TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

7.1 INTRODUCTION

This chapter provides an assessment of freshwater aquatic ecology of the proposed rail alignment. In doing so it describes the existing aquatic flora and fauna and the relevant habitats across the site. This report identifies the potential for the project to impact on existing aquatic flora and fauna in areas directly within or adjacent to the infrastructure footprint. The scope of the study included:

- a literature review and desktop assessment of publicly available databases, research publications and grey literature relevant to aquatic flora and fauna in the study area; and
- undertaking field investigations of the aquatic flora and fauna and associated habitat within the project area.

7.2 LEGISLATIVE AND PLANNING FRAMEWORK

Volume 1, Chapter 2 of this Environmental Impact Statement (EIS) provides a comprehensive review of legislation applicable to the project. Of particular relevance to Aquatic Ecology are the following sections of Volume 1, Chapter 2:

- s2.2.1.2 *Environment Protection and Biodiversity Conservation Act 1999*;
- s2.2.2.7 *Fisheries Act 1994 and Fisheries Regulation 2008*;
- s2.2.2.10 *Nature Conservation Act 1992*; and
- s2.2.2.16 *Water Act 2000*.

7.3 ASSESSMENT METHODS

7.3.1 DESKTOP ASSESSMENT

Desktop assessments were conducted prior to the commencement of the field survey to document the existing environment of the study area and to identify any listed species of flora and fauna or other matters of state or Commonwealth significance that may be associated with aquatic ecosystems in the project area. The assessments undertook searches of the following databases and literature sources:

- DSEWPC Protected Matters Search Tool to identify species listed under the Commonwealth EPBC Act that are predicted to occur within the study area;
- Commonwealth Government's ERT Database to obtain additional information on aquatic species of threatened status and invasive species of national significance associated with aquatic ecosystems predicted to occur within the study area;
- DSEWPC's on-line Australian Wetland Database for Wetlands that are listed Ramsar Convention (Ramsar) sites or listed in the Directory of Important Wetlands in Australia (DIWA);
- DERM Wildlife Online database to identify aquatic flora and fauna species including threatened species listed under the NC Act that have been historically recorded in the study area;
- DERM RE and Essential Habitat Mapping (Version 5.0, 2005) protected under the VM Act to determine the type and extent of remnant riparian and wetland vegetation as well as such areas recognised as essential habitat within the study area;
- DERM's on-line moratorium mapping facility to determine if any areas within the study area contained regrowth riparian and / or wetland vegetation protected under the *Vegetation Management (Regrowth Clearing Moratorium) Act 2009*;
- DERM Queensland Wetland Program Wetland Mapping and Classification base mapping (1:100,000);
- DERM wetland Info *"Wetland Summary Information"* (including listed plant and animal species) for river Basins (Burdekin and Don);
- DERM wetland Info *"Legislation and Planning Maps"* specifically for referable wetlands identified on the map as Great Barrier Reef (GBR) Wetland Protection Areas (WPA) and Wetland Management Areas (WMA);
- DEEDI Declared Fish Habitat area plans;
- Alluvium Consulting (2007). *Burdekin Dry Tropics NRM Region Fish Passage Study*, Report to Burdekin Dry Tropics NRM;
- Australian Centre for Tropical Freshwater Research (1999). *"Environmental Study of a Proposed Dam at Mt. Douglas on the Belyando River"*, ACTFR unpublished Report 99/28 prepared for the Queensland Department of Natural Resources;
- Burrows, D., Davis, A., and Knott, M. (2009). *"Survey of the Freshwater Fishes of the Belyando Suttor System, Burdekin Catchment, Queensland"* Australian Centre for Tropical Freshwater Research, James Cook

University, Townsville, unpublished Report 09/08 prepared for the North Queensland Dry Tropics NRM Board;

- Carter, J. and Tait, J. (2008). *"Freshwater Fishes of the Burdekin Dry Tropics NRM Region"*, Burdekin Dry Tropics and Alluvium Consulting, Townsville;
- Consortium of National Centre for Tropical Wetland Research and Centre for Riverine Landscapes web based Freshwater Fish Atlas of Northern Australia outputs for Burdekin and Don River Basins; and
- North Queensland Bulk Ports (2009). *Terrestrial and Aquatic Ecological Assessment*, Report for Proposed Abbot Point Multi Cargo Facility. Unpublished report prepared for North Queensland Bulk Ports Corporation Limited.

A review was undertaken of the Temporary Planning Policy (SPP1/10): *Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments*. The review assessed the existence of any wetlands mapped as being of high ecological significance occurring in close proximity to both the mine and rail alignment. The assessment interpreted the terrestrial vegetation mapping for wetland associated RE's to identify wetlands that may be impacted by the project. The rail does n ot crossed any areas that are declared wild rivers under the *Wild Rivers Act (2005)*.

7.3.2 FIELD SURVEYS

Field surveys and sampling were conducted to identify aquatic species and communities within the project area, fill information gaps in areas poorly served by available survey data and to verify the likelihood of the occurrence of EPBC Act and NC Act listed species identified via desktop searches as having the potential to occur within the rail alignment footprint. Verification was based on direct observation of flora, fauna, REs present or suitable habitat.

The primary aquatic ecological survey was conducted during the post wet season (May 2010) which provided optimum timing in terms on vehicular access, fauna activity, flora inflorescence and persistence of seasonal stream and water bodies.

7.3.2.1 Selection of Sites

Most of the project area is remote, poorly served by road networks, under freehold or leasehold land tenure and includes floodplain and hilly dissected terrain inaccessible by 4wd vehicle. The aquatic flora and fauna survey was dependent upon vehicle based mobilisation of survey equipment and this restricted the selection of survey sites to areas accessible by the available road and track network and subject to landholder permission. The location of the aquatic sampling sites relative to the rail alignment is shown in Figure 1 and Figure 2.

7.3.2.2 Aquatic Habitat

The aquatic habitat sites were assessed using the Australian River Assessment System (AusRivAS) rapid assessment technique developed under the National River Health Program by the Commonwealth Government in 1994. This technique broadly defines stream morphology; available aquatic habitats, vegetation and observed land use impacts. Stream morphology provides information such as flow characteristics, bed morphology, bed substrate, bed width and any seasonal variations.

Description of survey site habitats included aquatic physical and biotic features and adjoining riparian vegetation communities were derived from wetland associated RE mapping, application of State of the Rivers (Anderson 1993a and 1993b) reporting pro-forma protocols and additional qualitative description of observed habitat features. This information was stored on a Trimble Data Logger. Qualitative habitat descriptions were structured by a consistent set of descriptors across all sites including geomorphic setting, riparian vegetation structure and dominant overstorey, emergent and submergent plant species, available aquatic habitats, substrate type, hydrological regime, weeds and other disturbance factors and observed water clarity.

7.3.2.2.1 Aquatic Habitat Types

Aquatic ecosystems within the study area can be divided into four broad habitat types; estuarine, lacustrine, palustrine and riverine.

Estuarine habitats occur where freshwater from riverine habitats mixes with oceanic waters to produce a brackish environment. Estuarine habitats within the study area include saltwater wetlands (including mudflats and samphire wetlands) and adjacent tidal creeks. These habitats are located in the Abbot Point region and are generally associated with the Caley Valley Wetland.

Lacustrine habitats are open water bodies such as lakes and artificial dams. These habitats are generally deep and still or slow-flowing and are often utilised by fauna species during the dry season as a refuge when other water sources have dried up.

Palustrine habitats are primarily off-stream habitats such as wetlands, gilgais and billabongs that generally support a high abundance of emergent vegetation. Palustrine habitats are inundated during the wet season and gradually dry out as rainfall declines and water levels in the main river channel subside (depending on specific site conditions these habitats may or may not completely dry out). Due to their shallow depth and still water conditions, palustrine habitats can support a high diversity of in-stream habitat in form of detritus, fallen branches and logs.

Riverine habitats include all aquatic habitat types that occur within a channel (i.e. rivers and creeks) and may be periodically or permanently inundated by flowing water. This is the predominant habitat type within the study area.

Where relevant these areas have been identified through regional mapping tools and referred to during site assessment.

Figure 1. Aquatic Sampling Sites – KP05 to KP250 (Map 1 of 2)

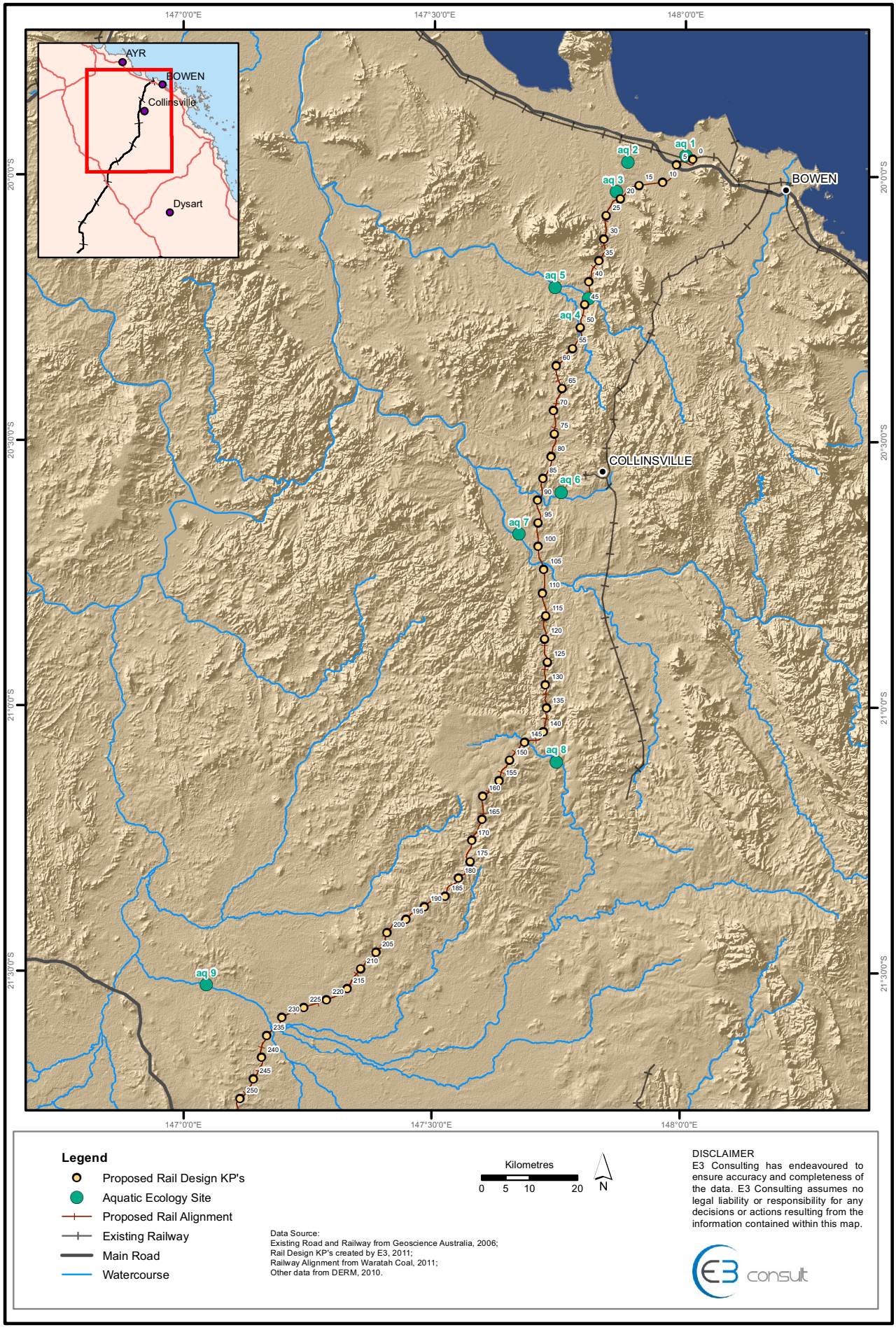
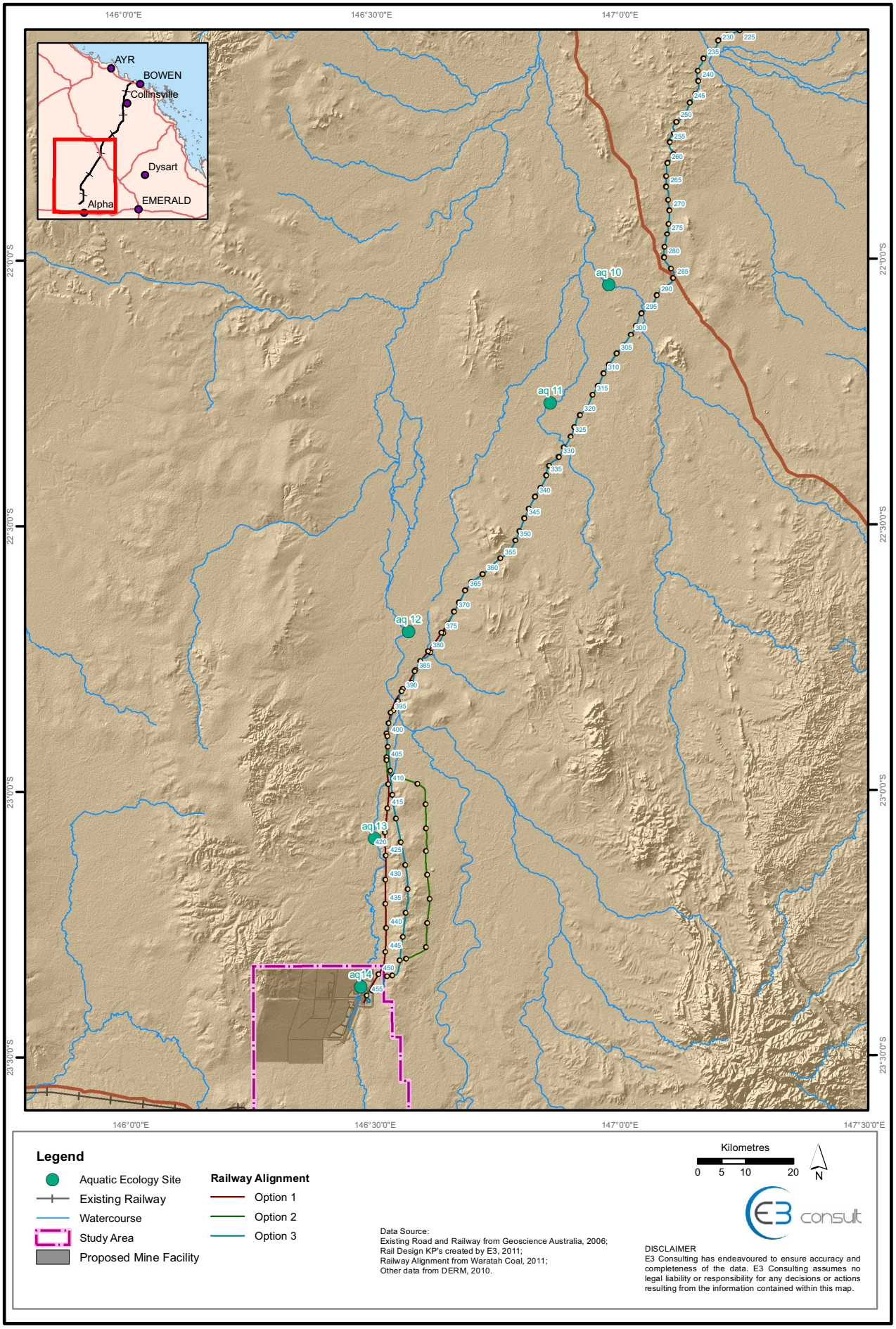


Figure 2. Aquatic Sampling Sites – KP235 to KP468 (Map 2 of 2)



7.3.2.3 Water Quality

Water quality samples were not taken as part of this work. The water quality of the project area was assessed and is described in the Surface Water Quality chapter (Volume 3, Chapter 9). A total of 11 sites were sampled across the rail alignment during both wet and dry seasons. Aquatic sampling sites were selected to be as close as possible to water quality sites; however, as a result of needing to use a motor vehicle to access the sites selected for aquatic ecology sampling exact replication of sites was not possible (a helicopter was used for surface water sampling).

7.3.2.4 Aquatic Flora

Aquatic macrophytes observed at each sites including emergent, submergent and floating forms were described as part of site habitat descriptions. The relative abundance, growth habit and preferred habitat of observed macrophytes were recorded. Plants were identified to species levels by reference to field guides (Sainty and Jacobs 2003, Stephens and Dowling 2003, Cowie, *et al* 2000), photographed and checked against lists of listed species known or predicted to occur in the project area.

7.3.2.5 Aquatic Macro Invertebrate Communities

The streambeds consist primarily of gravel, leaf litter, macropyhtes, sand and stones. Samples of invertebrates were taken from all habitats including riffles, runs and pool using a 250 µm dip net. Three replicate samples were taken by placing the net immediately below a sampled area and allowing the water flow to transport the sample into the net. Fist-sized stones (Phi Scale –7) were sampled by lifting the stone from the substrate, taking care not to include any accumulation of organic material underneath the stone and placing it in the net; a spray bottle was then used to remove the invertebrates from the stone. Kick samples were taken off the surface of sandy substrates by placing the net downstream of the sampler and disturbing a 10 x 10 cm^2 section of the substrate, and then moving the net through the disturbed substrate to collect the disturbed invertebrates. Leaf litter was collected by placing the net immediately downstream of the leaf litter pack, and picking up a 10 x 10 cm^2 section of leaf litter and placing it into the net.

All invertebrate samples (n = 36) were preserved in 70% ethanol and returned to the laboratory for processing. Macro invertebrates were screened through a 2 mm, 1 mm, 300 µm and 180 µm sieve and sorted based on the location within each sieve. Macro invertebrates were counted and identified under a stereo dissecting microscope. All taxa were identified using published keys (e.g. Williams, 1980) and reference collections obtained from the University of Queensland library and those held by staff at E3. Where the number of individuals of a family in a sample / sieve equaled greater than 50, the count was stopped for that particular family.

Stream Invertebrate Grade Number – Average Level (SIGNAL) scores were also calculated for all of the sites sampled using the order – class – phylum methodology outlined in Chessman (2003). SIGNAL scores provide an indication of waterway health with higher scores generally associated with healthier waterway ecosystems. The calculated SIGNAL scores were then compared to Gooderum and Tsyrlin (2002) to identify the relative health of the sampled stream. Signal scores were split into the following categories:

- greater than 6 – healthy habitat;
- between 5 and 6 – mild pollution;
- between 4 and 6 – moderate pollution; and
- less than 4 – severe pollution.

7.3.2.6 Fish and Macro Crustacea Communities

Fish and macro crustacea sampling was conducted using a site applicable subset of standardised quantitative and qualitative sampling methods. These methods included:

- gill netting;
- fyke netting;
- electrofishing;
- baited box traps;
- drag seine netting; and
- visual observation / spotlighting.

Fish and macro crustacea samples obtained by each method were identified to species level and counted in the field and released where possible. Where species identification was not possible, representative specimens were preserved and shipped to Brisbane for formal identification by the Queensland Museum. Up to 20 randomly selected specimens of each species from each

sampling device were measured for length frequency data in the following manner: Fish fork length to the nearest mm; prawn postorbital carapace length, to the nearest 0.1 mm; and crab carapace width to the nearest 0.1 mm. Once 20 individuals had been measured, they were only counted for overall catch data.

7.3.2.7 Turtle Communities

During the field based aquatic surveys, the available in-stream habitat including edge, bank, macrophyte beds and riparian habitat at each site was thoroughly inspected for the presence of turtles, their nests or pathways. Opportunistic sampling was undertaken and a number of individuals were caught, identified and measured. Turtles were identified through keys prepared by Cann (1998).

7.3.2.8 Other Aquatic Vertebrates

During the aquatic surveys, the available in-stream habitat including edge, bank, macrophyte beds and riparian habitat at each site was thoroughly inspected for the presence of other vertebrate fauna. Opportunistic sampling was undertaken and data collected. No dedicated trapping effort was undertaken at any of the sites for amphibians and / or avian fauna utilising these habitats.

7.3.2.9 Rapid Aquatic Ecology Habitat Assessment Sites

Visual observations of aquatic ecological habitats were undertaken as part of the water quality sampling using the AusRivas methodology to assess these habitats at waterways throughout the study area. Characteristics noted on site including stream morphology, dominant substrate type, flow regimes, vegetation structure and stream cover. A total of 11 sites were observed along the rail alignment.

7.4 EXISTING ENVIRONMENT

The rail alignment includes aquatic habitats within the Belyando, Suttor, Bowen and Lower Catchments including parts of the Don Catchment. The sample sites are split as follows:

- Lower Catchments – sites AQ3, AQ4 and AQ5 (approximately KP20 to KP50);
- Bowen Catchment – sites AQ6 and AQ7 (approximately KP50 to KP130);
- Suttor Catchment – sites AQ8 and AQ9 (approximately KP130 to KP250); and
- Belyando Catchment – sites AQ10, AQ11, AQ12 and AQ13 (AQ14 is also within the Belyando Catchment) (approximately KP250 to KP468).

Each catchment is described with reference to the topography, land use, location of the sites sampled, aquatic habitat, protected species, wetlands, remnant vegetation, aquatic flora (algae and macrophytes), macro invertebrates, macro crustacean, fish, turtles and other vertebrate communities observed within each catchment. Detailed descriptions of all the sites including photos are provided in the Technical report (Volume 5, Appendix 13).

Wetlands and REs are discussed with respect to each specific catchment. The rail alignment intersects a number of areas which include riparian vegetation that is protected under the EPBC Act, NC Act and VM Act. No listed fauna species were observed within the aquatic ecosystems intersected by the rail alignment.

A total of 33 macro invertebrate groups, seven macro crustacea and 24 fish species were observed across the entire rail alignment. A list of all macro invertebrate, macro crustacea and fish species caught / observed within the rail alignment area are provided in Table 1 to Table 3. An "x" indicates that the animal was observed during sampling. Macro invertebrates, macro crustacea and fish observed within each specific catchment are highlighted within the relevant section.

Table 1. Distribution of macro invertebrate families across the rail alignment

COMMON NAME	FAMILY	SPECIES	AQ3	AQ4	AQ6	AQ7	AQ8	AQ9	AQ10	AQ11	AQ12	AQ13
Caddisfly larvae	-	*Tricoptera*	X	X	X	X		X	X	X	X	X
Mayfly nymphs	-	*Ephemeroptera*	X	X	X	X	X	X	X	X	X	X
Sow bugs or isopods	-	*Isopoda*		X								
Stonefly nymphs	-	*Plecoptera*				X					X	X
Gnats or Midges	Chironomidae	*Diptera*	X	X	X	X	X	X	X	X	X	X
Orb-shell mussel	Corbiculidae	Class: *Bivalvia*								X	X	X
Mosquiotes	Culicidae	*Diptera*				X						
Diving beetles	Dytiscidae	*Coleoptera*	X	X	X	X	X		X		X	X
Water striders or pond skaters	Gerridae	*Hemiptera*	X		X	X						
Whirligig larvae	Gyrinidae	*Coleoptera*			X		X		X			
Crawling water beetles	Haliplidae	*Coleoptera*				X						
Riifle or Marl beetles	Helminthidae	*Coleoptera*	X		X	X	X	X	X	X	X	X
Helminthid larvae	Helminthidae	*Coleoptera*	X	X	X	X	X	X	X	X	X	X
Water measurer	Hydrometridae	*Hemiptera*						X		X		
Water scavenger beetles	Hydrophilidae	*Coleoptera*	X		X	X						X
Screech beetles	Hygrobiidae	*Coleoptera*	X		X		X		X	X	X	X
Pond snails	Lymnaeidae	Class: *Gastropoda*		X	X	X	X	X		X		
Water scorpion	Nepidae	*Hemiptera*		X								
Water boatman or backswimmers	Notonectidae	*Hemiptera*										X
Shrimp	Palaemonidae, Atyidae	*Decapoda*		X	X	X				X	X	X
Bladder or tadpole snails	Physidae	Class: *Gastropoda*			X			X		X		
Fisher spiders	Pisauridae	*Araneae*		X			X		X	X		
Ramshorn snails	Planorbidae	Class: *Gastropoda*	X		X	X						

COMMON NAME	FAMILY	SPECIES	AQ3	AQ4	AQ6	AQ7	AQ8	AQ9	AQ10	AQ11	AQ12	AQ13
Pigmy backswimmer	Pleidae	*Hemiptera*			X					X	X	X
Sand or Black flies	Simuliidae	*Diptera*			X	X	X	X			X	X
Sand or black fly pupa	Simuliidae	*Diptera*				X		X				
Pea-shell mussel	Sphaeriidae	Class: *Bivalvia*				X					X	
Dragonfly nymphs	Sub Order: Anisoptera	*Odonata*	X	X		X	X					X
Water fleas	Sub order: Cladocera	*Diplostraca*		X	X	X	X		X	X	X	X
Water mites	Sub Order: Hydracarina	*Acarina*		X				X	X	X		
Damselfly nymphs	Sub Order: Zygoptera	*Odonata*				X						
Crane flies or daddy-long-legs	Tipulidae	*Diptera*				X						
Water crickets	Veliidae	*Hemiptera*					X					X
Total Number Species Recorded / Site			**11**	**13**	**17**	**21**	**13**	**11**	**11**	**15**	**14**	**17**

Table 2. Distribution of macro crustacea species across the rail alignment

COMMON NAME	FAMILY	SPECIES	AQ3	AQ4	AQ6	AQ7	AQ8	AQ9	AQ10	AQ11	AQ12	AQ13
Shrimp	Atyidae	*Caridina sp.*	X	X	X	X	X	X		X	X	
Riffle Shrimp		*Australatya striolata*	X									
Australian River Prawn	Palaemonidae	*Macrobrachium australiense*	X	X	X	X	X	X	X	X	X	X
East Australian River Prawn		*Macrobrachium tolmerum*	X									
Orange Fingered Yabby	Parastacidea	*Cherax drepressus*					X					
Redclaw		*Cherax quadricarinatus* (T)			X			X	X		X	
Freshwater Crab	Parathelphusidae	*Austrothelphusa transversa*					X	X				X
Total Number Species Recorded / Site			**4**	**2**	**3**	**2**	**4**	**4**	**2**	**2**	**3**	**2**

Species type key: (T) Translocated to Basin or site

Table 3. Distribution of fish species across the rail alignment

COMMON NAME	FAMILY	SPECIES	AQ3	AQ4	AQ5	AQ6	AQ7	AQ8	AQ9	AQ10	AQ11	AQ12	AQ13
Agassiz's Glassfish	Ambassidae	*Ambassis agassizii*	X	X		X	X			X	X	X	X
Long-finned Eel	Anguillidae	*Anguilla reinhardtii* (M) (F)	X	X		X	X						
Lesser salmon Catfish	Arridae	*Neoarius graeffei* (F)					X						
Flyspecked Hardyhead	Atherinidae	*Craterocephalus stercusmuscarum*				X							
Barramundi	Centropomidae	*Lates calcarifer* (M)(F)					X						
Tilapia	Cichlidae	*Oreochromis mossambica* (E)				X			X		X	X	
Bony Bream	Clupeidae	*Nematalosa erebi*				X	X		X	X	X	X	
Southern Purple-Spotted Gudgeon	Eleotrididae	*Mogurnda adspersa*		X		X	X	X	X		X	X	X

COMMON NAME	FAMILY	SPECIES	AQ3	AQ4	AQ5	AQ6	AQ7	AQ8	AQ9	AQ10	AQ11	AQ12	AQ13
Empire Gudgeon		*Hypseleotris compressa*	x										
Western Carp Gudgeon		*Hypseleotris klunzingeri*	x			x					x		
Sleepy Cod	Eleotrididae	*Oxyeleotris lineolata* (F) (T @ sites> AQ7)				x	x	x	x	x	x	x	x
Speckled Goby	Gobiidae	*Redigobius bikolanus* (M)					x						
Tarpon	Megalopidae	*Megalops cyprinoides* (M)					x						
Eastern Rainbowfish	Melanotaeniidae	*Melanotaenia splendida splendida*	x	x	x	x	x	x	x	x	x	x	x
Yellow Belly	Percichthyidae	*Macquaria ambigua* (T)(F)										x	
Hyrtl's Tandan	Plotosidae	*Neosilurus hyrtlii*				x	x	x	x	x	x	x	x
Black Catfish		*Neosilurus ater* (F)				x	x		x	x		x	
Rendahl's Catfish		*Porochilus rendahli*							x	x			
Pacific Blue-eye	Pseudomugilidae	*Pseudomugil gertrudae*				x	x						
Spangled Perch	Terapontidae	*Leiopotherapon unicolor*	x	x	x	x	x	x	x	x	x	x	x
Sooty Grunter		*Hephaestus fuliginosus* (F)					x						
Smallhead Grunter		*Scortum parviceps* (R)						x	x	x	x	x	
Barred Grunter		*Amniataba percoides*				x	x						
Seven spot Archerfish	Toxotidae	*Toxotes chatareus* (F)					x						
Total Number Species Recorded / Site			**6**	**5**	**2**	**14**	**17**	**6**	**10**	**9**	**10**	**11**	**6**

Species type key: (E) Exotic, (F) Important to Traditional / commercial / recreational fisheries, (M) Migratory species with amphidromous, catadromous or marine vagrant life history, (R) Restricted Burdekin River Basin Endemic, (T) Translocated to Basin or site

7.4.1 LOWLAND CATCHMENTS

The lowland catchments include three sites, these being all on the northern side of the Clarke Range. The streams sampled were the Elliot River (AQ3), Bogie River (AQ4) and Sandy Creek (AQ5). A suite of sampling was undertaken at both AQ3 and AQ4. There was insufficient aquatic habitat present at AQ5 to carry out a full suite of sampling.

7.4.1.1 Catchment Description

7.4.1.1.1 Topography

Elevations in this area range from around 100 m Australian Height Datum (AHD) to over 1,000 m AHD; however the rail alignment reaches maximum elevations of about 200 m. The topography includes the granite hills of Mt Abbot (1056 m), Mt Aberdeen (910 m), Mount MacKenzie (514 m), Pine Hill (624 m), and Highlanders Bonnet (487 m). The geology of the Clarke Range is comprised of granite, rhyolite, diorite and other igneous rocks ranging in origin from Carboniferous to Early Permian age (354 to 270 million years). The foothills of the range are generally low undulations before rising to very rugged and broken country.

The major structural faults and shears that occur in close proximity to and / or intersect the rail alignment include those in the Bulgonunna Volcanics region where the north-west trending fault sets dominate including the Glenore Shear zone. Further to the south-east of the rail alignment, the Millaroo Fault Zone extends through the Lizzie Creek Volcanics. There are numerous other faults and structures exploited by dykes that mirror the north-west trend of these zones.

7.4.1.1.2 Land Use

Almost 100% of the land within the lower catchments is used for grazing land (production from relatively natural environments). Mount Aberdeen National Park is located approximately 5 km east of the rail alignment near KP35 to KP45. The Aberdeen Nature Refuge is set on two parcels of land. Both of these conservation areas are considered to be well outside the study area. The Mount Pleasant Nature Refuge is present and conjoins to the southern extent of the Mt Aberdeen Nature Refuge, extending from KP45 to KP55. There are also multiple parcels of land predominantly classified as State Forest; none of which are considered to encroach upon the rail alignment. A detailed description of land uses in the region can be found in **Volume 3, Chapter 4**.

7.4.1.2 Aquatic Habitat

AQ3 and AQ4 are sand bed dominated broad river channel incised within broad shallow valleys in an undulating low hills landscape. In contrast, AQ5 is a sand to cobble bedded creek channel within a narrow valley in an undulating low hills landscape. The majority of the substrate is coarse granite derived sands. Active flow channels incised through sand beds and surface flow was lacking in some sand bed reaches, typical of seasonal variations and reduction in flow post wet season, although the Bogie River has a braided, coalesce at bed rock exposure locations to form riffles and runs.

Alluvial terraces and benches are present across the Lower Catchment area. Where the canopy is undisturbed, ground cover is sparse and is dominated by leaf litter. Cattle have open access to streams and use the streams for water external to the troughs set up by the land owners. Stream flow at AQ3 is seasonal with only widely separated scour pools likely to be perennial in wetter than average years.

The riparian vegetation consists of open forest dominated by tall silver-crowned paperbark (*Melaleuca fluviatilis*) and white weeping paperbark (*M. leucadendra*) overstorey with co-dominant emergent Black Ironbox (*Eucalyptus raveretiana*) (protected under the EPBC Act and NC Act) and co-dominant river she oak (*Casuarina cunninghamiana*). Scattered Moreton Bay ash (*Corymbia tessellaris*) and silver-leafed paperbark (*Melaleuca dealbata*) are also present on the channel margins. The channel margin mid storey includes northern swamp box (*Lopostemon grandiflorus*), black tea-tree (*Melaleuca bracteata*), weeping bottlebrush (*M. viminalis*) and pandanus (*Pandanus spiralis*). At AQ4 and AQ5, Weeping Bottlebrush formed a near contiguous riparian vegetation corridor that extended across the river channel in areas of bed rock exposure. Other isolated canopy species present include Leichhardt trees (*Nauclea orientalis*) and Burdekin plum (*Pleiogynium timorense*).

Away from the channel margins, a semi evergreen vine thicket and semi-deciduous notophyll rainforest community are present on alluvial terraces. Species include red ash (*Alphitonia excels*), turpentine (*Canarium australianum*), blackbean (*Castanospermum australe*), native ebony (*Diospyros humilis*), pink mahogany (*Dysoxylum oppositifolium*), sandlewood sp. (*Exocarpos latifolius*), sandpaper fig (*Ficus opposite*), Brown macaranga (*Macaranga involucrate*), red

kamala (*Mallotus philippensis*), white cedar (*Melia azedarach*), cocky apple (*Planchonia careya*), mango trees (*Mangifera indica*) and tamarind (*Tamarindus indica*) are scattered through the canopy. Isolated vine towers of rubber vine (*Cryptostegia grandiflora*) are also present, while small understorey patches of lantana (*Lantana camara*) were present at AQ5. The alluvial terraces at AQ3 and AQ4 are dominated by stands of hyptis (*Hyptis suaveolens*). Cattle and pig disturbance of the riparian zone was apparent but does not appear to major. A feral pig (*Sus scrofa*) was observed at AQ4 while undertaking sampling.

The aquatic habitats present at the three sites include broad sand bedded stream channel with shallow flowing surface water runs, riffles and pools (~0.4 m max, most <0.2 m) formed against bank scours though some deeper pools backwater pools (~1.5 m max) that are likely to be perennial aquatic refugia. The majority of substrate is coarse granite derived sands, though solid bed rock exposures are also present in some reaches. Natural features of the stream include bed rock exposures and associated cobble bedded riffle zones, root masses, undercut banks, snags, large woody debris, litter piles and isolated submerged macrophyte beds in off channel backwaters. Flow exposed to bed rock formed extremely shallow riffles and runs. Water clarity was good to high though algal and bacterial surface scums were present at AQ5. At AQ3, a bed rock exposed reach 1 km downstream of the site is apparently semi-perennial (*pers comm*. Landholder), and aquatic biota recorded at this site would indicate the presence of perennial aquatic refugia within the river system that would have high ecological values.

7.4.1.2.1 Rapid Aquatic Habitat Assessment

Rapid habitat assessments were carried out at four sites (WQ8 – WQ11) within the Lowland Catchments during the water quality monitoring program. These were generally small, shallow streams (<10 m in width) with sandy soils and sediments and sparse riparian areas dominated by wetland species such as *Melaleucas*. No sites were flooded during the sampling events; however, all sites showed signs of recent flooding. All three sites displayed low to medium vegetation complexity and contained running water with some riffles. The substrates were sandy with some pebbles and gravel.

7.4.1.3 Protected Species

Desktop investigations suggested that fork-tailed swift (*Apus pacificus*) (EPBC Act – Migratory and Marine), saltwater crocodile (*Crocodylus porosus*) (EPBC Act and NC Act – Vulnerable), black-necked stork (*Ephippiorhynchus asiaticus*) (NC Act – Near Threatened), black ironbox, (EPBC Act and NC Act Vulnerable), white-bellied sea-eagle (*Haliaeetus leucogaster*) (EPBC Act – Migratory and Marine), white-throated needletail (*Hirundapus caudacutus*) (EPBC Act – Migratory and Marine), cotton pygmy-goose (*Nettapus coromandelianus*) (NC Act – Near Threatened) and Australian sheldrake (*Tadorna radja*)(NC Act – Near Threatened) have the potential to occur within the Lower Catchments.

The only one of these species observed during site surveys were stands of the vulnerable species black ironbox at AQ3 and AQ4. If this species is found within the rail footprint measures should be put in place to minimise or avoid impacts during construction and operations.

7.4.1.4 Wetland

AQ3 was observed to have RE11.3.25 (Riverine wetland – Forest Red Gum (*Eucalyptus tereticornis*) or river red gum (*E. Camuldalensis*) woodland fringing drainage lines). At AQ3 and upstream of the site where the rail alignment crosses the Elliot River, is a Great Barrier Reef (GBR) Wetland Management Area (WMA), which is also surrounded by a 100 m WMA trigger area. Under the VM Act, the site is listed as being of "Least Concern" and has a Biodiversity status listed as "Of Concern".

Both AQ4 and AQ5 exhibit RE11.3.25b (Riverine wetland or fringing riverine wetland) which is a variation of RE11.3.25 containing silver-crowned paperbark and / or cajuput trees (*M. Leucadendra*) and Leichhardt trees forming an open forest. Riverine Wetland RE11.3.25b at AQ4 and AQ5 are GBR WMAs, these being surrounded by a 100 m WMA trigger area. Under the VM Act, the two sites are listed as being of "Least Concern" and have a Biodiversity status listed as "Of Concern". Mapped wetlands are shown in **Figure 3** and **Figure 4**.

7.4.1.5 Remnant Vegetation

There is a diversity of remnant vegetation within the Lower Catchments, the majority being "Of Concern" subdominant RE.

At AQ3, RE11.3.25 (Riverine Wetland) is 184 m wide and forms a contiguous remnant ecotonal woodland extending from both high banks beyond the break in slope to the stream channel. Where the rail alignment crosses the Elliot River, RE11.3.25 is 150 m wide although the ecotonal woodland has been cleared on the eastern side of the river channel. Beyond the western bank, contiguous remnant vegetation extends beyond the high banks of both the main and adjoining tributary channel and includes a sub-dominant "Of Concern" RE. Importantly, the rainforest community present at AQ3 on the alluvial benches and terraces adjoining the stream channel in combination with black ironbox emergents is closely aligned with an endangered RE11.3.11 (Semi-evergreen vine thicket on alluvial plains) rather than the mapped RE11.3.25.

At both AQ4 and AQ5, RE11.3.25b (Riverine Wetland) is present. The riparian vegetation is up to 220 m and 85 m wide at AQ4 and AQ5 respectively and beyond the ecotone boundary of the northern bank. Past this, the land has been historically cleared and is now open regrowth woodland. Beyond the southern banks, the contiguous remnant ecotonal woodland including a sub-dominant "Of Concern" RE extends beyond the high bank of the creek channel. RE mapping is shown in Figure 5.

7.4.1.6 Aquatic Flora

Aquatic macrophytes were very sparse due to the active nature of the channel bed sands. Two submerged species were recorded from an off channel backwater, these being hydrilla (*Hydrilla verticillata*) and duck lettuce (*Ottelia alismoides*). Sunlit shallow runs at the sample sites also contained some filamentous algae (*Spirogyra* sp.) growth on sand beds although these were also rare.

Figure 3. GBR Referrable Wetlands – KP05 to KP95 (Map 1 of 4)

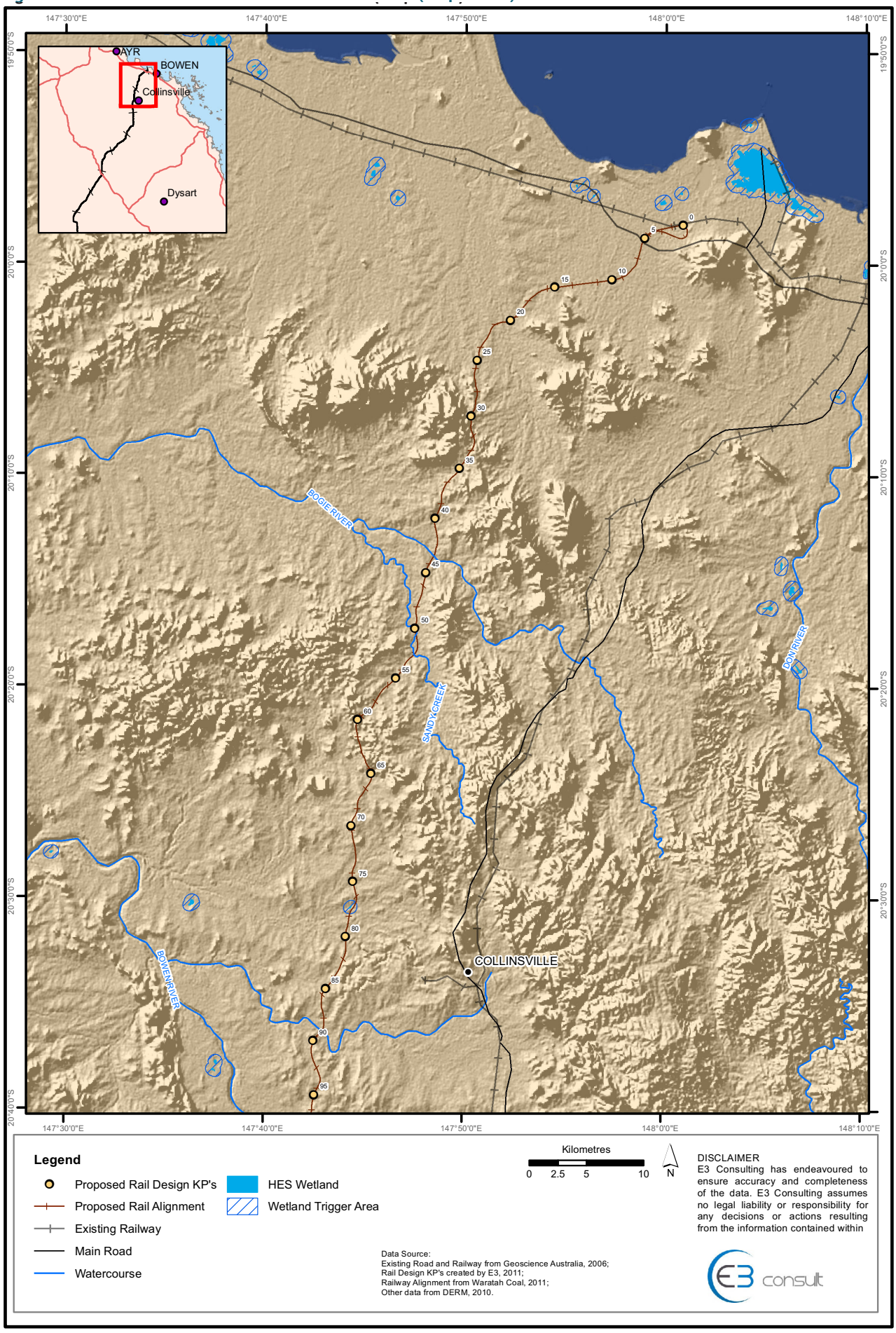


Figure 4. Wetland Associated RE – KP05 to KP95 (Map 1 of 4)

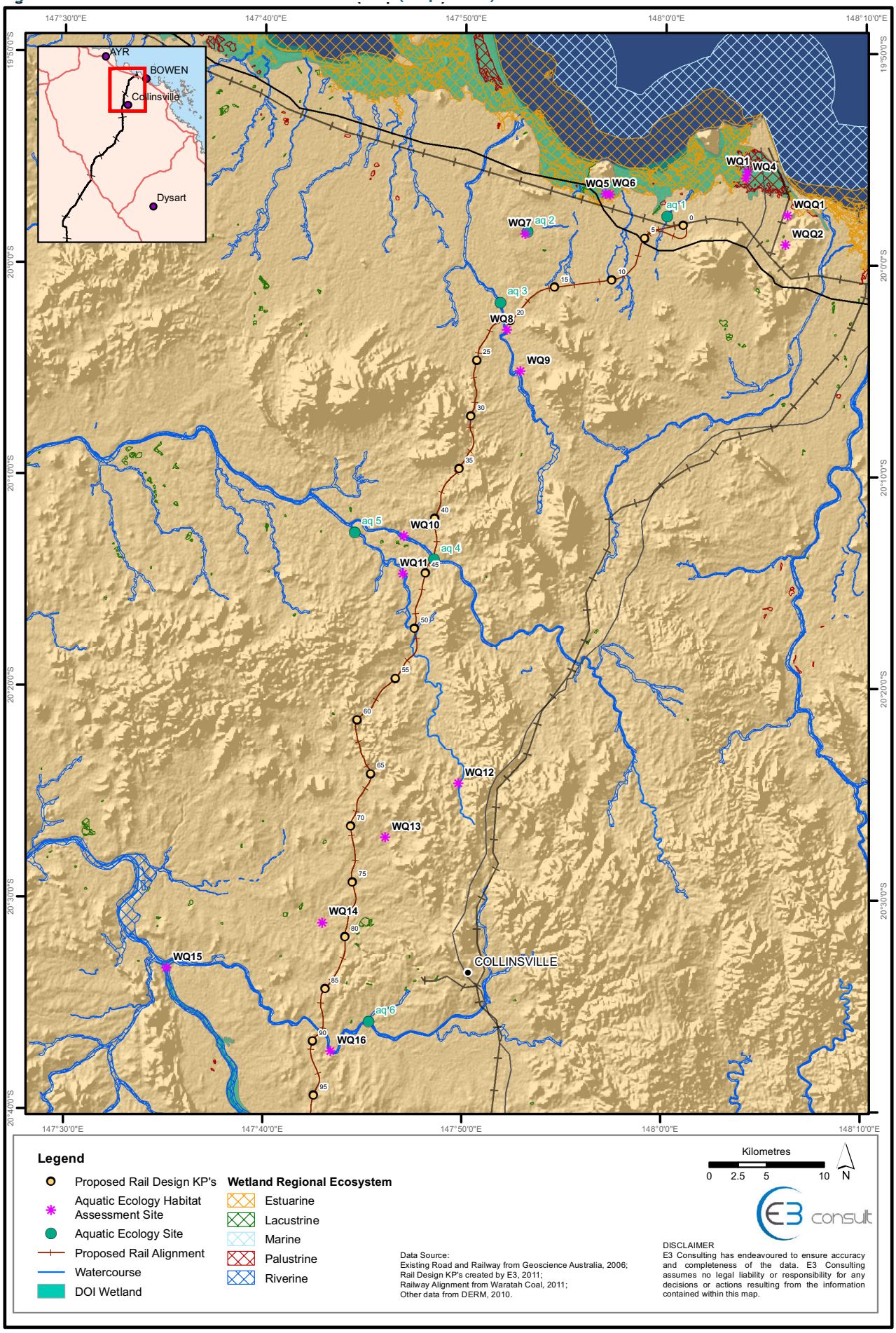
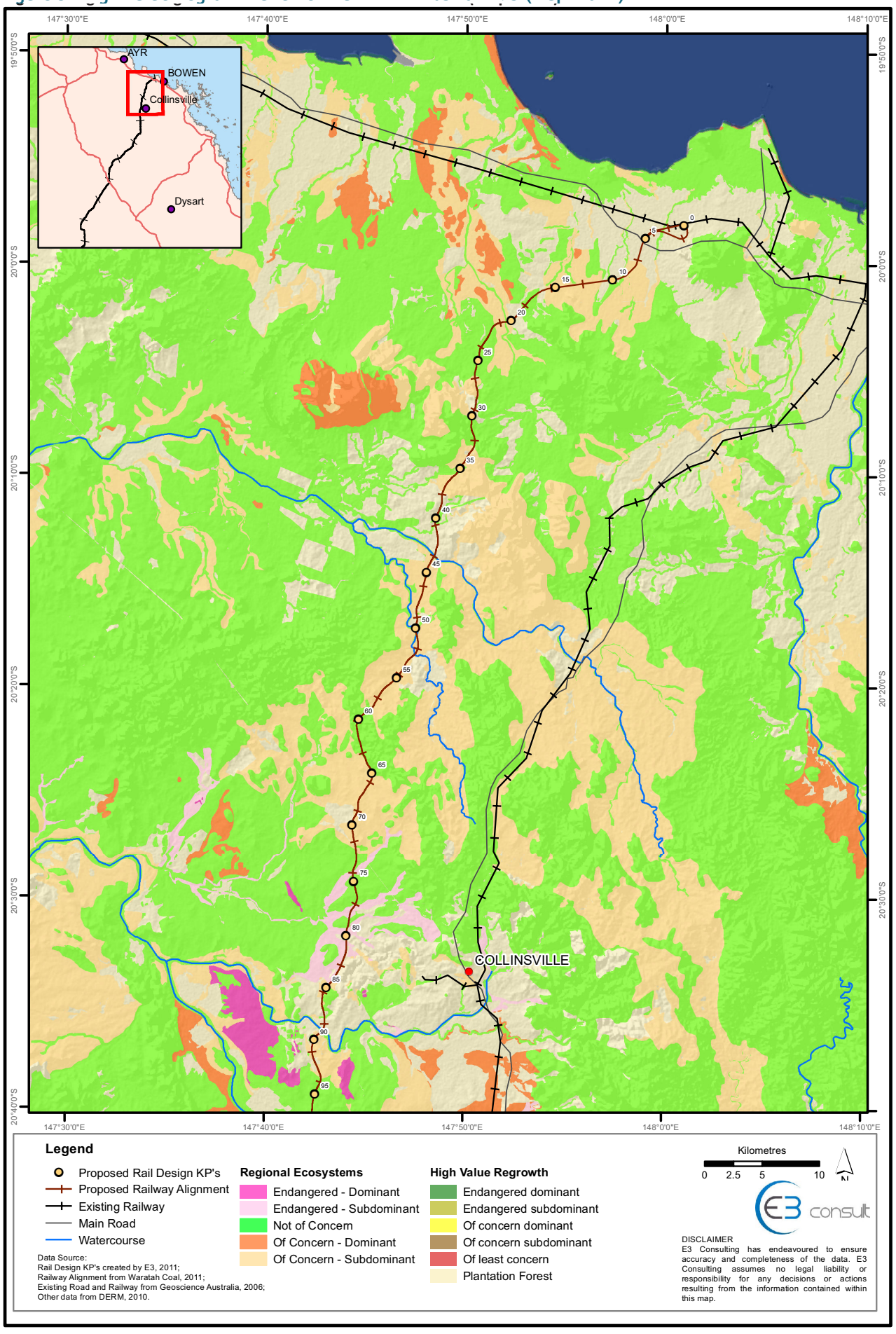


Figure 5. High Value Regrowth and Remnant RE – KP05 to KP95 (Map 1 of 4)



7.4.1.7 Aquatic Macro Invertebrate Communities

A total of 20 families of aquatic macro invertebrates were captured across the two sites sampled within the Lower Catchment area of the Project (11 families at AQ3 and 15 families at AQ4) (Table 4). There were high abundances of midges and mayfly nymphs at both sites. These high abundances, particularly of mayfly nymphs are likely to be as a result of the clean flowing water of the streams, particularly as they are filtered by sand.

Table 4. Distribution of macro invertebrates species across the lowland streams sampling sites

COMMON NAME	FAMILY	ORDER	AQ3	AQ4
Shrimp	Palaemonidae, Atyidae	Decapoda	0	8
Gnats or Midges	Chironomidae	Diptera	210+	151+
Dragonfly nymphs	Sub Order: Anisoptera	Odonata	1	2
Fisher spiders	Pisauridae	Araneae	0	2
Caddisfly larvae	–	Tricoptera	3	18
Mayfly nymphs	–	Ephemeroptera	79	92+
Riifle or Marl beetles	Helminthidae	Coleoptera	1	0
Pond snails	Lymnaeidae	Class: Gastropoda	0	1
Ramshorn snails	Planorbidae	Class: Gastropoda	2	0
Water mites	Sub Order: Hydracarina	Acarina	0	1
Water scavenger beetles	Hydrophilidae	Coleoptera	1	0
Screech beetles	Hygrobiidae	Coleoptera	3	0
Diving beetles	Dytiscidae	Coleoptera	2	14
Helminthid larvae	Helminthidae	Coleoptera	6	41
Water striders or pond skaters	Gerridae	Hemiptera	2	0
Water scorpion	Nepidae	Hemiptera	0	1
Cane Toad larvae	Bufo marinus	-	0	6
Sow bugs or isopods	–	Isopoda	0	3
Water fleas	Sub order: Cladocera	Diplostraca	0	1
Shrimp	Palaemonidae, Atyidae	Decapoda	0	8

SIGNAL calculations carried out for AQ3 and AQ4 gave scores of 5.3 and 4.4 respectively. This indicates mild pollution at AQ3 and moderate pollution at AQ4. These scores likely reflect the surrounding land uses at each of the sites with AQ3 being surrounded by relatively continuous stands of remnant woodland while land uses around AQ4 are predominantly agricultural outside of the immediate riparian area.

7.4.1.8 Macro Crustacea Communities

The macro crustacea fauna observed included four species (AQ3 – two species and AQ4 two species). The diversity at AQ3 included a freshwater prawn species dependent on access to estuarine habitats and surprisingly, a shrimp species associated with flowing habitats. The low diversity at AQ4 may be as a result of the high flows that have occurred in recent months that resulted in many of the species being flushed out of the system. The diversity of macro crustacea observed within the Lower Catchments is listed in Table 5.

Table 5. Distribution of macro crustacea species across the lower catchment sampling sites

COMMON NAME	FAMILY	SPECIES	AQ3	AQ4	AQ5
Shrimp	Atyidae	Caridina sp.	x	x	
Riffle Shrimp		Australatya striolata	x		
Australian River Prawn	Palaemonidae	Macrobrachium australiense	x	x	
East Australian River Prawn		Macrobrachium tolmerum	x		
Total Number Species Recorded / Site			**4**	**2**	**0**

Species type key: (T) Translocated to Basin or site

7.4.1.9 Fish Communities

The Lower Catchments recorded the low species richness in their fish community (seven species) (AQ3 – six species; AQ4 – five species and AQ5 – two species). The species comprised a ubiquitous seasonal stream species and one fishery associated catadromous fish species (long-finned eel (*Anguilla reinhardtii*)) dependent on migratory linkages to the ocean. No exotic, translocated, restricted or rare species were recorded. Only visual observation were used to record fish species at AQ5 and only two ubiquitous seasonal stream species were recorded. At least as many fish species as recorded at AQ4 would be expected to occur at AQ5 given its proximity and possibly more given the availability of deeper more complex habitat types.

The most abundance species observed at AQ3 was empire gudgeon (*Hypseleotris compressa*), 44 were caught in bait traps and 111 in the fyke net (minimum length 29 mm; maximum length 59 mm, mean length 46 mm). No individuals of this species were observed at AQ4. The most abundance species observed at AQ4 were eastern rainbowfish (*Melanotaenia splendida splendida*) and sailfin glassfish (*Ambassis agrammus*); however only 20 individuals and eight individuals respectively were observed at AQ3. A total of 166 Eastern rainbowfish individuals were caught, 13 in bait traps and 153 in the fyke net (minimum length 26 mm; maximum length 70 mm, mean length 41 mm), while a total of 157 sailfin glass individuals were caught, 139 in bait traps and only 18 in the fyke net (minimum length 24 mm; maximum length 44 mm, mean length 31 mm). There also was significant Long-finned Eel at AQ3 and only one larger individual at AQ4. There was a few smaller and two larger individuals, but overall, there was a large number of about 100 mm, which would suggest they were all from the same cohort. Other abundance species included spangled perch (*Leiopotherapon unicolor*).

A Long-finned Eel was observed to be the longest fish species caught at both sites (313 mm and 492 mm at AQ3 and AQ4 respectively). All other fishes were less than 100 mm. The diversity of fishes observed within the Lower Catchments is listed in Table 6.

Table 6. Distribution of fish species across the lower catchment sampling sites

COMMON NAME	FAMILY	SPECIES	AQ3	AQ4	AQ5
Agassiz's Glassfish	Ambassidae	Ambassis agassizii	x	x	
Long-finned Eel	Anguillidae	Anguilla reinhardtii (M) (F)	x	x	
Southern Purple-Spotted Gudgeon	Eleotrididae	Mogurnda adspersa		x	
Empire Gudgeon		Hypseleotris compressa	x		
Western Carp Gudgeon		Hypseleotris klunzingeri	x		
Eastern Rainbowfish	Melanotaeniidae	Melanotaenia splendida splendida	x	x	x
Seven spot Archerfish	Terapontidae	Leiopotherapon unicolor	x	x	x
Total Number Species Recorded / Site			**6**	**5**	**2**

Species type key: (F) Important to traditional / commercial / recreational fisheries, (M) Migratory species with amphidromous, catadromous or marine vagrant life history.

7.4.1.10 Turtle Communities

A juvenile saw-shelled turtle (*Elseya latisternum*) was observed during spotlighting at AQ3.

7.4.1.11 Other Vertebrates Communities

A number of other vertebrate species were observed within or around the sites. Evening spotlighting recorded two native frog species ornate burrowing frog (*Limnodynastes ornatus*) and desert tree frog (*Litoria rubella*). Litoria spp. tadpoles were observed to be common at the sites. Numerous cane toad (*Rhinella marina*) were also observed, as well as many dead specimens, which had been predated upon in a manner indicative of both water rat (*Hydromys chysogaster*) and avian fauna. A feral blue peafowl (*Pavo cristatus*) population was observed to inhabit riparian forest at AQ3.

7.4.2 BOWEN RIVER

The Bowen River Catchment includes two sites, these being Pelican Creek (AQ6) and the Bowen River (AQ7). Both streams are on the southern side of the Clarke Range and northern side of the Leichhardt Range.

7.4.2.1 Catchment Description

7.4.2.1.1 Topography

Topography varies over the catchment and is characterised by low relief floodplains with minor undulating slopes. The Bowen River is cut into the Lizzie Creek Volcanics including basalts, andesites, tuffs and minor acid volcanics and further to the south the Blackwater and Back Creeks Group comprising sedimentary rocks including sandstones, siltstones, shales and coal. Dominant soils in the river valley include dark clays at depth with sandy loam overlying these clays.

7.4.2.1.2 Land use

The dominant land use within both catchments is agriculture (grazing) in relatively natural environments such as semi cleared paddocks. In the Bowen Catchment, an operating coal mine is located adjacent to the rail alignment (near Collinsville). A detailed description of land uses in the region can be found in Volume 3, Chapter 4.

7.4.2.2 Aquatic Habitat

The two sites within the Bowen River catchment were distinctly different. AQ7 was formed on a substrate that varies from clayey loam margins, to coarse sands and outcropping bed rock within a narrower base flow channel. The narrow base flow has vegetated margins within a shallow broad valley in an undulating low hills landscape. The flow regime is semi-perennial, and larger pools are perennial and important drought refugia. Importantly, comments suggested that some reach sections are groundwater fed (*pers comm.*, landholder) which would indicate that the pools sampled are perennial and this would provide important aquatic refugia. The flood plain of the stream was dry, but when flowing, it would form a broad (~200 m) stream with open sand, gravel to cobble bedded anastomosing distributary and flood runner channels.

In contrast, the Bowen River site lies within a broad (~300 m) river channel incised into the alluvial plain to volcanic bedrock substrate. The channel base contains coarse sand bars, outcropping bedrock, clayey channel margins and loamy channel benches. The northern bank bench cliff is approximately 15 m high to the alluvial levee. The substrate varies through the site reach from coarse sands, though gravel and cobble to solid bed rock exposures and associated cobble bedded riffle zones are present in some reaches. Deeper pools within this reach of the Bowen River are important aquatic refugia for obligate freshwater biota. There are a number of important matters that need to be considered when assessing the Bowen River, including:

- the DIWA site QLD198 Birralee-Pelican Creek Aggregation is located 3 km downstream of the rail crossing; and
- the area has a history of camping and other recreational uses along the whole of the river.

The riparian zones and channel margins are dominated by an open riparian forest of silver-crowned paperbark and cajuput tree overstorey with co-dominant emergent Moreton Bay ash, grey bloodwood (*C. clarksoniana*), black ironbox and forest red gum. Other native channel margin species include northern swamp mahogany and bottle brush (*Melaleuca viminalis*) while other overstorey species present on loam benches include, river she-oak, sandpaper fig, cluster fig (*F. racemosa*), black teatree and Leichhardt tree. The mid storey is dominated by younger stands of canopy species. The semi-contiguous riparian vegetation at AQ7 provides a

regional faunal corridor and provides important nesting and feeding resources for surrounding terrestrial fauna including acting as a drought refuge (Blackman *et al* 1999).

The weediness of the riparian vegetation at AQ6 is indicative of high levels of past disturbance. The mid storey strata includes a co-dominant weed community including Captain Cook tree (*Cascabella thevetia*), parkinsonia (*Parkinsonia aculeate*), castor oil plant (*Ricinus communis*) and chinee apple (*Ziziphus mauritiana*). Vine towers of rubber vine are also conspicuous. Ground cover is also dominated by exotic species including khaki weed (*Alternanthera pungens*) and Guinea grass (*Panicum maximum*). The riparian vegetation although weedy includes a rare species, retains vigorous recruitment of native species and provides contiguous complex habitat valuable to fauna as feeding and nesting resources and as a movement corridor. Current cattle disturbance of riparian zone apparent but not major.

The ground cover at AQ7 is composed almost entirely of lawn of native couch (*Cynodon dactylon*). No weeds were observed at AQ7 although grewia (*Grewia asiatica*), parkinsonia and thornapple (*Salanum torvum*) have previously been reported (Blackman *et al* 1999). There are no fences or barriers blocking cattle access at both AQ6 and AQ7 but disturbance appears minor.

The aquatic habitat at AQ6 included shallow runs (~0.6 m), small scour and large channel hosted pools (~1.8 m depth max), rocky riffles, emergent macrophyte stands, submerged macrophyte beds, root masses, undercut banks, leaf litter piles and large woody debris. Sunlit reaches have sparse emergent macrophyte communities and a well-developed and diverse submerged macrophyte community. The water clarity was medium though opaque with a bluish tinge likely due to suspended colloids.

In contrast, there was a diverse range of aquatic habitats present at AQ7 including rapids, races, runs and broad (~60 m wide ~4 m deep) pools, root masses, undercut banks, rock cobble, boulders, large woody debris and back water pools isolated from the main channel containing sparse charophyte Muskgrass (*Chara* sp). algae beds. The water clarity was excellent.

7.4.2.2.1 Rapid Aquatic Habitat Assessment

Rapid habitat assessments were carried out at seven sites (WQ12 – WQ18) within the Bowen River Catchment during the water quality monitoring program. Riparian vegetation density was varied across the sites. Most sites had larger tree species, although WQ13, WQ14 and WQ18 had very limited large trees, and relatively undisturbed vegetation along the banks. WQ18 also had several trees within the stream itself. WQ14 was heavily cleared with grasses the only dominant vegetation. Most sites had limited to moderate shading depending on stream width.

All sites contained running water with some pooling and low complexity aquatic habitat. The substrate at all of the sites was course consisting predominantly of sands and pebbles.

7.4.2.3 Protected Species

Desktop investigations suggested that fork-tailed swift (EPBC Act – Migratory and Marine), saltwater crocodile (EPBC Act and NC Act – Vulnerable), black-necked stork (NC Act – Near Threatened), black ironbox (EPBC Act and NC Act Vulnerable), white-bellied sea-eagle (EPBC Act – Migratory and Marine), white-throated needletail (EPBC Act – Migratory and Marine), cotton pygmy-goose (NC Act – Near Threatened) and Australian sheldrake ((NC Act – Near Threatened) occur within the Bowen Catchment and Lower Catchments.

At AQ7, there were extensive stands of black ironbox. If similar stands are located within the construction footprint measures should be put in place to avoid or minimise potential impacts.

7.4.2.4 Wetland

Both AQ6 and AQ7 exhibit RE11.3.25b (Riverine wetland or fringing riverine wetland). The dominant species making up this RE include black tee-tree and / or cajuput tree and Leichhardt trees forming an open forest. Riverine Wetland RE11.3.25b at AQ6 and AQ7 are GBR WMAs, these being surrounded by a 100 m WMA trigger buffer area. Under the VM Act, the two sites are listed as being of "Least Concern" and have a Biodiversity status listed as "Of Concern". Local wetland mapping is shown in Figure 3 and Figure 4.

7.4.2.5 Remnant Vegetation

At both AQ6 and AQ7, RE11.3.25b (Riverine Wetland) is present. AQ6 and AQ7 respectively, the riparian vegetation is up to 100 m and 440 m wide and beyond the ecotone boundary of the northern bank. Past this, the land has been historically cleared and is now open regrowth woodland. Beyond the southern banks, contiguous remnant ecotonal woodland including a sub-dominant "Of Concern" RE extends beyond the high bank of the creek channel. At the rail crossing of Bowen River, RE11.3.25b is 350 m wide. An existing utilities corridor has been cleared through riparian and ecotonal woodland 230 m downstream of the rail alignment centreline. RE mapping is shown in Figure 5.

7.4.2.6 Aquatic Flora

The two sites had significantly different diversities of aquatic plants. At AQ6, the fringing emergent macrophytes include jointed twig rush (*Baumea articulate*), small flower umbrella sedge (*Cyperus difformis*), common sedge (*C. exaltus*), umbrella sedge (*C. involucratus*) (exotic) and bulrush (*Typa domingensis*). The submerged macrophyte community included extensive beds of Queensland lace plant (*Aponogeton queenslandicus*), bamboo plant (*Blyxa aubertii*), hydrilla (*Hydrilla verticillata*), waternymph (*Najas tenifolia*), duck lettuce (*Ottelia alismoides*), curly-leaf pondweed (*Potamogeton crispus*), fennel pondweed (*P. pectinatus*) and submerged and emergent beds of red water-milfoil (*Myriophyllum verucosum*).

No aquatic plants were observed at AQ7 other than the Charophyte algae *Chara* sp. During a dry season low flow period, Blackman *et al* (1999) indicated that the macrophyte community included maidenia (*Maidenia rubra*), red water-milfoil, *Nitella sp.*, native Water Lily (*Nymphaea violacea*), water snowflake (*Nymphoides indica*), swamp lily (*Ottelia ovalifolia*), curly-leaf pondweed, small pondweed (*P. javanicus*), floating pond weed (*P. tricarinatus*), and *Vallisneria caulescens* (no common name). It is likely that macrophytes that existed at the site were removed during extremely high flood flows experienced during Cyclone Olga in March 2010.

7.4.2.7 Aquatic Macro Invertebrate Communities

A total of 26 families of aquatic macro invertebrates were captured across the two sites within the Bowen Catchment area of the CFP (19 families at AQ6 and 22 families at AQ7), this being the most diverse catchment with respect to macro invertebrates (Table 7). There were high abundances of midges (Chironomidae) and riffle beetles (Helminthidae) at both sites and mayfly nymphs (Ephemeroptera) at AQ7. These high abundances, particularly of mayfly nymphs and sand flies (Simuliidae) are likely to be a result of the clean, flowing water of the Bowen River.

Table 7. Distribution of macro invertebrates species across the Bowen Catchment sampling sites

COMMON NAME	FAMILY	ORDER	AQ6	AQ7
Shrimp	Palaemonidae, Atyidae	Decapoda	10	29
Gnats or Midges	Chironomidae	Diptera	170+	161+
Dragonfly nymphs	Sub Order: Anisoptera	Odonata	1	24
Caddisfly larvae	-	Tricoptera	1	22
Mayfly nymphs	-	Ephemeroptera	112+	90+
Sand or Black flies	Simuliidae	Diptera	2	150+
Riifle or Marl beetles	Helminthidae	Coleoptera	11	2
Pond snails	Lymnaeidae	Class: Gastropoda	35	72+
Ramshorn snails	Planorbidae	Class: Gastropoda	46	2
Mosquiotes	Culicidae	Diptera	0	14
Water scavenger beetles	Hydrophilidae	Coleoptera	26	2
Screech beetles	Hygrobiidae	Coleoptera	4	0
Diving beetles	Dytiscidae	Coleoptera	3	2
Helminthid larvae	Helminthidae	Coleoptera	150+	121+
Water striders or pond skaters	Gerridae	Hemiptera	1	7
Water fleas	Sub order: Cladocera	Diplostraca	3	6
Bladder or tadpole snails	Physidae	Class: Gastropoda	54	0
Pigmy backswimmer	Pleidae	Hemiptera	2	0
Whirligig larvae	Gyrinidae	Coleoptera	1	0
Crane flies or daddy-long-legs	Tipulidae	Diptera	0	1
Damselfly nymphs	Sub Order: Zygoptera	Odonata	0	53
Pea-shell mussel	Sphaeriidae	Class: Bivalvia	0	1
Crawling water beetles	Haliplidae	Coleoptera	0	3
Stonefly nymphs	-	Plecoptera	0	9
Sand or black fly pupa	Simuliidae	Diptera	0	13
Shrimp	Palaemonidae, Atyidae	Decapoda	10	29

SIGNAL calculations carried out for AQ6 and AQ7 gave scores of 3.7 and 4.1 respectively. This indicates severe pollution levels at AQ6 and moderate pollution at AQ7. The low scores are likely a reflection of the agricultural land uses surrounding these streams.

7.4.2.8 Macro Crustacea Communities

The macro crustacea fauna was relatively depauperate (three species) and included the translocated red claw (*Cherax quadricarinatus*) also a species of interest to recreational fisheries. This may be as a result of the high flows, particularly in the Bowen River. The diversity of macro crustacea observed within the Bowen Catchment is listed in Table 8.

Table 8. Distribution of macro crustacea species across the Bowen Catchment sampling sites

COMMON NAME	FAMILY	SPECIES	AQ6	AQ7
Shrimp	Atyidae	*Caridina* sp.	x	x
Australian River Prawn	Palaemonidae	*Macrobrachium australiense*	x	x
Redclaw	Parastacidea	*Cherax quadricarinatus* (T)	x	
Total Number Species Recorded / Site			**3**	**2**

Species type key: (T) Translocated to Basin or site

7.4.2.9 Fish Communities

The Bowen River was the largest habitat sampled and recorded the most diverse fish community (17 species) of all sites including three catadromous, one facultative amphidromous fish species (bigmouth goby (*Redigobius bikolanus*)) dependent on migratory linkages to the ocean and seven fishery associated species including barramundi (*Lates calcarifer*). Pelican Creek recorded the second most diverse fish community (14 species) of all sites sampled including one fishery associated catadromous fish species (long-finned eel) dependent on migratory linkages to the ocean and two other recreational fishery associated species. Tilapia (*Oreochromis mossambicai*), an exotic species was common at the site. No translocated, restricted or rare species were recorded.

The most abundance species observed at AQ6 was the Australian lung fish (*Ambassis agrammus*); however not one individual was observed at AQ7. A total of 1646 individuals were caught, 332 in bait traps and 1314 in the fyke net (minimum length 17 mm; maximum length 53 mm, mean length 28 mm). The most abundance species observed at AQ7 was banded grunter (*Amniataba percoides*); however in contrast to the huge abundances of Australian lung fish at AQ6, only 29 individuals were observed of this species at AQ7, 21 individuals were caught in the 13 mm gill net caught and 8 during electrofishing (minimum length 22 mm; maximum length 93mm, mean length 82 mm). Other abundance species included (by abundance) eastern rainbowfish (*Melanotaenia splendida splendida*) and Spangled Grunter (*Leiopotherapon unicolor*).

Five long-finned eels was observed to be the longest fish species caught at both sites (600 mm and 700 mm at AQ6 and AQ7 respectively). Of other fish species, numerous Hyrtl's tandan (*Neosilurus hyrtlii*) exceeded 250 mm (minimum length 84 mm; maximum length 265 mm; mean length approximately 145 mm) at AQ6 and black catfish (*Neosilurus ater*) exceeded 400 mm (minimum length 159 mm; maximum length 445 mm; mean length approximately 375 mm) at AQ7. An individual barramundi was observed at AQ7 (366 mm). The diversity of fishes observed within the Bowen Catchment is listed in Table 9.

Table 9. Distribution of fish species across the Bowen catchment sampling sites

COMMON NAME	FAMILY	SPECIES	AQ6	AQ7
Agassiz's Glassfish	Ambassidae	*Ambassis agassizii*	X	X
Long-finned Eel	Anguillidae	*Anguilla reinhardtii* (M) (F)	X	X
Lesser salmon Catfish	Arridae	*Neoarius graeffei* (F)		X
Flyspecked Hardyhead	Atherinidae	*Craterocephalus stercusmuscarum*	X	
Barramundi	Centropomidae	*Lates calcarifer* (M)(F)		X
Tilapia	Cichlidae	*Oreochromis mossambica* (E)	X	
Bony Bream	Clupeidae	*Nematalosa erebi*	X	X
Southern Purple-Spotted Gudgeon	Eleotrididae	*Mogurnda adspersa*	X	X
Western Carp Gudgeon		*Hypseleotris klunzingeri*	X	
Sleepy Cod	Eleotrididae	*Oxyeleotris lineolata* (F) (T @ sites> AQ7)	X	X
Speckled Goby	Gobiidae	*Redigobius bikolanus* (M)		X
Tarpon	Megalopidae	*Megalops cyprinoides* (M)		X
Eastern Rainbowfish	Melanotaeniidae	*Melanotaenia splendida splendida*	X	X
Hyrtl's Tandan	Plotosidae	*Neosilurus hyrtlii*	X	X
Black Catfish		*Neosilurus ater* (F)	X	X
Pacific Blue-eye	Pseudomugilidae	*Pseudomugil gertrudae*	X	X
Spangled Perch	Terapontidae	*Leiopotherapon unicolor*	X	X
Sooty Grunter		*Hephaestus fuliginosus* (F)		X
Barred Grunter		*Amniataba percoides*	X	X
Seven spot Archerfish	Toxotidae	*Toxotes chatareus* (F)		X
Total Number Species Recorded / Site			**14**	**17**

Species type key: (E) Exotic, (F) Important to Traditional / commercial / recreational fisheries, (M) Migratory species with amphidromous, catadromous or marine vagrant life history, (R) Restricted Burdekin River Basin Endemic, (T) Translocated to Basin or site

7.4.2.10 Turtle Communities

A large sawshell turtle was captured in the multi panel gill net and Krefft's turtle (*Enydura krefftii*) was recorded by electrofishing at AQ7 (Bowen River).

7.4.2.11 Other Vertebrate Communities

Blackman *et al* (1999) identified 40 species of aquatic ecosystem dependent vertebrates including two amphibians, one reptile, and 37 riparian or wetland dependent bird species in the Bowen River catchment. This list includes seven species listed under either the EPBC Act and / or NC Act. None of these species were observed during sampling. However, *Litoria* spp. tadpoles were observed to be common at AQ6.

7.4.3 SUTTOR

Two sites were sampled within the Suttor Catchment, these being AQ8 (Upper Suttor River) and AQ9 (Suttor River at the Bowen Development Road). Due to access constraints, AQ9 is not within the buffer areas of the alignment but the site provides an accurate representation of the aquatic habitats, flora and fauna of the Suttor Catchment within the rail alignment.

7.4.3.1 Catchment Description

7.4.3.1.1 Topography

Topography varies over the catchment and is characterised by low relief floodplains with minor undulating slopes across the Suttor River floodplain. Dominant soils in the river valley include dark clays at depth with sandy loam overlying these clays. In the Suttor Catchment, the alignment crosses sedimentary rocks of the Suttor Formation and alluvium of the Suttor

River derived from these rock types. Dominant soils on the hilly land are shallow, gritty leached sands or sandy loams. The soils of the sloping plains consist of loamy duplex soils to loamy yellow, red and grey earths and cracking clays on the lower areas.

7.4.3.1.2 Land use

The dominant land use within the catchments is agriculture (grazing) in relatively natural environments such as semi cleared paddocks. A detailed description of land uses in the region can be found in the Volume 3, Chapter 4.

7.4.3.2 Aquatic Habitat

The two sites were distinct in that one was an upper catchment section of the stream, while AQ9 was in the lower areas of the catchment in the stream's floodplain with a diversity of aquatic habitats present set by variable hydrological settings within individual channels (i.e. active flowing versus backwaters). Much of the broader regional landscape has been cleared; therefore the semi-contiguous riparian vegetation and complex understorey vegetation of the Suttor River would provide a regional faunal corridor for small vertebrates and important nesting and feeding (particularly nectar) resources for surrounding terrestrial fauna particularly woodland birds and would act as a drought refuge.

AQ8 was a small "v" shaped channel cut into clay subsoil to volcanic basement rock in a gently undulating landscape. The active steam channel is ~5 m wide, incised a further ~2 m and has adjoining benches of clayey loam. Finer alluvial overbank deposits adjoin the high stream bank. The substrate varied from outcropping bed rock to clayey intermixed gravel beds to clay. The hydrological regime was assessed as seasonal with none of the observed aquatic habitats expected to persist through the dry season. The water clarity was poor with high turbidity associated with clay colloid levels. The aquatic habitats present at the time of the sampling included shallow seasonal riffles and runs, pools to ~1.8 m depth, undercut banks, large woody debris, leaf litter piles, gravel beds, clay banks and outcropping bed rock.

In contrast, AQ9 was located within a broad alluvial plain on an actively flowing channel and was one of four variably separated braided channels which include flood runner and back water systems. The substrate varied from outcropping bed rock to clayey intermixed gravel beds to clay with gravel in some higher flow areas. Flow is seasonal though several larger holes would be expected to persist through the dry season. The water clarity was poor with high turbidity associated with clay colloid levels.

The vegetation at AQ8 consisted of channel margins and benches which are dominated by an open riparian forest of River Red Gum. Scattered silver-crowned paperbark and cajuput tree saplings also occurred on and within the active channel margins though there were no mature specimens observed. Scattered stands of spiny mat rush occur on the channel margin with denser stands on the channel benches. Spikerush (*Eleocharis* sp.), perennial sedges (*Fimbristylis* sp.) and fingerushes (*Gahnia* sp.) also occur amongst a dense cover of mud grass (*Pseudoraphis spinescens*) and other riparian grass species growing from the water's edge to the outer bench margins. An open woodland of Moreton Bay ash, River Red Gum and Poplar Box (E. populnea) occurs on alluvial soils adjoining the high bank. No weed species were observed at the site. Cattle access the steam channel via the highly erodible duplex soils of the high bank and clayey soils of the lower channel that has caused significant gully erosion in reaches adjoining the site. There was also a small ford upstream from the sampling site; however an inspection suggested that it had not been used in many years.

Riparian overstorey consisted of open woodland co-dominated by river red gum and coolabah (*E. coolabah*) with scattered black tea-tree on channel margins. Back levee lagoons retain water levels elevated relative to the main channel and have a different overstorey community which includes gutta-percha (*Excoecaria parvifolia*) and bauhinia *Lysiphyllum gilvum*. Ground cover is variable composed of aquatic grasses such as *Spiny Mat Rush, Mud Grass*, sedges and spikerushs and flowering species amaranth redroot (*Alternanthera* sp), native wandering jew (*Commelina cyanea*) and knotweed (*Persicaria attenuate*). Weeds were not conspicuous although scattered plants included Noogoora burr (*Xanthium pungens*). Bank levee and channel margins showed exposed roots and bank erosion which could be as a result of prior cattle access and recent flood spate.

Aquatic habitats present at the time of sampling include shallow riffles and deeper runs, pools to ~2 m depth, including larger waterholes (15 x 20 m at AQ9) within the stream channel, undercut banks, abundant large woody debris, leaf litter piles, gravel beds, clay banks and emergent macrophyte margins. Backwater channels

hosting isolated pools contained a greater density of emergent macrophytes.

7.4.3.2.1 Rapid Aquatic Habitat Assessment

Rapid habitat assessments were carried out at ten sites (WQ19 – WQ28) within the Suttor River Catchment during the water quality monitoring program. Riparian vegetation density varied across the sites. The majority of sites had large tree species and relatively undisturbed vegetation with fairly regular vegetation along both banks; however sites WQ21, WQ22, WQ26 and WQ28 had highly disturbed riparian vegetation communities. All sites except for WQ22 had extensive coverage of trees, shrubs and grasses. Site W22 was heavily cleared with grasses the only dominant vegetation. Most sites had limited to slight shading.

All streams sampled contained flowing water during the wet season with WQ25, WQ26 and WQ28 (Suttor River, Verbena and Logan Creeks respectively) all flooding at the time of sampling. The streams on the Suttor catchment were predominantly remnant channels that were flat or two staged (stepped) banked streams. Most streams sampled had flowing and pooled water although two streams (WQ23 and WQ24) had significant flowing water (rapids and riffles >65%) and all the streams had extensive runs. The majority of the streams had no in stream aquatic plant growth except for site WQ22 that had some submerged aquatic plants.

Silt was the dominant particle in the southern area of the catchment while sand was the dominant sediment in the upper reaches of the catchment. The majority of streams were partly to very restricted at base flow with this either being a non-vegetated side channel bars in the upper reaches and vegetated mid channel bars in the lower reaches.

7.4.3.3 Protected Species

No protected species were observed at the sites and no habitat exists that suggests these species may be present.

7.4.3.4 Wetland

There are a wide variety of wetland REs within the Suttor catchment that may be impacted by the Project. These include RE11.3.25 (Riverine wetland) and River Red Gum or *E. tereticornis* woodland fringing drainage lines) and RE11.3.37 (Freshwater wetlands) or one of its subsets. These REs were observed at both AQ8 and AQ9.

Numerous palustrine wetlands mapped as RE11.3.27b (Freshwater wetland with naturalised species including *Egeria densa* flooded by overland flow) and RE11.3.27f (Freshwater wetland with naturalised species including *Egeria densa* less prone to flooding) occur within the area. RE11.3.25, RE11.3.27b and RE11.3.27f are classified as GBR WMA and WPA which are also surrounded by a 100m WMA and WPA trigger areas. Under the VM Act, the area is listed as being of "Least Concern" and has a Biodiversity status listed as both "Of Concern" and "Not of Concern at Present". Local wetland mapping is shown in **Figure 6** and **Figure 7**.

7.4.3.5 Remnant Vegetation

RE11.3.25 forms contiguous remnant ecotonal woodland including a dominant "Of Concern" RE that extends from the both high banks onto the adjoining alluvial plain around AQ8. At AQ9, seven separate channel associated occurrences of RE11.3.37 are crossed by the rail alignment across a ~2.5km wide flood plain of the Suttor River. Contiguous remnant ecotonal woodland on alluvial plains of a "Not of Concern" RE occurs between the crossing channels. Ecotonal woodland comprised of a sub-dominant "Of Concern" RE that extends onto the adjoining alluvial plain for a limited distance either side of the western and eastern channels of the Suttor River. There are a number of "Endangered" terrestrial REs within the alignment which are discussed in the **Volume 3, Chapter 6 – Terrestrial Ecology**. Remnant vegetation within the Suttor Catchment is mapped in **Figure 8**.

7.4.3.6 Aquatic Flora

No submerged macrophytes were present at either site due to the high turbidity of the water. Emergent, fringing and aquatic grass species included spike rushes and finger rushes, spiny mat rush and mud grass and sedges. Flowering species included native wandering jew and knotweed.

7.4.3.7 Aquatic Macro Invertebrate Communities

A total of 18 families of macro invertebrates were captured across the two sites within the Suttor Catchment area of the project (13 families at AQ8 and 11 families at AQ9) **(Table 10)**. There was an abundance of Midges at AQ8, while there was significantly higher numbers of sandfly and riffle beetle larvae at AQ9.

Table 10. Distribution of macro invertebrates species across the Suttor Catchment sampling sites

FAMILY	ORDER	COMMON NAME	AQ8	AQ9
Chironomidae	Diptera	Gnats or Midges	96+	80+
Sub Order: Anisoptera	Odonata	Dragonfly nymphs	1	0
Pisauridae	Araneae	Fisher spiders	3	0
-	Tricoptera	Caddisfly larvae	0	5
-	Ephemeroptera	Mayfly nymphs	14	21
Simuliidae	Diptera	Sand or Black flies	4	161+
Helminthidae	Coleoptera	Riifle or Marl beetles	15	5
Lymnaeidae	Class: Gastropoda	Pond snails	1	2
Sub Order: Hydracarina	Acarina	Water mites	0	1
Hygrobiidae	Coleoptera	Screech beetles	4	0
Dytiscidae	Coleoptera	Diving beetles	1	0
Helminthidae	Coleoptera	Helminthid larvae	3	200+
Sub order: Cladocera	Diplostraca	Water fleas	9	0
Physidae	Class: Gastropoda	Bladder or tadpole snails	0	1
Gyrinidae	Coleoptera	Whirligig larvae	1	0
Simuliidae	Diptera	Sand or black fly pupa	0	17
Veliidae	Hemiptera	Water crickets	1	0
Hydrometridae	Hemiptera	Water measurer	0	1

SIGNAL calculations carried out for AQ8 and AQ9 gave scores of 3.9 and 4.6 respectively. This indicates severe pollution levels at AQ8 and moderate pollution levels at AQ9. These scores likely reflect the surrounding land uses which are predominantly areas cleared for grazing and other agricultural purposes.

7.4.3.8 Macro Crustacea Communities

The macro crustacea fauna was diverse recording four species at the two sites **(Table 11)**. These species were distributed across a diverse range of taxa including a shrimp, prawn, crayfish and crab. Orange fingered yabby (*Cherax depressus*) is recognised to be undergoing range reductions with the Upper Burdekin River Basin due to competition with the translocated native species redclaw (*Cherax quadricarinatus*) (Burrows *et al*, 1999). The observance of these species highlights the sites upper catchment extra-limital location and its potential value as species refugia.

Table 11. Distribution of macro crustacea species across the Suttor Catchment sampling sites

COMMON NAME	FAMILY	SPECIES	AQ8	AQ9
Shrimp	Atyidae	*Caridina* sp.	x	x
Australian River Prawn	Palaemonidae	*Macrobrachium australiense*	x	x
Orange Fingered Yabby	Parastacidea	*Cherax drepressus*	x	
Redclaw		*Cherax quadricarinatus* (T)		x
Freshwater Crab	Parathelphusidae	*Austrothelphusa transversa*	x	x
Total Number Species Recorded / Site			**4**	**4**

Species type key: (T) Translocated to Basin or site

Figure 6. GBR Referrable Wetlands – KP95 to KP230 (Map 2 of 4)

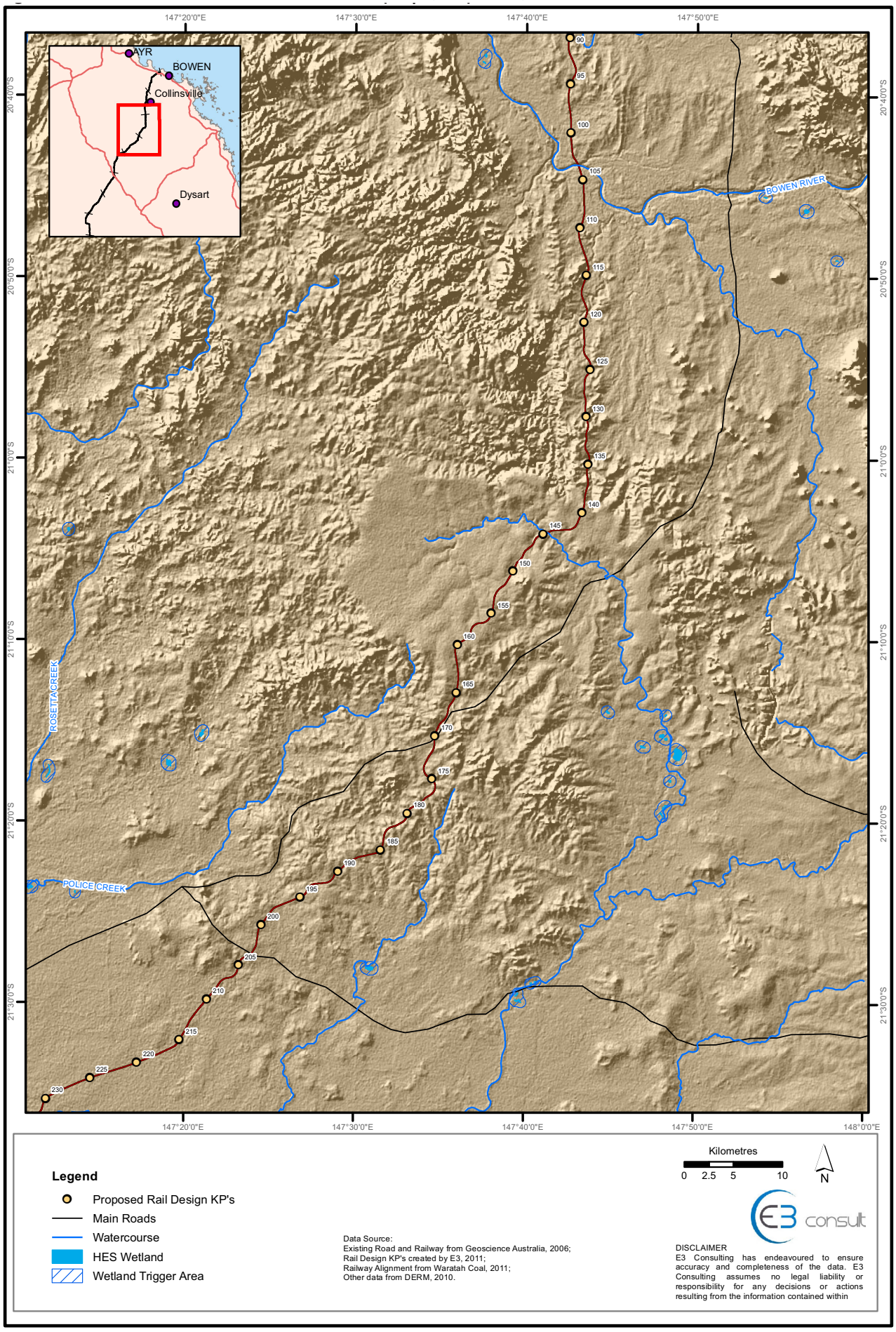


Figure 7. Wetland Associated REs and DOI Wetlands – KP95 to KP230 (Map 2 of 4)

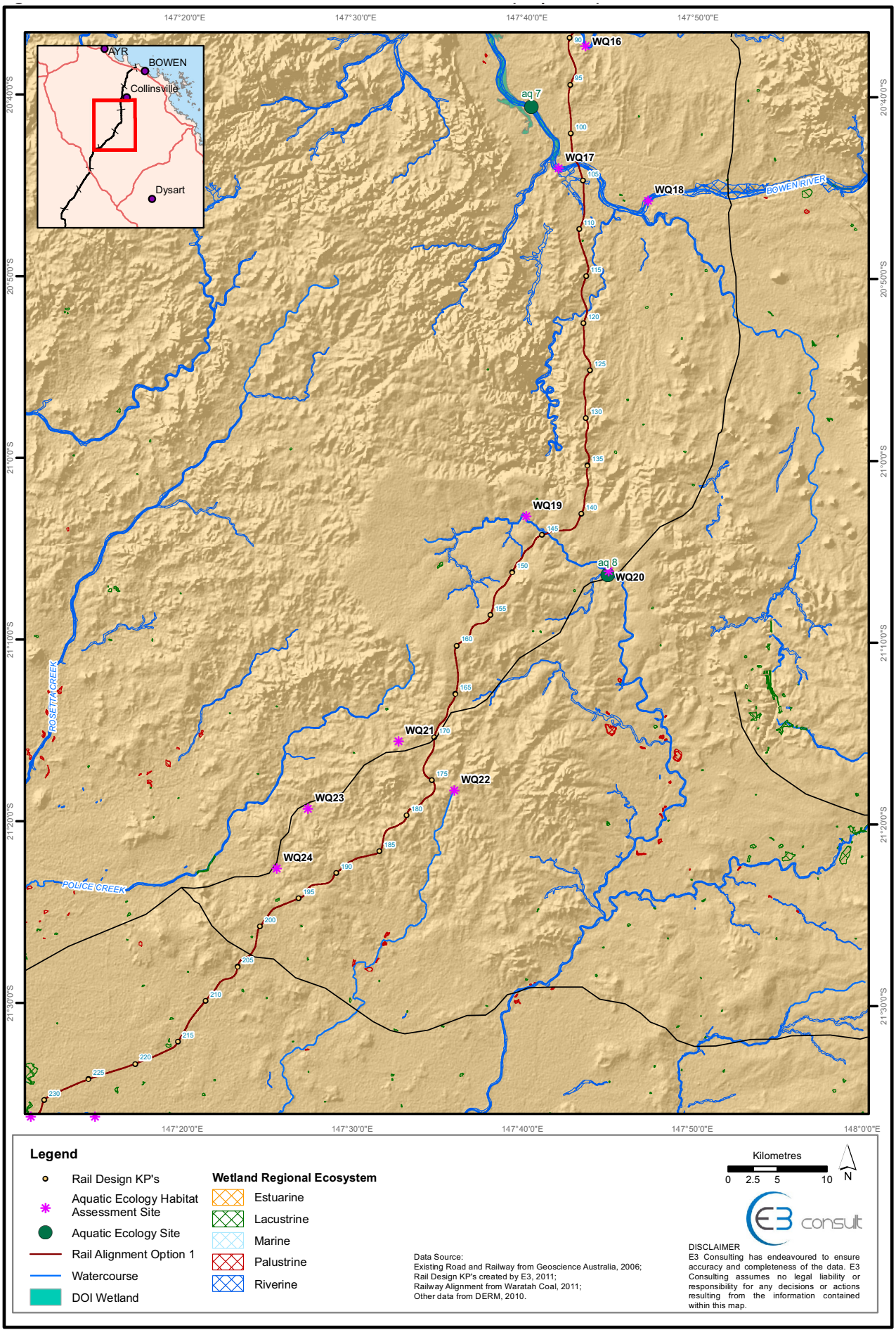
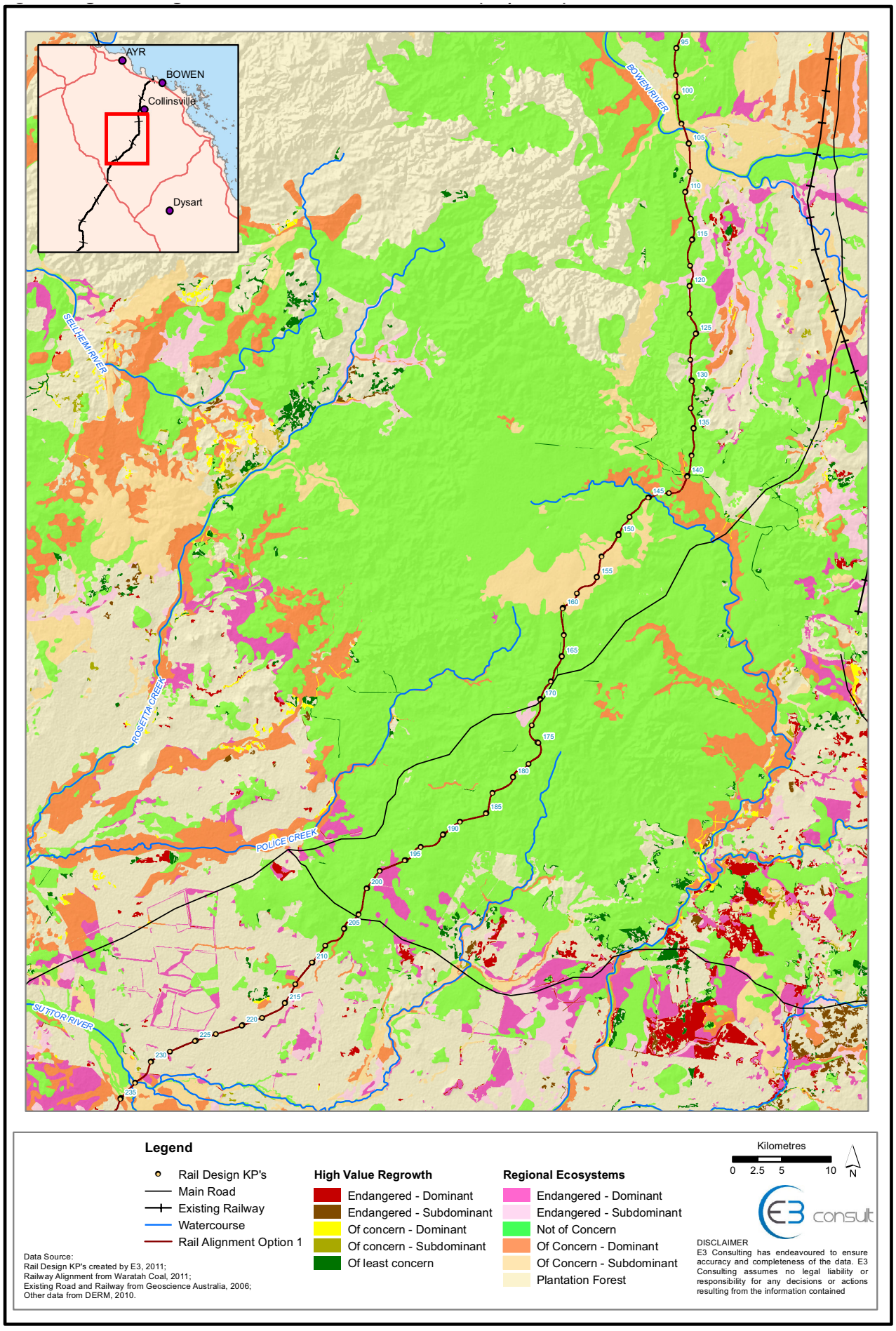


Figure 8. High Value Regrowth and Remnant RE – KP95 to KP230 (Map 2 of 4)



7.4.3.9 Fish Communities

Considering the small size and seasonality of AQ8, the site had a relatively diverse fish fauna (6 species). AQ9 had a relatively diverse fish (10 species). Only one exotic species, Tilapia was common at AQ9 (36 individuals) but was not observed at AQ8. Sleepy cod (*Ocyeleotris lineolata*) recorded at the site are translocated to the Upper Burdekin River Basin (Burrows *et al*, 1999). Two species of recreational fishery interest and one species Smallhead Grunter(*Scortum parviceps*) with a restricted distribution endemic to the Burdekin River Basin were also observed. Southern purple-spotted gudgeon (*Morgurnda adspersa*) is also recognised to be undergoing range reductions with the Upper Burdekin River Basin due to competition with translocated sleepy cod. The records for these species highlight the sites upper catchment extra-limital location and its potential value as species refugia.

The most abundance species observed was Hyrtl's tandan at both AQ8 and A9 with over 85 and 384 individuals caught respectively in the various sampling devices (AQ8 minimum length 74 mm, maximum length 96 mm; AQ9 minimum length 58 mm, maximum length 147 mm). Other species included (by abundance) eastern rainbowfish, spangled perch (*Leiopotherapon unicolour*), black catfish and sleepy cod.

Sleepy cod was observed to be the longest fish species caught at AQ8 (only one individual 166 mm). Spangled perch was the second longest species at AQ8 and the longest species at AQ9 (minimum length 35 mm; maximum length 205 mm; mean length approximately 111 mm). Fish species found at AQ8 and AQ9 are listed in Table 12.

Table 12. Distribution of Fish Species across the Suttor Catchment Sampling Sites

FAMILY	SPECIES	COMMON NAME	AQ8	AQ9
Cichlidae	*Oreochromis mossambica* (E)	Tilapia		x
Clupeidae	*Nematalosa erebi*	Bony Bream		x
Eleotrididae	*Mogurnda adspersa*	Southern Purple-Spotted Gudgeon	x	x
Eleotrididae	*Oxyeleotris lineolata* (F)	Sleepy Cod	x	x
Melanotaeniidae	*Melanotaenia splendida splendida*	Eastern Rainbowfish	x	x
Plotosidae	*Neosilurus hyrtlii*	Hyrtl's Tandan	x	x
	Neosilurus ater (F)	Black Catfish		x
	Porochilus rendahli	Rendahl's Catfish		x
Terapontidae	*Leiopotherapon unicolor*	Spangled Perch	x	x
	Scortum parviceps (R)	Smallhead Grunter	x	x
Total Number Species Recorded / Site			**6**	**10**

Species type key: (E) Exotic, (F) Important to Traditional / commercial / recreational fisheries, (R) Restricted Burdekin River Basin Endemic, (T) Translocated to Basin or site

7.4.3.10 Turtle Communities

A Krefft's turtle individual was recorded at AQ9.

7.4.3.11 Other Vertebrate Communities

Green striped frog (*Cyclorana alboguttata*) and bumpy rocket frog (*Litoria inermis*) were observed at both sites.

7.4.4 BELYANDO

Four sites were sampled within the Belyando Catchment, these being AQ10 (Mistake Creek), AQ11 (Middle Creek), AQ12 (Belyando Creek) and AQ13 (Sandy Creek). AQ14 also lies within this catchment.

Mistake Creek consisted of a broader set of anastamosing channels. Middle Creek is interlinked with Lascelles and Fox Creeks drainage system and is crossed numerous times by the rail alignment. Belyando Creek is within the upper reaches of the Belyando River and consists of permanent water holes. Sandy Creek is made up on broader set of anastamosing channels.

7.4.4.1 Catchment Description

7.4.4.1.1 Topography

The Belyando Catchment is predominately low relief floodplain with wide braided channels and alluvial plains (Roth *et al.*, 2002). The Belyando River flows in a northerly direction and joins the Suttor River in its lower reaches. It is bounded by the Great Dividing Range in the west of Denham and Drummond Ranges to the east. General topography within the Belyando catchment differs from other sub-catchments in the Burdekin Basin, lacking high mountain conditions with a drier, typically semi-arid landscape (ANRA 2002).

Surface geology at the catchment is dominated by unconsolidated Cainozoic sediments including sands, silts and clay, with thickness of up to 90 m in the eastern and central sections. Soils have low fertility and land use is limited to grazing and native pastures. Grazing lands are susceptible to surface soil degradation such as hard setting and crusting even when grazing intensity is low.

7.4.4.1.2 Land use

The Belyando Catchment is predominantly agricultural land with cattle grazing on natural vegetation. Cropping and / or horticulture are not undertaken within the area. The vegetation within the catchment and rail footprint itself is generally characterised as being in a degraded condition having been cleared and blade ploughed for grazing land.

7.4.4.2 Aquatic Habitat

The four sites had quite distinct aquatic habitats. AQ10 is located within a broad alluvial plain on the main channel of one of four variably separated braided anastamosing channels which include flood runner and back water systems. The substrate was predominantly pebble to gravel beds with clay channel margins. The site is a floodplain with the diversity of aquatic habitats present set by variable hydrological settings within individual channels with several of the larger holes that persisted through most dry seasons (pers comm. Land Holders). The water clarity was medium with bottom visible to~0.5 m.

Middle Creek (AQ11) is located within a broad alluvial plain in the main channel of one of many widely separated braided anastamosing channels. The substrate was predominantly pebble to gravel beds with clay channel margins. Flow is highly seasonal though several of the larger holes and an adjoining excavated dam site would be expected to be perennial. The water was very turbid.

Belyando Creek (AQ12) is a 70 m wide river channel incised in an alluvial plain to bedrock. The channel sides are steep though benches of alluvium occur within the channel and overbank alluvial deposits adjoin the high bank. The aquatic habitats present during the field survey included shallow flowing riffles and runs, pools to ~3 m depth, including a large channel waterhole (20 m wide x 400 m long), undercut banks, root masses, rocky outcrop and crevices, abundant large woody debris, leaf litter piles, gravel and sand beds and clay banks. The water clarity was medium (~1 m sechi depth). The substrate varied within the reach from clay in depositional areas to sand beds and bed rock. A small seasonal base flow was present at the time of sampling and the main waterhole is perennial in all but exceptionally dry years (pers comm. Land Holder).

Sandy Creek links directly with Lagoon Creek (AQ14) located on the mine. The aquatic habitats were very similar to that site, although at AQ13 Sandy Creek was a 100 m wide sand bed dominated stream channel with braided flow channels within an alluvial plain. More elevated benches of alluvium occurred in some of the reaches. While the site has highly seasonal flows, the Sandy Creek channel adjoining the rail alignment at KP416 appears to hold a semi-perennial waterhole which is likely to be important aquatic refugia within such a seasonal system.

The riparian vegetation at the sites was fairly consistent across the catchment. Each site had open woodland comprised of coolibah with semi contiguous band of black tea tree on channel margins although aq12 and aq13 had increased abundance of river red gum and cajeput Tree on the channel margins. At AQ12, the

higher levee had a different overstorey community which includes whitewood (*Atalaya hemigaluca*), gutta-percha, bauhinia and scattered brigalow (*Acacia harpophylla*). Ground cover along most shaded edges was sparse though dense stands of grasses occur on high levees but included some dense stands of spiny mat mush (*Lomandra longifolia*). Green couch (*Cynodon dactylon*) also occurred in sparse sunlit patches on alluvium near the water's edge. In most sites, there were no emergent macrophytes; however, at AQ12, amaranth redroot and small flower umbrella-sedge were observed and beds of filamentous algae were present in rocky shallows. In sunlit water margins, there was a range of emergent macrophyte species. At most sites, there were very few if any weeds observed, although Noogoora burr were recorded at AQ12. Cattle access varied from riparian fencing totally limiting access to areas where cattle access to the streams had generated significant bank erosion and most channel marginal tree roots were exposed by severe erosion. Some areas of the banks at Belyando Creek exhibited severe bank erosion from past tordon (herbicide) poisoning of levee vegetation.

All sites had some form of aquatic habitat, although the available habitat varied greatly. At all sites except for AQ13, there were large long channel hosted waterholes with some being as large as ~3 m depth x 20 m wide x 400 m long with undercut banks. AQ13 had limited available aquatic habitat, with these being shallow pools within sand beds, undercut banks, root masses, leaf litter piles, clay banks and large woody debris that were likely to dry within a month. Most sites had abundant large woody debris, leaf litter piles, gravel beds, clay banks and emergent macrophyte margins.

Much of the broader regional landscape has been cleared across the catchment although there are semi-contiguous riparian vegetation across the four streams that provide a regional faunal corridor and important nesting and feeding (particularly nectar) resources for surrounding terrestrial fauna and would act as a drought refuge. The perennial waterholes would also act as aquatic refugia.

7.4.4.2.1 Rapid Aquatic Habitat Assessment

Rapid habitat assessments were carried out at 15 sites (WQ29 – WQ43) within the Belyando River Catchment during the water quality monitoring program. The assessments identified riparian areas in the catchment as generally consisting of a layer of mature Eucalypts including ironbark and other eucalypts species, one or two trees thick directly on the banks of the streams surrounded by a layer of saplings and shrubs before the landscape opens up into grazing paddocks. The majority of sites had highly disturbed vegetation and accordingly, trees less that 10 m and grass were the dominant vegetation.

The streams in the lower reaches of the Belyando catchment were predominantly remnant channels that were flat, low or moderate banked streams. The streams ranged from 3 m to 60 m wide although most streams had an observed flood plain that extended up to 25 m either side of the centre of the stream. Most streams sampled had flowing and pooled water although two streams (WQ35 and WQ38) had significant flowing water (glides >65%) and over half the streams had extensive runs. All streams except for those with high flows also had large pools that covered extensive areas. The majority of the streams had no in stream aquatic plant growth except for site WQ31 that had significant emergent aquatic plants.

Silt was the dominant particle observed at the majority of sites. The majority of streams had partly or very restricted flows due to non-vegetated mid channel bars. Only WQ34 had unobstructed base flows.

7.4.4.3 Wetland

There is a wide variety of wetland REs within the Belyando Catchment that are found within the rail alignment. These include

- RE10.3.13 – Fringing wetland containing Silver-crowned paperbark and / or Cajuput tree and / or River Red Gum open-woodland and woodland occurs mostly as narrow bands along channels and on levees with sandy to clayey soils along larger watercourses;
- RE11.3.3c – Palustrine wetland made up if Coolabah woodland to open-woodland (to scattered trees) with a sedge or grass understorey in back swamps and old channels;
- RE11.5.3b – Palustrine wetlands including Poplar box on closed depressions;
- RE11.3.25 – Riverine wetland made up of River Red Gum or Forest Red Gum woodland fringing drainage lines);
- RE11.3.27 – Freshwater Wetlands;

- RE 11.3. 27b and RE11.3.27f – Palustrine wetland containing and / or Forest Red Gum open woodland to woodland fringing swamps); and
- RE11.3.37 – Riverine wetland (Coolabah fringing woodland on alluvial plains).

In addition to the riverine wetland crossed by the rail alignment, another eleven wetlands lie within 5 km of the alignment including:

- RE10.3.13 on both sides of Sandy Creek (AQ13) and 250 m to the west of the rail alignment at KP416;
- RE11.3.3c at KP375 (2.7 km to the north west);
- RE11.3.25 occur at KP357 (4.5 km north west), KP 370 (250 m to the north), KP379 (800 m to the north west); KP381 (350 m to the south east);
- RE11.3.27f occur within a 5 km corridor adjoining the proposed rail alignment between KP290 and KP292, at KP351 (150 m to the east); and
- RE11.5.3b lies 4.5 km to the south east at KP341.

All these wetlands are classified as GBR WMA and WPA which are also surrounded by either a 100 m or 500 m WMA and WPA trigger area. AQ12 and the immediately preceding creek crossings are not mapped as wetland REs and are not referable wetlands.

Under the VM Act, the area is listed as being of "Least Concern" and has a Biodiversity status listed as both "Of Concern" and "Not of Concern at Present". Local wetland mapping is shown in Figure 9 to Figure 12.

7.4.4.4 Remnant Vegetation

The predominant riparian remnant vegetation is RE11.3.25. Where the rail alignment crosses the streams located within the Belyando Catchment, the riparian remnant vegetation can be up to 390 m wide.

For example, at Mistake Creek, the riparian zone is approximately 110 m wide though in between that there are at least two other channels that are 20-30 m apart. A 300 m riparian corridor exists between KP316 and KP317 (Lascelles Creek). At the rail crossing of the Belyando River, three separate riparian corridors interpreted as remnant RE11.3.25 are crossed between KP380 and KP382 with widths of 60 m, 55 m and 390 m respectively. A 100 m wide riparian corridor of riparian vegetation on Lestree Hill Creek also interpreted as RE11.3.25 is crossed at approximately KP367. Beyond the high bank of the crossing sites, the vegetation has been cleared. Where the rail intersects with Sandy Creek, channel wetland associated riparian vegetation is approximately 280 m wide east to west. The alignment skirts the eastern boundary of the wetland associated RE which is cleared further to the east. RE mapping for the Belyando catchment is shown in Figure 13 to Figure 14.

Importantly, these high bank contiguous remnant ecotonal woodland including dominant and sub-dominant "Endangered" and "Of Concern" RE adjoining the high bank which changes to "Not of Concern" RE further onto the adjoining alluvial plain provide habitat for both terrestrial and aquatic related species.

7.4.4.5 Aquatic Flora

No submerged macrophytes were observed throughout the catchment areas although water clarity and bottom substrates would indicate the presence of submerged macropyhtes within the system. Fringing emergent macrophytes were composed of aquatic grasses mud grass and sedges small flower umbrella sedge, giant sedge (*C. exaltatus*), bunchy sedge (*C. polystachyos*) and Queensland lace plant. Flowering species included amaranth redroot, native wandering jew, knotweed and sesbania (*Sesbania cannabinna*).

Figure 9. GBR Referrable Wetlands – KP05230 to KP350 (Map 3 of 4)

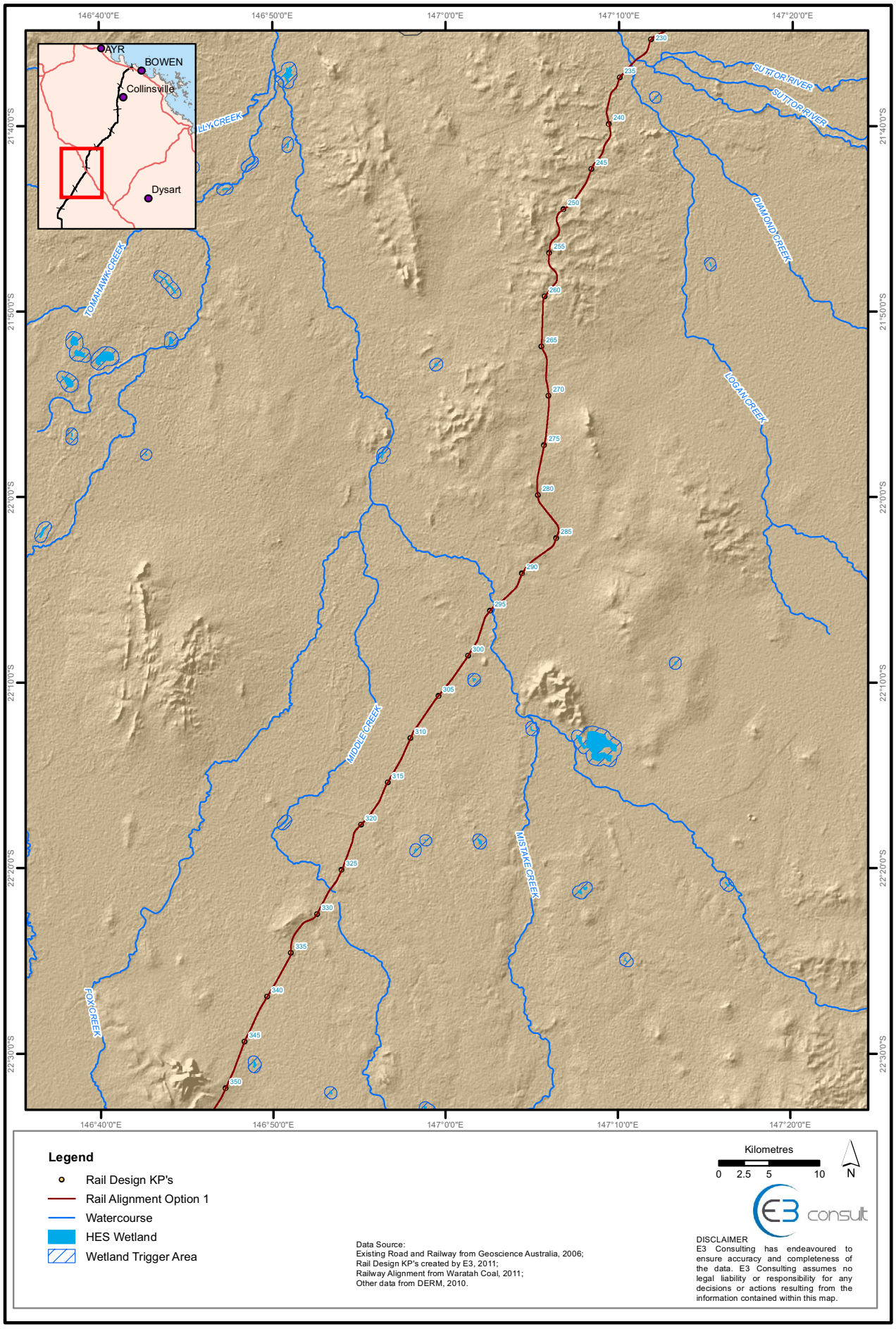


Figure 10. GBR Referrable Wetlands – KP350 to KP468 (Map 4 of 4)

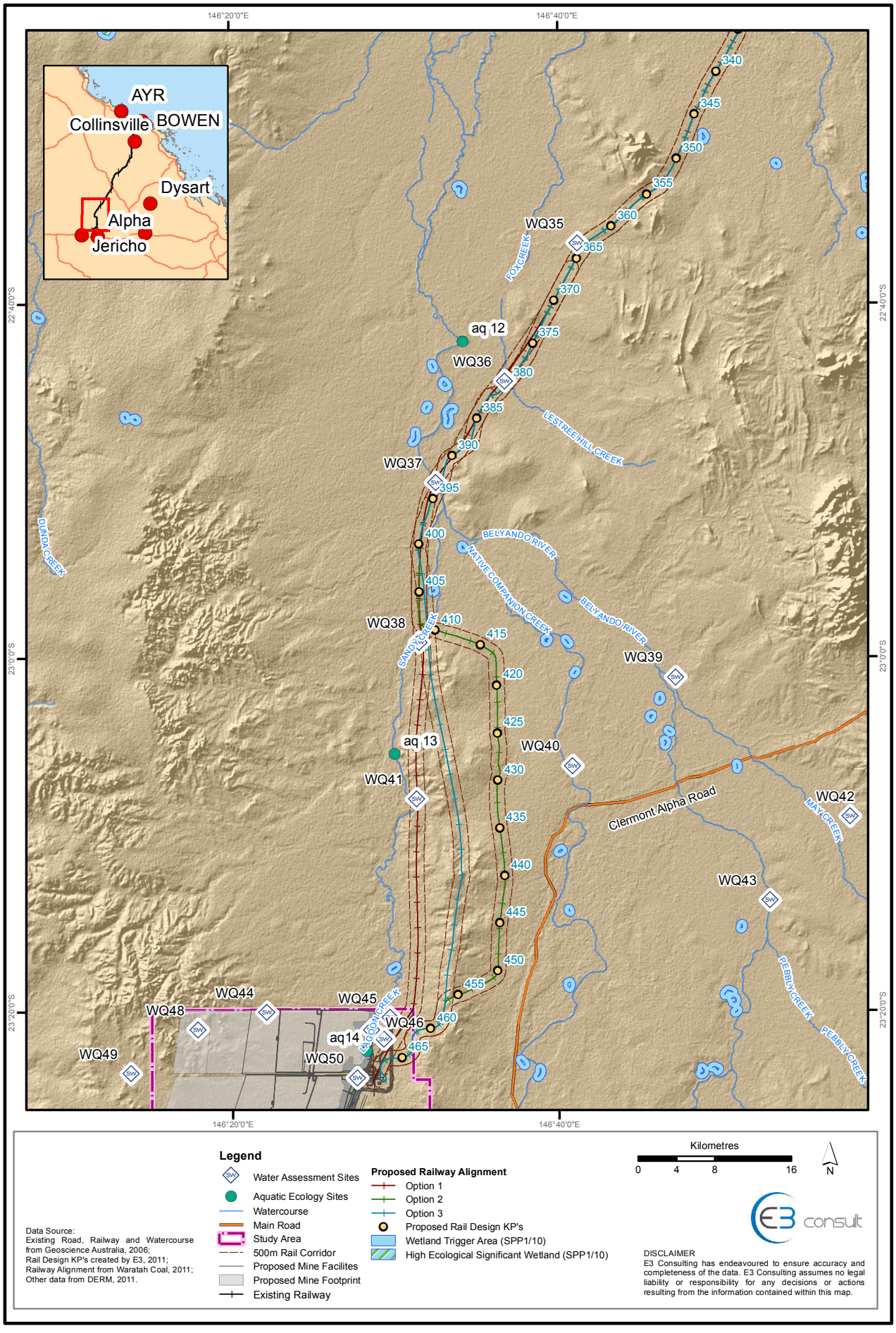


Figure 11. Wetland Associated REs and DOI Wetlands – KP230 to KP350 (Map 3 of 4)

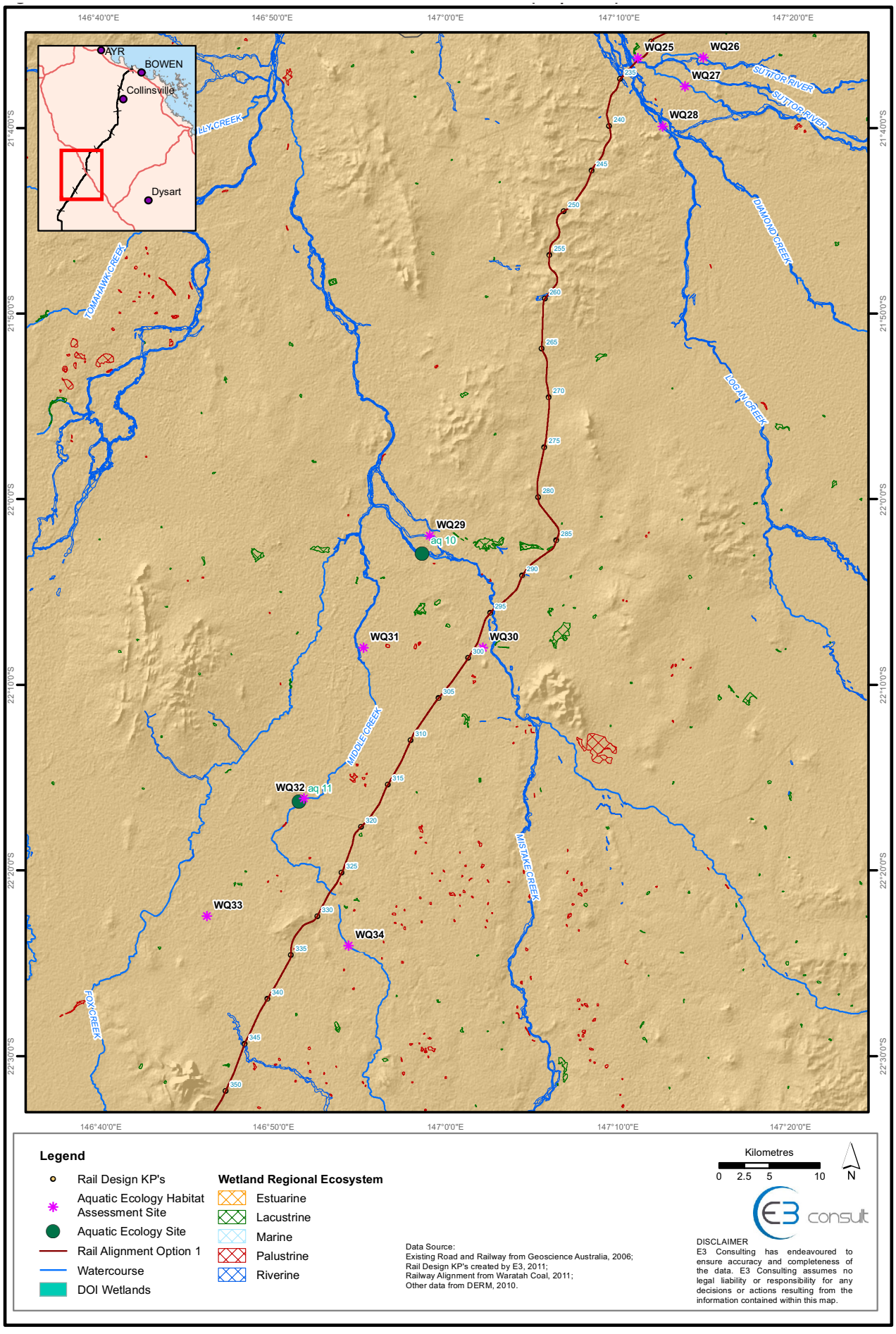


Figure 12. Wetland Associated REs and DOI Wetlands – KP350 to KP468 (Map 4 of 4)

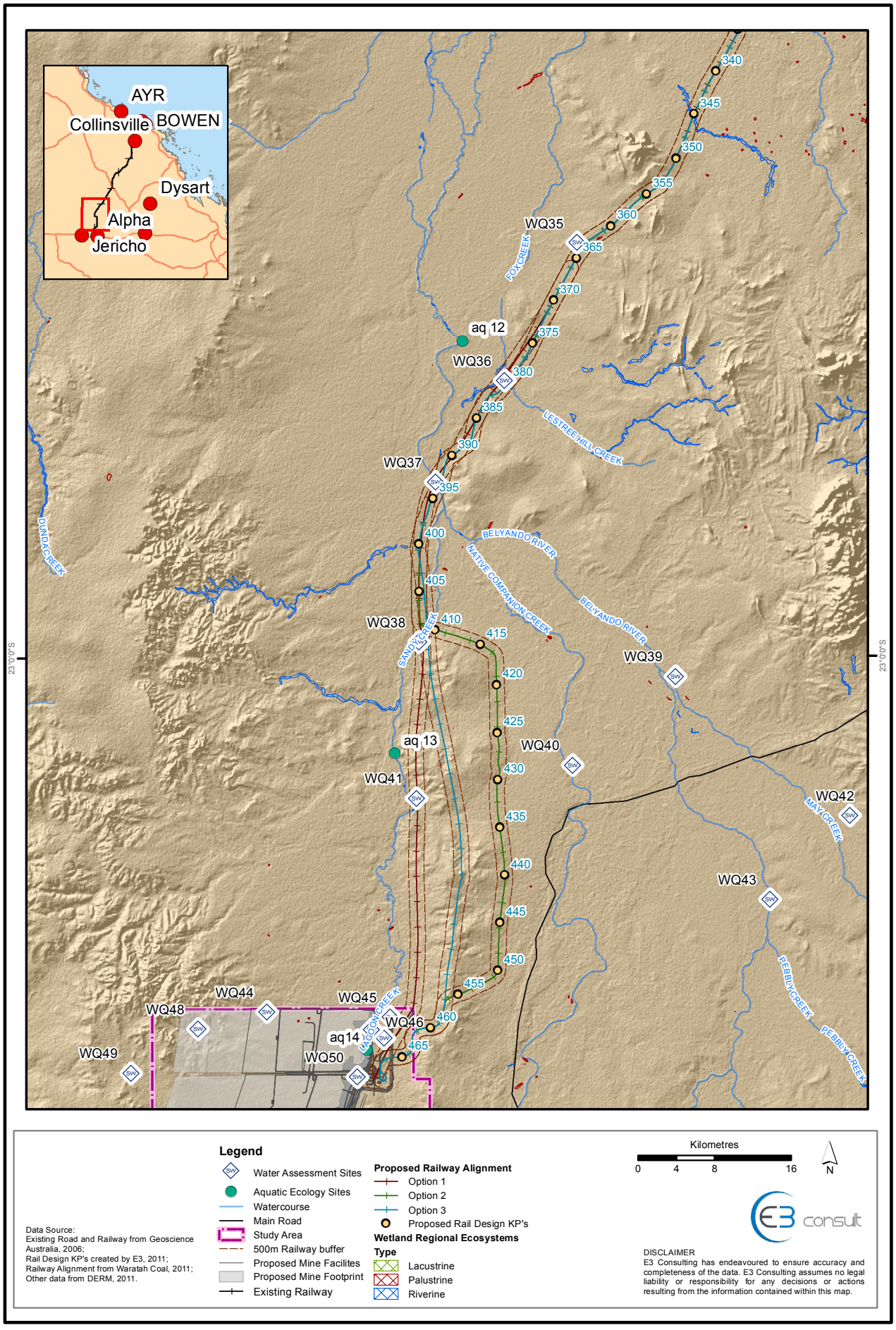


Figure 13. High Value Regrowth and Remnant RE – KP230 to KP350 (Map 3 of 4)

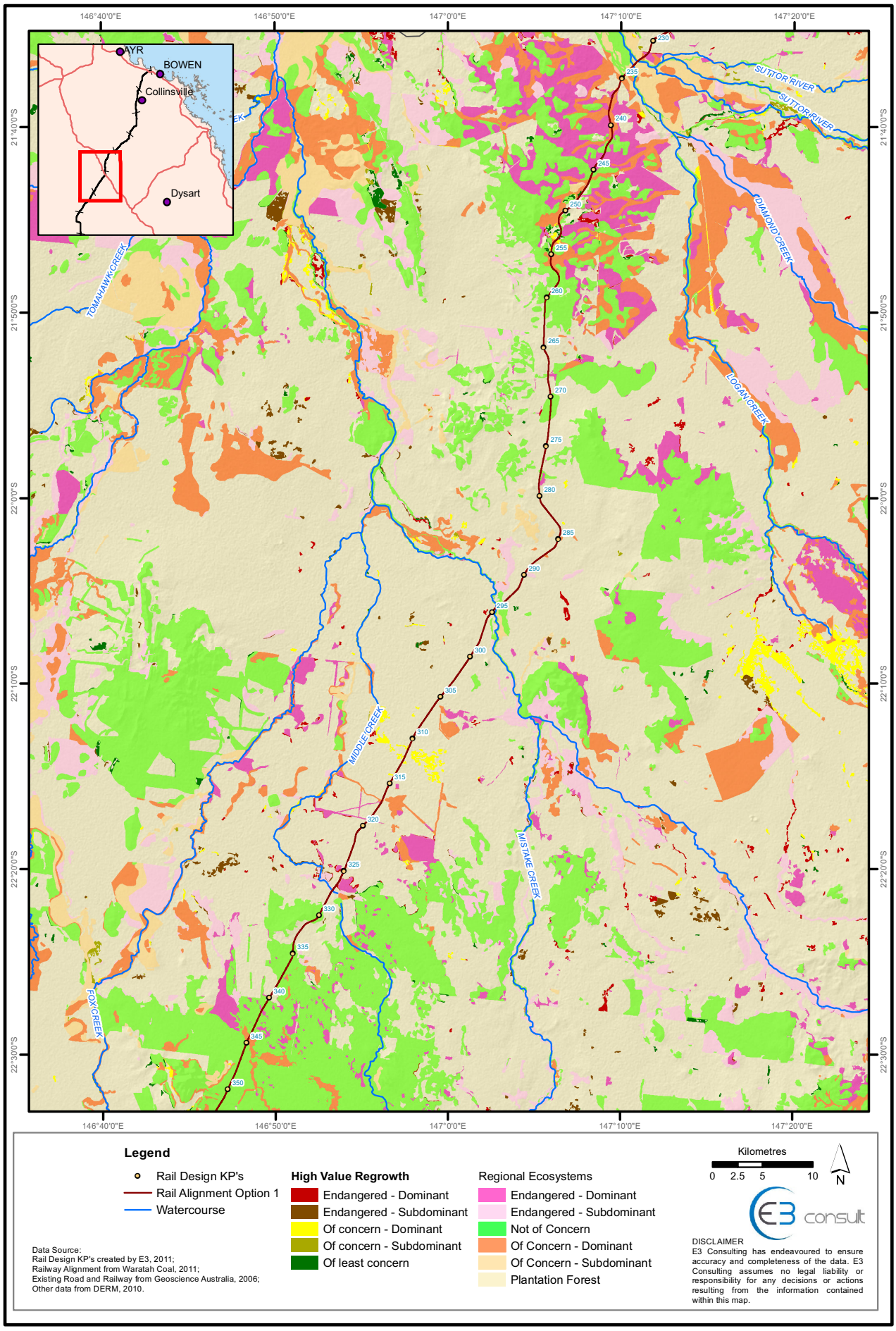
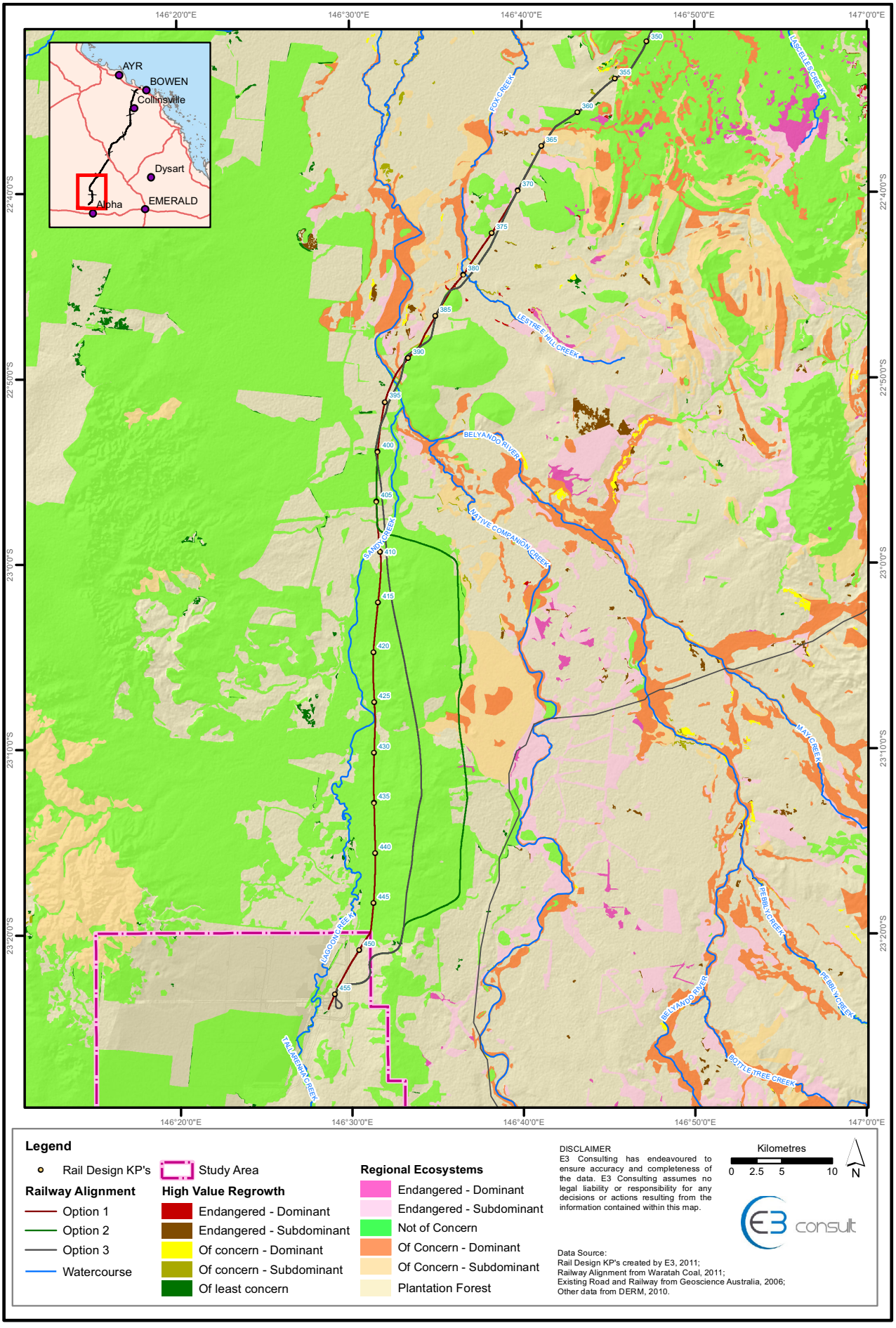


Figure 14. High Value Regrowth and Remnant RE – KP350 to KP468 (Map 4 of 4)



7.4.4.6 Aquatic Macro Invertebrate Communities

A total of 25 families of macro invertebrates were captured across the four sites within the Belyando Catchment (11 families at AQ10, 15 families at AQ11, 14 families at AQ12 and 17 families at AQ13) **(Table 13)**. The highest diversity of macro invertebrates was observed at AQ13 which is likely to be as a result of the limited available habitat and therefore, animals moving into the last remaining pools. There were high abundances of midges at all sites, while mayfly nymphs where in relatively high abundances at AQ10, AQ11 and AQ12. Marble beetle larvae were in high abundances at AQ12 and likewise, water boatman where in high abundances at AQ13 likely as a result of the restricted available habitat.

Table 13. Distribution of macro invertebrates species across the Belyando sampling sites

COMMON NAME	FAMILY	ORDER	AQ10	AQ11	AQ12	AQ13
Shrimp	Palaemonidae, Atyidae	Decapoda	0	1	2	1
Gnats or Midges	Chironomidae	Diptera	121+	167+	165+	148+
Dragonfly nymphs	Sub Order: Anisoptera	Odonata	0	0	0	1
Fisher spiders	Pisauridae	Araneae	1	2	0	0
Caddisfly larvae	-	Tricoptera	59+	15	3	16
Mayfly nymphs	-	Ephemeroptera	42	69+	76+	10
Sand or Black flies	Simuliidae	Diptera	0	0	3	1
Rifle or Marl beetles	Helminthidae	Coleoptera	3	3	16	23
Pond snails	Lymnaeidae	Class: Gastropoda	0	1	0	0
Water mites	Sub Order: Hydracarina	Acarina	1	9	0	0
Water scavenger beetles	Hydrophilidae	Coleoptera	0	0	0	3
Screech beetles	Hygrobiidae	Coleoptera	3	3	1	10
Diving beetles	Dytiscidae	Coleoptera	1	0	9	53+
Midges	Dixidae	Diptera	0	0	0	0
Helminthid larvae	Helminthidae	Coleoptera	2	1	191+	35
Water fleas	Sub order: Cladocera	Diplostraca	1	9	1	4
Bladder or tadpole snails	Physidae	Class: Gastropoda	0	1	0	0
Pigmy backswimmer	Pleidae	Hemiptera	0	1	1	1
Whirligig larvae	Gyrinidae	Coleoptera	1	0	0	0
Pea-shell mussel	Sphaeriidae	Class: Bivalvia	0	0	1	0
Stonefly nymphs	-	Plecoptera	0	0	1	2
Water crickets	Veliidae	Hemiptera	0	0	0	4
Water measurer	Hydrometridae	Hemiptera	0	1	0	0
Orb-shell mussel	Corbiculidae	Class: Bivalvia	0	1	3	1
Water boatman or backswimmers	Notonectidae	Hemiptera	0	0	0	100+

SIGNAL calculations carried out for AQ10, AQ11, AQ12 and AQ13 gave scores of 5.6, 4.6, 5.1 and 4.5 respectively. This indicates mild to moderate pollution of the waterways within the catchment. The generally higher scores for these streams compared to those in the lower catchments is likely due to the lower intensity of grazing and agriculture that occurs in these areas. While much of the land in this catchment has been cleared there remains a relatively high level of vegetation and open woodlands that would have the effect of "polishing" runoff before it enters creek systems.

7.4.4.7 Macro Crustacea Communities

Four species of macro crustacea were observed across the catchment **(Table 14)**. These included Australian river prawn (*Macrobrachium australiense*) which was observed at all sites and redclaw which are translocated to the upper Burdekin River Basin (Burrows *et al* 1999).

Table 14. Distribution of macro crustacea species across the Belyando Catchment sampling sites

COMMON NAME	FAMILY	SPECIES	AQ10	AQ11	AQ12	AQ13
Shrimp	Atyidae	*Caridina* sp.		x	x	
Australian River Prawn	Palaemonidae	*Macrobrachium australiense*	x	x	x	x
Redclaw	Parastacidea	*Cherax quadricarinatus (T)*	x		x	
Freshwater Crab	Parathelphusidae	*Austrothelphusa transversa*				x
Total Number Species Recorded / Site			**2**	**2**	**3**	**2**

Species type key: (T) Translocated to Basin or site

7.4.4.8 Fish Communities

Considering the larger sized habitats present at least three of the sites, the catchment had good fish diversity (13 species). There was medium diversity at AQ10, AQ 11 and AQ 12 which is likely attributable to the high seasonality of habitats present. AQ12 recorded the fourth highest fish diversity with eleven species recorded including three recreational fishery associated species, two of which are translocated, Australian bass (*Macquaria ambigua*) and sleepy cod (Burrows *et al* 1999). Smallheaded grunter, a species with restricted distribution endemic to the Burdekin River Basin was also recorded. One exotic species, tilapia was recorded and was common at AQ11 but were not observed (AQ10 and AQ13) or were in extremely low abundances (AQ12). Only a subset of sampling methods were undertaken at AQ11 (i.e. electrofishing, seine netting and macro invertebrates only) as overnight sampling could not be carried out due to access restrictions. Considering the limited sampling methods used at AQ11, the site had relatively high fish diversity (ten species).

The most abundance species observed was Hyrtl's tandan at both AQ10 and AQ12 with over 528 and 437 individuals caught respectively in the various sampling devices (AQ10 minimum length 77 mm, maximum length 241 mm; AQ12 minimum length 74 mm, maximum length 147 mm). Other abundance species included (by abundance) rainbowfish, striped gudgeon (*Leiopotherapon unicolor*) and sleepy cod.

Golden perch (*Macquaria ambigua*) was observed to be the longest fish species caught at all sites, although it was only observed at AQ12 from all surveys. Golden perch had a maximum fork length of 443 mm (minimum length 223 mm; mean length approximately 300 mm). The diversity of fishes observed within the Belyando Catchment is listed in **Table 15**.

Table 15. Distribution of fish species across the Belyando Catchment sampling sites

COMMON NAME	FAMILY	SPECIES	AQ10	AQ11	AQ12	AQ13
Agassiz's Glassfish	Ambassidae	*Ambassis agassizii*	X	X	X	X
Tilapia	Cichlidae	*Oreochromis mossambica* (E)		X	X	
Bony Bream	Clupeidae	*Nematalosa erebi*	X	X	X	
Southern Purple-Spotted Gudgeon	Eleotrididae	*Mogurnda adspersa*		X	X	X
Western Carp Gudgeon		*Hypseleotris klunzingeri*		X		
Sleepy Cod	Eleotrididae	*Oxyeleotris lineolata* (F)	X	X	X	X
Eastern Rainbowfish	Melanotaeniidae	*Melanotaenia splendida splendida*	X	X	X	X
Yellow Belly	Percichthyidae	*Macquaria ambigua* (T)(F)			X	
Hyrtl's Tandan	Plotosidae	*Neosilurus hyrtlii*	X	X	X	X
Black Catfish		*Neosilurus ater* (F)	X		X	
Rendahl's Catfish		*Porochilus rendahli*	X			
Spangled Perch	Terapontidae	*Leiopotherapon unicolor*	X	X	X	X
Smallhead Grunter		*Scortum parviceps* (R)	X	X	X	
Total Number Species Recorded / Site			**9**	**10**	**11**	**6**

Species type key: (E) Exotic, (F) Important to Traditional / commercial / recreational fisheries, (R) Restricted Burdekin River Basin Endemic, (T) Translocated to Basin or site

7.4.4.9 Turtle Communities

No turtles were observed within the Belyando catchment.

7.4.4.10 Other Aquatic Vertebrates

Green striped frog, bumpy rocket frog and the exotic cane toad were all observed in the catchment.

7.5 POTENTIAL IMPACTS

During construction and operation of the rail alignment, there are a number of mechanisms that have the potential to impact on aquatic ecosystems including:

- impacts on vegetation and banks during bridge construction through their removal, causing sediment movement;
- disturbance and stockpiling of soils causing increased turbidity or suspended solids within the water column;
- piling and culvert works for stream crossings;
- use of potentially contaminated / low quality water for dust suppression and other site activities; and
- storage of oil, fuel and chemicals on site.

7.5.1 CLEARING AND DISTURBANCE OF SOILS

Construction activities are expected to be relatively invasive, involving extensive excavations including removal of large areas of vegetation in order to create work areas near streams to construct culverts and bridges for crossings. This has the potential to increase sediment loads within the stream as well as nutrients and toxicants associated with the suspended sediment and reduce the quality and availability of aquatic ecosystems. The stockpiling of topsoils near streams also has the potential to increase sediment loads in streams if not managed properly.

Excavation activities may also result in the disturbance and exposure of ASS in the Don Catchment within the coal terminal area which can then impact on aquatic ecosystem; however, further testing needs to be undertaken to determine their presence and extent. Potential impacts from ASS disturbance include:

- damage or death of aquatic fauna and flora;
- the release of iron, aluminium and other metals into surface water, which reduces water quality;
- damage to infrastructure which is subject to corrosion from acidic water; and
- slumping of structures built on material containing ASS, as this soil type generally has a low-bearing capacity.

7.5.2 PILING

Construction will involve the driving of concrete piles and placement of culverts within the riparian zone and potentially the watercourse itself. These works will result in direct disturbance to the streams, especially for crossings requiring piling or the placement of structures in the stream itself. Potential impacts include the re-suspension of bottom sediments into the water column increasing turbidity and any toxicants present in the sediment.

Noise, light and vibrations associated with works on or near waterway crossings also have the potential to impact on aquatic species by disturbing fish behaviour or impairing hearing, sight and other identification mechanisms. This could disrupt normal behaviour such as breeding or predator / prey interactions.

7.5.3 RELEASE OF POTENTIALLY CONTAMINATED WATER

Construction of the railway will require substantial quantities of water for dust suppression (not quantifiable at present), landscaping, and surface stabilisation or compaction purposes. Due to the remoteness of large section of the rail alignment, town water supplies may not be available or practical for use. Supply for construction purposes is likely to be sought from non-potable sources such as existing streams, private dams or quarry sites (i.e. the quarry at Abbot Point). Water from non-potable sources may have poor water quality, and if run-off from the construction site occurs at a high velocity, it may contribute to lowering water quality in the catchment and therefore reduce the quality and availability of aquatic ecosystems.

7.5.4 SPILLS

Chemical spills or low-level exposure of the aquatic environment to chemicals (e.g. run-off from machinery, including potential vehicle accidents) would most likely involve hydrocarbon products such as fuels and lubricants. Fuels and chemicals will be stored, transported, handled and used in accordance with relevant legislation, regulations, standards and guidelines. As such, the risk of spillage would be low.

7.5.5 OPERATIONAL PHASE IMPACTS

There is little available information specifically addressing the effect of operational rail lines on water quality; however impacts to aquatic ecosystems may occur if site runoff is not managed correctly. It is likely that a number of potential contaminants could be released from trains, including oils and lubricants, which could disperse into downstream environments and reduce the quality and availability of aquatic ecosystems. Such releases could either occur as a result of a single major incident or multiple small releases from the day to day operations of rail infrastructure.

Major incidents releasing contaminants into streams have the greatest potential to impact on aquatic fauna if spill response efforts are not carried out in a timely manner. However, the effects of multiple small releases over extended periods are difficult to quantify and will be highly dependent on the nature of the chemical released.

7.6 MITIGATION AND MANAGEMENT

EMPs will be developed for the construction and operational phases of the rail alignment. Management measures addressing freshwater ecology issues will include:

- avoid disturbing broad diverse riparian vegetation assemblages, high value habitat nodes and corridors in highly fragmented landscapes to remove linkages across semi contiguous and contiguous corridors through placement of site infrastructure;
- design alignment crossings to be elevated to minimise dissection of contiguous ecotonal vegetation corridors and high value habitat nodes and corridors in highly fragmented landscapes;
- incorporate wildlife underpasses into design of bridges and culverts crossing waterways;
- revegetate understorey and mid storey vegetation in clearing corridors across drainage lines following construction;
- commit to best practice maintenance of fish passage via appropriate structures (Cotterell, 1998);
- ESCPs for the rail alignment detailing control measures to be implemented, construction details, dimensions, materials used, expected outcomes and staging of erosion and sediment control once construction is complete. The ESCP will be signed off by the appropriate authority prior to the commencement of works;
- where possible, and where water is present, vibrocorers will be used in preference to hammer pile drivers to reduce re-suspension of bottom sediments;

- all stockpiled material is to be kept inside bunded / sediment fenced areas with delineated access points;
- temporary sediment control fences will be installed around any stockpiles in place for more than one week;
- limit vehicle access during construction to access tracks and designated construction areas;
- sediment on vehicle should be prevented from being carried out from the site onto local roads. A vehicle shakedown area at the entrance to work sites will ensure sediment is removed before accessing off-site road networks;
- wash down of plant and equipment shall be undertaken only where there are appropriate handling facilities. If on-site wash down is unavoidable, a bunded, impervious receptacle will be used;
- limit lighting to that which is required for operations and employing lighting with directional guards to minimise effect on non-target areas;
- ensure safe and effective fuel, oil and chemical storage and handling on site;
- develop storm water management plans for each component of the construction. These should consider the use of storm water tanks and re-use of grey water; and
- where works are to be carried out within the streams themselves (i.e. piling for bridge crossings) sediment sampling will be carried out to identify potential contaminants.

An aquatic ecosystem monitoring program will be put in place for construction works through the Construction EMP. The monitoring program will incorporate the following:

- Impact monitoring criteria will be included in the EMP. Criteria will be developed for each of the catchments addressed in this report (Don, Lower Catchment, Bowen, Suttor and Belyando);
- Monitoring will include visual inspections of construction areas and surrounding waters for evidence of spills; and
- Physical and chemical water quality monitoring will be carried out up and down stream of work sites within the study area;

7.7 CONCLUSION

Baseline aquatic ecology investigations were undertaken along the rail alignment. Several wetlands listed as Great Barrier Reef Wetland Protection or management areas were located within or adjacent to the rail alignment. A total of 33 macro invertebrate groups, seven macro crustacea and 24 fish species were observed across the entire rail alignment. Species richness was highest within the Bowen River Catchment. A number of turtles and other aquatic related vertebrate species were also observed during field work that should be considered when constructing the project. SIGNAL scores calculated using macro invertebrate identified at each of the sites indicated that most of the waterways crossed by the rail alignment are considered to have some level of pollution, which is most likely a result of surrounding agricultural land uses.

Construction works that have the most potential to impact on aquatic ecosystems include:

- impacts on vegetation and banks during bridge construction through their removal, causing sediment movement;
- disturbance and stockpiling of soils causing increased turbidity or suspended solids within the water column;
- piling and culvert works for stream crossings;
- use of potentially contaminated / low quality water for dust suppression and other site activities; and
- storage of oil, fuel and chemicals on site.

Management measures including the variations of design including bridge structures and the development of an ESCP to reduce potential impacts resulting from the works and also an assessment prior to construction of important perennial waterholes that may act as refugia during dry seasons and based on that assessment, move the rail alignment so as the project does not impact these locations.

If properly managed the impacts to surface water resulting from the works are expected to be minimal.

7.8 COMMITMENTS

Waratah Coal commit to undertaking the following actions:

- develop an ESCP prior to the commencement of construction;
- ensure bridge and culvert design allows for the passage of aquatic species; and
- develop an EMP incorporating monitoring requirements for surface waters that include ongoing aquatic ecology monitoring.