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# Darwin Harbour Region Report Cards 2011



## Darwin Harbour Region Report Cards 2011

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Website: [www.nt.gov.au/nreta/water/aquatic/index.html](http://www.nt.gov.au/nreta/water/aquatic/index.html)

### Disclaimer

The information contained in this report comprises general statements based on scientific research and monitoring. The reader is advised that some information may be unavailable, incomplete or unable to be applied in areas outside the Darwin Harbour region. Information may be superseded by future scientific studies, new technology and/or industry practices.

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Symbols are courtesy of the Integration and Application Network ([ian.umces.edu/symbols/](http://ian.umces.edu/symbols/)), University of Maryland Center for Environmental Science, USA. Several conceptual diagrams were adapted from base diagrams from the Integration and Application Network.



# Message

from the Chair of the Darwin Harbour Advisory Committee

The Darwin Harbour Advisory Committee is pleased to support the Aquatic Health Unit, Department of Natural Resources, Environment, the Arts and Sport, in the release of the 2011 Darwin Harbour Region Report Cards.

This is the third year that data has been provided to the public in these easy to follow report cards which are world class. I congratulate the Aquatic Health Unit on providing this invaluable baseline data which will contribute to assessing changes to the health of the harbour, including the cumulative impacts of catchment development. This is particularly important as new industries consider the Darwin Harbour environs for their operations. This year the monitoring effort has been increased. There were 61 sites across the harbour under the magnifying glass giving an extended snapshot.

As Chair of the Darwin Harbour Advisory Committee I am also very pleased to acknowledge the progress in developing an Integrated Monitoring and Research Program for Darwin Harbour. Integration is one of the founding principles of DHAC's Darwin Harbour Strategy. An integrated program was endorsed in principle by the Northern Territory Government last year. The program will be a multi-stakeholder effort to integrate current programs and, in time, provide a more comprehensive picture of the health of Darwin Harbour.

The Department of Natural Resources, Environment, The Arts and Sport, in collaboration with the Australian Government, has embarked on Phase 2 of the Water Quality Protection Plan Project, an action plan developed under the National Water Quality Management Strategy. With the overall aim being to maintain water quality objectives and protect the community's values of waterways, Phase 2 will finalise a number of actions, including developing an integrated decision support system to assess the impact of further developments on Darwin Harbour.

Everyone can play their part in creating a healthy harbour and simple changes can make significant improvements. Fertiliser innocently spread on gardens, and litter carelessly discarded generally end up in the harbour impacting on water quality and becoming a threat to the life of animals such as turtles. Changing behaviours in our community will make a difference; for example washing cars on the lawn, limiting fertiliser applications in the wet season, composting and mulching gardens, and not draining pools to stormwater.

I encourage all readers of these Report Cards to also read the Darwin Harbour Strategy [www.harbourplan.nt.gov.au](http://www.harbourplan.nt.gov.au) and consider what you can do to work towards improving the health of the harbour.

**Bill Stuchbery**

Chair

Darwin Harbour Advisory Committee

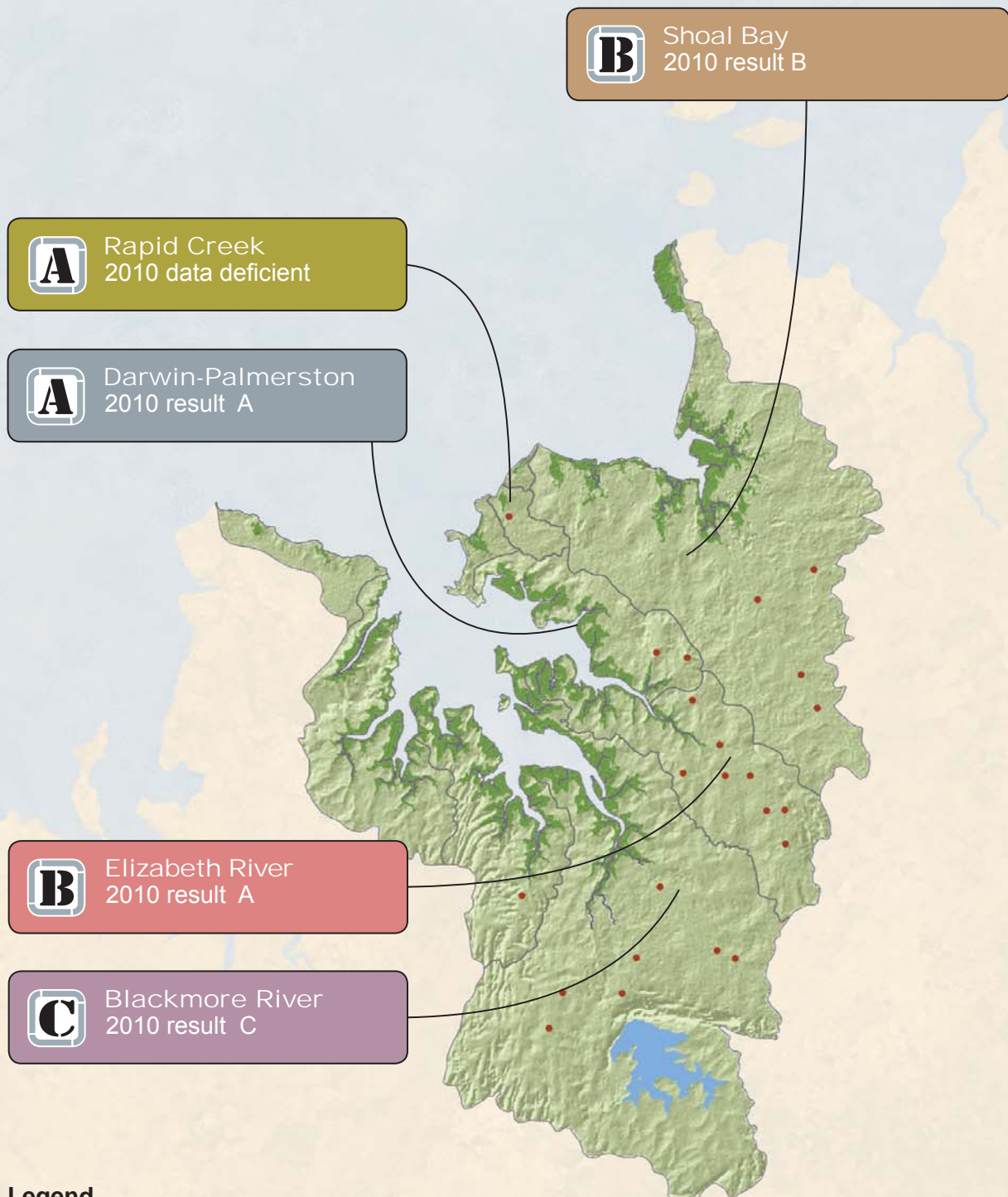
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# Summary of freshwater and marine water quality ratings

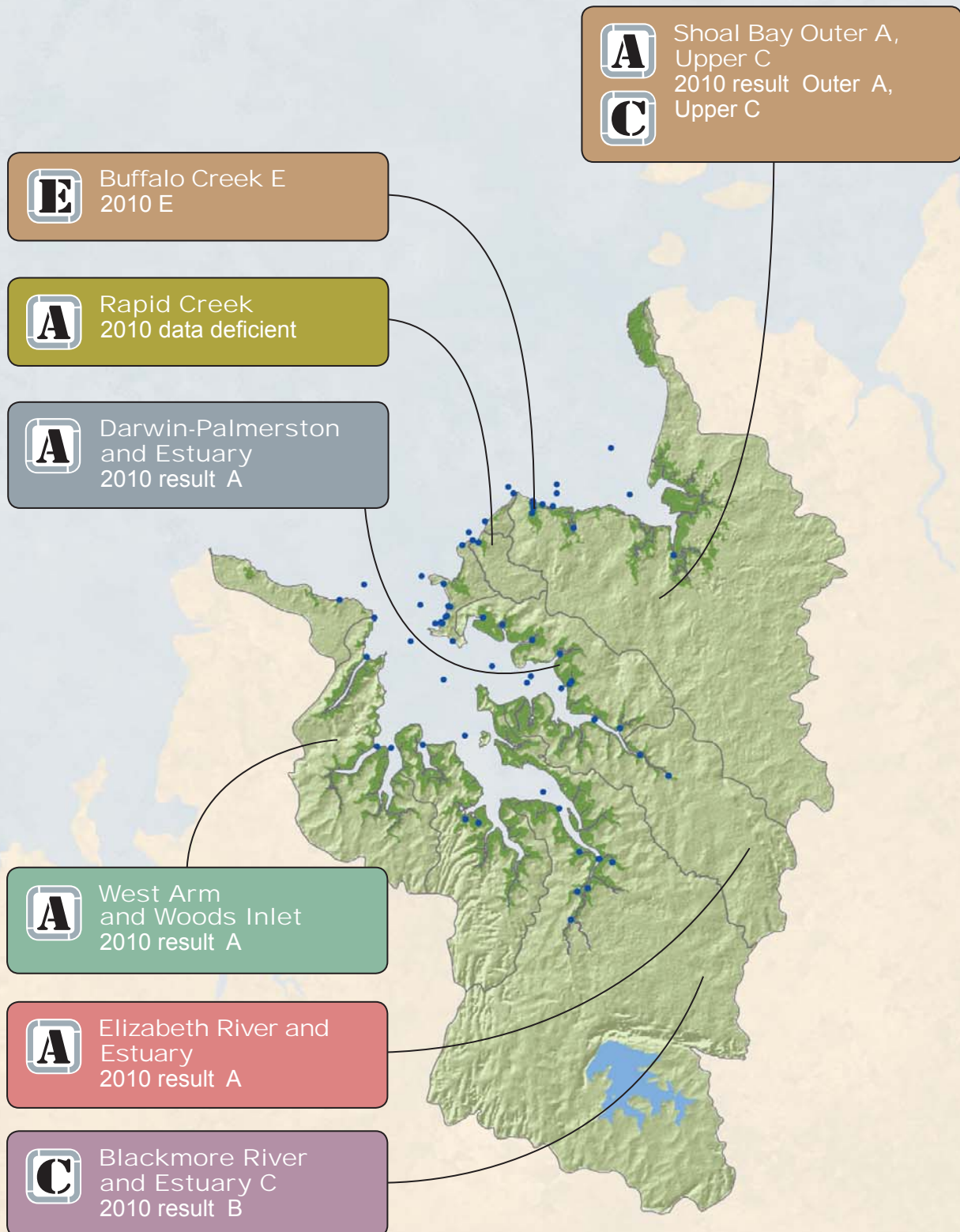


*Electrofishing is a widely recognised and non-lethal method to monitor fish communities*



**Legend**

Water quality rating	Water quality
A	Excellent
B	Very good
C	Moderate
D	Poor
E	Very poor



## Summary

### Water quality monitoring

Water quality monitoring has been undertaken in Darwin Harbour and its catchment by the Department of Natural Resources, Environment, The Arts and Sport (NRETAS) since 2001.

These Report Cards provide a snapshot of water quality at 29 freshwater and 61 estuarine sites monitored in 2011. The water quality of each site has been assigned a rating, from A to E, depending on compliance to local water quality objectives.


These Report Cards describe results of estuarine data collected approximately quarterly during a one year period (May 2010 to June 2011).

These Report Cards report on freshwater data collected in May 2011. The Rapid Creek Report Card also includes freshwater monitoring data supplied by Darwin International Airport.

### Water quality results

The maps on the previous pages provide a summary of water quality results in 2011 for all sites in Darwin Harbour and its catchment.

Darwin Harbour and its catchment received the following scorecard:

	A (Excellent)	Darwin Harbour Darwin-Palmerston Elizabeth River and Estuary West Arm and Woods Inlet Shoal Bay (outer) Rapid Creek (Freshwater) Rapid Creek (Upper marine)
	B (Very good)	Elizabeth (Freshwater) Shoal Bay (Freshwater)
	C (Moderate)	Blackmore River and Estuary Shoal Bay (Upper marine)
	D (Poor)	None
	E (Very poor)	Buffalo Creek (Shoal Bay catchment)



Water quality at the majority of estuarine sites across Darwin Harbour in 2010–11 was assessed as being moderate to excellent. Water quality at Buffalo Creek was very poor. Water quality in freshwater streams within the Harbour's catchments was assessed as being moderate to excellent at the sites monitored. The water-bug communities at catchment biological monitoring sites was largely in good condition with the majority of sites achieving an Ausrivas score of 'A'.

Differences in 'A to E' water quality ratings between years may not always reflect a real change in condition. Differences may arise from natural variability within short-term monitoring periods, and changes in sites.

Differences in biological ratings between years may not always reflect a real change in conditions due to variability. In future years, once sufficient data are collected, detection of trends over time may be possible.

## **Other monitoring in Darwin Harbour**

A selection of research and monitoring activities in the Darwin Harbour region is presented in the supplement to these Report Cards titled 'Darwin Harbour Region Other Projects and Monitoring 2011'. Several collaborative monitoring projects are reported on, including a study of investigations into the potential sources of the high bacterial counts on Darwin's beaches. Other Projects and Monitoring reported on include studies on the corals, seagrasses, marine worms, dolphins, Darwin Harbour habitat mapping and the Howard River toadlet.

## **The Report Cards**

The Darwin Harbour Region Report Cards describe the health of aquatic ecosystems based on water quality. The Report Cards contribute to the Darwin Harbour Strategy, the Territory 2030 Strategy and the Water Quality Protection Plan by providing knowledge to manage our healthy waterways.

## **Our harbour, our life, our future**

Darwin Harbour and its catchment has a population of over 120,000 people and faces increasing population and industrial growth. This growth may intensify pressure on the Harbour environment and the wildlife it supports.

The Darwin Harbour region has green turtles (doedlirra to Larrakia people), dugong (damaldanggala, Larrakia), barramundi (damabila, Larrakia), sea eagles (garngarn, Wadjigin name), magpie geese (gakkingga, Larrakia), brahminy kites (butumba, Larrakia), mud crabs (madla, Larrakia) and agile wallabies (milula, Larrakia).

## Culture – land and sea country

### **Larrakia Nation 2011**

Darwin Harbour has been home to the Gulumoerrgin (Larrakia people) for thousands of years. For the Larrakia, the region's environments are 'cultural landscapes' that are vital to well being.

Larrakia 'country' consists of both land (gwalwa) and sea (gunumitjanda). There are tidal mudflats and mangrove (moerroerrlma) lined waterways, lagoons, floodplains, freshwater creeks and woodland (matboerrma). The sea itself comprises a variety of plant (mayoema) and animal (majawa) resources, which are managed, harvested, hunted and fished by the Larrakia People. Larrakia people have oral traditions and written documentation of our unbroken relationship to our land, our sacred sites, stories and resources. Larrakia people like to refer to ourselves as 'saltwater people' and consider the species that are not hunted including saltwater crocodiles, dolphins and whales an important part of our ancestry.

*Footnote: It is traditional for Larrakia people to share their culture in the 'first person'.*

# Understanding water quality and pollution sources



*The Leanyer/Sanderson sewage treatment facility*

## Introduction

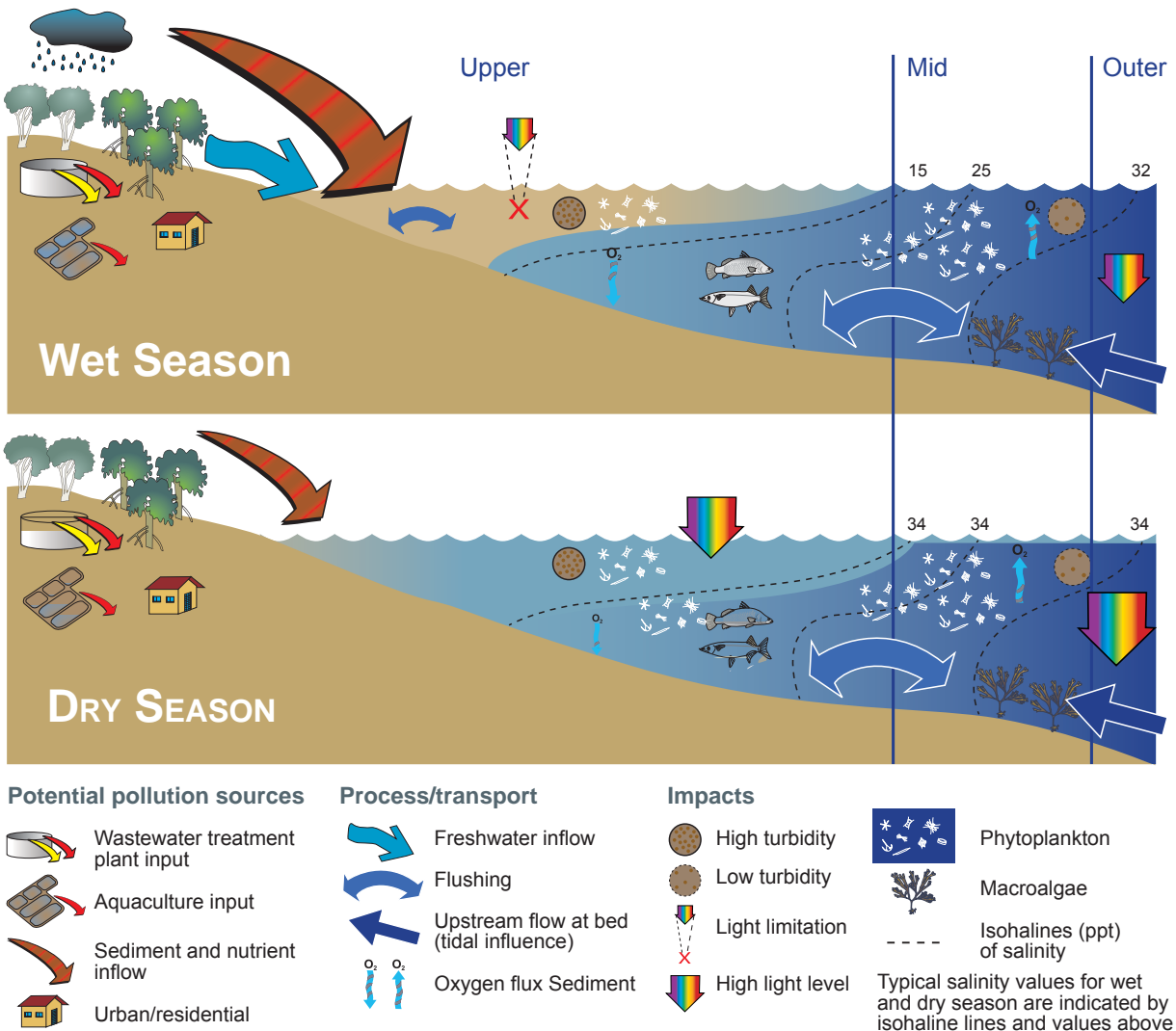
This section briefly describes some of the factors that affect the water quality of the Harbour.

### Potential pollutant sources

Potential pollutants to the waterways of the Darwin Harbour region include sediments, nutrients, heavy metals and human-related compounds (pharmaceuticals, petroleum compounds and chemicals). Pollutants can originate from both 'point' and 'diffuse' catchment sources. Point sources include discharges from a point, such as sewage treatment plant or an aquaculture facility. Point source discharges can occur throughout the year. Sewage treatment plants, for instance, have been identified as a major source of nutrients to the Harbour. Diffuse, or non-point, sources occur across a wide area, such as stormwater that enters waterways primarily during the wet season.

### Seasonal impacts on water quality

In estuaries, the main processes influencing water quality are subject to variation at seasonal and tidal time scales. Seasons and tides affect many aspects of water quality in the upper, mid and outer parts of the estuary. A simple representation is shown in the diagram below. Actual processes may be more complicated owing to the effect of salinity on sediment and possibly the resuspension of sediment due to monsoonal winds and wave action.



## Ecosystem health

Darwin Harbour and its catchment will come under increasing pressure in the future from human impacts. Reducing potential pollutants, such as nutrients and sediments from point and diffuse sources, maintaining riparian vegetation, and implementing improved management practices such as water sensitive urban design (WSUD) are important to protecting water quality.

Ecosystems meeting water quality objectives (local guidelines) are considered to be healthy, though there may be impacts not entirely related to water quality per se. Systems failing water quality objectives have poorer water quality and may have reduced ecosystem health. The diagram shows a general estuarine system which is meeting water quality objectives and conversely a system which is non-compliant with water quality objectives for nutrient, sediment and chlorophyll.

Environmental goals shown in the diagram include:

- Maintaining or improving water quality;
- Protecting or restoring marine and freshwater habitats;
- Protecting marine and freshwater biodiversity;
- Minimising algal blooms; and
- Minimising nutrients, sediment and other pollutants to waterways.



*Darwin Harbour and its catchment will come under increasing pressure in the future from human impacts. Implementing improved management practices such as water sensitive urban design (WSUD) are important to protecting water quality. New suburb of Bellamack under construction.*

## Achieving water quality objectives

## Not achieving water quality objectives

100% of indicators comply with water quality objectives

Less than 30% of indicators comply with water quality objectives

Excellent rating (e.g. A)

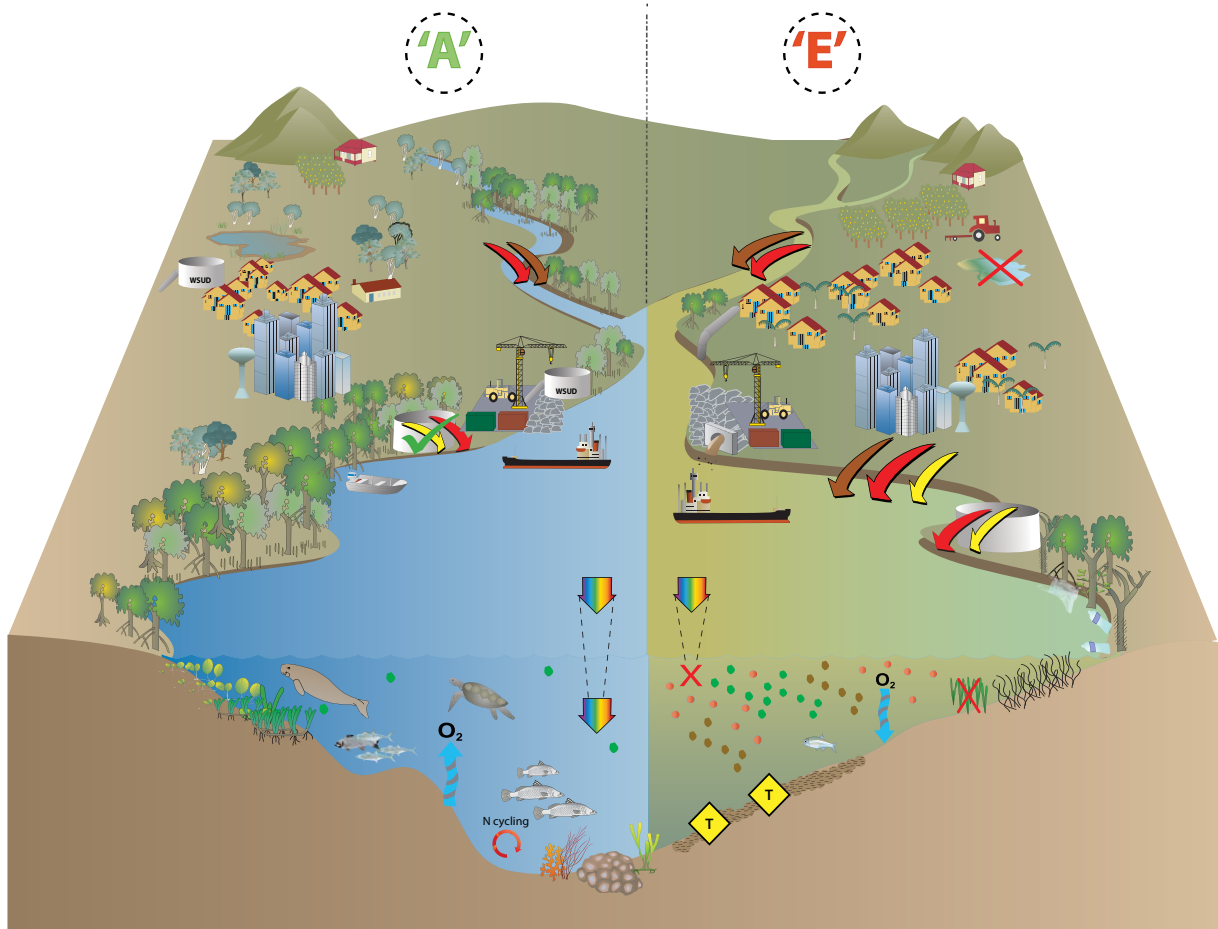
Poor rating (e.g. E)

Good ecosystem health – diverse species, iconic species present, seagrass present, low chlorophyll levels

Poor ecosystem health – few species, iconic species absent, seagrass abundance low, high chlorophyll levels

Good management practices implemented (e.g. WSUD, riparian zone planting, good stormwater practices)

Good management practices not implemented (e.g. no WSUD, minimal riparian zone planting, poor stormwater practices).



	Nutrient inputs		O <sub>2</sub> O <sub>2</sub> Oxygen depletion (arrow down) and availability (arrow up)		Seagrass		Seagrass loss
	Toxicant inputs		Toxicants		Mangroves		Suspended sediment
	Sediment inputs		N cycling Nitrogen cycling		<i>Lyngbya majascula</i>		Nutrients
	Wastewater treatment plant		Good light infiltration		Orchards		Phytoplankton
	Positive check: wastewater treatment - higher standard		Poor light infiltration		Urban development		Stormwater discharge
	Positive check				Stormwater discharge		Water sensitive urban design
	Negative or loss						

## Monitoring programs contributing to the Report Cards

The Northern Territory Government undertakes water quality monitoring and testing throughout the Darwin Harbour region. While most of this monitoring is undertaken to determine the water quality and ecosystem health of the region, monitoring is also undertaken to determine the suitability of beaches for swimming, and as part of licence conditions for waste discharges under the *Water Act* (for example, at the discharge points for sewage treatment plants).

The Darwin Harbour Region Report Cards include data collected from the following monitoring programs.

### Water quality monitoring

Between May 2010 and June 2011, NRETAS monitored water quality at 61 sites in Darwin Harbour. This includes quarterly monitoring at:

Report Card	Estuary region and class*	Number of sites sampled quarterly	Number of sites with other sample frequencies
Darwin Harbour	Outer	5	
Darwin Harbour	Mid	5	
Darwin-Palmerston	Upper	4	
Darwin-Palmerston	Myrmidon	1	3
Elizabeth	Upper	3	3
Blackmore	Upper	8	4
West Arm and Woods Inlet	Upper	4	
Rapid Creek	Upper		1
Shoal Bay	Outer	2	
Shoal Bay	Upper	3	
Beaches	Beaches		12**
	Tidal Creeks		3

\*Water class is typically derived from the sites location in the estuary, water quality and the hydrodynamic characteristics (flushing) it is subject to. This categorisation is considered in the determination of appropriate water quality objectives to apply. \*\*Sampled weekly between May and October

### Freshwater monitoring

NRETAS also monitored water quality annually at 25 sites in 2011 in the Darwin Harbour catchment. Sites monitored during May 2011 were:

Report Card	Freshwater routine annual sites 2011	Other freshwater sites 2011
Darwin-Palmerston	2	
Elizabeth	9	
Blackmore	7	
Rapid Creek	3	4*
Shoal Bay	4	

\* data supplied by Darwin International Airport

## Tidal creek and algal bloom monitoring

Water quality monitoring was undertaken on a fortnightly basis by NRETAS at the entrance of four tidal creeks (Vesteys Creek, Rapid Creek, Mindil Creek and Little Mindil Creek) from June to October 2011. Monitoring was conducted for bacteriological indicators, nutrients and the presence of the naturally occurring cyanobacteria (also known as blue-green algae), *Lyngbya majuscula*, which can proliferate in some urban tidal creeks and wash up on Darwin beaches in the dry season in most years. Large amounts of the algae have not grown in the tidal creeks or washed up on the beaches, this year, unlike in 2010.

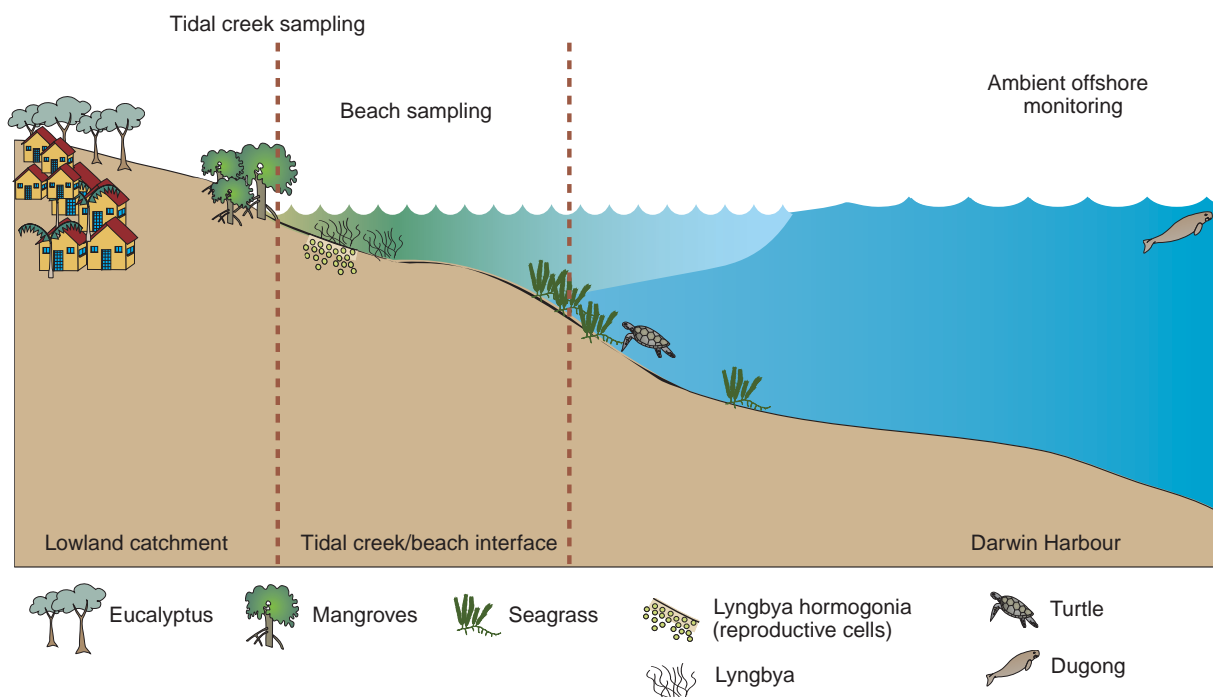
## Beach water quality monitoring

Weekly sampling was undertaken by NRETAS, on behalf of the Department of Health, at twelve beaches from Darwin city centre to Lee Point. These were: Vesteys Beach, Nightcliff Beach, Rapid Creek Beach, Little Mindil Beach, Mindil Beach, East Point Reserve, Casuarina Beach, Cullen Bay Beach, Lee Point Beach and Lameroo Beach. Monthly sampling was undertaken at Wagait Beach and Mandorah Beach.

The water samples were tested for levels of *E. coli* and enterococci until 30 June 2011. From 1 July 2011, samples were only tested for enterococci, as required by the National Health and Medical Research Council guidelines for recreation.

## Conceptual diagram of sampling effort to inform report cards.

The diagram below demonstrates sampling undertaken by NRETAS at tidal creeks and beaches. Outer harbour sampling is also undertaken as part of a broader monitoring program to inform water quality condition. Water quality measurements are taken at these sites quarterly to inform the Report Card grading for catchments.





# Interpreting the Report Cards



*Measuring flow as part of annual monitoring*













## Introduction

This section contains information to help interpret the Report Cards. The techniques used to assess water quality (compliance against local water quality objectives) are used in other regions of Australia. State and regional water quality objectives are considered more appropriate for water quality assessments than national guidelines. The methods used for these Report Cards have been established under the National Water Quality Management Strategy.

## Interpreting the Report Cards

### Water quality indicators

The following indicators were measured at the freshwater and estuarine water quality monitoring sites. Surface samples were collected from a depth of 25–50cm.

Indicator	What it represents	Why it is used as an indicator
 <b>Electrical conductivity</b>	A measure of amount of dissolved salts.	Inhibits plant and animal growth if too high.
 <b>Turbidity</b>	Cloudiness in water.	A measure of the light scattering by material suspended in water. This affects the amount of light available for photosynthesis.
 <b>pH</b>	Indicator of how alkaline or acidic the water is.	Important to chemical and biological processes.
 <b>Dissolved oxygen (% saturation)</b>	A measure of the amount of oxygen in the water. Varies with temperature and salinity.	Critical for aquatic organisms to survive. Low dissolved oxygen is the major cause of freshwater fish kills.
 <b>Total suspended solids</b>	Particulate material in the water column.	Indicator of eroded material such as sediment. Travels in water.
 <b>Chlorophyll a</b>	The green component of plants used in photosynthesis.	Is used as an index of the amount (biomass) of algae.
 <b>NO<sub>x</sub></b>	Nitrate + nitrite (dissolved) forms of nitrogen.	Stimulates plant growth. Travels with water in solution.
 <b>Ammonia</b>	Total ammonia is the sum of un-ionised ammonia and the ammonium forms of nitrogen.	Readily used by aquatic plants. Decomposition and excretion product. High ammonia concentrations can be toxic to biota.
 <b>Total nitrogen</b>	Nitrogen.	Nitrogen is essential for living organisms. Includes all forms of nitrogen.
 <b>Total phosphorus</b>	Phosphorus.	Phosphorus is essential for living organisms. Travels mainly with sediment in water.
 <b>Filterable reactive phosphorus</b>	Fraction of phosphorus that passes through a fine filter.	Stimulates aquatic plant growth. Travels with water in solution.
 <b>Enterococci</b>	A group of bacteria common to the faecal matter of warm-blooded animals, including humans (NHMRC 2008).	Enterococci are recommended for the assessment of marine waters for swimming by the National Health and Medical Research Council.

## Water quality objectives

Water quality objectives declared under the Northern Territory legislation (*Water Act* part 7) act as a local guideline level against which water quality is assessed. Water quality objectives describe the water quality needed to protect human uses and aquatic ecosystem values identified by the community (Beneficial Uses). The water quality objectives help guide planning and water management.

Water quality objectives for nutrients, total suspended solids, electrical conductivity, turbidity and chlorophyll *a* were calculated from the 80th percentile of ambient water sampling results from reference sites in the region. Water quality objectives for dissolved oxygen (% saturation) and pH were calculated using the 20th to 80th percentile range of ambient water sampling results from reference sites. Different water quality objectives apply for the outer, mid and upper estuarine regions of the harbour due to different residence times. Separate water quality objectives apply for freshwater. **Note:** These water quality objectives do not apply for microbiological testing for recreational purposes at beach sites.

## Compliance

A tick indicates that water quality at a site for an indicator was equal to or better than the water quality objective. A cross indicates that the current water quality at a site for an indicator does not comply with the water quality objective. Water quality data was calculated as the median of data collected over several sampling events.

## Water quality rating

Water quality ratings were assigned for each region using the degree of compliance to water quality objectives. A rating of A is considered excellent water quality, while a rating of E is considered very poor water quality. This rating system was also used in the 2009 and 2010 Report Cards. For these Report Cards, the total suspended sediment and dissolved oxygen (%) data were excluded from the marine water compliance and water quality ratings, as these are under revision.

Water quality rating	What the rating means	Compliance and method
A	<b>Excellent water quality</b>	100% of indicators comply with water quality objectives
B	<b>Very good water quality</b>	85% to <100% of indicators comply with water quality objectives
C	<b>Moderate water quality</b>	50% to <85% of indicators comply with water quality objectives
D	<b>Poor water quality</b>	30% to <50% of indicators comply with water quality objectives
E	<b>Very poor water quality</b>	<30% of indicators comply with water quality objectives

## Biological indicators

Organisms living in streams and rivers can tell us about the condition or “health” of waterways. Diverse communities of macroinvertebrates (or water-bugs) indicate a stream in good condition, while simple communities of few water-bug types indicate a degraded stream.

Water scientists monitored the health of Darwin Harbour streams using an assessment system known as AUSRIVAS. This stands for Australian River Assessment System, and works by comparing the water-bugs present in a stream with those expected to be present in reference streams of a similar type. The AUSRIVAS methodology produces a score or band (see table).

These Report Cards used a genus-level model, which was based on 192 taxa and 114 reference sites within the Darwin-Daly region.

Band	Description	What it represents
<b>X</b>	More biologically diverse than reference	More types found than expected. Potential biodiversity “hot-spot” or mild organic enrichment.
<b>A</b>	Similar to reference	Observed vs Expected scores range found at 80% of the reference sites, or equivalent to reference condition.
<b>B</b>	Significantly impaired	Potential impact either on water and/or habitat quality resulting in a loss of types.
<b>C</b>	Severely impaired	Many fewer types than expected. Loss of water and/or habitat quality.
<b>D</b>	Extremely impaired	Few of the expected types and only the hardy, pollution tolerant families remain.

## Microbiological indicators

Up until 30 June 2011, beach water samples were tested for levels of *E. coli* and enterococci and assessed against the *Northern Territory Recreational Microbiological Water Quality Guidelines (2007)*. The new *Public and Environmental Health Act* was enacted on 1 July 2011. The Department of Health formally adopted the National Health and Medical Research Council (NHMRC) '*Guidelines for Managing Risks in Recreational Water*'. Enterococci is now used as the trigger indicator for recreation in marine waters.

Guidelines for marine waters from 1 July 2011 are summarised in the table below. For full details and protocols refer to the guidelines list on the Department of Health website. ([http://www.health.nt.gov.au/Environmental\\_Health/Beach\\_Water\\_Quality/index.aspx](http://www.health.nt.gov.au/Environmental_Health/Beach_Water_Quality/index.aspx))

Mode	Marine water quality criteria from 1 July 2011 for enterococci
Green: Surveillance / Open for Swimming	All samples to be less than or equal to 50 enterococci /100 mL
Amber: Alert / Open for Swimming	All samples between 51 and 200 enterococci /100 mL
Red: Closed for Swimming	Two consecutive samples within 48 hours greater than 200 enterococci /100mL



Sampling in Darwin Harbour being undertaken by the Aquatic Health Unit. Northern Territory Parliament and CBD in background. Photo: John Drewry

# Darwin Harbour

## Summary

Water quality at the outer and mid Harbour monitoring sites was in excellent condition.

## Nature of system

- Estuarine system with outer estuary well mixed via tidal inflows and outflows
- Maximum tidal range of nearly 8 m
- Perennial freshwater inflows from Howard River, Berry Creek and Darwin River
- Extensive mangrove habitat and inter-tidal mudflats












## Potential sources of pollution

- Sediment, nutrient, industrial and other human-related pollutants in stormwater runoff from rural, urban and industrial catchment diffuse sources during the wet season
- Sewage treatment plant wastewater discharges at several points in the Harbour
- Other licensed wastewater discharges at several points in the Harbour



*Mangroves, Bleasers Creek*

Darwin Harbour marine water quality

Indicator and units	Water quality objective outer area	Compliance outer area	Water quality objective mid area	Compliance mid area
 pH	7.0–8.5	8.1–8.3 ✓	7.0–8.5	7.4–8.2 ✓
 Chlorophyll a (µg/L)	<1	0.8 ✓	<2	1 ✓
 NO <sub>x</sub> (µg N/L)	<10	2 ✓	<20	4 ✓
 Ammonia (µg N/L)	<20	5 ✓	<20	5 ✓
 Total nitrogen (µg N/L)	<440	170 ✓	<270	180 ✓
 Total phosphorus (µg P/L)	<20	10 ✓	<20	10 ✓
 Filterable reactive phosphorus (µg P/L)	<10	4 ✓	<5	4 ✓
Number of samples		15–16		19–20
<b>2011 rating</b>				
<b>2010 rating</b> (2009 data)		A		B
<b>2009 rating</b> (2001–2008 data)		A		A

# Darwin Harbour Beaches

## Summary

Three Darwin Harbour beaches were closed in the dry season due to levels of microbiological water quality indicators being greater than guidelines.

## Nature of system

- Estuarine system likely to be well mixed via tidal inflows and outflows
- Many stormwater drains enter tidal creeks or directly onto beachfront areas
- Mangrove habitat and inter-tidal mudflats in some parts
- A large proportion of the catchment has been urbanised
- Cyanobacteria blooms (e.g. maiden's tresses and sea sawdust) typically occur as a natural event in most years in the dry season and can wash ashore



## Potential sources of pollution

- Sediment, nutrient, bacteria, commercial and other human-related pollutants in stormwater runoff from rural, urban (e.g. residential, recreational facilities and areas, commercial areas) and diffuse sources in the catchment
- Sediment, nutrient, bacteria, and other pollutants from point sources (e.g. wastewater discharges, stormwater drains, recreational facilities and areas, commercial areas) to waterways



*Sailing at Vestey's Beach*



### Darwin Beaches monitoring 2011

This section presents the results of beach water quality monitoring for the period of 3 May to 24 October 2011.

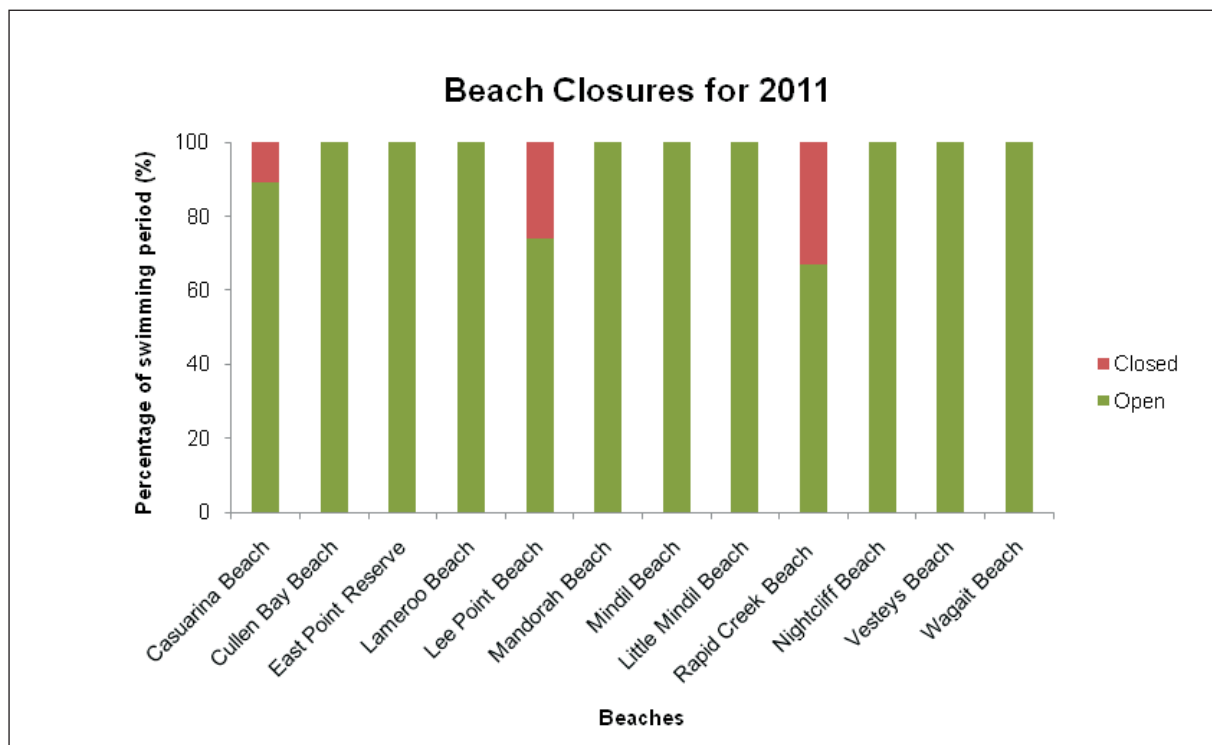
From 1 May to 30 September, beaches are monitored to determine the risk to swimmers associated with bacteria levels. The following trigger levels were used by the Department of Health to determine whether beaches were suitable for swimming and are described in the 'Interpreting the Report Cards' section of this document. The three modes of compliance are:

- Green Mode (open for swimming) – All samples to be less than or equal to 50 enterococci per 100mL.
- Amber Mode (open for swimming) – All samples between 51 and 200 enterococci per 100mL.
- Red Mode (closed for swimming) – Two consecutive samples within 24 hours greater than 200 enterococci per 100mL.

These criteria are drawn from the National Health and Medical Research Council 2008 Guidelines for Managing Risks in Recreational Water, which were formally adopted on 6 July 2011 by the *NT Public and Environmental Health Act 2011*.

Between 1 October and 30 April, beaches are closed to swimming due to the higher danger posed to swimmers during this period by the presence of Box Jellyfish. During this period in 2011–12, sampling of bacteria at beaches is being conducted to investigate the impact of rainfall on bacteria levels. Knowledge gained can be used to design future public health signage and further inform public education campaigns.

The figure below provides a summary of the closure results between 3 May and 24 October 2011. Most beaches are sampled weekly with the exception of Mandorah and Wagait which are sampled monthly.



Between 3 May and 24 October 2011, Casuarina Beach and Lee Point Beach were closed once to swimming and Rapid Creek Beach was closed on two occasions. Other beaches remained open.

Although individual sampling results in red mode occurred more frequently, two consecutive red mode samplings are required for a beach closure.

In August 2011, the Territory Government established the Darwin Harbour Beach Water Quality Taskforce to investigate the sources of bacteria on Darwin Harbour beaches. The Taskforce is chaired by Professor Andrew Campbell from the Charles Darwin University and includes senior officers from the Department of Health, the Department of Natural Resources, Environment, The Arts and Sport, the Power Water Corporation, the Darwin City Council and the City of Palmerston. The taskforce is also consulting with the Darwin Harbour Advisory Committee and the Rapid Creek Catchment Advisory Committee.

The Taskforce will report its findings and recommendations through two reports. The initial report will outline what is known and what is still to be determined about the sources of bacteria on Darwin Harbour beaches. The final report will outline actions to address sources of bacteria and recommend an ongoing monitoring program for Darwin Harbour beaches.

Data and results obtained from all 2010 and 2011 testing and analysis are now available on 'Greening the Territory' and NRETAS website and will continue to be updated regularly.

For results of sampling at Darwin beaches and the status of beaches for swimming visit the Department of Health's website:

[http://www.health.nt.gov.au/Environmental\\_Health/Beach\\_Water\\_Quality/index.aspx](http://www.health.nt.gov.au/Environmental_Health/Beach_Water_Quality/index.aspx)



*Rocky foreshore near Nightcliff jetty*

# Rapid Creek

## Summary

The fresh and marine waters of Rapid Creek were generally in excellent condition, although bacteria levels at Rapid Creek Beach occasionally exceeded recreational water quality guideline levels. Water quality monitoring data were provided from the Darwin International Airport for a number of sites along the freshwater reaches of Rapid Creek in addition to data collected by NRETAS for this Report Card.



## Nature of system

- Rapid Creek is the largest freshwater system within the Darwin city area
- A large proportion of the catchment has been cleared and urbanised
- Stream corridor and riparian area remains relatively intact
- Bacteria levels on Rapid Creek Beach are occasionally above water quality guideline levels














## Potential sources of pollution

- High sediment, nutrient and other human-related pollutant loads from urban areas, primarily during the wet season



*Mouth of Rapid Creek. Rapid Creek is known as Gurambai to Larrakia people*

Rapid Creek catchment freshwater and marine water quality

Indicator and units	Water quality objective freshwater	Compliance freshwater	Water quality objective marine	Compliance upper marine
 <b>Electrical conductivity</b> (µS/cm)	<200	35.6 ✓	NA	
 <b>Turbidity</b> (NTU)	<20	1.49 ✓	NA	
 <b>pH</b>	6.0–7.5	5.7–6.4 ✓	6–8.5	7.6–8 ✓
 <b>Dissolved oxygen</b> (%)	50–100	57–63 ✓	80–100	*
 <b>Total suspended solids</b> (mg/L)	<5	1.5 ✓	<10	*
 <b>Chlorophyll a</b> (µg/L)	<2	0.17 ✓	<4	0.5 ✓
 <b>NOx</b> (µg N/L)	<8	40 ✓	<20	15.5 ✓
 <b>Ammonia</b> (µg N/L)	NA		<20	nd
 <b>Total nitrogen</b> (µg N/L)	<230	130 ✓	<300	250 ✓
 <b>Total phosphorus</b> (µg P/L)	<10	5 ✓	<30	20 ✓
 <b>Filterable reactive phosphorus</b> (µg P/L)	<5	3 ✓	<10	6 ✓
<b>Number of samples</b>		29		19
<b>2011 rating</b>				
<p>Note: Four sites included the data from sites at Kimmorley Bridge, Yankee Pools, Henry Wrigley Bridge and DW21. Data for Kimmorley Bridge, Yankee Pools, Henry Wrigley Bridge and Mitigation Weir were supplied by Darwin International Airport.                      Note<sup>1</sup>: (nd). Limited or no data available Note<sup>2</sup>: (NA). Not applicable, no WQO developed                      * WQO currently under revision.</p>				

# Darwin- Palmerston and Estuary

## Summary

Water quality at the Darwin-Palmerston upper estuary monitoring sites was in excellent condition. Water quality at the freshwater monitoring sites in 2011 was in excellent condition. The water-bug community at the biological monitoring sites was assessed as significantly impaired at one site and severely impaired at the second site.



## Nature of system

- Long residence time and poor flushing in the tidal creeks
- Light limitation is possible in the upper reaches of estuarine creeks during the wet season due to high turbidity
- A large proportion of the catchment has been cleared and urbanised






































## Potential sources of pollution

- Sewage treatment plants with wastewater discharge from Darwin at Bleezers Creek and Palmerston at Myrmidon Creek
- High sediment, nutrient and other human-related pollutant loads during the wet season from established areas or recent urban developments



*New suburban development of Johnston*

## Darwin-Palmerston freshwater and marine water quality

Indicator and units	Water quality objective freshwater	Compliance freshwater	Water quality objective marine	Compliance Darwin-Palmerston marine	Compliance Myrmidon Ck marine
 <b>Electrical conductivity</b> (µS/cm)	<200	83.5 	NA		
 <b>Turbidity</b> (NTU)	<20	11.3 	NA		
 <b>pH</b>	6.0–7.5	6.1–6.8 	6–8.5	7.1–7.9 	7.3–8 
 <b>Dissolved oxygen</b> (%)	50–100	54–81 	80–100	*	*
 <b>Total suspended solids</b> (mg/L)	<5	3 	<10	*	*
 <b>Chlorophyll a</b> (µg/L)	<2	0.3 	<4	1 	1 
 <b>NOx</b> (µg N/L)	<8	2.2 	<20	3 	5 
 <b>Ammonia</b> (µg N/L)	NA		<20	8 	16 
 <b>Total nitrogen</b> (µg N/L)	<230	145 	<300	210 	190 
 <b>Total phosphorus</b> (µg P/L)	<10	10 	<30	15 	30 
 <b>Filterable reactive phosphorus</b> (µg P/L)	<5	4.5 	<10	4 	6 
<b>Number of samples</b>		2		16	10–13
<b>2011 rating</b>					**
<b>2010 rating (2009 data)</b>		A		A	
<b>2009 rating (2001–2008 data)</b>		A		B	

Note<sup>1</sup>: (nd). Limited or no data available. Note<sup>2</sup>: (NA). Not applicable, no WQO developed \* WQO currently under revision.

\*\* This year the Myrmidon Creek estuary has not been given a water quality rating. The Myrmidon Creek estuary water quality is highly variable in terms of its spatial variability of indicators and hydrodynamic flow. It is considered to be well flushed. For example, nutrient and chlorophyll values were highly variable even though several additional sites were sampled on several occasions on a short-term basis. A sampling protocol is currently being developed to better represent the high spatial variability of this system to better represent an appropriate rating.

The Myrmidon Creek estuary is influenced by the treated wastewater discharged from the Palmerston sewage treatment plant outfall. The treatment plant is subject to a Waste Discharge Licence. The licensed mixing zone is yet to be fully determined. It is possible that the monitoring sites are located within the discharge mixing zone, and that the water quality objectives may not apply. The wastewater is treated by waste stabilisation lagoons utilising a combination of sunlight, micro-organisms and algae to break down the raw wastewater. The presence of elevated concentrations of chlorophyll in Myrmidon Creek estuary may be largely due to the algae present in the treated wastewater discharge.

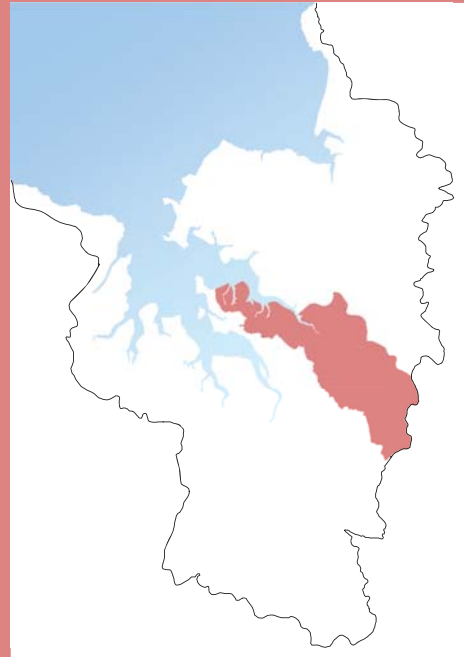
## Biological health using the AUSRIVAS score

Site	2009	2010	Change
DW23	A	C	Change
DW41	B	B	No change

# Elizabeth River and Estuary

## Summary

Water quality at the upper estuary monitoring sites was in excellent condition. Water quality at the freshwater monitoring sites was in very good condition in 2011. The water-bug community at most biological monitoring sites was assessed as being similar to reference condition.



## Nature of system

- Long residence time and poor flushing in the upper estuary
- Higher salinities in upper estuary during the dry season with no freshwater inputs
- Possible light limitation of the upper reaches of the estuary during the wet season due to high turbidity































## Potential sources of pollution

- Sediment and nutrient loads during the wet season from diffuse sources





## Elizabeth River freshwater and marine water quality

Indicator and units	Freshwater		Marine	
	Water quality objective	Compliance	Water quality objective	Compliance
 <b>Electrical conductivity</b> ( $\mu\text{S/cm}$ )	<200	21 	NA	
 <b>Turbidity</b> (NTU)	<20	3.7 	NA	
 <b>pH</b>	6.0–7.5	6.4–7.2 	6–8.5	7.3–8.1 
 <b>Dissolved oxygen</b> (%)	50–100	70–91 	80–100	*
 <b>Total suspended solids</b> (mg/L)	<5	2 	<10	*
 <b>Chlorophyll a</b> ( $\mu\text{g/L}$ )	<2	0.6 	<4	1 
 <b>NO<sub>x</sub></b> ( $\mu\text{g N/L}$ )	<8	5 	<20	7 
 <b>Ammonia</b> ( $\mu\text{g N/L}$ )	NA		<20	15 
 <b>Total nitrogen</b> ( $\mu\text{g N/L}$ )	<230	170 	<300	250 
 <b>Total phosphorus</b> ( $\mu\text{g P/L}$ )	<10	15 	<30	15 
 <b>Filterable reactive phosphorus</b> ( $\mu\text{g P/L}$ )	<5	5 	<10	4 
<b>Number of samples</b>		9		49–54
<b>2011 rating</b>				
<b>2010 rating (2009 data)</b>		A		A
<b>2009 rating (2001–2008 data)</b>		A		C

Note<sup>1</sup>: (nd). Limited or no data available Note<sup>2</sup>: (NA). Not applicable, no WQO developed \* WQO currently under revision.

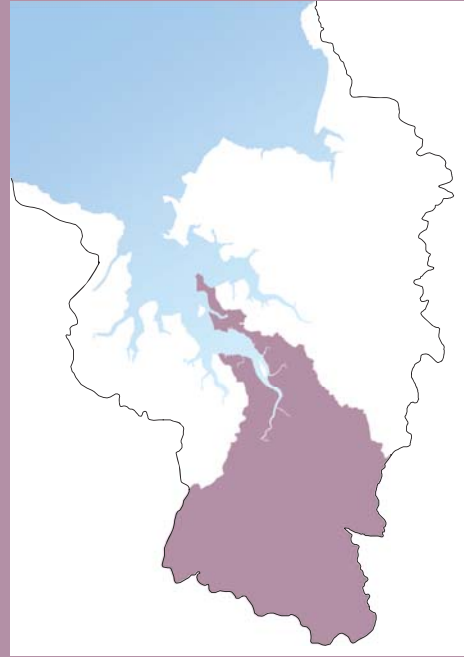
## Biological health using the AUSRIVAS score

Site	2009	2010	Change
DW26	A	A	No change
DW39	A	A	No change
DW40	A	A	No change
DW44	A	B	Change
DW52	A	A	No change
DW53	A	A	No change
DW71	A	A	No change
DW72	A	A	No change

# Blackmore River and Estuary

## Summary

Water quality at the upper estuary monitoring sites was in moderate condition. Water quality at the freshwater monitoring sites was in moderate condition. The water-bug community at the biological monitoring sites was assessed as being similar to reference condition, with two sites assessed as more biologically diverse than reference condition.



## Nature of system

- Long residence time and poor flushing in the upper estuary
- Potentially light limitation of the upper reaches of the estuary during the wet season
- Minor freshwater flows are maintained by Darwin River Dam and Berry Creek during the dry season































## Potential sources of pollution

- Several licensed aquaculture operations are located in the catchment and discharge into the Blackmore estuary
- Sediment and nutrient loads during the wet season from diffuse sources



*Blackmore River downstream of Cox Peninsula Road bridge*

## Blackmore River freshwater and marine water quality

Indicator and units	Freshwater		Marine	
	Water quality objective	Compliance	Water quality objective	Compliance
 <b>Electrical conductivity</b> ( $\mu\text{S}/\text{cm}$ )	<200	32.5 	NA	
 <b>Turbidity</b> (NTU)	<20	6.5 	NA	
 <b>pH</b>	6.0–7.5	5.7–6.2 	6–8.5	7.2–8 
 <b>Dissolved oxygen</b> (%)	50–100	64–72 	80–100	*
 <b>Total suspended solids</b> (mg/L)	<5	5.5 	<10	*
 <b>Chlorophyll a</b> ( $\mu\text{g}/\text{L}$ )	<2	1.9 	<4	3 
 <b>NO<sub>x</sub></b> ( $\mu\text{g N}/\text{L}$ )	<8	7 	<20	12 
 <b>Ammonia</b> ( $\mu\text{g N}/\text{L}$ )	NA		<20	27 
 <b>Total nitrogen</b> ( $\mu\text{g N}/\text{L}$ )	<230	240 	<300	305 
 <b>Total phosphorus</b> ( $\mu\text{g P}/\text{L}$ )	<10	15 	<30	35 
 <b>Filterable reactive phosphorus</b> ( $\mu\text{g P}/\text{L}$ )	<5	6.5 	<10	6 
<b>Number of samples</b>		8		31–40
<b>2011 rating</b>				
<b>2010 rating</b> (2009 data)		C		B
<b>2009 rating</b> (2001–2008 data)		B		B

Note1: (nd). Limited or no data available Note2: (NA). Not applicable, no WQO developed Note3: Pioneer Creek, just outside the Blackmore catchment, is included in the data and is the most western freshwater system systematically sampled in the catchment. \* WQO currently under revision.

## Biological health using the AUSRIVAS score

Site	2009	2010	Change
DW31	A	A	No change
DW36	A	A	No change
DW37	A	X	Change
DW46	A	A	No change
DW47	B	A	Change
DW73	A	A	No change
DW74	A	A	No change
DW75	A	X	Change

# Shoal Bay and Buffalo Creek

## Summary

Water quality in outer Shoal Bay was in excellent condition. Water quality at Shoal Bay upper estuary monitoring sites was in moderate condition. Water quality at freshwater sites was in very good condition for the 2011 reporting year. The water-bug community at the biological monitoring sites was assessed as similar to reference condition at two sites and significantly impaired at two sites. Water quality at the estuary monitoring site in Buffalo Creek was in very poor condition. For some water quality indicators in Buffalo Creek, water quality objectives were greatly exceeded.



## Nature of system

- Shallow embayment with series of sandbars changing with tides
- Possible light limitation of upper reaches of the estuary/marine waters during the wet season
- Perennial freshwater inflows from Howard River















## Potential sources of pollution

- Wet season diffuse source loads from the Howard and Shoal Bay sub-catchments
- Sediment and nutrient loads are high with runoff during the wet season
- Sewage treatment plant wastewater discharges to upper Buffalo Creek. Of note, in October 2011, the Territory Government improved and modernised the licensing regime for sewage treatment plant discharges into Darwin Harbour, including by increasing the monitoring and reporting requirements and focussing on improvements in wastewater discharge quality over time.











*Aerial view across part of southern Shoal Bay region towards Buffalo Creek and Darwin Hospital.  
Photo: Barry Ledwidge*

## Shoal Bay freshwater and marine water quality

Indicator and units	Freshwater		Outer Marine		Upper Estuary Marine	
	Water quality objective	Compliance	Water quality objective	Compliance	Water quality objective	Compliance
 <b>Electrical conductivity</b> (µS/cm)	<200	23 ✓	NA		NA	
 <b>Turbidity</b> (NTU)	<20	3.9 ✓	NA		NA	
 <b>pH</b>	6.0–7.5	6.8-7.3 ✓	7.0–8.5	7.8-8.2 ✓	6–8.5	7.7-8.1 ✓
 <b>Dissolved oxygen</b> (%)	50–100	79-88 ✓	80–100	*	80–100	*
 <b>Total suspended solids</b> (mg/L)	<5	3 ✓	<10	*	<10	*
 <b>Chlorophyll a</b> (µg/L)	<2	0.25 ✓	<2	1 ✓	<4	3 ✓
 <b>NOx</b> (µg N/L)	<8	4 ✓	<20	2 ✓	<20	2 ✓
 <b>Ammonia</b> (µg N/L)	NA		<20	5 ✓	<20	25 ✗
 <b>Total nitrogen</b> (µg N/L)	<230	165 ✓	<270	150 ✓	<300	310 ✗
 <b>Total phosphorus</b> (µg P/L)	<10	10 ✓	<20	5 ✓	<30	45 ✗
 <b>Filterable reactive phosphorus</b> (µg P/L)	<5	6.5 ✗	<5	2 ✓	<10	6 ✓
<b>Number of samples</b>		4		8		8
<b>2011 rating</b>						
<b>2010 rating</b> (2009 data)		B		A		C
<b>2009 rating</b> (2001–2008 data)		C		A		C

Note<sup>1</sup>: (nd). Limited or no data available Note<sup>2</sup>: (NA). Not applicable, no WQO developed \* WQO currently under revision.  
 Note that many of the median nutrient concentrations for the Shoal Bay upper estuary marine sites at Mickett Creek and Howard River estuary only exceeded the water quality objectives by a small amount. For example, the median total nitrogen concentration for the Shoal Bay upper estuary marine sites exceeded the water quality objective by only 3%.

## Buffalo Creek marine water quality

Indicator and units	Water quality objective	Compliance
 pH	6–8.5	7.3–7.8 ✓
 Chlorophyll a (µg/L)	<4	45 ✗
 NO <sub>x</sub> (µg N/L)	<20	40 ✗
 Ammonia (µg N/L)	<20	1775 ✗
 Total nitrogen (µg N/L)	<300	2735 ✗
 Total phosphorus (µg P/L)	<30	548 ✗
 Filterable reactive phosphorus (µg P/L)	<10	326 ✗
<b>Number of samples</b>		4
<b>2011 rating</b>		
<b>2010 rating</b> (2009 data)		E
<b>2009 rating</b> (2001–2008 data)		E
* WQO currently under revision. The Buffalo Creek monitoring site in the estuary is influenced by the treated wastewater discharged from the Leanyer-Sanderson sewage treatment plant outfall. The treatment plant is subject to a Waste Discharge Licence. The licensed mixing zone is yet to be fully determined. It is possible that the Buffalo Creek monitoring sites are located within the discharge mixing zone, and that the water quality objectives may not apply to this site. The Leanyer-Sanderson wastewater is treated by waste stabilisation lagoons utilising a combination of sunlight, micro-organisms and algae to break down the raw wastewater. The presence of elevated concentrations of chlorophyll in Buffalo Creek may be largely due to the algae present in the treated wastewater discharge.		

## Biological health using the AUSRIVAS score

Site	2009	2010	Change
DW42	A	B	Change
DW43	B	B	No change
DW45	A	A	No change
DW70	A	A	No change



*Mangroves are a feature of Shoal Bay*

# West Arm and Woods Inlet

## Summary

Water quality at the West Arm and Woods Inlet upper estuary monitoring sites was in excellent condition.

## Nature of system

- Stream and riparian areas intact
- Large areas dry on spring tides in West Arm
- Extensive mangrove habitat and inter-tidal mudflats
- Minimal development in this region
- Most remote from development impacts within the Harbour, hence commonly considered as 'reference' condition
- Considered to have minimal pollution

## Potential sources of pollution









- Sediment and nutrients from catchment diffuse sources during the wet season



*Sampling oysters (*Saccostrea cucullata*) for assessing micropollutant levels at a reef in West Arm. This area is commonly considered to be a "reference" area with minimal human impacts.*



West Arm and Woods Inlet marine water quality

Indicator and units	Water quality objective	Compliance
 pH	6–8.5	7.4–8.1 ✓
 Chlorophyll a (µg/L)	<4	1 ✓
 NOx (µg N/L)	<20	2 ✓
 Ammonia (µg N/L)	<20	6 ✓
 Total nitrogen (µg N/L)	<300	180 ✓
 Total phosphorus (µg P/L)	<30	10 ✓
 Filterable reactive phosphorus (µg P/L)	<10	4 ✓
<b>Number of samples</b>		16
<b>2011 rating</b>		
<b>2010 rating</b> (2009 data)		A
<b>2009 rating</b> (2001–2008 data)		nd
<p>Note<sup>1</sup>: (nd). Limited or no data available Note<sup>2</sup>: (NA). Not applicable, no WQO developed                      No freshwater or biological sites are routinely monitored in this region because the freshwater section of the streams is very short and flows for only a very brief part of the year.</p>		

### Further reading

Darwin Harbour Region Report Cards for 2009 and 2010:

<http://www.nt.gov.au/nreta/water/reportcards/2009/index.html>

<http://www.nt.gov.au/nreta/water/reportcards/2010/index.html>

Darwin beaches water quality:

<http://www.greeningnt.nt.gov.au/>

<http://www.health.nt.gov.au/>

Reports on water quality and biological health from the Aquatic Health Unit:

<http://www.nt.gov.au/nreta/water/aquatic/publications/index.html>

<http://www.nt.gov.au/nreta/water/aquatic/ausrivas/index.html>

Water Sensitive Urban Design Strategy for Darwin Harbour, Darwin Harbour Strategy, and Darwin Harbour Water Quality Protection Plan:

<http://www.nt.gov.au/lands/planning/wsud/index.html>

<http://www.nt.gov.au/nreta/water/quality/index.html>



