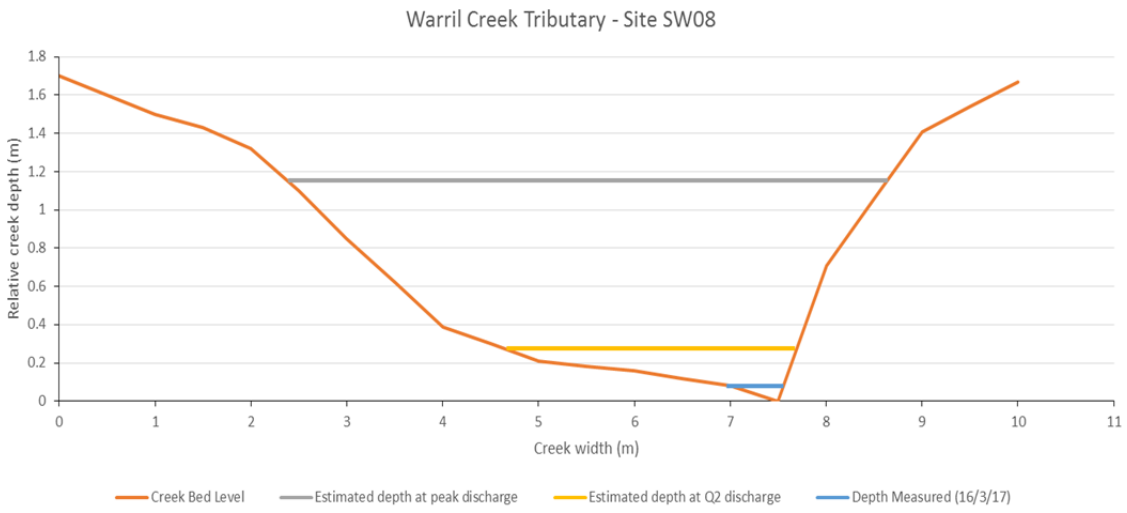

Figure 9: Warril Creek tributary – Site SW08 cross-section

Table 6: Warril Creek Tributary – Site SW08 cross-section and estimated or measured depths under different flow conditions

Parameter	Relative depth (m)	Measured velocity (m/s)	Estimated discharge (m^3/s)
Q2 discharge	0.27	-	-
Maximum discharge (2016/17 wet season)	1.15	-	-
20 year ARI 60 min. peak discharge *	-	-	13.4
20 year ARI 24 hr. peak discharge *	-	-	13.2
50 year ARI 60 min. peak discharge *	-	-	19.4
50 year ARI 24 hr. peak discharge *	-	-	18.4
100 year ARI 60 min. peak discharge *	-	-	22.2
100 year ARI 24 hr. peak discharge *	-	-	21.6
Field measurements			
01/02/2017	0.13	0.4	0.04
21/02/2017	0.08	0.08	0.003
16/03/2017	0.08	0.1	0.004
04/04/2017	0.15	0.3	0.04
20/04/2017	0.07	0.3	0.01

Cain Creek catchment description

Cain Creek is a first order stream. The upper catchment is located in the centre of the northern boundary of the project area. Its total catchment area is approximately 80 ha, and it flows directly into the Barron River 850 m after leaving the project area. It has a similar substrate and channel characteristics to the Warril Creek tributary to the east as it is a deeply incised, sandy creek. It crosses Barnwell Road near the northern project area boundary and was observed to run at this point all year in 2016 (albeit with very low flow in the late dry

season). This is surprising given its relatively short length and the lack of water in the larger stream to its east. Potential interactions with groundwater are discussed in RLA (2017).

The cross-section for Cain Creek is presented on **Figure 10**.

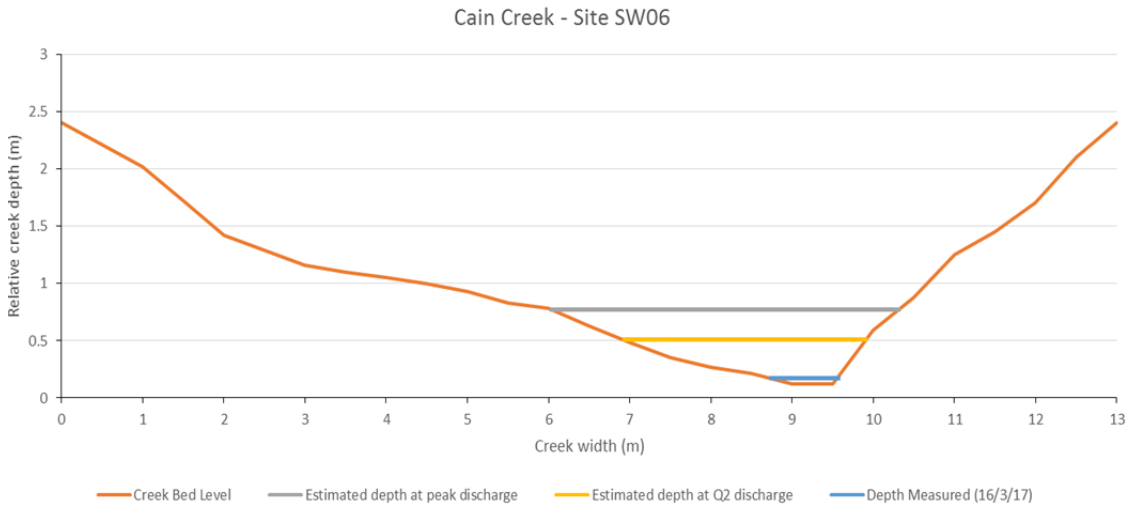

Figure 10: Cain Creek – Site SW06 cross-section

Table 7: Cain Creek – Site SW06 cross-section and estimated or measured depths under different flow conditions

Parameter	Relative depth (m)	Measured velocity (m/s)	Estimated discharge (m^3/s)
Q2 discharge	0.51	-	-
Maximum discharge (2106/17)	0.77	-	-
Field measurements			
01/02/2017	0.19	0.3	0.02
21/02/2017	0.14	0.002	0.08
16/03/2017	0.17	0.1	0.005
04/04/2017	0.22	0.1	0.011
20/04/2017	0.16	0.1	0.004

Note: no peak discharge data prepared for this location.

Observations of bed characteristics and sediment load

The main soil types on-site (described in NRA 2017b) have a high proportion of fine particles (silt and clay) in the soil profile. Surface soils are relatively stable, but subsoils can be a source of fine sediment when disturbed. The majority of catchments on-site (and along the route of proposed site access from the Kennedy Highway) contribute fine sediment to the system, although the sediment load varies with catchment characteristics such as slope and disturbance. The exception to this is the drainage lines in the south-western portion of the site, which comprise the upper reaches of Owen Creek and exhibit little to no evidence of fine sediment transport. This area is dominated by *Corymbia clarksoniana* and *Eucalyptus tereticornis* woodland, largely on areas mapped as a mixture of Galmara and shallow Seymour soils that are likely to have a higher proportion of coarse fragments than soils lower in the landscape.

Implications for frog habitat requirements

Breeding habitat for rare and threatened frog species occurs on the lower reaches of Haren and Owen Creeks and on Cain Creek. Warril Creek has potential habitat within the site, but has confirmed habitat downstream.

The monitoring of stream depth in 2017 suggests that the base stream discharge required to maintain frog breeding habitat throughout the breeding season (September (depending on rainfall) to March) is 0.3-0.4m^3/s at site SW03.

Any disruptions to base flow regimes due to changes in drainage and surface water hydrology modifications associated with the project have the potential to impact on frog breeding habitat. This has informed performance outcomes for water sensitive urban design (stormwater) and wastewater treatment plant discharge management.

References

DNRM 2014. *Watercourse lines – Queensland.* Spatial data layer, Department of Natural Resources and Mines, Brisbane. Accessed 2 February 2017, http://dds.information.qld.gov.au/dds?title="Watercourselines-Queensland".

DNRM 2016. *Drainage 25k – Queensland*. Spatial data layer, Department of Natural Resources and Mines, Brisbane. Accessed 1 February 2017, https://data.qld.gov.au/dataset/drainage-25k-queensland.

NRA 2017a. *KUR-World Water Quality and Aquatic Ecology Technical Report*, R03, prepared by NRA Environmental Consultants for Reever and Ocean Pty Ltd, November 2017.

NRA 2017b. *KUR-World Geology and Soils Technical Report*. R03, prepared by NRA Environmental Consultants for Reever and Ocean Pty Ltd, November 2017.

RLA 2017. *KUR-World Groundwater Report, Reever and Ocean Pty Ltd*. Report prepared by Rob Lait & Associates, October 2017.

USPD 2016. *KUR-World Integrated Eco-Resort – Initial Advice Statement*. Report prepared by Urban Sync Planning and Development, May 2016.