Environmental Values, Water Quality Objectives and Targets for the Black Ross Water Quality Improvement Plan

December 2009

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1. Introduction

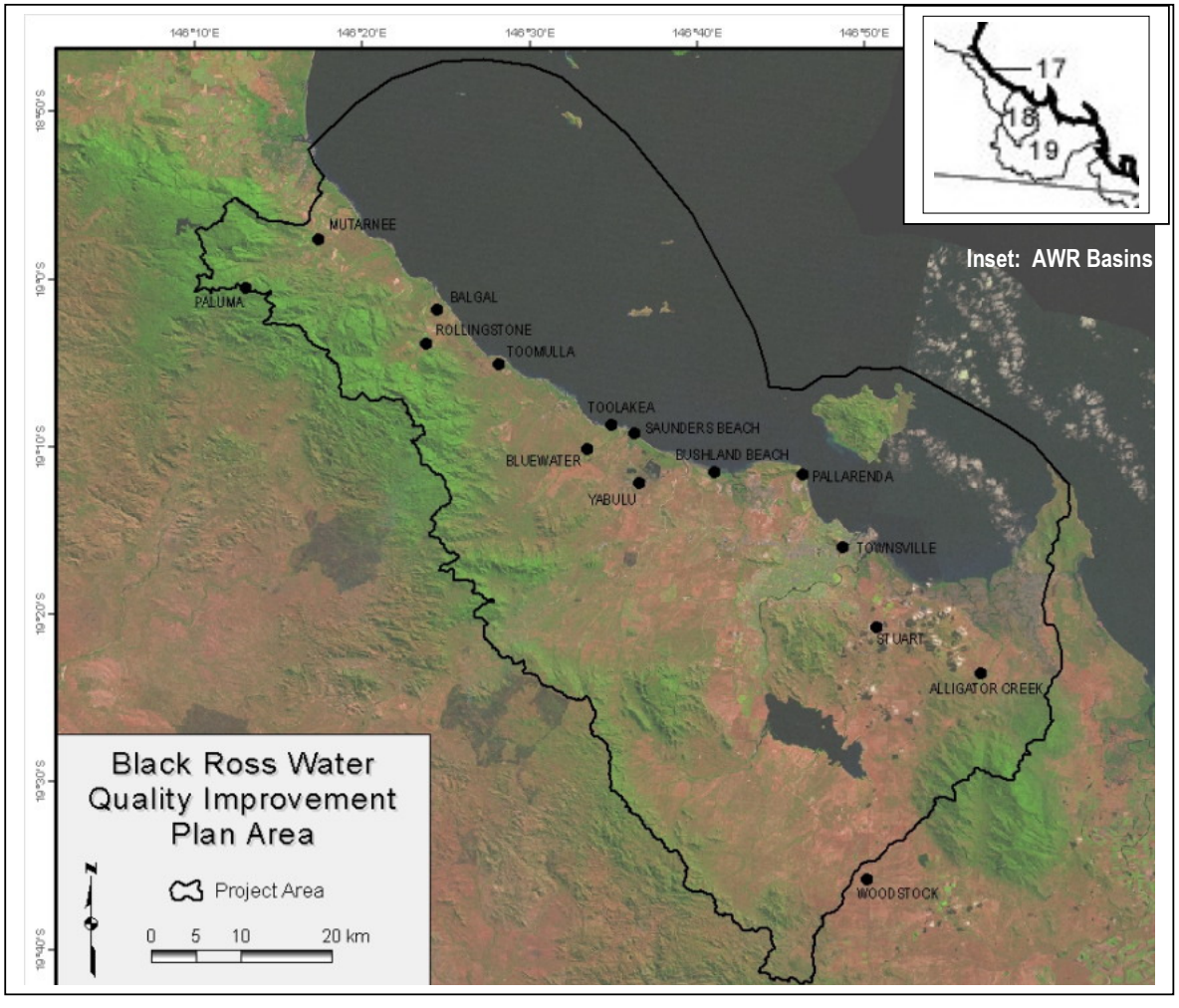
1.1 Background

Creek to Coral, Townsville City Council's healthy waterways initiative, managed the Coastal Catchments Initiative (CCI) project for the Black and Ross River Basins and along with its many partners was responsible for the preparation of a Water Quality Improvement Plan (WQIP). The Black Ross (Townsville) WQIP includes a number of elements including the establishment of environmental values and water quality objectives for the waterways and waters of the Black Ross (Townsville) WQIP area, and the determination of load based water quality targets for the receiving waters draining the Black and Ross River Basins and Magnetic Island. The process described in the National Water Quality Management Strategy was used as a guide to establish the environmental values and water quality objectives for the Black Ross (Townsville) WQIP area.

1.2 Black Ross WQIP Area

The Black Ross (Townsville) WQIP area covers most waterways within the Townsville City Council local government area with the exception of the Reid River and Major Creek catchments, which are part of the Haughton River Basin. The WQIP area includes the Black River (No. 17) and Ross River (No. 18) Australian Water Resource Council (AWR) Basins and a small part of the Haughton River Basin (No. 19), where the waterways flow to Cleveland Bay. It also includes Magnetic Island, as well as the coastal and marine waters of Cleveland Bay and Halifax Bay (see Figure 1.1).

Figure 1.1 Black Ross WQIP Area



1.3 National Water Quality Management Strategy

The National Water Quality Management Strategy (NWQMS) has been jointly developed by the Australian Government in cooperation with state and territory governments since 1992, currently administered under the Natural Resource Management Ministerial Council. The NWQMS is part of the Council of Australian Governments' (COAG) Water Reform Framework and is acknowledged in the National Water Initiative.

The NWQMS has three major elements: policies, process and guidelines.

"*The main policy objective of the NWQMS is to achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development*".

The NWQMS process involves community and government development and implementation of a management plan for each catchment, aquifer, estuary, coastal water or other waterbody. This includes use of high-status national guidelines with local implementation.

There are currently 21 NWQMS guidelines for managing key elements of the water cycle. The NWQMS guidelines cover:

- Policies and processes to achieve water quality;
- Effluent and sewerage system management;
- Urban stormwater and recycled water;
- Fresh and marine water quality;
- Monitoring and reporting;
- Groundwater protection; and
- Drinking water.

(Source: http://www.environment.gov.au/water/quality/nwqms/)

Components of Queensland's *Environmental Protection (Water) Policy 2009* (EPP Water) are based on the National Water Quality Management Strategy (NWQMS 2000). The EPP Water is subordinate legislation of the *Environmental Protection Act 1994* (EP Act), and was recently revised, replacing the 1997 version of the EPP Water. The object of the EPP Water, as identified by the EP Act, is to protect Queensland's waters while allowing for development that is ecologically sustainable. This purpose is achieved within a framework that includes:

- Identifying ***Environmental Values*** for Queensland waters; and
- Deciding and stating water quality guidelines and ***Water Quality Objectives*** to enhance or protect the environmental values.

Environmental Values (EVs) and Water Quality Objectives (WQOs) can be included in Schedule 1 of the EPP Water.

Various NWQMS documents and processes are used to assist with the determination of EVs and WQOs with the most relevant being the *Implementation Guidelines* (1998) and the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)*.

(Source: http://www.epa.qld.gov.au/environmental_management/water/ environmental _values__environmental_protection _water_policy_1997/)

Additionally Queensland now has a set of water quality guidelines, which are used as default guidelines unless local water quality guidelines have been prepared for the subject area.

The NWQMS has a particular terminology and definition set, which places the EVs and WQOs in context.

1.4 Definitions and Terminology

Environmental Values

The particular values or uses of the environment that contribute to public or private benefits (welfare) are called environmental values or beneficial uses. The determination of the regional community's preferred values and uses is an essential step in developing a water quality management program. (ARMCANZ/ANZECC 1994a, p.5)

The environmental values originally defined in the "*Australian Water Quality Guidelines for Fresh and Marine Waters*" (ANZECC 1992) were:

- Protection of Aquatic Ecosystems
    - Freshwater and marine ecosystems, production of fish and shellfish, wildlife protection.
- Recreational Water Quality and Aesthetics
    - Primary and secondary contact, visual appreciation.
- Raw Water for Drinking Water Supply
- Agricultural Water Use
    - Irrigation, stock watering, farmstead use
- Industrial Water Quality

(ARMCANZ/ANZECC 1994a, p.6)

Environmental values were updated and added to in the 2000 revision of the *Australian and New Zealand Guidelines for fresh and marine water quality (ANZECC 2000).*

Environmental values (EVs) are those qualities of the waterway that make it suitable to support particular aquatic ecosystems and human uses. These qualities require protection from the effects of pollution such as waste discharges, siltation and runoff. All waterways will possess at least one of the EVs listed (i.e. protection of aquatic ecosystems) and, in most cases, other human uses (e.g. irrigation, stock watering, drinking water, recreational uses) will also apply (EPA 2005, p.3).

Currently EVs are divided into two primary categories:

1. Aquatic ecosystem, and
2. Human use.

Human use EVs are further divided into types of human (beneficial) use while aquatic ecosystem EVs are divided into condition classes reflecting the degree of modification from natural conditions (see Table 1-1).

Water quality guidelines

A water quality guideline is a numerical concentration limit or narrative statement recommended to support and maintain a designated use of the water resource (GBRMPA 2008, p.23). Water quality guidelines are identified for different water quality indicators, such as pH, nutrients, heavy metals, pesticides, suspended solids, water clarity/turbidity, salinity, dissolved oxygen, and biological indicators (e.g. macroinvertebrate counts, seagrass distribution)(EPA 2005, p.4). As previously mentioned there are national water quality guidelines and water quality guidelines for Queensland. At present there are no local water guidelines for the Black Ross WQIP area.

Water Quality Objectives

Water Quality Objectives (WQOs) are established to protect the environmental values of waterways in the area of interest. Where more than one EV is identified for a waterway (e.g. water suitable for both irrigation and aquatic ecosystems), the water quality guidelines to support each EV should be identified and the most stringent guideline for each water quality indicator is selected as the draft WQO i.e. it will protect all identified EVs.

Draft WQOs are based on the community's initial choices for EVs and the subsequent identification of water quality guidelines to protect the EVs. Regional Natural Resource Management (NRM) bodies (and others) are encouraged to use this process to get to the draft WQOs, which they can then adopt, or use as the basis for water quality targets in NRM plans (EPA 2005, p.4).

Table 1-1 Environmental Value Definitions

EV symbol	Symbol	Interpretation
	**Aquatic Ecosystems**	Supporting pristine or modified Aquatic Ecosystems. There are three Levels of Protection: High conservation/ecological value systems (HCV or HEV). They are often found within national parks, conservation reserves or inaccessible locations. Slightly to moderately disturbed systems (SMD). These systems have undergone some changes but are not considered so degraded as to be highly disturbed. Highly disturbed systems (HD). These are degraded systems likely to have lower levels of naturalness. These systems may still retain some ecological or conservation values that require protecting. Targets for these systems are likely to be less stringent and may be aimed at remediation and recovery or retaining a functional but highly modified ecosystem that supports other environmental values also assigned to it. See further details in EPA (2005) for each level of protection.
Human Use (Beneficial use)		
	Irrigation	Irrigating crops such as sugar cane, lucerne, etc
	Stock watering	Water for stock e.g. cattle, horses, sheep
	Farm use	Water for farm use such as in fruit packing or milking sheds, etc
	Aquaculture	Water for aquaculture such as barramundi or red claw farming
	Human consumption	Human consumption of wild or stocked fish or crustaceans
	Primary recreation	Primary recreation with direct contact with water such as swimming or snorkelling
	Secondary recreation	Secondary recreation with indirect contact with water such as boating, canoeing or sailing
	Visual appreciation	Visual appreciation with no contact with water such as picnicking, bushwalking, sightseeing
	Drinking	Raw drinking water supplies for human consumption
	Industrial	Water for industrial use such as power generation, manufacturing plants
	Cultural & Spiritual	Cultural and spiritual values including the cultural values of traditional owners

Note: The Slightly to Moderately Disturbed aquatic ecosystems category was divided into two categories in the 2009 QWQG

Water Quality Targets

Water quality targets can be expressed in a variety of ways including as ambient concentrations, event mean concentrations and loads. Water quality targets can be expressed in relation to the WQOs (ambient concentrations) for an area of interest and, in some cases, can be a direct translation of the WQOs.

If water quality monitoring information is available to determine the existing water quality condition of waterways then targets may be different from WQOs especially if current condition is 'better' than the WQOs. In that case the appropriate water quality targets will be more closely aligned to the current condition of the waterways than to the WQOs.

When the current condition of a waterway is 'worse' than the WQOs then an analysis of the likely improvement that could be achieved with available resources would be employed to determine a realistic water quality target, which may be an interim step to achieving the WQO over time.

It needs to be recognised that in terms of the NWQMS, draft WQOs and water quality targets relate to ambient conditions and are different from the load targets that were required to be established as part of the Black Ross WQIP.

In the context of the Black Ross WQIP water quality targets are an expression of the anticipated achievement from implementation of water quality improvement actions, and are expressed as both load based targets, and event mean concentration targets for developing areas.

1.5 Catchment Management

The NWQMS (ARMCANZ/ANZECC 1994a) identified State agencies as the most likely entity for determining EVs and associated WQOs. Following on from the initial success of the Landcare movement the establishment of catchment management structures was seen as the main process for addressing issues associated with diffuse water pollution and erosion. The intent was to encourage more strategic community participation with consultative processes used for determination of such things as EVs. Catchment management in Queensland is a voluntary process for building community ownership of water quality and other environmental goals. Legislative or State government management structures are only used to assist in achieving outcomes when voluntary mechanisms are not adequate to deal with the issues.

Catchment management groups, and more recently regional NRM bodies, have been responsible for developing goal-based catchment and NRM regional plans. These participatory structures and processes are also useful for the development of WQIPs, which are in essence a more detailed sub component of a catchment management plan. Following the participatory determination of environmental values, water quality objectives and draft water quality targets the development of strategic plans for water quality management is based both on specific catchments as well as cross-catchment based themes.

In a similar vein to catchment management planning WQIPs are intended to:

- Promote control of diffuse sources not amenable to licensing;
- Encourage sound land use practices, which minimise diffuse pollution;
- Provide an integrated approach to water quality monitoring and reporting;
- Co-ordinate the activities of governmental authorities and private interests within and across catchments to achieve water quality improvements.

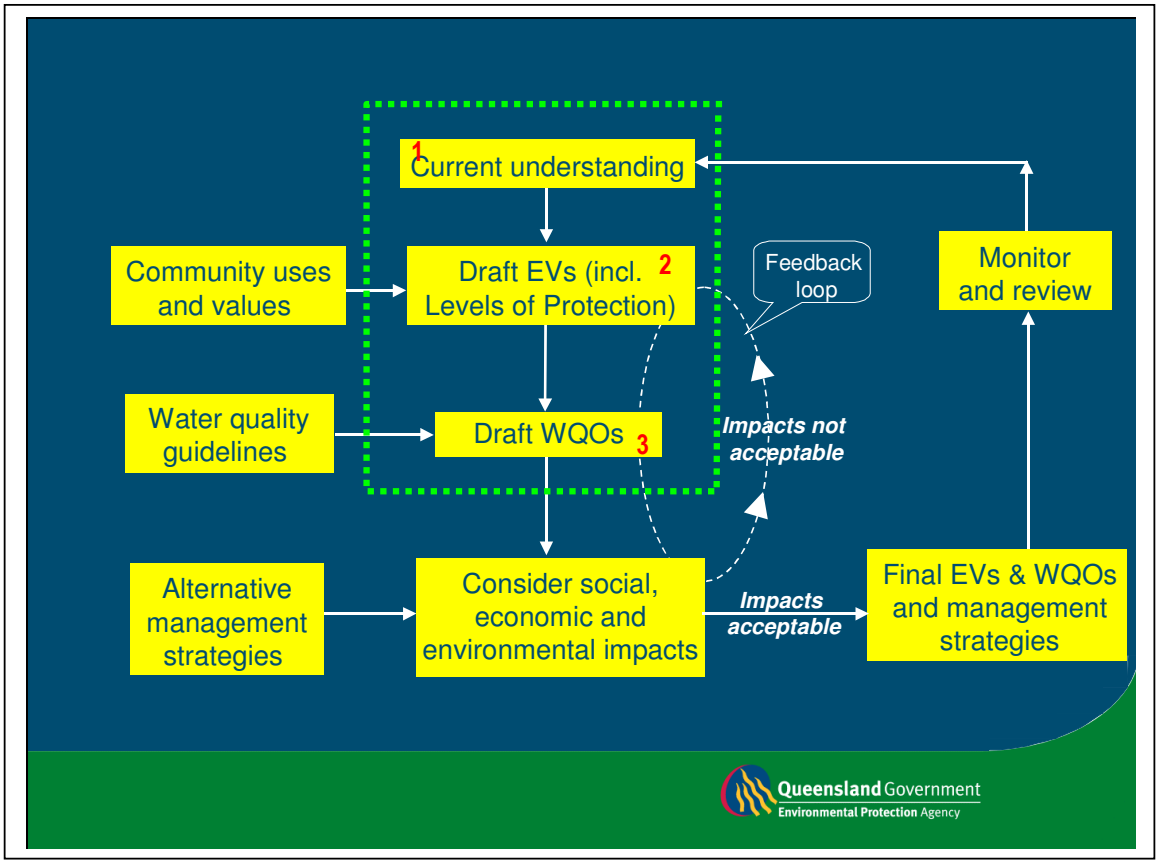
In the Black Ross WQIP area Townsville City Council's Creek to Coral initiative has assumed the role of a catchment management or regional NRM body to manage the preparation of the WQIP and provide an inclusive platform for community and stakeholder organisations input to goal setting and plan development.

As there is a significant urban population centre within the Black Ross WQIP area the Black Ross WQIP will necessarily combine the voluntary catchment management approach with the requirements and mechanisms of Queensland legislation to develop management strategies and actions that are both inclusive of community views and consistent with regulatory requirements.

1.6 Process for establishing draft EVs and WQOs

The initial three stages for identifying the current condition of waterways and establishing draft EVs and draft WQOs for specific waterways and waters, as per the NWQMS framework, are described briefly below (see Figure 1.2).

Figure 1.2 Water Quality Management Framework



Source: John Bennett (DERM/EPA)

The main areas of interest from the framework are the initial stages (i.e. in the green broken line box):

1. Stage 1 Information report;
2. Stage 2 Draft environmental values (includes input from community consultation); and
3. Stage 3 Draft water quality objectives (includes consideration of available water quality guidelines, with preference for locally derived guidelines)

1.6.1 Information report

This stage is about gathering and collating background information including water quality condition and any data that could be used for establishing environmental values and local water quality guidelines. This is the time to invite stakeholders who are involved in natural resource management to contribute information and expertise to assist with compilation of the background information. The background information can be used to provide a starting point for determining draft high ecological value waterways and waterbodies, and setting the scene for stakeholder and community consultation.

The type of information used to assist in identifying high ecological value waterways and waterbodies, based on aquatic ecosystem values and condition includes:

- Protected estate (e.g. national parks, fish habitat areas, marine park protection zones, etc.);
- Other designations of high ecological values e.g. in coastal management plans or other planning schemes;
- Areas or species/taxa/communities identified as being under 'threat' from current and/or future land use/water use activities;
- Areas/locations of suspected or known high ecological/conservation values, including good condition, high natural biodiversity, presence of rare/threatened species/taxa/communities, or displaying other special features; and
- Areas of identified ecosystem values to traditional owners.

Background information on human use environmental values (beneficial uses) e.g. irrigation supply, also needs to be collated and included in an information report.

1.6.2 Draft environmental values

Draft environmental values are established through a consultation process with stakeholders and the broader community. The background information prepared in the initial stage is used to provide the concepts, context and a starting point for participants involved in determining draft EVs. Stakeholder and community views are collated in relation to the:

- Condition of aquatic ecosystems;
- Current and future (where possible) human uses of waterways;
- Identification of water quality issues; and
- Any additional relevant details e.g. additional scientific studies, information on point and non-point sources of pollution.

(Note: The balancing of these agreed draft EVs with social and economic considerations, leading to final EVs, is part of the broader planning process as shown in Figure 1.2, outside the green broken line box)

1.6.3 Draft water quality objectives

Following stakeholder and community consultation and the establishment of draft EVs, the draft EVs are then related to the relevant available water quality guidelines to produce the draft water quality objectives (WQOs).

The draft WQOs then need to be reviewed in terms of practical management strategies and the associated environmental, economic and social impacts. Determination of 'final' WQOs for the Black Ross WQIP area, which will be based on the development of local water quality guidelines, will be done as part of the Black Ross WQIP implementation process.

1.6.4 Draft water quality targets

Draft (ambient) water quality targets are similar to WQOs and are determined through comparing draft WQOs with existing water quality monitoring information, and then analysing potential management interventions and associated triple bottom line impacts.

In terms of the Australian Government's requirements for WQIPs, water quality targets are load based. It is recommended that the determination of end of catchment load based water quality targets for WQIPs should be informed by an understanding of:

- Water quality objectives for ecosystem health determined by the water quality required to sustain the GBR environments; and
- Achievable water quality objectives based on the modelling of management scenarios.

This recognises that setting load based water quality targets requires an understanding of both the water quality required to sustain the desired ecological condition of the receiving waters (WQOs for ecosystem health), and the degree of water quality improvement that can be achieved from the implementation of existing management practices (achievable WQOs based on management scenarios). Catchment and receiving water models provide the methods to link management practice change with water quality and aquatic ecosystem health.

End-of-catchment water quality load targets are a contractual obligation under WQIPs with the responsibility for setting targets resting with the team developing the WQIP for their region. Where possible target setting should be supported by the best available science information and knowledge.
(Source: Notes for the Water Quality Target Setting Workshop – Supporting Water Quality Improvement Plans, Tues 11th October 2006, Townsville – CSIRO Davies Laboratory)

While some water quality modelling has been undertaken during the preparation of the Black Ross WQIP, linking ambient marine WQOs with end of catchment load targets for the Black Ross WQIP requires additional time and resources beyond those available through the CCI project funding. It is intended that the linkage will be made as part of the Black Ross WQIP implementation process.

For further information on water quality modelling, end of catchment loads and load based targets see the *Water Quality Pollutant Types and Sources Report: Black Ross Water Quality Improvement Plan* (Gunn and Barker 2009) and the *Black Ross Water Quality Improvement Plan Options, Costs and Benefits Report* (Gunn, and Manning 2009a).

Figure 1.3 Townsville Urban Meets Marine

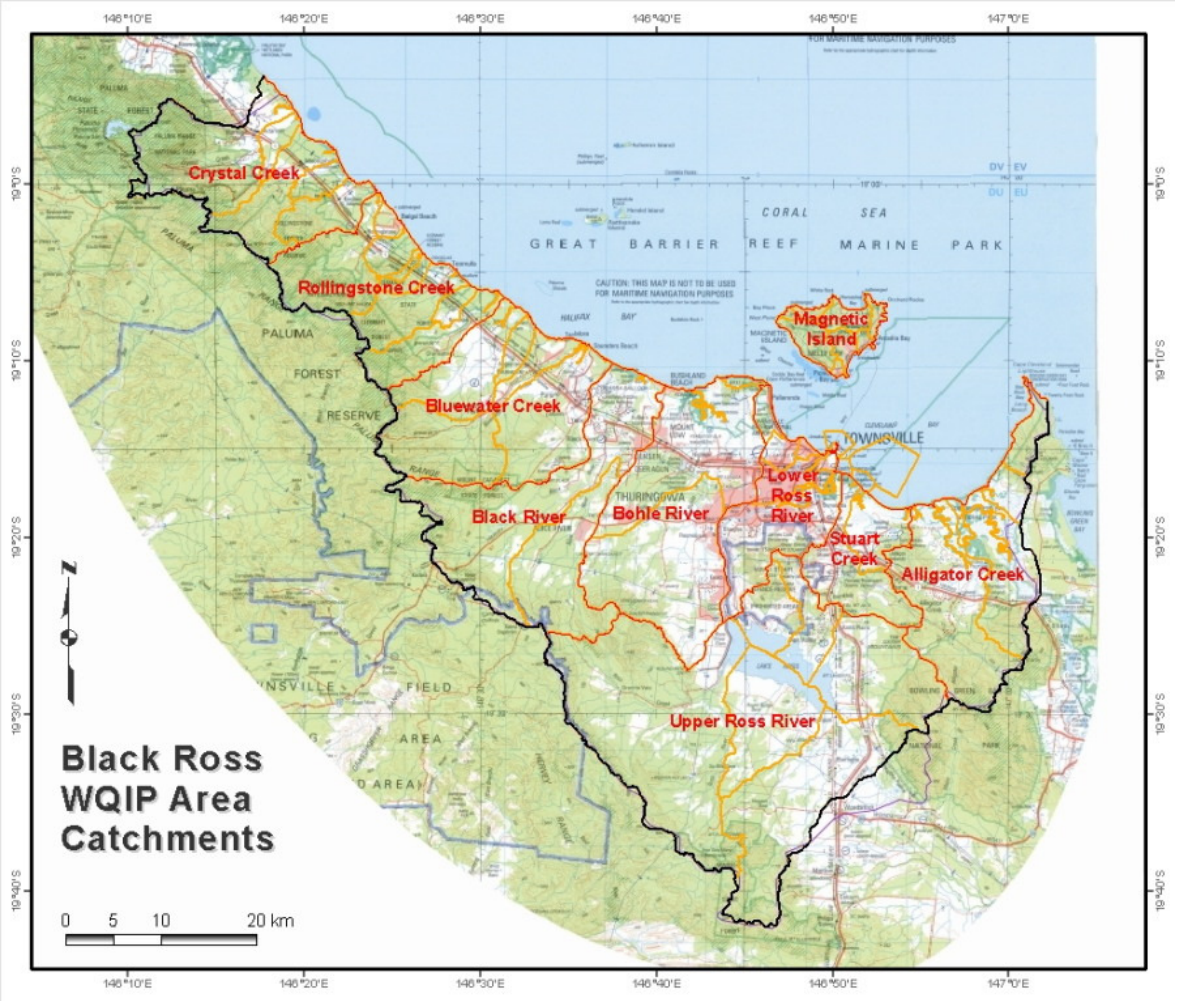
Source: J Gunn

2. Black Ross Environmental Values

2.1 Developing EVs for the Black Ross

The Black Ross WQIP area was divided into 10 sub basins and 47 catchments and sub catchments (see Figure 2.1), as well as a number of marine sections. These divisions were established to assist with condition assessment, monitoring, modelling and reporting. The divisions are also useful in grouping waterways with similar features to assist with determining EVs and WQOs. Profiles of the catchments, sub catchments and associated waterways, wetlands and receiving waters are provided in a separate report (Gunn and Manning 2009b).

Figure 2.1 Black Ross Sub Basins and Catchments



Note: Sub basins are delineated with red lines and catchments with orange lines

A Steering Group was established at the commencement of the Coastal Catchments Initiative (CCI) project to oversee the management of the project including the development of the Black Ross WQIP. Members of the Steering Group, along with other relevant individuals, formed a working group (EVs Working Group) for the purposes of gathering background information and guiding the process of determining draft EVs and WQOs for the Black Ross WQIP area.

The EVs Working Group consisted of members of the Creek to Coral CCI project team as well as staff from the Queensland Environmental Protection Agency (EPA) (now part of the Department of Environment and Resource Management - DERM) (Townsville and Brisbane) and the Great Barrier Reef Marine Park Authority (GBRMPA).

Tasks associated with determining human use EVs were predominantly carried out by the Creek to Coral CCI project team while aquatic ecosystem EVs related tasks were primarily the responsibility of the EPA and GBRMPA teams. The principal tasks undertaken in determining draft EVs for the Black Ross WQIP area are described below.

2.1.1 Human use

An information report and draft set of human use EVs was prepared as background for the community consultation workshops through:

- An initial questionnaire sent out to selected stakeholders. The results were collated and used as the starting point for the information report on human uses;
- A desktop study using a variety of public domain information sources. In some cases individuals were also consulted to clarify or source information; and
- Water extraction licence information provided by the Department of Natural Resources and Water (now included in DERM). This information was used to collate human uses for the waterways in the vicinity of the licenced property based on the purpose noted for the extraction licence.

2.1.2 Aquatic ecosystems

Creek to Coral partners, the EPA and the GBRMPA, took the lead role in collating the background information to determine a preliminary set of aquatic ecosystem high ecological value (HEV) waterways for discussion, and produced the associated mapping.

After the initial compilation of information Creek to Coral and partners hosted an expert panel workshop (12 October 2007) for the freshwaters of the Black Ross WQIP area to review the concepts and draft information.

A similar workshop was held for the estuarine and marine areas in March 2008, in conjunction with the Burdekin WQIP team, for the combined Black Ross WQIP area and the Burdekin WQIP area. The results of both workshops were compiled by the EPA and formed the basis for the draft HEV waterways to be used as a starting point for discussion at the community workshops.

2.2 Community workshops

Community workshops were held in July 2008 facilitated by Creek to Coral, EPA and GBRMPA using the combined background information previously prepared and confirmed/amended at the expert panel workshops. For consultation purposes the Black Ross WQIP sub basins were grouped into 3 main areas (see Figure 2.2):

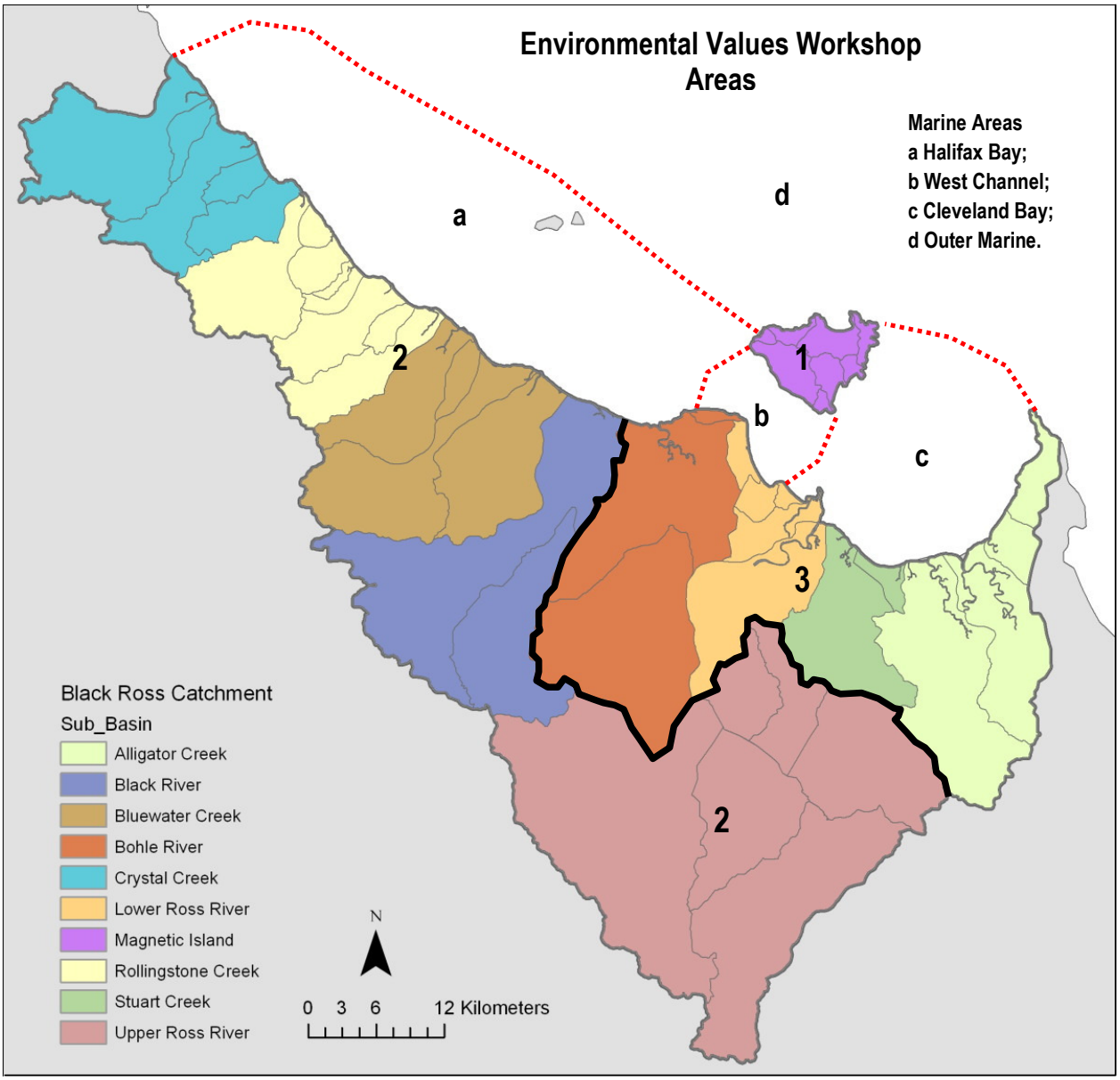
1. Rural (Crystal Creek to Black River and upper Ross River –above the Ross River Dam);
2. Urban and rural residential (lower Ross River, Bohle River, Stuart Creek and Alligator Creek sub basins including Cape Cleveland waterways flowing to Cleveland Bay); and
3. Magnetic Island.

The community workshops were held at:

- Magnetic Island (Arcadia) on 22 July 2008,
- Bluewater on 23 July 2008 (Rural), and
- Annandale on 24 July 2008 (Urban and rural residential).

Creek to Coral compiled workshop results for human use while EPA compiled the results for aquatic ecosystems. Results for marine areas were confirmed by GBRMPA. Human use results were posted on the Creek to Coral website in September 2008 and emailed to workshop participants for review and comment. Comments were incorporated and both the human use and aquatic ecosystem draft results were posted on the Creek to Coral website in January 2009 (**www.creektocoral.org**).

Figure 2.2 EV Consultation Areas



Notes: Area 1 is Magnetic Island, area 2 is Rural and area 3 is Urban and Rural Residential.

Human use environmental values from the workshops are included in Appendix B and aquatic ecosystem results from the workshop, with subsequent amendments and updates, are included as Appendix C.

The combined draft environmental values for the Black Ross WQIP area are displayed in Table 2-1, Table 2-2, Table 2-3, Table 2-4, Table 2-5 and Table 2-6.

The community consultation process for determining EVs and WQOs, in the context of developing the WQIP for the Black Ross, is illustrated in Figure 2.3.

Figure 2.3 Black Ross WQIP Consultation Process

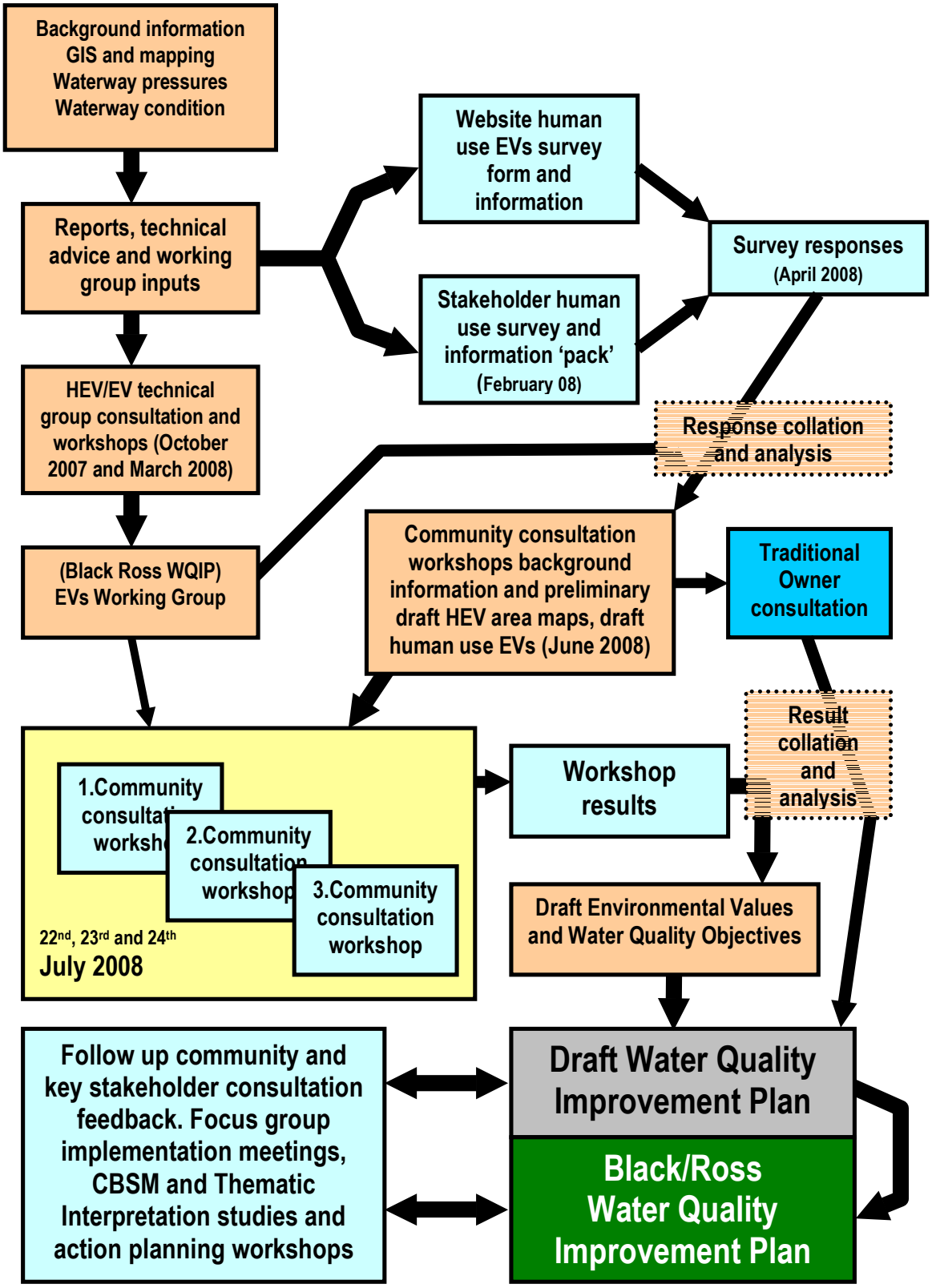


Figure 2.4 Community Workshops

2.2.1 Traditional Owner consultation

Burdekin Dry Tropics NRM (now NQ Dry Tropics) has been working with the Traditional Owners in their NRM region since the start of the Regional NRM planning process and has created a conduit for communication and working with Traditional Owners known as the Burdekin Dry Tropics Traditional Owner Management Group (BDT TOMG). Creek to Coral approached NQ Dry Tropics with the intent of using the established TOMG network as the initial point of contact for Traditional Owner consultation on the Black Ross WQIP.

Creek to Coral attended a TOMG meeting in September 2007 to outline the process for preparing the Black Ross WQIP and communicate the desire to include Traditional Owners of the Black Ross WQIP area in the consultation process for determining EVs of waterways and waters in the Black Ross WQIP area. After the presentation to the TOMG, the group was asked for their ideas on the most effective method/s to engage Traditional Owners in the consultation process.

The advice received was to publicly advertise the request for Traditional Owners to nominate their interest in being involved in identifying the environmental and cultural values of the waterways. Further advice was to continue to liaise with the TOMG, through their coordinator, to disseminate information. An advertisement was subsequently placed in the Townsville Bulletin and Herbert River Express (Ingham) in April 2008, with the view to convening a meeting of interested Traditional Owners prior to the completion of the draft Black Ross WQIP, due for completion by June 2008 (see Figure 2.5).

The ability to arrange a Traditional Owner consultation process while attempting to organise public consultation workshops and finalise a draft WQIP proved too demanding for the Creek to Coral team and it was decided to delay the Traditional Owner specific consultation until there were sufficient resources available to do the job properly. As mentioned above the community consultation workshops were held in July 2008 (following the grant of a time extension to complete the draft WQIP). The TOMG coordinator, Sam Savage, attended the 'urban' workshop held at Annandale and was on the distribution list for the draft results of the workshops with a request that he forward these onto any other interested parties, including members of the TOMG.

Figure 2.5 Traditional Owner Public Notice

PUBLIC NOTICE TO TRADITIONAL OWNERS OF THE COUNTRY ::

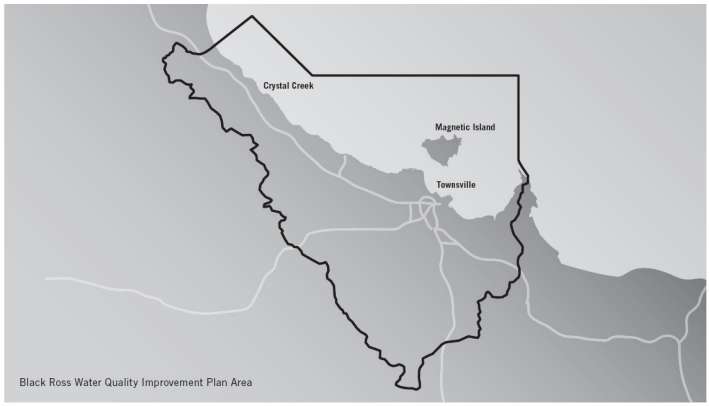
From Crystal Creek to Cape Cleveland and from Herveys Range to the coast, Magnetic Island and surrounding waters, the estuaries and marine waters of Cleveland Bay and Halifax Bay.

The New Townsville City is developing a Water Quality Improvement Plan and would like the input of Traditional Owners to help identify the environmental and cultural values of the waterways, estuaries and marine waters of the study area (see map). The Water Quality Improvement Plan will then look at ways that the areas identified can be protected and managed to improve the water quality.

Traditional Owners interested in being involved in identifying these values are asked to contact Chris Manning (Water Quality Improvement Plan Project Manager) to register their interest. Chris can be contacted on 47278660 or chris.manning@townsville.qld.gov.au

Further information on the WQIP can be found at www.creektocoral.org

A survey is also available on the website and can be downloaded and sent back. In addition, there will be community consultation workshops in mid May to identify environmental values and uses of the waterways in the study area.



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our waterways - our responsibility

THE NEW TOWNSVILLE CITY

1 CITY COMMUNITY COUNCIL DIRECTION

Following the compilation of the results of the community workshops Creek to Coral attended another meeting of the BDT TOMG and presented the draft findings of the community consultation on EVs of the waterways and waters of the Black Ross WQIP area. The TOMG was advised that participants at the community workshops had assigned a 'default' high value for the Cultural and Spiritual environmental value rating for all waterways and waters in the Black Ross WQIP area. This was done on the basis of not knowing the views of Traditional Owners and assuming that Traditional Owners would value the waterways and waters highly in both environmental, and cultural and spiritual terms.

The TOMG agreed that in their 'natural' state the environmental and cultural and spiritual values of the waterways and waters were high as the two were closely related. The rating from the community workshops was therefore confirmed. It was also agreed by the TOMG that it was desirable to have follow up meetings to better determine:

- The type of Traditional Owner values associated with waterways and waters of the WQIP area;
- The relative importance of waterways and waters and how to prioritise them for protection efforts;
- Potential management actions to protect the environmental, cultural and spiritual vales of the waterways and waters of the Black Ross WQIP area.

Again the imperative to complete the draft WQIP took priority and it was decided to include the ongoing Traditional Owner specific consultation process as an implementation action of the Black Ross WQIP. In addition to the public notices the BDT TOMG coordinator was included in the distribution list advising stakeholders of the request for comments on the draft Black Ross WQIP.

Table 2-1 Draft Environmental Values Black Basin

Waterway	Irrigation	Farm supply	Stock watering	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual appreciation	Drinking water	Industrial use	Cultural and spiritual values	Aquatic ecosystems
Freshwaters (Note: Instream storages (dams, weirs and barrages) have been underlined)												
Black River Basin												
Crystal Creek (Upland)						L	L	M - H	H		H	HEV
Crystal Creek (Lowland)	M	M	H		M	H	L - M	H	H		H	✓
Lorna Creek (Upland)						L	L	L			H	✓
Lorna Creek (Lowland)	M	M	H		M	H	L - M	H			H	✓
Ollera Ck (Upland)						L	L	L			H	HEV
Ollera Creek (Lowland)	M	M	H		M	H	L - M	H			H	✓
Scrubby Ck (Upland)						L	L	L			H	HEV
Scrubby Creek (Lowland)	M	M	H		M	H	L - M	H			H	✓
Hencamp Ck (Upland)						L	L	L			H	HEV
Hencamp Ck (Lowland)	M	M	H		M	H	L - M	H			H	✓
Rollingstone Ck (Upland)						L	L	L			H	HEV
Rollingstone Ck (Lowland)	M	L	H		M	H	L - M	H	L [E]		H	✓
Surveyors Ck	L [E]					L	L	L			H	HEV
Wild Boar Creek						L	L	L			H	HEV
Station Creek					L [S]	L	L	L			H	HEV
Saltwater Ck (Upland)						L	L	L			H	HEV
Saltwater Creek (Lowland)	M	L	H		M	H	M	M			H	HEV
Cassowary Ck (Upland)						L	L	L			H	HEV
Cassowary Ck (Lowland)	M	L	H		M	H	L - M	H			H	HEV
Leichhardt Ck (Upland)											H	HEV
Leichhardt Ck (Developed)	M	L	H		M	H	M	M	L		H	✓
Christmas Ck (Upland)											H	HEV
Christmas Ck (Developed)	L	L	H		M	H	L - M	H			H	✓
Sleeper Log Ck (Upland)											H	HEV

Waterway	Irrigation	Farm supply	Stock watering	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual appreciation	Drinking water	Industrial use	Cultural and spiritual values	Aquatic ecosystems
Sleeper Log Ck (Developed)	L	L	H		M	H	L - M	H			H	√
Two Mile Creek					L [S]		L [S]				H	√
Bluewater Ck (Upland)						L	L	M - H			H	HEV
Bluewater Ck (Lowland)	M - H	M	H		M	H	H	H			H	√
Althaus Creek (Upland)						L	L	M - H			H	HEV
Althaus Creek (Lowland)			H		L	H	H	H			H	√
Deep Creek (Upland)						L	L	M - H			H	√
Deep Creek (Lowland)	M - H	M	H		L	H	H	H			H	√
Healy Creek				?	L [S]		L [S]	L			H	√
Black River (Upland)						L	L	L			H	HEV
Black River (Lowland)	L		H		L	L			L [E]	M	H	√
Alick Creek (Black R trib.)	L [E]		L [E]								H	√
Log Creek (Black R trib.)	L [E]		L [E]								H	√
Scrubby Ck (Upland)					L [S]	L	L	L			H	√
Alice River (Developed)	L		H		L	L					H	√
Canal Creek (Alice R trib.)	L [E]								L [E]		H	√

Notes: These notes apply to all draft Environmental Values tables. Most of the human use values have been identified from stakeholder workshops where L = Low, M = Medium and H = High use/value.

Additional uses identified through a prior study and not identified at the workshop are indicated by [S] for the preliminary stakeholder survey, [X] from the human use study and [E] from DNRW water licencing extraction data (see Human Use EVs Report for more detail).

For Cultural and Spiritual human use a default high value was assigned at workshops. Additional consultation with Traditional Owners will be used to better define the values as part of the WQIP implementation process.

Aquatic ecosystem environmental values were initially identified through a desktop review and technical panel workshops. The draft aquatic ecosystem environmental values were then reviewed at stakeholder workshops. The WQIP study team is continuing to review/update this information and we welcome further comment on the draft ecological values identified in the tables.

HEV = High ecological/environmental value, SMD = Slightly to moderately disturbed, HD = Highly disturbed. SMD and HD categories were not identified. A √ has been placed in the Aquatic ecosystems column, where waterways are not identified as HEV, to indicate the importance of aquatic ecosystem values to all waterways.

Table 2-2 Draft Environmental Values Upper Ross Catchment

Waterway	Irrigation	Farm supply	Stock watering	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual appreciation	Drinking water	Industrial use	Cultural and spiritual values	Aquatic ecosystems
Freshwaters												
Ross River Basin (Ross River Dam and upstream)												
Lake Ross (Ross Dam)	L				L	L	L	M	H	M	H	√
Ross River (FrW)	L		M - H			L	L	L			H	√
Round Mountain Ck (Upland)											H	HEV
Round Mountain Creek	L		M - H			L	L	L			H	√
Lagoon Creek	L		M - H			L	L	L			H	√
Plum Tee Creek	L		M - H			L	L	L			H	√
Central Ck (aka Ross Ck)	L		M - H			L	L	L			H	√
Sandy Creek	L		M - H			L	L	L			H	√
Spring Creek	L		M - H			L	L	L			H	√
Deep Creek	L		M - H			L	L	L			H	√
Leichhardt Creek	L		M - H			L	L	L			H	√
Cattle Creek	L		M - H		L [X]	L	L	L			H	√
Six Mile Creek	L	L	M					L			H	√
Toonpan Lagoon	M [E]	L	M					L			H	√
Jimmys Lagoon	L	L	M					L			H	√
Four Mile Ck /Flagstone Ck	L	L	M					L			H	√
One Mile Creek/Spring Creek	H [E]	L	M					L			H	√
Lansdowne Creek	H [E]	L	M					L			H	√
Antill Plains Creek	L	L	M					L			H	√
Sachs Creek (Upland)											H	HEV
Sachs Creek	M [E]					L	L	M	L [E]		H	√
Blacksoil Gully/Mt Stuart (Up)											H	HEV
Blacksoil Gully/Mt Stuart						L	L	L			H	√

Note: Notes from Table 2-1 also apply to this table.

Table 2-3 Draft Environmental Values Ross River Basin (excluding Upper Ross River)

Waterway	Irrigation	Farm supply	Stock watering	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual appreciation	Drinking water	Industrial use	Cultural and spiritual values	Aquatic ecosystems
Freshwaters												
Ross River Basin (east)												
Alligator Ck (Upland)	L?					H	H	H	L		H	HEV
Alligator Creek (Lowland)	L - M	M	L		L - M	L	L - M	L - M	L		H	✓
Whites Creek (Upland)											H	HEV
Whites Creek	L		L		L	L	L - M	L - M			H	✓
Slippery Rocks Ck (Upland)											H	HEV
Slippery Rocks Creek	L		L		L	L	L - M	L - M			H	✓
Crocodile Creek	L		L		L	L	L - M	L - M	L		H	✓
Killymoon Creek (Upland)											H	HEV
Killymoon Creek	M		L		L	L	L - M	L - M	L		H	✓
Cape Cleveland						L	L	L			H	HEV
Stuart Creek (ephemeral)	L	L	L			L		L			H	✓
Stuart Creek (includes pools)	L	L	L		M	L	M	L - M			H	✓
Sandfly Creek			L			L	L	M			H	✓
Ross River Basin (west)												
	Now / future	**Now / future**	**Now / future**	**Now / future**	**Now / future**	**Now / future**	**Now / future**	**Now / future**	**Now / future**	**Now /future**	**Now / future**	
Stoney Creek	L		L		L	L	L	M			H	✓
Saunders Creek	L		L		L	L	L	M			H	✓
Bohle R (above Condon STP)	L	L	L		L	L	L	L			H	✓
Bohle R (below Condon STP)	L	L	L		M	M/H	M/H	M/H			H	✓
Little Bohle River	L		L		L	L	L	M			H	✓
Middle Bohle Creek	L		L		L	L	L	M			H	✓

Waterway	Irrigation	Farm supply	Stock watering	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual appreciation	Drinking water	Industrial use	Cultural and spiritual values	Aquatic ecosystems
Louisa Creek					L		L	L			H	✓
Town Common							L - M	H			H	✓
Ross River Basin (below the Ross River Dam)												
Ross River (below Dam)	M	L			H	H	H	H			H	✓
Ross River Weir Pools (All)	M				H	H	H	H			H	✓
Ross River (Black Weir)	H				H	H	H	H	H		H	✓
Ross R (Gleesons Weir)	L				H	H	H	H			H	✓
Ross River (Aplins Weir)	L				H	H	H	H			H	✓
Tributaries (Defence land)					L	L	L	L			H	HEV (parts)
University (Campus) Creek					L	L	L	M			H	HEV (parts)
Lavarack ? Ck with weirs					L	L	L	M			H	✓
Ross Creek and tributaries					H	L	L	H			H	✓
Pallarenda					H		H	H			H	✓

Note: Notes from Table 2-1 also apply to this table.

Table 2-4 Draft Environmental Values Magnetic Island

Waterway	Irrigation	Human consumer	Primary recreation	Secondary recreation	Visual appreciation	Drinking water	Cultural and spiritual values	Aquatic ecosystems
Freshwaters								
Magnetic Island								
Retreat Creek	H	L	M	H	H	L	H	HEV/SMD
Duck Creek	L		M	H	H	L	H	HEV/SMD
Chinamans Gully		L [S]	L	L [S]	L [S]		H	HEV/SMD
Ned Lee Creek			H	H	H	L	H	HEV/SMD
Butler Ck (Picnic Bay)		L	L [S]	L	M		H	✓
Picnic Bay west creek		L	L [S]	L	M		H	✓
Gustav Creek (Upland)		L	M	M - H	M - H		H	HEV
Gustav Creek (Lowland)		L	L	H	H		H	✓
Hoyer Creek (Nelly Bay)			L	L	H		H	✓
North Nelly Bay creek				L	H		H	HEV/SMD
Petersen Creek (Upland)		L	M - H	H	H		H	HEV
Petersen Creek (Lowland)			M - H	H	H		H	✓
Gorge Creek (Upland)		L	M - H	H	H		H	HEV
Gorge Creek (Lowland)		L	L	L	H		H	✓
Endeavour Creek (Upland)		L	M - H	H	H		H	HEV
Endeavour Creek (Lowland)			M - H	H	H		H	✓
East Horseshoe Bay creek		L	L	L - M	H		H	✓
Five Beach Bay			M - H	H	H		H	HEV

Notes: Where HEV/SMD is indicated the HEV areas are upstream from the break of slope between the coastal plain and the granite hills. Note: Notes from Table 2-1 also apply to this table.

Table 2-5 Draft Environmental Values Mainland Estuaries

Waterway	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual appreciation	Industrial use	Cultural and spiritual values	Aquatic ecosystems
Estuarine Waters								
Crystal Creek		H	M	M - H	H		H	√
Lorna Creek		H	M	M - H	H		H	√
Ollera Creek		H	M	M - H	H		H	HEV
Scrubby Creek		H	M	M - H	H		H	HEV
Hencamp Creek		H	M	M - H	H		H	√
Rollingstone Creek		H	L	H	H		H	√
Surveyors Creek		H	M	M - H	H		H	HEV
Wild Boar Creek		H	M	M - H	H		H	HEV
Station Creek		H	M	M - H	H		H	HEV
Saltwater Creek	H	H	L	H	H		H	HEV
Cassowary Creek		L	L	L	L		H	HEV
Leichhardt Creek		H	L	H	H		H	√
Christmas Creek		H	L	H	H		H	√
Two Mile Creek		H	L	H	H		H	√
Bluewater Creek		H	L	L	H		H	√
Deep Creek		H	L	H	H		H	√
Healy Creek		H	L	H	H		H	√
Black River		H	L	M	L		H	√
Bohle River (upper)		M		M	L - M		H	√
Bohle River (lower)		H		H	H		H	√
Town Common		L [SX]			H		H	√
Louisa Creek		M		M	M		H	√
Ross River sub basin		H		H	H	M	H	√
Stuart Creek sub basin	L	H	L	H	H		H	√
Alligator Creek sub basin	L	H	L	H	H		H	HEV

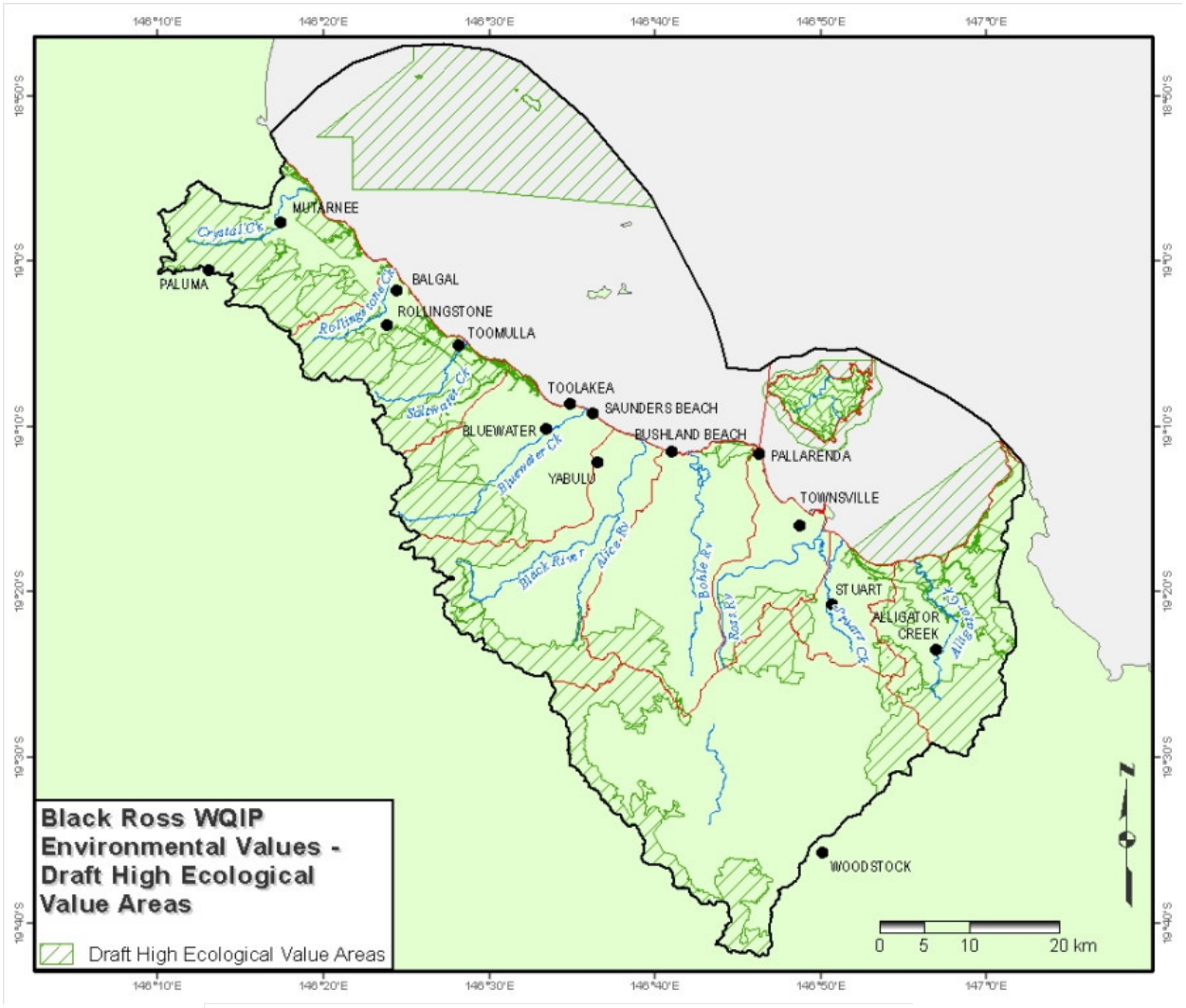
Note: Note: Notes from Table 2-1 also apply to this table.

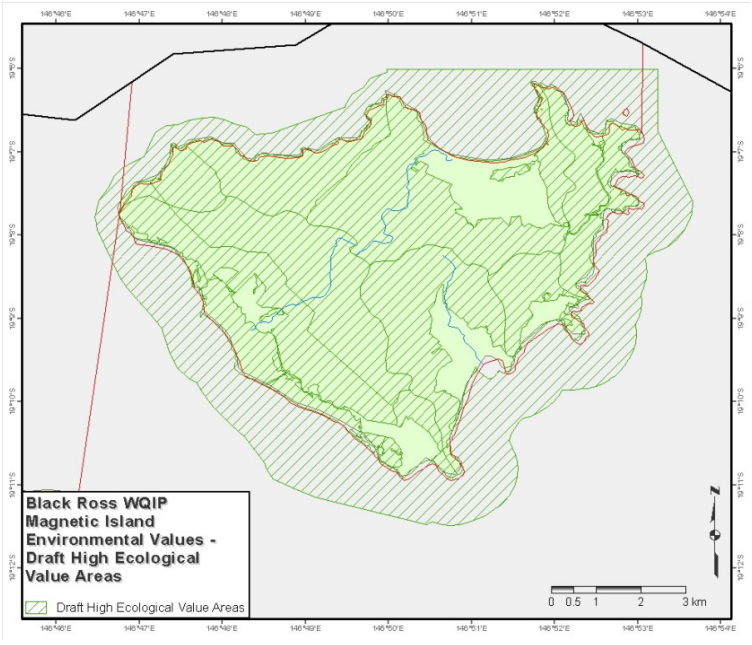
Table 2-6 Draft Environmental Values Magnetic Island Estuaries and Coastal and Marine

Waterway	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual appreciation	Cultural and spiritual values	Aquatic ecosystems
Estuaries							
Magnetic Island (in general)		H	L	L	H	H	HEV
Butler Creek		L	M	M	H	H	✓
Gustav Creek		L - M	H	H	H	H	✓
East Horseshoe Bay creek		L	L	L	H	H	✓
Near Coastal and Marine Waters							
Magnetic Island (near coastal)							
West Coast		H	M - H	H	H	H	HEV
Picnic Bay		H	M - H	H	H	H	HEV
Nelly Bay		H	M - H	H	H	H	HEV
Arcadia		H	M - H	H	H	H	HEV
Radical Bay		H	M - H	H	H	H	HEV
Horseshoe Bay	M	H	H	H	H	H	HEV
Five Beach Bay		H	M - H	H	H	H	HEV
Rollingstone Bay		H	M - H	H	H	H	HEV
Remainder (near coastal and marine)							
West Channel		H	H	H	H	H	✓
Cleveland Bay		H	H	H	H	H	HEV (parts)
Halifax Bay		H	H	H	H	H	✓
Outer Marine		H	H	H	H	H	HEV (parts)

Note: Note: Notes from Table 2-1 also apply to this table.

Figure 2.6 Draft High Ecological Value Areas





2.2.2 Draft Black Ross WQIP input

Following the development of the draft EVs for the Black Ross WQIP area, water quality guidelines were adopted (see section 3) and a set of draft WQOs was developed (see section 4) based on those guidelines. Creek to Coral partners, and in particular EPA and GBRMPA, provided input to the development of these draft materials which were subsequently included in the draft Black Ross WQIP and supporting documents.

The draft Black Ross WQIP, along with supporting documents and background reports, was released for public review and feedback on 12 June 2009. The release of the draft Black Ross WQIP was advertised in the Townsville Bulletin (see Figure 2.7).

Figure 2.7 Townsville Bulletin Advertisement

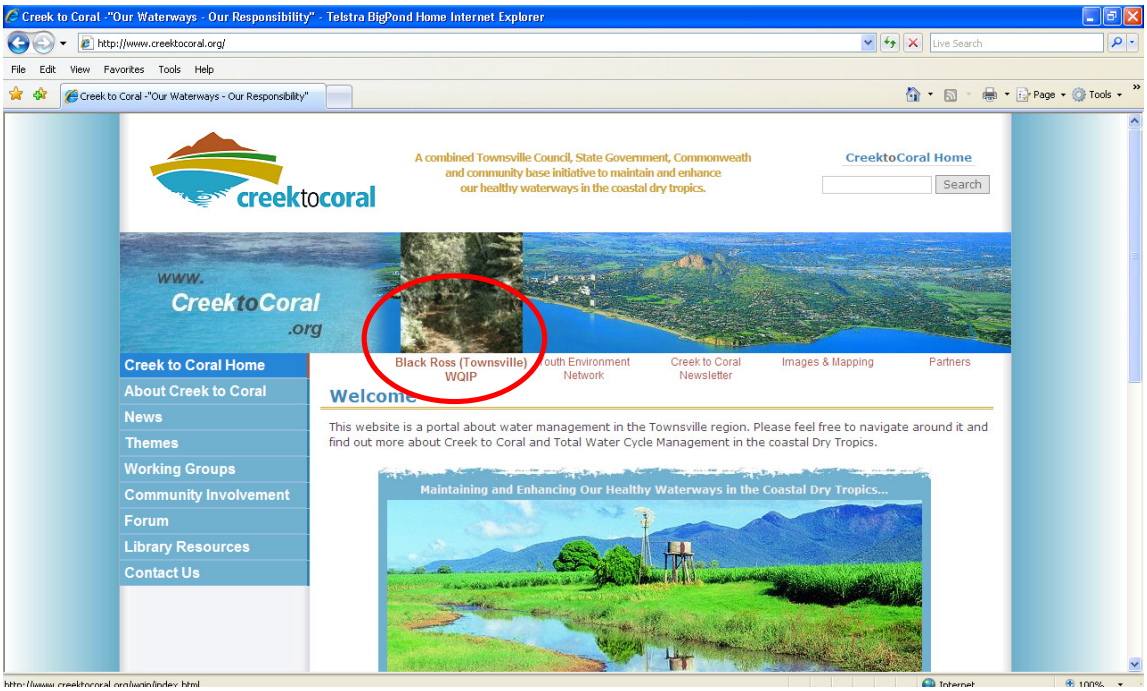
An email announcement, with an invitation to comment on the WQIP and supporting documents, was sent to all stakeholders who had participated in workshops, or in some way provided input to the draft Black Ross WQIP during its development. The Creek to Coral website advised that *"We would appreciate any comments you have on the Draft WQIP and supporting documents especially if returned to us early in July 2009 (by Tuesday 7 July)*". A tentative date was suggested and all comments were accepted.

The draft WQIP was also peer reviewed by C2⁰ Consulting, with comments incorporated into the revised draft.

Public feedback on the draft Black Ross WQIP was minimal. This was more than compensated for by a detailed review by DERM (EPA) and submission of comments. Comments were incorporated into the draft WQIP and further meetings and discussions were held with DERM staff to clarify and amend 'technical' aspects of the draft WQIP and supporting documents, especially in relation to EVs, WQOs, water quality improvement targets and the urban aspects of stormwater quality management.

The Black Ross WQIP along with draft and final associated documents can be viewed on the Creek to Coral website (see below). The draft documents will remain available on the Creek to Coral website as part of the history of the development of the Black Ross (Townsville) WQIP.

www.creektocoral.org



The following sections provide information on the selection of water quality guidelines, draft water quality objectives and water quality targets for the Black Ross WQIP area.

3. Water Quality Guidelines

3.1 Water Quality Indicators

Water quality guidelines are expressed in terms of water quality indicators. The potential water quality indicators (mostly physico-chemical) to be applied across the Black Ross WQIP area are listed in Table 3-1 with a brief description of each and reasons for their potential use. Not all indicators are used in all situations.

Table 3-1 Water Quality Indicators

WQ Indicator	Description	Reason for Use
TSS	Total suspended solids (sediment)	Indicator of erosion and transport of sediment to waterbodies. Can be related to vegetation cover/bare ground and management practices. Can result in inhibition of primary production and upon settling, smothering of benthic organisms
Turbidity	Visual measure of water clarity	Light penetration and subsequent biological activity is impacted by water clarity
OrgN/PN	Organic nitrogen / particulate nitrogen	Provides an indication of the amount of plant material entering the system and will become bioavailable in the longer term through decomposition
DIN	Dissolved inorganic nitrogen	Readily bioavailable and supports a range of biological interactions including algal growth
Total N	The sum of all forms of nitrogen	More common to have a value for total nitrogen than the different species of nitrogen
PP	Particulate phosphorus	Can become bioavailable in the longer term and is often related to TSS levels
FRP	Filterable reactive phosphorus	Readily bioavailable and supports a range of biological interactions including algal growth
Total P	The sum of all forms of phosphorus	As for total nitrogen, available data sets may not provide analysis of the different species of phosphorus
Chlorophyll a	A measure of algal growth	Is an indicator of algal growth and has a close relationship to nutrient concentrations, modified to some extent by water clarity
DO	Dissolved oxygen (percentage saturation)	Oxygen levels are important for fish and other aquatic organisms to survive. Low oxygen levels can occur naturally but are frequently caused by euthrophication and other disturbances, and are one of the main water quality issues in tropical Queensland.
pH	Indicator of acidity and alkalinity	pH is important for chemical and biological processes with highly acid and highly alkaline waters resulting in stressful or toxic conditions for many organisms leading to a change in biodiversity
EC	Electrical conductivity is a simple way to measure salt levels	In freshwaters, high levels of salt can impact plant growth and create conditions that are toxic to many organisms leading to a change in biodiversity
Pesticides	Various types	Inhibits plant and animal growth and may bioaccumulate
Urban Specific		
Hydrocarbons	Oil and petroleum based products	Excessive hydrocarbons can result in smothering of aquatic habitats. They can also increase morbidity and mortality in aquatic species, and impact reproductive cycles
Gross Pollutants	Debris items often >5mm. Litter including plastics, garden waste and coarse sediment	Organic material can lead to oxygen depletion during decomposition. Litter, especially plastic bags, can be harmful to marine organisms, are unsightly and may contribute to obstructions in stormwater infrastructure.
Metals/Heavy metals	Cadmium, Chromium, Copper, Nickel, Lead, Zinc	Excessive levels can be toxic to aquatic organisms and can bioaccumulate and be passed along the food chain (Cobalt, Selenium, Thallium, Silver, Arsenic, Antimony)

3.2 Australian Water Quality Guidelines

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000) i.e. the Australian water quality guidelines (AWQG), updated the original guidelines first published in 1992. These set benchmark values against which the quality of waters can be assessed. They also provide the technical base for determining draft WQOs.

The Australian water quality guidelines were developed under the National Water Quality Management Strategy (NWQMS). It is difficult for a national document to cover the vast range of water types found in Australia and the AWQG themselves recommend developing more regionally specific guidelines. The Queensland Water Quality Guidelines were developed as part of the effort to deliver this regional focus.

3.3 Water Quality Targets OnLine

Water quality targets online was developed to assist regional groups to set water quality targets. Essentially it is a tool that extracts guideline values from *The Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC 2000) to use as a starting point for developing water quality targets.
(Previously available online at http://www.environment.gov.au/water/publications/quality/targets-online/index.php)

Default water quality guidelines for human use and trigger values for aquatic ecosystems from Water quality targets online, are provided in the tables in Appendix A for the Tropical Queensland zone, which encompasses the Black and Ross Basins (Townsville). It should be noted that the trigger values are lower than the Queensland Water Quality Guidelines (QWQG) in some cases and are included for reference only (see Appendix A). The QWQG is the main reference for informing our draft set of water quality guidelines and WQOs. A summary of human use water quality guidelines derived from Water Quality Targets Online and the AWQG is provided in Table 3-8.

3.4 Queensland Water Quality Guidelines

The *Queensland Water Quality Guidelines 2006* (EPA 2006) (QWQG) were approved for commencement with the Environmental Protection (Water) Amendment Policy (No. 1) 2006 - Subordinate Legislation 2006 No. 30, on the 1st of May 2006. Minor amendments were made to the QWQG in 2007. Version 3 of the QWQG was released in September 2009.

The QWQG, developed by the Environmental Protection Agency (EPA), are technical guidelines for the protection of aquatic ecosystems. They complement the NWQMS, including the AWQG, by delivering guidelines that include locally and regionally relevant water quality data for fresh, estuarine and marine waters. The QWQG focus largely on aquatic ecosystem protection, initially across three geographic regions in Queensland for which regional data was available:

- South-east;
- Central Coast; and
- Wet Tropics.

The geographic area currently covered by the QWQG extends from Cape York to the Queensland/New South Wales border and west to the Great Dividing Range coastal watershed. The Black Ross WQIP area is within the Central Coast region.

3.4.1 Further details on the guidelines

The EPA has been collecting water quality data from reference (relatively unimpacted) waterways since 1992, and has used this data, together with data collected throughout Queensland by a range of government agencies, tertiary institutions and other organisations, to derive the QWQG.

The purpose of the QWQG is to provide guideline values that are tailored to Queensland regions and water types. When guideline information is required for Queensland waters, the Queensland guidelines should be consulted first. However, there are a number of indicators for human use environmental values including, human health, toxicants and primary industry for which the AWQG (ANZECC 2000) will remain a primary source of information.

To set about improving or maintaining water quality, clear targets are needed. To protect aquatic ecosystems, knowledge of the requirements for physical and chemical qualities for habitat and flows and what constitutes a healthy ecosystem, is necessary. For agricultural use, crop and livestock requirements need to be known, and for human recreational use, the risks to human health need to be known about. Such information is presented in the form of guidelines – compilations of information about water quality and its impacts on ecosystems and the various human uses of waters.
(Source: http://www.epa.qld.gov.au/environmental_management/water/water_quality_guidelines/#gen0)

3.4.2 Aquatic ecosystems

The physico-chemical water quality guidelines from the QWQG (EPA 2006) are presented in Table 3-2 for the Central Coast region, and in Table 3-3 for the Wet Tropics.

Table 3-2 Aquatic Ecosystem Physico-chemical Water Quality Guidelines – Central Coast

Water type	Physio-chemical indicator and guideline value													
	Amm N	Oxid N	Org N	Total N	FiltR P	Total P	Chl-a	DO (% sat)		Turb	Secchi	SS	pH	
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	Lower	Upper	NTU	m	mg/L	Lower	Upper
Open coastal	6	3	130	140	6	20	1.0	95	105	1	5	10	8.0	8.4
Enclosed coastal	8	3	180	200	6	20	2.0	90	105	6	1.5	15	8.0	8.4
Mid-estuarine	10	10	260	300	8	25	4.0	85	105	8	1.0	20	7.0	8.4
Upper Estuarine	30	15	400	450	10	40	10.0	70	105	25	0.4	25	7.0	8.4
Lowland streams	20	60	420	500	20	50	5.0	85	110	50	n/a	10	6.5	8.0
Upland streams	10	15	225	250	15	30	n/a	90	110	25	n/a		6.5	7.5
Freshwater lakes/reservoirs	10	10	330	350	5	10	5.0	90	110	1-20	nd	nd	6.5	8.0
Wetlands	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Source: Source: QWQG Table 2.5.2.1 Regional guideline values for physio-chemical indicators – Central Coast region (EPA 2006). These are the Water Quality Guidelines for the Central Coast Queensland region (Burnett River Basin to Black River Basin) for slightly-moderately disturbed aquatic ecosystems.
Notes: n/a is not applicable and nd is no data. Mid-estuarine water type includes tidal canals, constructed estuaries, marinas and boat harbours.
Amm N = ammonia nitrogen, Oxid N = oxidised nitrogen, Org N = organic nitrogen, Total N = total nitrogen, FiltR P = filterable reactive phosphorus, Total P = total phosphorus, Chl a = chlorophyll a, DO = dissolved oxygen (percent saturation), Turb = turbidity, Secchi = Secchi depth.
Additional notes from the table:
1 DO guidelines (% saturation) for freshwaters should only be applied to flowing waters, including those with significant sub surface flows. Stagnant pools in intermittent streams naturally experience values of DO below 50% saturation.
2 DO guideline values apply to daytime conditions. Lower values may occur at night but should not be more than 10%-15% less than daytime values.
3 DO values as low as 40% may occur in estuaries for short periods following material inflow events after rainfall. DO values consistently <50% are likely to significantly impact on the ongoing ability of fish to persist in a waterbody. DO values <30% saturation are toxic to some species. These values should be applied as absolute lower limit guidelines for DO. Very high DO (supersaturation) values can be toxic to some fish as they cause gas bubble disease.
4 During flood events or nil flow periods, pH values should not fall below 5.5 (except in wallum areas) or exceed 9.

5 In wallum areas, waters contain naturally high levels of humic acids and have a characteristic ti-tree stain. In these types of waters, natural pH values may range form 3.6-6.0.
6 During periods of low flow and particularly in smaller creeks, build up of organic matter derived from natural sources e.g. leaf-litter, can result in increased organic N levels (generally in the range of 400 to 800 µg/L). This may lead to total N values exceeding the QWQG values. Provided that inorganic N (i.e. NH3 and oxidized N) remain low, then the elevated levels of organic N should not be seen as a breach of the guidelines, provided this is due to natural causes.
7 For wetlands see (AWQG) ANZECC 2000 guidelines.
8 For estuaries the turbidity, secchi, and SS guideline numbers apply to estuaries less than 40km in length. Longer estuaries have naturally higher turbidity levels (and corresponding higher suspended solids levels and lower Secchi depth values) due to the longer retention times for suspended particulates and also to the continual resuspension of fine particles by high tidal velocities. Values are variable and site specific. However, most values are <100 NTU and very few values are >200 NTU.
9 For information on general application of the guidelines values, on their application under different flow conditions and on approaches to assessing pulse inputs of pollutants see Section 4 and Appendix D of the QWQG.
10 In the absence of better data, the guidelines adopted for freshwater are for the most part the default AWQG 2000 guidelines. It is acknowledged that these need to be updated with local data as soon as this is available.
11 Temperature varies both daily and seasonally, it is depth dependent and is highly site specific. It is therefore not possible to provide simple generic water quality guidelines for this indicator. The recommended approach is that local guidelines be developed. Thus, guidelines for potentially impacted streams should be based on measurements from nearby streams with a similar morphology and which are thought not to be impacted by anthropogenic thermal influences.
From an ecological effects perspective, the most important aspects of temperature are the daily maximum temperature and the daily variation in temperature. Therefore measurements of temperature should be designed to collect information on these indicators of temperature, and, similarly, local guidelines should be expressed in terms of these indicators. Clearly there will be an annual cycle in the values of these indicators and therefore a full seasonal cycle of measurements is required to develop guideline values.
Temperature – managers need to define their own upper and lower guideline values using the 80th and 20th percentiles of ecosystem temperature distribution from the AWQG (2000).
Conductivity values (EC) for freshwaters (from the QWQG Appendix G, p.103) for Central Coast North, based on the 75th percentile value, is 375 µS/cm for the Black Basin. The Ross Basin is in the Burdekin-Bowen region and the corresponding value is 271 µS/cm.

Table 3-3 Aquatic Ecosystem Physico-chemical Water Quality Guidelines – Wet Tropics

Water type	Physio-chemical indicator and guideline value													
	Amm N	Oxid N	Org N	Total N	FiltR P	Total P	Chl-a	DO (% sat)		Turb	Secchi	SS	pH	
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	Lower	Upper	NTU	m	mg/L	Lower	Upper
Open coastal	2	2	135	140	3	20	0.6	90	nd	1	nd	nd	8.0	8.4
Enclosed coastal	15	10	135	160	5	20	2.0	85	105	10	1.0	nd	7.5	8.4
Mid-estuarine *	15	30	200	250	5	20	3.0	80	105	10	1.0	nd	6.5	8.4
Lowland streams	10	30	200	240	4	10	1.5	85	120	15	na	-	6.0	8.0
Upland streams	6	30	125	150	5	10	0.6	90	100	6	na	nd	6.0	7.5
Freshwater lakes/reservoirs	10	10	330	350	5	10	3	90	120	2-200	nd	nd	6.0	8.0
Wetlands	10	10	330-1180	350-1200	5-25	10-50	10	90	120	2-200	na	nd	6.0	8.0
Tidal canals etc			NR	450		60	10	80	100	20	>0.5		6.5	8.5

Source: QWQG Table 2.5.3.1 Regional guideline values for physio-chemical indicators – Wet Tropics region (EPA 2006)
Note: General table notes from Table 3-2 and "Additional notes from the table" numbers 1-7, 9 and 11 are also relevant to this table. * Mid estuarine includes; tidal canals, constructed estuaries, marinas and boat harbours.

A summary of pesticide guideline values for aquatic ecosystems and human use is provided in Table 3-4 and a summary of metals guideline values in Table 3-5.

Table 3-4 Pesticide Guideline Summary by Environmental Value - Freshwater

Pesticide (ug/L)							
Diuron	2.0	30*	1.5 (fish)	40	30	-
Atrazine	-	40*	<3.4 (Rainbow Trout)	-	40	0.7 H 13 SM
Simazine	-	20*	10 (fish)	-	20	0.2 H 3.2 SM
Bromacil	-	300*	-	-	300	-
Hexazinone	-	300*	-	600	300	-
Endosulfan	-	30*	<0.003	40	30	0.03 H/SM
Malathion	-	-	<0.1	-	-	0.002 H 0.05 SM

Notes: Most stringent water quality guideline values are shaded yellow.

Source notes: Irrigation values from AWQG Table 4.2.12 Interim trigger value concentrations for a range of herbicides registered in Australia for use in or near waters

* Stock drinking water (AWQG - in the absence of guidelines derived specifically for livestock, refer to the Australian Drinking Water Guidelines (NHMRC & ARMCANZ 1996).

Aquaculture and human consumption values from AWQG Table 9.4.41 Water quality guidelines for 'safe levels' of pesticides, herbicides, etc

Recreation values from AWQG Table 5.2.4 Summary of water quality guidelines for recreational purposes: pesticides

Drinking water values from ADWG (2004) Table 10.11 Guideline values for pesticides (Also - Above detection limits specified by Qld Health Scientific Services QWQG Table 5.3.1)

Aquatic ecosystem values are H = High Ecological Value (99% of species protected) and SM = Slightly to Moderately Modified (95% of species protected) from AWQG Table 3.4.1 'Trigger values for toxicants at alternative levels of protection' (aquatic ecosystems) Part 8, 9 and 10 (all other values are ID i.e. insufficient data)

Table 3-5 Metals Guideline Summary by Environmental Value - Freshwater

Metal (ug/L)								
Cadmium (Cd)	10 LT 50 ST	10	3.0 (0.2-1.8)	2 mg/kg Molluscs	5	-	2	0.06 H 0.2 SM
Chromium (Cr)	100 LT 1000 ST	1000	100 (20)	-	50	-	50	0.01 H 1.0 SM
Copper (Cu)	200 LT 5000 ST	400-5000	6 (5)	-	1000	1000	2000	1.0 H 1.4 SM
Lead (Pb)	2000 LT 5000 ST	100	30 (1-7)	0.5 mg/kg Fish	50	-	10	1.0 H 3.4 SM
Nickel (Ni)	200 LT 2000 ST	1000	10 sw-40 hw (100)	-	100	50000	20	8 H 11 SM
Zinc (Zn)	2000 LT 5000 ST	20000	30- 60 sw 100-200 hw (5)	-	5000	-	ND	2.4 H 8.0 SM

Notes: Most stringent water quality guideline values are shaded yellow.
Source notes: Irrigation figures are LT long-term values and ST short-term values from AWQG Table 4.2.10.
Livestock drinking water values vary with livestock i.e. 400 (sheep), 1000 (cattle), 5000 (pigs), and 5000 (poultry) from AWQG Table 4.3.2.
Aquaculture sw is soft water and hw is hard water. The upper figures are from QWQG (Table 5.1.2) and figures beneath (in brackets) are from AWGQ Table 4.4.3. 'Toxicant guidelines for the protection of aquaculture species'.
Human consumption – Standard 1.4.1 Contaminants and natural toxicants (ANZFA food standards). Values are not directly comparable to concentrations in water and aquaculture values may be more applicable.
Recreation from AWQG Table 5.2.3 Summary of water quality guidelines for recreational purposes: general chemicals.
Drinking water from ADWG (2004) Table 10.10 Guideline values for physical and chemical characteristics.
Aquatic ecosystem values are H = High Ecological Value (99% of species protected) and SM = Slightly to Moderately Modified (95% of species protected) from AWQG Table 3.4.1 'Trigger values for toxicants at alternative levels of protection' (aquatic ecosystems) Part 1.

3.4.3 Human use guidelines

In the course of their work organisations in Queensland have developed water quality guidelines associated with human use, which are referred to in the QWQG (see Table 3-6), along with Australian guidelines.

Table 3-6 Human Use Water Quality Guides

QWQG Ref.	Title
Table 7.1.1 p.96	The general recommended levels of water quality parameters for tropical aquaculture (QPIF)
Table 7.1.2 p.97	Recommended levels of water quality parameters for optimal growth of particular species in freshwater (QPIF)
Table 7.1.3 p.98	Recommended levels of water quality parameters for optimal growth of particular marine species (QPIF)
Table 7.2.1 p.99	Guidelines for cyanobacteria (blue-green algae) for primary contact recreation (NH & MRC)
Table 7.3.1 p.100	Guidelines for drinking water supply in the vicinity of storage off-takes or in groundwater supplies, before treatment (SEQ Water)

Note: Queensland Primary Industries and Fisheries (QPIF) is part of Department of Employment, Economic Development and Innovation (DEEDI)

Figure 3.1 Black Weir

3.4.4 Other applicable guidelines

The QWQG recommend use of the following guidelines (see Table 3-7) in the absence of local guidelines.

Table 3-7 Other applicable guidelines for Queensland

Environmental value	Water quality guidelines for particular water types
Aquatic ecosystems	Toxicants in water, sediment and biota as per ANZECC 2000 (http://www.mincos.gov.au/publications/australian_and_new_zealand_guidelines_for_fresh_and_marine_water_quality) Release of sewage from vessels to be controlled in accordance with requirements of the Transport Operations (Marine Pollution) Act and Regulations, 1995 (http://www.msq.qld.gov.au/Home/Environment/Sewage/) Comply with Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance, ANZECC (http://www.environment.gov.au/coasts/pollution/antifouling/code/index.html)
Protection of the human consumer	Guidelines as per ANZECC 2000 and Food Standards Code, Australia New Zealand Food Authority, 1996, and updates. Can be accessed from http://www.foodstandards.gov.au/thecode/foodstandardscode/index.cfm#_three
Primary contact recreation Secondary contact recreation Visual recreation	Guidelines for managing risk in recreational waters, National Health and Medical Research Council (NH&MRC 2008) Can be accessed from http://www.nhmrc.gov.au/publications/synopses/_files/eh38.pdf
Cultural & spiritual values	Protect or restore Indigenous and non-Indigenous cultural heritage consistent with relevant policies and plans
Industrial use	No guidelines are provided in ANZECC 2000. Some were given in AWQG 1992 but guidelines vary according to the industry and this value is usually protected by other values, such as aquatic ecosystem
Aquaculture	Guidelines as: • Queensland Department of Primary Industries – Water Quality in Aquaculture – DPI Notes April 2004; and • ANZECC 2000 and Food Standards Code, Australia New Zealand Food Authority, 1996, and updates
Irrigation Stock watering Farm use	Guidelines as per ANZECC 2000 (http://www.mincos.gov.au/publications/australian_and_new_zealand_guidelines_for_fresh_and_marine_water_quality)
Drinking water supply	See Table 5.3.1 for local guidelines. See also Australian Drinking Water Guidelines (2004)
Drinking water	Guidelines as for Australian Drinking Water Guidelines (2004). Can be accessed on http://www.nhmrc.gov.au/publications/synopses/eh19syn.htm

Source: QWQG 2009 (p.108) Note: Weblinks have not been checked for currency.

A summary of human use physico-chemical water quality guideline values is provided in Table 3-8.

Table 3-8 Human Use Water Quality Guidelines Summary - Physico-chemical

Human Use	Ammonia N	Nitrite NO_2 N	Nitrate NO_3 N	Total N	Phosphates	Total P	Turbidity	Secchi depth	Suspended Solids	Salinity	Chloride	Sodium
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	NTU	m	mg/L	µS/cm	µg/L	µg/L
Recreation Primary	10	3,280	44,300					>1.6			400,000	300,000
Recreation Secondary	10	3,280	44,300					na			400,000	300,000
Recreation Visual	na	na	na				<20% change	<20% change			na	na
Drinking water (Health)	ns	3,000	50,000								nr	nr
Drinking water (Aesthetics)	500	ns	ns				5			1,000	250,000	180,000
Drinking water supply*							25		25			
Aquaculture (Freshwater)	<300	<100	<50,000		<100				<40	<3,000		
Aquaculture (Saltwater)	<100	<100	<100,000		<50				<10	33,000 - 37,000		
Livestock drinking water		<30,000	<400,000							<3,000		
Irrigation long term				5,000		50				1,000		
Irrigation short term				25,000 to 125,000		800 to 12,000					<175,000	<115,000

Source: **Recreation** - Water Quality Targets Online (Environment Australia (Department of Environment and Heritage 2002) (Formerly available at http://www.environment.gov.au/water/publications/quality/targets-online/index.php)

Drinking water - Australian Drinking Water Guidelines Part V Fact sheets

Aquaculture – AWQG Table 4.4.2 salinity, Table 9.4.12 suspended solids, Table 4.4.3 nitrate, nitrite and phosphate, Table 9.4.5 ammonia (unionised)

Livestock drinking water – AWQG section 4.3.3.3 nitrate and nitrite, Table 4.3.1 salinity

Irrigation – AWQG Table 4.2.6 Chloride, Table 4.2.8 Sodium, Table 4.2.11 nitrogen and phosphorus, Table 4.2.5 salinity

* QWQG "Table 5.3.1 Guidelines for drinking water supply in the vicinity of storage off takes or in groundwater supplies, before treatment" (EPA 2006, p.58) (see Table 3-2 and Table 3-3 for Aquatic Ecosystem water quality guideline values)

Notes: na is not applicable, ns is not specified, nr is not required. Drinking water (Aesthetics) is taste and odour. Aquaculture includes human consumption of aquatic food. Aquaculture ammonia values are for cold water (<20) and warm water (<30). Livestock drinking water salinity value is for poultry, the lowest impact on the most sensitive livestock type (values for less sensitive livestock are 2-2.5 times higher). Irrigation Chloride and Sodium vales are for sensitive crops (values for tolerant crops are 4-5 times greater than sensitive crop values). The highest human use guideline levels of protection for each water quality indicator are highlighted in yellow.

3.5 Adopted Water Quality Guidelines Freshwater and Estuaries

Insufficient data is available from the Black Ross region to derive locally relevant water quality guidelines for aquatic ecosystems at this time. Consequently, the QWQG (EPA 2006) (including references to the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC 2000)) were adopted as defaults as the preliminary step to establishing draft physico-chemical water quality objectives for fresh and estuarine waters for the Black Ross WQIP area. The water quality guideline values relevant to the established EVs are presented in Table 3-2 for aquatic ecosystems and Table 3-8 for human use (see Appendix A for more detail).

The most stringent value for each water quality indicator for freshwater and estuaries are shown in Table 3-9.

Table 3-9 Highest Water Quality Protection Guideline Values

Water type	Physio-chemical indicator and guideline value													
	Ammonia N	Oxides N	Organic N	Total N	FiltR P	Total P	Chl-a	DO (% sat)		Turbidity	Secchi	Susp Solids	pH	
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	Lower	Upper	NTU	m	mg/L	Lower	Upper
Mid-estuarine	10	10	260	300	8	25	4.0	85	100	8	1.0	20	7.0	8.4
Upper Estuarine	30	15	400	450	10	40	10.0	70	100	25	0.4	25	7.0	8.4
Lowland streams	20	60	420	500	20	50	5.0	85	110	50	n/a	10	6.5	8.0
Upland streams	10	15	225	250	15	30	n/a	90	110	25	n/a		6.5	7.5
Freshwater lakes/reservoirs	10	10	330	350	5	10	5.0	90	110	1-20	nd	nd	6.5	8.0

Notes: Guideline values are predominantly from the QWQG (EPA 2006) for aquatic ecosystem protection (slightly to moderately disturbed systems - Central Coast Region). Variations are shaded (blue) and noted below.

Ammonia - Recreation (Primary and Secondary) guidelines for Ammonia are more stringent in upper estuaries and lowland streams i.e. 10 µg/L.

Turbidity - Drinking water (aesthetics) guidelines for turbidity are more stringent for freshwater i.e. 5 NTU. (Nephelometric turbidity unit)

Secchi depth - Primary recreation guidelines for Secchi depth are more stringent for estuaries i.e. >1.6m.

3.5.1 Wet catchments

While being located in the QWQG Central Coast region the northern section of the Black Basin is more closely aligned to climatic conditions and rainfall patterns of the Wet Tropics region. As such the Wet Tropics water quality guidelines (see Table 3-3) have been adopted for the Crystal Creek and Rollingstone Creek sub basins.

3.5.2 Flow regimes

Water quality guidelines are generally representative of ambient or baseflow conditions and are therefore suitable for application under normal baseflow conditions. Streams of the Dry Tropics are often ephemeral and lack baseflow for part, or most, of the year. Streams are also subject to flood events with short periods of high flow. Determining appropriate water quality guidelines for these conditions is difficult as the water quality monitoring data is generally not available to do so.

Creek to Coral has undertaken two years of event monitoring as part of the development of the Black Ross WQIP and still needs a significant amount of additional information to determine local event water quality guidelines and normal baseflow water quality guidelines. The information that has been gathered to date will be used to make some initial assumptions about event flow guidelines while defaulting to the Queensland guidelines for baseflow (ambient).

The development of the database and collation of a significant amount of water quality data has been undertaken by Creek to Coral as part of the condition assessment process for the Black Ross WQIP. The water quality data gathered locally may be useful in determining water quality guidelines for baseflow and no flow conditions, however additional effort is needed beyond the collation of the data in a database to determine waterway condition. It is planned to undertake the additional work as a component of WQIP implementation and to inform the adaptive management strategy underpinning the Black Ross WQIP.

The QWQG identifies reference sites in the Black Ross WQIP area (see Table 3-10), which may be useful in the development of local water quality guidelines.

Table 3-10 Black Ross WQIP Area Reference Sites

Location	Water type	Latitude	Longitude
Little Crystal Creek at Paluma Road	Freshwater	-19.01640	146.26580
Little Crystal Creek at Moodys	Freshwater	-18.98190	146.28560
Bluewater Creek at foothills	Freshwater	-19.23972	146.48944
Alligator Creek at Bowling Green Bay NP	Freshwater	-19.43670	146.94580
Cleveland Bay	Open coastal	-19.18389	146.92111

Source: QWQG 2006 Appendix F

Figure 3.2 Bluewater Creek Potential Reference Site

3.6 Great Barrier Reef Marine Park Water Quality Guidelines 2009

The *Water Quality Guidelines for the Great Barrier Reef Marine Park* (Great Barrier Reef Marine Park Authority 2009) were developed as a set of water quality guidelines for the marine environment of the Great Barrier Reef.

GBRMPA emphasised that the levels of contaminants identified in the guidelines are not targets but rather "*they are guideline trigger values that, if exceeded, identify the need for management responses*" (GBRMPA 2009, p.2). WQIPs being developed for the Great Barrier Reef catchments and regional natural resource management plans are seen as the appropriate avenues to respond to water quality issues in the marine environment resulting from terrestrial activities in the Great Barrier Reef (GBR) catchments.

Five distinct water bodies were defined for the GBR guidelines (GBRMPA 2009, pp.11-12):

- Enclosed coastal (EC);
- Open Coastal (EC - 12km);
- Midshelf (12km - 48km);
- Offshore (48km - 120km); and
- The Coral Sea.

The enclosed coastal water body was adopted from the *Queensland Water Quality Guidelines 2006* (EPA 2006) to ensure a consistency between State and Australian water quality guidelines in the Great Barrier Reef Marine Park (GBRMP). The other water bodies are defined using a relative distance delineation where the shoreline has a value of zero, and the edge of the continental shelf has a value of one. The open coastal water body delineation extends from 0 – 0.1; the midshelf water body from 0.1 – 0.4; and offshore water body from 0.4 – 1.0. Approximate distances delineating the various water bodies for the Burdekin region are provided above.

3.6.1 Sediments and nutrients

"*For open coastal, midshelf and offshore water bodies a large number of studies and reviews exist that have demonstrated that high levels of nutrient and sediment lead to deteriorating ecosystem health in coral reefs (reviewed in Fabricius 2005) and many other benthic systems*" (GBRMPA 2009, p.22).

Information used in the determination of the GBR water quality trigger values for sediment and nutrients was extracted from a report by De'ath and Fabricius (2008). Guideline trigger values were derived for:

- Water clarity (Secchi depth);
- Chlorophyll a (as a proxy for dissolved inorganic nitrogen);
- Suspended solids;
- Particulate nitrogen;
- Particulate phosphorus;
- Sedimentation;
- Temperature; and
- Several pesticides and one biocide.

Water quality guideline trigger values for the GBR are discussed below. Parameters that are not listed here default to the Queensland Water Quality Guidelines (EPA 2006), which in turn default to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000).

3.6.2 Water clarity and chlorophyll a

"*Lack of water clarity is a key indicator of poor water quality and is an essential environmental factor for phototrophic organisms that dominate coral reefs, seagrass meadows and the seafloor microphytobenthos (De'ath and Fabricius 2008). Since inorganic nutrients are quickly taken up by phytoplankton, the effects of increased nutrient loads may be expressed as increased phytoplankton biomass, which is readily measured as chlorophyll a concentration, a biological trophic status indicator of the water body (Brodie and Furnas 1994).*" (GBRMPA 2009, p.23).

GBRMPA guideline trigger values for the related parameters of water clarity (secchi depth) and chlorophyll a are displayed in Table 3-11.

Table 3-11 GBRMP Water Clarity and Chlorophyll a Trigger Values

Water Body Parameter	Enclosed coastal Wet Tropics/ Central Coast	Open Coastal	Midshelf	Offshore
Secchi (metres) (minimum mean annual water clarity)[1]	1.0/1.5	10	10	17
Chl a (µg/L)[2]	2.0	0.45	0.45	0.4

Source: Table 2: Guideline trigger values for water clarity and chlorophyll a (GBRMPA 2009, p.24)

Notes: [1] At shallower depths Secchi will be visible on the seafloor. Guideline trigger values for water clarity need to be decreased by 20% for areas with greater than 5 m tidal ranges. Seasonal adjustments for Secchi depths are presently not possible due to the lack of seasonal data.

[2] Chlorophyll values are ~40% higher in summer and ~30% lower in winter than mean annual values.

3.6.3 Suspended Solids, Particulate Nitrogen and Particulate Phosphorus

"*Due to the high correlation between particulate nitrogen, particulate phosphorus, suspended solids and secchi, it is not possible to resolve their individual effects on ecosystem health*" so "*to obtain approximate guideline trigger values, to provide some measure of quantum of improvement required in the current status of the water quality of these parameters, the responses of biota to each of the water quality variables SS, PN and PP were analysed separately*" (GBRMPA 2009, p.26).

Guideline trigger values for suspended solids (SS), particulate nitrogen (PN) and particulate phosphorus (PP) developed by GBRMPA are provided in Table 3-12.

Table 3-12 GBRMP Guideline Trigger Values for SS, PN and PP

Water Body Parameter[1]	Enclosed coastal Wet Tropics/ Central Coast	Open Coastal	Midshelf	Offshore
SS (mg/L)	5.0[2]/15	2.0	2.0	0.7
PN (µg/L)		20	20	17
PP (µg/L)		2.8	2.8	1.9

Source: Table 3: Guideline trigger values for SS, PN, and PP (GBRMPA 2009, p.26)

Notes: [1] Seasonal adjustments for SS, PN and PP are approximately ± 20% of mean annual values.

[2] No regional data was available for suspended solids for the Wet Tropics. The current condition mean annual concentration for the enclosed coastal water body is adopted here as a guide.

3.6.4 Sedimentation

"*In the longer term, the Great Barrier Reef Marine Park Authority will consider the development of sediment quality guidelines. Such guidelines would aim to include trigger values for sediment nutrient concentrations, which at elevated levels may cause toxicity through the development of excess pore water ammonia and hydrogen sulphide*".

In the interim a guideline trigger value is established at a maximum mean annual sedimentation rate of 3 mg/cm²/day, and a daily maximum of 15 mg/cm² (GBRMPA 2009, p.28).

3.6.5 Temperature

"*Temperature is included in these guidelines because it is clear that corals suffer physiological stress when water temperatures increase above normal maxima*" (GBRMPA 2009, p.29).

A guideline trigger level for sea temperature is set at increases of no more than 1ºC above the long-term average maximum.

3.6.6 Pesticides

"*Seven main herbicides are in widespread use throughout the Great Barrier Reef catchment and are being widely detected in fresh and marine waters of the Great Barrier Reef region. The herbicides are diuron, atrazine, ametryn, simazine, hexazinone, 2,4 -D, and tebuthiuron*" (GBRMPA 2009, p.29).

Aquatic ecosystem protection is the environmental value currently applied to the entire World Heritage Area and for high ecological value (HEV) water bodies; a guideline concentration that is protective of 99% of species is ideal. High and moderate reliability pesticide trigger values are included in Table 3-13 with low reliability values included in Table 3-14.

Table 3-13 GBRMP Moderate and High Reliability Pesticide Trigger Values

Pesticide	99% species protection	95% species protection
	High reliability trigger value (µg/L)	
Chlorpyrifos	0.005	0.009
	Moderate reliability trigger value µg/L	
Diuron	0.9	1.6
Atrazine	0.4	2.4
Ametryn	0.5	1.0
2,4-D	0.8	30.8
Endosulfan	0.005	0.005[1]
Tributytlin (TBT) [2]	0.0002	0.003

Source: Table 26: Summary of high and moderate reliability guideline trigger values for pesticides (GBRMPA 2009, p. 50).
Notes: [1] 99th percentile value recommended reef-wide because of bioaccumulation
[2] added from GBRMPA 2009(p. 52)

Table 3-14 GBRMP Low Reliability Pesticide Trigger Values

Pesticide	Low reliability trigger value (µg/L)	
	95% coastal and inshore value	99% offshore value
Simazine	3.2	0.2
Hexazinone [1]	75	75
Tebuthiuron	2	0.02
MEMC	0.002	0.002
Diazinon	0.01[1]	0.00003

Source: Table 27: Summary of low reliability guideline trigger values for pesticides (GBRMPA 2009, p. 50)
Notes: [1] This trigger value may not protect keystone species given effect concentrations for adult coral colonies are observed at significantly lower concentrations.

Figure 3.3 Crystal Creek Sub Basin

3.7 GBRMP Water Quality Guidelines Summary

The following tables provide a summary of the GBRMP water quality guidelines. Unlisted parameters default to the QWQG (EPA 2006/2009), which in turn default to the AWQG (ANZECC 2000).

Table 3-15 GBRMP Guideline Trigger Values Summary

Water Body / Parameter	Enclosed coastal Wet Tropics/ Central Coast	Open Coastal	Midshelf	Offshore
Chl a (µg/L)	2.0	0.45	0.45	0.4
Secchi (metres) (minimum mean annual water clarity)[1]	1.0/1.5	10	10	17
SS (mg/L)	5.0/15	2.0	2.0	0.7
PN (µg/L)	na	20	20	17
PP (µg/L)	na	2.8	2.8	1.9
Sedimentation rate	Maximum mean annual sedimentation rate of 3 mg/cm²/day, and a daily maximum of 15 mg/cm²			
Sea temperature	Increases of no more than 1ºC above the long-term average maximum			

Source: GBRMPA 2009, p.68

Notes: [1] Guideline trigger values for water clarity need to be decreased by 20% for areas with greater than 5 m tidal ranges. Na indicates guideline trigger values are not currently available for these parameters for enclosed coastal waters.

"High, moderate and low reliability guideline trigger values were derived for listed pesticides, and for tributyltin, where sufficient marine specific data were available. Where there was insufficient data the trigger values from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 are repeated here. All pesticide and biocide trigger values are set protective of 99 per cent of species."(GBRMPA 2009, p. 69)

Table 3-16 GBRMP Pesticide Guideline Trigger Values Summary

Pesticide	Trigger value (µg/L)
	High reliability trigger value
Chlorpyrifos	0.005
	Moderate reliability
Diuron	0.9
Atrazine	0.4
Ametryn	0.5
2,4-D	0.8
Endosulfan	0.005
	Low reliability
Simazine	0.2
Hexazinone [1]	75[1]
Tebuthiuron	0.02
MEMC	0.002
Diazinon	0.00003
Biocide	**Moderate reliability**
Tributytlin (TBT)	0.0002

Source: GBRMPA 2009, p. 69

"*The trigger values identified in these guidelines are not targets, but are guideline trigger values that, when exceeded, trigger management responses. Management responses are a part of the adaptive management strategies in Water Quality Improvement Plans in the Great Barrier Reef catchments and in regional natural resource management plans.*"

3.8 Adopted Water Quality Guidelines Marine

As the most up to date set of water quality guidelines for the marine environment, the *Water Quality Guidelines for the Great Barrier Reef Marine Park* (GBRMPA 2009) have been adopted for the Black Ross WQIP. Where a guideline trigger value is not provided by GBRMPA, guideline values from the QWQG are used. The GBRMP and QWQG water quality guideline values are displayed together as interim marine physico-chemical water quality guidelines in Table 3-17. Trigger values for pesticides in marine waters are displayed in Table 3-18.

Table 3-17 Marine WQ Guidelines and Trigger Values

Indicator	Water type			
	Enclosed Coastal	Open Coastal	Midshelf	Offshore
Ammonia N (µg/L)	8/15	4/2	4/2	2
Oxidised N (µg/L)	3/10	3/2	2	2
Organic N (µg/L)	180/135			
PN (µg/L)		20	20	17
Total N (µg/L)	200/160	140	140	120/130
FRP – P (µg/L)	6/5	6/4	6/4	5/4
PP – P (µg/L)		2.8	2.8	1.9
Total P (µg/L)	20	20	20	12/10
Chlorphyll a (µg/L)	2	0.45	0.45	0.4
TSS (mg/L) [2]	15/nd	2	2	0.7
Turbidity (NTU)	6/10	1	<1	<1
Secchi depth (m)	1.5/1	10	10	17
pH	8.0-8.4/7.5-8.4	8.1/8.15-8.4	8.1/8.15-8.4	8.1/8.15-8.4
Diss. Oxygen (%)	90-105/85-100	95-105	95-105	95-105

Source: QWQG (DERM 2009). From Table 3.2.1b: Regional guideline values for physio-chemical indicators – Central Coast region coastal waters and Table 3.3.1b: Regional guideline values for physio-chemical indicators – Wet Tropics region open coastal, mid shelf and offshore waters. Based on the GBRMPA and the QWQG Guidelines.

Notes: For each water type column the figure on the left is for the Central Coast (CC) and the figure on the right is for the Wet Tropics (WT) i.e. CC/WT. Only one figure indicates the values are the same for CC and WT. nd is no data available.

Table 3-18 Pesticide Trigger Values for Marine Waters

Pesticides	
Chlorpyrifos (HR)	0.005
Diuron (MR)	0.9
Atrazine (MR)	0.4
Ametryn (MR)	0.5
2,4-D (MR)	0.8
Endosulfan (MR)	0.005
Simazine (LR)	0.2
Hexazinone (LR)	75
Tebuthiuron (LR)	0.02
MEMC (LR)	0.002
Diazinon (LR)	0.00003
Tributytlin [1] (MR)	0.0002

Note: [1] Tributytlin is a biocide. In the Pesticides column (HR) is high reliability trigger value, (MR) is medium reliability and (LR) is low reliability.

4. Water Quality Objectives

4.1 Draft Water Quality Objectives

This section addresses ambient conditions. Event flows are discussed in section 5.4. For slightly to moderately disturbed (SMD) and highly disturbed (HD) aquatic ecosystems water quality objectives (WQOs) are based on the adoption of the most stringent water quality guidelines (WQGs), for the relevant water quality indicators, which will protect and maintain the identified environmental values (EVs) of the waterways and waterbodies in the study area.

As there are currently no locally derived WQGs for the Black Ross WQIP a set of draft WQOs for ambient conditions has been adopted for the Black Ross WQIP area based on the QWQG (EPA 2006) and GBRMPA marine water quality guideline trigger values (2009).

For freshwater and estuaries the draft WQOs (see Table 4-1) are based principally on the guidelines for SMD aquatic ecosystems, which provide a higher level of water quality protection than is required for most human use EVs. In this way all human use EVs are protected by default if the aquatic ecosystem WQOs are maintained.

Where there is an exception to this generalisation (see Table 3-9) the higher level of protection for human use is adopted where a waterway or water body has been identified as having one or more of those human use EVs.

Table 4-1 Draft Ambient Physico-chemical Water Quality Objectives - Freshwater and Estuarine

Indicator	Freshwater (CC/WT)			Estuarine (CC/WT)	
	Upland	Lowland	Lakes	Mid Estuary	Upper Estuary
TSS (mg/L)	-	10/nd	10/nd	20/nd	25/nd
Ammonia N (µg/L)	10/6	[1]10/10	10	10/15	10/nd
Oxid – N (µg/L)	15/30	60/30	10	10/30	15/nd
DIN – N (µg/L)	25/36	80/40	20	20/45	45/nd
Organic N (µg/L)	225/125	420/200	330	260/200	400/nd
Total N (µg/L)	250/150	500/240	350	300/250	450/nd
FRP – P (µg/L)	15/5	20/4	5	8/5	10/nd
Total P (µg/L)	30/10	50/10	10	25/20	40/nd
Turbidity (NTU)	25/6	50/nd	1-20/2-200	8/10	25/nd
Chlorophyll a (µg/L)	na/0.6	5/1.5	5/3	4/3	10/nd
Dissolved Oxygen (%)	90-110/100	85-110/120	90-110/120	85/80-105	70-105/nd
pH	6.5-7.5	6.5-8.0	6.5/6.0-8.0	7.0/6.5-8.4	7.0-8.4/nd
EC* (µS/cm)	375/271	375/271	375/271		

Notes: Values are for Slightly to Moderately Disturbed (SMD) waterways using QWQG figures for Central Coast (CC) (on the left) and Wet Tropics (WT) (on the right) i.e. CC/WT, unless figures are the same for both regions.
nd is no data available. Where there is no data available the Central Coast values are adopted for the whole of the Black Ross WQIP area.
Dissolved oxygen is % saturation. DIN is the sum of Ammonia N and Oxid – N (oxidised nitrogen i.e. NOx).
* Conductivity values (EC) for freshwaters (from the QWQG Appendix G, p.103) for Central Coast North, based on the 75th percentile value, is 375 µS/cm for the Black Basin. The Ross Basin is in the Burdekin-Bowen region and the corresponding value is 271 µS/cm.
[1] Recreational guideline value adopted.

The drinking water aesthetic WQG value for turbidity is specific to a particular human use and therefore has not been applied to the whole of the Black Ross WQIP area. It is however applicable to Paluma Dam, the Crystal Creek catchment, Black Weir (part of the Lower Ross River sub basin) and the Upper Ross River sub basin, as these are sources of Townsville's drinking water supply.

For high ecological value (HEV) waters the intent is to maintain existing water quality (physico-chemical), relative to the 20th, 50th and 80th percentiles, and maintain existing habitat, biota, flow and riparian areas. The generic management intent for HEV waters comes from the AWQG (ANZECC 2000). The physico-chemical WQOs for HEV waters are therefore defined by the existing water quality. Due to the lack of water quality condition data for fresh

and estuarine HEV waters, no attempt has been made to define specific ambient WQOs for fresh and estuarine HEV waters.

For marine areas the draft WQOs (see Table 4-2) are based on aquatic ecosystem protection for SMD waters/systems. The same intent for marine HEV waters applies as for freshwaters and estuaries i.e. maintain existing condition.

Table 4-2 Draft Marine Physico-chemical Water Quality Objectives

Marine Water Type	Enclosed Coastal[2]	Open Coastal	Midshelf	Offshore
TSS (mg/L)	15 [2]	2.0 [1]	2.0 [1]	0.7 [1]
[2] Organic N (µg/L)	180 [2]	130 [2]	130 [2]	id
[1] PN (µg/L)	id	20 [1]	20 [1]	17 [1]
DIN – N (µg/L) *	11 [2]	9 [2]	9 [2]	id
Total N	200 [2]	140[2]	140[2]	id
[1] PP – P (µg/L)	id	2.8 [1]	2.8 [1]	1.9 [1]
FRP – P (µg/L)	6 [2]	6 [2]	6 [2]	id
Total P	20 [2]	20[2]	20[2]	id
Turbidity (NTU)	6 [2]	1 [2]	1 [2]	id
Chlorphyll a (µg/L)	2 [2]	0.45 [1]	0.45 [1]	0.4 [1]
Dissolved Oxygen (%)	90-105 [2]	95-105 [2]	95-105 [2]	id
pH	8.15-8.4 [2]	8.15-8.4 [2]	8.15-8.4 [2]	id
Secchi depth	1.5 [2]	10 [1]	10 [1]	17 [1]

Notes: [1] indicates values from the WQ Guideline for the GBRMP (GBRMPA 2009) and [2] indicates values from the QWQG (EPA 2006) for the Central Coast region. id is insuffiecient data.
There are no Offshore areas in the Black Ross WQIP area. See section 3.6 for definitions of Marine Water Type.

Draft WQOs for pesticides are listed in Table 4-3.

Table 4-3 Draft Pesticide Water Quality Objectives

	Freshwater		Marine	
Pesticides (µg/L)	**HEV**	**SMD**	**HEV**	**SMD**
Diuron	id	2.0	0.9	1.6
Atrazine	0.7	13	0.4	2.4
Simazine	0.2	3.2	0.2	3.2
Hexazinone	id	id	75	75
Endosulfan	0.03	0.03	0.005 [1]	0.005 [1]
Malathion	0.002	0.05	id	id
Chlorpyrifos	id	id	0.005	id
Ametryn	id	id	0.5	id
2,4-D	id	id	0.8	id
Tebuthiuron	id	id	0.02	id
MEMC	id	id	0.002	id
Diazinon	id	id	0.00003	id
Tributytlin[2]	id	id	0.0002	id

Source: Freshwater values are from AWQG ANZECC 2000 Table 3.4.1 Trigger values for toxicants at alternative levels of protection (aquatic ecosystems) Part 8, 9 and 10 (all other values ID). Marine values are from Water Quality Guidelines for the Great Barrier Reef Marine Park (GBRMPA 2009).
Notes: All values are measured in µg/L.
[1] This trigger value may not protect keystone species given effect concentrations for adult coral colonies are observed at significantly lower concentrations. [2] Tributytlin is a biocide.
id insufficient data to derive trigger values to establish WQOs.

WQOs have also been adopted for relevant indicators for urban areas (see Table 4-4 and Table 4-5).

Table 4-4 Draft Heavy Metal Water Quality Objectives

Indicator	Freshwater		Marine	
Heavy metal (µg/L)	**HEV**	**SM Dist.**	**HEV**	**SM Dist.**
Cadmium	0.06	0.2	0.7	5.5
Chromium	0.01	1.0	0.14	4.4
Copper	1.0	1.4	0.3	1.3
Lead	1.0	3.4	2.2	4.4
Nickel	8	11	7	70
Zinc	2.4	8.0	7	15
Hydrocarbons *	300	300		

Source: AWQG Table 3.4.1 Trigger values for toxicants at alternative levels of protection

Note: Trigger values for toxicants (µg/L) at alternative levels of protection (AWQG, pp.3.4-5 to 3.4-10) i.e. 99%, 95%, 90% and 80% for freshwaters and marine waters.

* Hydrocarbon reference (Oils and greases (including petrochemicals) <300 µg/L) appears in Aquaculture Table 4.4.3 Toxicant guidelines for the protection of aquaculture species Part 2. A range of specific hydrocarbons are also included in AWQG Table 3.4.1

Table 4-5 Draft Metals in Sediment Objectives

Metals in sediment	ISQG low	ISQG high
Cadmium	1.5	10
Chromium	80	370
Copper	65	270
Lead	50	220
Nickel	21	52
Zinc	200	410

Source: AWQG (ANZECC 2000) Interim Sediment Quality Guidelines Table 3.5.1.

Values are measured as mg/kg (dry weight), which is equivalent to parts per million (ppm). The guideline values/WQOs apply to SMD and HD aquatic ecosystems.

Additionally, a WQO has been set for gross pollutants as part of the process for developing the Water Sensitive Urban Design (WSUD) guidelines for the Townsville region. This is expressed as a 90% reduction in gross pollutants from current levels. Investigations are required to determine the current levels of gross pollutants to enable this WQO to be monitored over time.

Figure 4.1 Lower Ross River Sub Basin

5. Water Quality Targets

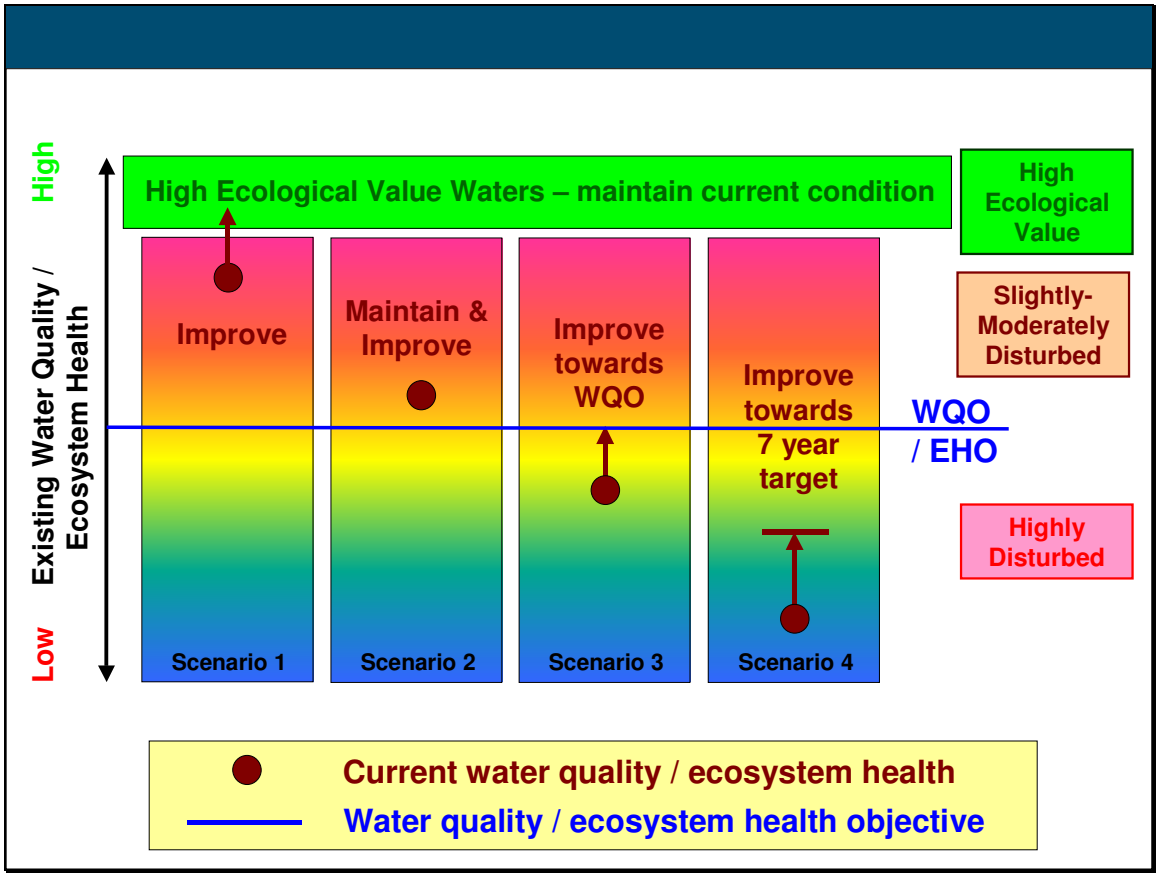
5.1 Indicative Ambient Targets

Draft water quality objectives (WQOs) from the QWQG (EPA 2006), AWQG (ANZECC 2000) and GBRMPA (2009) have been assigned to the waterways and waterbodies of the Black Ross WQIP area based on alignment with the environmental values (EVs) identified in section 2. As an associated exercise an indicative set of ambient water quality targets for sediment and nutrients was developed for the waters of the Black Ross WQIP area.

This indicative set of ambient water quality targets was derived from a preliminary assessment of available water quality condition data (see Connell Wagner 2008) and a subsequent comparison of the 'current' condition from that data with the draft WQOs. If the water quality monitoring information indicated that the water quality was better than the draft WQOs then an indicative water quality target was set that aligned with the current condition of the waterways.

The general concept for setting indicative ambient water quality targets is illustrated in Figure 5.1.

Figure 5.1 Target Setting Concept



Note: Water quality targets would be set on the basis of improving water quality condition by moving closer to the WQO from current condition, or by maintaining current condition if current condition is better than the draft WQO.

If the water quality monitoring information indicated that the water quality was worse than the WQOs for SMD waters then the magnitude of deviation of current condition from the WQO was calculated and an indicative water quality target was assigned on the basis of the likely improvement that could be achieved by 2021 with available resources. The aim in the longer term is to achieve the WQO.

For SMD waters where there is no condition data the indicative targets are the adopted WQOs.

Where water quality condition data is available the indicative targets will be current condition when current condition is better than the WQO (above the blue line in Figure 5.1).

When the current condition is worse than the WQOs (below the blue line in Figure 5.1) the targets are set using the following 'rules':

- If the difference between the condition and the WQO is less than or equal to 30% of the WQO, the WQO;
- If the difference between the condition and the WQO is greater than 30% of the WQO, the target is the WQO plus 50% of the difference between the condition and the WQO.

For HEV waters the intent is to maintain existing water quality hence the existing condition is also the indicative water quality target, assuming the current condition is as good as or better than the WQO.

Calculation of these initial water quality targets was intended to be an interim measure in the absence of any local water quality guidelines that could be used to derive WQOs. They are indicative targets only based on an eclectic mix of data that needs further analysis to determine its reliability. The draft water quality objectives, current condition and initial water quality targets are included in Table 5-1, Table 5-2 and Table 5-3 for freshwater systems, estuaries and marine waters, respectively.

Figure 5.2 Black River Sub Basin

Table 5-1 Draft Water Quality Objectives – Freshwater Systems

Catchment Unit	HEV	DIN (µg/L)			Organic N (µg/L)			Total N (µg/L)			FRP (µg/L)			Total P (µg/L)			TSS (mg/L)		
		WQO	CC	T	WQO	CC	T	WQO	CC	DT	WQO	CC	T	WQO	CC	T	WQO	CC	T
Crystal Creek Sub Basin																			
Crystal Creek (Up) 1-1	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Crystal Creek 1-1		40	14	14	200	95	95	240	109	109	4	2	2	10	4	4	10	2	2
Lorna Creek (Up) 1-2		36	ND	36	125	ND	125	150	ND	150	5	ND	5	10	ND	10	NWQO	ND	-
Lorna Creek 1-2		40	ND	40	200	ND	200	240	ND	240	4	ND	4	10	ND	10	10	ND	10
Ollera Creek (Up) 1-3	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Ollera Creek 1-3		40	ND	40	200	ND	200	240	ND	240	4	ND	4	10	ND	10	10	ND	10
Scrubby Creek (Up) 1-4	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Scrubby Creek 1-4		40	ND	40	200	ND	200	240	ND	240	4	ND	4	10	ND	10	10	ND	10
Hencamp Creek (Up) 1-5	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Hencamp Creek 1-5		40	35	35	200	300	250	240	340	290	4	5	4	10	20	15	10	11	10
[3]Paluma Dam (Up)		36	ND	36	125	ND	125	150	ND	150	5	ND	5	10	ND	10	NWQO	ND	-
Rollingstone Creek Sub Basin																			
Rollingstone Creek (Up) 2-1	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
[1]Rollingstone Creek 2-1		40	40	40	200	300	200	240	360	300	4	ND	4	10	20	15	10	8	8
Unnamed Creek 2-2		40	ND	40	200	ND	200	240	ND	240	4	ND	4	10	ND	10	10	ND	10
Surveyors Creek 2-3	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Wild Boar Creek 2-4	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Station Creek 2-5	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Saltwater Creek (Up) 2-6	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
[1]Saltwater Creek 2-6	√	40	15	15	200	200	200	240	223	223	4	5	4	10	20	15	10	14	12
Cassowary Creek (Up) 2-7	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Cassowary Creek 2-7	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Leichhardt Creek (Up) 2-8	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
[1]Leichhardt Creek 2-8		40	30	30	200	300	250	240	330	285	4	ND	4	10	20	15	10	10	10

Catchment Unit	HEV	DIN (µg/L)			Organic N (µg/L)			Total N (µg/L)			FRP (µg/L)			Total P (µg/L)			TSS (mg/L)		
		WQO	CC	T	WQO	CC	T	WQO	CC	DT	WQO	CC	T	WQO	CC	T	WQO	CC	T
Bluewater Creek Sub Basin																			
Christmas Creek (Up) 3-1	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Christmas Creek 3-1		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Sleeper Log Creek (Up) 3-1	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
[1]Sleeper Log Creek 3-1		80	17	17	420	200	200	500	240	240	20	5	5	50	30	30	10	17	14
[1]Two Mile Creek 3-2		80	19	19	420	200	200	500	228	228	20	9	9	50	40	40	10	25	18
Bluewater Creek (Up) 3-3	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Bluewater Creek 3-3		80	167	124	420	162*	420	500	280*	500	20	6	6	50	17*	50	10	5*	10
Althaus Creek (Up) 3-4	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Althaus Creek 3-4		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Deep Creek (Up) 3-4		25	ND	25	225	ND	225	250	ND	250	15	ND	15	30	ND	30	NWQO	ND	-
[1]Deep Creek 3-4		80	40*	80	420	300	300	500	370*	500	20	ND	20	50	20*	50	10	14	12
Healy Creek 3-4		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Black River Sub Basin																			
Black River (Up) 4-1	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Black River 4-1		80	40*	80	420	300	300	500	335*	500	20	35	28	50	32*	50	10	16	13
Alice River 4-2		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Bohle River Sub Basin																			
Stoney Creek 5-1		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Saunders Creek 5-1		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Bohle R (below H'way) 5-1		80	69*	80	420	500	420	500	620	500	20	86	53	50	130	90	10	21	16
Louisa Creek 5-1		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Town Common 5-1		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Bohle R (above H'way) 5-2		80	931	506	420	1000	710	500	1822	1161	20	4000	2010	50	2500	1275	10	24	17
Lower Ross River Sub Basin																			
Pallarenda 6-1		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Mundy Creek 6-2		80	ND	80	420	359	359	500	642	500	20	138	79	50	245	148	10	15	13
[1]Esplanade 6-3		80	30	30	420	300*	420	500	345*	500	20	ND	20	50	40	40	10	ND	10

Catchment Unit	HEV	DIN (µg/L)			Organic N (µg/L)			Total N (µg/L)			FRP (µg/L)			Total P (µg/L)			TSS (mg/L)		
		WQO	CC	T	WQO	CC	T	WQO	CC	DT	WQO	CC	T	WQO	CC	T	WQO	CC	T
Ross Creek 6-4		80	57	57	420	283	283	500	356	356	20	20	20	50	40*	50	10	18	14
[3]Ross River (below Dam) 6-5		80	40*	80	420	334*	420	500	430*	500	20	12	12	50	47	47	10	15	13
[3]Upper Ross River Sub Basin																			
Lake Ross (Ross Dam) 7-1		20	40	30	330	500	415	350	560	455	5	15	10	10	30	20	10	2*	10
Ross River (above dam) 7-1		80	40	40	420	500	420	500	560	500	20	15	15	50	30	30	10	2*	10
Round Mountain Ck (Up) 7-1	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Round Mountain Creek 7-1		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Central Creek (Up) 7-1	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Central Creek 7-1		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Ross River tributaries (Up) 7-1	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Ross River tributaries 7-1		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Six Mile Creek 7-2		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Toonpan tributaries (Up) 7-3	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Toonpan tributaries 7-3		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Antill Plains Creek (Up) 7-4	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Antill Plains Creek 7-4		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Sachs Creek (Up) 7-5	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Sachs Creek 7-5		80	ND	80	420	248	248	500	564	500	20	29	25	50	50	50	10	7*	10
Ross Dam tributaries (Up) 7-6	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Ross Dam tributaries 7-6		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Stuart Creek Sub Basin																			
Stuart Creek 8-1		80	40*	80	420	500	420	500	708	604	20	79	50	50	130	90	10	52	31
[1]Sandfly Creek 8-2		80	780	430	420	1400	910	500	2040	1270	20	ND	20	50	460	50	10	25	10
Alligator Creek Sub Basin																			
Alligator Creek (Up) 9-1	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Alligator Creek 9-1		80	30	30	420	225	225	500	330	330	20	15	15	50	30	30	10	8	8
Whites Creek (Up) 9-1	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Whites Creek 9-1		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10

Catchment Unit	HEV	DIN (µg/L)			Organic N (µg/L)			Total N (µg/L)			FRP (µg/L)			Total P (µg/L)			TSS (mg/L)		
		WQO	CC	T	WQO	CC	T	WQO	CC	DT	WQO	CC	T	WQO	CC	T	WQO	CC	T
Slippery Rocks Creek (Up) 9-1	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Slippery Rocks Creek 9-1		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Crocodile Creek 9-2		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Killymoon Creek (Up)	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Killymoon Creek		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Cocoa Creek 9-3		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Cape Cleveland 9-4	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Magnetic Island Sub Basin																			
Retreat Creek (Up) 10-1	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Retreat Creek 10-1		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Duck Creek (Up) 10-1	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Duck Creek 10-1		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Chinamans Gully (Up) 10-1	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Chinamans Gully 10-1		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Ned Lee Creek (Up) 10-1	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Ned Lee Creek 10-1		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Cockle Creek 10-1		80	ND	80	420	ND	420	500	630	500	20	10*	20	50	105	78	10	17	14
Butler Ck (Picnic Bay) (Up) 10-2		25	ND	25	225	ND	225	250	ND	250	15	ND	15	30	ND	30	NWQO	ND	-
Butler Ck (Picnic Bay) 10-2		80	ND	80	420	ND	420	500	570	500	20	10*	20	50	120	85	10	20	15
Picnic Bay west creek (Up) 10-2		25	ND	25	225	ND	225	250	ND	250	15	ND	15	30	ND	30	NWQO	ND	-
Picnic Bay west creek 10-2		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Gustav Creek (Up) 10-3	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Gustav Creek10-3		80	ND	80	420	ND	420	500	225*	500	20	10*	20	50	20*	50	10	7*	10
Hoyer Ck (Nelly Bay) (Up) 10-3		25	ND	25	225	ND	225	250	ND	250	15	ND	15	30	ND	30	NWQO	ND	-
Hoyer Creek (Nelly Bay) 10-3		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
North Nelly Bay creek (Up) 10-3	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
North Nelly Bay creek 10-3		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Petersen Creek (Up) 10-4	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]

Catchment Unit	HEV	DIN (µg/L)			Organic N (µg/L)			Total N (µg/L)			FRP (µg/L)			Total P (µg/L)			TSS (mg/L)		
		WQO	CC	T	WQO	CC	T	WQO	CC	DT	WQO	CC	T	WQO	CC	T	WQO	CC	T
Petersen Creek 10-4		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Gorge Creek (Up) 10-6	✓	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Gorge Creek 10-6		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Endeavour Creek (Up) 10-6	✓	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Endeavour Creek 10-6		80	90	80	420	ND	420	500	950	725	20	10*	20	50	100	75	10	69	40
East Horseshoe Bay creek 10-6		80	ND	80	420	ND	420	500	ND	500	20	ND	20	50	ND	50	10	ND	10
Five Beach Bay 10-7	✓	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]

Notes: HEV is high ecological value and indicates waterways that are in good ecological condition (denoted by a tick ✓) as determined by a technical panel and confirmed/modified at community workshops. All other waterways are either slightly to moderately disturbed (SMD) or highly disturbed (HD). SMD and HD waterways have not yet been determined. The table is indicative of the presence of HEV waterways only. To confirm the location of HEV waterways please refer to the maps (see Figure 2.6) and GIS data prepared by DERM/EPA during the development of the Black Ross WQIP.

DIN is dissolved inorganic nitrogen (the sum of Ammonia N and Oxidised N), Organic N is organic nitrogen, Total N is total nitrogen, FRP is filterable reactive phosphorus, Total P is total phosphorus, TSS is total suspended solids, WQO is Water Quality Objective (to protect SMD and HD waters); CC is current condition (from the WQ Condition report prepared by Connell Wagner (2008)); T is draft water quality target, EWQ is existing water quality, ND is no data, NWQO is no defined Water Quality Objective due to absence of guideline value, id is insufficient data for a meaningful median or mean to be calculated.

(Up) is the upland reach of the stream. Upland reaches are above the 150 metre contour (to be reviewed and may be revised to the circa 70 metre contour). All other streams are lowland freshwater reaches i.e. below the 150 metre contour. Estuarine reaches are listed in a separate table. The numbers after the waterway name in the Catchment Units column are Catchment unit codes used in the Black Ross WQIP (see Figure 2.1 for sub basin and catchment boundaries and Gunn and Manning 2009b for a full description of all catchment units).

The Central Coast lowland water quality guideline (WQG) for TSS has been adopted as the WQO for the Wet Tropics lowland streams in the absence of a Wet Tropics WQG.

Data for current condition (CC) was derived from the Water Quality Condition Report prepared by Connell Wagner (2008) (now Aurecon) using the median values (50th percentile). When there were less than 3 data sets the current condition column was marked id (insufficient data).

Values in green indicate that when current condition is better/less than the Water Quality Objective the current condition data was used to define the draft water quality target. Values in red indicate that when current condition is worse/greater than the Water Quality Objective the draft water quality target was calculated by applying the following formula (CC – WQO) x 0.5 + WQO = DT. This is equivalent to a 50% reduction of the amount above the WQO. If the difference between the WQO and current condition is less than 30% of the WQO then the WQO is adopted as the target rather than using the formula.

* indicates inconsistency or a wide variation in the data, or insufficient data to calculate percentiles. In these cases, rather than adopting the current condition as the draft target the WQO is adopted as the draft target (subject to review of the available data and possible subsequent revision).

[1] data is dated and may not reflect current condition (data review required and current condition and targets to be revised accordingly).

[2] EWQ = Maintain existing water quality (20th, 50th and 80th percentiles), habitat, biota, flow and riparian areas for HEV waters.

- The generic management intent for HEV waters comes from the ANZECC (2000) *Aust and NZ Water Quality Guidelines: "…management would be expected to ensure there is no change in biological diversity relative to a suitable reference condition*" (2000; 2-9) and *"the Guidelines advise that there should be no change from ambient conditions, unless it can be demonstrated that such change will not compromise the maintenance of biological diversity in the system."* (2000; 3.3-6)

[3] Waterways and waters have human use (drinking water) environmental values. Waterways in the Upper Ross River Basin are part of the catchment area of Ross Dam. Black Weir is an emergency drinking water supply impoundment for Townsville. Paluma Dam feeds Crystal Creek. Refer to Table 3-9 for turbidity WQOs relevant to drinking water.

WQOs for Ross Dam are from Central Coast Lakes/Reservoirs WQGs.

Table 5-2 Draft Water Quality Objectives – Estuarine Systems (µg/L)

Catchment Unit	HEV	DIN (µg/L)			Organic N (µg/L)			Total N (µg/L)			FRP (µg/L)			Total P (µg/L)			TSS (mg/L)		
		WQO	CC	T	WQO	CC	T	WQO	CC	DT	WQO	CC	T	WQO	CC	T	WQO	CC	T
Crystal Creek Sub Basin																			
Crystal Creek	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Lorna Creek	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
[1]Ollera Creek		45	ND	45	200	ND	200	250	ND	250	5	ND	5	20	ND	20	NWQO	ND	20
Scrubby Creek	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Hencamp Creek	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Rollingstone Creek Sub Basin																			
*Rollingstone Creek		45	ND	45	200	ND	200	250	ND	250	5	ND	5	20	ND	20	NWQO	ND	20
*Rollingstone Creek (north)	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
*Rollingstone Creek (south)	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Surveyors Creek	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Wild Boar Creek	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Station Creek	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
*Saltwater Creek (developed)		45	ND	45	200	ND	200	250	ND	250	5	ND	5	20	ND	20	NWQO	ND	20
*Saltwater Creek (undeveloped)	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Leichhardt Creek	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Bluewater Creek Sub Basin																			
*Sleeper Log Creek (channel)		20	ND	20	260	ND	260	300	ND	300	8	ND	8	25	ND	25	20	ND	20
*Sleeper Log Creek (surrounds)	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
*Two Mile Creek (channel)		20	ND	20	260	ND	260	300	ND	300	8	ND	8	25	ND	25	20	ND	20
*Two Mile Creek (surrounds)	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Bluewater Creek		20	ND	20	260	ND	260	300	ND	300	8	ND	8	25	ND	25	20	ND	20
Deep Creek		20	ND	20	260	ND	260	300	ND	300	8	ND	8	25	ND	25	20	ND	20
Black River Sub Basin																			
Black River		20	ND	20	260	ND	260	300	ND	300	8	ND	8	25	ND	25	20	ND	20
Bohle River Sub Basin																			
*Bohle River		20	ND	20	260	ND	260	300	ND	300	8	ND	8	25	ND	25	20	ND	20
*Shelley Beach	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]

Catchment Unit	HEV	DIN (µg/L)			Organic N (µg/L)			Total N (µg/L)			FRP (µg/L)			Total P (µg/L)			TSS (mg/L)		
		WQO	CC	T	WQO	CC	T	WQO	CC	DT	WQO	CC	T	WQO	CC	T	WQO	CC	T
Lower Ross River Sub Basin																			
Ross River		20	ND	20	260	ND	260	300	ND	300	8	ND	8	25	ND	25	20	ND	20
Ross Creek		20	ND	20	260	ND	260	300	ND	300	8	ND	8	25	ND	25	20	ND	20
Mundy Creek		20	ND	20	260	ND	260	300	ND	300	8	ND	8	25	ND	25	20	ND	20
Stuart Creek Sub Basin																			
Stuart Creek		20	ND	20	260	ND	260	300	ND	300	8	ND	8	25	ND	25	20	ND	20
Sandfly Creek		20	ND	20	260	ND	260	300	ND	300	8	ND	8	25	ND	25	20	ND	20
Sandfly Creek (east)	✓	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Alligator Creek Sub Basin																			
*Alligator Creek		20	30	25	260	300	260	300	330	300	8	ND	8	25	30	25	20	10	10
*Alligator Creek	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Crocodile Creek	✓	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Cocoa Creek	✓	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Magnetic Island Sub Basin																			
Retreat Creek	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Duck Creek	✓	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Ned Lee Creek	✓	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Butler Creek		20	ND	20	260	ND	260	300	ND	300	8	ND	8	25	ND	25	20	ND	20
Gustav Creek		20	ND	20	260	ND	260	300	ND	300	8	ND	8	25	ND	25	20	ND	20
Petersen Creek		20	ND	20	260	ND	260	300	ND	300	8	ND	8	25	ND	25	20	ND	20
Gorge Creek		20	ND	20	260	ND	260	300	ND	300	8	ND	8	25	ND	25	20	ND	20
Endeavour Creek		20	ND	20	260	ND	260	300	ND	300	8	ND	8	25	ND	25	20	ND	20
East Horseshoe Bay Creek	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Five Beach Bay	✓	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
[1]Rollingstone Bay	✓	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]

Notes: HEV is high ecological value and indicates waterways that are in good ecological condition (denoted by a tick ✓) as determined by a technical panel and confirmed/modified at community workshops. All other waterways are either slightly to moderately disturbed (SMD) or highly disturbed (HD). SMD and HD waterways have not yet been determined. The table is indicative of the presence of HEV waterways within a catchment unit and does imply that the whole of the catchment has HEV waterways. To confirm the location of HEV waterways please refer to the maps (see Figure 2.6) and GIS data prepared by DERM/EPA during the development of the Black Ross WQIP.

DIN is dissolved inorganic nitrogen (the sum of Ammonia N and Oxidised N), Organic N is organic nitrogen, Total N is total nitrogen, FRP is filterable reactive phosphorus, Total P is total phosphorus, TSS is total suspended solids. WQO is Water Quality Objective (to protect SMD and HD waters); CC is current condition (from the WQ Condition report prepared by Connell Wagner (2008)); T is draft water quality target, EWQ is existing water quality, ND is no data.

Mid estuary values have been adopted for both the Central Coast and Wet Tropics. Where there is no WQO for the Wet Tropics the Central Coast WQO has been adopted as the target.

[1] no information available and no values assigned at the community workshops. Aquatic ecosystem value assumed from limited knowledge of surrounding areas.

[2] EWQ = Maintain existing water quality (20^{th}, 50^{th} and 80^{th} percentiles), habitat, biota, flow and riparian areas for HEV waters. The generic management intent for HEV waters comes from the ANZECC (2000) *Aust and NZ Water Quality Guidelines: **"...**management would be expected to ensure there is no change in biological diversity relative to a suitable reference condition*" (2000; 2-9) and *"the Guidelines advise that there should be no change from ambient conditions, unless it can be demonstrated that such change will not compromise the maintenance of biological diversity in the system."* (2000; 3.3-6)

* Division of these waterways into HEV and SMD areas was based on background research by EPA staff, technical panel input and comments received at community workshops. For more detail refer to EPA notes in tables from HEV community workshops (see Appendix C).

Values in green indicate that when current condition is better/less than the Water Quality Objective the current condition data was used to define the draft water quality target. Values in red indicate that when current condition is worse/greater than the Water Quality Objective the draft water quality target was calculated by applying the following formula (CC – WQO) x 0.5 + WQO = DT. This is equivalent to a 50% reduction of the amount above the WQO. If the difference between the WQO and current condition is less than 30% of the WQO then the WQO is adopted as the target rather than using the formula.

Table 5-3 Water Quality Objectives, Current Condition and Targets - Marine Waters

Marine Area	HEV	DIN (µg/L)			Organic N (µg/L)			PN (µg/L)			Total N (µg/L)			FRP (µg/L)			PP (µg/L)			Total P (µg/L)			Chlorophyll a (µg/L)			TSS (mg/L)			Secchi Depth (m)		
		WQO	CC	T	WQO	CC	T	WQO	CC	T	WQO	CC	T	WQO	CC	T	WQO	CC	T	WQO	CC	T	WQO	CC	T	WQO	CC	T	WQO	CC	T
Near Coastal (Magnetic Island)																															
West Coast	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Picnic Bay	√	EWQ[2]	2.1*[3]	2.1	EWQ[2]	ND	EWQ[2]	EWQ[2]	23*[3]	20	EWQ[2]	97*[3]	97	EWQ[2]	2.5*	2.5	EWQ[2]	3.8*[3]	2.8	EWQ[2]	19.2*[3]	19.2	EWQ[2]	0.45[3]	0.45	EWQ[2]	2.5*[3]	2	EWQ[2]	4.3*[3]	4.3
Nelly Bay	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Nelly Bay Harbour		9	ND	9	130	ND	130	20	ND	20	140	ND	140	6	ND	6	2.8	ND	2.8	20	ND	20	0.45	1.35[3]	0.9	2	ND	2	1.5	ND	1.5
Arcadia/Geoffrey Bay	√	EWQ[2]	2*[3]	2	EWQ[2]	ND	EWQ[2]	EWQ[2]	20[3]	20	EWQ[2]	97[3]	97	EWQ[2]	2.7	3	EWQ[2]	4.1[3]	2.8	EWQ[2]	14	14	EWQ[2]	0.83*[3]	0.45	EWQ[2]	2.4	2	EWQ[2]	4[3]	4
Radical Bay	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Horseshoe Bay	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	17.9*[3]	18	EWQ[2]	89*[3]	89	EWQ[2]	2.8*	3	EWQ[2]	3.4*[3]	2.8	EWQ[2]	22.7*[3]	20	EWQ[2]	0.45*[3]	0.45	EWQ[2]	4.1*[3]	2	EWQ[2]	ND	EWQ[2]
Five Beach Bay	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Rollingstone Bay	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Open Coastal to Midshelf																															
West Channel/Middle Reef		9	3.7*[3]	4	130	ND	130	20	22*[3]	20	140	109*[3]	109	6	2.8	3	2.8	5.7[3]	4.2	20	15.2[3]	16	0.45	0.53[3]	0.45	2	4.2*	3	10	2*[3]	2
Cleveland Bay	√	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]	EWQ[2]	ND	EWQ[2]
Cleveland Bay		9	13	11	130	100	100	20	13.2*[3]	20	140	116	116	6	4	4	2.8	2.1*[3]	2.8	20	20	20	0.45	0.53[3]	0.45	2	6	4	10	6.5*[3]	10
Halifax Bay/Pandora Reef	√	EWQ[2]	1.2[3]	1.2	EWQ[2]	ND	EWQ[2]	EWQ[2]	12.1[3]	12.1	EWQ[2]	84[3]	84	EWQ[2]	2.1	2.1	EWQ[2]	2.5[3]	2.5	EWQ[2]	8.4[3]	8.4	EWQ[2]	0.30[3]	0.30	EWQ[2]	2[3]	2	EWQ[2]	6.0	6.0
Halifax Bay		9	ND	9	130	ND	130	20	ND	20	140	ND	140	6	ND	6	2.8	ND	2.8	20	ND	20	0.45	ND	0.45	2	ND	2	10	ND	10

Notes: DIN is Dissolved Inorganic Nitrogen, PN is Particulate Nitrogen, Total N is Total Nitrogen, FRP is Filterable Reactive Phosphorus, PP is Particulate Phosphorus, Total P is Total Phosphorus, TSS is Total Suspended Sediments, WQO is Water Quality Objective; CC is Current Condition; T is Water Quality Target, ND is No Data available and EWQ is maintain existing water quality.

HEV is high ecological value and indicates waterways that are in good ecological condition (denoted by a tick √) as determined by a technical panel and confirmed/modified at community workshops. All other waterways are either slightly to moderately disturbed (SMD) or highly disturbed (HD). SMD and HD waterways have not yet been determined. The table is indicative of the presence of HEV waterways within a catchment unit and does imply that the whole of the catchment has HEV waterways. To confirm the location of HEV waterways please refer to the maps (see Figure 2.6) and GIS data prepared by DERM/EPA during the development of the Black Ross WQIP.

[2] relates to HEV areas

[3] water quality data extracted from spreadsheet provided by GBRMPA (contains some small datasets).

* data is limited i.e. 3 datasets or less, so WQO is adopted for SMD and HD areas. For HEV areas the target is interim and may be revised based on further water quality monitoring results. If existing water quality is worse than the WQO then the WQO is adopted as the target rather than existing water quality.

Values in green indicate that when current condition is better/less than the Water Quality Objective the current condition data was used to define the draft water quality target.

Values in red indicate that when current condition is worse/greater than the Water Quality Objective the draft water quality target was calculated by applying the following formula (CC – WQO) x 0.5 + WQO = DT. This is equivalent to a 50% reduction of the amount above the WQO. If the difference between the WQO and current condition is less than 30% of the WQO then the WQO is adopted as the target rather than using the formula.

West Coast includes Young Bay and Cockle Bay. Whitfield Cove, Arthur Bay, Gowrie Bay and Unnamed Bay/s between Gowrie Bay and Horseshoe Bay are not listed in the table and are included in the HEV category and have no current condition data.

A summary of freshwater quality condition median data compared to the draft WQOs for SMD streams in the Black Ross WQIP area is provided in Table 5-4.

Table 5-4 WQ Data Compared to Draft WQOs

Sub Basin and Waterways	DIN	Org N	TN	FRP	TP	TSS
Crystal Creek Sub Basin [2]						
Crystal Creek 1-1	√ 65%	√ 53%	√ 55%	√50%	√ 60%	√ 80%
Hencamp Creek 1-5	√ 13%	X 50%	X 52%	X 25%	X 100%	X 10%
Crystal Creek Sub Basin	**DIN**	**Org N**	**TN**	**FRP**	**TP**	**TSS**
Crystal Creek 1-1	√ 83%	√ 77%	√ 78%	√ 90%	√ 92%	√ 80%
Hencamp Creek 1-5	√ 56%	√ 29%	√ 32%	√ 75%	√ 60%	X 10%
Rollingstone Creek Sub Basin [2]	**DIN**	**Org N**	**TN**	**FRP**	**TP**	**TSS**
[1]Rollingstone Creek 2-1	√	X 100%	X 50%	ND	X 100%	√ 20%
[1]Saltwater Creek 2-6	√ 65%	√	√7%	X 25%	X 100%	X 40%
[1]Leichhardt Creek 2-8	√ 25%	X 100%	X 38%	ND	X 100%	√
Rollingstone Creek Sub Basin	**DIN**	**Org N**	**TN**	**FRP**	**TP**	**TSS**
Rollingstone Creek 2-1	√ 50%	√ 29%	√ 28%	ND	√ 60%	√ 20%
Saltwater Creek 2-6	√ 81%	√ 52%	√ 55%	√ 75%	√ 60%	X 40%
Leichhardt Creek 2-8	√ 63%	√ 29%	√ 34%	ND	√ 60%	√
Bluewater Creek Sub Basin	**DIN**	**Org N**	**TN**	**FRP**	**TP**	**TSS**
[1]Sleeper Log Creek 3-1	√ 78%	√ 52%	√ 52%	√ 75%	√ 40%	X 70%
[1]Two Mile Creek 3-2	√ 76%	√ 52%	√ 54%	√ 55%	√ 20%	X 150%
Bluewater Creek 3-3	X 109%	√* 61%	√* 44%	√ 70%	√* 66%	√* 50%
[1]Deep Creek 3-4	√* 50%	√ 29%	√* 26%	ND	√* 60%	X 40%
Black River Sub Basin	**DIN**	**Org N**	**TN**	**FRP**	**TP**	**TSS**
Black River 4-1	√* 50%	√ 28%	√* 33%	X 75%	√* 36%	X 60%
Bohle River Sub Basin	**DIN**	**Org N**	**TN**	**FRP**	**TP**	**TSS**
Bohle R (below H'way) 5-1	√* 14%	X 16%	X 24%	X 330%	X 160%	X 110%
Bohle R (above H'way) 5-2	X 1,064%	X 138%	X 264%	X 19,900%	X 4,900%	X 140%
Lower Ross River Sub Basin	**DIN**	**Org N**	**TN**	**FRP**	**TP**	**TSS**
Mundy Creek 6-2	ND	√ 15%	X 28%	X 590%	X 390%	X 50%
[1]Esplanade 6-3	√ 63%	√* 29%	√* 31%	ND	√ 20%	ND
Ross Creek 6-4	√ 29%	√ 33%	√ 29%	√	√* 20%	X 80%
Ross River (below Dam) 6-5	√* 50%	√* 20%	√* 14%	√ 40%	√ 6%	X 50%
Upper Ross River Sub Basin	**DIN**	**Org N**	**TN**	**FRP**	**TP**	**TSS**
Lake Ross (Dam) 7-1 (Lake)	X 100%	X 52%	X 60%	X 200%	X 200%	√* 80%
Sachs Creek 7-5	ND	√ 41%	X 13%	X 45%	√	√* 30%
Stuart Creek Sub Basin	**DIN**	**OrgN**	**TN**	**FRP**	**TP**	**TSS**
Stuart Creek 8-1	√* 50%	X 19%	X 42%	X 295%	X 160%	X 420%
[1]Sandfly Creek 8-2 (Mid estuary)	X 875%	X 233%	X 308%	ND	X 820%	X 150%
Alligator Creek Sub Basin	**DIN**	**Org N**	**TN**	**FRP**	**TP**	**TSS**
Alligator Creek 9-1 (Lowland)	√ 63%	√ 46%	√ 34%	√ 25%	√ 40%	√ 20%
Alligator Creek 9-1 (Mid estuary)	X 50%	X 15%	X 10%	ND	X 17%	√ 50%
Magnetic Island Sub Basin	**DIN**	**Org N**	**TN**	**FRP**	**TP**	**TSS**
Cockle Creek 10-1	ND	ND	X 26%	√* 100%	X 110%	X 70%
Butler Ck (Picnic Bay) 10-2	ND	ND	X 14%	√* 100%	X 140%	X 100%
Gustav Creek10-3	ND	ND	√* 55%	√* 50%	√* 60%	√* 30%
Endeavour Creek 10-6	X 13%	ND	X 90%	√* 100%	X 100%	X 590%

Notes: Tick/cross denotes if the WQO is met (tick √) or not (cross X) for the waterway based on the median value for the water quality indicator. The percentage indicates the amount by which the WQO is met or not met (the difference between the WQO and water quality condition median as a percentage of the WQO). No % is listed if the water quality condition is the same as the WQO. ND is no data.
DIN is dissolved inorganic nitrogen, Org N is organic nitrogen, TN is total nitrogen, FRP is filterable reactive phosphorus, TP is total phosphorus and TSS is total suspended solids (sediment).
* indicates inconsistency or a wide variation in the data, or insufficient data to calculate percentiles.
[1] indicates data is dated and may not reflect current condition.
[2] indicates that water quality guidelines for the Wet Tropics were used to derive the WQOs for these sub basins. WQOs for all other sub basins are based on water quality guidelines for the Central Coast

Table 5-5 provides a summary of the number of waterways in sub basins that meet the WQOs for SMD waters for suspended solids and nutrients i.e. nitrogen and phosphorus.

Table 5-5 WQOs Met by Sub Basin

	Sub Basins									
	[2]Crystal Creek	[2]Rollingstone Creek	Bluewater Creek	Black River	Bohle River	Lower Ross River	Upper Ross River	Stuart Creek	Alligator Creek	Magnetic Island
* Catchments (number)	5	8	4	2	2	5	6	2	4	7
* Waterways (number)	5	8	7	2	5	5	10	2	7	15
[1] Water quality (WQ) data	2	3	4	1	1	4	2	2	1	4
Waterways with WQ data	40%	38%	57%	50%	20%	80%	20%	100%	14%	27%
Waterways meet all WQOs	1/1	0/2	0	0	0	1	0	0	1	1
Waterways meet 80% of WQOs	1/2	0/3	4	0	0	3	0	0	1	1
Waterways meet 50% of WQOs	1/2	1/3	4	1	0	3	1	0	1	1
Waterways meet TN WQO	1/2	1/3	4	1	0	3	0	0	1	1
Waterways meet DIN WQO	2/2	3/3	3	1	0	3[3]	0[3]	1	1	0[3]
Waterways meet Org N WQO	1/2	1/3	4	0	0	4	1	0	1	0[3]
Waterways meet TP WQO	1/2	0/3	4	1	0	3	1	0	1	1
Waterways meet FRP WQO	1/2	0/1[3]	3[3]	0	0	2[3]	0	0[3]	1	4
Waterways meet TSS WQO	1/1	2/2	1	0	0	0	2	0	1	1

Notes: * denotes the main catchments delineated, and major waterways, tributaries and waterbodies identified and included in the Black Ross WQIP.
[1] indicates the number of waterways and waterbodies with some water quality data, which has been included in the WQ database and subsequent WQ Condition Report (Connell Wagner 2008). Not all waterways have a complete set of data for all water quality indicators used in the Black Ross WQIP indicative targets table (DIN, Org N, TN, FRP, TP and TSS). Not all WQ data is current and/or considered reliable in terms of assessing existing condition or setting targets for all waterways in the Black Ross WQIP area. Waterways with WQ data indicates the percentage of waterways in the sub basin with available WQ data, either current or historic.
[2] Wet Tropics WQ guideline (WQG) values were used for these sub basins and the first number in the 'meet WQO' rows relates to compliance with WQOs based on Wet Tropics WQGs. The second number denotes compliance with Central Coast WQOs, which are based on Central Coast WQGs.
[3] indicates that one or more of the waterways did not have data for this indicator

The indicative ambient water quality targets are different from the load targets that have been established as part of the Black Ross WQIP Coastal Catchment Initiative funding agreement.

The ambient marine water quality targets are however related to end of catchment load targets and require further investigation to determine the correlation between the two types of targets. Better defining the relationship between end of catchment loads and ambient marine concentrations is part of a longer term water quality monitoring and modelling program proposed as an implementation action of the Black Ross WQIP.

This subject is discussed in more detail in the report prepared by the Australian Centre for Tropical Freshwater Research (ACTFR) titled *Integrated Monitoring and Modelling Strategy for the Black Ross Water Quality Improvement Plan*, ACTFR Report No. 08/17 (Bainbridge et al 2008).

5.2 Black Ross WQIP Load Targets

A set of draft end of catchment load based targets have been developed for the waters of the Black Ross WQIP area based on the results of a catchment modelling study undertaken by BMT WBM. Modelling results based on 2005 landuse are shown in Table 5-6.

Table 5-6 Baseline Modelling Results

Sub Basin		Area	Flow	TSS	TN	TP
	No.	Hectares	ML/year	kg/year	kg/year	kg/year
Crystal Creek	1	22,629	239,443	5,513,449	90,122	9,383
Rollingstone Creek	2	21,822	144,387	1,603,046	40,448	4,021
Bluewater Creek	3	28,872	145,698	2,806,946	92,700	4,641
Black River (no STP)	4	29,539	114,396	7,195,425	69,178	10,022
Black Basin total		102,861	643,925	17,118,866	292,448	28,067
Bohle River (no STP)	5	33,194	131,708	9,295,613	78,328	14,146
Lower Ross River	6	13,244	53,714	4,205,854	33,120	6,981
Upper Ross River	7	74,929	196,870	8,108,550	100,444	12,784
Stuart Creek (no STP)	8	11,024	47,483	1,650,930	18,956	2,959
Alligator Creek	9	27,490	104,834	2,104,936	42,716	4,811
Ross Basin total		159,882	534,608	25,365,882	273,565	41,680
Magnetic Island	10	4,815	27,390	342,217	6,286	944
Black Ross Total		267,559	1,205,923	42,826,965	572,299	70,690

Note: Alligator Creek sub basin has been grouped with the Ross River AWR Basin. It is part of the Haughton River AWR Basin. Figures do not include point source loads (from STPs). No. is the sub basin number adopted for the WQIP.

For further information on end of catchment loads and targets see the *Water Quality Pollutant Types and Sources Report: Black Ross Water Quality Improvement Plan* (Gunn and Barker 2009).

5.3 Environmental Flow

Environmental flow is a term used to express the amount/proportion of the natural flow of a watercourse required to maintain aquatic habitat health and ecological function in waterways and waterbodies. Environmental flow is usually related to regulated waterways where there are impoundments. Environmental flow also applies to unregulated waterways where water entitlements permit landowners to extract water for irrigation and other purposes.

There are two regulated systems in the Black Ross WQIP area i.e. the Ross River and Crystal Creek. Both of these systems are the subject of an Interim Resource Operations Licence (IROL) under the *Water Act 2000* (Qld).

The remainder of the WQIP area is subject to the general provisions of the Water Act with regard to taking water from a watercourse or other waterbody. If a landowner wants to take water from a stream, lake or other waterbody they are required to apply to the Department of Environment and Resource Management (DERM) (formerly the Department of Natural Resources and Water) for a water licence.

If a Water Resource Plan (WRP) or Resource Operations Plan (ROP) is in place for an area then the ROP can define the process for granting a water licence in that area. This is not the case for the majority of the Black Basin and the sub basins of the Ross Basin at present. Unregulated systems and the two regulated systems are discussed below in relation to current extraction and flow regimes.

5.3.1 Unregulated systems

The allocation of water licences, previously permits, has largely been based on an incremental system, which started in the late 1960's and accelerated during the 70's (an unusually wet period), resulting in over allocation in some instances. This means the entitlements are not achievable in many years and there is no actual use/extraction i.e. water allocation is higher than actual extraction. New entitlements in these watercourses are generally restricted to flood harvesting to off stream storages, based on minimum start up flows. As yet there has been no systematic approach in the Black and Ross Basins to determine sustainable yields and environmental flows. In the past there has been some attempt to restrict entitlements based on maintenance of minimum flows and protection of waterholes (pers. comm. Ian Boyce DERM - NRW).

As the majority of the streams in the Black and Ross Basins are ephemeral it is not an easy matter to determine sustainable yield based on an 'average' annual flow. Allowing an allocated amount of water harvesting when a stream has reached a minimum flow level is at present the best approach to maintaining adequate flow for environmental purposes in the ephemeral streams of the Townsville coastal Dry Tropics. A WRP will be prepared for Black and Ross Basins by DERM sometime in the future, which will address these matters.

Surface water extraction figures for the streams of the Black and Ross Basins, as provided by DERM (formerly DNRW), are included in Table 5-7 along with stream flow estimates.

It should be noted that the figures provided in Table 5-7 are indicative only and have not been validated (see associated table Notes also). When a WRP and ROP is in place for the Black and Ross River Basins a set of validated entitlements will be published by DERM.

Figure 5.3 Rollingstone Creek Sub Basin

Table 5-7 Extraction Rates and Flow for Black and Ross Basins

Name	ML (by ha)	Alloc. (ML)	No. of Alloc.	Flow est.	% of flow
Crystal Creek	1,088		8		
Bullocky Toms Creek	437.6		3		
UT Bullocky Toms Creek	48		1		
Little Crystal Creek	280		3		
Crystal Creek and tributaries	**1,854**		**15**		
UT Halifax Bay (Spring Gully)	264	28	3		
Ollera Creek	320		2		
Hencamp Creek	448		3		
Crystal Creek Sub basin [1]		**2,914 [1]**	**23**	**288,712**	**1%[1]**
Crystal Creek Sub basin [2]		**21,500 [2]**	**1**	**288,712**	**7.4%[2]**
Rollingstone Creek	792		11		
Rollingstone Creek West	200		1		
Leichhardt Creek	208		1		
Rollingstone Creek Sub Basin		**1200**	**14**	**169,790**	**<1%**
Sleeper Log Creek	4		1		
Bluewater Creek	143.2	27.4	37		
Healy Creek	8		1		
Bluewater Creek Sub Basin		**183**	**39**	**155,189**	**<1%**
Black River	544	56.5	10	82,283ML*	
Alick Creek	32		1		
UT Canal Creek	160		1		
Black River Sub Basin		**793**	**12**	**116,431**	**<1%**
Black Basin Total	4,976.8	111.8	87		
Black Basin Total Megalitres [1]		**5,089**	**87**	**730,121**	**<1%**
Black Basin Total Megalitres [2]		**26,589**	**88**	**730,121**	**3.6%**
Ross River	30.4	75,000	3	125,784ML**	
Lansdowne Creek	1,360		9		
UT Ross River	240		1		
Lower Ross River Sub Basin				60,464	
Ross River Sub Basin		**76,630**		**186,000**	**41%**
Bohle River		50	1	133,854	**<1%**
Stuart Creek	92.8		2	41,943	**<1%**
Alligator Creek	616.8		21	116,589	**<1%**
Gustav Creek (Magnetic Island)		1.8	1		
Ross Basin Totals	2,340	75,052	38		
Ross Basin Total Megalitres		**77,392**	38	**478,386**	**7%**
Black Ross WQIP total ML [1]		**82,480**	**125**	**1,208,500**	**6.8%**
Black Ross WQIP total ML[2]		**103,980**	**126**	**1,208,500**	**8.6%**

Source: DNRW "WERD periodic reports @ 08-Feb-2009"

Notes: These figures are water allocations as per licences issued and are not an indication of actual water use. In the ML (by ha) column nominal mega litre (ML) allocations have been calculated where allocations were provided in hectares (a use rate of 8ML per hectare per annum is assumed). This was the old style of allocation i.e. by land area to be irrigated. Flow estimate is annual average flow in mega litres from: * 117002A Black River at Bruce Highway and ** 118104A Ross River at Ross Dam Headwater. Other flows are from WaterCAST modelled outputs (pre 9/6/09 figures used).

If the Ross Dam allocation is excluded the licenced extraction rate for all waterways in the Black and Ross Basins is approximately 7,480 ML per annum.

[1] Figures do not take into account extraction associated with the water drawn from Crystal Creek as part of the IROL.

[2] Figures include the total take allowable from the Paluma-Crystal water supply scheme.

5.3.2 Regulated systems

The two regulated systems in the Black/Ross WQIP are at the opposite ends of the WQIP area with the Crystal Creek system having Wet Tropics features i.e. perennial flow, while the Ross River system is a more typical Dry Tropics ephemeral system. Due to its ephemeral nature and the location of three weirs downstream of the dam the Ross River Water Supply Scheme does not provide for environmental 'flows' but does maintain the water levels in the weir pools. The main features of both regulated systems are discussed in brief below.

5.3.3 Paluma-Crystal Water Supply Scheme

An interim water allocation was granted to Townsville City Council (TCC) on 30 April 2008 to service the Paluma-Crystal Water Supply Scheme. The allocation involves the taking of water from the Paluma Dam storage, located on Swamp Creek, and Crystal Creek (Crystal Creek Weir). This is a high priority entitlement of 21,571 megalitres per (water) year. There are other entitlements downstream of Crystal Creek Weir (presumably lower priority).

The Paluma-Crystal Water Supply Scheme involves extraction of water from Crystal Creek and Swamp Creek, as well as inter-catchment transfers. Paluma Dam (11,400ML commandable storage) is located in the Swamp Creek catchment (Burdekin Basin) and water is transferred from the dam to Crystal Creek (Crystal Creek catchment/Black Basin) when required.

Water is drawn from Crystal Creek Weir and piped via the Mt Spec pipeline to supply points. While Crystal Creek is a perennial stream it has characteristic wet and dry season flow patterns. Crystal Creek Weir overflows at median flows of 24ML/day and average flows 62ML/day. Low flows can be as little as 10ML/day in drier periods. It appears, from the little data available, that the flow regime of Crystal Creek has periodic pulses overtopping a low base flow during the 'dry' season.

Figure 5.4 Mt Spec Pipeline

The maximum allowable take of water from Crystal Creek weir is 59.1 ML/day, however, as noted, this is probably not achievable and a more realistic maximum extraction rate is in the vicinity of 40 ML/day. The average flows of 62 ML/day may also be misleading, as it is believed that TCC often supplement the volume with water from Paluma Dam to enable extraction of between 30 and 40 ML/day.

Crystal Creek Weir has a capacity of 1ML; therefore pass flows are dependant on three factors:

- Natural Crystal Creek flows, plus
- Water releases from Paluma Dam to Crystal Creek, minus
- Water extraction.

It is recognised in the IROL that due to the seasonal variation in flows the water supply extraction from Crystal Creek Weir can impact downstream entitlements and other interests e.g. environment and public. To accommodate downstream requirements, including environmental flow, the IROL provides for a diversion of water from Paluma Dam to Crystal Creek when the natural flow upstream of Crystal Creek Weir has been less than 65ML/day for a period of 30 days or more. In this event a minimum of 35ML/day is required to be diverted from Paluma Dam to Crystal Creek for a period of two days. In the event that no water has spilled over the weir for a period of nine months, and there has been flow in Crystal Creek, then TCC is required to allow 1ML/day of water to spill over the weir for a period of ten days. While these figures were correct at the time of publication they may change when a WRP is prepared for the Black and Ross Basins.

5.3.4 Ross River Water Supply Scheme

An interim water allocation was granted to Townsville City Council on 30 April 2008 to service the Ross River Supply Scheme. The allocation involves the taking of water from the Ross River (Ross River Dam and Black Weir) with an entitlement of 75,000 megalitres per (water) year. The Ross River Water Supply Scheme also has the option of transferring water from the Burdekin-Haughton Water Supply Scheme, via the Haughton pipeline, into Toonpan Creek, which then flows into the Ross River Dam.

The associated IROL permits Townsville City Council (formerly NQ Water) to "*take a volume equivalent to the amount required to meet town water supply demands*" (nominally 75,000 ML) (DNRW Information Notice 28 April 2008). Water managed under the IROL includes that impounded by the Ross River Dam and Black Weir. Black Weir is the emergency supply (approximately two weeks supply) in the event that water can't be drawn from Ross River Dam. The IROL is an interim arrangement until a WRP and ROP are prepared for the area.

Following the upgrade of the Ross River Dam the commandable (extractable) storage capacity is 233,000ML. Black Weir has a total storage capacity of 3,780ML with a commandable storage of 2,800ML. The only provision for release of water is to maintain Black Weir at a level not lower than 2.5 metres below its full supply (EL 11.31m AHD).

The licensee releases to the Ross River (Black Weir) below the Ross River storage area, all water that has been collected by the Ross River Dam collection system. This collection system aims to maintain groundwater levels below the dam wall at a desired level. The licensee also tests the water quality to assess dam wall integrity.

Figure 5.5 Lower Ross River Sub Basin

5.3.5 North Queensland Regional Water Supply Strategy

The Strategy area includes stream catchments in the coastal strip from Bowen to the northern boundary of Townsville City i.e. Crystal Creek, and closely mirrors the coastal component of the Burdekin Dry Tropics NRM area and is equivalent to the combined Black Ross WQIP area and the coastal section of the Burdekin WQIP area. The various stages in the development process of the North Queensland Regional Water Supply Strategy (NQRWSS) are listed in the text box below.

It should be noted that the NQRWSS is not a statutory document and will not directly impact surface water allocations in the Black Ross WQIP area. However, information gathered as part of the NQRWSS may influence policy and subsequent statutory water resource planning associated with the Black Ross WQIP area.

Some of the research and investigations, which are well advanced, may be useful to inform the Black Ross WQIP in terms of background information relevant to environmental flows and aquatic ecosystem health e.g. current extraction rates as a percentage of flow and potential future demand. It is assumed that the information collated for the NQRWSS will be available for inclusion in any future WRP and ROPs prepared for the Black and Ross Basins.

Regional Water Supply Strategy Process

1. Research Phase – Define supply objectives
   - Current supply/demand situation;
   - Future demand scenarios;
   - Establish water supply objectives.
2. Investigation Phase – Evaluate supply options in meeting supply objectives
   - Infrastructure options;
     - Stage 1 – selection of viable projects based on coarse economic/engineering filter,
     - Stage 2 – refinement of viable projects based on triple bottom line and other criteria.
   - Non-infrastructure options;
   - Evaluate options against supply objectives to develop draft Strategy.
3. Development Phase – Develop and consult on a draft Strategy taking in best options
   - Consult with internal stakeholders;
   - Incorporate stakeholder comments and revise draft Strategy.
4. Pre-approval Phase – Seek state-agency support, then Cabinet approval for draft Strategy
   - Consult with State Government agencies;
   - Lodge Cabinet Submission for approval of proposed final Strategy.
5. Approval and Implementation Phase
   - Implementation of approved Strategy and programme of works.

5.4 Event Sediment Target

Stream flow in the Dry Tropics is highly seasonal with potentially high and flood flows during the wet season (December to April) and limited baseflow, or no flow, in many of the streams during the drier months (May to November). The WQOs described earlier relate to ambient conditions (low or baseflow), while the end of catchment load targets are an annual average.

Given the seasonal flow patterns and the potential for erosion and sediment movement resulting from land disturbance created during development and construction a draft water quality target for sediment in rainfall run-off has been defined. This provides initial guidance as to acceptable sediment levels that can be discharged from developing areas and construction sites. The sediment target is listed in Table 5-8, along with event mean concentrations (EMC) for sediment and nutrients measured from water quality monitoring of run off events over two wet season. EMC targets for nutrients are yet to be determined.

Table 5-8 Event Mean Concentrations and Sediment Target for Developing Areas

	TSS (mg/L)	Total N (µg/L)	DIN – N (µg/L)	PN – N (µg/L)	Total P (µg/L)	PP – P (µg/L)	FRP – P (µg/L)
Average EMC	476	747	160	198	277	125	130
EMC target	285	-	-	-	-	-	-

Source: ACTFR event water quality monitoring data 2006-2008.
Note: TSS is total suspended solids (sediment), N is nitrogen, P is phosphorus, DIN is dissolved inorganic nitrogen, PN is particulate nitrogen, PP is particulate phosphorus, FRP is filterable reactive phosphorus.

The EMC water quality target for sediment for developing urban areas was derived by summing and averaging three of four EMCs derived from event water quality monitoring samples taken from waterways of developing coastal plains in Townsville (the highest value outlier was discarded). The average EMC value was then reduced by 40% to give the EMC water quality target. The 40% reduction was adopted, as it is a theoretic potential reduction based on best management practice incorporated in existing regulations for erosion and sediment control (ESC).

5.5 Conclusion

Information included in this report has been used in the preparation of the Black Ross (Townsville) WQIP and may be used as baseline information for the development of local water quality guidelines and water quality objectives that can be scheduled under the Environmental Protection (Water) Policy 2009.

Until the requisite work is completed to develop local water quality guidelines and analyse the water quality data collated during the preparation of the Black Ross (Townsville) WQIP the environmental values and water quality objectives identified for Townsville should be considered to be interim results.

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