Appendix B – Cockatoo Creek Aquatic Values Management Plan

Australia Pacific LNG Pipeline Aquatic Values Management Plan:

Cockatoo Creek

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frc Ref: 110208

Document Control Summary

Project No.:	110208
Status:	Final Report
Project Manager:	Lauren Thorburn
Title:	Australia Pacific LNG Pipeline Aquatic Values Management Plan: Cockatoo Creek
Project Team:	J. Charlish, A. Craven, D. Holzheimer, L. James, M. Langridge, L. Thorburn
Client:	Australia Pacific LNG
Client Contact:	Sarah de Man
Date:	April 2012
Edition:	110208RCii
Checked by:	Lauren Thorburn _____
Issued by:	Lauren Thorburn _____

Distribution Record

APLNG:	1 word and 1 PDF

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Contents

Summary **i**

1 Introduction **1**

1 Project Background **2**

1.1 Watercourse Crossings: Cockatoo Creek 2

1.2 Construction Methodologies 2

2 Aquatic Values of Cockatoo Creek **8**

2.1 Methods 8

2.2 Results 15

3 Potential Impacts of Open Cut Crossing **27**

3.1 Operation of Vehicles and Equipment 27

3.2 Vegetation Clearing and Earthworks 27

3.3 Creek Crossings 29

4 Proposed Mitigation Measures **32**

4.1 Impacts to Salt Pipewort 40

4.2 Impacts to Fitzroy River Turtle 40

4.3 Suitability of Construction Methodology 41

4.4 Post-construction Monitoring 42

5 References **43**

Appendix A: Site Assessment Summary Sheet for Cockatoo Creek

Tables

Table 3.1	Habitat bioassessment scores used to derive overall condition categories.	9
Table 3.2	Water quality objectives for *in situ* water quality parameters in Cockatoo Creek.	10
Table 3.3	Macrophyte growth forms.	11
Table 3.4	Applicable biological water quality objectives for the Lower Dawson catchment, which includes Cockatoo Creek.	13
Table 3.5	Water quality objectives and in situ water quality at Cockatoo Creek.	19
Table 3.6	Total percentage cover and species richness of macrophyte species at site MKP75.51.	20
Table 3.7	Fitzroy Basin biological WQOs for the Lower Dawson Catchment.	23
Table 4.1	Limits for the disposal of hydrostatic test water to land.	30
Table 5.1	Key mitigation and management measures to be implemented at watercourses, including Cockatoo Creek.	32

Figures

Figure 2.1	Overview of proposed mainline pipeline showing location of detailed in-field assessment at site MKP75.51.	3
Figure 3.1	Riparian vegetation at site MKP75.51.	16
Figure 3.2	Erosion on the left bank at site MKP75.51.	16
Figure 3.3	Aquatic vegetation at site MKP75.51.	17
Figure 3.4	Common rush (*Juncus usitatus*).	21
Figure 3.5	*Cyperus* sp. 11.	21
Figure 3.6	Spring habitat approximately 100 m upstream of the Mainline crossing location on Cockatoo Creek (Dawson catchment).	22

Figure 3.7 Spangled perch. 24

Figure 3.8 Eastern rainbowfish. 24

Figure 3.9 Unidentified fish from the family Percichthyidae or Teraponidae. 24

Summary

The aquatic ecological condition of Cockatoo Creek is moderate to high and slightly better than what is known of the wider catchment. Agricultural development and road crossings have impacted on freshwater aquatic habitats and communities in Cockatoo Creek.

Water quality at site MKP75.51 was within the water quality objectives (WQOs) for the Lower Dawson for pH and turbidity, but was greater than the WQOs for electrical conductivity and dissolved oxygen (Table 2.5). Electrical conductivity depends on a number of factors including catchment run-off and local geology. The high dissolved oxygen concentrations are likely to reflect the time of day measurements were taken (plants photosynthesise during the day, producing oxygen) and the photosynthetic rates of macrophytes recorded at the site.

Aquatic biodiversity of Cockatoo Creek is moderate, generally with high diversity but low coverage of macrophytes, moderate macroinvertebrate diversity and poor to moderate fish diversity and fish species that are generally tolerant of the varying and often harsh conditions that characterise ephemeral and intermittent streams. However, it is considered that Cockatoo Creek provides breeding and dispersal habitat for native fish, and is likely to contribute to the success of downstream populations through movement / migration.

No listed (under State or Commonwealth legislation) species of aquatic flora or fauna were recorded during the field survey of Cockatoo Creek. It is unlikely that the Fitzroy River turtle occurs at Cockatoo Creek, as no turtles were caught here and there was no suitable nesting habitat. The salt pipewort was not found during targeted surveys of Cockatoo Creek. No suitable habitat for the boggomoss snail and no active breeding places for migratory species were observed during the detailed aquatic assessment and pre clearance ecological assessments.

The Project is unlikely to impact on any listed vulnerable or endangered aquatic species or ecological communities (as listed under State or Commonwealth legislation), or conversationally significant habitats, if appropriate mitigation measures are put in place. If during construction activities or during further surveys MNES species or habitats are identified at Cockatoo Creek, species specific management plans in accordance with condition 8 will be prepared.

The potential impacts of fuel handling and vegetation clearing associated with construction of the pipelines can be minimised if the recommended mitigation measures are implemented. It has been determined that site specific mitigation measures outlined

in Table 4.1 and Appendix A adequately protect against adverse impacts to MNES in Cockatoo Creek, specifically the salt pipewort.

Open cut construction has been identified as a suitable methodology during dry or low flow conditions, avoiding the period between September and October). During times of moderate to high flows, the following order of actions will be undertaken to protect against adverse impacts to MNES species or habitat:

- construction crews wait till flow recedes
- aquatic ecologists to determine on site prior to works commencing if undetected MNES species is present or habitat will be impacted
- if no impact identified open cut crossing and implement site specific measures, and
- if impact identified assess crossing for suitability of HDD, based on limitation criteria outlined in Section 1.2.

To enable rapid assessment of flow conditions during construction, flow is defined as outlined below:

- Low flow conditions are considered to be situations where the crossing site is dry, contains pooled water or there is flow but water levels are contained to the low flow channel (as determined by bank shape and vegetation features).
- Moderate flows are considered to represent times when there is flow in the watercourse and the water is at mid-height on the bank.
- High flows represent times when the water level is above the middle of the bank.

1 Introduction

Australia Pacific LNG Pty Ltd (APLNG) are developing the APLNG Project, which includes development of gas fields in south central Queensland, construction and operation of an approximately 450 km gas transmission pipeline to an liquid natural gas (LNG) facility on Curtis Island near Gladstone, and construction and operation of the LNG facility.

The Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) approved the development, construction, operation and decommissioning of the Australia Pacific LNG high pressure gas transmission pipeline network that links the Coal Seam Gas Field to the LNG facility on Curtis Island under Sections 130(1) and 133 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 21 February 2011. This approval (EPBC Approval No. 2009/4976) requires the development, submission and approval of the Aquatic Values Management Plan for the gas transmission pipeline (the pipeline) under conditions 28 to 30.

Australia Pacific LNG commissioned frc environmental to contribute to the Aquatic Values Management Plan for the pipeline crossings of watercourses. Specifically, this included:

- desktop review of the pipeline alignments and previous aquatic and watercourse information provided to the Queensland Department of Environment and Resource Management (DERM)
- confirmation of the rational behind a survey plan to complete detailed in-field aquatic ecology assessments at a sub-set of representative watercourse crossing sites
- undertaking dry season (completed) and wet season (in progress) detailed in-field aquatic ecology assessments, and
- contributing to the Aquatic Values Management Plan (AVMP) based on the results of the in-field assessments.

This report describes the results of the dry season survey at Cockatoo Creek, and describes the required mitigation measures for construction of the pipeline crossing at Cockatoo Creek to avoid impacts to the salt pipewort (*Eriocaulon carsonii*). This report has been prepared to satisfy Condition 28(f) of the SEWPaC approval, and supports the AVMP.

1 Project Background

1.1 Watercourse Crossings: Cockatoo Creek

The pipeline crosses Cockatoo Creek at MKP75.51, with the watercourse crossing being located in the Lower Dawson Catchment, within the Fitzroy Basin. MKP75.51 is approximately 55 km upstream of the confluence with the Dawson River. There are also several spring complexes in the area, with the closest DERM-mapped spring being approximately 2.4 km downstream of MKP75.51 (Figure 1.1).

1.2 Construction Methodologies

The following construction activities apply to open cut trenching methodology at watercourses crossed by the pipeline:

- clear – access and Right of Way (ROW)
- grade
- pipe welding
- trenching and pipe laying, and
- reinstatement.

1.2.1 Clearing

The right-of-way (ROW) is a strip of land that contains the pipeline and is where all onsite construction activities occur. It is surveyed, cleared of brush and trees, and levelled to give workers and equipment access to build, inspect and maintain the pipeline and network infrastructure. Clearing around and through a waterway crossing will take place in two parts, as discussed below.

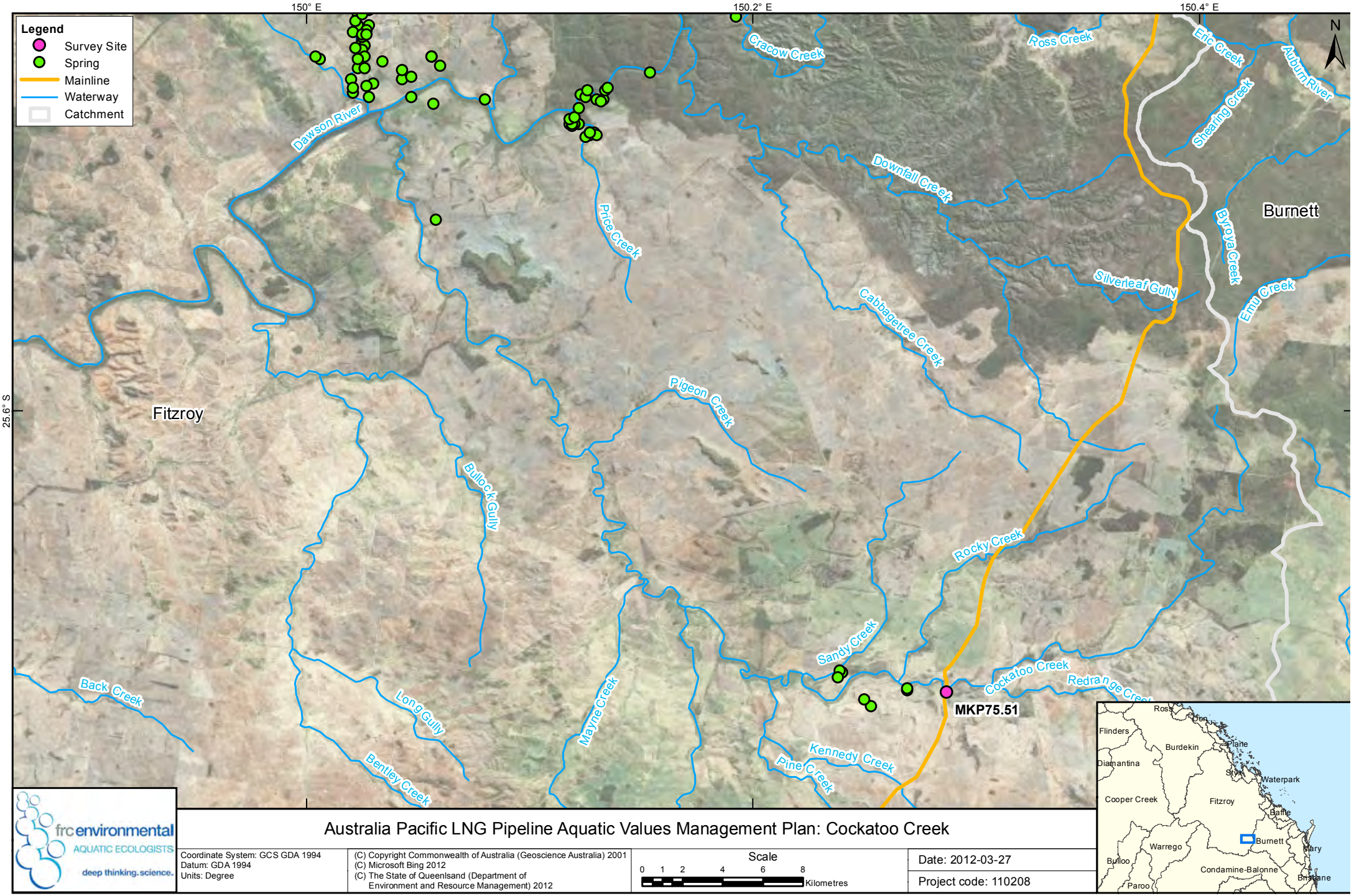

Figure 1.1 Overview of proposed mainline pipeline showing location of detailed in-field assessment at site MKP75.51.

Part 1 – Access Track

Wherever practicable, the existing road network and private access tracks will be used to access the proposed ROW and associated construction sites, and for moving plant, equipment and personnel.

Access across watercourses is likely to be required where the construction is not adjacent to an existing track. For dry watercourses the access would need to be in place for the duration of construction. Access tracks through dry waterways will be a bed level crossing constructed no higher than the natural bed level. The track will be constructed from materials similar to the natural bed material at the site with the surface left rough.

For watercourses with flow the access will vary depending upon the level. For low flowing streams, flumes/ culverts will be used to maintain the water flow until the construction activities at the site are fully reinstated. For high flows, alternative access locations will be sought, normally utilising existing fords or bridges.

The width of any new access track will be restricted to the minimum required to enable safe vehicle movement; where possible, existing tracks will be used to minimise additional clearing.

Part 2 – Right of Way

The ROW across the watercourse will be the minimum practical for safe construction of the crossing taking into account the condition of the crossing site, surrounding ecology and required vehicle movements. For steep banks it will be necessary to lay the bank back to create a safe access. Additional work area will need to be used beyond the riparian zone to allow for stockpiling of the excavated material. The additional work area zone will be determined by terrestrial ecologists through detailed field assessments.

Clearing of vegetation at major watercourses will occur just prior to the crossing installation; dry, ephemeral, minor watercourse will be cleared as part of the construction works.

Grading

Grading will be used to remove topsoil in areas where construction is likely to unduly damage topsoil and inhibit regeneration or soil conditions cannot accommodate

construction activities. This activity will be undertaken just prior to the crossing installation. Excavated material will be stored away from the creek banks.

Once cleared of vegetation the ROW will be levelled to the required gradient using graders, backhoes and bulldozers. Topsoil will be removed, typically to a depth of between 100 and 150mm or more, depending on soil type. Topsoil and vegetation material will be stockpiled separately for use during rehabilitation.

Pipe Stringing and Welding

Following clearing and grading activities the pipe materials will be delivered to the adjacent ROW and welded into a continuous length sufficient for the watercourse crossing. All surface joints are cleaned and coated to prevent corrosion. The pipe is integrity tested (e.g. non-destructive testing) prior to installation in the watercourse. Weighted pipe (i.e. concrete coated) is used at all watercourses where buoyancy is considered an issue; this is determined during detailed design.

Trenching and Pipe Laying

The trenching and pipe laying technique along with the specific equipment used at each watercourse crossing will be dependent on the watercourse condition. The following conditions have been taken into consideration:

- minor watercourse crossings with no water flow time of construction
- minor watercourse crossings with water flow at time of construction, and
- major watercourse crossing open cut.

Trenching may be undertaken prior to, during or after pipe stringing, depending on logistics.

Trenches in the waterway crossings will be open for the minimum period possible. Typical practice would be a maximum of two days from start of trenching until backfilling of the trench.

Larger crossings would require the trench to be open for up to four days. In the very unlikely event of having to blast the trench open the trench may be open for up to six days.

Reinstatement

The easement will be re-contoured to match the surrounding land as soon as practicable after pipe laying and backfilling. Bank erosion controls will be constructed or installed, where necessary. The ROW surface will usually be lightly scarified before spreading the topsoil, to promote vegetation regrowth and protect against the topsoil loss. Where contours need to be altered to allow for rig and vehicle access, they will be sufficiently stabilised in order to prevent erosion.

Rehabilitation will be undertaken in accordance with industry practice and in consultation with landholders, and will ensure that:

- any water ingress into trenches will be handled with pumping from the trench
- temporary facilities such as waterway barriers will be removed and the areas rehabilitated
- seed spreading may be carried out in areas at risk of erosion or in densely vegetated watercourse to enhance natural regeneration, and
- pipe will be backfilled and normal flow reinstated as soon as practicable.

1.2.2 Trenchless Crossings: Horizontal Direction Drilling

Horizontal Directional Drilling (HDD) is the primary trenchless construction methodology to be used on watercourses. Horizontal Directional Drilling for the 42 inch pipeline requires the following steps:

- Geotechnical investigations to determine ground conditions.
- Set up of drill pad, which typically requires the clearing of an area 100 m x 75 m (7500 m^2).
- Installation of the drill rig including sumps for drilling mud.
- Drilling large hole from the surface on one side of the watercourse. Drilling follows a designed profile below and beyond the watercourse to exit at the surface on the other side.
- The second phase entails the reaming of the large hole to increase the diameter to sufficiently large enough to accept the pipeline.
- Clearing of the pipe string area between 500 – 700 m. This clearance may not align with the ROW due to changes in direction of the pipeline.
- Stringing, welding and testing of the pipeline as per other watercourse crossings.

- Hydro testing of the pipeline string prior to installation. Biosecurity and weed control plans will be implemented to prevent the spread of weeds and pests during hydro testing.
- Pulling the pipe string into place within the enlarged hole.
- Disposal of 20 to 30 truckloads of drilling as regulated waste.
- Additional stringing on the other side of the crossing 500 – 700 m on existing ROW in length (on average).

HDD will take around 3 months to complete for a 42 inch diameter pipe. There is a low possibility of break throughs occurring during drilling and contaminants being released into watercourse.

The 42 inch diameter pipeline requires the following equipment for HDD:

- Rig Unit
- Drill pipe
- Storage
- Slurry mixing tank pump
- Water pump
- Bentonite Storage
- Power generation
- Entry point slurry containment
- Cutting settlement pit
- Cutting separation pit

Due to the large footprint and the risk associated with breakthroughs for a 42 inch diameter pipeline, locations presenting the following limitations are deemed impractical for HDD:

- Geotechnical surveys identify ground conditions are not suitable. If ground conditions are deemed unsuitable (e.g. rock) the potential risk of a breakthrough is increased.
- Additional work areas required for drill pad and stringing of pipe outside the ROW impacting on Regional Ecosystems (RE) or matters of national environmental significance (MNES).
- Pipeline easement is dictated by licensed corridors and there is no allowance for alternative locations or additional work area. This relates to the pipeline in the CIC and GSDA licensed corridors.
- Size of the crossing versus the magnitude of the work required.
- Prohibitive cost associated with the trenchless method technique versus the cost to implement mitigation and reinstatement measures.

2 Aquatic Values of Cockatoo Creek

2.1 Methods

2.1.1 Survey Design

Aquatic habitat condition (including *in situ* water quality), aquatic flora, aquatic macroinvertebrates and aquatic vertebrates (e.g. fish, turtles and platypus) were surveyed at Cockatoo Creek (site MKP75.51) in the dry season on 11 November 2011.

2.1.2 Aquatic Habitat

Habitat Assessment

Based on the AUSRIVAS protocol described in the *Queensland AUSRIVAS Sampling and Processing Manual* (DNRM 2001), the in-stream habitat condition at each site was assessed based on the following parameters:

- riparian vegetation and adjacent land use
- bank stability
- substrate composition (silt or clay, sand, pebble, cobble and boulder)
- channel diversity
- in-stream habitat (in-stream vegetation and substrate characteristics), and
- water quality.

Habitat Bioassessment Scores

Habitat bioassessment score datasheets in the Australia-Wide Assessment of River Health: Queensland AUSRIVAS Sampling and Processing Manual (DNRM 2001) were used to numerically score nine criteria, which were then allocated to one of four categories (excellent, good, moderate and poor). The sum of the numerical rating from each category produced an overall habitat assessment score (Table 2.1):

- Excellent >110,
- Good 75 to 110,
- Moderate 39 to 74, and
- Poor ≤38.

Table 2.1 Habitat bioassessment scores used to derive overall condition categories.

Habitat Category	Category Score Range			
	Excellent	**Good**	**Moderate**	**Poor**
bottom substrate / available cover	16–20	11–15	6–10	0–5
embeddedness	16–20	11–15	6–10	0–5
velocity / depth category	16–20	11–15	6–10	0–5
channel alteration	12–15	8–11	4–7	0–3
bottom scouring & deposition	12–15	8–11	4–7	0–3
pool / riffle, run / bend ratio	12–15	8–11	4–7	0–3
bank stability	9–10	6–8	3–5	0–2
bank vegetative stability	9–10	6–8	3–5	0–2
streamside cover	9–10	6–8	3–5	0–2
Total Score for the Site	**111–135**	**75–110**	**39–74**	**0–38**

In situ Water Quality

In situ water quality measurements were collected at site MKP75.51. A Hydrolab Quanta water quality meter was used to measure:

- water temperature
- pH
- electrical conductivity, and
- dissolved oxygen.

A Hach 2100Q turbidity meter was used to measure turbidity. The Hydrolab Quanta water quality meter was calibrated daily and the Hach 2100Q was calibrated at the beginning of the field survey.

Data Analysis

The results were compared to the water quality objectives (WQOs) scheduled under the Environmental Protection (Water) Policy 2009 for waterways in the Fitzroy Basin (DERM 2011).

Table 2.2 Water quality objectives for *in situ* water quality parameters in Cockatoo Creek.

Parameter	Units	Water Quality Objectives for Fitzroy Basin
		Lower Dawson
temperature	°C	–
pH	pH units	6.5–8.5
electrical conductivity	µS/cm	340
dissolved oxygen [a]	% saturation	85–110
turbidity	NTU	50

Source: DERM (2011a)

[a] dissolved oxygen values derived from daytime measurements, and may vary overnight and with depth

– not available

µS/cm = microSiemens per centimetre

NTU = nephelometric turbidity unit

2.1.3 Aquatic Flora (Macrophytes)

The macrophyte community was assessed along a 200 m reach within the creek and riverbanks (100 m upstream and downstream of the pipeline crossing). Two transects were established on each bank covering the channel and approximately 15 m of each bank. Plants were identified, and the following was recorded:

- taxonomic richness
- total percent cover (% of substrate (bed or bank) covered by each aquatic species)
- growth form of each species (submerged, floating (free-floating or rooted) and emergent) (Table 2.3)
- whether the plant was native or introduced to Australia, and
- whether the plant was listed under state or Commonwealth legislation.

Targeted searches for salt pipewort (*Eriocaulon carsonii*) were done along each transect and opportunistically in other locations within the site boundary if suitable habitat was noted.

Table 2.3 Macrophyte growth forms.

Growth Form	Description
submerged	• predominantly grow beneath the surface of the water • flowers may project above the water surface • some leaves may float on the water surface
floating	• can be either free-floating or rooted • free-floating species are usually not attached to the substrate • rooted species are attached to the substrate and normally have at least the mature leaves floating on the water surface
emergent	• rooted in the substrate • stems, flowers and most of the mature leaves project above the water surface

source: (Sainty & Jacobs 2003)

Total percent cover of each species was assessed visually and the presence of listed protected species, under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* or Queensland's *Nature Conservation Act 1992* was determined.

Macrophyte species were identified in the field, where practical. Representative specimens were collected for identification in the laboratory (or by the Queensland Herbarium, if required). Species were identified as native or exotic according to the *Census of Queensland Flora 2007* (Queensland Herbarium 2007).

2.1.4 Aquatic Macroinvertebrates

AUSRIVAS Samples

One macroinvertebrate sample from the bed habitat and one macroinvertebrate sample from the edge habitat was collected. This sampling followed the methods in the Queensland AUSRIVAS sampling manual, and is designed to provide a broad description of macroinvertebrate communities, rather than a quantitative assessment (DNRM 2001). A standard triangular-framed, macroinvertebrate sampling net with 250 µm mesh was used to collect the samples. In this method, a 10 m long section of bed or edge habitat was disturbed, and a sample was obtained by sweeping the net through the disturbed area.

The sampling of macroinvertebrates was conducted under Queensland Scientific Licence WISP05080608 issued to frc environmental.

Macrocrustacean Samples

Macrocrustaceans (e.g. prawns, shrimps and yabbies) were caught in the fish survey, using a combination of electrofishing (backpack unit), baited traps and seine net. Macrocrustaceans were also caught in macroinvertebrate surveys, using a macroinvertebrate sampling net.

All available habitats (e.g. pool, riffle, run and bend) were fished. Electrofishing was conducted in accordance with the *Australian Code of Electrofishing Practice 1997*, using a Smith-Root LR-24 backpack electrofisher. Macrocrustacean communities were also surveyed with five small (2 mm mesh size) baited traps and two opera traps (10 mm mesh size), which were set for approximately five and a half hours.

2.1.5 Sample Processing

All macroinvertebrate samples were preserved using ethanol and returned to frc environmental's Brisbane benthic laboratory where they were sorted, counted and identified to the lowest practical taxonomic level (in most instances family), to comply with AUSRIVAS standards and those described by Chessman (2003).

All macrocrustaceans were identified and counted in the field and specimens were returned to the environment.

2.1.6 Data Analysis

Calculation of Indices

Abundance, taxonomic richness, PET richness and SIGNAL 2 scores were calculated for each sample. These indices were used to indicate the current ecological health of surveyed waterways. The results from surveys in the Dawson catchment were compared with the relevant Fitzroy Basin biological water quality objectives (WQOs) (DERM 2011).

Table 2.4 Applicable biological water quality objectives for the Lower Dawson catchment, which includes Cockatoo Creek.

Catchment	Indicator	Habitat	Fitzroy Basin WQOs
Dawson catchment (Upper and Lower Dawson)	taxonomic richness	composite [a]	12–21
		edge	23–33
	PET richness	composite [a]	2–5
		edge	2–5
	SIGNAL 2 scores	composite [a]	3.33–3.85
		edge	3.31–4.20

Source: DERM (2011a)

[a] comprises all bed habitat within the site, including sandy pool, rocky pool, riffle, run and cascade

Abundance

Abundance is the total number of macroinvertebrates.

Taxonomic Richness

Taxonomic richness is the number of taxa (in this assessment, families). Taxonomic richness is a basic, unambiguous and effective diversity measure. It is however, affected by arbitrary choice of sample size. Where all samples are of equal size, taxonomic richness is a useful tool when used in conjunction with other indices. Richness does not take into account the relative abundance of each taxon, so rare and common taxa are considered equally.

PET Richness

While some groups of macroinvertebrates are tolerant to pollution and environmental degradation, others are sensitive to these stressors (Chessman 2003). Plecoptera (stoneflies), Ephemeroptera (mayflies), and Trichoptera (caddisflies) are referred to as PET taxa, and they are particularly sensitive to disturbance. There are typically more PET families within sites of good habitat and water quality than in degraded sites. PET taxa are often the first to disappear when water quality or environmental degradation occurs (EHMP 2007). The lower the PET score, the greater the inferred degradation.

SIGNAL 2 Scores

SIGNAL (**S**tream **I**nvertebrate **G**rade **N**umber — **A**verage **L**evel) scores are also based on the sensitivity of each macroinvertebrate family to pollution or habitat degradation. The SIGNAL system has been under continual development for over 10 years, with the current version known as SIGNAL 2. Each macroinvertebrate family has been assigned a grade number between 1 and 10 based on their sensitivity to various pollutants. A low number means that the macroinvertebrate is tolerant of a range of environmental conditions, including common forms of water pollution (e.g. suspended sediments and nutrient enrichment).

SIGNAL 2 scores are weighted for abundance. The scores take the relative abundance of tolerant or sensitive taxa into account (instead of only the presence or absence of these taxa). The overall SIGNAL 2 score for a site is based on:

- the total of the SIGNAL grade
- multiplied by the weight factor for each taxon, and
- divided by the total of the weight factors for each taxon.

2.1.7 Fish

Fish communities were surveyed using a combination of electrofishing (backpack unit), baited traps and seine nets.

All available habitats (e.g. pool, riffle, run and bend) were fished and electrofishing was conducted in accordance with the *Australian Code of Electrofishing Practice 1997*, using a Smith-Root LR-24 backpack electrofisher. Fish communities were also surveyed with five small (2 mm mesh size) baited traps and two opera traps (10 mm mesh size), which were set at each site for approximately five and a half hours.

Specimens that were unable to be identified in the field were euthanised and returned to the laboratory for identification.

The sampling of fishes was conducted under General Fisheries Permit No. 54790 and Animal Ethics Approval No. CA 2009/03/343 issued to frc environmental.

Data Analysis

Fish communities were assessed for the:

- taxonomic richness (total number of species)
- total abundance (total number of individuals)
- abundance at each life-history stage
- abundance of exotic species, and
- abundance of listed protected species.

2.1.8 Turtles

While electrofishing, observations for turtles were also made. Five baited cathedral traps were also set along the bank and next to cover (e.g. vegetation and snags) for approximately five and a half hours. The design of the traps was similar to traps used by the Queensland Department of Environment and Resource Management's (DERM's) turtle research group. The traps had a series of collapsible chambers (approximately 3.5 m in height and 0.7 m in diameter) and two, one-way entrances in the lower baited chamber. Traps were set so that the top of the chamber allowed turtles access to the surface to breathe. Traps were closely monitored to ensure that no turtles or other air-breathing species were entangled or trapped below the surface. The sampling of turtles was conducted under Animal Ethics Approval No. CA 2009/03/343 and QLD Scientific Purposes Permit WISP05080608 issued to frc environmental.

2.1.9 Other Aquatic Vertebrates

Any other aquatic vertebrates observed in the survey area were noted.

2.2 Results

2.2.1 Habitat assessment

Riparian Vegetation and Adjacent Land use

The riparian vegetation was intact and comprised grasses, shrubs and both small and large trees (Figure 2.1). The land immediately next to the riparian zone was predominantly used for grazing.

Figure 2.1

Riparian vegetation at site MKP75.51.

Bank Stability

Bank erosion was present at site MKP75.51, and was most extensive along the left bank, which had a steeper gradient and was the erosional bank located on the outside edge of the bend (Figure 2.2).

Figure 2.2

Erosion on the left bank at site MKP75.51.

Channel Diversity

Channel diversity was moderate at site MKP75.51 and included:

- large pools
- small pools, and
- runs.

Changes in water depth are likely to provide additional channel diversity during periods of higher flow.

In-stream Habitat

In-stream habitat (i.e. structural elements) provides refuge and food for aquatic fauna such as fish, turtles and macrocrustaceans. In-stream habitat at site MKP75.51 included:

- deep pool habitat
- woody debris
- aquatic vegetation
- trailing bank vegetation, and
- cobble / boulder (Figure 2.3).

Figure 2.3

Aquatic vegetation at site MKP75.51.

2.2.2 Habitat Bioassessment Scores

Site MKP75.51 had a good bioassessment score (95), which was due to:

- good availability of cover
- variety of substrates
- limited bottom scouring and deposition, and
- limited channel alteration.

2.2.3 Water Quality

Water quality at site MKP75.51 was within the WQOs for the Lower Dawson for pH and turbidity, but was greater than the WQOs for electrical conductivity and dissolved oxygen (Table 2.5). Electrical conductivity depends on a number of factors including catchment run-off and local geology. The high dissolved oxygen concentrations are likely to reflect the:

- time of day measurements were taken (plants photosynthesise during the day, producing oxygen)
- photosynthetic rates of algae and macrophytes (which are affected by light availability and temperature), and
- rate of oxygen uptake by micro-organisms in the waterway associated with decomposing organic matter, and amount of surface mixing (caused by wind, water movement and bird activity).

Table 2.5 Water quality objectives and in situ water quality at Cockatoo Creek.

Parameter	Units	Water Quality Objectives for Fitzroy Basin	Cockatoo Creek (site MKP75.51)
		Lower Dawson	
temperature	°C	–	27.93
pH	pH units	6.5–8.5	7.09
electrical conductivity	µS/cm	340	1179*
dissolved oxygen [a]	% saturation	85–110	115*
turbidity	NTU	50	4.08

Source: DERM (2011a)

[a] dissolved oxygen values derived from daytime measurements, and may vary overnight and with depth

– not available

* value was greater than the WQOs

µS/cm = microSiemens per centimetre

NTU = nephelometric turbidity unit

2.2.4 Aquatic Flora (Macrophytes)

Fourteen species of macrophyte were present in Cockatoo Creek (Table 2.6). Rushes (*Juncus usitatus*) (Figure 2.4) and sedges (*Cyperus* sp.) (Figure 2.5) had the greatest percentage cover. All macrophytes were of an emergent growth form, except for the submereged water milfoil (*Myriophyllum* sp.).

Table 2.6 Total percentage cover and species richness of macrophyte species at site MKP75.51.

Species Name	Common Name	Growth Form	Percent Cover at site MKP75.51
Alternanthera denticulata	lesser joyweed	E	1
Cyperus concinnus	–	E	1
Cyperus curvistylis	–	E	1
Cyperus sp.	–	E	1
Cyperus sp. 11	–	E	4
Cyperus victoriensis	–	E	2
Eleocharis cylindrostachys	drooping spike rush	E	1
Eragrostis elongata	–	E	1
Fimbristylis sp. 2	–	E	2
Juncus continuus	sand rush	E	3
Juncus usitatus	common rush	E	15
Lomandra longifolia	mat rush	E	1
Myriophyllum sp.	water milfoil	S	1
Poaceae sp.	–	E	2
Total percentage cover			**36**
Species richness			**14**

E – emergent macrophyte; S – submerged macrophyte

Figure 2.4

Common rush (*Juncus usitatus*).

Figure 2.5

Cyperus sp. 11.

Salt Pipewort

Salt pipewort (*Eriocaulon carsonii*) is listed as endangered under the Commonwealth's EPBC Act and Queensland's *Nature Conservation Act 1992* (NCA), as listed in the Nature Conservation (Wildlife) Regulation 2006. Salt pipewort is a perennial herb that usually forms mat-like colonies and can vary in appearance. In western Queensland, plants are smaller (up to 10 cm tall) with hairless flower heads, while in southern, eastern and northern Queensland they are larger (up to 50 cm tall) with hairy flower heads (DERM 2012a).

Flowing or active mound springs are critical to the survival of salt pipewort. Mound springs are formed at springs that lie on faults, which provide direct access for artesian

water to reach the surface, where mud deposits to form mounds from 1 to 10 m high and 2 to >100 m diameter. Salt pipewort is generally associated with vegetated mounds that have formed over considerable time (NSW NP&WS 2003). Salt pipewort is found at 12 mound springs in Queensland, 1 in New South Wales, and 9 in South Australia. Except for two populations in the Einasleigh Uplands region of north Queensland, the Great Artesian Basin sustains the wetlands that support this species (DERM 2012a). While mound springs occur on all margins of the Great Artesian Basin (Habermehl 1980; Ponder 1986), these landforms occupy an extremely small percentage of semi-arid Australia, and are probably the rarest landform on the continent (NSW NP&WS 2003). In Queensland, all populations of salt pipewort occur in spring wetlands fed by permanent groundwater in relatively flat landscapes, except for one population that is found in a spring-fed area on the side of a gentle range (DERM 2012a).

Springs are known to occur in Cockatoo Creek. A potential spring was identified approximately 100 m upstream of the pipeline crossing site within Cockatoo Creek (Figure 2.6). However, this area has not been mapped as a spring by DERM (Figure 1.1), and extensive surveys for the salt pipewort were conducted at this site, and this species was not found.

Figure 2.6

Spring habitat approximately 100 m upstream of the Mainline crossing location on Cockatoo Creek (Dawson catchment).

No salt pipewort was observed during the survey or has been recorded within 4 km of site MKP75.51; however it has been recorded within 5 km of site MKP75.51 (DERM 2012b). This is likely to be in the spring complex located approximately 4.9 km to the west of site MKP75.51 (Figure 1.1).

No exotic species or species listed under the EPBC Act or the NCA were observed during the survey of Cockatoo Creek.

2.2.5 Aquatic Macroinvertebrates

There are no WQOs for the abundance of macroinvertebrates, which ranged between 558 individuals in bed habitat and 238 individuals in edge habitat at Cockatoo Creek. Macroinvertebrate taxonomic richness and PET richness in bed and edge habitat was within the WQOs for the Lower Dawson Catchment. SIGNAL 2 scores were below the WQOs for both bed and edge habitat (Table 2.7), indicating that the macroinvertebrate communities were dominated by moderately tolerant taxa.

Table 2.7 Fitzroy Basin biological WQOs for the Lower Dawson Catchment.

Catchment	Indicator	Habitat	MKP75.51	Fitzroy Basin WQOs
Lower Dawson catchment	Abundance	composite [a] / bed	558	NA
		edge	238	NA
	taxonomic richness	composite [a]/ bed	11	12–21
		edge	30	23–33
	PET richness	composite [a]/ bed	2	2–5
		edge	3	2–5
	SIGNAL 2 scores	composite [a]/ bed	2.86*	3.33–3.85
		edge	2.90*	3.31–4.20

Source: DERM (2011a)

[a] comprises all bed habitat within the site, including sandy pool, rocky pool, riffle, run and cascade

* value was lower than the WQOs

2.2.6 Fish

A total of 1 034 individuals were caught at site MKP75.51, which comprised three species (out of a known 20 species in the Dawson catchment). The most abundant were unidentified individuals from the family Percichthyidae or Teraponidae, which made up 99.6% of the total catch. Three spangled perch and one eastern rainbowfish were also caught (Figure 2.7, Figure 2.8, Figure 2.9).

Figure 2.7

Spangled perch.

Figure 2.8

Eastern rainbowfish.

Figure 2.9

Unidentified fish from the family Percichthyidae or Teraponidae.

Each of the fish species recorded requires some physical in-stream habitat for shelter or for reproduction. A variety of physical aquatic habitat (e.g. woody debris and substrate diversity) also supports diverse macroinvertebrate communities, which are prey to many of the fish in the survey area.

Many of the fish known in the region are native to intermittent and ephemeral systems of central and western Queensland, and move up and downstream, and between different habitats, at particular stages of their lifecycle (Cotterell 1998; Marsden & Power 2007). Environmental conditions in Australian rivers are extremely variable, and fish may need to move up and downstream to avoid deteriorating water quality and the drying of reaches (Freshwater Fisheries Advisory 1996; Kennard 1997). Stimuli for movement may include small and large discharge events and increases in water temperature. That is, the majority of fish movement / migration and spawning is likely to occur in the wet season; although many species can reproduce throughout the year when conditions are suitable. It is therefore likely that additional fish species use Cockatoo Creek at different times of the year. The high abundance of juvenile fish at Cockatoo Creek indicated that it provides suitable breeding habitat and that they cross at the site.

No exotic species, or species listed under the EPBC Act or NCA, were caught during the survey.

2.2.7 Turtles

No turtles were observed or caught during the survey. Fitzroy River turtles have been recorded in the Dawson catchment (Limpus et al. 2007), but not within 25 km of site MKP75.51 (DERM 2012b). The species is particularly difficult to catch in nets, and rarely enters traps (M. Gordos, Conservation Manager, NSW DPI, pers. comm. July 2007). The most successful, and therefore most commonly used, method to survey Fitzroy River turtles is to catch them by hand, on snorkel (M. Gordos, Conservation Manager, NSW DPI, pers. comm. July 2007). Evening spotlighting for Fitzroy River turtles is also a successful survey technique (frc environmental 2011). Snorkel surveys were not undertaken in the current survey, as there was no suitable habitat for the Fitzroy River turtle at sites within the Fitzroy Basin (Dawson catchment), including Cockatoo Creek.

Little information is available on the abundance and life history of the Fitzroy River turtle across its greater distribution. Riffle zones are an important habitat for the Fitzroy River turtle, with the home ranges of individuals typically overlapping these habitats (Tucker et al. 2001), possibly due to increased foraging success in these habitats (Legler & Cann 1980) or a greater efficiency of aquatic cloacal respiration in highly oxygenated waters such as riffle zones (Priest 1997; Franklin 2000; Gordos et al. 2004).

However, under low-flow events, or as riffle zones become seasonally ephemeral (i.e. completely dry), the Fitzroy River turtle retreats to deeper sections of pool habitats, or even isolated waterholes, next to riffle zones (Tucker et al. 2001; Limpus et al. 2007). As riffle zones throughout most of the range of the Fitzroy River turtle are likely to be ephemeral, this species should not be considered to be a riffle zone specialist; rather, they exploit this habitat to forage for abundant food sources such as benthic invertebrates and algae during the wet season and early dry season (Limpus et al. 2007). This allows the turtles to take up nutrients and build fat reserves for the dry season, which is essential for preparing to breed (Limpus et al. 2007). Therefore, while large, slow-flowing pools can support populations of the Fitzroy River turtle, the pools are likely to have a lower carrying capacity than reaches containing riffle zones (Limpus et al. 2007).

Biological data on the movement patterns of *R. leukops* is largely limited to tracking studies in the Fitzroy River at Glenroy Crossing (above the Eden Bann Weir). Home ranges typically vary widely among individuals; however, on average, turtles were observed to have a local mean range span of 417 m. Individual turtles exhibit relatively long sedentary periods, ranging from 3 to 24 hours. When active, mean movement was 20 m per day on average, with a range of 0 to 350 m per day (Tucker et al. 2001). Fitzroy River turtles nest from September to October on river sandbanks 1–4 m above water level (Cann 1998).

Gordos and Franklin (2002) observed a weakly bimodal pattern of increased surfacing activity during dawn and dusk in *R. leukops*; however this pattern was not consistently observed among individual turtles. At the time of writing no information on diurnal habitat preferences of *R. leukops* was available. No seasonal movement patterns have been observed for *R. leukops*.

Based on the known habitat preferences of this species (i.e. large, permanent pools with ephemeral riffles and large woody debris) (Limpus et al. 2007), it is considered highly unlikely that the Fitzroy River turtle occurs at site MKP75.51 on Cockatoo Creek.

3 Potential Impacts of Open Cut Crossing

3.1 Operation of Vehicles and Equipment

3.1.1 Fuel Spills

Both diesel and petrol are toxic to aquatic flora and fauna at relatively low concentrations. Spilt fuel is most likely to enter the creeks via an accidental spill on the roads near creek crossings; or when there are construction activities adjacent to waterways. A significant fuel spill to waterways (in the order of tens or hundreds of litres) is likely to have a locally significant impact on both flora and fauna, with the quantity spilt and the volume of water in the creeks being the most significant factors influencing the length of stream impacted.

Risks associated with the spillage of fuels and other contaminants can be substantially reduced, if not eliminate by implementing the mitigation measures outlined in Section 4.

Where fuels and oils have been managed in accordance with Australian Standard 1940-2004 and any spills have been effectively cleaned up, no residual impacts from spilt fuels and oils are expected.

3.2 Vegetation Clearing and Earthworks

There is a high potential for soil erosion and sedimentation following vegetation clearing and earthworks, due to the intense seasonal rainfall and soil characteristics present on-site. This could lead to impacts on aquatic ecology via increased turbidity and nutrient levels in these waterways, as well as alteration of aquatic habitats.

3.2.1 Increased Turbidity

Vegetation clearing and/or earthworks have the potential to increase sediment runoff to creeks, resulting in elevated turbidity. Increased turbidity may negatively impact fish and macroinvertebrates because highly turbid water reduces respiratory and feeding efficiency (Karr & Schlosser 1978: cited in Russell & Hales 1993). Increased turbidity may also adversely affect submerged macrophytes as light penetration (required for photosynthesis) is reduced. Reduced light penetration can also lead to a reduction in temperature throughout the water column (DNR 1998).

Based on the published tolerances of the species caught, the fish and macroinvertebrate communities of Cockatoo Creek are capable of living in turbid waters. Given these background conditions, small increases in turbidity would be unlikely to have a significant impact on aquatic ecology. Significant increases in turbidity could adversely impact the health, feeding and breeding ecology of some species of macroinvertebrates and fishes, and submerged macrophyte growth.

The probability of increased turbidity resulting in impacts to aquatic ecology will be minimised by implementation of an erosion and sediment control plan specific to Cockatoo Creek. Details on site-specific erosion and sediment controls will be determined by suitably qualified professionals at time of construction to suit the current conditions.

3.2.2 Decreased Habitat for Aquatic Fauna

Vegetation clearing and earthworks near and within Cockatoo Creek may decrease the diversity of habitats for aquatic fauna. Habitats (apart from the general bed and banks), which might be of importance to aquatic fauna, include large and small woody debris, detritus, tree roots, boulders, undercut banks, overhanging and trailing bank vegetation. All are features of waterways in the survey area.

In-stream structure is an important habitat component and territory marker for many fish and macroinvertebrates. Many species live on or around particular structural features. These might provide shelter from temperature, current and predators; contribute organic matter to the system; and be important for successful reproduction. Australian fish species typically spawn either on in-stream vegetation or on hard surfaces like cobbles, boulders, and woody debris.

The deposition of fine sediments can decrease in-stream bed roughness and habitat diversity and may result in existing pools being filled in. In larger watercourses such as Cockatoo Creek, sediment deposition could lead to a decrease in habitat diversity and a reduction in the number of pools available as ‘refuge’ habitat in the dry season. If appropriate erosion and sediment control measures are in place, it is unlikely that available habitat will decrease.

A decrease in habitat available for aquatic fauna would lead to a decline in the abundance and diversity of both macroinvertebrate and fish communities in the creeks, and potentially also on dependant predators (such as birds, reptiles and small mammals). The rehabilitation and revegetation of riparian zones and the stabilisation of earthworks using vegetation may offset the potential decrease in available habitat, once construction is complete.

3.3 Creek Crossings

Construction of new permanent and temporary crossings for pipelines and tracks may disturb sediments, leading to increases in localised turbidity and sediment deposition. When construction is carried out during the dry season, these impacts will be minimal or absent, although a highly localised loss of aquatic flora may be expected within the construction footprint. The impacts of disturbance to habitat will be highly localised and are considered acceptable in both a local and regional context, as appropriate control measures will be implemented and no listed threatened species will be directly impacted. However, after the installation of crossings, the newly formed bed and banks on the higher order streams may continually erode due to the high flows that occur in the region in the wet season. This may result in an increase in channel width and a loss in channel definition.

3.3.1 Pipelines

From an aquatic ecology perspective, open trench construction of the pipeline crossing of Cockatoo Creek is considered to be appropriate if construction takes place in the dry season.

A temporary waterway barrier works approval will be required for construction of access tracks and the open trench pipeline crossing of Cockatoo Creek (refer to site assessment sheet in Appendix A).

Open trench construction is not recommended in Cockatoo Creek during the wet season due to significant flows and the possible transient presence of MNES species.

3.3.2 Access Tracks

In order to maintain fish passage, the use of flumes (pipe culverts) for the access track across Cockatoo Creek is required.

3.3.3 Water Quality Monitoring

Water quality can be impacted during construction, Table 2.2 outlines the acceptable water quality guidelines for Cockatoo Creek. Mitigation measures to achieve these are outlined in Section 4.

Where the results for any of the parameters exceed the water quality objectives, results at the downstream site are to be compared to results at the upstream site. Where results at the downstream site are more than 10% above or below the result for the upstream site, it is recommended that construction cease and that stormwater and erosion and sediment control measures be revised prior to re-commencement of construction.

Monitoring should be done by an appropriately qualified professional in accordance with the Monitoring and Sampling Manual (DERM 2010), which includes requirements for quality assurance / quality control measures such as the daily calibration of water quality meters.

3.3.4 Disposal For Hydrostatic Test Water

Disposal of hydrotest water will not occur at Cockatoo Creek. For all other watercourse crossing sites along the pipeline alignment, specific management measures will be implemented which will take into account the chemical nature of the products used and that of the receiving environment, as well as other environmental considerations prior to any release. The water quality limits for disposal to land are presented in Table 3.1. Soil management measures will be detailed in Soils Management Plan (SMP) and line lists to prevent impact to soils of hydrotest water.

Suitable hydrotest water discharge locations will be identified and assessed in conjunction with landowners and the administering authorities.

Hydrotest water will be discharged through sediment control devices if it is required to be discharged off-site. Engineering controls such as scour protection and flow volume/rates will be used when discharging to land to minimize erosion. All controls will be implemented and maintained as per the Site Environmental Plan Erosion and Sediment Control (SEP-ESC, to be developed).

Table 3.1 Limits for the disposal of hydrostatic test water to land[1].

Parameter	Maximum Value
pH	6.5–8.5 (Range)
Arsenic (mg/L)	2.0
Cadmium (mg/L)	0.05
Chromium (mg/L)	1

[1] Disposal limits in line with EA condition D74 of Environmental Authority PEN101808610

Parameter	Maximum Value
Copper (mg/L)	5
Iron (mg/L)	10
Lead (mg/L)	5
Manganese (mg/L)	10
Zinc (mg/L)	5
Nitrogen (mg/L)	5
Phosphorus (mg/L)	1
Electric Conductivity (µS/cm)	2000

4 Proposed Mitigation Measures

Key mitigation / management measures and corrective actions to be implemented at watercourses impacted by pipeline activities, including Cockatoo Creek, are outlined in (Table 4.1). This section details the general mitigation measures that will be applied to all watercourse crossings.

Detailed mitigation measures relevant to Cockatoo Creek are provided in the site assessment sheet (Appendix A).

Table 4.1 Key mitigation and management measures to be implemented at watercourses, including Cockatoo Creek.

Management measures to be implemented during operation of the main pipeline
• Routine inspections of watercourse crossings will be undertaken to ensure riparian vegetation has developed in accordance with the rehabilitation plan. • Bank and scour protection measures associated with watercourse crossings will be maintained and monitored. • Vehicular access to watercourse crossings for inspection and maintenance work will be restricted to stable crossing points. • Temporary stabilisation of the banks at watercourse crossing points will be installed using protective materials until vegetation cover is re-established. • Riparian vegetation will be maintained in accordance with the rehabilitation plan and RRRMP. • Measures, as set out in the EM Plan (Q-1801-MP-15-0002), will be carried out to ensure that erosion and scour of watercourse crossings and introduction or spread of weed species is avoided. Where any such events are identified they will be immediately rectified. • If water is required during operations any water extraction pumps will be fitted with filters to ensure that translocation of noxious fish species is avoided at all times.
Management measures managing flow and fish passage during construction
• Watercourse crossings will be constructed during no to low flow periods. • Construction will only occur during moderate flows in major watercourses when site assessment by aquatic ecologists has deemed it suitable. • If flowing water is present, flow will be maintained downstream by using

appropriately sized pumps or flume piping.

- Where access tracks are constructed across the watercourse, disturbance to fish passage and fish habitat will be achieved by (Cotterell 1998):
  - Constructing access tracks in the dry season,
  - Ensuring the access track is as narrow as possible, as determined by the pre clearance survey,
  - Installing flume pipes that are as large as reasonably practical in diameter,
  - Ensuring that the bottom of the flumes are below bed level, and natural bed material and / or rocks and gravel are placed in the bottom of the flumes,
  - Ensuring flumes are maintained so that they remain free of debris, and
  - Ensuring work area is rehabilitated once the crossing is removed, including re-instatement of the bed and bank shape and revegetation of the banks.
- If flowing water is present upstream and downstream dams will be installed on the edge of the workspace, to maximise the area of the workspace. These dams will:
  - be constructed of an appropriate material for each creek (e.g. steel plates, flumes, sand bags or aquadam), and
  - be made impermeable by using polyethylene liner and sand bags.
- Once flow is diverted from isolated workspaces, stranded fish will be captured and translocated to waterholes downstream of the workspace in accordance with the Department of Employment, Economics Development and Innovation (DEEDI) guideline: *Fish Salvage Guidelines* (DPI&F 2004), as summarised below:
  - fauna captured by suitably-qualified aquatic ecologists during a one-off intense fauna survey prior to the dewatering of the isolated workspace,
  - salvaged fauna translocated to suitable waterholes in the same waterway (to prevent the transfer of exotic fish or aquatic disease),
  - fish, macrocrustaceans and turtles captured using gear appropriate to the waterways and species present (this is likely to include electrofishing, seine nets and set traps), and
  - aquatic fauna handled, transported and released so as to minimise damage to the fish (e.g. handle with wet hands, hold correctly etc.).
- The dams will be removed via the following method;
  - The upstream dam is slowly removed, to allow water to flush the sediment

from the workspace area, - Sediment-laden water is pumped into sumps or onto vegetation, - Operation of the clean-water pump sustains flow below the downstream dams until the downstream dam is removed, and - Pump intakes will be screened, with openings no larger than 2.54 mm, to ensure that no fish are trapped. • The duration of any temporary diversion must be limited to the minimal time required for the crossing. • Rehabilitation of instream habitat will be done. This will include as appropriate: - bed and bank re-profiling, - stream bed rehabilitation and • re-instatement of habitat such as boulders and large woody debris will be done.
Management measures to be implemented to protect hydrology of watercourse during crossing construction
• Crossings have been located away from complex meanders and steep banks, where possible. • Watercourse crossings, including vehicular and maintenance tracks, will, within the constraints or engineering design, be at right angles to the direction of flow to minimise associated scour potential. • The pipeline route has been selected to avoid direct impact to artesian mound springs. • Existing watercourse crossings have been utilized where available. • Temporary stream flow diversions will be undertaken during periods of very low water flow, with consideration of short-term weather forecasting to avoid any potential for flooding during the crossing. • Temporary stream flow diversions will be removed as soon as the pipeline construction has been completed and the bed and banks are stabilised. • Diverted watercourse water will be discharged (i.e. flume and dam & pump crossings) directly back into the watercourse over rip-rap protection downstream of the crossing. • Schedulers will remain vigilant regarding flood warnings, receiving daily weather reports and subscribing to flood warning services where available. • Refer to the site specific watercourse crossing plans for any site specific

management measures.
Management measures to be implemented to manage stormwater at watercourses during all construction phases
• Stormwater will be managed by diverting run-off around disturbed areas to stable ground through the use of berms upslope from the watercourse and installing erosion and sediment control structures. • Areas will be revegetated as soon as practicable after the completion of commissioning.
Management and Rehabilitation requirements to protect terrestrial ecology such as riparian vegetation, ecosystems and sensitive flora and fauna in and around watercourses during construction
• All watercourse crossings have been selected taking into account terrestrial and aquatic ecology, terrain, construction constraints and engineering design constraints. • Pre-clearing surveys will be undertaken by qualified terrestrial ecologists in accordance with the requirements of the relevant approvals. • Where any populations of protected species are identified measures will be taken to avoid or minimise the impact on these species. Consideration will be given to realignment to avoid; where this is not possible the ROW will be narrowed to a safe construction width to avoid damage or loss of these populations. • All identified populations of protected species will be documented in the Pre Clearance survey reports for each pipeline section. • No protected species will be cleared without the appropriate permits being in place. • Prior to clearing of riparian vegetation, photographic evidence will be taken of crossing area to be disturbed as reference for restoration. • Where safe to do so riparian vegetation will be trimmed rather than removed, especially large canopy trees. • The riparian vegetation to be maintained at watercourses until construction was imminent. If regrowth trees within this buffer require removal, it should be done by hand. • Flagging will be used to mark significant riparian vegetation and large canopy trees that are to be retained. • Temporary stabilisation of the banks at watercourse crossing points will be

installed using protective materials until vegetation cover is re-established.

- All watercourses with fringing riparian woodland or floodplain eucalypt woodland will be crossed at right angles to minimise the distance transected. Clearing widths will be 35m within this habitat.
- The pipeline route has been subjected to terrestrial and aquatic ecological assessments and has been realigned to avoid mature trees with hollows and permanent waterholes and billabongs.
- Migratory species are addressed in the threatened fauna management plan (TFMP).
- Construction activities within and near watercourses will be restricted to dry weather during dry or low flow conditions where reasonably practicable.
- Construction in the known distribution of the endangered Fitzroy Turtle (*Rheodytes leukops*) will not occur during September-October to minimise impacts on breeding and nesting.
- If the construction schedule requires construction through one of these watercourses during this period they will be inspected by an aquatic ecologist for evidence of nesting. If no nesting works may proceed. If nesting the area must be avoided for 46-97 days. Works may only commence on the authority of the qualified aquatic ecologist that it is safe to do so.
- Weed management will be implemented to prevent the introduction of introduced and spread of flora species to waterways. Activities will also be undertaken in accordance with Table 11.9 Weed and pest management plan p 115 of the approved Q-1801-15-MP-0002 APLNG Main pipeline EM Plan.
- No water will be transferred between water catchment systems, unless it has been treated to remove any pest fish and other aquatic species.
- Rehabilitation and revegetation will be undertaken as soon as construction is completed and designed to promote plant growth and maintain groundcover.
- Diverted hydrological flows will be reinstated post construction to minimise subsequent disturbance to vegetated areas and reduce erosion potential leading to sediment runoff.
- Revegetation will be based on existing local vegetation and soil type characteristics in accordance with the rehabilitation plan.
- Access to the constructed ROW will be restricted to the required vehicles and equipment to promote the rehabilitation of surrounding riparian habitat.

Management of water quality during crossing construction
• Monitoring of in-situ water quality will occur daily during construction when the workspace is isolated from flow, for the following parameters: - water temperature, - conductivity, - pH, and - turbidity. • Two sites will be monitored at each creek crossing construction location: one 50 m upstream of the construction site, and one 50 m downstream. The results will be compared to the relevant water quality objectives outlined in Table 2.2.
Management measures to be implemented to control erosion and sediment in and around watercourses
• Erosion control measures will be installed in accordance with the Soils and Erosion management plan p 64 Table 10-5 of the approved Q-1801-15-MP-0002 APLNG Main pipeline EM Plan. • Sediment fencing will be installed around active erosion adjacent to watercourses, as needed to keep areas stable. • Erosion and sediment control measures (e.g. contour banks, earth banks, turn off drains, silt fences) will be installed and maintained, as appropriate and advised by the soils expert. • Erosion control measures such as silt fences, berms and drains will be appropriately maintained. • Monitoring will note the condition of such measures and the need for remedial action. • Clearing of slopes leading to watercourses will be delayed, where safely practicable, until construction of the crossing is imminent. • Erosion control measures will be installed on slopes to prevent and/or minimise erosion and sedimentation risk.
General good practice management measures to be implemented in and around watercourses
• Vehicle maintenance areas, portable refuelling stations and storage of fuels, oils and batteries will be undertaken within bunded areas, designed and constructed in accordance Australian Standard 1940 (1940-2004) – *The storage and*

handling of flammable and combustible liquids (as is proposed) and are located above the Q100 flood level of nearby waterways and dams.

- All spills of contaminant over 20 litres will be reported to an Environmental Officer (or delegated person).
- Appropriate spill containment kits will be available, and used for the cleanup of spills in the field. Equipment that is susceptible to spills and/or leakages will have a spill kit within 5 m of the equipment at all times. The kits will contain equipment for clean up of both spill on land or in dry creek beds, and spills to water (such as floating booms).

Monitoring requirements to be implemented to protect aquatic values for watercourse crossings

- Monitoring will occur - Daily during crossing of watercourses with standing or flowing water at the crossing point, daily during works in a watercourse and following significant rainfall events, annually as part of the regular patrols and after heavy rainfall.
- Monitoring of water quality 50 m upstream and 50 m downstream for the following parameters will be carried out: water temperature, conductivity, pH, turbidity and litter.
- Visual monitoring of hydrocarbons (slicks or sheens on the water) and sediment deposition, erosion and bank stability downstream of watercourse crossings.
- Visual inspection of pipeline watercourse crossings for erosion, bank stability of the pipeline easement and, in particular, the condition of watercourse bed, banks and riparian vegetation will be inspected in accordance with the monitoring program.
- Upon completion of the construction and rehabilitation, each crossing location will be inspected by an ecologist to verify that the rehabilitation has been completed to a standard suitable for protecting the ecological values of the watercourse in the long-term.
- Detailed in-field aquatic assessments will be completed at the same sub-set of sites surveyed for the pre-construction dry and wet season assessments. These surveys will be completed in the first post-wet season following construction, to allow time for the aquatic ecological values to recover, and to assess the stability of the bed and banks after the wet season. The monitoring methods used will be consistent with those used for the pre-construction surveys, to allow a direct comparison of results.
- Where the post-construction surveys indicate that there has been a decline in aquatic values, additional rehabilitation measures will be recommended, and

further follow-up surveys completed until there is recovery of the pre-construction aquatic values.
Hydrostatic test water
• Hydrostatic test water will be re-used where practicable, thereby minimizing the volumes required. • At no stage will hydrotest water be released directly to surface waters. • All hydrotest water disposed will be in accordance Table 3.1 Limits for the disposal of hydrostatic test water to land.
Corrective Actions to be implemented at watercourses
• Erosion and sediment control devices will be cleared, repaired or replaced whenever inspection show signs of non- compliance or ineffective capability or capacity. • Where erosion and sediment control devices are found to be not in accordance with the erosion and sediment control management plan, work in the affected area will cease and the control devices will re-established to meet the design criteria prior to recommencing works. • Construction activities in watercourses will cease where a major rainfall event is forecast that will create heavy flows in the watercourse. Work must not re-commence until a site inspection has determined that the watercourse has returned to stable flow (or no flow) conditions. • If weed or pest species associated with project activities are detected, corrective action must be undertaken in accordance Table 11.9 Weed and pest management plan p 15 of the approved Q-1801-15-MP-0002 APLNG Main pipeline EM Plan. This can include controlled use of herbicide sprays in dry watercourses or physical capture and removal of pest species from infected waterways by a licensed operator. • Additional temporary water diversions will be installed, if ephemeral watercourses are likely to flow during construction of crossings, Refer to the additional measures in the site specific management measures developed for sites that are likely to have water for. • Re-enforced bank stabilisation measures must be installed at any sites subject to ongoing erosion and scouring. • Additional rehabilitation and/ or revegetation of disturbed areas must be undertaken in accordance with the rehabilitation plan.

4.1 Impacts to Salt Pipewort

Salt pipewort is known from Cockatoo Creek and listed as endangered under the EPBC Act and NCA. Salt pipewort was not recorded during detailed surveys of the crossing location on Cockatoo Creek. Site specific mitigation measures in accordance with condition 28(f) are summarised above and detailed in Appendix A. As the species was not located at the crossing point a species management plan in accordance with condition 30 has not been prepared.

4.1.1 Likelihood of Impacts to Salt Pipewort

It is considered that the construction and operation of the pipeline will not have a direct impact on this species, as it was not recorded during detailed surveys of the crossing location on Cockatoo Creek. However, further surveys will be done immediately prior to construction to confirm that this is the case. If the species is recorded prior to construction, a detailed species management plan will be prepared.

Secondary impacts to potential downstream populations as a result of changes in flow or water quality will be mitigated by implementing the measures outlined in Table 4.1 and Appendix A.

4.2 Impacts to Fitzroy River Turtle

The Fitzroy River turtle (*Rheodytes leukops*) is listed as vulnerable under the EPBC Act. The species occurs in flowing rivers with large deep pools and rocky, gravelly or sandy substrates, connected by shallow riffles (Cogger 1996; Limpus et al. 2007). Preferred habitats have high water clarity and are often associated with ribbon weed (*Vallisneria* sp.) beds (Cogger 1996). The Fitzroy River turtle is endemic to the natural permanent riverine habitats of the middle and lower Fitzroy catchment (Limpus et al. 2007).

4.2.1 Likelihood of Impacts to Fitzroy River Turtle

The likelihood of impacts to this species at Cockatoo Creek have been assessed based on the results of the detailed in-field surveys (which indicate that Fitzroy River turtle and Fitzroy River turtle breeding habitat is highly unlikely to occur at the crossing site in Cockatoo Creek), and the proposed mitigation and management measures outlined above, specifically:

- open-cut construction during the dry season where practical, avoiding the breeding season (September to October),
- if the construction schedule requires construction during this period, the crossing site will be inspected by an aquatic ecologist for evidence of nesting. If no nesting works may proceed. If nesting the area must be avoided for 46-97 days. Works may only commence on the authority of the qualified aquatic ecologist that it is safe to do so,
- salvage of aquatic fauna from isolated workspaces, and
- rehabilitation of in-stream habitat after construction.

In summary, it is considered that where the above mitigation measures are implemented, the construction and operation of the pipeline crossing of Cockatoo Creek will not have a significant impact on this species.

4.3 Suitability of Construction Methodology

It has been determined that site specific mitigation measures outlined in Table 4.1 and Appendix A adequately protect against adverse impacts to MNES in Cockatoo Creek, specifically the salt pipewort.

Open cut construction has been identified as a suitable methodology during dry or low flow conditions, avoiding the period between September and October). During times of moderate to high flows, the following order of actions will be undertaken to protect against adverse impacts to MNES species or habitat:

- construction crews wait till flow recedes
- aquatic ecologists to determine on site prior to works commencing if undetected MNES species is present or habitat will be impacted
- if no impact identified open cut crossing and implement site specific measures, and
- if impact identified assess crossing for suitability of HDD, based on limitation criteria outlined in Section 1.2.

To enable rapid assessment of flow conditions during construction, flow is defined as outlined below:

- Low flow conditions are considered to be situations where the crossing site is dry, contains pooled water or there is flow but water levels are contained to the low flow channel (as determined by bank shape and vegetation features).
- Moderate flows are considered to represent times when there is flow in the watercourse and the water is at mid-height on the bank.
- High flows represent times when the water level is above the middle of the bank.

4.4 Post-construction Monitoring

Upon completion of the construction and rehabilitation, each crossing location will be inspected by an ecologist to verify that the rehabilitation has been completed to a standard suitable for protecting the ecological values of the watercourse in the long-term.

A detailed in-field aquatic assessment will also be completed at the same site surveyed for the pre-construction assessment. It is proposed that this will be done in the first post-wet season following construction, to allow time for the aquatic ecological values to recover, and to assess the stability of the bed and banks after the wet season. The monitoring methods used will be consistent with those used for the pre-construction surveys, to allow a direct comparison of results.

Where the post-construction surveys indicate that there has been a decline in aquatic values, additional rehabilitation measures will be recommended, and further follow-up surveys completed until there is recovery of the pre-construction aquatic values.

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Appendix A Site Assessment Sheet for Cockatoo Creek

Mainline	Coordinates (WGS 84)	
MKP75.51 Cockatoo Creek Catchment: Dawson River	**Latitude** -25.726051°	**Longitude** 150.286736°

Stream Order and Geomorphology
Stream Order 4
Spring fed stream; pipeline crossing location is ~100 m downstream of likely spring. Slow flowing main channel, likely to receive runoff from adjacent gullies during rainfall. Channel substrate composed of sand, with some silt, clay and pebble substrate. Cattle grazing was the adjacent land use.

Erosion Risk
Moderate. Erosion already present, particularly on the steeper left bank. Erosion risk most likely due to higher flows in the wet season.

Riparian Vegetation (Further detail on riparian vegetation in the pre clearance plan)
Riparian vegetation composed of grasses, trees (Melaleucas and Eucalypts) and shrubs. Meandering channel through stands of *Melaleuca trichostachya*.

Aquatic Flora and Fauna, Including Breeding Habitat
Variety of in-stream habitat present including cobbles, boulders, pebbles, in-stream vegetation (grasses) and some woody debris. Many tadpoles, frogs, dragonflies and juvenile fish present. Species common to the region were caught during the field survey. These species are adapted to living in variable aquatic environments. Site likely to support additional species in the wet season.

Endangered / Vulnerable / Rare (EVR) Flora and Fauna
Nil recorded during field survey. The Fitzroy River turtle (*Rheodytes leukops*) unlikely to occur at the crossing location due to lack of suitable habitat. The salt pipewort (*Eriocaulon carsonii*) is known from the springs in the area, but was not found during detailed targeted surveys for this species.

Aquatic Values
Habitat Bioassessment Score: 95 (good)
Macroinvertebrate Richness: 11 (bed); 30 (edge)
Macroinvertebrate PET Richness: 2 (bed); 3 (edge)
Macroinvertebrate SIGNAL 2 Score: 2.86 (bed); 2.90 (edge)
Level of Disturbance: slightly to moderately disturbed

Overall Aquatic Values:
Dry Season: Moderate to high
Wet Season: High – likely to provide breeding or dispersal habitat for fish

Mitigation and Management Measures
Apply all standard mitigation and management measures as per the EM Plan and APIA code of environmental practice.

Apply the following specific management measures:

Timing Constraints
Nil (no EVR species likely to be present)

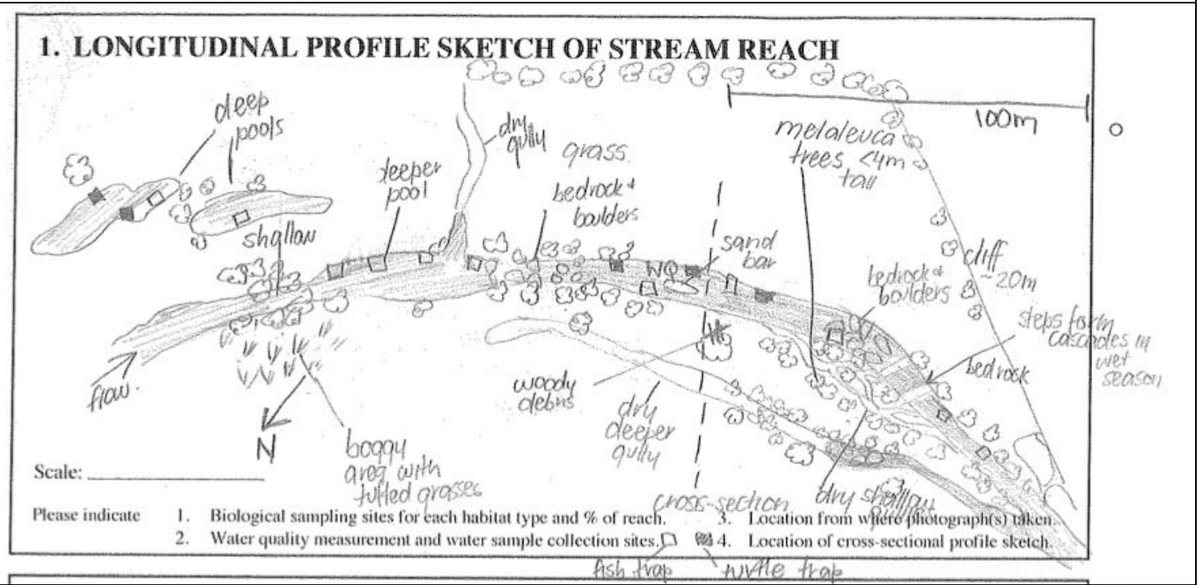
Site-specific Pipeline Construction Methods and Mitigation Measures
Open trench during no or low flows. Isolate workspace; divert flows. Fish salvage from isolated workspace and water quality monitoring required. Will require a temporary waterway barrier works approval from DEEDI (does not meet requirements of self-assessable code due to large bankfull stream width). Revegetate banks and replace bed material and in-stream habitat (in particular, large woody debris and cobble substrate) when construction complete. Heavy clearing required due to surrounding state forest.

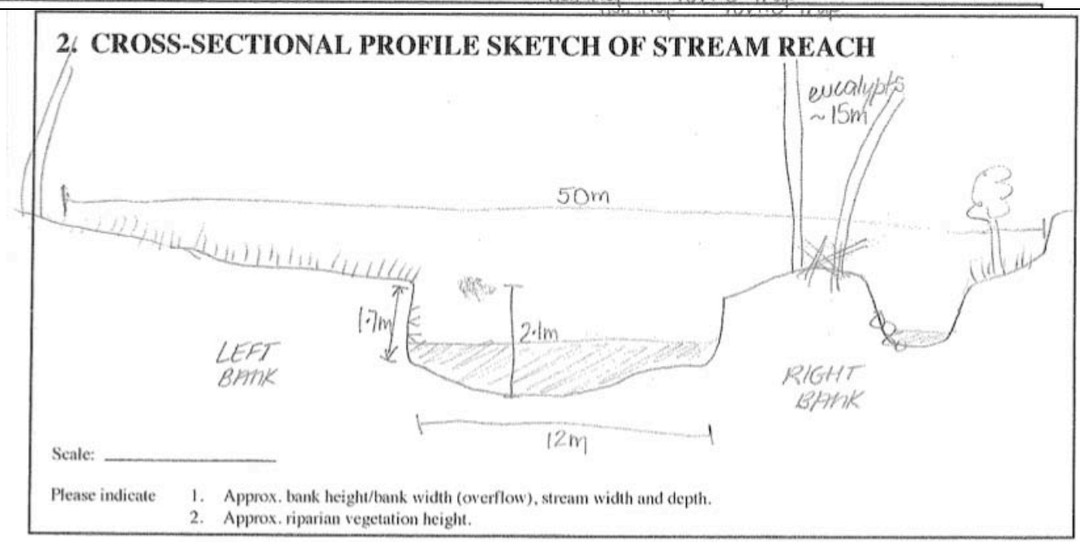
If construction is in wet season: use trenchless method (e.g. HDD).

Site-specific Access Track Construction Methods and Mitigation Measures
Culverts under crossing e.g. flumes required. Will require a temporary waterway barrier works approval from DEEDI. Water quality monitoring is required during construction. Revegetation and rehabilitation of banks required. Construction not recommended during moderate or high flows. Flumes must be appropriately sized to allow moderate to high flows to pass.

Implement temporary and permanent erosion control measures as per the site sedimentation and erosion control plan. Rehabilitation as per general pipeline ROW plan.

Aerial Photograph of KP





Downstream	Upstream	Left Bank	Right Bank