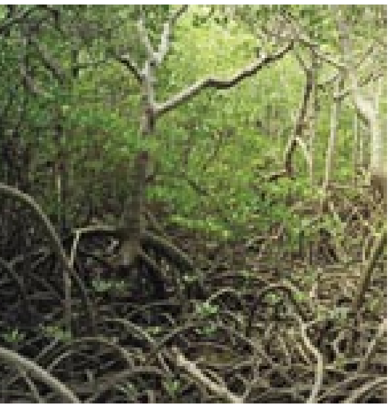
Appendix E

Blacktip Project EIS: Hydrology and Water Quality prepared by EWL Sciences

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Blacktip Project EIS: Hydrology & Water Quality

Prepared for: EcOz Environmental Services
Prepared by: EWL Sciences Pty Ltd

Authors: Ian Hollingsworth, Phillipe Puig, Michael Welch

July 2004

EWL Sciences Pty Ltd
Darwin Office 482 Stuart Highway, Winnellie NT 0820
PO Box 39443, Winnellie NT 0821
Tel: (08) 8922 5200 Fax (08) 8922 5260

ABN 12 000 955 171 Registered Research Agency No 31639

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Authors:

Ian Hollingsworth, Phillipe Puig, Michael Welch

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Project Manager: ______________ *Ian Hollingsworth*

Reviewer: ______________ *Alan Puhalovich*

General Manager: ______________ *Dr A R Milnes*

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ACKNOWLEDGEMENTS:

- External document assistance, Kylie Harvey (EcOz),

EXECUTIVE SUMMARY

Background

A desktop survey was made to identify the potential wetland, riparian and groundwater impacts arising from the Blacktip Project. The locations of project components were overlaid on hydrogeological mapping (1:250 000), drainage (1:250 000) and raster topographic mapping (1:100 000). Intersections between project co-ordinates and high quality groundwater resources close to existing bore fields, drainage systems and wetlands were recorded as potential areas of hydrological impact. Standard methods for qualitative risk assessment were applied to rank the perceived impacts associated with the construction and operational activities of the project. A wetland classification and a matrix of water quality parameters was extracted from national guidelines for ecosystem protection. The guidelines were applied to assess surface and groundwater quality impacts. Statements of intent that we have made on behalf of the proponent are taken from the project design documentation provided to us.

Hydrology

The desktop study (using 1:100 000 scale mapping) did not identify any surface drainage in the immediate project area. Groundwater fed, near coastal wetlands occur 1 to 3 km away, down gradient to the north and south. The groundwater aquifer beneath the proposed Blacktip onshore project area is shallow, good quality and high yielding. It is a significant resource that supports nearby wetland ecosystems and will underpin agricultural and residential development in the Port Keats area into the future. The shallow depth to groundwater means that it is vulnerable to contamination through the land surface. Although the demands on the aquifer are currently minor and discharge from it supports near coastal wetlands, the high quality of the groundwater resource requires a high level of protection.

Impact Assessment & Recommendations

Potential hydrocarbon contamination of a relatively vulnerable and productive groundwater resource is the primary concern from the Blacktip project. This concern is moderate because most of the hydrocarbon at the site is volatile gas that will vent from buried infrastructure to the atmosphere. However, the condensate fraction and the fuel storage on site may potentially move directly to groundwater if a catastrophic rupture occurred. The project infrastructure and hydrological features upon which impacts were assessed are shown in Map 1.

There are knowledge gaps in understanding the risks to the groundwater resource in the vicinity of the gas plant and pipeline. Site-specific fate and transport modelling to identify potential flow paths and receptors of possible hydrocarbon contamination plumes arising from the project would help to address the risks and design an effective groundwater monitoring and spill response program. The groundwater monitoring system will need to be able to detect potential leakage of condensate and fuel hydrocarbons in particular from the Blacktip Project into the shallow groundwater system and assess impact on the receiving environment and municipal groundwater supplies. Monitoring and responding to groundwater impacts would pre-empt and reduce the risk of impact to near coastal wetlands, which are the local groundwater discharge areas. A site hydrogeological investigation is recommended once project planning is complete.

Detailed recommendations on crossing design, track construction, clearing and rehabilitation are provided in the body of this report to address potential impacts on surface water systems. Water extraction and disposal options need to be considered in consultation with landowners.

Marine or groundwaters are the preferred source for hydrotest water. The groundwater aquifer at the site could be used with a relatively low level of perceived environmental detriment for the volumes of water required for hydrotesting and ancillary services. If seawater is used, then disposal of the hydrotest water to the ocean outfall is recommended. If freshwater is used, then hydrotest water could be disposed of by land application to stable (rocky) vegetated areas. This approach would minimise impacts on surface and groundwater quality and the potential for introducing foreign plant and animals into local ecosystems.

1 INTRODUCTION

1.1 BACKGROUND

The desktop assessment of possible hydrological and water quality impacts associated with the onshore infrastructure of the Blacktip Gas Project were based on draft EIS guidelines (February 2004) that specify the documentation on baseline conditions, impact assessment and management that the proponent will need to consider.

1.2 PROJECT OBJECTIVES

The project objectives were to assess the potential environmental impacts of the Blacktip Project on surface and groundwater hydrology and recommend mitigation measures. The following assessment framework for onshore facilities from the EIS guidelines (Section 4.3 Draft EIS Guidelines February 2004) was used.

Baseline

- Provide a general description of the surface water systems that may be impacted by the onshore pipeline and gas processing facilities including storm water systems; natural and artificial catchment systems, drainage lines, wetlands and waterways; and the direction of overland flows.
- Describe the groundwater systems along the onshore pipeline route and facilities site.
- Provide details of the potential locations of pipeline waterway crossings including bed and bank profiles and describe selection criteria for determining the final crossing locations. Including information on the flow regime of the waterways in the vicinity of the pipeline, in particular the timing (and volume) of flows in relation to any construction work.

Impacts

- Describe how the pipeline and other components of the project might impact on the surface and groundwater features described above.
- Provide details of typical crossings that would be constructed at each water way crossing location and likely impacts associated with the crossing.
- Detail the options for the source and impact of water for hydrostatic testing and any other construction / operational water use, together with plans for its disposal after use.

Management

- Discuss measures to ensure the beds and banks of water courses remain stable and protected from the natural forces of erosion as required, incorporating preferred methodologies of relevant Advisory Agencies where practicable particularly where there has been any disturbance to the bank or bed.
- Discuss measures to safeguard downstream surface and ground water quality including appropriate management of any excavated acid sulfate soils and wetland crossings.

- Describe measures to address extraction and dewatering of groundwater from the trench including use of impoundment's.

Based on discussions with the proponent via EcOz, and our analysis of the available information, we understand that the onshore pipeline and gas plant will not intersect surface drainage systems. Consequently, field descriptions of bed and bank profiles have not been made. However, drainage depressions on the pipeline route not identified in the 1:100 000 scale base mapping provided to us will need to be considered during construction. The proposed scope of work was developed following consultation with *EcOz* and consideration of the draft EIS guidelines.

2 BASELINE CONDITIONS

2.1 CLIMATE

The climate is tropical monsoonal with a dry season which extends from May to September. This is followed by a wet season that typically lasts until the end of April. The mean annual rainfall in the region is about 1,400 mm, with a majority of the precipitation occurring during the wet season. Precipitation is negligible during the dry season.

2.2 INFORMATION RESOURCES

The groundwater and surface water data were obtained from the Wadeye/Nauiyu Water Study (Haig and Matsuyama 2003). Geographic information and documentation that was used is listed in Table 1. All map data is in geographic co-ordinates and WGS84 datum.

2.3 SURFACE WATER

The Blacktip onshore project area is wholly located within the Moyle River basin. The Moyle River basin (NLWRA 2000) comprises sub-catchments that are described as being unaffected by development. The average annual runoff is estimated to be around 600,000 ML/annum, with total diversions believed to be negligible. The Blacktip Gas Project is located within the southern sub-catchment of the Moyle River basin. The southern sub-catchment has an area of approximately 250 km^2. There is no well-defined surface drainage in the project area. Coastal inlets and associated mangroves with seasonally inundated inland swamps occur 2-3 km from the project area at Injin Beach to the north and around the inlet on Yelcher Beach to the south. These wetlands are down gradient of the Blacktip Project and the development activities may consequently have some impact on them via groundwater pathways in the future.

There are limited stream flow measurements. Stream gauging stations in the Moyle catchment (within 50 km of the project area) are listed in Table 2. Many of the creeks and streams have small flows at the end of the dry season. In most cases, the creeks dry up each year and do not flow again until the next wet season. There is no perennial stream network in the vicinity of the proposed development. The Port Keats gauge at Dee Creek (G8130003) is similar to that in the southern sub-catchment in which the proposed development is located.

Flows peak at the Port Keats tide gauge at the Dee River landing (G8130003) in December and January. Some of the largest flows in the region have been measured in the Daly River near Nauiyu, Tom Turners creek near Peppimenarti and the Moyle Rover between Peppimenarti and Nganmarriyang (Palumpa).

Table 1 Geographic information

Theme	File name	Source	Custodian
Outstations	Outstations.shp	(Haig and Matsuyama 2003)	Manager of Spatial Data and Mapping, Natural Systems, DIPE, NT Government ph) 08 89993603, fax)08 89993667 Address) 4th Floor Goyder Building, 25 Chung Wah Terrace, Palmerston, NT 0830, or PO Box 30, Palmerston, NT 0831
Stream gauges	All_stream_gauge_sites.shp	As above	As above
Rain gauges	All_rain_gauge.shp	As above	As above
Bores	All_keats_bores.shp	As above	As above
Evaporation gauges	All_evap_gauge.shp	As above	As above
Tracks	Tracks.shp	As above	As above
Minor roads	Roads_minor.shp	As above	As above
Major roads	Roads_major.shp	As above	As above
Catchments	Swma_geom_nat_polygons .shp	As above	As above
Hydrogeology	Keats_hydro_final	As above	As above
Sub-catchments	Sub_basins.shp	As above	As above
Seasonal wetlands	Seasonal_habitats.shp	(Gecoz 2001)	As above
Coastal wetlands	Nt wetlands.shp	(Gecoz 2001)	As above
Pipeline alignment	Pipeline_alignment_5_2004 0303_polyline.shp	Mipela (GIS) Pty Ltd	Hayden McDonald GPO Box 1152 Brisbane QLD 4001, p 07 32525589, f 07 32522477
Pipeline corridor	Pipeline_corridor_5_200402 24_region.shp	Mipela (GIS) Pty Ltd	Hayden McDonald
100K Topographic mapping	topo 100k raster mosaic	As above	As above
Project locations	Site_locations_040406.shp	Woodside	Ceri Morgan
Project Description	R11UMP_DraftA_Ch4.doc	SKM	C Morgan
10 km staging points	10k_Flags_5_20040303_poi nt.shp	Mipela	H McDonald
Drainage	Drainage_250k_polyline.sh p	Mipela	H McDonald
Roads	Roads_250k_polyline.shp	Mipela	H McDonald
Locality	Locality_250k_point.shp	Mipela	H McDonald
Hydrogeology	All_hydro_final.shp	DIPE	Lynton Fritz
Stream gauges	all_stream_gauge_sites.shp	DIPE	Lynton Fritz
Bores	all_keats_bores.shp	DIPE	Lynton Fritz

Table 2 Key gauging stations

Station	Name	Easting (AGD66)	Northing (AGD66)	Commenced	Ceased	Minimum flow (L/s)
G8130001	Moyle River at Port Keats Road Crossing	614400	8421500	8/08/66	19/07/86	5
G8130002	Tom Turners Creek at Tom Turners Crossing	623600	8431600	8/08/66	6/11/86	134
G8130003	Port Keats Tide Gauge at Dee Creek Landing	561151	8433761	6/09/79	6/11/86	NA
G8130004	Quins Creek at Road Crossing	582000	8418000	19/07/86	6/11/86	11
G8130010	Karrowa Creek at U/S Port Keats Road	617200	8428500	21/06/79	21/06/79	17

As part of the Wadeye/Nauiyu water study 108 surface water samples were collected from monitoring sites (Haig and Matsuyama 2003). About 20 samples were collected from small creeks and rivers between the Daly and Fitzmaurice rivers. Descriptive statistics for the general water quality parameters are shown in Figure 1.

The 95% Confidence Interval values from Figure 1 for pH (7.4-7.6), Electrical Conductivity (354-450 $\mu S.cm^{-1}$), temperature (21-30?C) and turbidity (73-92 NTU) are indicative of the range in baseline conditions. No permanent, fresh, surface water resources were identified in or adjacent to the proposed Blacktip gas processing facility. However, ephemeral runoff would appear to support near coastal wetland ecosystems. There is no evidence of contamination or acid generation.

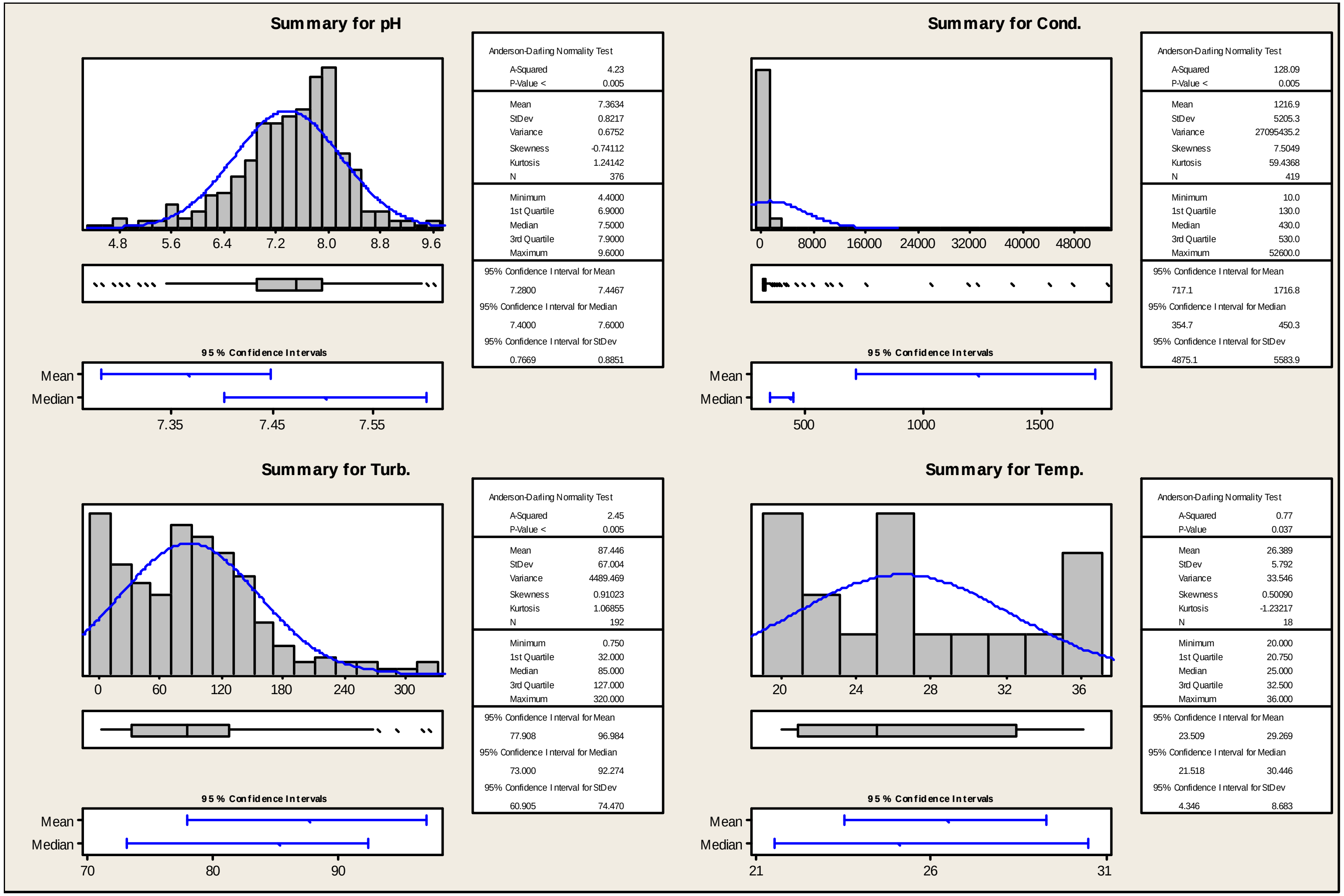

Figure 1 Surface water quality, general parameters

2.4 GROUNDWATER

Relatively shallow aquifers are present in sandstone, siltstone and claystone sediments of the Upper Permian Hyland Bay Formation. An impervious claystone at a depth of 50 to 100 metres marks the base of the aquifer. Shallow aquifers are the source of groundwater for the community of Wadeye and the outstations of Ditchi, Nangu, Kuduntiga, Ngardiniitchi, Old Mission, Kuy and Yedderr. Housing development is currently being extended along the road to the proposed development site. Shallow aquifers also have environmental beneficial uses - supporting wetlands and spring fed vegetation.

A high yielding, widespread shallow aquifer system underlies the Blacktip onshore project area. Water table depths at 10 to 15 m occur in the vicinity of the Blacktip Project. Pipeline trench excavation during the dry season is unlikely to intersect the water table. Yields commonly exceed 5 L/s and less often 10 L/s. In general, bore yields are very inconsistent and vary between 9.5 and 22 L/s. Higher yielding bores are associated with fracturing or a local source of recharge. This is a significant resource with potential to supply industrial or residential development in the future. In the view of the groundwater resources authority in the NT Government this is a community resource that requires a high level of protection.

The Wadeye community has a designated borefield for domestic water supply. The use of water from the reticulated water supply is allocated for drinking and the irrigation of lawns, community parks or football ovals. An essential service officer (ESO) with the Power Water Corporation maintains the community water supply. The Port Keats borefield has a number of monitoring bores where water levels are measured periodically. Monitoring bores were measured either monthly or once a year between 1985 and 1997. Between 1997 and 2002, there were no water level measurements made in monitoring bores.

The community production bores have production yields measured with a constant rate pump test. Community bores are usually not pumped at the maximum yield. The bores are pumped at rates that will meet community needs and storage restrictions. The bores are pumped at between 2 and 7 L/s at different times of the year. Wadeye has one high yielding bore that can be pumped at rates as high as 18 L/s if needed. Estimated daily water consumption for the Wadeye community is 1,295,000 L/day. This estimate is taken from Table 4 in the Wadeye Nauiyu water study report (Haig and Matsuyama 2003). It is based on records between 1999 – 2001, a population of 2,452 and usage of 528 L/person/day.

Certain plants, animals, and ecosystems rely on water from groundwater sources. Groundwater dependant ecosystems occur on Injin Beach to the north of the project area, and in the freshwater inlet to the south on Yelcher Beach. The Yelcher Beach inlet is the main catchment drainage system. The hyetograph of changing water levels in Port Keats (Figure 2) indicates stable groundwater levels over time. Presently the volume extracted from the municipal bore fields has not caused any noticeable impact on areas of environmental significance.

Water quality analyses from relevant outstation and community bores are summarised in Table 3, together with the groundwater investigation levels (GIL's). The GIL values, with consideration of ambient groundwater qualities, form the basis for the assessment of contaminated groundwater and associated risks and are taken from on the Australian Water Quality Guidelines (AWQG) and the Australian Drinking Water Guidelines (ADWG) as set out in Schedule B(1) Table 5-B (NEPC 1999a). The GIL values define acceptable water quality at the point of use and apply as investigation levels at the point of extraction and as response levels at the point of use, or where there is likelihood of an adverse environmental effect at the point of discharge.

Water sampling of all outstations and community bores indicates that the water quality is generally within the *Water Quality and Monitoring Guidelines* (ANZECC 2000) as outlined by the *Australian and New Zealand; Guidelines for Fresh Water Quality*. Low ambient groundwater pH occurred at the Wadeye bore RN027211 and may indicate naturally acid conditions.

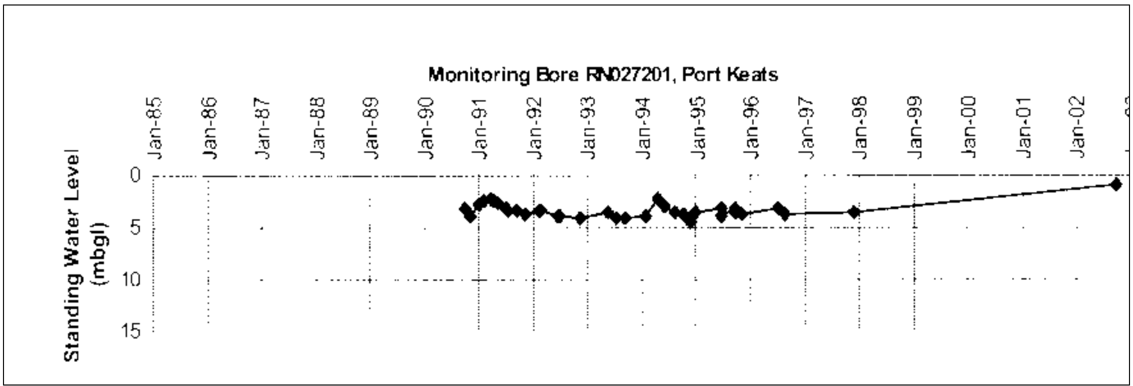

Figure 2 Monitoring bore data, Port Keats

Table 3 Regional groundwater chemistry and groundwater investigation levels (GIL's)

Bore RN	**RN025961**	**RN024308**	**RN027211**	
Outstation or community	Ditchi	Ngardinitchi	Wadeye	**GIL**
Bore yield (L/s)	10.0	5.0	22	na
pH	6.1	6.5	4.8	6.5-8
EC (µS/cm)	50	75	28	1500
Total Dissolved Solids (mg/L)	55	70	27	500
Sodium, Na (mg/L)	3	5	3	300
Potassium, K (mg/L)	4	4	1	na
Calcium, Ca (mg/L)	3	5	1	1000
Magnesium, Mg (mg/L)	1	1	1	<600
Iron (total), Fe (mg/L)	0.7	1.1	0.1	0.3
Total Hardness (mg/L)	8	17	4	na
Total Alkalinity (mg/L)	12	17	2	na
Bicarbonate, HCO3 (mg/L)	15	20	2	na
Silica, SiO2 (mg/L)	22	22	16	na
Chloride, Cl (mg/L)	6	10	6	250
Sulfate, SO4 (mg/L)	4	5	1	400
Nitrate, NO3 (mg/L)	1	1	1	na
Fluoride, F (mg/L)	0.1	0.1	0.1	na

3 IMPACTS FROM CONSTRUCTION AND OPERATION

The EIS guidelines require assessment of possible impacts from the construction and operation of the proposed development on surface and groundwater systems. Specifically in terms of:

- how components of the project might impact on the surface and groundwater features;
- details of typical crossings that would be constructed at each waterway crossing location and likely impacts associated with the crossing; and
- the options for resource use and impact of water for hydrostatic testing and any other construction/operational water use, together with plans for its disposal.

3.1 PROJECT COMPONENTS

Site location details have been taken from the project description document (Sinclair Knight Mertz 3/3/04). The co-ordinates of the project components identified in this draft document, and on which the assessment of hydrological impacts is based, are shown in Table 4. These co-ordinates represent the general location of the project and are likely to change in the final project plan. The onshore gas processing plant has a footprint of 750 by 750 m. Key project components that represent potential hydrological impact are listed in Table 5.

Table 4 Project co-ordinates

Project Component	Co-ordinates
Blacktip Reservoir	128° 27'E to 128° 30'E 13° 53'S to 13° 55'S
Export Pipeline Landfall	129°24'43"E 14°14'33"S
Onshore Gas Processing Plant	129°25'52.09"E 14°14'33.60"S 129°26'05.87"E 14°14'13.22"S 129°26'26.77"E 14°14'26.66"S 129°26'12.99"E 14°14'47.04"S
Spread Mooring for Condensate Export	129°23'27.77"E 14°14'27.65"S 129°23'19.10"E 14°14'36.58"S 129°23'10.44"E 14°14'45.52"S 129°23'01.78"E 14°14'54.46"S

Table 5 Key Blacktip development characteristics

Project element	**Purpose**	**Characteristics**
Condensate storage and export	Onshore condensate stabilisation and storage facilities	Approx. 6km pipeline for condensate export from onshore storage facilities to nearshore spread mooring. Spread mooring in 14 m water with condensate loading facilities onto tankers.
PW Facilities	Treatment of PW to remove condensate and contaminants Disposal of PW	PW treatment plant and settling ponds. Approx. 2 to 3 km pipeline (4 to 6" diameter) to ocean outfall for disposal of treated PW.
Gas Export Pipeline	Transport of reservoir fluids from wellhead platform to onshore facilities Includes shore crossing and onshore component of pipeline	Approx. 2 to 3 km from low water mark to onshore gas processing facility.
Laydown Areas	Beach storage area for pipeline sections during installation Onshore storage area for construction materials and vehicles	Pipe laydown area on the beach for pipeline construction materials 50 m x 50 m. Plant laydown area within 750 m x 750 m onshore footprint for materials, vehicles, construction camp, onshore facilities
Gas Processing Plant	Processing, compression and metering of gas	Within 750 m x 750 m footprint Slug catcher and primary liquids separation. Water and hydrocarbon dew-pointing Compressor including turbines (3 x 50%) and stacks to compress gas to 150 bar
Utilities	Support facilities for onshore processes	Power generation Firewater Instrument air, liquid and gaseous fuel systems
Accommodation	One accommodation camp will be used during all phases of the project	Within 750m x 750m onshore footprint for materials, vehicles, construction camp, onshore facilities. Up to 200 (peak) personnel during construction. The camp will be downsized following peak construction period to a capacity of approx. 40 personnel. Up to 4 operational personnel, with additional personnel as required for maintenance
Access and Haul Routes	Several options are being considered to transport provisions, equipment and personnel to and from the site during construction, operations and decommissioning	Dry season access via existing Wadeye airstrip or via road from Darwin. Wet season access via existing Wadeye airstrip or existing Wadeye barge landing. A road will need to be constructed from Wadeye to the onshore plant area.

3.2 CONSULTATION

The project officer from the supervising authority (Rod Johnson, NT Department of Environment & Heritage) and Principal Water Resources Engineer (Peter Jolly, NT Department of Infrastructure, Planning & Environment) were consulted. The scope of this discussion is given in Appendix A, with key issues identified as:

1. define the extent of disturbance associated with cathodic protection arrays (document 13832-7);
2. identify possible metal contaminants (extrusion treatments / surface coatings) associated with the pipe pressure testing using water;
3. identify possible contamination associated with epoxy mechanical / abrasion protection coatings;
4. hydrocarbon pipeline, storage and processing infrastructure in the vicinity of high quality groundwater resources, such as at Blacktip, will require detailed fate and transport assessment consistent with investigations for contaminated site risk assessment.

The proponent has provided the following information to address these issues:

Item 1. Cathodic protection (CP) arrays: shallow ground beds will probably be used in which case a trench will be dug 3 m deep, 600 mm wide and 25 m long. Eight anodes surrounded with petroleum coke (conductor) in a bag will be placed in the trenches, which will be backfilled to bury the anodes. Riser pipes will be inserted into the trenches to allow for watering if required. Beds can be up to 500m from the pipeline and are connected by a buried cable. Beds will usually be located at scraper facilities, as the CP system requires a source of power (solar).

Item 2. Potential contamination from linepipe coatings: linepipe is not coated internally and therefore will only contaminate the hydrotest water with rust. The pipe will be heated during the coating process so that any oil used in the forming of the pipe will likely have been removed. Note that the pipe is not extruded but is continuously formed from a flat strip and an Electric Resistance Weld (ERW) used to join the edges of the strip. An oxygen scavenger such as sodium sulphite may be used in the hydrotest water to minimise corrosion of the pipe. The joint coating is on the outside of the pipe and will not come in contact with the hydrotest water.

3.3 IMPACT ASSESSMENT

Assessment of surface water impact from project construction and operation was based on a national wetland classification and water quality criteria for ecosystem protection. The proposed wetland classification system in Table 6 follows that outlined in the Directory of Important Wetlands in Australia (Environment Australia 2001), which is based on the system used by the Ramsar Convention in describing Wetlands of International Importance. The proposed water quality criteria in Table 7 are based on national guidelines for environmental protection (ANZECC 2000).

Assessment of groundwater impact from project construction and operation follows the risk based approach recommended in national guidelines (NEPC 1999b). These guidelines initially apply generic criteria (ADWG 1996; NHMRC and ARMCANZ 1996) to provide a system that responds appropriately as knowledge about the levels of protection required becomes available. Further investigations involving detailed fate and transport monitoring and modelling are triggered when and where generic criteria (NEPC 1999a) are exceeded or if there is a high level of environmental risk.

The locations of project components were overlaid on hydrogeological mapping (1:250 000), drainage (1:250 000) and raster topographic mapping (1:100 000). Intersections between project co-ordinates and high quality groundwater resources close to existing bore fields, drainage systems and wetlands were recorded as potential areas of hydrological impact.

Table 6 Wetland classification system

Wetland class	**Wetland class description**
A- Marine and Coastal Zone Wetlands (lowland river/creek)	
A5	Sand, shingle or pebble beaches; includes sand bars, spits, sandy islets
A7	Intertidal mud, sand or salt flats
B- Inland wetlands (upland river/creek)	
B1	Permanent rivers and streams; includes waterfalls
B2	Seasonal and irregular rivers and streams
B4	Riverine floodplains; includes river flats, flooded river basins, seasonally flooded grassland, savanna and palm savanna
B10	Seasonal/intermittent freshwater ponds and marshes on inorganic soils; includes sloughs, potholes, seasonally flooded meadows, sedge marshes
B17 **(other wetlands)**	Freshwater springs, oases and rockpools

Table 7 Key physical and chemical water quality parameters

Water Quality Parameter	Upland river/creek	Lowland river/creek	Other wetlands	Notes
Dissolved oxygen (% saturation)	**B1, B2, B4, B10**	**A5, A7**	**B17**	
Lower Limit	90	85	90	Dissolved oxygen values derived from daytime measurements.
Upper limit	120	120	120	Values may vary diurnally & with depth
pH				
Lower Limit	6	6	6	pH's of lower than 6 are not unusual in poorly buffered upland streams (e.g. sandstone country), where respiration from decaying organic material produces CO_2, thereby lowering pH (S. Townsend, DIPE *pers. Comm.*)
Upper limit	7.5	8	8	
Salinity/Electrical Conductivity (mScm^{-1})	20-250	20-250	90-900	Conductivity in upland streams will vary depending on catchment geology. Values at the lower end of range typical of ephemeral flowing NT rivers. For other wetlands, values at lower end of range are found in permanent billabongs in the NT but generally increase in late dry season due to concentration effect of evaporation.
Turbidity (NTU)	2-15	2-15	2-200	For NT rivers, low values for base flow conditions. Wetlands vary greatly, depending on general condition of catchment or river draining into the wetland, recent flow events & water levels.
Temperature				
Lower limit	20th percentile	20th percentile	20th percentile	
Upper limit	80th percentile	80th percentile	80th percentile	

3.4 CONSTRUCTION

The project infrastructure, surface drainage, wetlands, bore locations, stream gauging locations and hydrogeological units are depicted in Map 1. Impacts to surface water drainage and freshwater aquatic life may arise in areas where sediment load into creeks is increased during the wet season as a result of land clearing and earthmoving without the establishment of sediment and erosion controls.

Project structures that will require construction on site will include the onshore gas processing plant and associated facilities, gas pipeline, access routes and a construction camp. The machinery and equipment will be brought onto the site to undertake the construction and installation activities, including compactors, welding machines, cranes and concrete trucks. The surface hydrological features that the project is likely to directly impact are identified in Table 8. Potential hydrological impacts during construction are listed in Table 9.

Table 8 Hydrological impact locations and areas

Project component	Wetland type	Code	Location
Shore crossing	Sand, shingle or pebble beaches; includes sand bars, spits	A5	*From*: Lat. -14.2425, Long. 129.412 *To*: Lat. -14.2426, Long. 129.413
Pipe Laydown Temporary: Storage of pipe lengths and other pipeline components during site preparation and construction / installation	Sand, shingle or pebble beaches; includes sand bars, spits	A5	Beach near shore crossing (area 100x100 m)

The Shore Crossing

The export pipeline crosses the shore on a beach 10km to the south-west of Wadeye. Co-ordinates of the shore crossing are provided in Table 4. The crossing site comprises sandy beach and dune facies. A photograph of the shore crossing site from the Blacktip Technical Overview presentation to the NT Office of Environment & Heritage (March 2004) is shown in Plate 1. A desktop study of acid sulfate soils in relation to the shore crossing (SKM 2004) concluded that there was a moderate to high risk of acid sulfate soils associated with the landfall and beach crossing portions of the proposed pipeline route.

The coastal and marine environment is the principal receptor of potential environmental impacts. Risks have been identified in Table 9 in relation to potential acid sulfate soils (acidity) and turbidity from disturbed soil material and hydrocarbon contamination from excavating equipment.

Plate 1 Shore crossing

Table 9 Hydrological impacts

Project Component	**Receptor**			**Potential Impact type**					
	Groundwater	**Marine & coastal**	**Inland drainage**	**Chemical**	**Biological**	**Acidity**	**Salinity**	**Turbidity**	**Hydrocarbons**
Construction									
Shore crossing									
nearshore dredging		X				X		X	X
beach / dune trench excavation		X				X		X	X
pipeline installation		X							X
backfilling		X						X	X
rehabilitation and pipeline marking		X						X	X
Onshore pipeline									
working width preparation	X		X					X	X
topsoil stripping and grading	X		X					X	X
trenching	X	X	X					X	X
stringing	X	X	X					X	X
line-up and welding	X	X	X					X	X
pipeline lowering	X	X	X					X	X
tie-in and testing	X	X	X				X		X
backfilling	X		X					X	X
rehabilitation and pipeline marking	X		X					X	X
Gas Processing Plant									
construction of access roads and an accommodation camp	X		X					X	X
vegetation clearing - lay down area	X		X					X	X
laying foundations and erecting facilities	X		X					X	X
installing equipment and systems	X			X				X	X
installing ancillaries	X			X				X	X
hydrostatic testing and pre-commissioning of systems and equipment	X	X		X	X		X		
clean up following construction	X							X	X
plant and pipeline access	X							X	X
Access & laydown areas									
Road access			X					X	X
Barge access		X						X	X
Pipe Laydown (temporary)		X						X	X
Plant Laydown (permanent)	X							X	X
Construction camp (temporary)	X		X		X			X	X
Construction material (off-site source)								X	X
Operational components									
Gas Processing Plant									
condensate storage	X								X
produced water	X	X					X		X
export Pipeline Landfall		X							X
Ancillary facilities									
Diesel & material storage	X								X
Gas flare	X								X
Water supply	X								
Drainage	X	X						X	
Accommodation	X	X						X	
Sewerage & putrescible waste	X	X		X	X				
Plant access			X					X	
Decommissioning									
Production shutdown	X	X	X					X	
Pipeline flushing	X	X						X	X
Removal of facilities	X	X	X					X	X

Onshore Gas and Condensate Pipelines

The onshore section of the export pipeline extends for approximately 2 to 3 km from the shore crossing to the gas processing plant. The onshore section of the pipeline will be designed and installed in accordance with Australian Standard AS2885, relevant legislation and licence requirements. Pipeline specifications will be similar to those of the shore crossing section. Cathodic protection via impressed current may be implemented to prevent corrosion. No significant quantity of powder over spray material would be left deposited on the 'right of way' during pipeline construction. The desktop study of acid sulfate soils (SKM 2004) concluded that there was a low to nil risk of potential acid sulfate soils associated with the proposed pipeline route.

The local groundwater system and near coastal ecosystems are the principal receptors of potential environmental impacts. Risks have been identified in Table 9 in relation to potential acid sulfate soils (acidity), turbidity from disturbed soil material and hydrocarbon contamination from excavating and pipe laying equipment.

Hydrostatic Testing

Project documentation (Morgan 2004) indicated that water for pressure testing could be extracted from surface water, groundwater or marine sources. Hydrostatic testing for the onshore pipeline and facilities will be separate from the offshore pipeline and hydrostatic test water is likely to be discharged offshore. Each 1 km section of pipe will require 1.25 ML of water for pressure testing with significantly larger volumes of water used if testing the Blacktip facility is linked to testing the Trans Territory Pipeline spreads connected to it. The water discharged from the pipeline will contain construction debris and mill scale. The water may contain residual oxygen scavenger, such as sodium sulphite, which is used to minimise corrosion of the pipe.

The local groundwater system and near coastal and marine ecosystems are the principal receptors of potential environmental impacts. Risks have been identified in Table 9 in relation to chemical, biological and saline water contamination arising from extracting and discharging possibly saline and chemically contaminated test water originating elsewhere into a local woodland, wetland or marine environment.

Plant Access and Laydown Areas

No road, river or stream crossings were identified between the shore crossing and the gas plant. However, the proponent is considering the following options for access to the onshore processing plant and pipeline during the construction phase:

- existing roads from Darwin to Wadeye and proposed road to plant
- use of existing boat ramp near Wadeye followed by road to facilities
- beach landing or prepared landing ramp in the vicinity of the pipeline landfall to bring in equipment and construction materials.

The crossing over the headwaters of Sandfly Creek on the unsealed access from Wadeye airport to the pipeline landfall represents a potential impact on surface water quality.

The proponent intends to transport large loads required during construction on trailers by barge (either landing barge or flat top) to the beach near the pipeline landfall. Either barge type would require some earthworks on the beach to support the trailers, and a dry weather, heavy duty access road would be required from the beach landing to the plant site. The temporary laydown area (100 x 100 m) for line pipe during construction is located on the beach near the shore crossing.

The inland and near coastal and surface drainage systems are the principal receptors of potential environmental impacts. Risks have been identified in Table 9 in relation to turbidity and hydrocarbons in runoff from roads, tracks and lay down areas discharging into drainage lines and coastal environments.

Gas Processing Plant

The location of the Gas Processing Plant is depicted in Plate 2. The receptors for impacts from gas plant construction are local groundwater systems and the near coastal wetlands that groundwater discharge supports. Inland drainage system receptors are remote from the site. Potential impacts from construction and operation are associated with turbidity from disturbed land, hydrocarbons and chemicals.

Construction Camp & Workforce

The temporary construction camp will cater for a maximum of 200 personnel within the 750x750m^2 onshore footprint. The majority of the camp will be removed once construction is complete, although facilities will remain on site for the life of the project to accommodate operations and maintenance personnel. The construction workforce will range from 60 to 130 personnel, operations will consist of approximately four staff and maintenance will peak at 20 to 40 personnel every three years. Water supply for the camp will be extracted from a bore within the onshore footprint. Wastewater disposal will incorporate sewage, septic, adsorption trenches or bio-filter treatment of effluent.

The local groundwater system and near coastal wetlands are the principal receptors of potential environmental impacts. Risks have been assessed in relation to biological and hydrocarbon contamination in recharge and turbidity in runoff.

Construction Material

Sources of sand and aggregate for construction have not been finalised. The project may make use of igneous rock sources of aggregate such as a dolerite from three small deposits adjacent to the Moyle River. Regardless of the sources used for sand and aggregate in construction they are unlikely to directly impact on the immediate project area. However, environmental guidelines for extractive industries in the Northern Territory would apply to any borrow areas that are developed.

The localised groundwater systems and inland drainage systems are the principal receptors of potential environmental impacts. Risks have been identified in Table 9 in relation to hydrocarbon contamination in recharge and turbidity in runoff.

Plate 2 Gas processing plant location

3.5 OPERATION

The Gas Plant, Condensate Storage and export

The gas processing plant consists of various systems to separate the reservoir fluids and produce dry gas suitable for export. The plant will be operated for 24 hours a day, seven days a week. The proponent envisages that two storage tanks will be required to store the condensate and these will be located within the onshore processing plant. Condensate will be pumped offsite, on a batch basis of up to 1000 bpd per day, via the condensate pipeline to a spread mooring. The volume of hydrocarbon being processed, stored and exported over the life of the project represents a significant environmental hazard.

The local groundwater system and near coastal and marine environments are the principal receptors of potential environmental impacts. Risks have been identified in Table 9 in relation to hydrocarbon contamination in recharge and subsequent discharge into receiving environments.

Rupture of buried liquid natural gas pipeline infrastructure will be a hazard to groundwater. Natural gas is lighter than air and in the event of a pipeline rupture, a considerable volume of gas could be released and vaporised. The potential impacts of a catastrophic rupture are therefore less than from an oil pipeline. The impacts of such an event could include freezing of soil in the vicinity of the rupture, vegetation dieback and impacts on soil dwelling animals caught in the upwelling zone and impacts on surface animals and birds in the immediate vicinity. The impacts would be localised.

Rupture of buried condensate export pipeline infrastructure will be a hazard to groundwater. Project documentation (Morgan 2004) indicates that the condensate will be lighter than gas after it is stabilised. However, in the event that liquid petroleum condensate is produced and piped or stored in buried infrastructure there is a risk that a catastrophic rupture could lead to groundwater contamination that may be extensive. In this respect, the location of buried condensate storage and transport infrastructure in relation to water supply bores and groundwater discharge areas needs to be carefully considered.

Produced Water

Produced Water (PW) is potentially saline and will probably be discharged to the ocean outfall (Morgan 2004). Hydrocarbons and corrosion inhibitors may be removed in settling ponds prior to ocean outfall discharge. The produced water constitutes a slight hazard to the onshore environment in the event that buried infrastructure leaks PW to the groundwater system.

Groundwater and marine & coastal systems are the principal receptors from any Produced Water (PW) treatment and disposal system. Risks have been identified in Table 9 in relation to salinity, chemical and hydrocarbon contamination in recharge and subsequent discharge into receiving environments.

Ancillary Facilities

The level of activity at the site during the operational phase will influence the degree of environmental hazard. The following activities are described in the project description document (Morgan 2004). A workforce of two to four personnel will undertake daily maintenance of the facilities along with standard operations activities. The processing plant will be operated 24 hours a day, seven days a week throughout the year. The two to four personnel required to operate the plant will be accommodated on site and will operate on a shift basis. Activity will increase when full-scale maintenance operations are undertaken every three years for a period of three to five days during which operations will be shutdown. This will require 20 to 40 additional personnel. Accommodation facilities will be provided for the additional personnel in the plant, who will travel to the onshore facilities using established access routes. Testing of equipment and replacement of the silica used for gas processing will be undertaken. There will not be any silica disposed on site.

Diesel for power and equipment such as pumps, generators, compressors and machinery will be stored in drums during construction. Diesel will also be used to power fire pumps and to back-start the gas generator during processing plant operation. Diesel storage facilities during the operational phase of the project are located onshore, within the processing plant laydown area, and consist of bunded tanks or drums. A 1,000 to 2,000 L capacity tank will be used to store diesel for the emergency generator and firewater pumps.

There is a risk that wastewater, fuel and chemical storage systems could contaminate the shallow groundwater aquifer, with subsequent impacts on local wetlands. The risks associated with biological contamination from waste treatment and disposal systems could be exacerbated by ineffective site drainage. Groundwater is the principal receptor while hydrocarbons and biological contamination are the contaminants of concern identified in Table 9. A low level of risk exists of turbid runoff water in the site drainage system entering near coastal wetland environments.

Decommissioning

The decommissioning objective is to close down operations and abandon the development area leaving the environment as near as practicable to its original condition.

Decommissioning of the proposed Blacktip Development is expected to occur approximately 40 years after start-up and will most likely include:

- shutting down of production processes;
- flushing of pipelines and sub-sea facilities;
- plugging and abandonment of wells; and
- removal of onshore facilities.

Land disturbance and infrastructure flushing during decommissioning represent some hazard to receiving environments. Near coastal wetland and marine environments are the principal receptors. Turbidity in runoff and hydrocarbons in offshore disposal of pipe and plant flush water are the contaminants of concern identified in Table 9.

3.6 RISK ASSESSMENT & SAFEGUARDS

A qualitative risk assessment was conducted using the Australian Standard AS/NZS 4360:1999 *Risk Management*. The system of assessment combines *likelihood* of possible contaminants impacting on recognised receptors (and hence causing detriment) and the consequences of the event occurring.

The measures of *consequence* used in the detailed risk analysis are listed in Table 10. From the design documentation and baseline information we estimated *likelihood* of a failure occurring (Table 11). In particular, the likelihood that a failure occurs in the gas facility and onshore pipeline during the life of the project can be moderated based on design consideration. The consequence (Table 10) and likelihood (Table 11) allocations were multiplied to rank and prioritise the issues in a risk analysis matrix (Table 12).

Contaminant types from the project description (Morgan 2004) are listed in Table 13 with the consequence and likelihood allocations from the risk analysis (key provided in Table 12) to the public and/or the environment. A column headed "Residual Risk" has been included in Table 13 to identify where mitigation measures can be applied to high risk activities to reduce the incidence of failure and consequently reduce the residual risk ranking. Issues with a score of less than 6 are considered a moderate to low risk but further consideration in the design and/or incorporation into the Environmental Management Plan may be justified based on the precautionary principle.

The issues flagged as having moderate risk rankings in Table 13 were associated with:

- turbidity and acid sulfate soil risks at the shore crossing;
- discharge of poor quality water from hydrostatic testing of the onshore pipeline and gas plant;
- seepage and runoff contamination from laydown areas and construction camp facilities including waste treatment and fuel/chemical storage; and
- hydrocarbon contamination from condensate storage/transport facilities during project operation and decommissioning.

Table 10 Measures of consequence for environmental issues

Consequence		Description
1	Insignificant	Negligible impact remediated by site personnel using standard operating procedures.
2	Minor	Minor on-site surface contamination. Short-term environmental impact remediated by site personnel. Environmental consequences for <6 months.
3	Moderate	On-site surface and phreatic zone contamination. Medium-term environmental impact remediated by site personnel. Environmental consequences for 6<12 months.
4	Major	Off-site impact to external receptors via groundwater pathways. Medium to long term environmental and community health impacts remediated by specialised non-site personnel. Environmental consequences for 1-2 years.
5	Catastrophic	Off-site major deterioration in the water resource resulting in visible and/or severe contamination resulting in permanent or long-term loss of beneficial use. Environmental consequences for >2yrs.

Table 11 Likelihood of an environmental impact occurring

Occurrence		Description
1	Rare	Impact may occur in exceptional circumstances
2	Unlikely	Impact could occur based on design option used
3	Moderate	Impact could occur at some time in the life of the project based on the design option used
4	Likely	Impact will probably occur at some time in the life of the project based on the design option used
5	Almost certain/currently occurring	Impact expected to occur in most circumstances, including already occurring

Table 12 Qualitative risk analysis matrix

LIKELIHOOD	CONSEQUENCE				
	1 INSIGNIFICANT	2 MINOR	3 MODERATE	4 MAJOR	5 CATASTROPHIC
1. RARE	1	2	3	4	5
2. UNLIKELY	2	4	6	8	10
3. MODERATE	3	6	9	12	15
4. LIKELY	4	8	12	16	20
5. ALMOST CERTAIN	5	10	15	20	25

Key

LOW RISK	1 to 4 points	Low risk expected, apply precautionary principle
MODERATE RISK	5 points	Moderate risk of low level, possibly chronic impacts (occur continually)
HIGH RISK	6 to 9 points	High risk expected
EXTREME RISK	10 to 25 points	Extreme risk expected

Table 13 Risk assessment results

	Impact type	Likelihood	Consequence	Risk ranking	Residual risk[1]
Construction					
shore crossing	Hydrocarbons	3	1	3	
	Turbidity	2	3	6	
	Acid drainage	2	3	6	
onshore pipeline	Hydrocarbons	3	1	3	
	Salinity	2	2	4	
	Chemical additives	3	2	6	
	Turbidity	2	2	4	
gas plant	Hydrocarbons	3	2	6	
	Turbidity	2	2	4	
plant access & laydown areas	Hydrocarbons	3	2	6	
	Turbidity	2	3	6	
construction camps	Hydrocarbons	2	3	6	
	Turbidity	2	3	6	
	Biological	2	3	6	
Operation					
gas processing	Hydrocarbons	2	3	6	
condensate	Hydrocarbons	2	4	8	6
produced water	Hydrocarbons	1	1	1	
	Turbidity	2	1	2	
	Salinity	2	2	4	
	Temperature	2	2	4	
Export pipeline landfall	Hydrocarbons	2	3	6	
ancillary systems	Hydrocarbons	2	4	8	6
	Chemicals	2	3	6	
	Turbidity	2	1	2	
	Biological	2	3	6	
Decommissioning					
gas plant	Hydrocarbons	2	3	6	
	Turbidity	3	2	6	
export pipeline	Hydrocarbons	2	3	6	

Fuel storage and condensate storage and transport during Blacktip operations were flagged as having a high risk ranking in Table 13. This ranking is based on the perceived potential for major off-site impact to external receptors via groundwater pathways; medium to long-term environmental and community health impacts; and the need for remediation by specialised non-site personnel with medium term environmental consequences (Table 10).

Moderate residual risk rankings for impacts from buried condensate and fuel storage and transport infrastructure in Table 13 indicate that hydrocarbon leakage to groundwater is unlikely during the life of the project if the following mitigation measures are considered in the design:

[1] Residual risk for high risk activities after mitigation measures or safeguards outlined in Section 3.6 have been applied

- storing hydrocarbons above ground;
- regular hydrocarbon inventory measurement and record reconciliation;
- leak detection systems and regular visual inspection for leaks; and
- underground tank designs incorporating a double wall with an interstitial space that can be monitored, corrosion protection, overfill protection and removal or transfer connections located within a spill containment device.

The potential impact from extraction and disposal of hydrotest water will depend on the chemistry of the source (marine or groundwater) and whether it is disposed of to surface streams, land application or ocean outfall. If surface water is extracted:

- aquatic biota may be physically removed from water bodies by pumping.
- substantial/complete abstraction of water from small water bodies may impact on aquatic ecosystems by removal of dry season refuges, therefore affecting species composition/abundance.
- translocation of water from one water body to another poses a risk of introducing non-endemic aquatic biota, therefore changing species composition and predator-prey relationships.
- change in physical/chemical properties (e.g. temperature, pH, salinity) of water may impact on aquatic biota by changing species composition/abundance.

If groundwater is used and discharged into inland or near coastal waterways, a change in the physical/chemical properties (e.g. temperature, pH, salinity, chemical additives) of water may impact on:

- aquatic biota by changing species composition/abundance; and
- drinking water quality.

Using groundwater or marine sources for hydrostatic testing and disposal by land application away from drainage lines or offshore will avoid impacts on inland and near coastal water bodies. Because the local aquifer has a potentially high yield, the impact of local groundwater extraction (of the volumes being considered for hydrotesting) on the local water table level should be slight. The offshore disposal option would remove any potential for impact to the onshore hydrological environment.

The risk of hydrocarbon spillage from excavation equipment is low, providing that effective safety and spillage response systems are in place. The risk of turbid runoff from disturbed land impacting on marine & coastal areas and inland drainage systems is also low, providing that standard sediment & erosion control planning measures will be implemented, as no surface drainage features were identified.

The construction camp and workforce facilities present risks to groundwater quality from fuel/oil spills and biological contamination from sewage and putrescible wastes generated from the accommodation camp. Wastes will need to be treated and/or disposed of in accordance with regulatory requirements. Vehicle maintenance and refuelling in contained areas will prevent ad hoc, localised contamination.

The perceived high risk from condensate and fuel contamination to groundwater via buried pipeline and storage infrastructure is due to:

- the long life of the project;
- the volumes of gas and condensate being processed and exported;
- historical problems with leakage from buried fuel storage tanks; and
- the high resource value of the underlying, shallow groundwater system.

Corrosion is a key risk management issue to be mitigated by cathodic protection and anti-corrosion treatment of the line pipe in particular. The large intertidal range at the landfall has warranted consideration of anti-corrosion coating design.

The standard risk management approach (NEPC 1999b) warrants site specific investigation into the fate and transport of contaminants that present a greater than moderate risk in the local hydrogeological environment. Also, a clear account of impacts from some of these contamination processes will be required at specific receptor sites during the life of the project.

Mitigation measures would reduce the likelihood of a hydrocarbon contamination, and consequently the overall risk ranking from high to moderate. However, the susceptibility of the local aquifer to contamination, the proximity of the Wadeye borefield and the proximity of groundwater discharge areas (wetlands) warrants site specific investigation into the fate and transport of heavier than air hydrocarbons in the gas condensate and fuel storage system.

The types and quantities of chemicals required for production, maintenance and operation are not yet known. However, chemicals that may be stored on site could include acids and solvents, glycol, surface active agents and detergents, defoamers, lubricating fluids and greases, hydraulic oils/fluids, paints, inhibitor chemicals (e.g. corrosion and scale inhibitors), specialised cleaning fluids, and cooling system treatment chemicals. Removing chemicals from site when not in use will reduce risks.

The settling ponds and piped discharge line in any Produced Water treatment and disposal system represent a low risk to the groundwater resource. The risk factors are principally hydrocarbons and salinity. The settling ponds may not be used. In this event there will be no risk to the local groundwater system from this source.

3.6.1 Conclusions

Construction

There is a low to moderate risk of hydrocarbon spillage, turbidity and acid sulfate soil impacts on surface water during construction. The unsealed road from the Wadeye airport to the project site will require upgrading and installation of culverts. A low risk of turbid runoff from land disturbed during clearing the pipeline corridor, access tracks and gas processing plant and laydown areas impacting on marine & coastal areas and inland drainage systems was assessed.

The receptors for impacts from gas plant construction are principally groundwater and near coastal wetland systems supported by groundwater discharge. The potential impact types include turbidity, hydrocarbons and chemicals used to hydrostatically test the gas plant. Extraction and disposal of the water used to test the integrity of pipeline, gas storage and processing equipment prior to commissioning presents a moderate risk of impact on groundwater and near coastal surface water systems.

Sources of sand and aggregate for construction have not been finalised. However, NT government environmental standards for extractive industries will need to be followed.

Operation

There is high level of risk over the long term to groundwater resources from hydrocarbon processing, storage and export and fuel storage and distribution. This can be mitigated by engineering design such that failure during the project life becomes highly unlikely. However, because the groundwater resource is shallow and high yielding, it is both susceptible to contamination and potentially an important resource for community development. Consequently, anti-corrosion coating design and cathodic protection systems are warranted.

The groundwater resource at the site has *realistic future* uses in support of industry and residential development. This potential, together with its shallow depth, making it vulnerable to contamination through the land surface, mean that site specific assessment of contaminant fate and transport is warranted. The NEPM guidelines for groundwater investigations and groundwater risk assessment on contaminated sites indicate that a simulation modelling approach to explore different exposure scenarios and several potential receptors (water supply and ecosystem). Modelling is a relatively cheap alternative to directly investigating all data gaps and is the primary method for identifying receptors. Groundwater can be considered to be contaminated whenever there is a change in water quality that produces a noticeable or detectable change in its characteristics (National Water Quality Management Strategy definition). Consequently, monitoring is needed to detect change in groundwater quality and the risk assessment process must consider any impact from site contamination on groundwater quality which causes groundwater parameters to differ from ambient quality..

A low to moderate risk of impacts was assessed on surface and groundwater quality from the construction camp and workforce and monitoring and maintenance operations. Surface drainage systems are remote from the immediate site and unlikely to be impacted upon. Potential impact types include turbidity, hydrocarbons and biological contamination. Corrosion will be a chronic risk management issue.

Baseline water quality information for groundwater at the Blacktip Project is incomplete and not a sufficiently reliable basis for a groundwater quality monitoring program. Tidal influence in the nearest surface drainage system, the tidal inlet on Yelcher Beach to the south of the project area would make surface water monitoring of project impacts problematic. However, monitoring groundwater beneath the site and in the groundwater flow field between the site and the receiving environment in near coastal water bodies and municipal bore fields would give pre-emptive advice of any likely impacts on surface water environments.

Decommissioning

Decommissioning of onshore facilities will involve the removal of the gas processing plant, condensate and PW treatment systems, and all associated utilities and infrastructure. The final decision in regard to best approach to the subsea and onshore components of the pipeline must minimise potential environmental impacts and comply with legislative requirements, relevant Australian Standards and industry practice in force at the time of abandonment. Consequently, the pipeline may remain intact after decommissioning.

4 IMPACT MITIGATION RECOMMENDATIONS

Recommendations and statements of intent from the proponent may need to be changed as particular aspects of the project design are completed. During the construction phase of the project, mitigation actions need to address the moderate risks of environmental impact that are associated land disturbance on the near coastal and marine environment and on ensuring a high level of environmental performance during the operational phase of the project. During the project operation, mitigation actions are focussed on addressing the moderate risks of environmental impact that are associated with the processing, storage and transport of hydrocarbons. Site security, maintenance and monitoring activities will be important components of the risk management system. During the decommissioning phase of the project, mitigation actions are focussed on minimising the risk of turbidity arising from land disturbance on receiving wetland and coastal environments, and meeting stakeholder expectations of the closure process.

Specific recommendations arising from our desktop review of risk the surface and groundwater hydrology follow.

1. As a general principle, confining construction and operational activities involving land disturbance in the second and third quarters (dry season months between May and September) will reduce environmental risks associated with the project.

2. At the shore crossing, effective safety and spillage response systems need to be implemented to minimise the risk of hydrocarbon spillage from excavation equipment.

    - Identify potential acid sulfate soils and if necessary implement an acid sulfate soil management plan in line with the recommendations in the main EIS report.

3. An effective sediment and erosion control program will minimise impacts from turbidity in runoff during construction and operation. We recommend the proponent develop and implement a sediment and erosion control plan that:

    - follows guidelines for the control of erosion and sedimentation at construction sites (Witheridge and Walker 1996) and NT soil conservation guidelines (Hadden 1993);
    - demonstrates control of all drainage onto, and leaving disturbed areas at all times;
    - includes prefabrication of onshore facilities, including the gas processing plant and ancillary systems, as far as practicable offsite, transporting to site, and constructing within the lay down area to minimise or control potential impacts on groundwater and surface water systems;
    - includes reinstating the ‘running track’ along the right of way (ROW) or working width by:
        - loosening excessively compacted soil by harrowing, ripping or equivalent;
        - reinstating sub-soil and topsoil layers over the cleared area;
        - respreading cleared vegetation leaving only a 4WD track with surface drainage;
        - disposing of any large rocks in an acceptable manner to landowners;
    - ensures that any quarrying or extraction complies with the appropriate NT Government regulations relating to extractive industries and borrow pit remediation;

- manages access route and laydown area construction to mitigate potential impacts from turbidity on surface water and hydrocarbons on groundwater resources by:
    - installing culverts on the unsealed access road from Wadeye;
    - restricting road access to the dry season;
    - specifying the precautions to be taken to minimise the potential impacts associated with land disturbance and road use in the sediment & erosion control plan;
    - restoring areas used for barge landings when construction is completed to mitigate ongoing risks to the coastal environment.
- takes precautions during access track construction and pipeline installation to contain sediment, minimise erosion and stabilise the work area when watercourses, drainage depressions and wetlands are crossed. The suggested design guidelines for crossings are:

A. Pipeline crossings

- construct pipeline crossings at right angles to the direction of water flow;
- clear felled trees from the floodplain if there is the potential for this material to cause damage downstream if they are carried away in flood waters;
- minimise clearing of riparian vegetation;
- maximum 6 m width of disturbance;
- maximum of 0.6 m of cut and fill;
- construct in a stable (straight) stream section;
- cross along the shortest possible route;
- prevent crossing from storing or diverting water;

B. Vehicle crossings

- gravel or rock cover the approaches, otherwise track layout and drainage design will be needed to prevent water from running down the approaches and into the stream;
- make service track approaches to water courses as level as practicable, otherwise gravel cover the wheel tracks on the approaches;
- protect access to a gully or water course with a diversion channel immediately above the access cut;
- avoid box cuttings in road construction as they present drainage problems, otherwise establish diversion drains to facilitate cross drainage;
- direct access down banks in the downstream direction;
- clear all fill material from the water course not used to backfill excavations;

C. Permanent crossings

- do not use fords where the stream has a deep cross-section requiring considerable excavation on the approach roads;
- consider the effects of debris blockages and erosive forces caused by overtopping flows in culvert design;

- make culverts 450 mm diameter or larger and discharge over stable surfaces (not fill);
- make the culvert flow area approximately equal to the in-bank area of the watercourse;

D. Temporary crossings

- locate crossings on sites with stable stream bed material where bank restoration will be possible;
- time construction activities to coincide with dry weather;
- restore bed and bank profiles to as near as possible to their original condition;
- drain approaches to prevent runoff flowing directly into the stream.

4. Implementing a water management plan with respect to hydrostatic testing, potable water supply and wastewater disposal will reduce the risk to receiving water bodies. We recommend that the proponent develops a water management plan:

- specifying consultation with landowners is made prior to hydrotesting to develop an agreed plan for extracting and disposing of test water;
- stipulating marine or groundwater sources are used for hydrotest water;
- if seawater is used, then disposal of the hydrotest water to the ocean outfall is recommended;
- if a groundwater source is used, then disposal of hydrotest water by land application to stable (rocky) vegetated areas could be considered;
- ensuring trench dewatering (if any) is disposed of by land application;
- ensuring the water quality criteria for receiving surface and groundwater systems are met (Table 7);

5. Design of condensate, chemical & fuel storage and waste water treatment facilities will reduce long term risks to the hydrological environment. We recommend that the proponent:

- stores hydrocarbons above ground;
- makes regular hydrocarbon inventory measurement and record reconciliation;
- implements leak detection systems and regular visual inspection for leaks; and
- designs underground storage tanks incorporating a double wall with an interstitial space that can be monitored, corrosion protection, overfill protection and removal or transfer connections located within a spill containment device.
- constructs bunds around condensate storage tanks as per legislative requirements such as the *Explosives and Dangerous goods Act 1961*, and the *Explosives and Dangerous Goods (Dangerous Goods Handling and Storage) Regulations 1992*;
- designs fuel & chemical storage facilities and handling equipment according to legislation and Australian guidelines to prevent and contain any spills;

- designs drainage systems on based on:

- measured soil hydraulic properties, design storm intensities and the topography of the site providing drainage for storm water and process wastewater within the 750 m^2 footprint of the facility;
- controlling surface drainage and wastewater discharge from the site to minimise local flooding;
- capturing any contaminated water generated by equipment wash down during maintenance;
- providing bunded drains around equipment that could leak lubricant, diesel or other substances;
- directing any contaminated storm water or process wastewater to a treatment system and ultimate off-shore disposal via the PW system; and
- treats and disposes of sewage and putrescibles generated from the accommodation camp according to NT government codes of practice.

6. An effective groundwater monitoring program will assure stakeholders of environmental performance and identify any hydrological impacts in a timely way. We recommend that the proponent:

   - implements a fuel inventory and reconciliation procedure to identify leaks;
   - implements a site-specific groundwater modelling approach to assess the fate and extent of possible groundwater contamination plumes from fuel and condensate storage and transport facilities and assess possible impacts on environmental and drinking water uses;
   - ensures that values for hydraulic conductivity, contaminant load and degradation rates underpinning a modelling approach are accurate
   - monitors groundwater level and quality to identify leakage and potential impact from onshore pipeline, condensate storage & transport and diesel & chemical storage on the local groundwater system;
   - is able to use the groundwater monitoring data to support predictions of contaminant fate and transport made on the basis of site specific modelling.

7. A plan for decommissioning and rehabilitation developed in consultation with relevant authorities and stakeholders will help to ensure that the area is suitably rehabilitated with acceptable levels of risk and impact remaining to surface and groundwater beneficial uses at the end of the project. We recommend that the proponent:

   - determines and agrees on decommissioning activities and implementation with stakeholders in accordance with legislation, guidelines and industry best practicable technology; and
   - plans to flush residual hydrocarbons out of the onshore pipeline; and
   - makes a decision in regard to best approach to the onshore component of the pipeline that will minimise potential environmental impacts and comply with legislative requirements, relevant Australian Standards and industry practice.

5 REFERENCES

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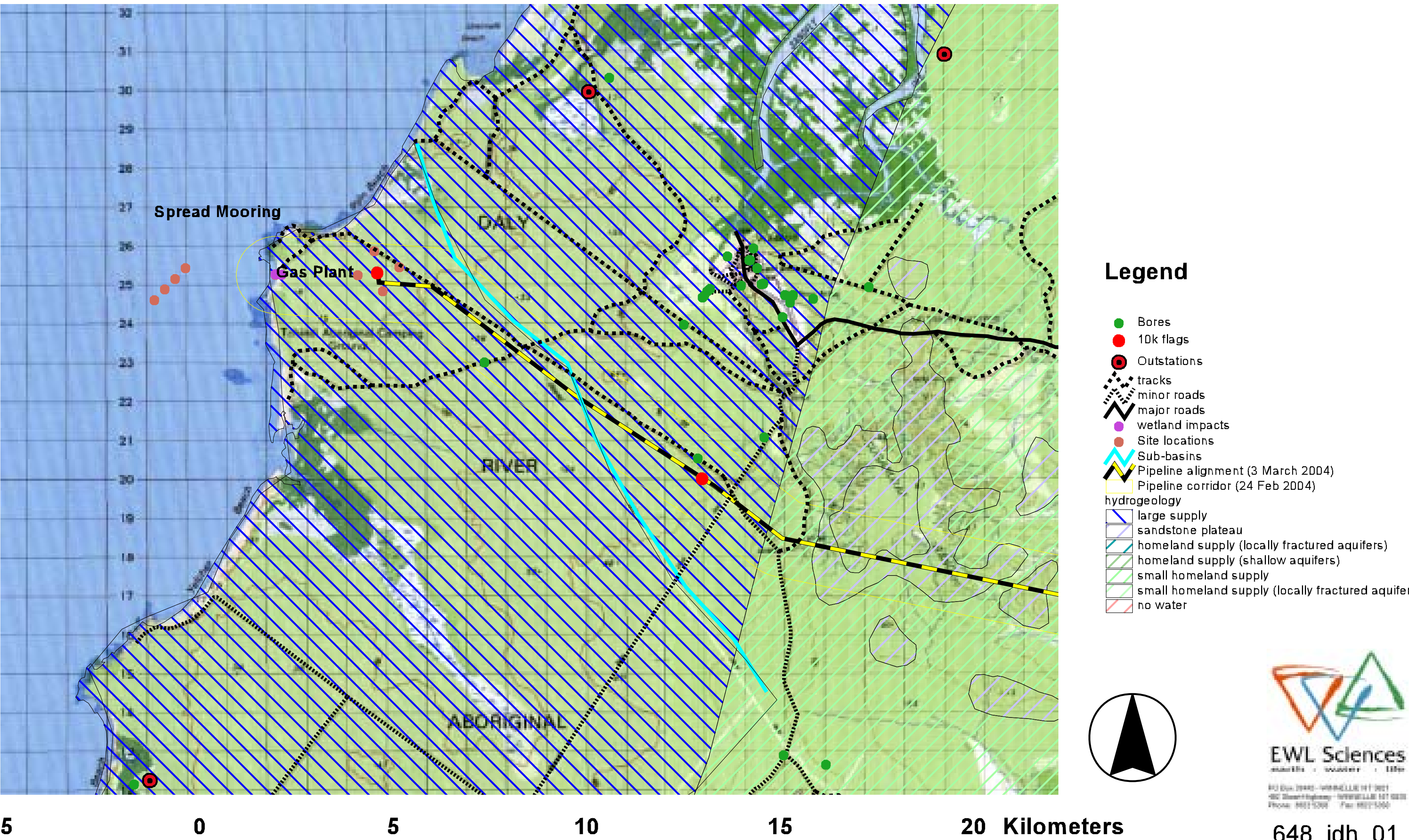
Map 1 Blacktip Hydrological Impacts



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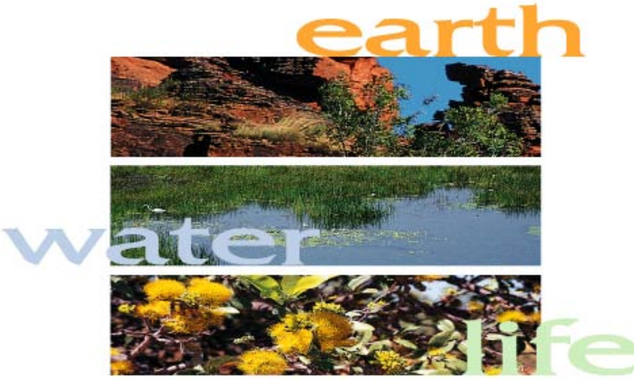
APPENDICES

Appendix A
Consultation

Memo outline of consultation with DIPE – 7 April 04

EWL Sciences
earth · water · life



memorandum

TO : Peter Jolly & Rod Johnson
COPIES :
FROM : Ian Hollingsworth
REF : 577, 648
SUBJECT : **Blacktip and TTP EIS – Hydrological Impacts consultation on approach**
DATE : 7 April 2004

Information sources for hydrological resources and beneficial uses

- Wadeye / Nauiyu Water Study (NT Gov. Sept 2003)
- Environmental Water Requirements of the Daly River (NT Gov. March 2003)
- West Arnhem Land Water Study (NT Gov.)
- East Arnhem Land Water Study (NT Gov.)
- 1:250 000 vector drainage and road data

Selection criteria for pipeline crossing location and design

- Crossing selection criteria:
- straight section of stream bank
- low bank profile

Crossing design:

- perennial watercourses – directional drilling
- intermittent water courses and wetlands – open trenching

Crossing construction:

- bank profile reinstatement
- reinstatement of bed material
- dry season operation (May – September)

Impact assessment criteria

- Wetland Classification – based on Directory of Important Wetlands in Australia
- Water quality criteria – pH, EC, temperature, turbidity, dissolved oxygen
- Assessment of risk to bore fields – flow path length criteria of 100 m

Advisory guidelines for waste water impoundments

- Volume
- Distance from water courses

Advisory guidelines for bed and bank stabilisation

- Timing
- Surface treatment
- Minimising impact

REPORT FOR REVIEW

REPORT TITLE:	Blacktip Project EIS
JOB NO:	Hydrology & Water Quality
SENIOR AUTHOR:	
TARGET DATE FOR SUBMISSION TO CLIENT:	

REPORT REVIEWER(s):____

PLEASE COMMENT: - IMMEDIATELY/ASAP/WITHIN A WEEK

(circle appropriate time frame),

and make specific comments as appropriate directly on the report.

	Signature
GENERAL COMMENTS	
THE DATA PRESENTED ARE ACCURATE, COMPREHENSIVE AND RELEVANT TO THE SCOPE OF WORKS	
From the viewpoint of someone **not specialising in this technical area,** the report reads well and addresses the scope of work	
The methods used to present and analyse data, results/observations (statistical methods used, graphs, tables, diagrams etc) are appropriate to the type of data gathered	
The visual aids (photos, maps, boxes, figures etc) are of a high quality and facilitate comprehension	
The references are appropriate and match those in the text	

On completion of review return report to:____