7. Hydrology / hydraulics and surface water quality

7. Hydrology/hydraulics and surface water quality

This chapter addresses the existing environment in terms of the hydrology/hydraulics and water quality of the watercourses and wetlands within and downstream of the project area. The potential impacts of the Project, both within and downstream of the project area, are discussed. Mitigation measures are proposed to reduce any potential impacts to the receiving waters during construction and operational phases of the Project.

7.1 Study area

The project area is located in the lower reaches of the Plane Creek Drainage Basin (AWRC Basin 126), which encompasses an area of approximately 250,000 ha. The proposed works are located within the Plane and Willy Creek catchments. The Plane Basin includes several small streams which discharge directly into Sarina Inlet, which is part of the Great Barrier Reef World Heritage Area (GBRWHA) and the Great Barrier Reef Marine Park (GBRMP), which is an area of international, national and state significance. A description of the ecological values of the watercourses and wetlands is outlined in Chapter 6.

7.2 Hydrology/hydraulics

A hydraulic assessment report has been prepared that fully documents the investigation undertaken and this is presented in Appendix I2. This section of the EIS provides an overview of the assessment undertaken and summarises the key outcomes.

7.2.1 Study data

A range of data was available or sourced for this Project, including:

- Detailed survey of QR assets within the study area
- Digital contour data with 1 m interval for areas surrounding Jilalan Station Yard supplied by Queensland Department of Natural Resources and Mining (DNRM)
- Intensity Frequency Data (IFD) for Sarina derived in accordance with Australian Rainfall and Runoff (ARR 1987)
- Queensland Urban Drainage Manual (Neville Jones & Associate 1993)
- Road Drainage Design Manual (Department of Main Roads, June 2002)
- Tide data was sourced from *The Official Tide Tables & Boating Safety Guide* (Queensland Transport 2006)

7.2.2 Methodology

Preliminary catchment investigation indicated that all catchments generating flow to the study area could be classified as small, with the exception of Plane Creek. Additionally, with the exception of Plane Creek, no catchments relevant to this investigation were gauged resulting in an absence of recorded stream flow data for flood frequency analysis or calibration of sophisticated runoff routing hydrologic models.

The Rational Method is a simple method commonly used in Queensland to estimate peak discharges for drainage design in smaller catchments. The Rational Method was adopted to derive peak discharges for all catchments in this study, with the exception of Plane Creek where a detailed quasi 2-dimensional hydraulic model was developed using the MIKE 11 software package. The hydraulic assessment for these catchments was undertaken as summarised below.

- Identification of drainage routes within the study area.
- Delineation of catchments contributing flows to Jilalan Rail Yard.
- Determination of flood discharges from contributing catchments using the Rational Method.
- Preliminary assessment of appropriate drainage options.

- Hydraulic analysis of proposed drainage options manually and in some instances with HEC – RAS.
- Review of hydraulic analysis outcomes.
- Recommendations for drainage.

The Plane Creek catchment was considered significant and as such a detailed quasi 2-D model was developed using MIKE 11. The hydraulic assessment of the catchment was undertaken as summarised below.

- Delineation of the Plane Creek catchment and sub-catchments using available mapping.
- Formulation of a RAFTS hydrologic model and simulation of 1, 2, 5, 10, 20, 50, 100 and 500 year Average Recurrence Interval (ARI) storm events to derive respective design storm discharge hydrographs for the creek system.
- Preparation of a MIKE 11 hydraulic model of Plane Creek extending from east of the Bruce Highway to the creek's point of discharge into Sarina Inlet.
- Simulation of the tidal Highest Astronomical Tide (HAT) and Mean High Water Springs (MHWS) events, and the 1, 2, 5, 10, 20, 50, 100 and 500 year ARI storm events to derive peak flood levels in Plane Creek.

Full detail of the investigation undertaken is presented in the hydraulic assessment report in Appendix I2.

7.2.3 Plane Creek

Existing environment

Plane Creek catchment encompasses 92 km^2 and drains east from the Connors Ranges through a primarily rural landscape, prior to discharging into Sarina Inlet. Plane Creek is 35 km in length and is highly regulated with one main dam (Middle Creek Dam) on Middle Creek (a tributary of Plane Creek) and four weirs (Jackson's Weir, Council Dam, Mill Dam and CSR Dam) along its length (Brodie 2004). The main urban area in the basin is Sarina, which is situated along the lower reaches of Plane Creek (Rohde *et al* 2006). The northern extent of the project area is located within the Plane Creek catchment and the lower reaches of Plane Creek flow parallel to the project area and discharges into Sarina Inlet, part of the GBRWHA and Marine Park. At the survey site Plane Creek was a wide flowing creek with a rocky-lined bed and riffles. The banks of the creek, at the survey site, were composed of sand and sediment.

A RAFTS hydrologic model of the Plane Creek catchment was formulated to derive design discharge hydrographs. Gauging station 126002A was located in Plane Creek near Sarina during the period 1972 to 1988, points of interest include:

- The data period was limited to 16 years between 1972 and 1988.
- The available data period was insufficient for calibration of the hydrologic model.
- The peak discharge was 663 m^3/s recorded in 1978.
- The maximum recorded discharge was in the order of the 24 hour duration 10 year design event yielded by the hydrologic model.

A MIKE11 hydraulic model was developed to represent:

- The existing conditions at the site.
- Proposed scenarios for the site.

Comparison of the pre and post flood characteristics enabled quantification of any resultant variation.

Geomorphological conditions

North of the project area where the Goonyella Branch Line crosses Plane Creek, riparian vegetation along both banks were dominated by dense strands of marine plants and active erosion processes such as gravity driven scouring and aggradation and sediment deposition within the base of the stream channel resulting from overland flow and tidal inundation processes (refer Photo 7.1).

Photo 7.1 Plane Creek

Potential impacts

Bridges allow for the passage of flood flows to utilise available storage on the downstream side of the railway embankment resulting in negligible increases in existing peak flood levels. Areas around bridge abutments would be suitably protected to avoid scour. Detailed hydraulic analysis to ascertain negligible impacts on existing flood patterns will occur during the detailed design phase.

7.2.4 Elizabeth Creek

Existing environment

Elizabeth Creek is a tributary of Willy Creek and drains east from the Connor Ranges (west of the Bruce Highway) through irrigated cane land, and joins Willy Creek west of Gurnetts Road. Elizabeth Creek intersects the mid-section of the area of the proposed works. The upstream waters of the creek are ephemeral in nature, and the downstream waters are tidally influenced discharging into the Llewellyn Bay.

Currently under the existing track the creek passes through a cell of three 3 x 2.1 m reinforced concrete box culverts (RCBC).

Geomorphological conditions

Evidence of erosion processes within and surrounding the project area indicated that areas of moderate sheet and rill erosion associated with the gently undulating plain between Elizabeth and Willy Creeks intercepting the central southern section of the project area were occurring. Areas of severe sheet and rill erosion were also present in the upper reaches of Elizabeth Creek. Erosion processes within the project area included gravity driven scouring from overland flow towards the stream channel (refer Photo 7.2).

Photo 7.2 Elizabeth Creek

Potential impacts

The works proposed at Elizabeth Creek include new wagon maintenance tracks downstream of the existing crossing and additional tracks for the provisioning and bypass lines further downstream. It is proposed that the new culverts be extended through the future works at both locations. Additionally, a straight 10.6 m wide rock lined channel is to be excavated to connect the two sets of culverts to replace the natural channel. This has been proposed to provide for efficient hydraulic conveyance between culvert cells, and also to avoid works associated with aligning the existing channel with the preferred culvert alignment.

The channel immediately downstream of the existing rail culvert is shallow and insufficient to accommodate the design flow. Flow which breaches the existing embankment currently flows into Willy Creek. It is expected that the new culverts in Elizabeth Creek will result in an increase in this bypass flow.

Once the flow has passed through the new culvert under the provisioning and bypass lines, it will discharge upstream of Gurnetts Road. The flow will then cross Gurnetts Road in a similar manner to the existing regime.

At the outlet of the first set of culverts a high velocity of 5.1 m/s was noted, however a hydraulic jump forms at this location and the velocity decreases to an acceptable level of 2.4 m/s almost immediately.

Hydraulic analysis presented in Appendix I2 shows that the entire peak discharge for the 100 year ARI event is conveyed through the culverts.

During construction a large volume of fill will be transported from north of Elizabeth Creek to south of Willy Creek. Due to the timeframes required to facilitate this, the following options will be considered:

- Completely close Elizabeth Creek and divert all flows to Willy Creek.
- Allow base flows to pass through via pipe and discharge to natural creek channel east of the proposed rail structures. All other flows will be diverted to Willy Creek.
- Allow all flows to pass through via box culverts and discharge to natural creek channel east of the proposed rail structure.
- Implement bridge structures for each required crossing with associated culverts and all other areas remaining as natural channel. All flows will continue along the existing creek line.

Mitigation measures

Scour protection is proposed at all culvert inlets and outlets to prevent erosion from high velocities. The base of the channel will also be lined with rock to prevent souring. The meanders of the natural Elizabeth Creek channel between the proposed rail lines not excised by the proposed drainage alignment will remain in their existing state and open to the excavated channel.

Where the flow exits the proposed alignment and discharges into the existing bank, gabions will be installed to prevent scour and the channel bed will be protected with rip-rap. The characteristics of flow leaving the property and crossing Gurnetts Road remain essentially unchanged from existing patterns, whereby Gurnetts Road is subject to regular inundation.

7.2.5 Willy Creek

Existing environment

The catchment of Willy Creek has its headwaters in the Connor Ranges and flows east through a primarily rural landscape discharging into Llewellyn Bay. The upstream waters of the creek are ephemeral, and the downstream waters are tidally influenced. The main land use activities surrounding Willy Creek are sugar cane cultivation and cattle grazing. The banks of the creek are steep and the bed of the creek is rock-lined with riffles and pooled areas. The water levels at the time of inspection were low but there was water movement still occurring. The channel of the creek, within the project area, was realigned approximately 15 years ago to accommodate the expansion of the cane fields and vegetation was also introduced along the bank to provide a riparian buffer.

Geomorphological conditions

Erosion processes were observed within and surrounding the project area that indicated areas of moderate sheet and rill erosion associated with the gently undulating plain between Elizabeth and Willy Creeks as well as severe sheet and rill erosion associated with the upper reaches of Willy Creek.

Active erosion processes occurring at this site included gravity driven scouring from overland flow to the stream channel and erosion of exposed soils on slopes was evident, which had resulted in minor channelling and sheet erosion; however the soils in relatively flat areas appeared to be stable (refer Photo 7.3).


Photo 7.3 Willy Creek

Potential impacts

The works proposed at Willy Creek include new wagon maintenance tracks downstream of the existing crossing and additional tracks for the provisioning and bypass lines further downstream. It is proposed that the existing culverts be extended through the future works at both locations. Additionally a straight 27 m wide rock lined channel is to be excavated to connect the two sets of culverts to replace the natural channel. This has been proposed to provide for efficient hydraulic conveyance between culvert cells, and also to avoid works associated with aligning the existing channel with the preferred culvert alignment. Once the flow has exited the second culvert cell, it discharges upstream of Gurnetts Road.

Mitigation measures

Velocities at the outlets of the culvert cells were found to be around 0.9 m/s, and as a precaution it is proposed to use rip-rap at these locations for scour protection. The base of the channel will also be rock lined to prevent erosion. The excavated channel will encompass the existing natural channel between the culverts.

Analysis also showed that the velocity and peak discharge of the flow as it leaves the property is similar to existing levels, and hence it is not necessary to undertake any further works to lessen the impact of flooding on Gurnetts Road.

7.2.6 Minor catchment rail cross drainage structures

Potential impacts

The proposed works include widening of the track at various locations in the project area. Where minor drainage structures currently exist, hydraulic analysis has shown that these structures will simply be replicated or extended in the proposed works. This analysis is presented in Appendix I2.

7.2.7 Rail Yard drainage

Potential impacts

Rain falling directly onto Jilalan Rail Yard will permeate into the ballast and percolate to the formation before continuing in the downstream direction. For intense, longer duration events significant volumes of water will be conveyed within and beneath the ballast.

A drainage network consisting of inlets, pits, branch and trunk pipes and drains has been proposed to intercept flows within the ballast and on the formation surface.

Flows within the ballast (including those along the formation surface) would be intercepted by “jump ups”. Jump ups are essentially pits with cylindrical covering grates extending vertically into the ballast. The openings in the top and wall of the grate allow water to enter but exclude ballast material. Jump ups would be located in ballast beside tracks but not between a pair of tracks.

Proposed jump ups are in accordance with QR standard drawings 2291 and 2292.

In wider, potentially trafficable areas of the formation where ballast would not be placed, field inlets have been proposed. Proposed field inlets are in accordance with QR standard drawings 2287 and 2288.

Water received into the ‘jump ups’ would discharge to a collection pipe that services several others ‘jump ups’ and field inlets along a particular drainage alignment. Each drainage alignment would be, generally, perpendicular to the tracks.

The collection pipes discharge to:

- A trunk drainage pipe where the formation at that point is in cut.
- An open drain where the formation is in fill.

Flow discharging from the formation to a drain will not be allowed to run along the formation batter but be delivered to the drain via a lined drain to avoid scouring.

The ultimate point of discharge would generally be into Willy or Elizabeth Creeks depending from where the flow originated.

Variations to the existing catchments through which the proposed formation will be constructed are minimal. Subsequent redirection of runoff is negligible and Elizabeth and Willy Creeks remain the legal points of discharge for the main areas of the proposed Project. These creeks converge to form a single water way about 300 m downstream of the legal point of discharge. The resultant water way continues for approximately 700 m more before discharging to its ultimate receiving waters of Llewellyn Bay.

Downstream of the point of discharge, the waterway route passes through agricultural land only. Change in land use for the proposed development will result in a negligible increase in runoff potential.

It is considered highly unlikely that the negligible increase in peak discharge at the legal point of discharge would result in a negative impact to downstream areas. Therefore flow detention has been considered unnecessary and no detention basin has been proposed.

Mitigation measures

Water quality treatment measures in the drainage network upstream of the points of discharge into Elizabeth and Willy Creeks are recommended to comply with the EPA Licence conditions, the Environmental Values and Water Quality Objectives (WQO) of ANZECC and Queensland Water Quality Guidelines. The proposed measures include grassed swales and either bio-retention ponds or wetland areas.

7.3 Description of Environmental Values

7.3.1 Environmental Values

The *Environmental Protection (Water) Policy 1997* (EPP(Water)) under the EP Act identifies Environmental Values and WQO for waters within Queensland.

The EPP (Water) serves to protect Queensland's environment while allowing for ecologically sustainable development. This is achieved through the policy by providing a framework for:

(a) identifying environmental values for Queensland waters; and
(b) deciding and stating water quality guidelines and objectives to enhance or protect the environmental values; and
(c) making consistent and equitable decisions about Queensland waters that promote efficient use of resources and best practice environmental management; and
(d) involving the community through consultation and education, and promoting community responsibility.

Part 3, Section 7 of the policy states that:

(1) The "environmental values" of waters to be enhanced or protected under this policy are:
(a) for a water in schedule, column 1—the environmental values stated in the document opposite the water in schedule 1, column 2; or
(b) for another water—the qualities in subsection (2).

(2) The qualities are:
(a) if the water -
(i) is a pristine water - biological integrity of a pristine aquatic ecosystem; or
(ii) is not a pristine water - biological integrity of a modified aquatic ecosystem; and
(b) suitability for recreational use; and
(c) suitability for minimal treatment before supplying as drinking water; and
(d) suitability for agricultural use; and
(e) suitability for industrial use.

(3) However, if a natural property of the water precludes enhancement or protection of a particular environmental value, subsection (1)(b) does not apply to the value.

(4) For subsection (1)(a), a document is taken to state environmental values for a water if it states one or more values (however described) that are equivalent to a quality or qualities in subsection (2).

Watercourses within the project area are defined by the EPP (Water) as being a modified aquatic ecosystem. In the absence of specific WQO for the watercourses intersecting the project area, Environmental Values have been determined from the EPP (Water). Table 7.1 identifies the Environmental Values for the watercourses and receiving environment of the project area.

Table 7.1 Environmental Values for the watercourses and receiving environment of the project area

Environmental Values	Supporting details	Plane Creek	Elizabeth Creek	Willy Creek	Freddy Creek	Llewellyn Bay	Sarina Inlet-Ince Bay Wetland
Aquatic ecosystem	Slightly to moderately disturbed ecosystem	✓	✓	✓	✓	✓	✓
Primary industries	Irrigation		✓	✓	✓		
	Farm water supply						
	Stock watering		✓	✓	✓		
	Aquaculture						
	Human consumers of aquatic food	✓				✓	✓

Environmental Values	Supporting details	Plane Creek	Elizabeth Creek	Willy Creek	Freddy Creek	Llewellyn Bay	Sarina Inlet-Ince Bay Wetland
Recreation and aesthetics	Primary recreation	✓	✓	✓		✓	✓
	Secondary recreation					✓	✓
	Visual recreation	✓	✓	✓	✓	✓	✓
Drinking water							
Industrial uses							
Cultural and spiritual values						✓	✓

Table Note:
✓ Identifies the Environmental Values of the watercourse

The Environmental Values of these systems are related to adjacent land use. The systems are primarily used for agricultural purposes (grazing and sugar cane cultivation).

7.4 Water Quality Guidelines

The Australian and New Zealand Environment and Conservation Council (ANZECC) Guidelines provide guideline values or descriptive statements for different indicators to protect aquatic ecosystems and human uses of waters (eg primary recreation, human drinking water, agriculture, stock watering). The ANZECC Guidelines are a broad scale assessment and it is recommended that, where applicable, locally relevant guidelines are adopted.

The Queensland EPA's Queensland Water Quality Guidelines 2006 (QWQG) are intended to address the need identified in the ANZECC Guidelines by:

- Providing guideline values (numbers) that are tailored to Queensland regions and water types.
- Providing a process/framework for deriving and applying local guidelines for waters in Queensland (ie more specific guidelines than those in the ANZECC).

7.4.1 Freshwater

The waters above the tidal influence, within the project area, include Willy, Elizabeth, and Freddy Creeks and the lacustrine wetland located on a tributary of Willy Creek (EPA Wetland Mapping 2007).

The freshwater regions of the creeks were assessed using water quality guidelines derived from the QWQG for the Central Coast Queensland region (refer Table 7.2). There are currently no water quality guidelines available for the wetlands in the Central Coast Queensland region under the QWQG. The ANZECC 2000 guidelines provide default water quality triggers values for wetland habitats in Tropical Australia and these can be applied in the absence of more local guidelines. It is intended in this EIS, however to assess the quality of the wetlands based on ecological components (refer Chapter 6) rather than through chemical analysis. This is due to the high fluctuation of parameters within wetlands and in the absence of regionally specific guidelines.

7.4.2 Tidally influenced waters

The ANZECC Guidelines and QWQG provide guideline values or descriptive statements for different indicators. WQOs identified in Table 7.2 have been derived from the QWQG. Where there is no guideline value under the QWQG for a particular parameter (ie heavy metals and pesticides), the ANZECC Guideline value has been used.

Table 7.2 Water Quality Objectives for the Mackay region (derived from the QWQG and ANZECC 2000 Guidelines)

Parameter		Units	Freshwater	Tidally influenced waters
Temperature		°C	N/A	N/A
pH	Upper limit		8.0	8.4
	Lower limit		6.5	7.0
Conductivity		µS/cm	375	N/A
DO	Upper limit	% sat	110	100
	Lower limit	% sat	85	70
Turbidity		NTU	50	25
Suspended Solids		mg/L	10	25
Total Nitrogen		µg/L	500	450
Organic N		µg/L	420	400
Oxidised N		µg/L	60	15
Ammonia N		µg/L	20	30
Total Phosphorus		µg/L	50	40
Filterable Reactive Phosphate		µg/L	20	10
Chlorophyll-*a*		µg/L	5	10

7.5 Water quality monitoring

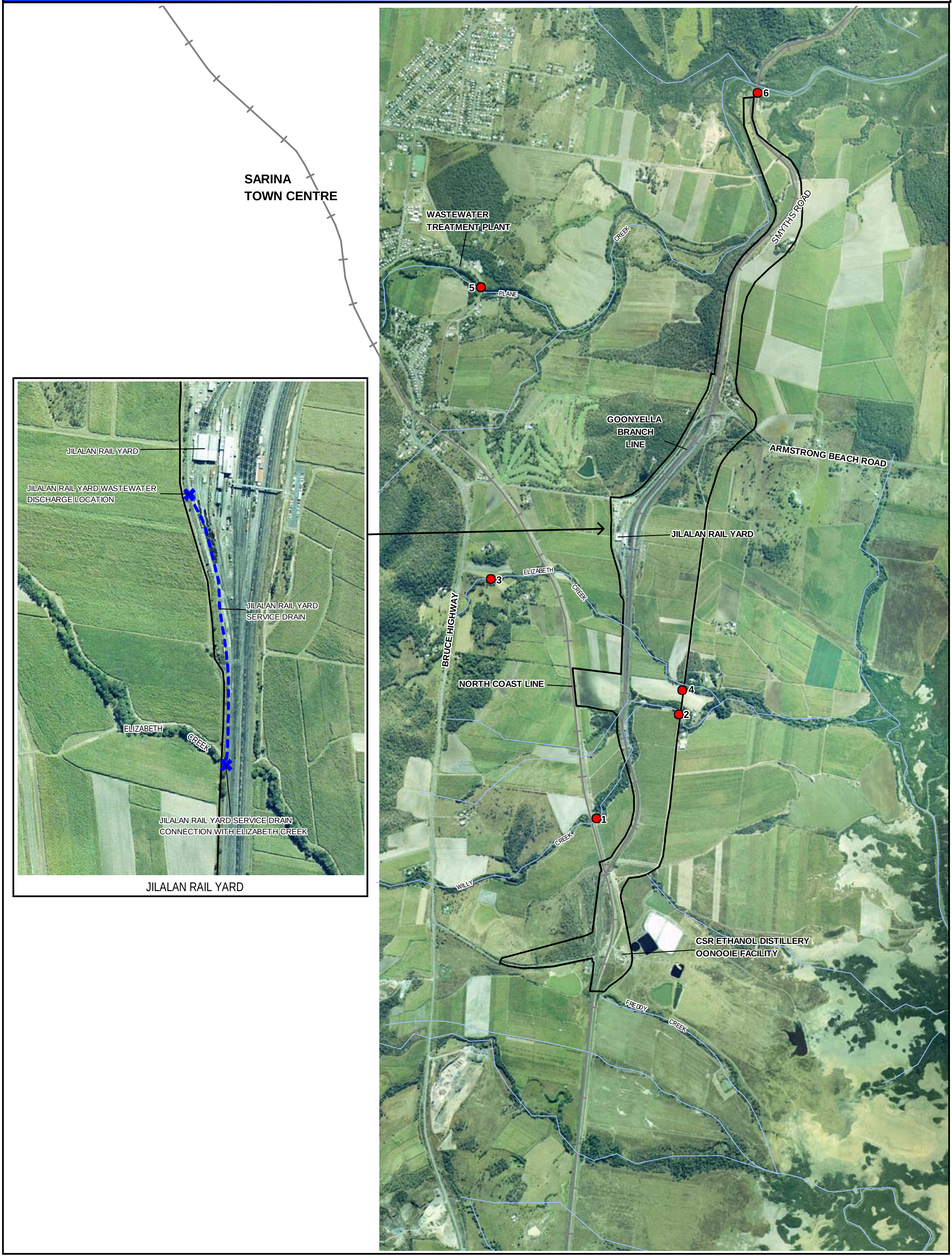
Water quality monitoring activities were undertaken by Connell Hatch in June 2007, for Plane, Elizabeth and Willy Creeks. Due to the inaccessibility of Freddy Creek it was not possible to conduct water quality monitoring at this location. For each of these creeks water quality monitoring was undertaken at two locations, one upstream and one downstream of the project area (refer Figure 7.1). A brief description of each monitoring site and its characteristics are outlined in Table 7.3.

Table 7.3 Water quality monitoring locations

Creek name	Water quality monitoring locations		Site description and surrounding water quality influences
	Easting	Northing	
Plane Creek (upstream of project area)	730718.7	7629055.78	Estuarine. Tidal influence
Plane Creek (downstream of project area)	732672.14	7630414.35	Estuarine. Tidal influence
Elizabeth Creek (upstream of project area)	730791.63	7627014.5	Freshwater
Elizabeth Creek (downstream of project area)	732125.13	7626234.87	Freshwater
Willy Creek (upstream of project area)	730386.42	7624921.31	Freshwater
Willy Creek (downstream of project area)	732102.69	7626065.06	Freshwater
Freddy Creek (downstream of project area)			Freshwater

Table Note:
Site locations identified during June 2007 sampling period.

Jilalan Rail Yard Upgrade Project



N

0 1250 (m)

Scale 1:25 000 (m) (@ A3 size)

LEGEND

Rail

Project Area

Watercourse

Connell Hatch Water Quality Monitioring Location

WATER QUALITY ASSESSMENT

FIGURE 7.1

V:\Projects\Qld_Rail\HR50001\GIS\Workspaces\Jilalan_27.wor By: SLG Date: 10/09/07 Version 3

7.5.1 Sampling methodology

The following sampling and analysis methodology was applied for both the freshwater and tidally influenced waters. The mean annual rainfall for the Plane Creek catchment varies between 15.9 mm and 307.0 mm with approximately 75% of this rainfall occurring between December and April.

These parameters consisted of a single sample at the surface (approximately 0.2 m below the surface) of the water body. No continuous data logging of the water quality was undertaken as part of the Connell Hatch monitoring.

In addition, water samples were collected at each site for laboratory analysis. Samples were collected and transported to a National Accredited Testing Authority (NATA) laboratory. Water samples were analysed for the following analytes:

- Nitrogen: Total Nitrogen, Oxides of Nitrogen and Ammonia as N
- Phosphorous: Total Phosphorous and Filterable Reactive Phosphorous
- Total Petroleum Hydrocarbons (TPH)
- Suspended solids
- Chlorophyll-*a*
- Total and dissolved heavy metals
- Organophosphorous and organochlorine pesticides

7.6 Existing environment

This section of the EIS addresses watercourses within the project area, with particular reference to the water quality of the aquatic systems traversed by the project sites and areas downstream of the proposed Project, which may potentially be affected by construction and operational activities. These include:

- A description of the wetlands.
- An assessment of the existing water quality of the waterways and wetlands.
- An assessment of the environmental values of the waterways and wetlands.

The assessment is descriptive and based on existing literature and observations during site visits that occurred in May and June 2007. The water quality monitoring was undertaken at locations upstream and downstream of the project area and provides details of the water quality of these waterways during the dry season. Additional water quality sampling will be conducted prior to construction, including the wet season (October – April) to provide an assessment of the watercourses over two seasons (the wet and dry). This would provide minimal data to assess whether any changes to water quality of the watercourses occur as a result of the construction or operational activities of the Project.

7.6.1 Watercourses within the project area

Under the *Water Act 2000*, a watercourse means:

- *A river, creek or stream in which water flows permanently or intermittently in a natural channel, whether artificially improved or not.*
- *Or in an artificial channel that has changed the course of the watercourse. It also includes the bed and banks and any other element of a river, creek or stream confining or containing water. The watercourses within the project area all fall under this definition and will be assessed as such.*

The Project has been declared a significant project under Section 26 of the SDPWO Act and is therefore assessable under the *Vegetation Management Act 1999* (VM Act). Queensland's vegetation management framework is supported by a number of codes and policies which ensure that vegetation clearing is undertaken in a way that meets the purposes of the VM Act.

Under the VMC, a watercourse is defined as:

> "*the area of land between the high banks of a natural channel, whether artificially improved or not, in which water flows permanently or intermittently, that is shown on the most recent version of a 1:100,000 Geoscience Australia topographic map, or where there is no 1:100,000 Geoscience Australia topographic map of the area showing watercourses, on a 1:250,000 Geoscience Australia topographic map of the area showing watercourses*."

The proposed works are located within the Plane Creek Drainage Basin in close proximity (approximately 5 km) to the Marine Park and GBRWHA. The northern extent of the project area is located within the Plane Creek catchment, below the limit of tidal influence. Land use within the area of the works is primarily irrigated cropping, which reduces the buffering capacity of the system, as riparian vegetation and intertidal wetlands are cleared. The intertidal wetlands within the lower reaches of Plane Creek and Sarina Inlet are dominated by mangroves (refer Chapter 6). The southern section of the proposed works is located in close proximity to a number of ephemeral drainage lines which flow into Llewellyn Bay. The watercourses which traverse the project area drain east from the main range to the west (ie Connors Ranges) prior to discharging into Sarina Inlet and Llewellyn Bay.

Plane Creek

Plane Creek is part of the Plane Creek Basin. Plane Creek is macro tidal having tidal ranges of < 4 m and the creek has naturally high turbidity due to its tidal influences (refer Photo 7.4). The main land use activity in this area is irrigated cropping and cattle grazing. Chemicals and other inputs from these industries are carried into the creek through overland runoff. Other water quality influences include water extraction and runoff from urban stormwater, as well as influences from a number of other industries located in the area which discharge into the creek, including the Sewage Treatment Plant (Healthy Waterways 2007). These inputs can facilitate the infestation of various weeds (refer Chapter 6).

The water quality within the Plane Creek Basin is determined largely by seasonal flow regimes. High flows are experienced in the catchment during the wet summer periods and during the late dry season the streams may be reduced to a series of pools (Healthy Waterways 2007). The Plane Creek catchment is defined by the Reef Water Quality Protection Plan as being a high risk catchment in terms of the surrounding land use.

Photo 7.4 Plane Creek

Elizabeth Creek

Elizabeth Creek is part of the Rocky Dam Creek catchment. The environmental values of the aquatic systems have been impacted through surrounding land use activities, such as land clearing for agricultural development, which reduces the buffering capacity of the land. Sugar cane cultivation and cattle grazing are the predominant activities occurring on the surrounding land. It is likely that the runoff from the existing land use activities have contributed to the downstream waters having increased levels of nutrients (nitrogen and phosphates) and high sediment loads (refer Photo 7.5).

Photo 7.5 Elizabeth Creek

Willy Creek

Willy Creek is also part of the Rocky Dam Creek catchment. As with Elizabeth Creek, little water quality monitoring has been conducted along the creek and the potential impacts of runoff from the surrounding land activities on the receiving creek waters has not been quantified. However, runoff associated with the surrounding land use would be expected to contain elevated nutrients and increased sediments loads (refer Photo 7.6). This would impact on the water quality of the receiving and downstream waters of Willy Creek, including Llewellyn Bay.

Photo 7.6 Willy Creek

The creek is adjacent to cane fields, in some areas. The channel of the creek, within the project area, was realigned approximately 15 years ago to accommodate an expansion of the cane fields and vegetation was also introduced along the bank to provide a riparian buffer. Agricultural activities utilise water from the creek to irrigate crops and runoff from the adjacent cane fields may enter the aquatic environment. A narrow riparian strip of vegetation is present providing filtration of runoff to the creek, although the width of this buffering habitat varies along the length of the creek.

Freddy Creek

Freddy Creek is also part of the Rocky Dam Creek catchment. Freddy Creek lies at the southern end of the project area. Surrounding land includes grazing and the CSR Ethanol Distillery, Oonooie Facility. The main drainage for this creek is through a cement culvert which lies under the rail lines (refer Photo 7.7). Invasive grasses are dominant along the creek line with minimal riparian vegetation (refer Chapter 6). The creek line has been modified to accommodate the land uses.

Photo 7.7 Freddy Creek Culvert

7.6.2 Wetlands

Wetlands are extremely valuable resources providing a variety of important ecosystem functions, including nutrient removal and transformation, groundwater recharge and discharge, alteration of flood flow and providing habitat and resources for a variety of flora and fauna (including migratory birds).

Under the VMC a wetland is defined as:

> *"the area of land that supports plants that are adapted to and dependent on living in wet conditions for at least part of their life cycle, and is one or more of the following:*
>
> - *A regional ecosystem listed Table 13; or*
> - *The area on the ground represented as a swamp, lake, marsh, waterhole, wetland, billabong, pool, spring or like, on the most recent version of 1:100,000 Geoscience Australia topographic map showing watercourses; or where there is no1:100,000 Geoscience Australia topographic map of the area showing watercourses, on a 1:250,000 Geoscience Australia topographic map of the area showing watercourses;" or*
> - *Listed as an 'active' spring in the Queensland Spring Database, accessible at http://www.epa.qld.gov.au/nature_conservation/habitats/wetlands/springs"*

Intertidal wetlands

A nationally important wetland in the area is the Sarina Inlet-Ince Bay aggregation which is listed in the directory of important wetlands in Australia (ANCA 1996). There are no Wetlands of International Significance (Ramsar) in the area. The nearest Ramsar site is the Shoalwater and Corio Bay Area, which is located approximately 150 km to the southeast of the project area.

Sarina Inlet Wetland

This wetland area includes bays, intertidal areas and channels, which are generally flooded by marine and estuarine waters and receive drainage water from Plane, Rocky Dam, Cape and other watercourses in the area. During wet season events, freshwater flooding and stream flow from the catchment results in some of these areas being diluted to brackish levels. Freshwater habitats in the area are shallow and receive water from stream flow and flood events (DOE 2007). Land use activities have altered the watercourses and creek systems which are now irrigation drainage lines.

Llewellyn Bay

Llewellyn Bay is located approximately 40 km south of the city of Mackay and forms part of the Great Barrier Reef Marine Park coastal area. The Llewellyn Bay catchment includes a number of creeks, including Elizabeth and Freddy Creeks, which originate in the Connors Ranges and drain into Llewellyn Bay (Roder and Roelofs 1999).

Sugar cane cultivation and dryland grazing are the main land uses of Llewellyn Bay catchment, with sugar cane cultivation predominating in the lower catchment area. Runoff from surrounding land uses results in the release of high sediment loads, nutrients and pesticides being discharged to the bay area (Roder and Roelofs 1999).

Freshwater wetlands

During the Connell Hatch June 2007 survey a lacustrine wetland was identified within the project area (refer Photo 7.8). This wetland is located on a tributary of Willy Creek and is situated west of the existing rail and south of the proposed turning angle for Jilalan and is identified in the QLD EPA Wetland Mapping for the Mackay region. This wetland is predominately a Melaleuca wetland, with native aquatic plants and some invasive weed species (refer Chapter 6) and is of local significance supporting local, regional and migratory species. No water quality data is currently available for this wetland. The ecological value of the wetland has been described in detail in Chapter 6. The surrounding influences on water quality may include erosion and sedimentation either side of the wetland area, dust deposition from the transport of coal and nutrients and pesticides from the surrounding cane fields.

Photo 7.8 Wetland on Willy Creek

An assessment of this wetland to provide further water quality information on its current status and condition will be undertaken prior to construction works commencing.

Additional, lacustrine wetland systems are also present to the south west of the project area which link into the estuarine system of Llewellyn Bay. A palustrine wetland system exists downstream of Willy Creek and also links in the estuarine system of Llewellyn Bay.

7.7 Water quality analysis

7.7.1 Existing water quality information

A review of the background information of the existing environment in the project area has identified that there is little available water quality data of the creeks that traverse the project area. Some historic water quality data is available from the Queensland EPA. Sampling within Plane Creek was conducted between 1995 - 1998 and sampling within Elizabeth Creek occurred between 1987 -1988. This data is considered dated and does not accurately reflect the current condition of the existing creeks.

Some relevant water quality information on the creek systems, which has been included in this EIS assessment, was supplied by CSR and QR from water quality monitoring sites located upstream, within and downstream of the project area. The information provided by CSR and QR provides additional information on the water quality of some of the creeks during the wet season and also provides some water quality data for Freddy Creek (which was inaccessible during the Connell Hatch June 2007 monitoring period). However, the CSR and QR data does not provide extensive water quality information on all of the creeks traversed by the project area and therefore, further water quality monitoring was conducted by Connell Hatch in June 2007.

The Healthy Waterways Ambient Monitoring Programme includes waterways in the Plane Creek Basin, including Plane Creek since 2005 (Healthy Waterways 2007). The Healthy Waterways monitoring programme indicated that one of the main water quality issues for Plane Creek was related to high levels of Filterable Reactive Phosphorus (FRP), which can result in increases in the nuisance plant populations. Detectable levels of FRP in the waterways were found to be associated with high rainfall events. The clarity of the waterways was usually found to be high, however during periods of high rainfall the turbidity of the water increased with higher sediment loads transported downstream. Increased dissolved oxygen (DO) levels for Plane Creek were found to be relatively stable with a slight decrease in the DO levels in the lower catchment while pH levels were found to be constant at most sites within Plane Creek (Healthy Waterways 2007).

7.7.2 Results of water quality sampling

This section outlines the results obtained from the water quality monitoring undertaken by Connell Hatch during sampling period in June 2007 and incorporated existing data from relevant CSR and QR monitoring sites. Water quality data for each watercourse is presented in Tables 7.4 to 7.6.

It is important to note that approximately 200 mm of rainfall had been recorded for the Mackay region in the three weeks leading up to the June 2007 sampling. This is over three times the monthly average for the month of June. This can skew the results typically expected of a dry season.

Plane Creek

A summary of the median value for each of the physical water quality parameters in Plane Creek monitoring locations is presented in Table 7.4.

Table 7.4 Water quality results for Plane Creek

Parameter	Plane Creek upstream dry season	Plane Creek downstream dry season	Water Quality Objective
Turbidity (NTU)	6	22	25
Chlorophyll-*a* (µg/L)	**21**	5	10
pH	7.1	7.7	7.0-8.4
Conductivity (µS/cm)	400	12,670	N/A
Suspended Solids (mg/L)	11	**34**	25
Dissolved Oxygen (% sat)	86	85	70-100
Total Nitrogen (µg/L)	**900**	**600**	450
Ammonia (µg/L)	21	**185**	30
Oxides of Nitrogen (µg/L)	10	**228**	15
Total Phosphorous (µg/L)	**50**	**140**	40
Filterable Reactive Phosphorous (µg/L)	10	**93**	10

Table Note:
Bold indicates exceedance of water quality objective

Most notable of results in Table 7.4 is the highly elevated levels of nitrogen and phosphorous. In particular, the downstream site of Plane Creek. These levels, especially the ammonia readings, would most likely be attributable to the wastewater treatment plant that was situated upstream from this monitoring location (refer Figure 7.1). However, even upstream from this point source the total nitrogen and total phosphorous levels were above the QWQG, particularly total nitrogen. This could be considered attributable to a build up of organic leaf matter upstream elevating the organic nitrogen and thereby elevating the total nitrogen result. Combined with a low oxides of nitrogen reading, it is most likely organic nitrogen and not considered to breach the QWQG.

Sediment may enter the aquatic environment as overland flow, watercourse or piped discharges from the surrounding land resulting in increased levels of suspended sediment and increased turbidity in the receiving and downstream environment. The levels of sediment entering the aquatic environment will depend on a variety of factors including the use of the surrounding land, the buffering capacity of the riparian habitat (eg width and composition) and will also be influenced seasonally during periods of high rainfall or flood events.

The results of the monitoring indicated that the DO and pH levels of the estuarine and freshwater waterways upstream and downstream of the project area were relatively uniform and fell within the required WQO. The suspended solids present at Plane Creek (downstream) are elevated above the required WQO for suspended solids and may be attributed to the increase in the rainfall prior to the sampling event.

Chlorophyll-*a* is an indicator of algal mass and excessive high levels of algae blooms can adversely affect water quality. The chlorophyll-*a* level of Plane Creek, upstream of the project area, was found to be higher than the WQO for upper estuarine waters. The increase in chlorophyll-*a* levels in this area may have been the result of increased nutrients being washed down from higher up the catchment area, as a result of high rainfall and increased flow. The release of nutrients from suspended solids during high rainfall events will stimulate the growth of phytoplankton (GBRMPA 2001). The chlorophyll-*a* levels at for the Plane Creek downstream area although elevated are not high enough to contribute to a significant impact on water quality or aquatic ecology.

Overall, the physical parameters measured at the majority of the monitoring locations were within the WQO. The high rainfall prior to the sampling period may explain the high turbidity and suspended solid levels at some of the monitoring locations.

Sugar cane cultivation is the dominant land use in the Plane Creek catchment requiring use of fertilisers containing nitrogen, phosphorous and potassium for growth. Fertiliser application rates on cane lands can result in elevated levels of nutrients entering the surrounding waterways, however additional factors such as flow rate and the health of the riparian vegetation can also influence the actual nutrient loading entering the waterways. The elevated levels of nutrients recorded during the June 2007 sampling period may be a result of the increased rainfall leading up to and during the sampling period, which would increase runoff from the surrounding land. High levels of nutrients can have significant impacts on the receiving and downstream aquatic environments, sometimes resulting in eutrophication with the proliferation of algal blooms or nuisance macrophyte species. DO is essential for the survival of aquatic species and extreme or prolonged eutrophication events may result in a reduction of DO levels and injury or death of aquatic species (eg fish kills).

Elizabeth Creek

A summary of the median value for each of the physical water quality parameters in Elizabeth Creek monitoring locations is presented in Table 7.5.

Table 7.5 Water quality results for Elizabeth Creek

Parameter	Elizabeth Creek upstream dry season	Elizabeth Creek downstream dry season	Water Quality Objective
Turbidity (NTU)	42	**53**	50
Chlorophyll-*a* (µg/L)	5	5	5
pH	7.1	7.2	6.5-8.0
Conductivity (µS/cm)	**550**	**380**	375
Suspended Solids (mg/L)	3	**18**	10
Dissolved Oxygen (% sat)	95	75	85-110
Total Nitrogen (µg/L)	**1,350**	**3,850**	500
Ammonia (µg/L)	17	**41**	20
Oxides of Nitrogen (µg/L)	**118**	**346**	60
Total Phosphorous (µg/L)	**130**	**2,680**	50
Filterable Reactive Phosphorous (µg/L)	10	**1,210**	20

Table Note:
Bold indicates exceedance of water quality objective

The most notable of results in Table 7.5 is the nutrient results, nitrogen and phosphorous. The upstream values show a highly elevated total nitrogen. This could be considered attributable to a build up of organic leaf matter upstream elevating the organic nitrogen and thereby elevating the total nitrogen result. Combined with a low ammonia reading, it is most likely organic nitrogen and not considered to exceed the QWQG. This may also explain the elevated total phosphorous reading as the FRP result is low. Another contributing factor to these elevated nutrient results at the upstream site may be runoff from surrounding cane farms from fertiliser use and high rainfall preceding the sampling. This is demonstrated by elevated inorganic nitrogen (oxides of nitrogen plus ammonia).

Nutrient readings at the downstream site are highly elevated for all species of nitrogen and phosphorous. This site is downstream from the Jilalan Rail Yard and all water from the site is discharged into Elizabeth Creek upsite from this monitoring location (refer Figure 7.1). Water from the site's pollution control system discharges to a service drain west of the Jilalan Rail Yard. The onsite sewage treatment plant also discharges to this point. Water from this service drain then flows into Elizabeth Creek. Water from this service drain is the single point source of receiving water between the upstream site and the downstream site. High levels of nutrients can lead to algal blooms and ultimately eutriphication in severe cases. Algal growth was observed at the Elizabeth Creek downstream monitoring site in June 2007 (refer Photo 7.9).

Photo 7.9 Algal growth at the downstream monitoring site of Elizabeth Creek

Table 7.5 indicates that conductivity levels in Elizabeth Creek exceed the QWQG. While this is strictly true, the guideline has recommended the use of the 75th percentile value. The 90th percentile value however is 560 µS/cm which would allow the results to be within the guidelines. Additionally these guidelines are trigger values only, and further investigations will occur to ensure a more robust data set. The salinity may be attributable to the discharged waters of the Jilalan Rail Yard and other catchment land uses, however, it is not considered to be high enough to have any significant impact on the natural water quality of the creek.

The turbidity and suspended solids of Elizabeth Creek (downstream) slightly exceed that of the freshwater QWQG and may have been a result of the high rainfall prior to the sampling period.

Willy Creek

A summary of the median value for each of the physical water quality parameters in Willy Creek monitoring locations is presented in Table 7.6.

Table 7.6 Water quality results for Willy Creek

Parameter	Willy Creek upstream dry season	Willy Creek downstream dry season	Water Quality Objective
Turbidity (NTU)	5	10	50
Chlorophyll-*a* (µg/L)	5	5	5
pH	7.5	7.1	6.5-8.0
Conductivity (µS/cm)	230	310	375
Suspended Solids (mg/L)	**18**	4	10
Dissolved Oxygen (% sat)	91	90	85-110
Total Nitrogen (µg/L)	**600**	**900**	500
Ammonia (µg/L)	**31**	**84**	20
Oxides of Nitrogen (µg/L)	**62**	**336**	60
Total Phosphorous (µg/L)	30	**210**	50
Filterable Reactive Phosphorous (µg/L)	12	**152**	20

Table Note:
Bold indicates exceedance of water quality objective

These results show the same pattern as the results for Plane and Elizabeth Creeks with elevated nutrient levels in Willy Creek, especially at the downstream monitoring site. With no point source of discharge from specific industry, these results are most likely attributable to fertiliser runoff from surrounding cane fields, a build up of organic matter and high rainfall preceding sampling.

The suspended solids present at Willy Creek (upstream) are elevated above the required WQO for suspended solids and may be attributed to the increase in the rainfall prior to the sampling event.

Freddy Creek

Some limited data supplied by the CSR Ethanol Distillery, Oonooie Facility (refer Appendix I1), indicates that downstream of the Project is freshwater with EC readings of under 300 µS/cm. pH data shows a median value of 7.2 for the dry season.

Heavy metals and other toxicants

The results of the heavy metal, pesticides and hydrocarbon analyses are contained in Appendix I1.

Heavy metals were analysed as part of the Connell Hatch monitoring in June 2007 and were generally within the WQO in the waterways both upstream and downstream of the Project. Variations to note include total aluminium, which was significantly higher than the WQO for all waterways upstream, with values for the same waterways increasing in the downstream sites.

Copper is slightly elevated in Plane Creek (downstream), Elizabeth Creek (upstream and downstream) and Willy Creek (downstream). Particularly in the downstream site of Elizabeth Creek during the dry season. It has been noted that the pollution control system at the Jilalan Rail Yard frequently discharges treated water with high levels of copper. A management plan is in place to manage the levels of copper.

Iron levels, although without any specific guidelines can be seen to increase by nearly four times in the corresponding downstream sites to those upstream. Most of this is present in an undissolved form.

Heavy metals are found naturally in rocks and soils but other introduced sources of heavy metals are present in fertilisers applied to crops, either as essential micronutrients (such as copper, zinc and iron) or contaminants (including cadmium, lead and mercury). Levels of heavy metals had been found to be higher in soils used for sugar cane cropping (GBRMPA 2001). Most heavy metals are bound to soil particles and may enter the aquatic environment through soil erosion or sediment mobilisation. Heavy metals may also be leached from oxidised acid sulfate soils (ASS) in estuarine or marine areas. Once heavy metals are released into the water column they may be taken up and bioaccumulated by aquatic organisms (GBRMPA 2001).

The total petroleum hydrocarbons were below the Limit of Reporting (LOR) for all sites.

The water quality analysis of the waterways in the area also included an assessment for the presence of pesticides and herbicides. Many of the pesticides/herbicides analysed for were below the LOR for each site. Pesticides and herbicides such as lindane, DDT, diuron and 2,4-D and polychlorinated biphenyls are widely used in the production of sugar cane and the Plane Creek catchment has been identified as having the third highest rate of fertiliser application of all the Great Barrier Reef catchments (GBRMPA 2001). Pesticides and herbicides may enter the aquatic environment through terrestrial runoff from surrounding canelands and may become adsorbed onto fine particulates and carried downstream, or may be bioaccumulated by aquatic organisms. Herbicides, such as atrazine and diuron are used extensively by the sugar industry in Queensland and exposure of aquatic plants to high levels may result in reduced rates of photosynthesis and loss of leaves (GBRMPA 2001).

7.8 Potential impacts

The construction and operational phases of the Project have the potential to impact the existing water quality of Plane, Elizabeth, Willy, and Freddy Creeks, the receiving waterways and locally significant wetlands within or adjacent to the project area. These waterways drain directly and/or indirectly into the downstream receiving waters of Llewellyn Bay and Sarina Inlet which form part of the GBRWHA.

During the construction and operational phases of the Project direct and indirect impacts may occur in waterways within and downstream of the project area, which may threaten the Environmental Values identified by the EPP (Water) and outlined in Table 7.1. These include:

- Changes or alterations to environmental flows and overland runoff.
- Impacts to the water quality of the overland runoff or riverine waters.
- Loss or disturbance of threatened and migratory aquatic species.
- Loss of habitat and biodiversity.

The potential impacts will vary for the construction and operational phases of the Project and sources of surface water contamination may include:

- Disturbance of ASS.
- Increased sediment loads as a result of erosion and runoff from disturbed areas, including instream sediments.
- Mobilisation of pesticides from adjoining lands during clearing and earthworks.
- Hazardous and chemical substances (such as hydrocarbons from oil spills, chemical leaks and small scale spills from vehicles and storage areas, solvents, cement slurry, wash waters and sludge) and litter.
- Discharge from retention/sedimentation ponds.
- Discharges from sewerage and site facilities.
- Discharge from the pollution control system at the Jilalan Rail Yard.
- Storage and disposal of waste material.
- Coal dust generated from coal wagons.
- Use of herbicides to control weeds along railway lines.

7.8.1 Construction

The potential impacts of the Project on water quality and the Environmental Values of the region during the construction phase are discussed in this section.

A high risk activity during the construction phase involves works within the waterways. Works in these areas will ultimately impact to the downstream environs of the WHA.

During construction works, potential sources of surface water contamination include:

- Disturbance of ASS.
- Sediment from disturbed and exposed areas.
- Disturbance of instream sediments.
- Hydrocarbon or chemical leaks and small scale spills from vehicles.
- Hydrocarbon or chemical spills from storage areas.
- Discharges from temporary sewerage and site facilities and reused where possible.
- Use of improperly treated recycled water.
- Storage and disposal of waste material including spoil placement.
- Degradation of Environmental Values associated with loss of riparian vegetation along Elizabeth and Willy Creeks.
- The construction activities associated with the rail infrastructure may impact upon wetland vegetation at Site K (refer Chapter 6) either directly by clearing (0.2 ha) or indirectly by sediment runoff.

The following potential impacts are discussed in other chapters of the EIS:

- ASS and contaminated soils (refer Chapter 5)
- Groundwater quality (refer Chapter 8)
- Downstream aquatic values (refer Section 6.5)

Sedimentation and runoff

High risk construction activities for water quality issues relate to sedimentation and runoff. This will occur after removal of vegetation and/or excavation and earthworks. Sediment is transported offsite by runoff into the drainage network, into the receiving waters and onto adjacent properties. Rail infrastructure construction requires tracks of land to be filled, which may impact on water quality through sediment or other contaminants (depending on the content and quality of the fill) in runoff and by altering the flow path. Construction activities taking place in the vicinity of a watercourse also have the potential to impact on the quality of the immediate and downstream waters.

Trapping and redirection of overland runoff may impact on the freshwater and tidal ecosystems. Overland flow may also transport nutrients and other contaminants into the downstream environments. An increase in nutrients can impact on the health of the system through growth of nuisance plants especially blue-green algae (eg Lyngbya). This can have an impact on the environmental value of GBR WHA, including environmental, recreational and aesthetic values. Stormwater management measures should be designed to capture and filter runoff without significantly compromising overland flows.

Clearing activities and excavation activities within marine and/or estuarine environs and other environs of the project area may disturb ASS. Impacts on downstream environs include the change of water pH, the increase in sulfate and will ultimately impact the flora and fauna of the waterway (refer Chapters 5 and 6). Prior to construction, an investigation will be undertaken to determine the presence of ASS within the site, particularly in areas adjacent to watercourses.

Stormwater discharge and flow redirection

Changes to the hydrology of the area, including temporary and permanent alterations to the existing waterways, may impact on the quantity and quality of freshwater influx and hence the health of the wetlands (intertidal and palustrine) and riparian zones within and downstream of the project area. Freshwater and tidal influx and exchange are important to the health of wetland ecosystems, including the vegetation communities and fauna assemblages inhabiting these areas. Changes to drainage channels may also impact on fauna assemblages, fauna movement, dispersal and recruitment.

Alteration or impediment to flow through the construction of an impoundment during the construction phase of the Project will alter the physical dynamics of an aquatic system, which in turn will have implications for its ecology. In some cases the impacts may only be short-term, for example the creation of temporary impoundments during bridging works where impacts associated with this activity are likely to be short-term, especially as the majority of the systems are ephemeral. The development of infrastructure may also impede water movement during baseline flows and/or flooding events. This includes the pooling within waterways, diversion of overland flow, and changes to frequency and quantity and quality of environmental flows. Other temporary impediments include stockpiling of soil and materials, equipment and machinery.

Construction activities, including bridge or culvert construction, may result in alteration to or removal of instream habitats, riparian vegetation and/or intertidal wetlands which will affect the stability of the waterway banks. This increases the risk of sedimentation and erosion and may result in the resuspension of toxicants. It also reduces the buffering capacity of the area to environmental flows and overland runoff (ie flow velocity and water quality).

Hydrocarbon and chemical spills

Other potential pollutants can include hazardous and chemical substances (such as hydrocarbons from oil spills, asphalt plumes, solvents, cement slurry and wash waters) and litter if not properly managed through appropriate storage and bunding. Stockpiling of materials and soils during construction activities, disturbance of soils and substrates during excavation activities and accidental chemical spills or leakages if not prevented can result in the release of potential sources of contaminants to the aquatic environment. The influx of contaminants such as hydrocarbons and heavy metals can impact on the aquatic biota through acute and chronic toxicity and bioaccumulating through the food web. This can impact on the environmental, commercial and recreational value of the area.

Construction water supply

Water will be required for the following onsite construction activities:

- Dust suppression
- Earth compaction
- Vehicle washdown

Approximately 2 ML/day (peak demand) will be required and it is proposed to source water from one or more of the following locations:

- Existing Jilalan Rail Yard supply
- Local farm dams
- Council effluent dam located west of the existing Jilalan Rail Yard
- Plane Creek
- Groundwater from new or existing bores
- Treated effluent from STPs associated with the Project

Reuse of water from various locations can benefit the surrounding environment by reducing the demand on potable water supply. Additionally, by implementing appropriate treatment before use, water reuse can reduce the levels of contaminants in the otherwise untreated discharge. It is favoured to use treated water from the Council effluent dam as priority subject to supply.

However, the use of saline water (from any of the above listed sources) has the potential to impact adversely upon the receiving environment. High sodium levels in the soil can cause serious soil problems, including erosion, dispersion and plants can have difficulty absorbing water. The Plane Creek downstream monitoring site has an EC reading of 12,670 µS/cm. The upstream site reading was 395 µS/cm. Groundwater bore site 81402 has an EC reading of 3,050 µS/cm (refer Chapter 8). The Queensland Water Recycling Guidelines (EPA 2006) recommend an EC reading of 1,000 µS/cm for all applications, including dust suppression, earth compaction and truck wash. Should the use of saline water be adopted, an evaluation into the propensity of the soils to be impacted by saline water, taking into account such factors as the sodium absorption ration (SAR) and a proposed maximum allowable salinity and sodium content for water to be applied to land will be conducted. Soil physical and chemical testing will occur during the geotechnical investigations (refer Chapter 5).

7.8.2 Potential operation impacts

The key locations where potential impacts may occur from operation are areas where runoff and/or discharge waters from the Project can enter waterways and drainage lines. The potential impacts of the Project on water quality during the operation of the facility are discussed below.

Sewage treatment plant

Treatment of sewage onsite is proposed via one of the following three options:

- Continued use of the existing sewage treatment plant and a connecting pipe to take the untreated water from the proposed expansion site to the existing facility.
- A new sewage treatment plant to be constructed on the proposed upgrade site with consideration of water reuse options.
- The construction of a sump for storage of sewage from the proposed expansion to be tankered offsite.

Impacts to water quality may occur from discharged water that has been insufficiently treated. Untreated sewage contains high levels of nutrients. The receiving creek (Elizabeth Creek) currently has highly elevated levels of nutrients which can be attributed to water discharged from catchment land uses. Should these conditions become extreme it is likely that an algal bloom could be generated. This in turn can cause a reduction in DO and can ultimately lead to fish kills. This process is called eutrophication. Another risk from untreated sewage is from high levels of faecal coliforms. This poses a significant human health risk.

Pollution control system

Treatment of process water onsite is proposed via the construction of an additional pollution control system. The pollution control system will collect and treat water from:

- Wagon maintenance shed
- Wagon wash bays
- Provisioning shed
- Locomotive maintenance

Impacts to water quality may occur from discharged water that has been insufficiently treated. Untreated process water contains high levels of sediment, oils and the site has a history of high levels of copper which are likely the result from washdown of the locomotives. Should these enter the receiving waters, it is likely that the water will become turbid. This can interfere with normal ecological process by forming a layer of silt or oil over aquatic organisms. Oils can also reduce the potential for water oxygenation.

Sedimentation and runoff

The impacts on water quality during operation will include runoff from the supporting infrastructure. Runoff may contain elevated levels of various contaminants from different areas potentially including heavy metals and petroleum hydrocarbons.

Runoff from the roads, rail lines and maintenance areas may contain elevated levels of sediment and coal, heavy metals, petroleum hydrocarbons, polynuclear aromatic hydrocarbons (PAHs) and herbicides. These potential contaminants may result from a combination of the breakdown, spillage and normal operational emission of automotive components. These include tyres, clutch and brake linings, hydraulic fluids, automotive fuels or lubricants, particulates from exhaust emissions and materials from the vehicles themselves.

A chemical/fuel spill has the potential to cause significant damage to the terrestrial and downstream waterways and to public health. The potential environmental damage from a spill may be long term and, in the case of groundwater, the effects may persist for many years.

Stormwater discharge and flow redirection

Drainage impacts have the potential to affect the quantity and the quality of the water. Larger volumes of water will increase flow velocity and, if the drainage channel is not clearly defined, the potential for erosion (particularly during peak flows after storm events) will increase.

Additionally, the release of stormwater from settlement ponds in times of high rainfall and overland runoff from unconfined areas will impact on water quality. The following contaminants are considered the highest risk of stormwater contamination due to the nature of the development:

- Elevated levels of suspended solids (including coal) and turbidity in stormwater runoff.
- Generation of toxic materials, including waste/runoff, adhesives and paints.
- Generation of construction and general wastes.
- Oils, grease and hydrocarbons from vehicle movement, storage and maintenance onsite.

7.9 Mitigation measures

7.9.1 Design phase

The design phase of the Project is the most important phase for integrating water quality mitigation measures to ensure cost effectiveness and functionality. The mitigation measures below will be further refined during the detailed design phase of the Project.

Stormwater

The project design will include various stormwater drainage systems to convey stormwater over the site (refer Section 2.10). Drainage systems will be required for:

- Road and rail cross drainage
- Maintenance facilities

Road and rail drainage

The design of the bridges or culverts should, where possible, endeavour to retain the natural morphology of the waterway to maintain the natural flow and water quality of the waterway. A culvert which is too small, or becomes clogged with debris, will constrict water flow, increasing water velocity, which during periods of peak flow may increase the risk of erosion of adjacent stream banks and increased suspended solids entering the waterway (Cotterell 1998).

The project design includes alterations to the waterways and mitigation measures should be considered to minimise the potential impacts to these aquatic systems and ensure that their integrity and value is maintained. Where rail lines cross Elizabeth and Willy Creeks, bridges should be used where possible, rather than culverts to minimise the clearing of riparian vegetation and minimise disruption to the creek channel. Where this is not possible, it is recommended that the potential Elizabeth Creek diversion should allow for the passage of a base flow. This will ensure that downstream habitats will continue to receive flow and that the impact is localised and constrained to the direct impacts of the bridge structures. Additionally it is recommended that a high flow bypass channel across previously cleared land is used rather than straightening Elizabeth Creek.

During the design phase, issues relating to transport of sediment from exposed and disturbed land entering into runoff and drainage lines will be considered. These will include the preparation of a number of management plans and mitigation measures, including:

- ASS mitigation measures
- Erosion and Sediment Control Plan
- Waste Management Sub Plan

Maintenance facilities

Stormwater that is generated in areas with a higher risk of contamination should be isolated from the general overland flow and directed to additional pollution control systems. Other areas should be treated for the specific contaminants that are generated in that area. As sedimentation is high risk due to the nature of the facility, it is recommended that stormwater be allowed to pass through sedimentation devices before secondary treatment (eg areas with hydrocarbon generation should incorporate oil/water separators).

The existing wagon maintenance facility will be converted into a locomotive maintenance facility. The estimated pollutant loads from this facility (particularly copper and hydrocarbons) will need to be quantified and the existing pollution plant assessed for suitability and upgraded if required.

During the design phase, issues relating to the management of stormwater quality for both construction and operation of the Project will be considered. These will be addressed via an Erosion and Sediment Control Plan.

Pollution control system

During operation, the additional pollution control system will receive water from:

- Wagon maintenance facility
- Wagon wash bays
- Provisioning shed

It will also received water from the existing plant if the existing plant is out of service. The new pollution plant should therefore also have the capability to treat expected pollutants from the locomotive maintenance facility.

The system should be designed to treat water to the standard as outlined in the existing and upgraded Development Application Licence Conditions (refer Table 7.7).

Table 7.7 Release quality characteristic limits

Quality characteristics	Release point number	Release limit
BOD_5	C1, C2	20 mg/L
Suspended Solids	C1, C2	30 mg/L
pH	C1, C2	6.5 - 8.5
Dissolved Oxygen	C1, C2	> 2 mg/L
Anionic Surfactants	C1	1.0 mg/L
Oil and Grease	C1	10 mg/L
Total Copper	C1	0.1 mg/L
Free Residual Chlorine	C2	0.3 - 0.7 mg/L

Source: EPA Licence No. NM0029, Queensland Rail

Sewage treatment plant

It is proposed that treated water from the new sewage treatment plant will be treated to at least the same standard that is consistent with the existing licence conditions (refer Table 7.7). Alternatively the treated water may be reused elsewhere on the site (eg wagon wash bay area).

7.9.2 Construction phase

Potential impacts to water quality during the construction phase will be managed through the Erosion and Sediment Control Plan and the implementation of appropriate mitigation measures such as:

- Sediment and erosion control and drainage control
- Sediment basins before discharge
- Gross pollutant traps to remove litter before secondary treatment
- Oil/grit separator for areas of vehicle maintenance or fuel/oil storage
- Separation of clean/dirty water

Sedimentation and runoff

To reduce the amounts of sediment carried in stormwater runoff during construction, the following measures will be implemented:

- Maximise the areas of vegetation within the project area. Wetland communities and riparian zones are natural buffer zones removing sediment and other pollutants.
- Stockpile materials and soils away from natural drainage areas.
- Implement mechanisms to slow and/or prevent overland runoff. Such mechanisms include the planting of vegetation and/or the installation of artificial structures (ie geofabric and bunds).
- Areas of erosion and/or dispersive soils to be isolated and remediated to prevent further degradation.
- Where possible undertake significant earthworks during the dry season and install temporary bunding or sediment traps.
- Where practical, monitor discharges on an event basis from all discharge points.
- Minimise works within watercourses and riparian zones.
- No filling, draining or alteration of any waterway, excluding that necessary for the development.
- To minimise sedimentation and scouring of the watercourse, design culverts and bridge abutments to conform to the watercourse morphology where possible.

- Minimise the removal of riparian vegetation and minimise disturbance to the natural beds and banks of the waterways.
- The outer banks of stream bends are often particularly unstable and prone to erosion, therefore access or disturbance to these areas should be minimised during construction works.
- Minimise heavy machinery within fragile or erosion-prone areas.
- Due to the ephemeral nature of many of the creeks, stream construction works should, where possible take place during the dry season when the risks of sedimentation and downstream impacts will be minimised.
- Effective erosion and sediment control measures should be installed prior to construction works commencing (eg such as the use of appropriately designed sediment containment screens).
- Where a waterway has a continuous flow throughout the year, other control measures may be implemented to reduce impacts to water quality downstream of the site (eg the use of floatation sediment curtains).
- The effectiveness of all sediment and erosion control devices should be regularly monitored and maintained to ensure their effectiveness.
- Design and implement a Erosion and Sediment Control Plan to minimise the sedimentation from the project area to downstream of waterways.
- Stabilise disturbed areas of soil (where possible) as soon as practical, to minimise soil erosion and downstream sedimentation.
- Ensure dust suppression measures are implemented throughout the construction process to minimise damage to prevent dust deposition on waterways and wetland habitats within the project area.
- Ensure a competent person with experience in environmental management is present on the project area during construction to address any environmental issues in a timely manner.
- Establish a water quality monitoring programme within the vicinity of the affected creeks and their downstream environs.

Hydrocarbon and chemical management

To minimise the impact of a hydrocarbon or chemical spill, the following measures will be implemented:

- As part of the Standard Operating Procedure all employees will be educated in the response to a spill or leak.
- Chemical spill kits will be located within vehicles carrying chemicals and near chemical storage areas.
- Chemical storage areas and wash down facilities are to be located away from existing drainage lines and have appropriate bunding and waste water collection mechanisms.
- Chemical and hydrocarbon wastewater must be disposed to a liquid waste disposal facility or company, or treated to an acceptable level for discharge with the permission of the responsible authority.
- Waste storage facilities and spoil placement areas are to be located away from existing drainage lines and have appropriate bunding and drainage mechanisms.

Water supply

Water supply for construction activities will be required to be treated to minimum quality standards outlined in the Queensland Water Recycling Guidelines (EPA 2005) to avoid any adverse impacts from salinity, nutrients, sediment and faecal coliforms (refer Table 7.8). Should saline water (from Plane Creek, groundwater bores, farm dams or the Council effluent dam) be used for construction activities, maximum levels of sodium should be adopted from the soil physical and chemical properties testing during the geotechnical investigations (refer Chapter 5).

Table 7.8 Water quality guidelines for recycled water uses

Activity	Class	*E. coli* (median) cfu/100mL	BOD_5 mg/L (median)	Turbidity NTU 95th%ile (max)	SS mg/L (median)	TDS, mg/L or EC, µS/cm (median) TDS/EC	pH
Open system where aerosol generation is constant eg truck wash, dust suppression with aerosol	A+ [1]	<1	20	2	5	1000/1600	6.0 – 8.5
Above ground open space irrigation, uncontrolled access eg, earth compaction	A	<10	20	2	5	1000/1600	6.0 - 8.5
Open system (potential for human contact but with safeguards in place) eg non aerosol dust suppression, non aerosol truck wash	A	<10	20	2	5	1000/1600	6.0 - 8.5
Closed system, low human contact, irrigation of "no public access" areas	C	<10,000	-	-	-	1000/1600	6.0 – 8.5

Source: Queensland Water Recycling Guidelines, EPA 2005
Table Note:
1 For additional information regarding Class A+ recycled water refer to the Queensland Water Recycling Guidelines, EPA, 2005.

Disinfection to treat *E. coli* is proposed either by chlorine or ultra violet radiation (UV).

7.9.3 Operational phase

The implementation of an Operational Environmental Management Plan for the Jilalan Rail Yard will reduce potential operational water quality impacts. Potential mitigation measures will include:

Stormwater discharge and flow redirection

- Wagon Maintenance Shed, Wagon Wash Bays and Provisioning Shed will all be covered and clean water will be directed away from the new pollution control system. This will prevent contaminating stormwater with untreated water from these areas.
- Stormwater generated from the carpark will be directed to a grass swale to remove sediment and filter out any hydrocarbons generated in this area. This water will then be directed to the area north of the car park. This approach should be applied to any other area of the site that is not directed through the pollution control system.
- Stormwater generated on rail and road will drain away from these structures.

Hydrocarbon and chemical management

- Herbicides should be applied carefully to ensure that there is no potential for excess herbicides entering the aquatic environment (refer Chapter 6).
- Minimise the amount of coal dust emanating from coal wagons passing through the project area to reduce the potential risk of dust being deposited on the water ways and wetland habitats in the surrounding area.
- Ensure all chemicals used on the project area are properly contained and disposed of to prevent soil contamination and subsequent leaching and damage to waterways.
- Bunding of all chemical storage areas to reduce the potential risk of a chemical/fuel spill impacting on the surrounding waterways and groundwater.

Pollution control system

The existing environmental licence conditions will be amended and consolidated to accommodate additional pollution control systems. The water quality monitoring locations will remain as existing with the addition of a new site as required under the new licence conditions.

It is recommended that the Jilalan Rail Yard management plan adopted for the management of copper levels in the discharge water be monitored and review if needed as per the EPA licence conditions.

Sewage treatment plant

The new sewage treatment plant will be designed to treat water in accordance with the discharge limits outlined in the environmental licence. Consultation with the EPA will be undertaken during the detailed design phase to confirm the discharge limits.

7.10 Monitoring

7.10.1 Construction

During the construction phase of the Project *in-situ* monitoring and analyses of water samples will be conducted and compared with the background water quality analyses collected prior to the commencement of works.

In-situ monitoring

In situ event based monitoring will provide valuable real-time information of the water quality of the waterways potentially influenced by the construction works:

- *In situ* parameters to be measured will include pH, conductivity, DO, turbidity, with a visual assessment of each monitoring site for the presence of oil or grease films on the water surface.
- Water quality monitoring will be event based and conducted at appropriate points of discharge to the waterway and also at points downstream of the discharge point or construction works. This will provide information on the potential sources of contamination and extent of the potential impacts.
- *In-situ* monitoring of water samples and water quality analyses will be conducted at the same time to enable the correlation of related parameters. Monitoring will also be conducted upstream and downstream of the project area, preferably at the sites already established.
- This monitoring programme will be conducted twice prior to construction, to provide information on the water quality of the waterways, within the project area, during the wet and dry season. Note: Dry season water quality data was collected in June 2007.

Water sample analyses

The collection and analysis of water samples will provide additional information on the factors influencing water quality during construction (such as suspended solids and heavy metals), unable to be measured by an *in-situ* water quality meter, and will also enable the correlation of related parameters (such as chlorophyll-*a* and nutrients, pH and heavy metals, suspended solids and metals etc):

- Water samples will be collected and sent for laboratory analysis for nutrients, chlorophyll-*a*, suspended solids and heavy metals (the same spectrum of analyses undertaken during the June 2007 background assessment). Pesticides/herbicides used in the area will also be assessed as these may enter the waterways through runoff from disturbance of soils during construction works.

- *In-situ* monitoring of water samples and water quality analyses will be conducted at the same time to enable the correlation of related parameters. Monitoring will also be conducted upstream and downstream of the project area, preferably at the sites already established.

7.10.2 Operation

During operation waterways within the area will be monitored in accordance with the new ERA licence conditions.

Results gathered through the water quality assessment will be compared with the background values obtained during the pre-construction phase of the Project, as well as the Environmental Values and WQO of QWQG and ANZECC 2000. If levels are encountered which exceed the trigger levels then additional investigation and mitigation measures will be implemented as soon as possible.

7.11 Reporting

The records and results of the monitoring programme should be retained for a period suitable for inspection or reporting on request by government agencies. Non conformances should be reported to the site environmental officer within 24 hours of an incident occurring to ensure corrective action is taken immediately.

7.12 Conclusion

7.12.1 Hydrology and hydraulics

The hydraulic assessment for the catchments within the project area was undertaken using a variety of models and calculations.

Along Elizabeth Creek, analysis showed that the velocity and peak discharge of the flow as it leaves the project area is similar to existing levels, and is not necessary to undertake any further works to lessen the impact of flooding on Gurnetts Road.

Scour protection should be installed at all bridge abutments, culvert inlets and outlets to prevent erosion from high velocities. The base of the Elizabeth Creek channel will also be lined with rock to prevent souring.

7.12.2 Surface water quality

Water quality monitoring of the existing condition of the waterways potentially impacted by the proposed upgrade contain high levels of nitrogen, phosphorous and aluminium. Particularly in Elizabeth and Plane Creeks downstream from the Jilalan Rail Yard and agricultural land uses. Additionally, there are high levels of copper present at the downstream site of Elizabeth Creek.

The proposed rail yard upgrade may impact on the water quality through increased sedimentation during construction works. This will be mitigated through appropriate sediment control such as sediment basins and monitoring.

Water use for construction activities will be tested to ensure no adverse impacts to the surrounding environment, particularly salinity levels.

Proposed diversions of Elizabeth Creek will incorporate measures to ensure a base flow continues to discharge east of the project area.

During the operational phase, close monitoring of nutrient and copper levels in any discharge waters from the Jilalan Rail Yard will occur to maintain and improve the health of Elizabeth Creek.