Haughton Solar Farm Hydraulic Impact Assessment

Pacific Hydro

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Document history and status

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0-Draft	24/02/2017	Draft for Client review	MJR	GR/JM	GR
1- Draft	09/03/2017	Updated after client review	MJR	GR/JM	GR

Contents

Executive Summary

Pacific Hydro is proposing to construct a solar farm with a capacity of up to 500 MW in the Burdekin Shire Council area, adjacent to the Haughton River, Piccaninny Creek and Oaky Creek. Within a larger site area, a development area has been identified by Pacific Hydro based on an assessment of environmentally sensitive areas, and areas at risk of flooding. In this report, a further assessment has been undertaken of potential impact of the proposed Haughton Solar Farm on flooding and drainage.

Hydraulic flood modelling has been undertaken to estimate existing flood levels for the 1% Annual Exceedance Probability (AEP) flood event. The hydraulic model showed that the site is partly affected by flooding from Oaky Creek. The impact of the proposed development on flood levels has been quantified by including the proposed solar farm in the flood model. This indicated that the solar farm would not cause any significant afflux.

The impact of the development on stormwater runoff from site has been estimated by assuming a 40% of developed site as impervious. This conservative analysis found that the peak 1% AEP flow from the site would increase by about 7.9m^3/s. This is approximately 1.2% of the peak flow in Oaky Creek. The peak runoff from the site is expected to occur before the peak flow in Oaky Creek, hence the change to the peak flow in Oaky Creek likely to be less than 1.2%. Therefore, it is not expected to significantly impact the receiving water environment.

The proposed use has been compared to the land and catchment management water quality targets, and the development would meet these targets. Potential impact on water quality has been assessed. No significant impacts are expected provided that appropriate stormwater management practices are adopted.

1. Introduction

1.1 Project background

Pacific Hydro has engaged Jacobs to undertake a hydraulic impact assessment of the proposed Haughton Solar Farm. The solar farm is proposed to generate up to 500 MW, using around one million photovoltaic panels on steel support structures.

The proposed solar farm would be located in the Burdekin Shire Council area, located approximately 17km north-west of Clare and 37km south-west of Ayr in North Queensland on Lots 4 GS602 and 30 SP100843.

The site is confined between the Haughton River in the north, and Piccaninny Creek and Oaky Creek in the south, and is affected by flooding from these waterways in large flood events.

The contours displayed in **Figure 1** show that the site drains to the east into Oaky Creek, which in turn flows into Barratta Creek. **Figure 1** shows that the development area is chosen such to create sufficient distance between the proposed development and areas defined as wetlands.

1.2 Reliance statement

The sole purpose of this report and the associated services performed by Jacobs is to provide an assessment of flood impact in accordance with the scope of services set out in the contract between Jacobs and Pacific Hydro.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by Pacific Hydro and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from Pacific Hydro and/or that available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

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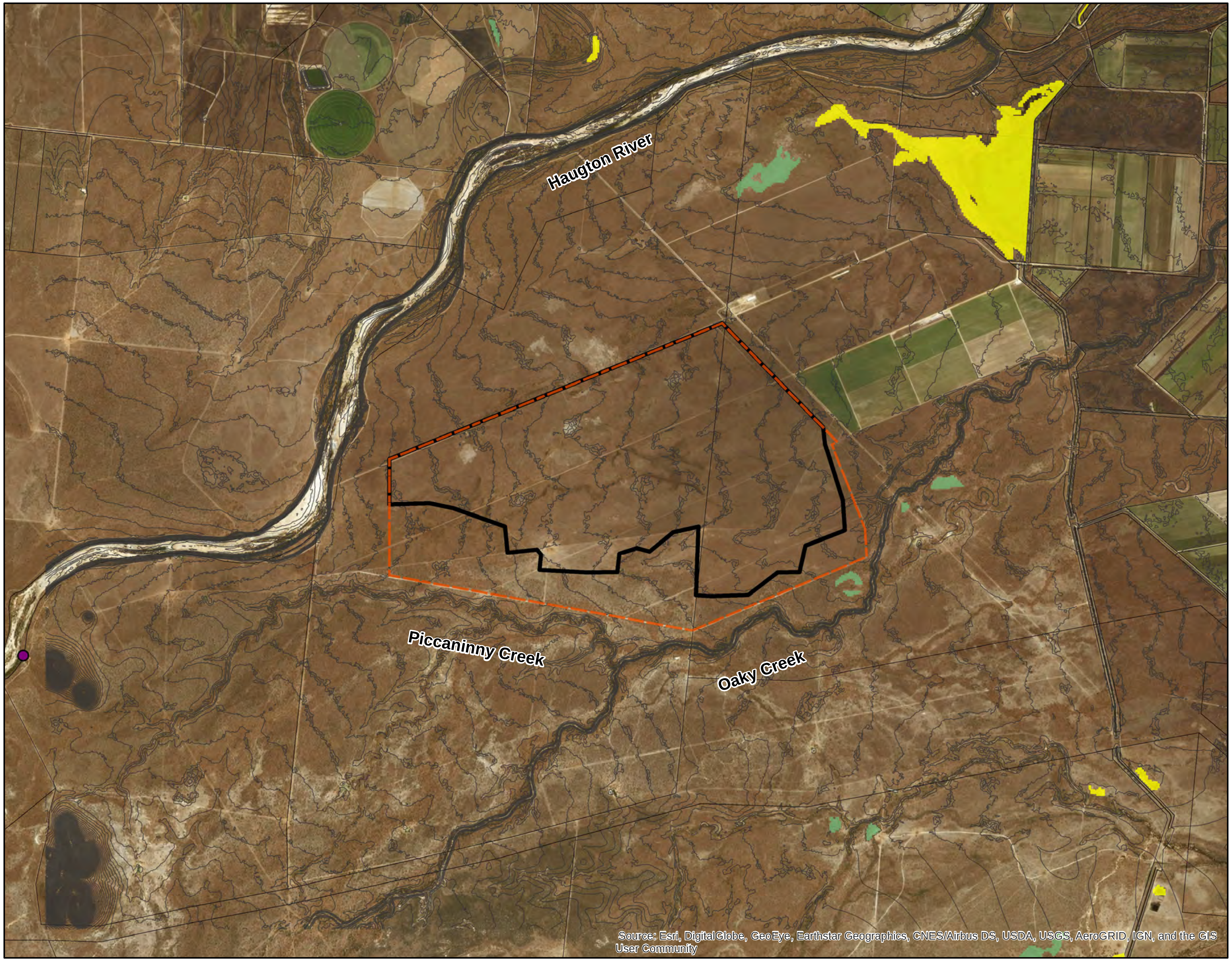
FIGURE 1: Locality Plan



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- River gauge 119005A
- Property boundaries
- 1m contour
- Site boundary
- Proposed development layout

Wetlands

- Lacustrine
- Palustrine

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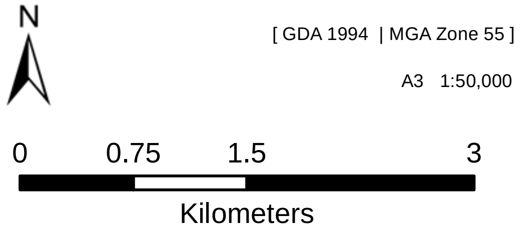

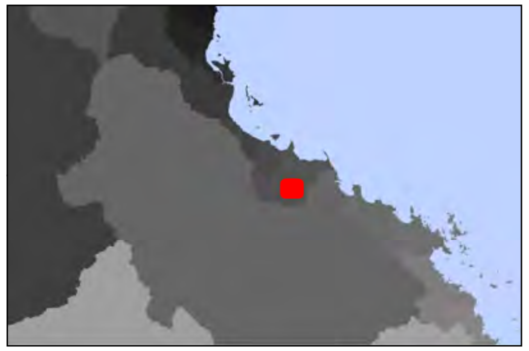

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1.3 Scope and purpose of flood impact assessment

This study identifies potential flooding impacts external to the proposed site due to the construction, operation and decommissioning of the solar farm. The assessment investigates any potential flood impact and addresses relevant legislation.

1.4 Relevant legislation

Burdekin Shire Planning Scheme 2011

The proposed site falls within the Burdekin Shire. Hence the Burdekin Shire IPA Planning Scheme 2011 is applicable for this proposed development. The Strategic Framework described in the Planning Scheme regarding sustainable growth in the Burdekin Shire is outlined in three broad strategies.

> ***Strategy 1*** *– Flooding and Coastal Processes: Minimise the detrimental effects of inundation by storm surge, tidal surge or flood waters upon development in the Shire; and Support the dynamic relationship between the river catchments and the coastal processes and minimise the adverse effects of development upon the coastal zone and marine environments*
>
> *Outcomes:*
>
> *(a) Development (material change of use and reconfiguration of lot) is located to avoid detrimental inundation by floodwaters, stormwater or tidal surge and accommodates the dynamic relationship between the river catchments and the coastal processes.*
>
> *(b) New development within the existing urban environment of the Burdekin is developed to accommodate any potential flooding impacts from floodwaters, stormwater or tidal surge.*
>
> ***Strategy 2*** *– Integrated Catchment Management: Implement integrated catchment management principles to protect the catchments and the sub-catchments of the Shire's creek and river systems.*
>
> *Outcomes:*
>
> *(a) The biodiversity values of the Burdekin River catchment and other significant local catchments including but not limited to those of the Haughton River, Bowen River, Bogie River, Barramundi Creek and Barratta Creek, are recognised and protected for their environmental values.*
>
> *(b) Development protects ground and surface water quality, retains native vegetation and riparian corridors and protects biodiversity to conserve valuable ecosystems.*
>
> ***Strategy 3*** *– Land and Water Management: Land and water resources are used sustainably for the economic, social and environmental wellbeing of the Shire.*
>
> *Outcomes:*
>
> *(a) Development minimises adverse impacts including the capability of long-term consequences on land and water systems including surface and ground water quality;*
>
> *(b) Development in all areas of the Shire protects existing drainage regimes and does not negatively impact on overland surface water flows.*
>
> *(c) Land uses occur sustainably by utilising existing and available land and water resources, including irrigation and ground water recharge channels; and*
>
> *(d) Development retains native vegetation, riparian corridors and protects biodiversity to conserve viable ecosystems.*

Besides these broad strategies, the Planning Scheme provides Specific Outcomes for development in Table 1 of Part 6 – Codes. **Section 3.5** of this report outlines how this development addresses these Specific Outcomes.

2. Flooding Impact Assessment

2.1 Hydrology

2.1.1 Haughton River

The flood level of the Haughton River for the flood event with a 1% Annual Exceedance Probability (AEP) has been estimated with a flood frequency on the recorded flood levels and estimated flows from the flood gauge 119005A Haughton River at Mount Piccaninny. This flood gauge is located approximately 3 km upstream of the subject site, and has recorded water levels since 1971.

From this 47 year dataset, annual flow maxima have been extracted, and a flood frequency analysis was undertaken. The data was fitted using a generalised extreme value (GEV) distribution with LH moments. The annual flow maxima and the fitted GEV distribution are shown in **Figure 2.**

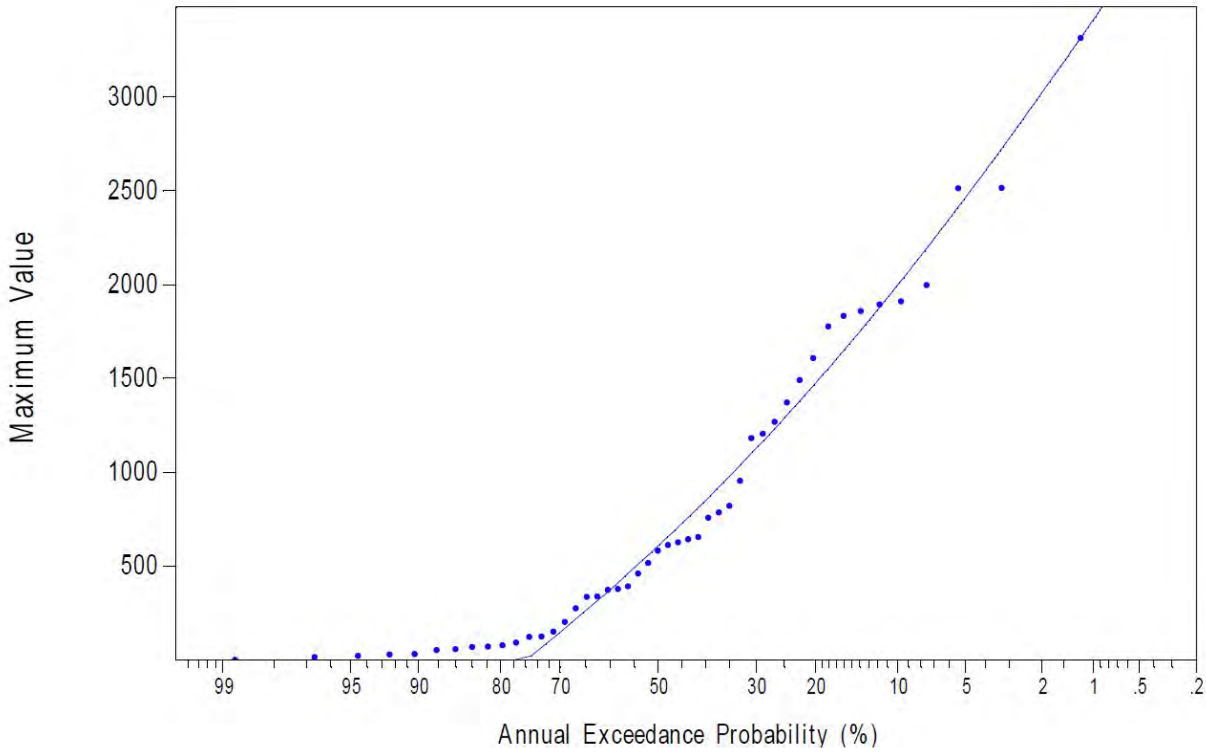


Figure 2 - Annual maxima of peak discharge and the fitted GEV distribution

The resulting peak flows for a range of design events is shown in **Table 1**. The 1% AEP peak flow derived with this method is slightly higher than the 1% AEP peak flow provided by the Bureau of Meteorology (BoM) for this site, which is approximately 3,375 m³/s. The difference is caused by the statistical method the BoM used to fit a distribution to the data, which is a Pearson 3. This leads, in this case, to a slightly lower peak flow for large events. As both methods are likely to be appropriate in this case, the larger, and therefore more conservative, has been used in this study.

Table 1 - Peak flows for the Haughton River at Mt Piccaninny gauge, resulting from the flood frequency analysis

AEP (%)	ARI (year)	Peak flow (m³/s)
50	2	606
20	5	1,473
10	10	1,997

AEP (%)	ARI (year)	Peak flow (m³/s)
5	20	2,465
2	50	3,023
1	100	3,409

1.1.1 Piccaninny Creek and Oaky Creek

As Piccaninny Creek and Oaky Creek are ungauged, no reliable information is available on historical flood levels. Hence, the Regional Flood Frequency Estimation Model (RFFE) has been used to obtain peak flows for the 1% AEP flood event. This method is based on known peak outflows of catchments with similar properties, such as location, shape, and size.

The catchment area for Piccaninny Creek is approximately 26 km², and approximately 65 km² for Oaky Creek. The peak flows for Piccaninny Creek and Oaky Creek resulting from the RFFE for a range of design events are shown in **Table 2** and **Table 3**. The results for the RFFE analysis for the combined catchments of Oaky Creek and Piccaninny Creek is shown in **Table 4.** Note that the values in this table are not a direct summation of the flows in Table 2 and Table 3 as the peak flow does not linearly increases with catchment area due to timing issues and attenuation of peak flows.

Table 2 - Peak flows for Piccaninny Creek at the confluence with Oaky Creek

AEP (%)	ARI (year)	Peak flow (m³/s)
50	2	51
20	5	92
10	10	126
5	20	163
2	50	218
1	100	265

Table 3 - Peak flows for Oaky Creek at the confluence with Piccaninny Creek

AEP (%)	ARI (year)	Peak flow (m³/s)
50	2	97
20	5	176
10	10	241
5	20	311
2	50	416
1	100	505

Table 4 - Peak flows for Oaky Creek downstream of the confluence with Piccaninny Creek

AEP (%)	ARI (year)	Peak flow (m³/s)
50	2	129
20	5	235
10	10	322
5	20	417
2	50	557
1	100	676

2.2 Hydraulics

A 2D hydraulic model has been created using the TUFLOW software package to derive the 1% AEP flood extent.

2.2.1 Inflow

Flood depths for the 1% AEP flood event have been derived running the hydraulic model with the inflows discussed in Section 2. The inflow for the Haughton River has been increased by 20% to account for uncertainty in the flood frequency analysis.

The model was simulated with a constant peak flow (steady state), which is conservative in the smaller Oaky Creek and Piccaninny Creek, where shorter flood peaks are more likely. This also meant that the peak flows of the two creeks coincided in the model, making it a more conservative assessment of the 1% AEP flood extent. The model was run sufficiently long for outflows to be similar to the inflows.

2.2.2 Elevation and bathymetry data

The elevation and bathymetry was based on elevation contour data provided by Pacific Hydro, which was transferred into a 10m grid of elevation data. This grid was then used as the base of the 10m grid TUFLOW model.

2.2.3 Hydraulic Roughness

The hydraulic roughness of the terrain is modelled using a Manning's roughness or Manning's '*n*' value. The Manning's '*n*' value used in the model is shown in **Table 5** and were derived based on previous experience in calibrating 2D flood models in this area and inspection of aerial photography to map different areas of vegetation, and are generally consistent with the recommended values in the Australian Rainfall and Runoff guideline (AR&R 2016).

Table 5 - Hydraulic roughness as used in the 2D model

Description	Manning's '*n*'
Open grass land	0.05
Haughton River bed	0.05
Vegetated river banks	0.07
Medium dens vegetated areas	0.06
Pasture / cropping	0.04
Solar Farm (developed case)	0.1

2.2.4 Model boundary

The downstream boundary is approximately 5km downstream of the area of interest. Any influence of assumptions made at this boundary is therefore minimal at the subject site.

2.3 Existing flood extent

The estimated 1% AEP peak water depths are shown in **Figure 3**. Review of this figure shows:

- There are no breakouts in the Haughton River at the location of the proposed solar farm. Moderate breakouts are shown further downstream. Sensitivity analysis on the Manning's n values (not shown here) has shown that at higher water levels breakouts occur on the northern side of the Haughton River, which is consistent with the breakout locations visible on the aerial background in this figure. The absence of breakouts in a large flood event such as the 1% AEP flood event is somewhat surprising, but may be explained by the topography just upstream of the modelling extent. Here, the river is restricted by several large hills on both sides of the river, forcing the river in a specific path which leads to an incised river with a river bed about 13 metres below the river banks. Further downstream, the influence of these hills reduces and breakouts are observed.

- Within Piccaninny Creek, the extent of the 1% AEP flood is relatively limited. However, downstream of the confluence of Piccaninny Creek and Oaky Creek the flood is no longer confined and the floodplain widens. This breakout is partly explained by the relatively conservative steady state approach, which allows water levels in the floodplain to continue to rise for longer than what would occur in reality. The flood extent mapping at this site can therefore be seen as conservative.

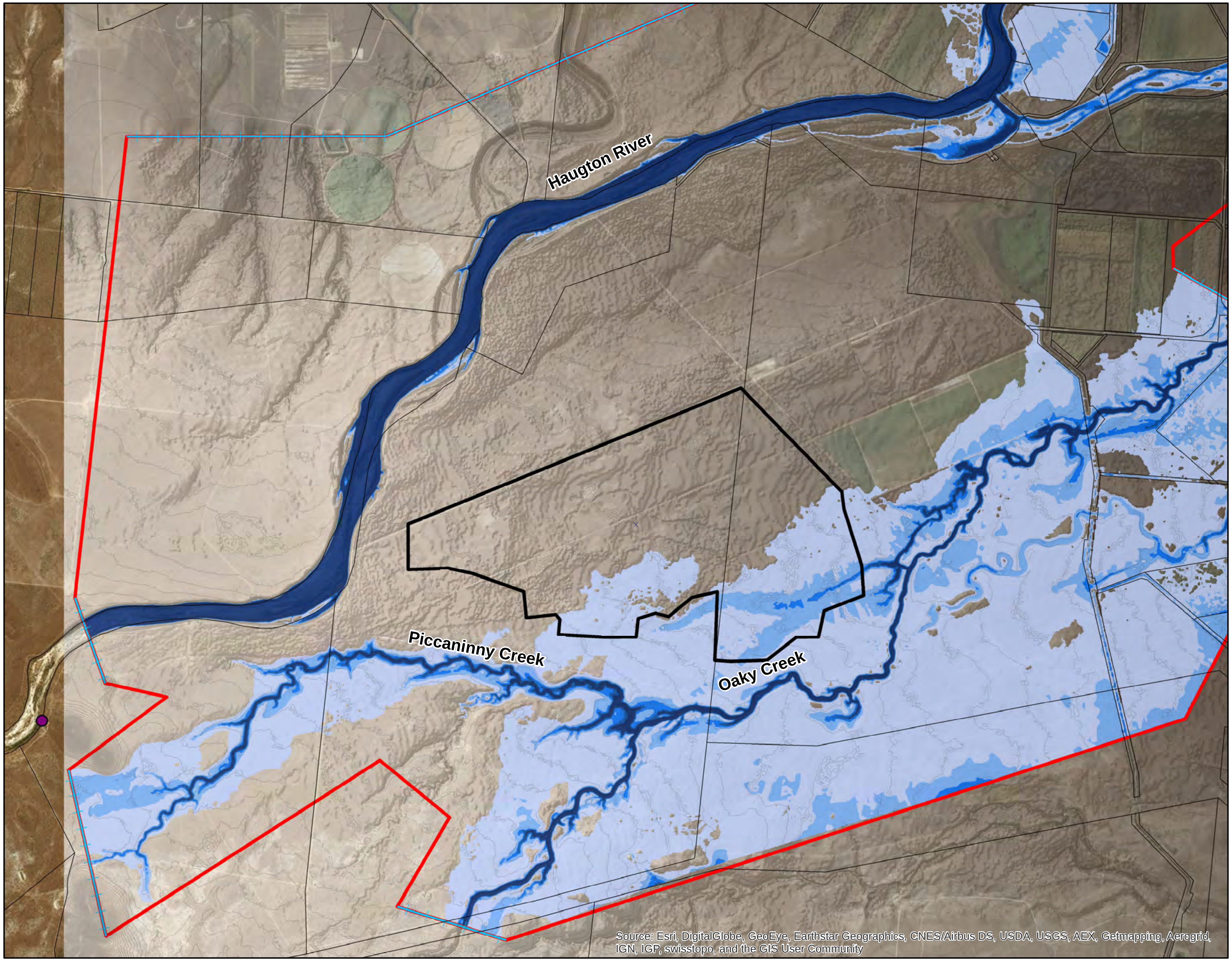
- Local storm water runoff from within the subject site itself not been included in the modelling and is, therefore, not mapped. Impact from local stormwater is further discussed in **Section 3.4**.

2.4 Impact on flood levels

As shown in **Figure 3**, part of the site falls within the 1% AEP flood extent. In order to assess the impacts of the site, the 1% AEP flood event has been modelled with the solar farm in place, represented in the hydraulic model by an area with higher hydraulic roughness. To model this increased roughness, a Manning’s ‘n’ value of 0.1 has been applied within the proposed site layout. This Manning’s ‘n’ value of value of 0.1 is recommended in the Australian Rainfall and Runoff guideline for floodplains with “heavy timber or other obstacles” (ARR 2016).

Figure 4 shows the results of the difference between existing flood levels and post-development flood levels. Review of this figure shows there would not be afflux larger than 10 mm both on the site, or external to the site. The proposed development is, therefore, not expected to cause any significant impact.

FIGURE NO 3: 1% AEP flood depth



LEGEND

- River gauge 119005A

1% AEP flood depth (m)

- 0 - 0.5
- 0.5 - 1
- 1.0 - 1.5
- 1.5 - 2.0
- over 2m

Topography (mAHD)

High : 120.682

Low : 15.9824

- Model in/out flow boundary
- Model extent
- Property boundaries
- 1m contour
- Proposed site layout

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Kilometers

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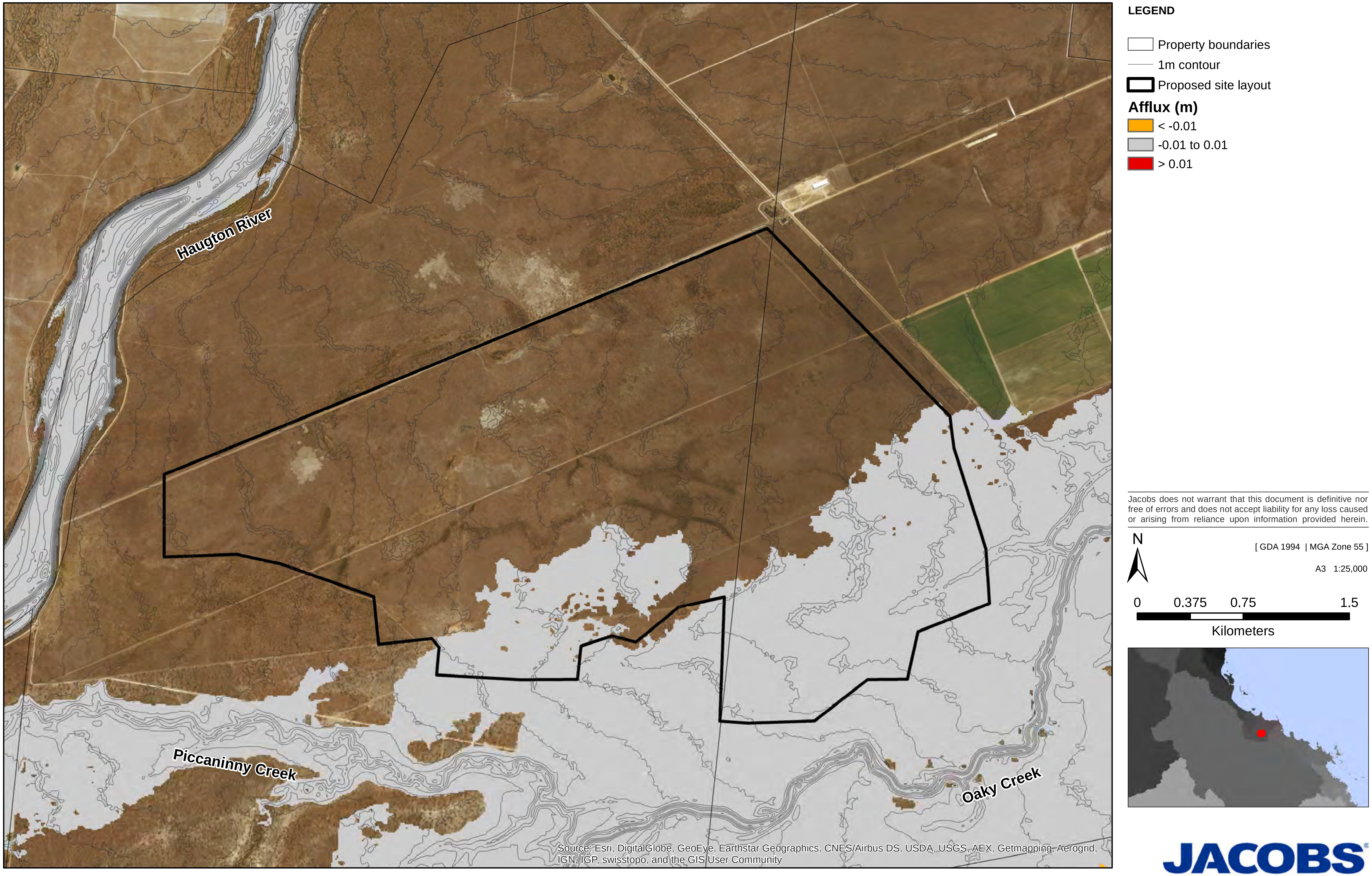
FIGURE 4: 1%AEP afflux



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3. Stormwater Impact Assessment

3.1 Catchment description – existing condition

The Barratta Creek catchment is part of the Lower Burdekin River delta and floodplain. Underlying the delta is a substantial fresh water aquafer system supporting agricultural, pastoral and domestic use in the Lower Burdekin.

The Burdekin Falls Dam has supplemented groundwater in the delta area since construction in 1986. This water availability, led to an expansion of the cane industry into an area north of the Burdekin River extending to the Haughton River, which is known as the Burdekin river Irrigation area (BRIA), see **Figure 5**. A system of natural and artificial drainage channels supplies water to farms across the BRIA. Most tail-water discharges from the BRIA occur through the Haughton River and Barratta Creek system and then into Bowling Green Bay.

Figure 5 - Extent of the BRIA in the Lower Burdekin catchment and approximate location of the proposed Haughton Solar Farm (marked in orange). Figure adopted from NQ Dry Tropics 2016b.

The soils of the BRIA are substantially different from those of the delta area, and are predominantly composed of more impermeable duplex soil types (NQ Dry Tropics 2013).

According to the 2016 Burdekin Water Quality Improvement Plan, the Barratta Creek catchment is identified as a priority sub catchment to focus support on improved management practices to minimise fertiliser and pesticide losses from sugarcane farms. Soil erosion in the Barratta Creek catchment is relatively low, at around 300 kg/ha/yr. (NQ Dry Tropics 2016b).

The nitrate and nitrite concentrations in the upper Barratta Creek catchment are relatively high for the wider Burdekin catchment, see **Figure 6**.

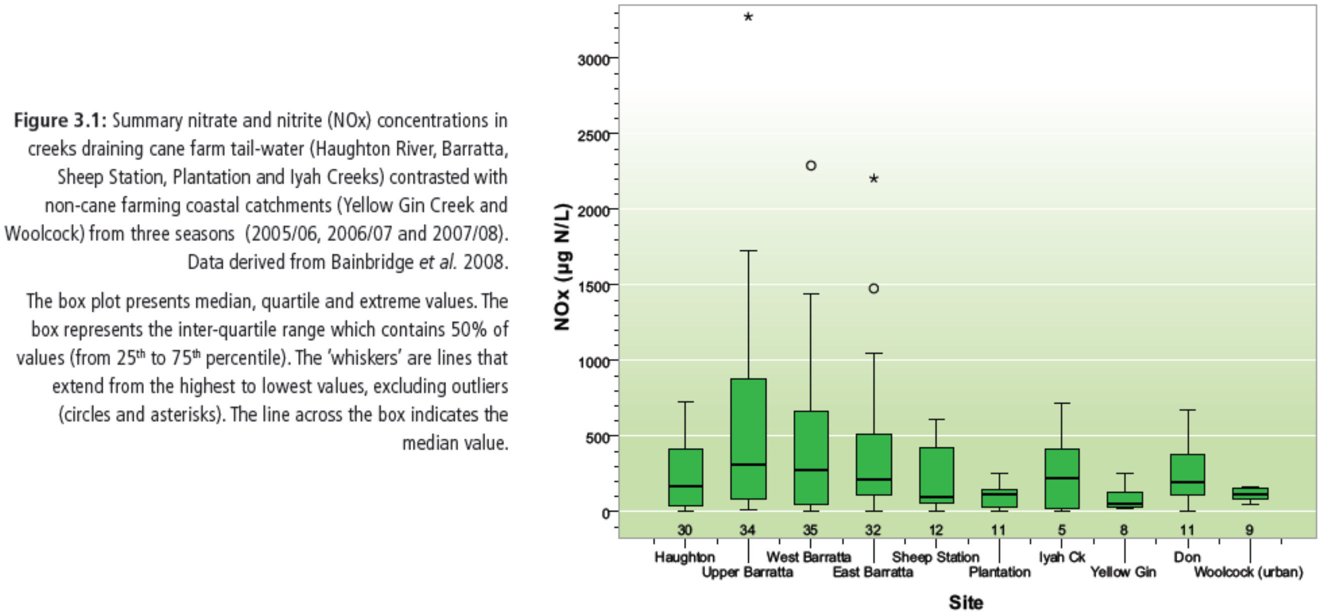

Figure 6 - Nitrate and nitrite concentrations (figure taken from Burdekin Water Quality Improvement Plan, 2009)

3.1.1 Environmental values

A framework for identifying and setting Environmental Values has been established through the National Water Quality Management Strategy (NWQMS) and Queensland Environmental Protection (Water) Policy 2009 (EPP Water). The draft Environmental Values were published in December 2016 in the Burdekin Water Quality Improvement Plan and are reproduced in **Table 6**.

A review of this table shows that the Barratta Creek catchment has most of the environmental values as outlined in the Burdekin Water Quality Improvement Plan.

Table 6 – The Draft Environmental Values available in the Barratta Creek catchment - adopted from Burdekin Water Quality Improvement Plan 2016

Environmental Values	Activities in the Barratta Creek catchment
Aquatic Ecosystems	Yes
Irrigating crops	Yes
Water for Farm Use	Yes
Stock watering	Yes
Water for Aquaculture	Yes
Human Consumption	Yes
Primary Recreation	Yes
Secondary Recreation	Yes
Visual Recreation	Yes
Raw Drinking Water	No
Water for Industrial Use	No
Cultural and Spiritual	Yes

3.2 Stormwater quality impact assessment

3.2.1 Proposed activities on the site

The activities during the construction, operational and decommissioning phases are listed below.

Construction phase

- Minor civil works, including vegetation removal, grading, drainage, erosion and sediment controls
- Temporary site amenities;
- Staggered delivery of shipping containers and equipment;
- Mechanical installation of the mounting structure and PV modules;
- Installation of solar panels onto mounting structures;
- Installation and connection of the solar panels to the combiner boxes;
- Trenching of underground cabling;
- Hammering of piles;
- Installation of energy storage facility (i.e. battery storage);
- Roadworks;
- Installing of electrical cabling, inverters and associated electrical equipment;
- Preparation and installation of the kiosk transporter and associated upgrade works to existing distribution lines if required; and
- No major chemical stores are required.

Operational phase

- Remote monitoring;
- Full servicing of inverters and substation equipment on a quarterly basis;
- Cleaning of panels will be performed approximately two (2) times per year depending on weather conditions and yield optimisation factors. An automatic monitoring station may be used to determine optimum cleaning time and frequency. Water is expected to be brought to the site for cleaning purposes;

- No major chemical stores are required, however minor storage of hazardous goods and materials will be managed through an approved EMP;
- A team of approximately ten (10) permanent staff members are required for the ongoing operation of the facility; and
- Vehicle movements generated by the facility once operational will be minimal, limited to staff movements.

Decommissioning phase

- The economic life of the solar panels and facility is 25 years. After this time, the facility will either be refurbished or decommissioned.
- If decommissioning would consist of removal of all above ground infrastructure for recycling or disposal, revegetation of all disturbed land, and returning the land to agricultural use.

Review of the activities in the Construction Phase, Operational Phase and decommissioning Phase identified spills and leaks and erosion as the main risk in any phase of the project. These risks have been addressed the next section.

3.2.2 Soil and Contamination Management

The storage and handling of hazardous substances will be an important consideration during the construction phase. Spills/leaks from chemical or hydrocarbon storage areas, as well as discharge of treated or untreated wastewater from on-site waste water treatment facilities will be managed through prescribed controls and measures documented in a site specific EMP.

A range of mitigation measures are identified to minimise these potential impacts, summarised as follows:

- Implementation of best practice erosion and sediment control measures during the construction phase (including dust control);
- Safe storage of chemicals and hydrocarbon materials (e.g. away from waterways and drainage lines), to ensure that any spillages are contained;
- Re-vegetation of soil beneath solar panels with native or naturalised perennial species, to stabilise the land, reduce peak stormwater flows and reduce sediment discharge via stormwater runoff;
- Use of glyphosate-based products (or similar non-residual and non-persistent herbicides) to manage weeds on-site, to minimise the potential risk of harmful herbicide by-products entering the surface water receiving environment;
- Design, construction and maintenance of stream crossings in accordance with industry best practice; and
- Installation and operation of a septic tank to service the operations and maintenance building; this will be designed and operated in accordance with relevant statutory requirements and Australian Standards. Regulated wastes will be removed from site and disposed in a suitable facility by a licensed operator.

Overall, it is considered that the potential soil and contamination impacts associated with the project can be appropriately managed by developing and implementing an erosion and sediment control plan that contains best practice drainage, erosion and sediment controls for the various stages of work.

3.3 Land and catchment management targets

The Burdekin Dry Tropics Water Quality Management Plan 2016 identifies four main targets to achieve water quality of a sufficient standard. **Table 7** outlines how the Project meets these four targets.

Table 7 - Land and catchment management targets (after Burdekin Dry Tropics Water Quality Management Plan 2016) and

Land and catchment targets	Applicability on the proposed Haughton Solar Farm
90 per cent of sugarcane, horticulture, cropping and grazing lands are managed using best management practice systems (soil, nutrient and pesticides) in priority areas;	While the proposed development is not one of the uses described in the targets, it is likely to have reduced impacts on the total load of nutrients and pesticides in the Barratta Creek catchment, compared to cropping/grazing. Glyphosate-based products, or similar non-residual and non-persistent herbicides, will be used for weed management to manage vegetation on-site, while minimising harmful by-products. No additional nutrients are utilised on the development site.
Minimum 70 per cent late dry season ground cover on grazing lands;	The site will be maintained at a minimum groundcover percentage of 70% (perennial species), before erosion and sediment control measures are removed. There will be no grazing on the site; hence ground cover is expected to remain intact post-construction..
The extent of riparian vegetation is increased; and	No development is proposed within 250 metres from the riparian zone.
There is no net loss of the extent of natural wetlands. There is an improvement in the ecological processes and environmental values of natural wetlands	No development is proposed in the wetlands, and the minimum distance from the proposed development layout to a defined wetland is over 550 metres. No negative impacts are expected on wetlands external to the site.

3.4 Stormwater quantity impact assessment

As the solar panels cover a part of the site, some concentration of runoff is expected in significant rainfall events, which could lead to a minor increase in peak runoff from the site.

The existing and post development peak flows for the catchment were assessed using the Rational Method, in accordance with the Queensland Department of Transport and Main Roads (TMR) 2010 '*Road Drainage Manual'* for urban catchments. While the site is rural, this urban method was used as it allows for an assessment of increase in runoff due to an increase in impervious areas. The rainfall intensities have been extracted from the 2016 Intensity Frequency Duration (IFD) tool as provided by the Bureau of Meteorology.

The panels are aligned in rows of two metres wide, and with a three metre space between the rows. This means that 40% of the area of the development site is covered by the solar panels. This percentage is likely to be less in practice as this is only reached for a completely horizontal alignment of all the panels. During significant rainfall event, the panels are likely to be rotated to prevent potential (hail) damage, effectively reducing the percentage covered by the panels.

As the total size of the catchment is 1,570ha is larger than the development area, the part of the catchment potentially covered by solar panels is 30.1%.

To assess impact on site runoff, the catchments area covered by the solar panels is assumed to be 100% impervious. This assumption can be considered as very conservative, as any surface under the panels will still be allowing water to infiltrate. The resulting increase in site peak runoff shown in **Table 8** is therefore conservative as well.

Table 8 - Assessment of peak flow

Case	% covered by panels	Mainstream length (km)	Equal area slope (%)	Time of concentration ($t_{c,\ mins}$)	Runoff coefficient (C_{10})	Runoff coefficient (C_{100})	1%AEP peak flow (m^3/s)
Existing	0	6.68	0.19	258	0.7	0.84	157.6
Post development	30	6.68	0.19	258	0.73	0.88	165.6

A review of the peak flow calculations indicates an increase of 7.9 m³/s. This is approximately 1.2% of the 1% AEP peak flow of 676 m³/s in Oaky creek, as shown in **Table 5**. It must be noted that the development area is approximately 10 times smaller than the Oaky Creek catchment, and is expected to generate a peak outflow well before the peak flow in Oaky Creek arrives at the site. As a result, any additional flow of the site to the peak flow in Oaky Creek is expected to be less than 1.2%.

Therefore, changes to the stormwater runoff from the development site are not expected to have any significant impact in the receiving environment.

3.5 Response to Specific Outcomes and Acceptable Solutions

Table 9 below addresses the relevant items in the Burdekin Shire Planning Scheme in relation to the proposed development. The development complies with all of the eights specific outcomes relating to stormwater.

Table 9 – Response to Specific Outcomes and Acceptable Solutions

Specific outcome / acceptable solution	Specific outcome	Acceptable solution	Proposed development complies	Comment
O13 / S13	Development on land within 100m of a waterway protects the habitat and biodiversity values of the waterway.	Riparian vegetation is retained and/or rehabilitated along each side of a waterway, within at least: a) 50m of each high bank of a river; and b) 25m of each bank of a creek or stream.	Yes	The proposed development is located more than 50m of each high bank of a river; and more than 25m of each bank of a creek or stream.
O14 / S14	Wetlands are adequately protected from the impacts of adjacent development.	Wetlands are adequately protected from the impacts of adjacent development.	Yes	No negative impact is expected on any wetlands as the site drains into Oaky Creek, and any increase in peak flow is expected to have no significant impact on water levels and velocities in the creek.
O17 / S17	All activities maintain the water quality of Burdekin Shire's	Premises: a) with activities which involve the handling of water-borne pollutants are provided with bunded,	Yes	a) Any hazardous substances on site will be stored on bunded and impervious locations, above the 1%AEP flood level b) These substances will be stored in properly

Specific outcome / acceptable solution	Specific outcome	Acceptable solution	Proposed development complies	Comment
	groundwater, waterways and surface water storages.	impervious surfaces linked to an integrated drainage and treatment system; b) with activities which involve the storage of waste water are provided with properly designed and constructed, secure, sealed storage facilities; and c) contain all liquid wastes and discharge them to a sewer or removed from the site for treatment and disposal to an approved facility.		designed and constructed, secure, sealed storage facilities; and c) Hazardous liquid waste will be removed from the site for treatment and disposal to an approved facility.
		Development is set back: - 25 metres for stream orders 1 or 2; - 50 metres for stream orders 3 or 4; - 100 metres for stream orders 5 or greater With stream orders determined by 1:100,000 DNRM topographic mapping (or 1:250,000 where 1:100,000 is unavailable).	Yes	The proposed development is set back a minimum of 25 metres from any mapped creek or river.
O18 / S18	Development has adequate provision for managing stormwater, to ensure that the environmental values of the surface and ground water resources are not diminished.	Premises have: a) adequate physical measures for intercepting and treating surface water drainage and spilled substances prior to their release to the waterway; b) bunding of sites or areas within sites or integrated drainage systems which include waste water treatment measures, where chemicals, fuels, lubricants and other soluble pollutants are being handled on site; and c) discharges to surface waterways meet ANZECC guideline standards.	Yes	a) Any hazardous substances on site will be stored on bunded and impervious locations, above the 1%AEP flood level b) These substances will be stored in properly designed and constructed, secure, sealed storage facilities; and c) Any stormwater from the site is expected to meet ANZECC guideline standards
O19 / S19	Development minimises erosion occurring on the site and sediments leaving the site.	Development incorporates soil erosion and sedimentation management by: a) avoiding extensive land clearing and earthworks of land with a slope steeper than 15%; b) minimising the extent of disturbance on slopes steeper than 10% (1:10);	Yes	d) The prosed development is on land with a slope in the order of 0.1% to 0.25%. e) No significant earthworks are proposed for the development. Hence, it is not expected to change the flow paths on site. f) During construction and decommissioning, and at times when ground cover has not yet been established, sediment traps will be installed and maintained regularly.

Specific outcome / acceptable solution	Specific outcome	Acceptable solution	Proposed development complies	Comment
		c) managing and controlling surface drainage by using natural flow paths where ever possible; and d) incorporating sediment traps to prevent the movement of sediment off site.		g) No increase in pollutants (incl. sediment) is expected during the operational phase if perennial groundcover is maintained at 70% or greater. h) Given the cover and low slope of the land, treatment and/or detention of stormwater for the removal of sediments and gross pollutants prior to the release to the environment is not considered necessary.
O20 / S20	All premises make adequate provision for stormwater and liquid wastes to be managed so that the: a) environmental values of surface and ground water resources are not diminished; and b) the health and well being of the Shire's inhabitants are maintained.	All liquid wastes are contained and discharged to a sewer or removed from the site for treatment and disposal to an approved facility.	Yes	Hazardous liquid waste will be either treated on-site (effluent disposal and treatment system) or removed from the site for treatment and disposal to an ap-proved facility.
O21 / S21	Site drainage is detained and treated for the removal of sediments and gross pollutants prior to the release to the environment.	Sealed impervious areas are provided with receptors for spills and contamination to be treated or removed off-site.	Yes	The storage and handling of hazardous materials will occur in bunded areas, away from natural drainage lines.
O22 / S22	Soluble and insoluble pollutants do not flow to the environment either by stormwater flows or inadequate liquid waste management.	Stormwater drainage from a high frequency storm event over the site is treated for the removal of sediments, gross particulates and oil residues prior to release to an approved point of discharge.	Yes	During construction and decommissioning, and at times when ground cover has not yet been established, best practice erosion and sediment controls will be implemented and maintained. During operation, after sufficient permanent ground cover with perennial vegetation has been established, no increase in runoff in gross pollutants and sediments is expected.

4. Conclusion

Pacific Hydro proposes to construct a Solar Farm with a capacity of up to 500 MW in the Burdekin Shire Council area, adjacent to the Haughton River, Piccaninny Creek and Oaky Creek. Within a site area, a smaller development area has been identified by Pacific Hydro, based on assessment of sensitive environmental areas with native vegetation, and land more likely to be flood affected. This study investigates the potential impacts of stormwater discharges from the project on surface water quality and quantity from a range of activities during the construction, operation and decommissioning phases.

This study concludes that the impacts associated with the project could be appropriately managed by implementing a range of mitigation measures during the various phases of the project. The proposed development meets the four main land and catchment management targets, relating to best practice land management, ground cover, protection of the riparian vegetation, and protection of natural wetlands.

Any increase in water level or velocity external to the site due to obstruction of flow or increase in runoff is not expected to have a significant impact on the receiving environment.

5. References

Burdekin Shire Planning Scheme – March 2011

Community Draft Environmental Values for the waters of the Burdekin Dry Tropics region (NQ Dry Tropics June 2013)

Water Quality Improvement Plan (NQ Dry Tropics December 2016a)

Burdekin Water Quality Improvement Plan (NQ Dry Tropics June 2009)

Lower Burdekin Catchment factsheet (NQ Dry Tropics December 2016b)

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2016, Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia

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