

Environmental Risk Assessment

Belyuen Waste Stabilisation Ponds 2023

Document History

Document Title: Environmental Risk Assessment 2023 - Remote Community Waste Discharge Licences – Belyuen Waste Discharge Licence 215-02			
TRIM Container:		F2016/797	Document # D2023/1315548
Version:	Date Prepared:	Prepared by:	Version reviewed by/Issued to:
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Final 1.0	30/08/2017	Remote Water Planning	Department of Environment and Natural Resources Northern Territory Government waste@nt.gov.au
Draft 0.2	15/03/2021	Emma Fakes Power and Water Corporation	Simon Ruckenstuhl & Jessica Huxley Power and Water Corporation
Final 2.0	13/04/2021	Remote Water Planning	Department of Environment, Parks and Water Security Northern Territory Government waste@nt.gov.au
Draft 0.3	22/03/2023	Lenin Villamar & Oliver Crick Power & Water Corporation	Tahlia Kemp Power and Water Corporation
Final 3.0	20/04/2023	Oliver Crick Power and Water Corporation	Department of Environment and Natural Resources Northern Territory Government

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Glossary

Abbreviation	Explanation
ANZECC	Australian Water Quality Guidelines for Fresh and Marine Waters
ARMCANZ	Agriculture and Resources Management Council of Australia and New Zealand
Assessment end-points	The explicit expressions of the actual environmental value that is to be protected, operationally defined by an ecological entity and its attributes.
BOD	Biochemical oxygen demand
BUD	Beneficial Use Declaration – the uses of water specified in subsection 3 of the <i>Water Act</i> (1992)
BOM	Bureau of Meteorology
CSM	Conceptual site model
Cultural values	To provide water to meet aesthetic, recreational and cultural needs.
d	Day
DEPWS	Department of Environment, Parks and Water Security (NT)
DO	Dissolved oxygen
<i>E. coli</i>	<i>Escherichia coli</i>
Environmental Values	To provide water to maintain the health of aquatic ecosystems.
EPBC	Environment Protection and Biodiversity Conservation Act
ERA	Environmental risk assessment
ET	Equivalent Tenement – an average residential dwelling or house. Other developments are converted to an ET value by relating their average water demand (or sewage flow) to demand from one average house.
ICEGs	Indigenous Community Engineering Guidelines
kL	Kilolitre
Km	Kilometre
L	Litre
m	Metre
m²	Square metre
Macrotidal estuary	Estuaries where the tidal range is in excess of 4 metres.
mg	Milligram
mL	Millilitre
N/A	Not applicable

N/C	Normally closed
NOx	Nitrogen oxides – the sum of nitrate and nitrite ionic species.
NT	Northern Territory
NTU	Nephelometric turbidity units
NT EPA	Northern Territory Environmental Protection Authority
PL	Primary lagoon
PWC	Power and Water Corporation previously Power and Water Authority (PAWA)
%	Per cent
Risk characterisation	The culmination of the planning, problem formulation and analysis of predicted or observed adverse ecological effects related to the assessment end-points.
Risk hypothesis	Assumptions made in order to evaluate logical or empirical consequences, or suppositions tentatively accepted to provide a basis for evaluation. They are used to test if an activity (e.g. contaminant discharges) has adverse effects on an assessment end-point.
s	Second
SL	Secondary lagoon
SOCs	Site of conservation significance
SPS(s)	Sewage pump station(s)
SS / TSS	Suspended solids / total suspended solids
TDS	Total dissolved solids – the portion of solids in wastewater that passes through a 2.0 micron filter.
TN	Total nitrogen
TP	Total phosphorous
TPWC	Territory Parks and Wildlife Conservation Act
WDL(s)	Waste discharge licence(s)
WwTP(s)	Wastewater treatment plant(s). All facilities that treat wastewater disposed of to the sewerage system consisting primarily of sewage as well as stormwater inflow and infiltration. These facilities may include a range of different types of treatment technologies e.g. waste stabilisation ponds.

Note: Not all abbreviations may be used in this document

Executive Summary

This desktop environmental risk assessment (ERA) provides an assessment of the risks associated with the discharge of secondary treated effluent from the Belyuen wastewater treatment plant (WwTP) to Woods Inlet.

Based on this ERA and water quality data, there is limited evidence to suggest deleterious impacts to the beneficial uses and environmental values identified for this receiving environment.

Risks to the assessment end-points, associated with the source, were assessed as having low to high risk rankings. These rankings were associated with the very low discharge volumes into a macro-tidal estuary with minimal flushing constraints, while higher risk rankings were associated with impacts to cultural values including human health risks through primary and secondary contact and aquatic food safety.

The risk rankings may change as uncertainties associated with current assessments are addressed. A range of recommendations have been made in this risk assessment to address knowledge gaps and identify opportunities for improvement.

Introduction

PWC operate the Belyuen WwTP pursuant to Waste Discharge Licence (WDL) 215-02 issued on 12th July 2021. This WDL allows for continuous discharge of secondary treated sewage effluent from an authorised discharge point to Woods Inlet in the Darwin Harbour.

Belyuen (Delissaville) is located on the eastern side of Cox Peninsula approximately 20 km south of Mandorah (Figure 1, Figure 2). Belyuen has an estimated population of 175 in 2023 (BushTel 2023).

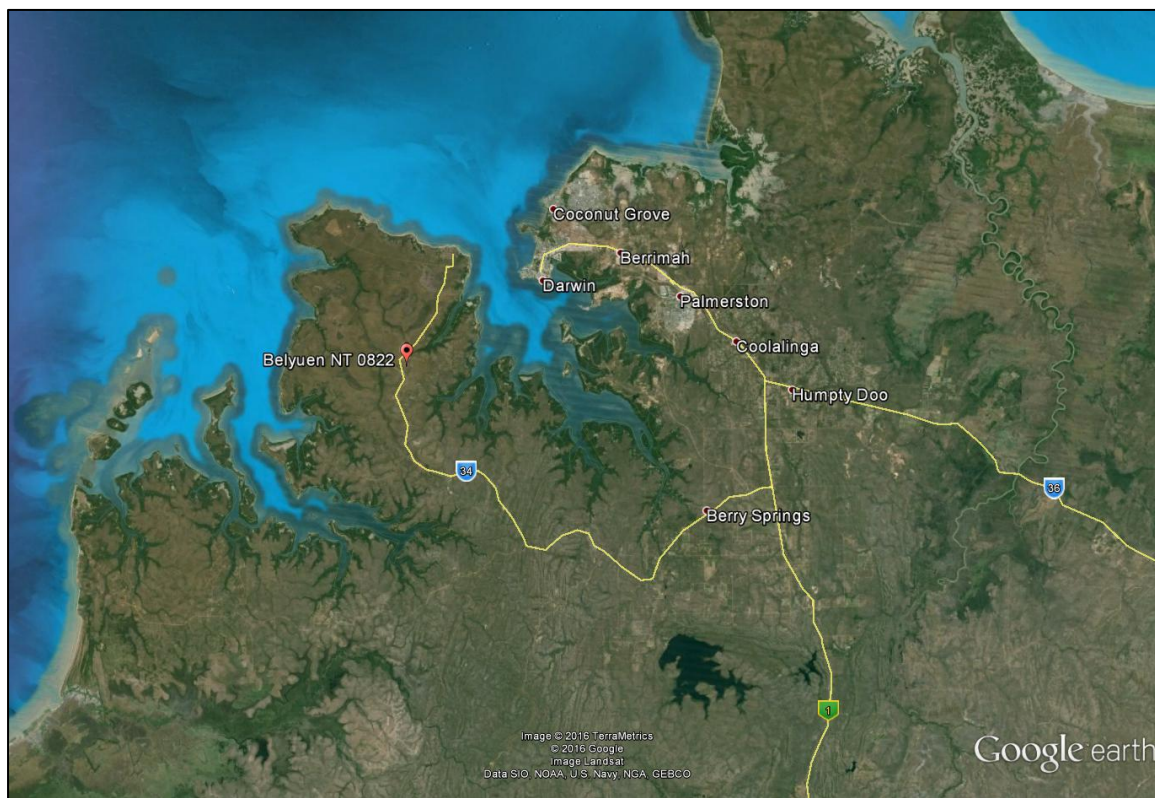


Figure 1. Belyuen locality map (Google Earth 2016)



Figure 2. Belyuen site layout including WwTP and outfall location (NT ILIS 2016)

Background

Condition 29 of this WDL requires PWC to update the environmental risk assessment for the licensed activity and submit to the Northern Territory Environment Protection Authority (NT EPA).

Condition 29 of the WDLs specifies that the Environmental Risk Assessment must:

- 29.1. be conducted in reference to a conceptual site model;
- 29.2. characterise the impacts of discharge(s) on the relevant Environmental Values;
- 29.3. inform the development of the Performance Improvement Plan; and
- 29.4. be submitted to the Adminstrating Agency at least sixty business days prior to the end date of this licence, with the understanding that the Adminstrating Agency may require the licensee to revise, amend and/or resubmit the proposed assessment.

Purpose of the desktop ERA:

- identify assessment end-points;
- characterise environmental risks associated with the facility; and
- Initiate an ongoing iterative environmental risk process associated with ongoing operation of the facility.

Risk Assessment Methodology

The methodology employed has been adapted from ERAs completed by the PWC Water Quality team and the Victorian EPA *Guidelines for Risk Assessment of Wastewater Discharges to Waterways* ('the guidelines') (VIC EPA 2009). The guidelines utilise a framework (

Figure 3) consistent with nationally and internationally accepted risk assessment frameworks by the Australian and New Zealand Environment and Conservation Council and Agriculture and Resources Management Council of Australia and New Zealand (2000).

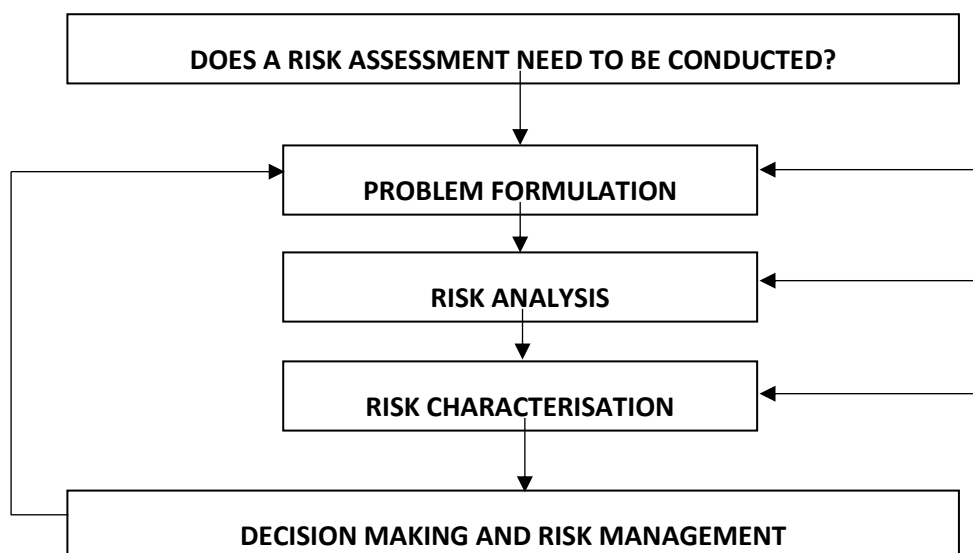


Figure 3. Risk assessment framework for wastewater discharges to waterways (Victoria EPA 2000)

Limitations

The following items have been identified as limitations associated with the preparation of this ERA:

- limited availability of inflow/outflow data;
- use of estimated inputs used in pond performance modelling;
- remoteness of communities impacting on the ability to understand systems due to costs, logistics and available expertise; and
- limited access to pond discharge points and surrounding environment due to climatic, safety and geographic factors.

Problem Formulation

The purpose of this ERA is to characterise the impacts of discharge on the relevant values and has been prepared with reference to section 1.1.

This problem is explored through the following:

- characterisation of the treated effluent discharged to the receiving environment;
- characterisation of the treated effluent discharge regime and subsequent dilution of treated effluent within receiving water; and
- identified values of receiving water and assessment end-points representative of those values.

Belyuen Wastewater Treatment Plant

The community utilises a gravity fed sewer reticulation system which drains raw sewage from the community to the WwTP (Figure 4.). The Belyuen WwTP utilises waste stabilisation pond technology and ultraviolet disinfection to achieve secondary level treatment of sewage effluent. Based on current circumstances, the raw sewage is almost entirely domestic in nature with no chemicals added during the treatment process. The WwTP was constructed in January 1981 (PWC 2021a), and consists of a primary facultative pond which gravity feeds into a secondary maturation pond.

There is no gross pollutant screening, grit removal, maceration or storm flow separation located on the inlet to the pond system. The majority of the removal process for gross pollutants and other entrained materials involves settling out to sludge layers or entrapment in concentrated surface scums that can be physically removed. Desludging of the WSP is conducted periodically to remove accumulated solids and increase hydraulic performance, which may result in improved treatment performance. Desludging was recently completed at Belyuen in 2015.

Prior to 2016, no regular wastewater monitoring was undertaken at the site. Regular wastewater monitoring commenced in March 2016, consistent with WDL 215. Samples of the secondary pond outlet are currently collected on a monthly basis. Monitoring results are included in the *PWC Annual Monitoring Report – Remote Community Waste Discharge Licences*, a summary is provided in Appendix F, Table 9.

Surface water monitoring commenced at Woods Inlet in 2019, consistent with WDL215-01 downstream from the Belyuen WwTP authorised discharge point. An assessment table of the surface water monitoring results against the *Water Quality Objectives for the Darwin Harbour Region* has been included in Appendix G, Table 10.

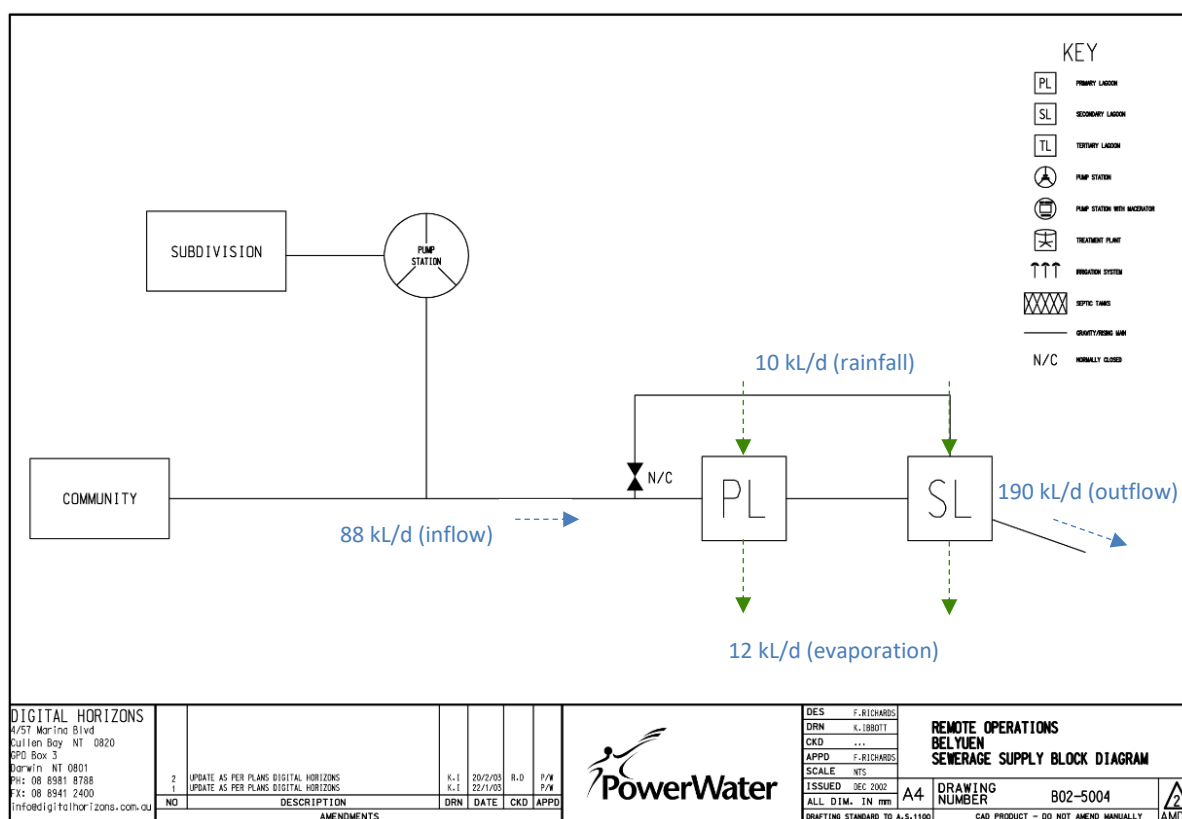


Figure 4. Belyuen wastewater collection and treatment configuration including modelled mean flow rates

Discharge Regime

Discharge from the facility occurs from a discharge pipe located in the secondary maturation pond. Discharge is continuous on an as-required basis and occurs directly into a brackish estuary (Woods Inlet). The discharge outfall from the secondary maturation pond is approximately 60 m in length and the outlet is located at the creek bank.

During the 2019 and 2020 dry seasons, it was observed that the Belyuen WwTP ceased discharging to the receiving environment, from approximately July to January in both years seen in Figure 5 and Figure 6 (PWC 2021b). Following the installation of an outflow meter this seasonal outflow can be confirmed; there was no outflow between the 25/06/2022 & 26/11/2022.



Figure 5. No discharge occurring to the receiving environment – Dry Season 2019 (PWC 2019)



Figure 6. No discharge occurring to the receiving environment – Dry Season 2020 (PWC 2020)

The annual water balance is estimated based on forecast sewage Equivalent Tenement (ET) flow, estimated total sewer ET, rainfall, evaporation and pond area (Appendix D, Table 7). It is estimated that the mean daily inflow of untreated wastewater into the WwTP is 88 kL/day. This is supplemented by an average daily rainfall contribution of 10 kL/d and reduction due to evaporation of 12 kL/d giving the total mean outflow of 190 kL/day.

Note that the volume of treated wastewater discharged to the environment varies seasonally with changes in evaporation and rainfall. During the wet season, substantial infiltration of water into the gravity sewer network occurs. Due to the constraints of quantifying this volume and a negligible associated pollutant load, it is not included within the flow rate calculations.

Pond Performance

In the past, a model based prediction of the Belyuen WwTP performance was undertaken by Louey-Gung (2011) utilising industry standard design models. The model utilised various pond parameters to predict treated wastewater quality using mean biochemical oxygen demand (BOD) removal performance and mean predicted *E.coli* disinfection performance. This model was utilised in absence of *in-situ* wastewater monitoring data.

The modelled water quality results at the pond outlet for mean BOD removal and *E.coli* disinfection were 70 mg/L (65% removal) and 1,740/100 mL (3.5 log removal) respectively (modelled data used as pond performance indicator only).

In 2019, Power and Water implemented monthly wastewater monitoring of the WwTP discharge, which provides a characterisation of the treated effluent discharged to the receiving environment.

The median *in-situ* water quality results for BOD and *E. coli* were 12.5 mg/L and 6,200/100mL respectively; which are relatively consistent with modelled water quality results utilised to assess pond performance. Additional monitoring at the primary pond inlet is required to accurately verify pond performance.

Power and Water have increased wastewater monitoring at a number of remote communities in 2020, however inlet monitoring has yet to be conducted at Belyuen WwTP due to restricted funding under Indigenous Essential Services (IES). For the purpose of this risk assessment, *in-situ* monitoring data are illustrated on the conceptual site model (CSM) (Appendix A,

Figure 14).

Receiving Environment

Woods Inlet is a tidal brackish creek 7.72 km long (Geoscience Australia 2009), within the Darwin Harbour macro-tidal estuary. The creek also receives water from a sandstone aquifer spring seen in

Figure 7 (Tien 2006) and the discharge enters the creek approximately 1 km downstream of the spring seen in

Figure 8.



Figure 7. Upstream spring (PWC 2016)



Figure 8. Belyuen WwTP discharge outlet (PWC 2016)

Woods Inlet is considered an upper estuary water type within the Darwin Harbour Region (Fortune 2015). The nature of the system consists of an extensive mangrove habitat and inter-tidal mudflats and is considered to have minimal pollution. The receiving environment downstream from the WwTP at the surface water monitoring point can be seen in Figure 9 and Figure 10 below. As there is

minimal development in this region and it is the most remote from development impacts within the harbour, it is considered a pristine receiving environment (PWC 2010). Monitoring data by the Department of Environment, Parks and Water Security (DEPWS) from the Woods Inlet is reported within the zone “West Arm and Woods Inlet” under the Darwin Harbour Report Card (DEPWS 2021). Within this sampling zone, three of 22 sampling points are located in Woods Inlet with the closest point approximately 3 km downstream of the discharge point (Appendix B, Figure 15). In the period of 2009 – 2019, Woods Inlet achieved compliance with all indicators indicating excellent marine water quality (DEPWS 2021; Fortune 2015). In the 2015 report card, Woods Inlet achieved compliance with all but the parameter of water clarity indicating very good marine water quality. Windy weather conditions during the Dry Season are believed to have influenced this zone of the harbour, stimulating more turbid conditions during sampling (Fortune 2016).



Figure 9. Woods Inlet receiving environment sampling site (SBLEP01), indicated with red circle - January 2020 (TWS 2020)



Figure 10. Woods Inlet receiving environment, downstream (left) and upstream (right) of the sampling site (SBLEP01) – January 2021 (TWS 2021)

Woods Inlet is located within the boundaries of the Darwin Harbour site of conservation significance (SOCS) number six (Appendix C, Figure 16). Darwin Harbour is a nationally significant wetland listed in the Federal Directory of Important Wetlands in Australia with 15 threatened species reported from within this SOCS. The conservation status for these species listed under the Territory Parks and Wildlife Conservation Act 2000 (TPWC) and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC) are summarised below in Table 1.

Table 1. Conservation status of species within Darwin Harbour SOCS

Common name	Species name	National Status (EPBC)	NT Status (TPWC)
Cycad	<i>Cycas armstrongii</i>	-	VU
Bladderwort	<i>Utricularia singeriana</i>	-	VU
Australian Bustard	<i>Ardeotis australis</i>	-	VU
Christmas Frigatebird	<i>Fregata andrewsi</i>	VU	-
Gouldian Finch	<i>Erythrura gouldiae</i>	EN	EN
Masked Owl	<i>Tyto novaehollandiae kimberli</i>	VU	VU
Partridge Pigeon	<i>Geophaps smithii</i>	VU	VU
Red Goshawk	<i>Erythrotriorchis radiatus</i>	VU	VU
Northern Quoll	<i>Dasyurus hallucatus</i>	EN	CR
Merten's Water Monitor	<i>Varanus mertensi</i>	-	VU
Yellow-spotted Monitor	<i>Varanus panoptes</i>	-	VU
Flatback Turtle	<i>Natator depressus</i>	VU	-
Green Turtle	<i>Chelonia mydas</i>	VU	LC
Hawksbill Turtle	<i>Eretmochelys imbricata</i>	VU	-
Atlas Moth	<i>Attacus wardi</i>	-	EN
CR – Critically Endangered, EN – Endangered, VU – Vulnerable			

The structural features of the mangrove communities in the Woods Inlet is typical for that of Darwin Harbour and is described schematically by Metcalfe (2007) in Figure 11. The inlet features pronounced shoreline zonation with assemblages developed on frequency and extent of tidal inundation (Metcalfe 2007, PWC 2015a, PWC 2015b). Woods Inlet is dominated by the tidal creek mangrove *Rhizophora stylosa* and *Camptostemon schultzei* (Figure 12). Sparse patches of open forest (*Avicennia marina*/ *Ceriops tagal*) and shoreline forest (*Rhizophora stylosa*) can also be found along the inlet. Behind the tidal creek communities are the *Ceriops tagal* mid tidal flat communities and mixed species hinterland communities (PWC 2015a, PWC 2015b).

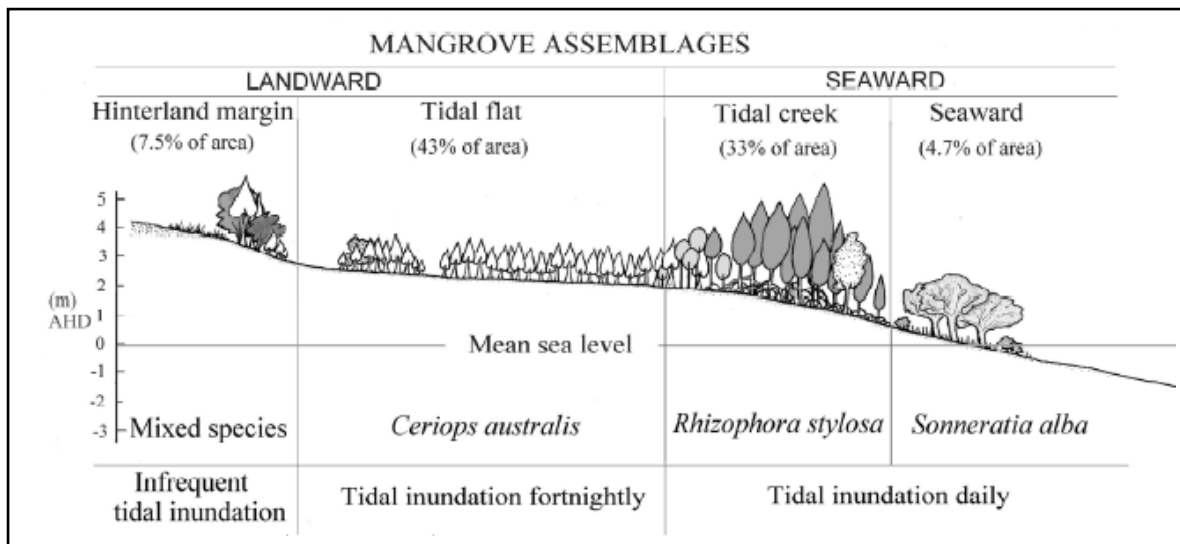


Figure 11. Landward to seaward mangrove community assemblages of Darwin Harbour (Metcalfe 2007)

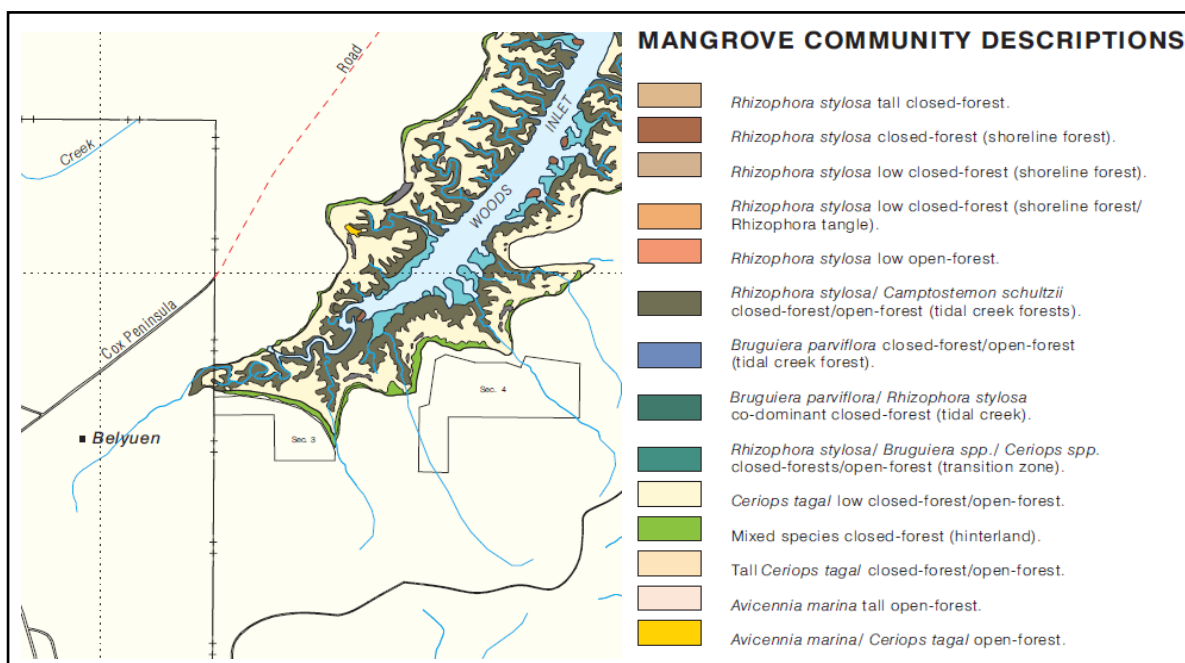


Figure 12. Mangrove communities in Woods Inlet Map Sheet 5027-4 (DLPE 2002)

Screening Level Risk Assessment

A screening level risk assessment is used to determine if a risk to the assessment end-point exists that should be further investigated. It is a method for prioritising risks and minimising effort in assessing low risks. Table 3 provides a summary of the screening level risk assessment.

Risk hypotheses for the stressors identified in the conceptual site model (CSM) (Appendix A,

Figure 14) are defined with respect to their potential effects on the identified beneficial uses of the receiving environment.

The identified beneficial uses of the receiving environment are summarised below in Table 2.

Table 2. Beneficial uses of the Darwin Harbour (Gazette No. G37 11 September 1996) at risk from the Belyuen WwTP

Beneficial Use		Receptors	Values
Cultural	Recreational Water Quality	Humans	Fishing Swimming/Wading Shellfish harvesting
Cultural	Aesthetics	Humans	Visible water quality
Environment	Aquatic Ecosystem Protection	Invertebrates	Water insects
		Fish	Barramundi
		Wildlife	Crocodiles Wallabies
		Plants	Mangroves Eucalyptus

Table 3. Screening level risk assessment for key indicators and stressors associated with Belyuen WwTP discharge

Indicator (water quality parameter)	Stressor (change to indicator)	Risk Hypothesis		Assessment end-points		Scope of this desktop ERA	Further investigation required?
		ENVIRONMENTAL	CULTURAL	ENVIRONMENTAL	CULTURAL		
Gross pollutants	Presence and accumulation of gross pollutants from influent carried through to effluent	That gross and micro-scale pollutants are ingested by biota resulting in death of animals and environmental degradation.	That gross pollutants are resulting in the reduction of visual amenity in the receiving environment.	To maintain the presence of biota in the environment.	To maintain the visual amenity of the environment.	The WwTP is considered a relatively effective barrier to gross pollutant entry to the receiving environment. This is due to the settling out to sludge layers and accumulation on pond surface where gross pollutants are physically removed as required. No evidence of gross pollutant accumulation during visual monitoring of discharge site (qualitative discharge criteria). No further investigation necessary at this stage.	No
Organic matter	Increase in BOD, decrease in DO	That BOD is leading to oxygen depletion in the environment resulting in loss of biota (e.g. fish kills) and changes to ecosystem structure.	That BOD is leading to odours resulting in the reduction of amenity in the receiving environment.	To maintain the presence of biota in the environment.	To maintain oxygen levels in the environment sufficient to prevent production of odours.	The median concentration of BOD in the discharge of Belyuen WwTP between 01/2020 & 01/2023 is 12.5 mg/L. As BOD is present in the discharge, it is determined at a screening level that a risk is present and further investigation is necessary.	Yes
Nutrients (nitrogen and phosphorus)	Increase in nutrient concentrations	That nutrients are leading to nuisance plant growth (e.g. phytoplankton blooms) resulting in oxygen depletion; displacement of endemic species; diminished light availability; release of toxins; and changes to ecosystem structure.	That nutrients are resulting in the reduction of amenity of receiving environment through reduction in water clarity, objectionable discolouration and odours; toxic blooms that are a public health risk; and blooms of toxin producing species whereby the toxins bio-accumulate in shellfish and fish ingested by humans.	To maintain nutrient levels so that the levels of primary production do not have an adverse impact on ecosystem structure.	To maintain the amenity of the environment.	As nutrients are present in the discharge, it is determined at a screening level that a risk is present and further investigation is necessary.	Yes
Toxicants	Increase in free ammonia concentration	That free ammonia is resulting in toxicity to aquatic organisms in water and sediments.		To maintain the presence of biota in the environment.		The average concentration of free ammonia in the discharge of Belyuen WwTP between 01/2020 & 01/2023 is 4.74 mg/L. At a screening level it is determined that a risk is present and further investigation is necessary.	Yes
Pathogens	Presence of <i>E.Coli</i>		That pathogens are leading to the contamination of water resulting in primary and secondary contact recreation a public health risk; and accumulation in shellfish resulting in the consumption of shellfish a public health risk.		To maintain that pathogens from municipal wastewater are not increasing the risk of illness via primary and secondary contact recreation and consumption of shellfish.	The median pathogen concentration in the discharge of Belyuen WwTP between 01/2020 & 01/2023 is 6,200 mpn /100mL. At a screening level it is determined that a risk is present and further investigation is necessary.	Yes

Risk Analysis and Characterisation

Power and Water Risk Management Framework

PWC has adopted a qualitative risk assessment methodology aligned to the Australia/New Zealand Standard “AS/NZ 4360: Risk Management” (PWC, 2009). This process is used to assess and manage activities that have potential to cause environmental harm.

The first step in the ERA process is to identify the aspects (problem formulation i.e. discharge of treated wastewater) (section 2.0) and corresponding potential impacts associated with each assessment end-point identified in the screening level risk assessment as seen in Table 3.

This methodology is based on knowledge of the existing environment and incorporates site-specific environmental factors into the analysis of the potential impacts. An assessment of each impact is analysed for likelihood and consequence.

The categories and associated rankings for environmental impact consequences are shown in Table 4 and the likelihood of an event occurring are shown in Table 5. A risk score for each potential impact is determined by combining likelihood with consequence results as seen in **Error! Reference source not found.**

Low to medium risks can typically be managed by routine procedures and integration into management plans, while high to extreme risks require senior management attention, immediate action or more detailed research and management planning.

Table 4. PWC corporate risk ranking consequence table

	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Severe (5)
Health & Safety	Minor event with or without injury; and/or No on-going impact to health.	Injuries requiring first aid treatment; and/or Minor short term inconvenience.	Medical Treated injury; and/or Short term reversible disabling effect to human health; and/or Lost Time Injury <1 week lost.	Hospitalisation; and/or Injuries resulting in Lost Time Injury > 1 week lost; and/or Long term (chronic) chemical health exceedance or short term chemical exceedance of chemical with acute health impacts; and/or Long term aesthetic exceedance with health impact on supply.	One or more fatalities; and/or One or more persons seriously injured (includes long term disabling effect); and/or Widespread release of untreated water (eg due to disinfection failure).
Financial (impact on EBITDA)	Loss less than \$500K.	Impact between \$500K and \$2M.	Impact between \$2m and \$10m.	Impact between \$10m and \$40m.	Impact greater than \$40m.
Legal/ Regulation	Legal issues managed by corporate procedures or practices; and/or Breach of internal policies or procedures without the need for formal investigation.	Matter requires legal advice to address issues; and/or Internal breach of policies or procedures requiring a formal investigation.	Required to operate under limited regulatory restrictions or orders; and/or Incident which requires legal representation resulting in court proceeding.	Required to operate under significant regulatory restrictions or orders; and/or Government inquiry/ intervention.	Criminal charges / civil litigation against the Corporation and/or Officers; and/or Operating licences revoked.
Environmental	Localised low level damage controlled but no remedial action required.	Localised low level damage controlled and remedied with minimal resources.	Widespread temporary damage with extended resources to remedy.	Long-term detrimental effect on environment and once controlled results in minor permanent damage.	Substantial permanent damage to widespread and sensitive areas.
Service Delivery (external customers only)	Category 1 loss of service (refer to Appendix C of this document)	Category 2 loss of service (refer to Appendix C of this document)	Category 3 loss of service (refer to Appendix C of this document)	Category 4 loss of service (refer to Appendix C of this document)	Category 5 loss of service (refer to Appendix C of this document)
Reputation	No media attention; and/or Isolated community or individual issue-based concern; and/or Localised dissatisfaction which is managed by normal business processes; and/or Short term aesthetic exceedance.	Occasional once-off negative media attention; and/or Localised community impacts and customer concerns; and/or Localised staff dissatisfaction which requires Human Resources in resolution; and/or Long term aesthetic exceedance.	Brief adverse media attention and/or community/customer condemnation (days); and/or Limited, localized loss of confidence by the community; and/or Localised staff dissatisfaction with localised impacts to service deliver and/or Short term chemical health exceedance.	Prolonged adverse media attention and/or community/customer condemnation (weeks); and/or Prolonged, widespread community/ customer loss of confidence (weeks); and/or Widespread dissatisfaction and loss of confidence by staff resulting in temporary service delivery issues.	Sustained adverse media attention and/or community/customer condemnation (months); and/or Irreconcilable community/ customer loss of confidence; and/or Loss of stakeholder confidence in Board and/or Management; and/or Widespread dissatisfaction by staff resulting in sustained service delivery issues.

Table 5. PWC corporate risk ranking likelihood table

(E) Almost Certain	Event is expected to occur on a regular basis. One or more times per annum.	Not Applicable
(D) Likely	An event is expected to occur from time to time. Once every 1 – 3 years	Probability of occurring is greater than 33%
(C) Possible	An event should occur at some time. Once every 4 – 10 years.	Probability of occurring is greater than 10% and up to and including 33%
(B) Unlikely	An event could occur at some time. Once every 11 to 30 years	Probability of occurring is greater than 3% and up to and including 10%
(A) Rare	An event not expected but possible. Less than once in 30 years	Probability of occurring is up to and including 3%

		Consequence				
		Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Severe (5)
Likelihood	Almost Certain (E)	Medium	High	Very High	Extreme	Extreme
	Likely (D)	Low	Medium	High	Very High	Extreme
	Possible (C)	Low	Low	Medium	High	Very High
	Unlikely (B)	Low	Low	Medium	High	High
	Rare (A)	Low	Low	Low	Medium	Medium

Figure 13. Corporate risk matrix

Risk assessment for key indicators and stressors identified in screening level assessment

Table 6. Risk assessment for key environmental and cultural assessment end-points associated with Belyuen WwTP discharge using corporate risk ranking methodology

Hypothesis	Consequence	Likelihood	Risk Ranking
Environmental			
BOD is leading to oxygen depletion in the environment resulting in loss of biota and changes to ecosystem structure.	There is currently no BOD guideline available for brackish environments however the Darwin Harbour report card for Woods Inlet indicates compliance with DO water quality objectives (DEPWS 2021; Fortune and Patterson 2016). The estimated dilution volume ratio between effluent (187 kL) and receiving environment (at 2 km downstream) (52,749 kL) is 1:610 (Appendix E) suggesting any observed oxygen demand would be absorbed by the environment.	Based on sampling data since 2020, the median discharge BOD concentration is 12.5mg/L. These BOD concentrations are relatively consistent in comparison to concentrations at other remote communities, and is considered to be classified as low effluent strength (<40mg/L) (PWC 2020). BOD is observed to substantially reduce in concentrations from the final pond outlet to the immediate discharge point from 12.5 mg/L to 1 mg/L due to mixing and dilution within receiving waters (Table 10). No indicators of oxygen depletion within the receiving waters have been observed downstream from the WwTP during monthly site inspections – creek banks are fringed with dense living riparian vegetation, healthy small fish and crustaceans were observed living in and close to the water (TWS 2023). Stressor not typically observed with such small discharge volumes and tidal creeks. As the ponds have been observed to intermittently discharge during the wet season, any potential impacts would only be observed during this period when greater dilution from rainfall is occurring (PWC 2021b). Oxygen depletion also unlikely to be sustained as estuary is well flushed from other water inputs upstream of the discharge point.	Low
Nutrients are leading to nuisance plant growth resulting in oxygen depletion; displacement of endemic species; diminished light availability; release of toxins; and changes to ecosystem structure.	Based on WDL sampling to date, Belyuen WwTP contributes 0.52 and 0.069 tonnes/year of total nitrogen and phosphorus respectively. These inputs are dwarfed by the Woods Inlet catchment inputs of 13.6 and 0.970 tonnes (for a typical Wet Season rainfall) for total nitrogen and phosphorus respectively (Skinner, Townsend and Fortune 2009). The Darwin Harbour report card for Woods Inlet also indicates compliance with total nitrogen and total phosphorus water quality objectives ¹ (DEPWS 2021; Fortune and Patterson 2016).	The median total nitrogen (7.8 mg/L) and total phosphorus (1 mg/L) concentrations at the final pond outlet are lower in comparison to concentrations at other remote communities, and is considered to be classified as low effluent strength (<50mg/L;<10mg/L) (PWC 2020). TN and TP concentrations are substantially decreased from the final pond outlet to the immediate discharge point from 7.8 to 0.78 mg/L and from 1 to 0.04 mg/L respectively due to mixing and dilution within receiving waters (Table 10). Chlorophyll a levels have also decreased from 128 ug/L within the pond outlet to 3 within the receiving waters, demonstrating compliance with the DHWQO. No indicators of algal blooms as a result of the WwTP within the receiving waters have been observed downstream from the discharge point during monthly site inspections (TWS 2023). Impacts from excessive nutrients resulting in nuisance plant growth would be more likely during the dry season, when minimal discharge to the receiving environment is occurring (PWC 2021b). Based on the sampling results to date, PWC considers that the likelihood of nuisance plant growth in the receiving environment is unlikely.	Low

Free ammonia is resulting in toxicity to aquatic organisms in water and sediments.	The Darwin Harbour report card for Woods Inlet indicates compliance with ammonia water quality objectives ¹ (DEPWS 2021; Fortune and Patterson 2016). No fish kills reported in Woods Inlet to date.	Minor	Free ammonia concentrations at the final pond outlet is 4.74 mg/L. These ammonia concentrations are very low in comparison to concentrations at other remote communities (PWC 2020). Low pH may also be an indicator of increased ammonia toxicity (ANZECC 2000); a median pH of 6.77 at Belyuen suggests the risk of ammonia toxicity to be low. Free ammonia concentrations are substantially decreased from the final pond outlet to the immediate discharge point from 4.74 mg/L to 0.02 mg/L (Table 10). Median free ammonia levels are within the DHWQO at the receiving point. No indicators of algal blooms as a result of the WwTP within the receiving waters have been observed downstream from the discharge point during monthly site inspections (TWS 2021). Substantial dilution would occur during the wet season discharge. Stressor not typically observed with such irregular and small discharge volumes. Based on the sampling results to date, PWC considers that the likelihood of toxicity to aquatic organisms in water and sediments is unlikely.	Unlikely	Low
Cultural					
BOD is leading to odours resulting in the reduction of amenity in the receiving environment.	Access to Woods Inlet is primarily by boat. The Inlet has a designated boat ramp 2 km downstream of the discharge point. Due to the narrowing of the waterway and increase in mangrove density, upper boat access is however limited up-stream of this point (Appendix A). Terrestrial access is also limited due to the dense vegetation surrounding the discharge point.	Minor	Immediate discharge site not readily accessed and there is no evidence of human disturbance. Stressor not typically observed with such small discharge volumes. Estuary is also well flushed from spring located 1 km upstream of the discharge point. No evidence of odours during monthly site inspections (TWS 2023). BOD odours would be less of an issue during the wet season. PWC considers that the likelihood of reduction in amenity from BOD is unlikely.	Unlikely	Low
Nutrients are resulting in the reduction of amenity of receiving environment through reduction in water clarity, objectionable discolouration and odours.	Access to Woods Inlet is primarily by boat. The Inlet has a designated boat ramp 2 km downstream of the discharge point. Due to the narrowing of the waterway and increase in mangrove density, upper boat access is however limited up-stream of this point (Appendix A). Terrestrial access is also limited due to the dense vegetation surrounding the discharge point. The Darwin Harbour report card for Woods Inlet indicates compliance with water clarity water quality objectives ¹ (DEPWS 2021; Fortune and Patterson 2016).	Minor	Immediate discharge site not readily accessed and there is no evidence of human disturbance. Stressor not typically observed with such small discharge volumes. Estuary is well flushed from spring located 1 km upstream of the discharge point. No evidence of reduction in water clarity, objectionable discolouration of receiving water or odours during monthly site inspections (TWS 2023). PWC considers that the likelihood of reduction in amenity from nutrients is unlikely.	Unlikely	
Nutrients are resulting in toxic blooms that are a public health risk; and blooms of toxin producing species whereby the toxins bio-accumulate in shellfish and fish ingested by humans.	Tidal creeks not generally considered recreational water bodies due to the presence of dangerous aquatic animals (Campbell 2012). Woods Inlet however is identified as having cultural beneficial uses for primary and secondary recreation including exposure of children through exploratory wading in terrestrially accessed shallower waters near boat ramp. There is currently limited available data to indicate toxic blooms however ingestion of shellfish known to the area includes oysters, mud whelks, long bums and periwinkles (Padovan <i>et. al</i> 2013).	Major	Based on the primary and secondary contact recreation and cultural uses of Woods Inlet including exposure of children through exploratory wading in terrestrially accessed shallower waters near boat ramp, PWC considers that the likelihood of toxicant exposure is possible. Assigned likelihood is worst-case scenario based on exposure to humans and limited nutrient data.	Possible	High

Pathogens are leading to the contamination of water resulting in primary and secondary contact recreational a public health risk.	Tidal creeks not generally considered recreational water bodies due to the presence of dangerous aquatic animals (Campbell 2012). Woods Inlet however is identified as having cultural beneficial uses for primary and secondary recreation including exposure of children through exploratory wading in terrestrially accessed shallower waters near boat ramp.	Major	Median pathogen concentrations of 6,200 mpn/100mL <i>E. coli</i> within the Belyuen WwTP discharge are relatively consistent in comparison to concentrations at other remote communities (PWC 2020). Pathogen concentrations are observed to be greatly reduced from the final pond outlet to the immediate discharge point (Table 10); however levels within the receiving waters are seen as elevated against the DHWQO. Dilution of the treated effluent would occur during the wet season, reducing risk of contamination of water. Based on the primary and secondary contact recreation and cultural uses of Woods Inlet, PWC considers that the likelihood of the illness from pathogen exposure is possible. Assigned likelihood is worst-case scenario based on exposure to humans and limited localised pathogen data (Appendix B).	Possible	High
Pathogens are leading to accumulation in shellfish resulting in the consumption of shellfish a public health risk.	Collection and consumption of shellfish such as oysters, mud whelks, long bums and periwinkles is known to the area (Padovan <i>et. al</i> 2013).	Major	Based on the cultural uses of Woods Inlet, PWC considers that the likelihood of the illness from pathogen exposure through the consumption of shellfish is possible. Assigned likelihood is worst-case scenario based on exposure to humans and limited localised pathogen data.	Possible	High

¹Values are an average of three samples taken in Woods Inlet downstream of the WwTP and a further 18 sites within the West Arm reporting zone (Appendix B).

Summary and recommendations

The ERA found that the key beneficial uses and environmental values of the Woods Inlet at risk from the Belyuen WwTP discharge were recreational water quality, aesthetics and aquatic ecosystem protection.

The key stressors that posed a risk to these values were presence and accumulation of gross pollutants from influent carried through to effluent; increase in BOD; increase in nutrient concentrations; increase in free ammonia concentration and the presence of *E.Coli*.

When discharging concentrations of the key stresses have substantially decreased from the final pond outlet to the Woods Inlet sampling site downstream, suggesting mixing and dilution is occurring within the creek. Based upon continuous flow data, during the last 12 months the discharge from the Belyuen WwTP did not occur during the months of July-November, reducing concentrations of key stressors being discharged to the receiving environment. Further assessment of the surface water monitoring conducted at Woods Inlet in comparison to relevant guideline values is detailed in the Annual Monitoring Report.

The ERA process has determined that the discharge from the Belyuen WwTP poses a low to high risk to the identified beneficial uses of the receiving waterway. The influence of the intermittent discharge on the receiving environment is considered sustainable within the well-flushed macro-tidal estuary and large catchment area. Based on this ERA and water quality data, there is limited evidence to suggest deleterious impacts to the receiving environment.

All risk rankings have considerable uncertainties attached to the assessments. The risk rankings may change as uncertainties associated with current assessments are addressed.

Based on the ERA process and outcomes, PWC make the following recommendations:

- continue monitoring quality of wastewater discharged to the environment;
- conduct pond performance monitoring;
- incorporate recommendations into future Performance Improvements Plans;
- continuously monitor the volume of treated wastewater effluent discharged to the environment; and
- update the ERA and CSM based on new information and additional wastewater quality data.

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Appendix A: Belyuen conceptual site model

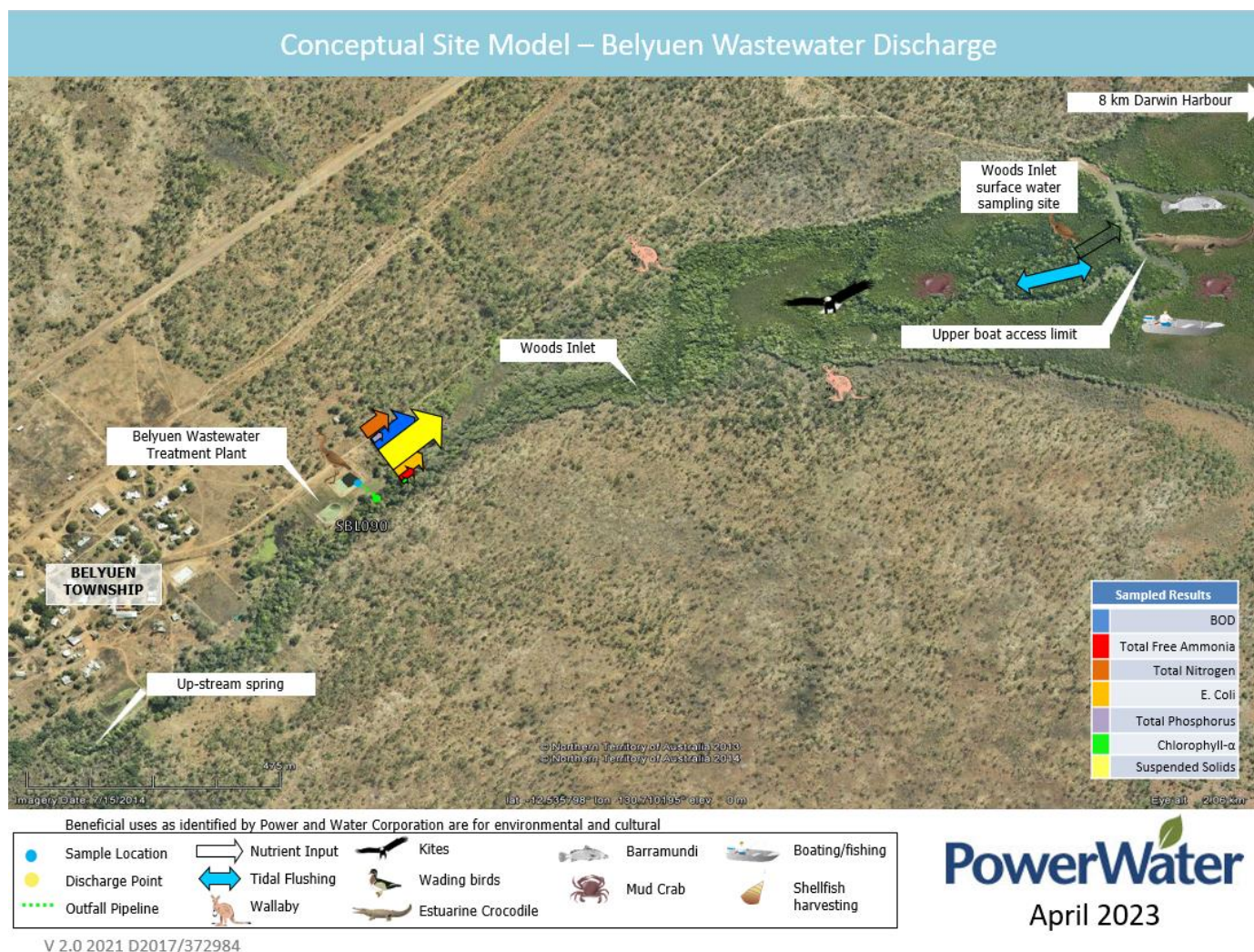


Figure 14. Conceptual site model for the Belyuen WwTP

Appendix B: West Arm and Woods Inlet reporting zone and monitoring sites

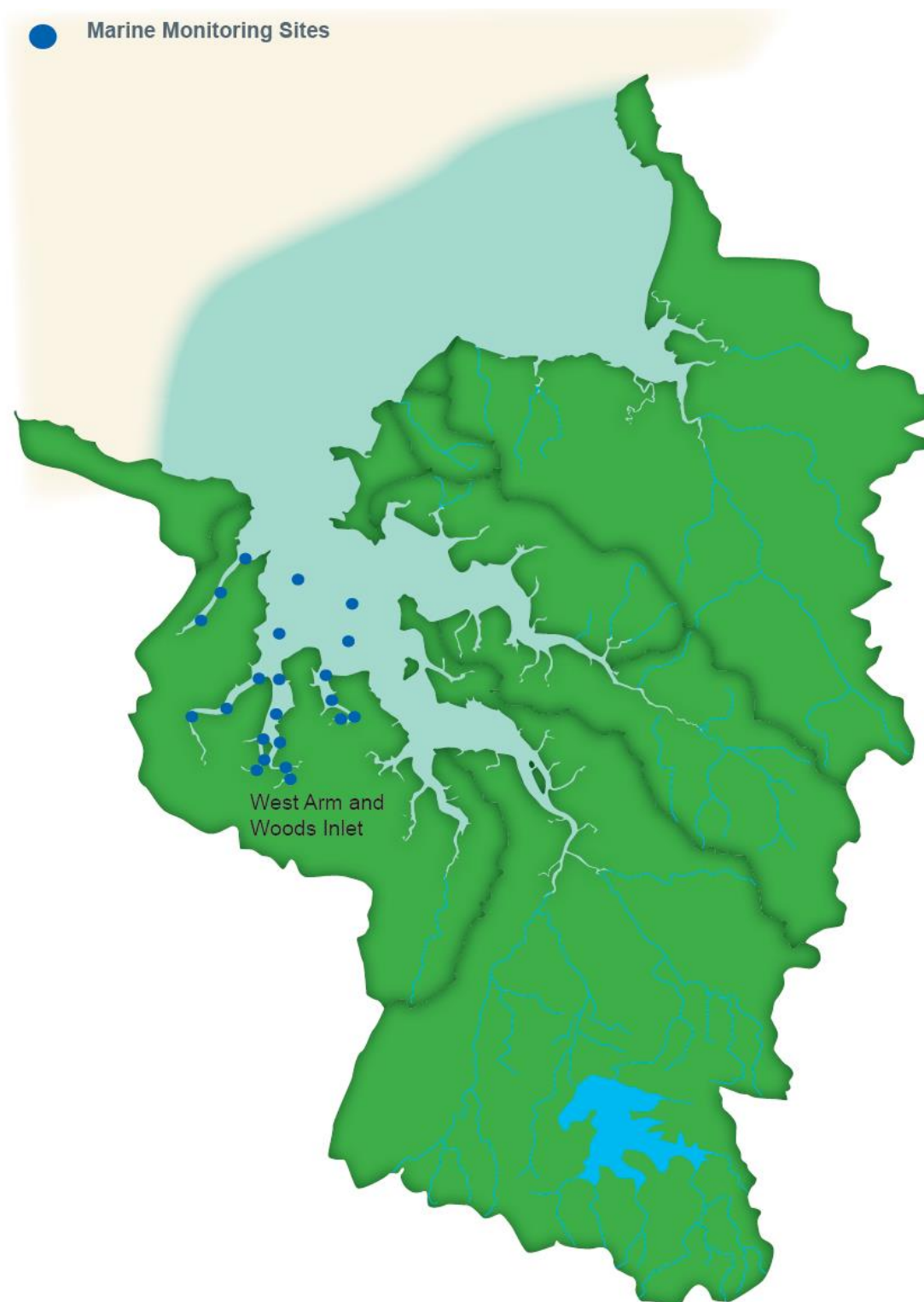


Figure 15. West Arm and Woods Inlet reporting zone and monitoring sites (DLRM 2016)

[illegible]

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Appendix D: Estimated flow rates for Belyuen WwTP

Raw wastewater flow rate is based on ICEG (2017) forecast sewage ET flow of 850 L/day and estimated total sewer ET for Belyuen of 104 (PWC 2021a). The outflow meter recently installed gives accurate outflow data as well as a better idea of the seasonal differences in outflow volumes.

Rainfall catchment estimates based on mean monthly rainfall for all available years from Bureau of Meteorology (BOM) and total pond surface area (1846 m²) (PWC 2021a). Belyuen does not currently have a weather station therefore data from the nearest weather station (station number 014238) located 12.8 km away was used.

Evaporation estimates are based on mean monthly evaporation for all available years from BOM and total pond surface.

Flow rates are summarised in the table below (Table 7).

Table 7. Estimated average annual flows

Month	Inflow kL/d	Rainfall kL/d	Evaporation kL/d	Total outflow kL/d
January	88	23	11	413
February	88	23	11	N/A
March	88	11	11	433
April	88	7	12	517
May	88	0	13	344
June	88	0.3	13	160
July	88	0	13	0
August	88	0	14	0
September	88	1	15	0
October	88	9	14	0
November	88	15	12	5
December	88	31	12	198
Mean	88	10	12	190

Appendix E: Dilution ratio for Belyuen WwTP and Woods Inlet

After leaving the outfall, treated wastewater from the site travels through an unnamed creek before entering Woods Inlet, which is estuarine in nature.

Prior to entering the estuary, limited dilution of the treated wastewater would occur during the dry season. Dilution within Woods Inlet has been calculated using the method for estimating diffusion mixing in continuous discharge to a river outlined by Metcalf and Eddy (1991). Due to the tidal nature of the estuary, a time-averaged approximation has been calculated assuming that the net advective velocity in the estuary is equal to the volumetric flowrate of the treated wastewater entering the estuary. This would be the case in the conservative scenario when no other dilution is occurring from runoff in the catchment. A typical diffusion mixing decay constant of 0.3 d^{-1} has been assumed. The locations for which dilution ratios have been calculated are shown in Figure 13. Calculated dilution ratios are tabulated in Table 8.

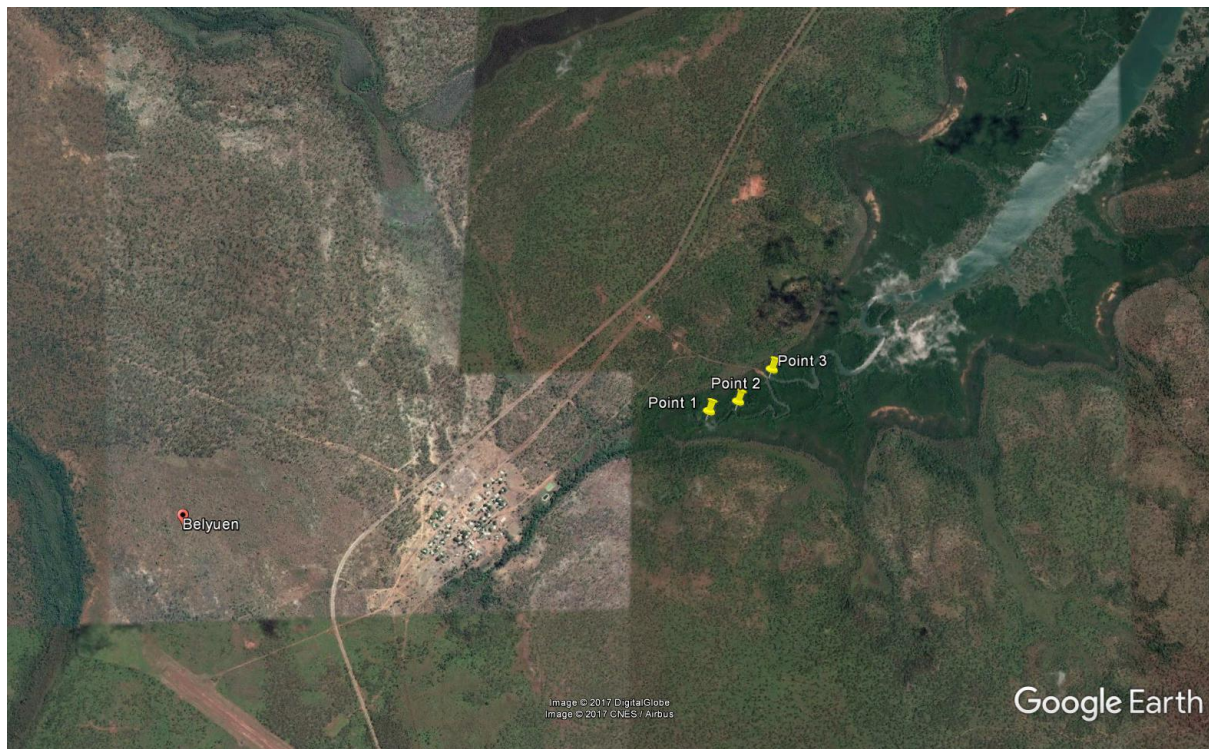


Figure 17. Woods Inlet at 300, 600 and 1500 m from discharge point (Google Earth 2017)

Table 8. Discharge volume and dilution ratio calculation

Distance from discharge point	Point 1 (300)	Point 2 (600)	Point 3 (1500) Boat Ramp
Width of estuary channel (m)	8	10	21
Estimated mean depth of channel (m)	0.5	0.75	1.0
Maximum treated wastewater flow (kL/d) ¹	190		
Net advective velocity (m/s)	2.5×10^{-4}	2.4×10^{-5}	4.7×10^{-5}
Ratio	1:33	>1:5 ⁶	>1:5 ⁶

¹ See Appendix D for discharge volume calculations.

Appendix F: Wastewater Quality Monitoring Results

Table 9. Summary of PWC wastewater quality results for Belyuen WwTP 2020-2023

Sample Location/Asset: SBR090 (Pond 5 Outlet)			
Indicator	Reporting Value		
	Median Wet Season	Median Dry Season	Median
Physio-chemical Parameters			
pH	6.02	7.05	6.77
Electrical Conductivity (uS/cm)	47	300	125
Dissolved Oxygen (% Saturation)	41.5	14	18
Turbidity (NTU)	9.45	43	23
Total Suspended Solids (mg/L)	16.5	46.5	36
Biological Parameters			
Biochemical Oxygen Demand (mg/L)	5.85	21.5	12.5
Chlorophyll-a (ug/L)	104.5	234	128.5
Nutrient Parameters			
Ammonia (Total ¹ as N – NH ₃ -N) (mg/L)	1.64	6.8	2.7
Total Nitrogen ² (mg/L)	4.29	15.3	7.8
Oxidised Nitrogen (NO _x)	0.05	0.05	0.05
Total Phosphorus (mg/L)	0.5	1.7	1
Pathogen Indicators			
Escherichia coli (E. coli/100mL)	5,875	12,997	6,200
Enterococci (Enterococci/100mL)	2,375	1,086	826

¹Calculated as NH₃-N Free

²Calculated NH₃-N Organic + NH₃-N Free + NO_x

Appendix G: Surface Water Assessment in Woods Inlet

Table 10. Tabulated surface water assessment in Woods Inlet

Site Code	Site Description	Collected Date	Physical-chemical Parameters							Biological Parameters							Total N (mg/L)	FRP (mg/L)	Total P (mg/L)	VSS (mg/L)	Notes	
			pH (pH units)	EC (uS/cm)	DO (mg/L)	DO % Sat.	Turbidity (NTU)	TDS (mg/L)	SS (mg/L)	BOD (mg/L)	Chl-a (ug/L)	Pheo-a (ug/L)	NH3-N Free (mg/L)	NH3-N Organic (mg/L)	NO2 - N (mg/L)	NO3 - N (mg/L)						NOX - N (mg/L)
SBL090	Wq-Belyuen Pond 2 Outlet	08/01/2020 10:18:29	7.55	290	<0.1	<10	200	180	105	54.0	225	105	5.4	15.0	<0.1	<0.1	<0.1	20.45	1.1	2.9		
SBL090	Wq-Belyuen Pond 2 Outlet	05/02/2020 10:07:12	7.06	140	4.23	49	18	88	22	6.7	216	71	3.9	3.4	<0.1	<0.1	<0.1	7.35	0.4	1.0		
SBL090	Wq-Belyuen Pond 2 Outlet	04/03/2020 12:15:33	5.0	30	4.64	53	1.0	19.0	7	1.8	29	15.0	0.7	1.6	<0.1	<0.1	<0.1	2.35	0.1	0.2		
SBL090	Wq-Belyuen Pond 2 Outlet	08/04/2020 10:30:35	5.75	32	6.71	79	9.2	21.0	14	<1	108	38.0	0.8	2.6	<0.1	<0.1	<0.1	3.45	0.1	0.2		
SBL090	Wq-Belyuen Pond 2 Outlet	06/05/2020 09:26:37	5.77	26	4.75	57	5.3	16.0	6	1.2	123	20.0	0.8	2.4	0.14	<0.1	<0.1	3.25	0.1	0.1	6.0	
SBL090	Wq-Belyuen Pond 2 Outlet	03/06/2020 09:42:51	6.08	47	2.08	25	3.1	29.0	10	4.5	32	9.0	1.1	1.3	<0.1	<0.1	<0.1	2.45	0.1	0.3	10.0	Pond most likely not discharging to the environment. D2020/314882.
SBL010	Wq-Belyuen Pond 1 Outlet	08/07/2020 09:05:17	6.94	470.0	<0.1	<10	100.0	300.0	48.0	100.0	65.0	<1	20.0	5.3	<0.1	0.2	0.14	25.44	1.8	2.1	48.0	Pond levels very low during time of sample - sample may not be representative - Pond 2 not discharging
SBL010	Wq-Belyuen Pond 1 Outlet	05/08/2020 09:14:33	7.41	530	0.1	5	190	330	63	54.0	90.0	124.0	24.0	6.6	0.1	0.1	0.1	30.7	2.8	3.7	63	Pond levels very low during time of sample - sample may not be representative - Pond 2 not discharging
SBL010	Wq-Belyuen Pond 1 Outlet	02/09/2020 12:08:33	7.59	580	<0.1	5	110	360	85	83.0	349	<1	24.0	12.0	<0.1	0.1	<0.1	36.05	3.8	4.7	80.0	Pond levels very low during time of sample - sample may not be representative - Pond 2 not discharging
SBL090	Wq-Belyuen Pond 2 Outlet	08/10/2020 08:22:00	7.62	330	4.69	56	220	210	145	12.0	2,880	391.0	3.2	17.0	<0.1	0.2	0.29	20.49	2.7	4.7	115.0	Pond levels very low during time of sample - sample may not be representative - Pond 2 not discharging
SBL090	Wq-Belyuen Pond 2 Outlet	04/11/2020 08:22:29	7.02	350.0	<0.1	<10	801	220.0	2001	38.0	1,090.0	3,350.0	2.9	25.0	<0.1	0.1	0.14	28.04	1.3	4.1	1,001.0	Pond levels very low during time of sample - sample may not be representative - Pond 2 not discharging
SBL090	Wq-Belyuen Pond 2 Outlet	02/12/2020 08:45:21	7.24	230.0	0.41	<10	58.0	140.0	60.0	26.0	392.0	95.0	2.9	8.0	<0.1	<0.1	<0.1	10.95	1.1	2.0	53.0	Pond levels very low during time of sample - sample may not be representative - Pond 2 not discharging
SBL090	Wq-Belyuen Pond 2 Outlet	06/01/2021 09:15:49	6.09	56.0	1.37	16.0	73.0	35.0	118.0	13.0	47.0	106.0	2.0	3.9	<0.1	0.1	0.1	6.0	0.3	0.7	78.0	
SBL090	Wq-Belyuen Pond 2 Outlet	10/02/2021 09:10:52	5.36	24.0	4.9	52.0	1.3	15.0	6.0	<1	2.0	2.0	0.8	0.7	<0.1	0.1	0.1	1.6	<0.1	0.4	6.0	Pond 2 now discharging to the environment. D2021/24152.
SBL090	Wq-Belyuen Pond 2 Outlet	03/03/2021 09:15:23	5.5	23.0	5.34	64.0	3.0	15.0	<5	2.7	11.0	5.0	1.1	1.8	<0.1	0.1	0.1	3.0	<0.1	0.1	<5	
SBL090	Wq-Belyuen Pond 2 Outlet	07/04/2021 08:34:34	5.53	27.0	3.34	41.0	3.4	17.0	<5	3.4	7.0	4.0	0.9	1.1	<0.1	0.1	0.1	2.1	<0.1	0.2	<5	
SBL090	Wq-Belyuen Pond 2 Outlet	05/05/2021 07:54:58	5.82	32.0	3.99	37.0	6.0	20.0	8.0	5.4	43.0	12.0	0.5	1.3	0.1	0.1	0.1	1.9	0.1	0.2	8.0	
SBL090	Wq-Belyuen Pond 2 Outlet	02/06/2021 09:00:36	6.57	70.0	10.9	120.0	18.0	44.0	32.0	16.0	458.0	76.0	0.7	4.0	<0.1	0.3	0.3	5.0	0.1	0.4	32.0	Pond most likely not discharging to the environment. D2020/314882.
SBL090	Wq-Belyuen Pond 2 Outlet	07/07/2021 09:30:00	7.62	220.0	4.72	53.0	51.0	140.0	72.0	49.0	1,090.0	152.0	2.7	9.1	<0.1	<0.1	<0.1	11.85	0.3	1.6	60.0	
SBL090	Wq-Belyuen Pond 2 Outlet	04/08/2021 11:45:45	7.06	310.0	0.78	<10	140.0	190.0	1,850.0	48.0	2,090.0	1,110.0	4.7	19.0	<0.1	<0.1	<0.1	23.75	0.7	2.7	1,001.0	
SBL090	Wq-Belyuen Pond 2 Outlet	08/09/2021 11:05:23	7.09	350.0	1.48	18.0	140.0	220.0	95.0	43.0	56.0	<0.1	9.8	10.0	<0.1	<0.1	<0.1	19.85	1.0	2.3	95.0	
SBL090	Wq-Belyuen Pond 2 Outlet	06/10/2021 08:45:00	7.24	340.0	1.37	17.0	40.0	220.0	85.0	44.0	1,080.0	95.0	11.0	9.2	<0.1	<0.1	<0.1	20.25	1.8	3.0	80.0	
SBL090	Wq-Belyuen Pond 2 Outlet	21/10/2021 11:01:00	7.2	333.0			44.0	184.0	193.0	40.0	823.0		8.291	15.0	0.01	0.008	0.018	14.42	1.92	3.57	60.0	
SBL090	Wq-Belyuen Pond 2 Outlet	03/11/2021 09:00:32	7.34	270.0	0.69	<10	62.0	170.0	70.0	17.0	659.0	266.0	0.5	15.0	<0.1	0.1	0.1	14.42	1.5	2.5	60.0	
SBL090	Wq-Belyuen Pond 2 Outlet	11/11/2021 10:35:00	7.3	259.0			35.0	126.0	22.0	754.0	754.0		5.45		0.007	0.0015	0.008	14.01	1.47	2.53		
SBL090	Wq-Belyuen Pond 2 Outlet	08/12/2021 08:00:43	7.22	240.0	1.55	16.0	44.0	150.0	40.0	17.0	251.0	261.0	4.2	6.1	<0.1	<0.1	<0.1	10.35	1.0	1.8	32.0	
SBL090	Wq-Belyuen Pond 2 Outlet	13/12/2021 12:22:00	7.0	222.0			170.0	123.0	640.0	48.0	1,250.0		3.66		0.006	0.008	0.014	22.11	1.02	3.36		
SBL090	Wq-Belyuen Pond 2 Outlet	05/01/2022 10:50:48	6.6	110.0	0.53	<10	14.0	70.0	91.0	14.0	276.0	31.0	3.3	4.1	0.2	<0.1	<0.1	7.45	0.7	1.0	25.0	
SBL090	Wq-Belyuen Pond 2 Outlet	24/01/2022 13:03:00	6.4	71.0			9.7	39.0	19.0	8.0	102.0		1.982		0.008	0.046	0.054	5.13	0.203	0.607		
SBL090	Wq-Belyuen Pond 2 Outlet	02/02/2022 14:49:56	5.95	38.0	4.57	48.0	2.9	24.0	<5	<1	4.0	8.0	1.2	1.1	<0.1	0.2	0.2	2.5	0.1	0.3	5.0	
SBL090	Wq-Belyuen Pond 2 Outlet	10/02/2022 12:15:00	5.7	37.0			1.9	20.0	6.0	5.0	53.4		0.713		0.008	0.084	0.092	1.99	0.018	0.219		Flow meter data available
SBL090	Wq-Belyuen Pond 2 Outlet	02/03/2022 08:31:36	5.61	25.0	5.01	60.0	1.9	16.0	<5	<1	8.0	6.0	1.3	1.1	<0.1	<0.1	<0.1	2.45	0.1	0.1	<5	
SBL090	Wq-Belyuen Pond 2 Outlet	10/03/2022 11:07:00	5.3	27.0			2.0	15.0	9.0	3.0	63.0		0.019		0.004	0.04	0.044	1.61	0.007	0.167		
SBL090	Wq-Belyuen Pond 2 Outlet	06/04/2022 08:00:00	5.42	22.0	5.63	69.0	3.4	14.0	5.0	1.0	18.0	13.0	0.4	0.8	<0.1	0.1	0.1	1.3	0.1	0.1	5.0	
SBL090	Wq-Belyuen Pond 2 Outlet	07/04/2022 10:41:00	5.3	25.0			1.2	14.0	7.0	4.0	48.7		0.195		####	0.107	0.11	1.0	0.009	0.066		
SBL090	Wq-Belyuen Pond 2 Outlet	04/05/2022 06:00:00	5.51	27.0	5.51	61.0	5.2	17.0	7.0	4.0	42.0	20.0	0.5	4.7	<0.1	0.1	0.1	5.3	0.1	0.2	7.0	
SBL090	Wq-Belyuen Pond 2 Outlet	10/05/2022 11:02:00	5.6	34.0			4.9	12.0	6.0	134.0			0.086		####	0.076	0.079	1.61	0.004	0.168		
SBL090	Wq-Belyuen Pond 2 Outlet	08/06/2022 08:00:00	6.38	77.0	1.22	14.0	12.0	49.0	25.0	6.6	137.0	55.0	2.4	4.9	<0.1	<0.1	<1	7.8	0.1	0.4	25.0	
SBL090	Wq-Belyuen Pond 2 Outlet	09/06/2022 12:14:00	6.3	74.0			15.0	34.0	10.0	352.0												
SBL090	Wq-Belyuen Pond 2 Outlet	06/07/2022 08:50:00	7.23	220.0	0.15	<10	42.0	140.0	38.0	7.5	121.0	<1	8.2	3.7	<0.1	<0.1	<0.1	11.95	0.8	1.1	34.0	No discharge
SBL090	Wq-Belyuen Pond 2 Outlet	03/08/2022 13:07:24	7.26	290.0	1.2	14.0	42.0	180.0	50.0	27.0	331.0	544.0	6.8	8.4	<0.1	0.1	0.1	15.3	0.7	1.5	45.0	No discharge
SBL090	Wq-Belyuen Pond 2 Outlet	07/09/2022 10:28:45	7.03	360.0	0.58	<10	52.0	230.0	45.0	29.0	121.0	202.0	12.0	5.9	<0.1	<0.1	<0.1	17.95	1.1	1.7	55.0	No discharge
SBL090	Wq-Belyuen Pond																					

Alias	Asset Description	Collected Date	Chlorophyll-a (ug/L)	pH (pH units)	BOD (mg/L)	EC (uS/cm)	NH3-N Free (Ammonia Nitrogen)	NO2 - N(mg/L)	NO3 - N(mg/L)	NOX - N(mg/L)	Total Kjeldahl N (mg/L)	Total N (mg/L)	P_Reactive High (mg/L)	P_Total (mg/L)	SS (mg/L)	Turbidity (NTU) (lab)	Notes
Belyuen Woods Inlet																	Phys-chem suite analysed at DPIR - some analytes may not have been tested.
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	23/01/2020 13:36:03	1.93	6.77	2.8	1,500	0.3	0.05	0.1	0.14	0.52	0.55	0.01	0.084	104	22	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	13/02/2020 10:08:00	1.79	7.81	0.5	47,000	0.0025	0.0015	0.0015	0.025	1.97	1.97	0.032	0.028	135	7	Check this is uploaded to envirosys.
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	05/03/2020 10:50:00	1.49	6.6	1	2,930	0.0025	0.0015	0.003	0.006	0.09	0.1	0.007	0.028	3	22	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	22/04/2020 04:59:00	2.91	6.6	1	2,960	0.0025	0.0015	0.01	0.013	0.21	0.22	0.01	0.011	50	34	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	28/05/2020 10:35:00	1.55	7.7	1	49,000	0.013	0.0015	0.001	0.004	1.83	1.83	0.012	0.028	5	5.3	Check this is uploaded to envirosys.
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	25/06/2020 10:20:00	1.37	7.8	1	52,200	0.005	0.004	0.0015	0.004	1.29	1.29	0.016	0.039	6	4.0	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	29/07/2020 11:51:00	4.42	7.7	1	41,400	0.008	0.0015	0.0015	0.0015	1.84	1.84	0.004	0.046	16	14.0	Ponds not discharging - results are naturally occurring
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	13/08/2020 10:57:00	3.03	7.4	1	45,500	0.0025	0.0015	0.006	0.009	1.61	1.62	0.02	0.038	12	9.3	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	10/09/2020 09:59:00	1.66	7.6	1	54,900	0.0025	0.0015	0.0015	0.0015	0.7	0.7	0.004	0.041	6	4.5	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	08/10/2020 09:45:00	0.97	7.4	1	25,700	0.0030	0.0015	0.0015	0.0015	0.67	0.67	0.004	0.033	28	27.0	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	19/11/2020 09:50:00	2.6	7.7	1	56,100	0.0025	0.0015	0.017	0.02	0.73	0.75	<0.003	0.039	13	8.1	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	10/12/2020 11:30:00	7.59	7.6	1	48,800	0.0025	0.0015	0.0015	0.0015	1.05	1.05	0.017	0.06	17	14.0	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	07/01/2021 11:34:00	3.39	6.8	1	5,610	0.027	0.0015	0.012	0.015	0.23	0.25	<0.003	0.036	21	22.0	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	18/02/2021 12:20:00	2.41	6.9	1	6,430	0.01	0.0015	0.006	0.009	0.14	0.15	0.006	0.012	9	6.0	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	16/03/2021 10:20:00	2.52	7.3	1	24,300	0.008	0.0015	0.0015	0.0015	0.09	0.09	0.003	0.033	15	13.0	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	22/04/2021 13:58:00	4.91	6.6	4.0	4,130	0.0025	0.0015	0.011	0.014	0.06	0.07	0.007	0.022	10	9.9	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	20/05/2021 10:41:00	1.47	7.1	1	8,440	0.0025	0.0015	0.0015	0.0015	0.17	0.17	0.006	0.025	4	6.8	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	17/06/2021 12:13:00	5.22	7.5	1	42,800	0.0025	0.0015	0.0015	0.0015	0.5	0.5	0.009	0.028	1	3.3	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	14/07/2021 14:37:00	4.56	7.3	1	37,200	0.039	0.0015	0.003	0.006	1.57	1.58	0.006	0.034	0.5	9.7	Ponds not discharging - results are naturally occurring
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	19/08/2021 11:40:00	2.41	7.4	1	31,500	0.027	0.0015	0.003	0.006	0.35	0.36	0.005	0.037	0.5	4.6	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	16/09/2021 11:00:00	3.06	7.5	1	53,500	0.0025	0.0015	0.005	0.008	0.82	0.83	0.008	0.04	16.0	10	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	21/10/2021 12:19:00	27.9	7.0	4.0	54,900	0.0025	0.0015	0.0015	0.005	0.76	0.77	0.017	0.327	290.0	130	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	11/11/2021 10:02:00	2.16	7.4	1	48,600	0.0025	0.0015	0.0015	0.0015	2.16	2.16	0.004	0.026	0.5	5	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	13/12/2021 12:55:00	2.75	7.4	1	45,600	0.025	0.0015	0.0015	0.0015	3.05	3.05	0.005	0.027	0.5	7	Discharge commenced roughly around 12/11/2021.
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	24/01/2022 13:30:00	4.52	7.1	1	14,900.0	0.006	0.003	0.018	0.021	0.46	0.48	0.004	0.064	40.0	36.0	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	10/02/2022 12:59:00	0.51	6.6	1	2,750.0	0.0025	0.0015	0.0015	0.0015	0.14	0.14	0.006	0.016	11.0	7.5	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	10/03/2022 04:59:00	2.13	6.4	1	2,560.0	0.005	0.0015	0.0015	0.003	0.15	0.15	0.0015	0.015	0.5	6.2	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	07/04/2022 11:06:00	3.29	7.3	2.0	24,500.0	0.0025	0.0015	0.0015	0.0015	0.45	0.45	0.006	0.036	0.5	5.0	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	10/05/2022 11:33:00	0.79	6.6	1	5,220.0	0.022	0.0015	0.0015	0.003	0.16	0.16	0.004	0.034	4.0	6.3	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	09/06/2022 12:41:00	1.77	6.8	3.0	8,680.0	0.05	0.0015	0.0015	0.003	0.14	0.14	0.004	0.022	24.0	7.7	
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	07/07/2022 12:19:00	5.04	7.4	1	26,200.0	0.005	0.0015	0.0015	0.0015	0.84	0.84	0.0015	0.031	10.0	6.2	No Discharge
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	23/08/2022 11:01:00	1.3	7.3	1	26,600.0	0.0025	0.0015	0.0015	0.0015	0.11	0.11	0.0015	0.015	15.0	2.8	No Discharge
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	08/09/2022 13:36:00	4.60	7.3	1	48400	0.0025	0.0015	0.0015	0.0015	<0.05	<0.05	0.0015	0.020	6	4.8	No Discharge
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	06/10/2022 09:47:00	5.51	7.3	1	48400	0.0025	0.0015	0.0015	0.0015	0.17	0.17	0.005	0.020	8	6.1	No Discharge
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	17/11/2022 10:50:00	2.93	6.87		49,800.0	0.1400	0.005	0.005	0.01	0.5	0.5	0.005	0.12		15.0	No Discharge
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	15/12/2022 11:08:00	1.9	7.77	5	47,800.0	0.0800	0.005	0.24	0.24	0.5	0.5	0.005	2.97	2.5	6.1	Discharge commenced around 29/11/2022.
SBLEP01	WQ - SBLEP01 Belyuen Outfall Woods Inlet	30/01/2023 14:20:00	0.6	7.09	1	5,660.0	0.0090	0.001	0.013	0.013	0.1	0.11	0.004	0.009	8.0	6.6	
Mean			3.5	7.2	1.3	28473.0	0.0	0.0	0.0	0.0	0.8	0.8	0.0	0.0	27.1	14.9	
95th Percentile			6.3	7.7	3.5	54900.0	0.0	0.0	0.0	0.0	2.0	2.1	0.0	0.1	118.0	34.9	

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