Section 6
Existing Biophysical Environment

6. Existing Biophysical Environment

6.1 Studies and Surveys

This section of the Draft EIS presents a description of the existing biophysical environment within the region of the TTP. As part of the baseline data collection process, environmental studies and surveys were undertaken to provide detailed and up-to-date information for environmental receptors in order to gain a better understanding of the potential environmental issues. Due to the length of the proposed pipeline route, together with the relatively inaccessible terrain and climatic conditions prevailing in the area, many of these studies were conducted over a number of years.

Biophysical studies and surveys undertaken for the TTP include:

- desktop assessment of geology;
- desktop assessment of soils and land systems;
- desktop assessment of acid sulfate soils (ASS);
- desktop assessment of hydrology and water quality;
- aquatic ecology surveys;
- terrestrial vegetation and flora surveys;
- terrestrial fauna surveys;
- biting insect surveys.

The complete findings of the surveys can be found in **Volume 2** of this Draft EIS.

6.2 Physical Environment

6.2.1 Regional Setting

The TTP is located in the northern most part of the Northern Territory, also referred to as the 'Top End'. The Top End lies within the tropics and experiences a monsoonal climate with distinctive wet and dry seasons. Much of the Territory is relatively flat except for the presence of some disconnected ranges. The eastern part of the Top End contains the sandstone escarpment and plateau of Western Arnhem, rising from the Gulf of Carpentaria and continuing along the coast (MAAP 2004). The plateau is a distinct topographical feature, rising to 400–450 m in height. Other notable features include the Mitchell Ranges within the project area, located to the east of Katherine, and the Wingate Mountains situated east of Wadeye. There are a large number of river systems in the region. Rivers draining into the Joseph Bonaparte Gulf to the west of the region include the Daly, Moyle, Victoria and Keep Rivers. Rivers draining eastward into the Gulf of Carpentaria include the Roper and McArthur Rivers. There are many wetlands including permanent swamps, most notably the Arafura Swamp in Central Arnhem Land, as well as vast seasonally inundated floodplains, permanent and semi-permanent freshwater lake systems and ephemeral saline lakes (Northern Territory 2004).

6.2.2 Climate

The typical climatic regime of the Top End region has several distinct seasons. The 'Dry Season' occupies the five months from May to September. The 'Transition' and the 'Monsoon' encompass the 'Wet Season' which occupies the seven months from October to April. Climatic variations throughout the year will influence the TTP construction schedule, with much of the construction taking place in the dry season.

Dry Season: During the 'Dry Season' dry south-easterly airstreams pass over the Top End resulting in rain being uncommon. Depending on the intensity of the high pressure system, winds can be strong, creating rough seas in coastal waters and increasing the wildfire risk around the Top End and further inland. Temperatures remain warm to hot during the day usually ranging between the high twenties and low thirties, accompanied by relatively low humidity.

Wet Season: The 'Transition' period, commonly referred to as the 'Build Up', is the seasonal change from the end of the 'Dry' to the onset of the monsoon rains. Humidity increases during the 'Build Up', with November and early December generally being the hottest periods. Weather conditions during the wet season are largely determined by the position and activity of the monsoon trough, which is the joining of the dry south-east trade and the moist monsoon winds from the north-west. Daytime temperatures are typically in the low to middle thirties in coastal regions with minimum temperatures mostly around the middle twenties. Winds are mainly light and humidity remains high in coastal areas throughout the day.

Climatic variations experienced across the study area are geographically distinct and include:

- Coastal Western Climate
- Inland Western Climate
- Inland Eastern Climate
- Coastal Eastern Climate

Annual rainfall, temperature, wind roses and wind trajectory data for this region are presented in **Appendix B, Volume 2** of this Draft EIS.

Coastal Western: The 'Coastal Western' climatic region receives the highest rainfall out of the four Top End climatic regions traversed by the TTP. Annual rainfall totals in this region typically exceed 1300 mm. Coastal areas in the west are also subject to strong onshore monsoonal winds which have been known to reach gale force, two to three times every ten years. On average, one cyclone passes within 75 nautical miles (nm) of the coast every two years.

Inland Western: The 'Inland Western' region typically displays the same basic weather pattern as the 'Coastal Western' region but is a little less wet and humid with higher daytime and lower night-time temperatures. The region experiences less exposure to strong monsoonal winds and tropical cyclones than the 'Coastal Western' region. However, heavy rainfall and flooding can be associated with the passage of monsoonal lows through the region.

Inland Eastern: This region is generally the driest of the four climatic regions traversed by the TTP. Annual rainfall totals normally exceed 750 mm. Heavy rainfall events are known to occur, especially when former Gulf cyclones move over the region. Very high daytime temperatures (mid 40's) can be experienced in this region as early as October and the 'Build Up' typically occurs a month later than in the regions to the west. Strong easterly winds are experienced for the majority of the year with some westerly winds occurring from December to February.

Coastal Eastern: The 'Coastal Eastern' region is wetter than the 'Inland Eastern' region; however, not as wet as the 'Coastal Western' region. The wet season in this region typically commences about six weeks later than in the 'Coastal Western' region and the transition period to the 'Dry' season is extended, with regular shower activity persisting until June or later. Monsoonal winds are not as prevalent; however, the Gulf waters do provide a favourable environment for the formation of tropical cyclones during the wet season. The Nhulunbuy region on average will have one cyclonic system pass within 75 nm of the coast every wet season.

6.2.3 Topography

The proposed pipeline route encounters a range of topographical features (**Figure 6-1**). To the west of the study area the pipeline will transect the coastal Moyle Flood Plain, from where it will rise over the Wingate Mountains in an easterly direction. To the east of Katherine the pipeline passes through the High Black Range and skirts the edge of Arnhem Land Plateau for approximately 200 km of its total length. The pipeline will then transect the Mitchell Ranges along the eastern section of the route, before reaching the Gove Peninsula. A summary of the topographical features along the proposed pipeline route is presented in **Table 6-1**.

6.2.4 Geology

There are many variations in geology along the proposed pipeline route. These features are shown in **Figure 6-2** and are described in detail in **Table C-1, Appendix C**, **Volume 2** of this Draft EIS. A glossary of geological terms is also contained in this Appendix.

The geology of the study area comprises rock dated between the Mesozoic and Proterozoic eras. The oldest rock formations through which the proposed TTP will pass are of Proterozoic Orogens (Pine Creek Orogen) dating back to 1800–1860 million years ago. Pine Creek Orogen is located to the west of the study area and represents a deformed and metamorphosed Palaeoproterozoic succession which is overlain by the Paleo to Mesoproterozoic McArthur Basin in the east and the Victoria Basin to the south-west. These rocks are sediments ranging from fluviatile facies to shallow marine and evaporitic carbonates to siltstone and shale (NTG 2004a).

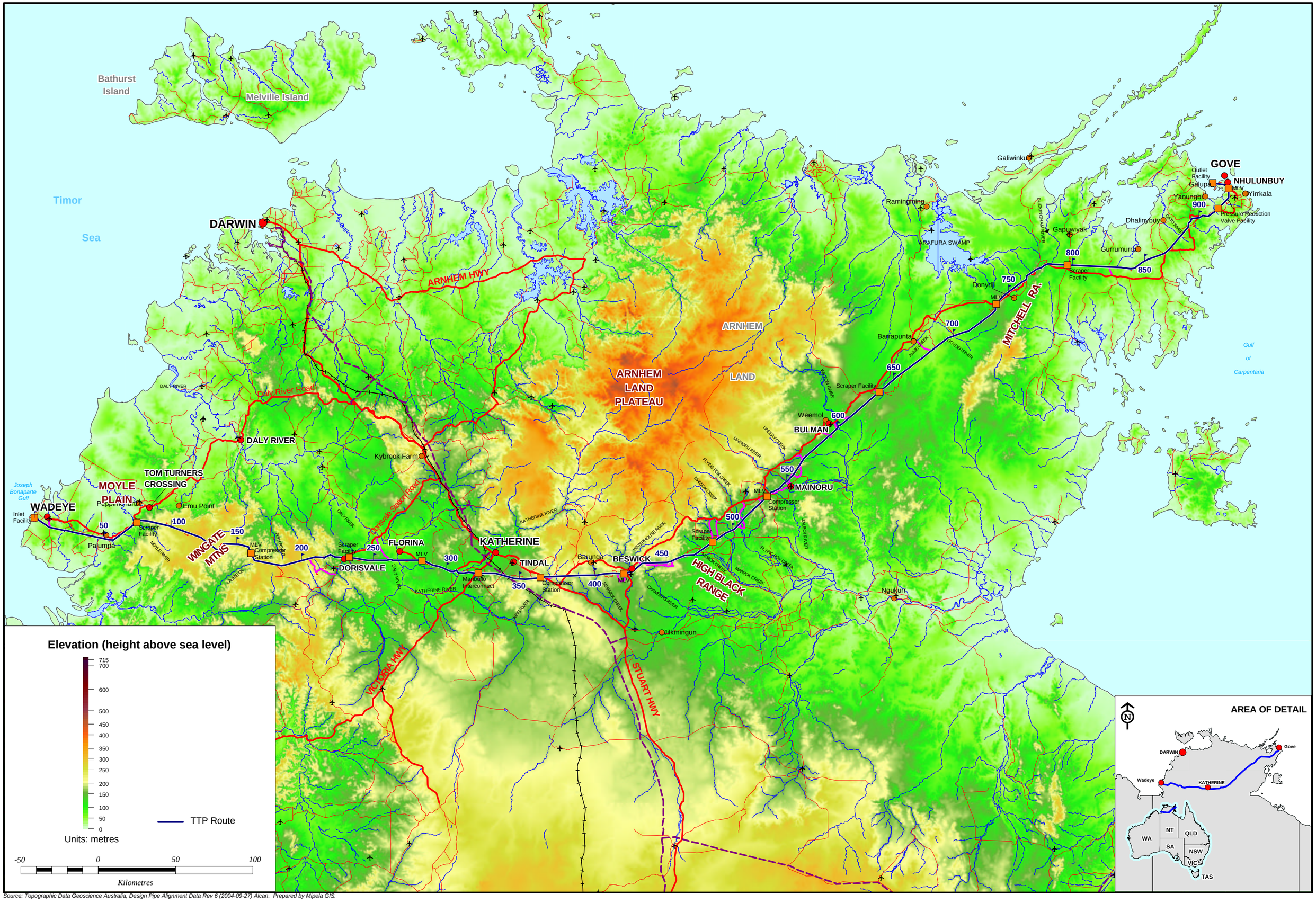
Table 6-1 Topographical Description of Features along the Proposed TTP Route

Pipeline KP	Description of Topography
0–70	Flat topography with a slope of less that 1:1000 from east to west. The elevation ranges from approximately 10 m above Australian Height Datum (m AHD) to 70 m AHD.
70–90	Ridges and valleys associated with the northern end of the Macadam Ranges. The elevation ranges from approximately 70 m AHD to 250 m AHD. Nearby spot heights range from 196 m AHD to 234 m AHD.
90–135	Flat to slightly undulating terrain. The closest spot heights to the alignment range from 245 m AHD to 291 m AHD.
140–210	Valleys and ridges associated with the Wingate Mountains. The pipeline alignment follows the path of minimal topographic variation. The closest spot heights to the alignment given range from 284 m AHD to 307 m AHD.
210–230	Follows a tributary of Bradshaw Creek.
230–273	Flat to slightly undulating terrain. Many seasonal streams and drainage lines are present in the area and as such topographic variation is expected when crossing these lines and the Daly River system. The closest spot heights to the alignment range from 180 m AHD to 189 m AHD.
273–303	Limited topographic variation. Some stream crossings and undulations may be encountered.
303–428	Generally limited topographic variation. Some stream crossings and undulations may be encountered. The estimated average elevation is 200 m AHD with nearby spot heights ranging from 220 m AHD to 270 m AHD.
418–460	Large topographic variations as valleys and ridges associated with a mountain/hills system. No specific height contour information is available on the maps provided. The closest spot heights to the alignment range from 240 m AHD to 280 m AHD.
460–740	Flood plain area with flats and seasonal streamlines associated with drainage from the Arnhem Plateau to the north-west of the area.
740–780	Large topographic variations as valleys and ridges associated with the northern portion of the Mitchell Ranges.
780–875	Flood plain area with flats and seasonal streamlines associated with monsoonal drainage lines. The estimated average elevation of this area is 100 m AHD.
875–900	Large topographic variations as valleys and ridges associated with a mountain/hill system.
900–940	Flat topography with a slope towards the coast. Some tidal-influenced streams may be encountered.

Note: KP - kilometre point from zero at Blacktip Gas Plant at Wadeye, to 940 km at Alcan Gove

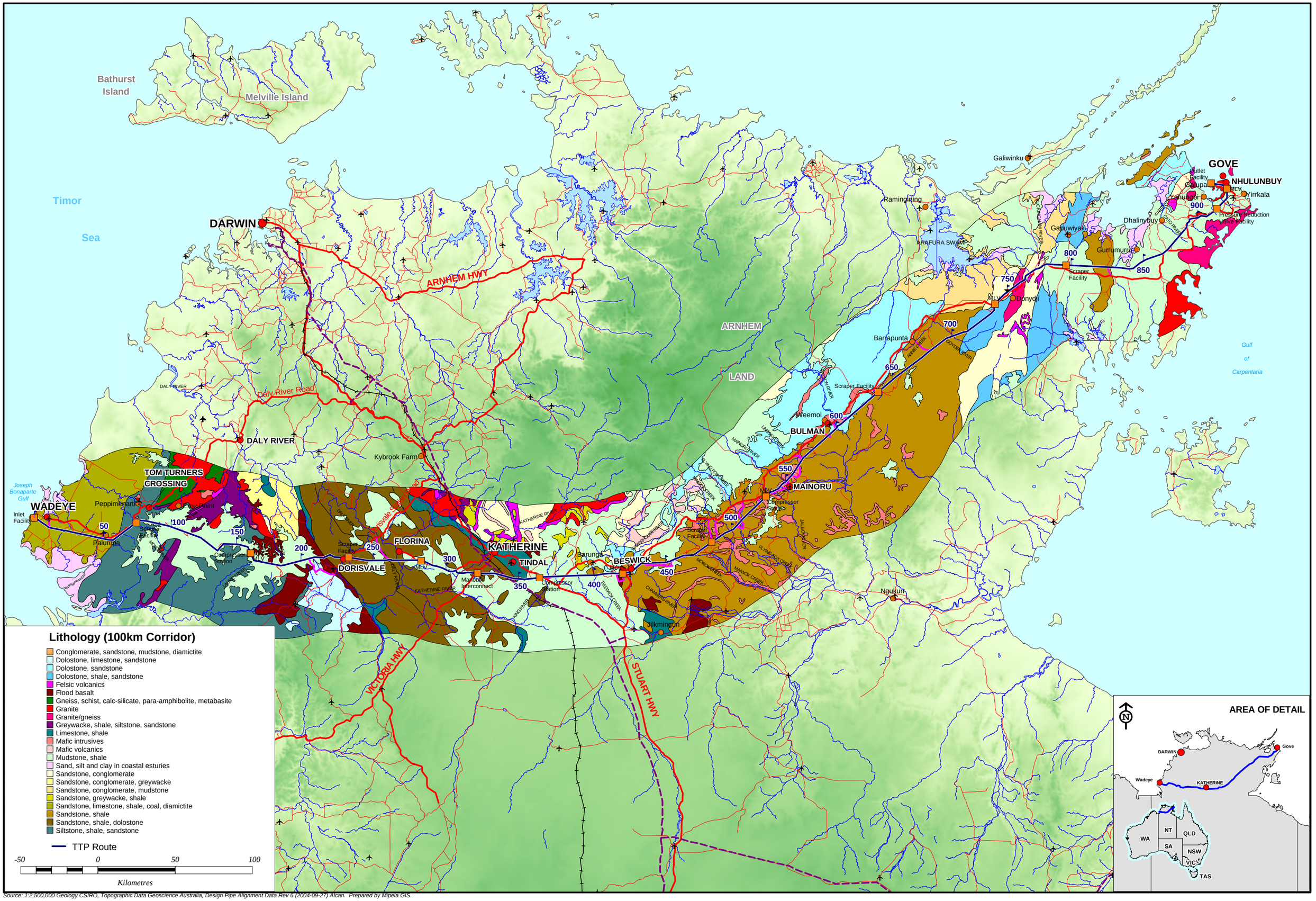
Source: Interpretation of AGSNT 1:250,000 Raster maps for Port Keats, Ferguson River, Katherine, Urapunga, Mount Marumba, Blue Mud Bay, Arnhem Bay Gove. The full titles of the reports are provided in the reference list (Section 15).

Figure 6-1: Topography in the Project Region



Source: Topographic Data Geoscience Australia, Design Pipe Alignment Data Rev 6 (2004-09-27) Alcan. Prepared by Mipela GIS.

Figure 6-2: Geology in the Project Region



Source: 1:2,500,000 Geology CSIRO, Topographic Data Geoscience Australia, Design Pipe Alignment Data Rev 6 (2004-09-27) Alcan. Prepared by Mipela GIS.

The pipeline passes through McArthur Basin which is a Proterozoic Basin, formed 1790–1500 million years ago and is slightly younger than the Proterozoic Orogens as described previously. McArthur Basin comprises predominantly sedimentary successions (sandstone and shales) and approximately 50% of TTP passes over this rock (NTG 2004a).

Palaeozoic Basins in the form of the Bonaparte and Daly Basins are also found in the vicinity of the proposed TTP. The Bonaparte Basin is mainly offshore covering one million km^2 and was formed following sedimentation in the Cambrian Period resulting in an outpouring of basaltic lavas between Precambrian and continental blocks (NTG 2004a).

The most recent rock formations within the vicinity of the TTP are Mesozoic Basins. The Bonaparte Basin contains early Palaeozoic to Mesozoic sediments in which rifts developed in pre-existing sag basins (NTG 2004a). Sedimentation in the Bonaparte Basin consists of a marine evaporate sequence.

From approximately KP611 to KP614 and from KP872 to the proposed Gove Gate Station at Alcan Gove, the geology is described as containing fossils. These locations do not coincide with areas identified as potentially requiring blasting during trenching (**Section 5.9.5**).

6.2.5 Land Systems and Soils

This section addresses aspects of land systems and soils traversed by the TTP which are relevant to the assessment of environmental impacts. Understanding of soils is critical in addressing environmental aspects of the TTP. The potential for erosion is one of the more important considerations in planning and managing the construction and operation of the TTP.

Several published datasets were available for this study. They provided broad coverage of soils and land systems, but did not provide the detail required for full interpretation of soils and their potential erodibility. Observations on the ground will be required for the whole route in addition to review of the field data already obtained prior to and during construction in order to make decisions on appropriate preventative and management options.

The mapped information provides a broad overview of the land systems encountered, but significant variability between land systems reports was found. The detail in mapping of the land systems varied considerably, the older mapping providing much coarser definition, and no specific soils mapping, whereas the more recent ones provided soils mapping under the recent Soil Order classifications. The older reports provide no information on erodibility, whereas the most recent reports provided some indication of potential erodibility.

Land Systems Reports: Reports on land systems of the region, which contain details of soil properties, have been published since 1965. The coverage of the more recent reports overlap to some degree with previous coverages. The Land Systems reports are documented in **Table 6-2**. Their coverage for each section of the TTP is shown, with an estimate of the overlap of each report.

- **Table 6-2 Land Systems Reports which cover the TTP Route**

Short Title	Year Published	Scale Of Mapping	Overlaps Previous Reports	Estimated Overlap (KP Range)	Coverage (KP Range)
Tipperary Area Lands	1965	4 miles to 1 inch(1:253,440)	Nil		219–374
Ord-Victoria Area Lands	1970	1:50,000 aerial photos (map scale probably 1:250,000)	Nil		113–219
Port Keats	1972	1:250,000	Ord-Victoria	0–113	0–113
Roper River Catchment	1992	1:250,000	Tipperary	374–425	374–580
Arnhem Land	1997	1:250,000	Roper	580–628	580–940

Note: KP means kilometre point from zero at Blacktip Gas Plant at Wadeye, to 940 km at Alcan Gove. The full titles of the reports are provided in the reference list (Secton15).

The TTP traverses around 100 different land systems described in the land system reports. The reports provide details of the types of land units encountered in each of the land systems in considerable detail. Land units are subdivisions of land systems. Each land system may have a few or many land units which may vary from topographic highs to valleys and plains. Unfortunately, they are not location specific, so the descriptions do not relate specifically to ground conditions where the TTP is likely to encounter each of the land units, and the information contained in the land unit descriptions does not provide very useful information for the purposes of environmental assessment.

Published Soils Data: The soils information which can be derived from the three older land systems mapping reports is less than adequate for this project, because they describe soils in very generalised terms for the major land units. The most recent report (for Arnhem Land – Lynch & Wilson 1997) describes soils in more precise terms using the Australian Soils Classification (Isbell 2002). The Arnhem Land Systems report also provides an indication of the types of lands and soils where erosion potential may be high, medium and low. While this provides some guidance on erodibility, site-specific investigations and observations in the field will be necessary to plan for management and mitigation.

The older land systems reports to the west, including the Roper, Tipperary and Ord-Victoria Systems do not provide sufficient detail for a reliable assessment of erodibility. They also do not provide resolution at the land unit scale, which is smaller than the land systems. For these, field data must be relied upon, and these are discussed below.

The Australian Soils mapping, based on original maps produced by Northcote between 1960 and 1968, provides an overview of the types of soils encountered across the TTP route. These have been mapped at a scale of 1:2,000,000 and therefore provide little specific guidance for interpretation of soils on the ground. The Australian Soils map is shown in **Figure 6-3**. The soil classification used was the Principal Profile Forms (PPF) developed by Northcote (1979). These PPFs have not yet been converted to the current Australian Soil Classification (Isbell 2002), which describes soils in Soil Orders. They therefore differ from the current Australian Soil Classification

used for the eastern part of the route. It was not possible to adequately correlate the two classifications. Neither the Australian Soils map nor the PPFs discuss erosion hazard. This is discussed in the more recent Australian Soils and Landscapes (McKenzie *et al.* 2004) reference work, using the Australian Soil Orders, but as the soils for most of the TTP have not been described using this methodology, it is of limited value to the project.

Field Soil Investigations: Detailed geotechnical studies of soils were undertaken during surveys for the pipeline route in 2003 and 2004 (Golder 2004). A summary of the findings of these studies is contained in **Appendix D**, **Volume 2** of this Draft EIS.

These soils data are too complex to be mapped for the purposes of this report and analysis. They provide specific data on soils encountered along the route, including soil descriptions down to around 1.5 m below the surface. Over 600 data points from 262 drilled auger bores are included in the data set, including descriptions of soil characteristics using the Unified Soil Classification (an engineering method of description). Aspects described include soil texture groups, soil plasticity, field moisture, and other descriptors. The data points have been mapped in **Figure 6-3**. The field data do not provide interpretations of erodibility of the soils. **Table 2**, **Appendix C**, **Volume 2**, of this Draft EIS provides descriptions of topography, soils, streams and trafficability along the pipeline route.

These field data provide the most accurate descriptions of the soils found along the route, and remove the many ambiguities and contradictions in the published and mapped data otherwise available. The field soils descriptions which were obtained during field work for the TTP do not match precisely with the Australian Soils mapping at 1:2,000,000 scale, as the latter soils were described using the Factual Key PPF descriptions (Northcote 1979) which is based on texture and colour, whereas the TTP field soils were described using texture and engineering descriptions. Nevertheless, the field descriptions of soils, being point specific, provide a good base for understanding the engineering properties of the soils encountered, and were a close approximation in most cases for the soils described from the Australian Soils map.

Table C-2, **Appendix C**, **Volume 2** of this Draft EIS summarises the key features for each surveyed point along the route.

6.2.6 Acid Sulfate Soils

Acid sulfate soils (ASS) are soils that contain iron sulfides which, when drained or disturbed, produce sulfuric acid and result in the release of soluble iron, sulfate and aluminium. These soils occur in coastal plain landscapes at low elevations and when they are excavated and drained produce low pH leachate which have the potential, if unmanaged, to contaminate land and adjacent waterways, severely degrading the in-stream environment.

Inland occurrence of these soils is associated with stranded shorelines leaving Quaternary (or sometimes older) estuarine sediments at some distance from the coast and at elevations above sea level. Current guidelines (ARMCANZ 1999; Dear *et al.* 2002) identify ASS with Quaternary sediments in coastal environments below 5 m AHD, and the possibility of these soils occurring at

higher elevations in near coastal sedimentary environments. The national strategy (ARMCANZ 1999) for the management of coastal ASS recognises that elevations less than 10 m AHD represent an ASS risk. While current land management advice in Queensland identifies coastal environments at elevations below 10 m AHD with ASS risk, in the Northern Territory, geomorphological studies on the Mary River floodplain indicate Holocene sediments occur below 4 m AHD (Woodroffe and Mulrennan 1993). Advice on the distribution of ASS along the Northern Territory coastline is based on generalised land resources mapping (1:250 000). Coastal ASS mapping is currently under review nationally and advice is likely to change. However, based on current information, ASS risk is associated with coastal wetland and floodplain environments at elevations below 10 m AHD.

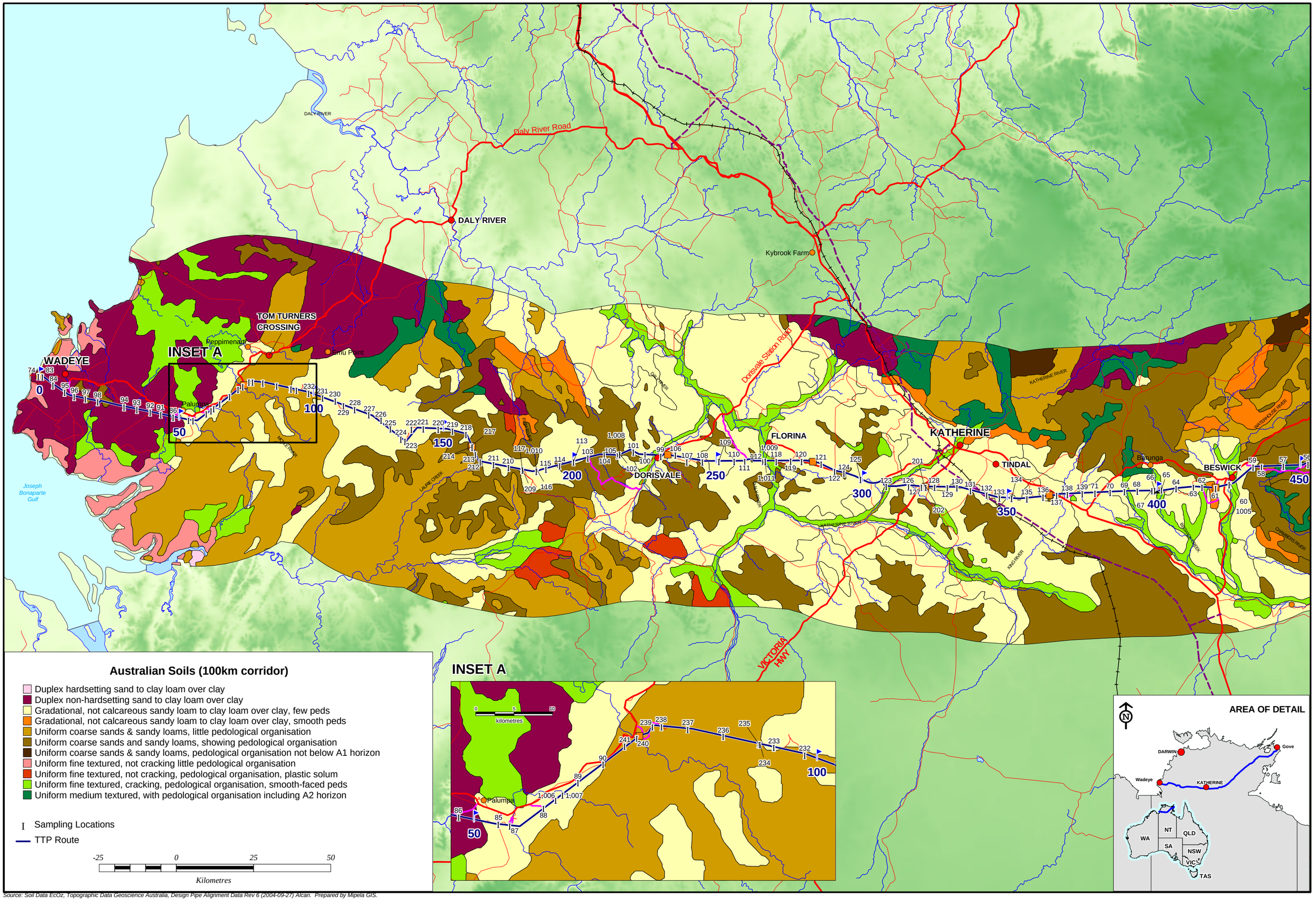
Based on a review of ASS risk mapping provided by the Northern Territory Government (NTG 2004b), three areas of potential risk have been identified in the vicinity of the pipeline route (**Figure 6-4**). Areas where the pipeline alignment intersects low-lying coastal wetlands were identified with a risk of potential ASS. The 20 m contour is the lowest elevation on the 1:100,000 topographic base mapping. Consequently, areas where the pipeline alignment intersects with coastal wetland mapping at elevations below 20 m AHD were identified with a risk of potential ASS. Ten wetland sites on two river systems assessed with potential ASS risk are detailed in **Table 6-2**. Soil samples taken at these locations were described from drilling to 1.6 m depth, and are provided in **Appendix D, Volume 2**. Most of the soils contained clays at depth, but none were considered wet, but only moist at depth. This would suggest that the soils are unlikely to be ASS soils, although they were not tested for these properties.

On the Moyle River floodplain the pipeline passes south of an area of potential ASS, classified as medium risk. At approximately KP832 on the Goromuru River the pipeline is in close proximity to a 'medium' ASS risk area. At approximately KP922 on the Latram River the pipeline is in close proximity to a 'high' ASS risk area, although the pipeline at this location passes through clay and sandy soils across the Latram River.

- **Table 6-3 Coastal Wetlands Assessed with Potential Acid Sulfate Soil Risk**

Location	ID from Hydrology Report	Longitude	Latitude	Ecosystem Type	Soil samples to 1.6 m from geotechnical report
Latram River Valley		136.77	-12.30	Lowland river	255, 158
Goromuru River Valley	73	136.17066	-12.71102	Lowland river	150, 151, 155, 250
	74	136.17188	-12.71119	Lowland river	
	75	136.17231	-12.71125	Lowland river	
	77	136.17588	-12.71172	Wetlands	
	79	136.18499	-12.71294	Lowland river	
Moyle River	408	129.94167	-14.36992	Wetlands	87, 88, 89, 90, 241
	412	129.96372	-14.35328	Wetlands	
	413	129.96145	-14.35499	Wetlands	
	427	130.05831	-14.28203	Wetlands	

Figure 6-3: Soil Types And Sampling Locations in the Project Region (Map 1 of 2)



Source: Soil Data EcOz, Topographic Data Geoscience Australia, Design Pipe Alignment Data Rev 6 (2004-09-27) Alcan. Prepared by Mipela GIS.

Figure 6-3: Soil Types And Sampling Locations in the Project Region (Map 2 of 2)

Australian Soils (100km corridor)

- Duplex hardsetting sand to clay loam over clay
- Duplex non-hardsetting sand to clay loam over clay
- Gradational, not calcareous sandy loam to clay loam over clay, few peds
- Gradational, not calcareous sandy loam to clay loam over clay, smooth peds
- Uniform coarse sands & sandy loams, little pedological organisation
- Uniform coarse sands and sandy loams, showing pedological organisation
- Uniform coarse sands & sandy loams, pedological organisation not below A1 horizon
- Uniform fine textured, not cracking little pedological organisation
- Uniform fine textured, not cracking, pedological organisation, plastic solum
- Uniform fine textured, cracking, pedological organisation, smooth-faced peds
- Uniform medium textured, with pedological organisation including A2 horizon

I Sampling Locations

TTP Route

-25 0 25 50

Kilometres

CONTINUED IN INSET B

ARNHEM LAND

Ramingining

ARAFURA SWAMP

Gapuwiyak

Dhalinybuy

Yirrkala

Yanungbi

Gurrumuru

Donydji

Barrapunta

Weemol

BULMAN

MAINORU

Jilkmingan

Ngukurr

Gulf of Carpentaria

INSET B

GOVE

NHULUNBUY

Galupa

Yirrkala

Yanungbi

Dhalinybuy

Gapuwiyak

CATORBER

kilometres

AREA OF DETAIL

DARWIN

Gove

Wadeye

KATHERINE

NT

QLD

WA

SA

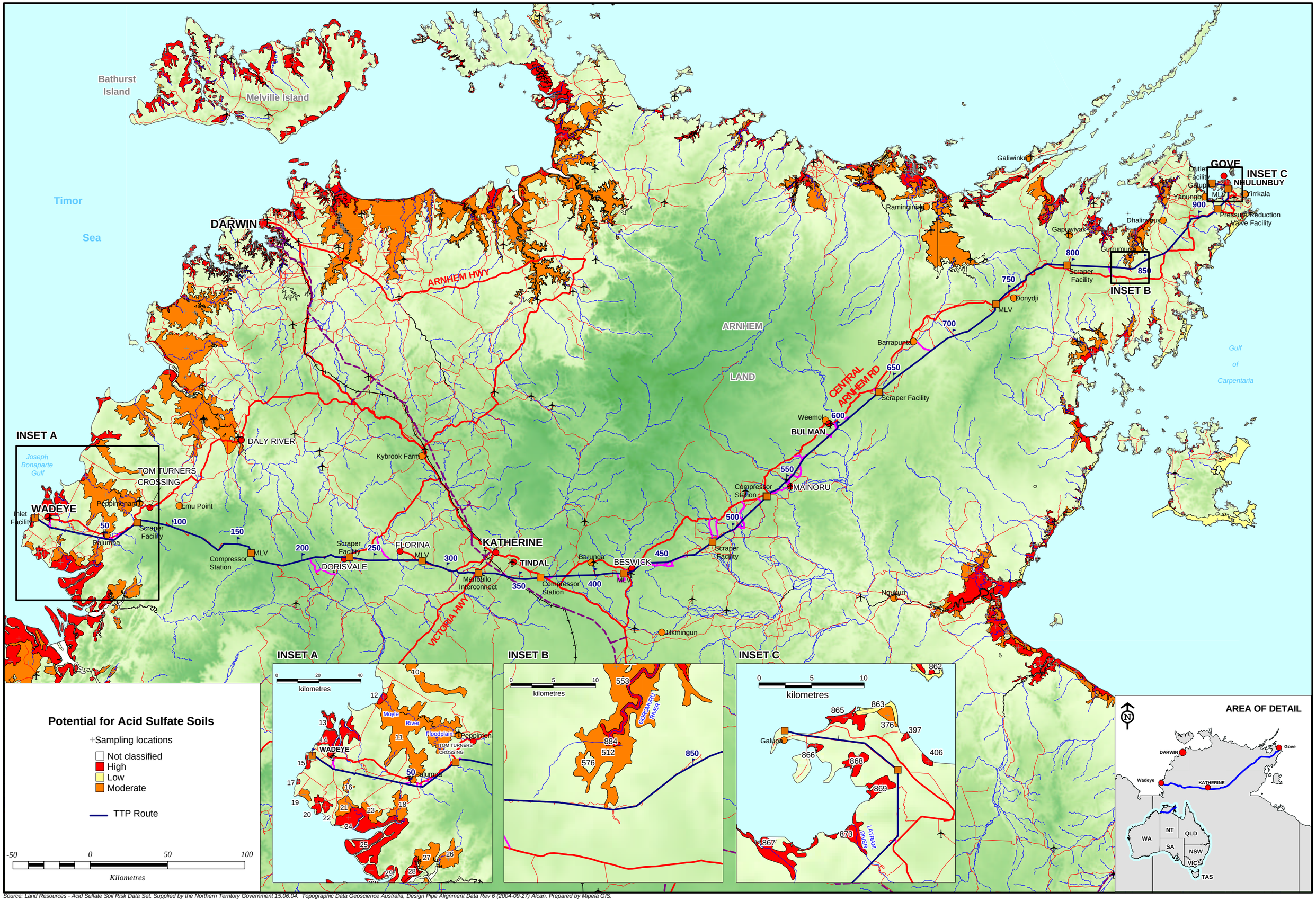
NSW

VIC

TAS

Source: Soil Data EcOz, Topographic Data Geoscience Australia, Design Pipe Alignment Data Rev 6 (2004-09-27) Alcan. Prepared by Mipela GIS.

Figure 6-4: Potential Acid Sulfate Soil Locations in the Project Region



Source: Land Resources - Acid Sulfate Soil Risk Data Set. Supplied by the Northern Territory Government 15.06.04. Topographic Data Geoscience Australia, Design Pipe Alignment Data Rev 6 (2004-09-27) Alcan. Prepared by Mipela GIS.

6.2.7 Seismicity

As Australia is not located on the edge of any plates, earthquake activity in Australia is considered low (OSD Energy Services 2004). Earthquakes have occurred in Australia in the past, but activity is generally confined to the west coast of Western Australia and to isolated pockets in all other states (Geoscience Australia 2004).

Historically, several large distant earthquakes have been felt in the vicinity of the Gove Peninsula of the Northern Territory since European settlement (URS 2004). There have been a limited number of moderate earthquakes in the vicinity of the Gove Peninsula since 1900. The seismicity of the Gove Peninsula area over the past 28 years is characterised by a series of earthquakes without significant main shock-aftershock sequences (URS 2004).

In 1991, three areas of high earthquake activity were identified in the Northern Territory and in Western Australia, namely, Tennant Creek, Simpson Desert and Lake Tobin. Recorded activity in the Tennant Creek region began in 1987 with a magnitude event of 5.2 on the Richter scale. Seismicity at this location has remained above average level and small earthquakes continue to occur. The Simpson Desert is located in the south-east of the Northern Territory, near to the South Australia border. Earthquakes have been recorded here since 1937 and following a long period of inactivity, a magnitude 6.2 event was recorded in 1972 (UWA 2004). Recorded activity in the Lake Tobin area began in 1970 with a 6.2 magnitude event.

Seismicity is discussed further in a preliminary risk assessment (OSD Energy Services 2004) undertaken for TTP in accordance with AS2885, and is presented in **Appendix E**, **Volume 2** of this Draft EIS.

6.2.8 Geotechnical Stability

The geotechnical survey, outlined in **Section 6.2.5**, carried out along the route of the proposed pipeline during the 2003 and 2004 dry seasons (Golder 2004), determined the ground conditions down to a level of approximately 1.5 m below the natural surface in order to assess the excavation characteristics.

The work involved the drilling of 262 auger holes and recording a geotechnical log of the drilling operation and an observation of the surface conditions.

A summary of the results of the survey is contained in **Appendix D**, **Volume 2** of this Draft EIS. Generally, the results show that less than 10% of the route encounters rock at a depth that will affect the trenching operation.

6.2.9 Surface Water

The water resources along the pipeline route can be described in relation to the surface water management areas in the national catchment framework used for Territory-wide environmental audit reporting (NLWRA 2000). The surface waters that occur in the project area are summarised below and described in full in **Appendix G**, **Volume 2** of this Draft EIS.

The proposed pipeline will traverse extensive areas of five major river basins, and touches on two (the Fitzmaurice and Koolatong catchments) (**Figure 6-5**). Catchment statistics as summarised in **Table 6-4** for each of these major river basins identify the size of the surface water resource and perceived development pressure. The largest surface water resource is in the Roper River basin. The next largest is in the Daly River basin. Resource use (measured by diversions) and development pressure (measured by estimated future use) identify these two catchments as recognised, economic water resources. The surface water resources in other catchments along the corridor are undeveloped and do not currently have recognised development potential.

- **Table 6-4 Catchment Statistics**

Parameter	Units	Moyle	Daly	Roper	Goyder	Buckingham
Area	km^2	7,020	52,940	79,130	10,360	8,330
Runoff	Ml/yr	600,000	6,740,000	5,540,000	1,685,000	2,800,000
Diversions	Ml/yr	0	7,465	526	0	0
Sustainable yield	Ml/yr	110,000	1,110,000	950,000	302,800	440,000
Estimated use in 2020	Ml/yr	Nil	102,770	620	nil	nil
Estimated use in 2050	Ml/yr	Nil	104,530	720	nil	nil
Disturbance		<30%	<30%	<30%	<30%	<30%

Moyle River Basin (KP000–125): The catchment covers 7,020 km^2. The mean annual rainfall varies from 1200 mm in the south to 1500 mm in the north. There are three major Aboriginal communities namely Wadeye, Peppimenarti, and Palumpa. The basin is drained by the Moyle River and several creeks. The Moyle River flows from the escarpment country and drains into the floodplains before flowing into the Timor Sea. There is no surface water licensing, and no surface water usage is recorded. Sections of the pipeline corridor from KP14 to KP30 and from KP39 to KP46 traverse the headwaters of the Fitzmaurice River catchment. The catchments are described as being unaffected by development.

The average annual runoff in the Moyle River catchment is estimated to be around 600,000 Ml/yr, with total diversions believed to be negligible. Most of the numerous stream crossings that occur along the corridor are ephemeral and flow during the wet season only. The few rivers and creeks that typically have measurable flow at the end of the dry season are the Fitzmaurice River, Moyle River and Tom Turners Creek. However, stream gauging stations are sparse and some other creeks may support continuous streamflow.

There are limited stream flow measurements. In most cases, the creeks dry up early in the dry season each year and do not flow again until the next wet season. Some of the largest flows in the region have been measured in the Daly River near Nauiyu, Tom Turner's creek near Peppimenarti and the Moyle Rover between Peppimenarti and Nganmarriyang (Palumpa). Graphs of mean monthly discharge records for Bradshaw Creek indicate that flow ceases between April-May and November.

Thirty-nine intersections between the pipeline corridor and the surface drainage features in the Moyle River basin were identified. The only major permanent river traversed by the pipeline corridor in this basin is the Moyle River.

Daly River Basin (KP125–374): Daly River is the major river in this basin and the Katherine River is one of the major tributaries. The catchment covers an area of 52,940 km^2. The mean annual rainfall varies from 700 mm in the south to 1500 mm in the north near the coast and the mean annual runoff is 67,400,000 Ml/yr. The upper part of the catchment is moderate escarpment country and the lower part around the coastal areas is flat. There is only one major diversion, the Donkey Camp Weir on Katherine River. Pastoral Leases cover 50%, Aboriginal land covers 20%, National Park covers 9%, and the rest of the catchment is used for horticulture, agriculture and mining. The surface water usage is for urban water supply and irrigation, stock watering, mining, rural water supply and aquaculture.

There is a large baseflow component to the Daly River system. The basin is largely unmodified. Total diversions have increased from 3,730 Ml/yr in 1983/84 to 7,465 Ml/yr in 1996/97. The majority of this increase was attributed to urban supply. However, 53% of the diversions are for irrigation while 40% are for urban/industrial uses. Agricultural development has put pressure on water quality and has stimulated research into the environmental flow regimes needed to maintain groundwater dependant ecosystems (Erskine *et al.* 2003).

Graphs of mean monthly discharge records for the Daly River, the Katherine River and Bradshaw Creek indicate that ephemeral stream flow ceases slightly later than areas further west, with the flow free period extending between May and November.

Seventy four intersections between the pipeline corridor and the surface drainage features in the Daly River Basin were identified. Major permanent rivers traversed by the corridor in this basin are the Daly River and Katherine River.

Roper River Basin (KP374–628): The Roper River Basin covers an area of 79,130 km^2. The mean annual rainfall varies from 600 mm in the south to 900 mm in the north and the mean annual runoff is 5,540,000 Ml/yr. There are no major infrastructure or diversions for surface water extraction within this river basin. However there is 'run of river' extraction for public water supply for two communities, and irrigation. About 60% of the area is pastoral leasehold and 35% is Aboriginal land. Soils with few limitations for agriculture, cover about 38% of the area. The Roper is the main river that drains the whole area into the Gulf of Carpentaria. Phelp River, Wilton River, Waterhouse River and Hodgson River are the main tributaries of Roper River. They flow from the escarpment country through well-defined valleys and finally flow into the Gulf of Carpentaria through mildly sloping low valleys. A surface water license has been issued for a community water supply, and three licenses for irrigation. Surface water is also used for stock watering. Tourism, irrigated agriculture, marine and riparian uses are the likely potential developments. Forecast usage of surface water is mainly for public water supply, irrigation and stock watering.

One hundred and seventy nine intersections between the pipeline corridor and the surface drainage features in the Roper River Basin were identified. Major permanent rivers traversed by the pipeline corridor in this basin are the Wilton River and Waterhouse River.

Goyder River Basin (KP628–778): The Goyder River catchment covers an area of 10,360 km^2. The mean annual rainfall varies from 900 mm in the south to 1100 mm in the north and the mean annual runoff is 1,685,000 Ml/yr. The entire basin is on Aboriginal land and there are no infrastructure or diversions. About 4.5% of the land area has soils with few limitations to agriculture.

The Goyder River is the major river, and Gulbuwangay River is the major tributary. Both these rivers which join in the lower part of the basin and discharge into the Arafura Sea, originate from the escarpment country and flow through the low valleys into low mildly sloping country. There is no surface water licensing, and surface water usage is zero. No potential development issues have been identified for this catchment.

Fifty three intersections between the pipeline corridor and the surface drainage features in the Goyder River Basin were identified. The only major permanent river traversed by the pipeline corridor in this basin is the Goyder River.

Buckingham River Basin (KP778–KP840): The Buckingham River Basin covers an area of 8,330 km^2. The mean annual rainfall varies from 1,300 mm in the south to 1,400 mm in the north and the average annual runoff is 2,800,000 Ml/yr. This basin is entirely within Aboriginal land and there are no major infrastructure or diversions for surface water extraction. The potential for agricultural development is considered to be low.

The main rivers in the Buckingham River basin are the Woolen River, Buckingham River, Habgood River, Cato River, Peter John River and Giddy River. There are few rivers that flow from the escarpment country in the west and low hill country in the east to the sea. The lower part of the basin is mildly sloping to flat country. No surface water licenses have been issued, and no surface water usage has been recorded.

Graphs of mean monthly discharge records for Durabudboi River and Yirrkala Creek indicate that flow ceases between June and December. Flow ceases a month earlier and commences a month later than in the Moyle River basin traversed by the western most section of the pipeline corridor. Regional variations in flow regimes will have implications for the timing of construction activities, especially at watercourses.

Eighty two intersections between the pipeline corridor and the surface drainage features in the Buckingham River Basin were identified. The major permanent rivers traversed by the pipeline corridor in this basin are the Buckingham River, Cato River, Giddy River and Latram River.

Surface Water Features: Four hundred and twenty six surface water features are intersected by the proposed pipeline corridor as identified in the full report at **Appendix G, Volume 2** of this Draft EIS. Each surface water feature intersected by the pipeline corridor was classified in accordance

with the aquatic ecosystems classification used in ANZECC and ARMCANZ (2000). In summary the proposed pipeline corridor traverses:

- 16 major permanent rivers and streams namely: Moyle River, Bradshaw Creek, Daly River, Katherine River, King River, Roper Creek, Beswick Creek, Water House River, Flying Fox Creek, Mainoru River, Wilton River, Goyder River, Boggy Creek, Cato River, Giddy River and Latram River;
- 338 seasonal and irregular rivers and streams;
- three riverine floodplains subject to seasonal flooding;
- 63 seasonal/intermittent freshwater ponds and marshes;
- five freshwater springs.

Figure 6-5 presents the locations of surface water features that occur in the project area.

6.2.10 Ground Water

The groundwater resources that occur in or near the project area are summarised in this section; the full report is found in **Appendix G**, **Volume 2** of this Draft EIS.

Recharge processes in areas traversed by the pipeline corridor are considered to be distributed rather than localised in particular parts of the landscape (Chin *et al*. 2000). Licensing for groundwater extraction is organised around eight Groundwater Management Units (GMUs) as shown in **Figure 6-6**. These represent selected major aquifer systems within gazetted 'Water Control Districts' across the Northern Territory and Unincorporated Areas (UAs). The shallow high yielding aquifers in the Bonaparte Gulf Basin, the Daly River Basin (Tindal-Katherine Water Control District) and an un-named, porous sandstone aquifer in the eastern Mac Arthur Basin have identifiable conservation values in the national water quality management planning framework (EA 2001).

Water bores within the pipeline corridor with measured yields greater than 1 l/s were identified as having potential water supply value (**Figure 6-6**). In the Moyle River Basin, eight water bores were identified. In the Daly River Basin, three bores were identified. In the Roper River Basin, four bores were identified. In the Buckingham River Basin, 31 water bores were identified. Locations of these bores, plus dams and springs, are listed in **Appendix C** to the technical report at **Appendix G**, **Volume 2** of this Draft EIS. The groundwater resources along the route are described in the following sections.

Wadeye (KP0–KP013): A high yielding, widespread shallow aquifer system underlies the pipeline corridor in the vicinity of the Wadeye community. The rock types consist of sandstone, siltstone and claystone sediments of the Upper Permian Hyland Bay Formation. An impervious claystone at a depth of 50 to 100 m marks the base of the sandstone. This aquifer is 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 in the area and therefore it is expected that the aquifer will also supply these new developments.

Bore yields commonly exceed 5 l/s and less often 10 l/s. However, bore yields are very inconsistent and vary between 0.5 and 22 l/s. Higher yielding bores are associated with fracturing or a local source of recharge. The water quality is usually good. The Wadeye community has a designated borefield for domestic water supply. The use of water from the reticulated water supply is reserved for drinking and the irrigation of lawns, community parks or football ovals. Estimated daily water consumption for the Wadeye community is 1,295,00 l/day. An essential service officer (ESO) with the Power Water Corporation maintains the community water supply.

In addition to drinking water the shallow aquifers also have environmental beneficial uses - supporting wetlands and spring-fed vegetation. The hyetograph of changing water levels in Wadeye indicates that current consumption has not drawn the aquifer down. Water quality is within Australian Drinking Water Guidelines (ANZECC 2000) for the selected physical and chemical parameters. The aquifer traversed by the pipeline corridor near to Wadeye is a significant resource that will underpin agricultural and residential development in the Wadeye area into the future. The high quality of the groundwater resource requires a high level of protection.

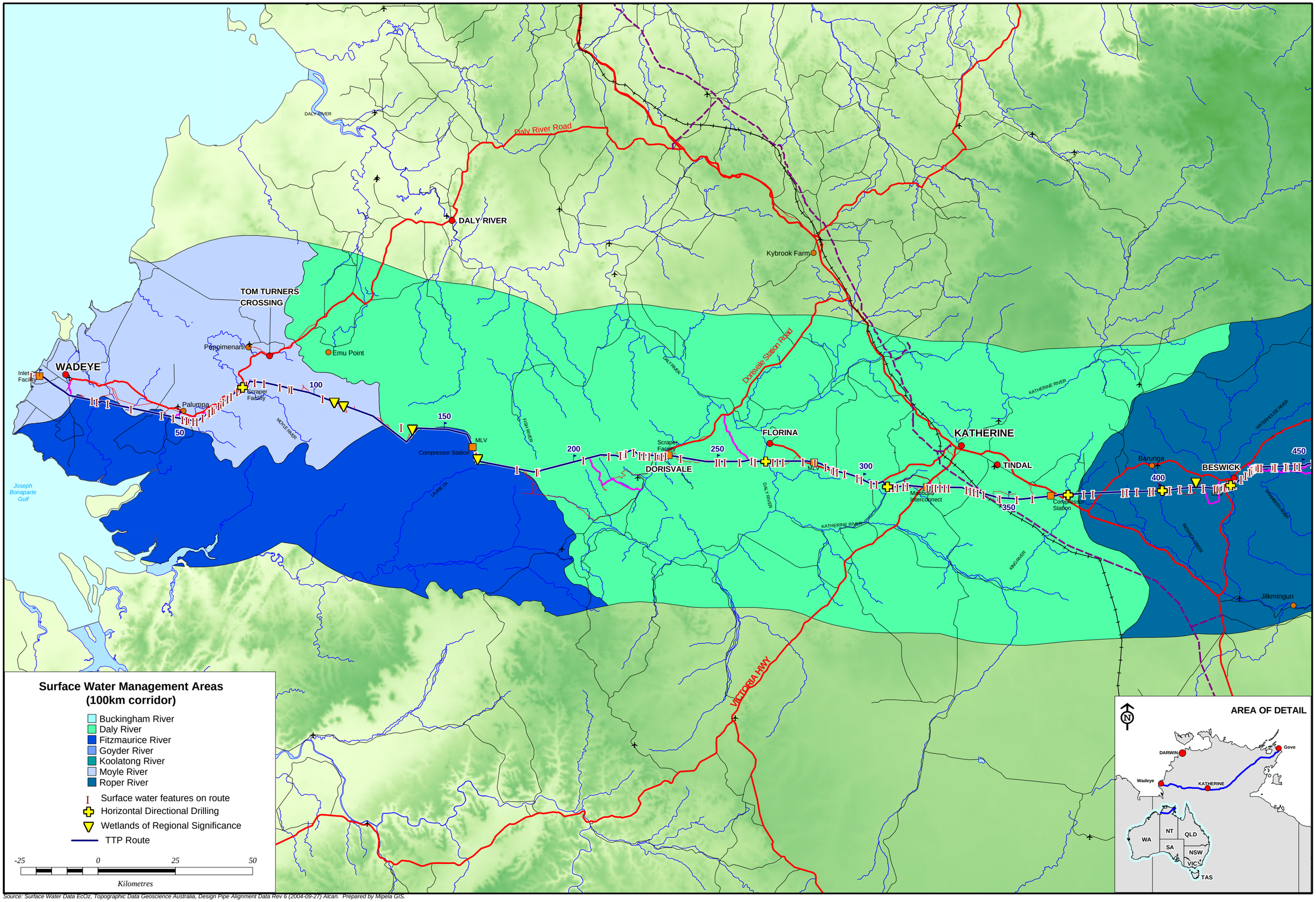
Palumpa (2.5 km north of KP51): A significant homeland supply occurs in the Southern Shallow Aquifer identified in the Wadeye/Nauiyu Water Study in the vicinity of Palumpa. The shallow aquifer occurs in sandstones extending from Table Hill in the south to the outstation of Tchindi in the north. Shallow bores have been successfully located, yielding between 1 and 5 l/s. A deep sandstone aquifer with bore yields between 4 and 20 l/s underlies the Woodycupaldiya area. Higher yielding bores in the shallow and in the deep aquifer are not necessarily associated with fracturing or faulting.

Daly River Basin (KP125–374): The Daly basin lies on a bed of Cambrian limestone and sandstone formations, but the surface formations are mostly of Cretaceous origin. The area is characterised by three types of fractured, karstic rocks known as Tindal limestone (limestone and siltstone), Oolloo limestone dolomitic sandy limestone) and the Jinduckin Formation (a mixture of limestone, siltstone and shale). All three rock types contain extensive unconfined aquifers that serve as the primary groundwater resources in the area and, as a result, provide the base flow of the majority of the rivers and creeks in the Daly basin. Groundwater has a very important role in wetland hydrology in the Daly basin (McGowan 1989; Begg *et al.* 2001).

The depth to the watertable varies from one year to another in response to rainfall amount. At sites underlain by Tindal limestone the watertable can vary during the course of a year from 3–25 m.

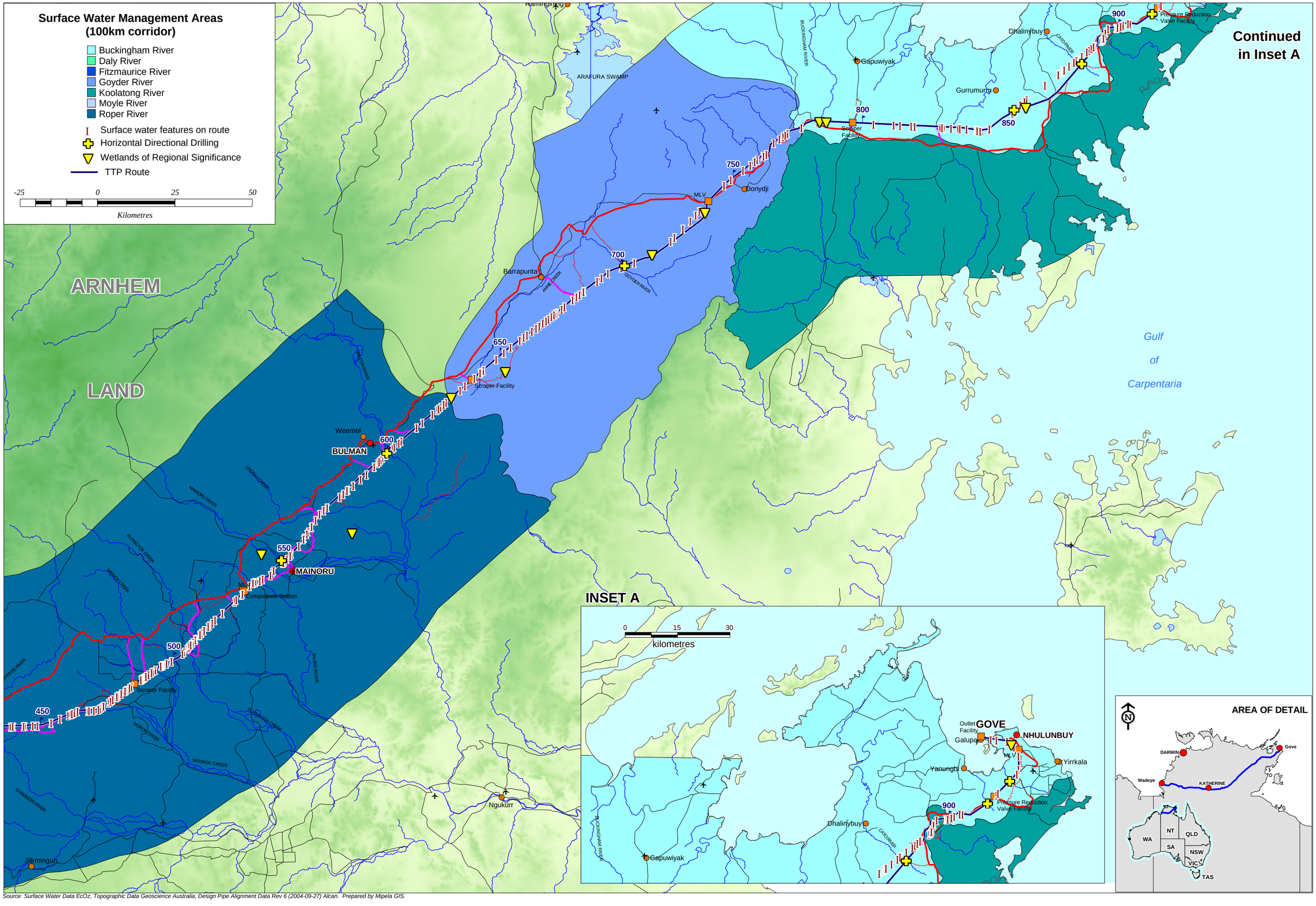
Florina-Gum Creek-Cutta Cutta Caves (KP268–360): A significant groundwater supply with identified land development potential extends between Florina and Gum Creek (KP268 to KP305). The limestone cave system in the dolomite aquifer down gradient from the pipeline alignment near KP355 (*Cutta Cutta Caves*) has significant heritage values that warrant protection.

Figure 6-5: Surface Water Features in the Project Region (Map 1 of 2)



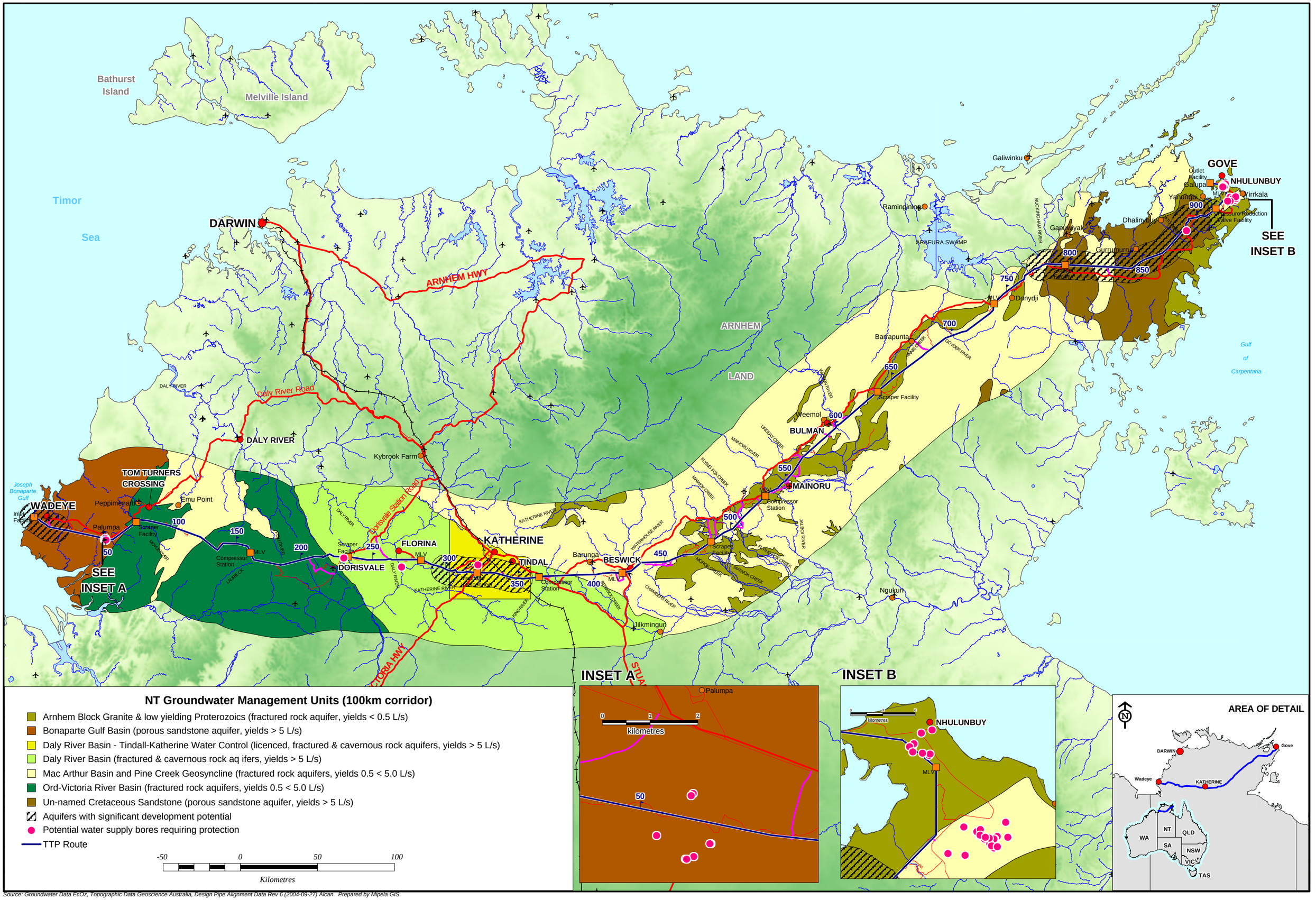
Source: Surface Water Data EcOz, Topographic Data Geoscience Australia, Design Pipe Alignment Data Rev 6 (2004-09-27) Alcan. Prepared by Mipela GIS.

Figure 6-5: Surface Water Features in the Project Region (Map 2 of 2)



Source: Surface Water Data EcOz, Topographic Data Geoscience Australia, Design Pipe Alignment Data Rev 6 (2004-09-27) Alcan. Prepared by Mipela GIS.

Figure 6-6: Groundwater Resources in the Project Region



Source: Groundwater Data EcOz, Topographic Data Geoscience Australia, Design Pipe Alignment Data Rev 6 (2004-09-27) Alcan. Prepared by Mipela GIS.

Bamyili-Beswick (KP394–KP424): The water resources survey for Bamyili-Beswick indicates local weathered zone and fractured rock aquifers with yields up to 5 l/s. The Mataranka settlement on the Roper River and Waterhouse River, 40 km downstream of Beswick is well known for tourism activities focussed on groundwater fed springs.

Bulman (KP595–KP605): A significant homeland supply occurs in fractured sandstone, siltstone and dolomite. Higher yields can occur in fault zones where the fracturing is intense or where the rocks are deeply weathered.

Goyder River Basin (KP628–778): A shallow aquifer with large groundwater supplies occurs between KP700 and KP710. The aquifer type consists of poorly consolidated sandstone or limestone and has high porosity and permeability. The aquifer has a narrow intersection (downstream of the gas pipeline) with the headwaters of the Goyder River.

Gove: Aquifers with large groundwater supplies occur between KP786 to KP816, KP826 to KP908 and KP918 to KP928. These sections are large regional aquifers that consist of poorly consolidated sandstone or limestone. They provide the most substantial and reliable groundwater resources in the region. This aquifer type has high porosity and permeability and can supply large volumes of water. Individual bore yields are generally more than 10 l/s and can be up to 50 l/s with efficient bore construction. This type of aquifer supplies water to the Alcan Gove Refinery, Nhulunbuy and Yirrkala.

The volume of water that can be extracted from these aquifers may be sufficient for long term industrial or agricultural use. These aquifers naturally discharge large volumes of water throughout the year and are responsible for the baseflow of many of the large rivers. Consequently, they require a high level of protection. Monitoring of these aquifers and due care will be exercised where groundwater is extracted for the project.

Groundwater Depth: Areas of shallow groundwater depth are of most interest to construction of the pipeline as dewatering of the trench will be required if the water table is intersected. Shallow groundwater depth is associated with wetlands, floodplains and drainage lines. Logged information on bores within the pipeline corridor was used to estimate the standing water level during the dry season when the pipeline will be constructed. Wet season groundwater levels are likely to rise closer to the surface but should not be relevant to assessing conditions during construction. The findings of the desktop investigation of groundwater depth are discussed below.

Bore logs in the pipeline corridor for the Moyle River Basin indicate standing water levels between 2.9 m and 23.4 m in shallow, unconfined aquifers. Groundwater variation reported in the Daly Basin indicates variation between 2 m and 62 m during the course of the year. No bore log information or standing water level data were available for the Roper River Basin. However, groundwater studies describe seasonal variation in the shallow aquifer and indicate dry season standing groundwater levels below 2 m. Bore logs in the pipeline corridor in the Buckingham River Basin near Gove indicate standing water levels between 0.2 m and 35.6 m in shallow, unconfined aquifers. The very shallow groundwater measurement was taken in the wet season

(February). Shallow groundwater levels are closely linked to annual rainfall and stream flow. The shallow groundwater level rises rapidly during the wet season in response to rainfall and provides stream baseflow into the dry season, with groundwater levels falling rapidly in the subsequent dry season.

6.3 Ecological Environment

The TTP covers six bioregions identified in the Interim Biogeographic Regionalisation of Australia (Environment Australia 2000). These are the Darwin Coastal, Victoria-Bonaparte, Daly Basin, Gulf Fall and Uplands, Central Arnhem and Arnhem Coastal bioregions. The bioregions delineate areas that have a common set of ecological attributes, and provide a framework for characterising the diversity of ecological environments that are encountered from the west of the project area to the east. The ecological attributes that characterise the Northern Territory bioregions have been documented and assessed by Woinarski (2002). Some of the information contained in these summaries has been used in the descriptions of the ecological environment contained in the following sections of the Draft EIS document. The bioregions traversed by the pipeline corridor are shown in **Figure 6-7**.

6.3.1 Vegetation and Flora

The vegetation and flora that characterise the project area were identified through:

- a desktop review of literature and datasets;
- consultations with experts from the Northern Territory Parks and Wildlife Service and Northern Territory Department of Infrastructure, Planning and Environment (DIPE);
- field surveys comprising over 15 weeks of continuous traverse of the pipeline corridor and flora surveys at 334 sites.

The results of the vegetation and flora study are summarised in this section from the full report contained in **Appendix H**, **Volume 2** of this Draft EIS.

Vegetation Communities: The vegetation in the project area is characterised by 16 Vegetation Units as defined by Fox *et al.* (2001) in their classification of the vegetation of the Australian tropical savannas. The location and extent of each of the Vegetation Units in relation to the pipeline corridor is summarised in **Table 6-5** and shown in **Figure 6-8**. The vegetation maps provided a useful broad classification of the vegetation in the project area for the purpose of assessing the impacts of the proposed project on vegetation in a regional and national context. The field survey data were used in combination with land systems mapping (**Section 6.2.5**) to derive a more detailed description of the vegetation patterns. The general vegetation patterns observed in the project area during the field surveys are summarised in **Appendix F**, **Volume 2, Table 1** of this Draft EIS, along with photos taken in representative vegetation types. Botanical data and site descriptions collected during the field surveys are collated in the full report in **Appendix H**, **Volume 2** of this Draft EIS.

Geographically restricted vegetation communities including riparian corridors, wetlands (swamps and floodplains), monsoon vine forests and sandstone communities occur within the dominant Eucalyptus\Corymbia woodland matrix but are not accurately represented in the vegetation classification prepared by Fox *et al* (2001). These communities, because of their restricted distribution, and associated value as habitat for flora with special habitat requirements, are of high conservation value. Ecologically sensitive vegetation communities that occur in or near the project area are discussed in **Section 6.3.4**.

'Threatened' Flora Species: A review of the distribution and habitat requirements of plant species afforded protection under *Territory Parks and Wildlife Conservation Act 2000* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* legislation identified 13 'threatened' plant species in the bioregions traversed by the pipeline corridor as summarised in **Table 6-6**). Each of the 'threatened' species identified are listed in **Table 6-6** along with an indication of the likelihood of the plant occurring in the project area.

Pternandra coerulescens is the only 'threatened' plant species that may be found along the pipeline corridor. This plant is typically a medium tree to 15 m tall, or a several stemmed erect rambling shrub to 6 m tall, that inhabits spring-fed rainforests and riparian forest communities (Kerrigan *et al.* 2002). In the Northern Territory it is known from four localities in north-east Arnhem Land. *P. coerulescens* has previously been recorded from a location 750 m south-east of where the pipeline corridor will cross the Latram River (KP922), however, surveys of the Latram River at the proposed HDD pipeline crossing did not identify any specimens of this species.

Other Species of Conservation Significance: The Northern Cypress Pine *Callitris intratropica* is a species of interest that currently occupies only a fraction of its potential range and has experienced a widespread collapse due to the impact of contemporary fire regimes (Bowman and Panton 1993). This species has been the subject of a number of scientific studies looking at contemporary fire regimes and Aboriginal burning practices. *C. intratropica* was observed at a number of locations during field surveys, along the proposed pipeline corridor and at a site near the Buckingham River proposed for a construction camp (**Figure 6-8**). Observations ranged from large *C. intratropica* trees scattered through Eucalyptus woodland\forest communities to small homogenous patches of *C. intratropica* consisting of both mature individuals and juveniles. Dead *C. intratropica* trees were observed at a number of locations mainly in flat Eucalyptus woodland\forest communities on sandy soils.

Cycad species are of interest as they are regionally endemic and have potential commercial values. Eight out of the ten species of Cycad that occur in the Northern Territory are endemic to the region in which they are found. Four of these species were identified in the pipeline corridor during field surveys, these were *Cycas maconochei ssp. maconochiei* (KP0–50), *Cycas canalis* (KP90), *Cycas orientis* (Goyder River east) and *Cycas arnhemica* (Goyder River east). Cycads are typically slow growing, have a localised distribution and little is known about their ecology, which gives rise to concerns about their sustainable management in the face of threats such as land clearing, contemporary fire regimes and illegal harvesting in some areas

(Parks and Wildlife Service NT 2003). The Northern Territory Government through the Draft Plan of Management for Cycads has committed to taking the potential local and regional effects on the status of cycad populations into account in considering land clearing and other development applications. None of the Cycads that occur or are likely to occur in the pipeline corridor are classified as 'threatened' species.

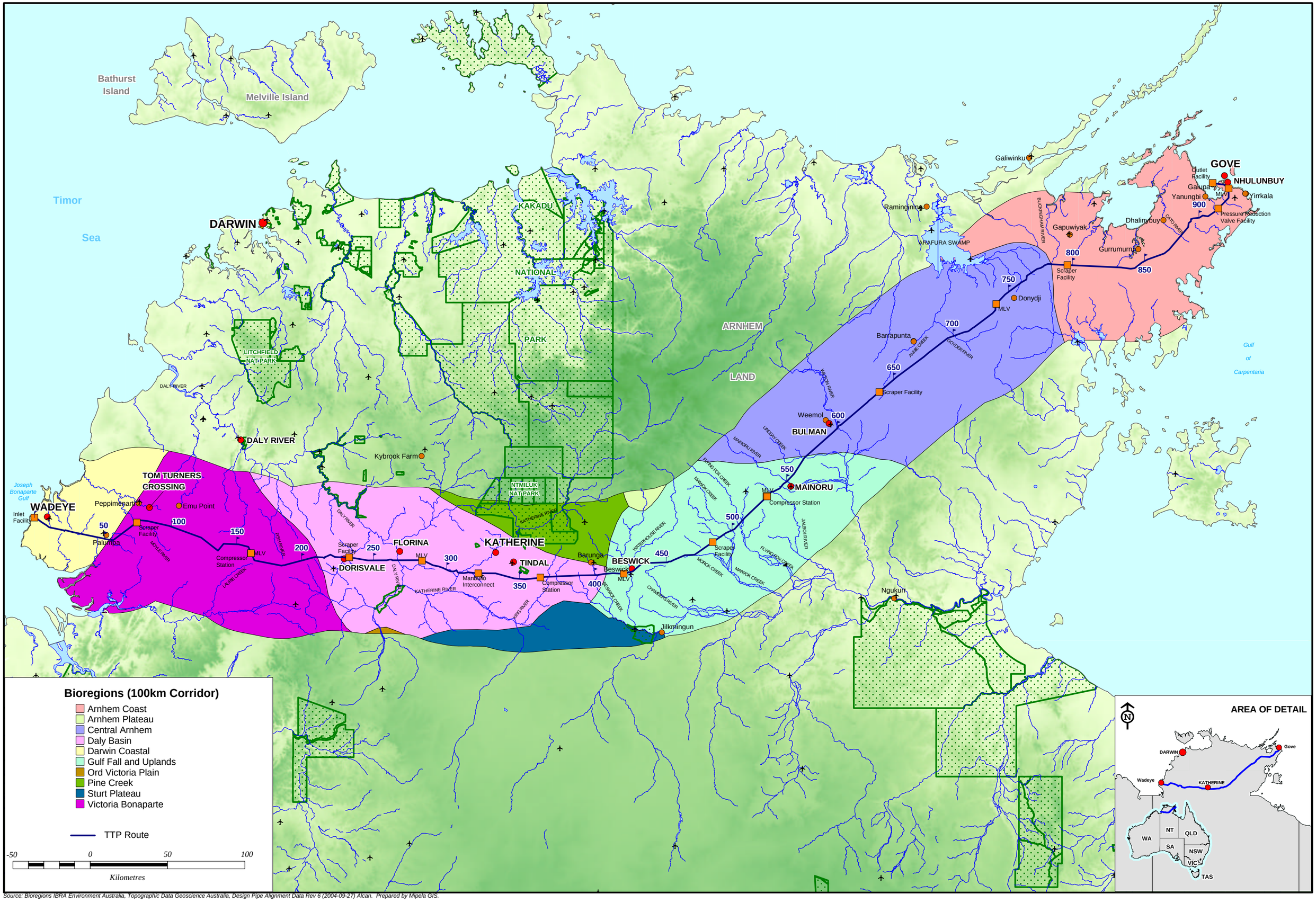
Weeds: Fifteen weed species were recorded during field surveys, and a further 16 weeds of potential concern were identified from published information and consultations with the Weeds Branch of the Department of Infrastructure, Planning and Environment (DIPE). Locations in the TTP area where weed species have been recorded in recent and previous field surveys are shown in **Figure 6-8**.

Weed distribution in the project area is generally related to environmental disturbances caused by the construction of roads and tracks, cattle grazing and feral animals. Weeds were most prevalent on land under pastoral lease, and on the freehold properties in the Katherine region. In these areas infestations are generally concentrated around infrastructure such as water points, fence lines and tracks, and also along the banks of watercourses where cattle and feral animals tend to congregate.

Nineteen of the species identified in the project area are 'declared' weeds under the *NT Weeds Management Act* (

Table 6-7). Weeds of National Significance (WONS) recorded in the project area include Prickly Acacia *Acacia nilotica* and Parkinsonia *Parkinsonia aculeata,* both of which were recorded on Mainoru Station. The WONS Mimosa *Mimosa pigra* occurs on the floodplains in the western coastal areas of the Northern Territory including sites on the Moyle River floodplain, however, no infestations were observed during the field surveys. A full list of the weed species recorded or likely to occur in the project area is provided in **Appendix H**, **Volume 2, Table 4** of the Draft EIS.

Figure 6-7: Bioregions in the Project Region



Source: Bioregions IBRA Environment Australia, Topographic Data Geoscience Australia, Design Pipe Alignment Data Rev 6 (2004-09-27) Alcan. Prepared by Mipela GIS.

- **Table 6-5 Broad Vegetation Groups and Vegetation Units in the Project Area.**

Broad Vegetation Groups*	Vegetation Units*	KP Ranges	Total Distance Traversed (km)
Woodlands and open-woodlands dominated by *Eucalyptus tetrodonta* and *E. miniata* (5)	*Eucalyptus miniat*a and *E. tetrodonta* open forest with *Sarga spp.* Tussock grasses (D4)	0-41 , 84-127, 263-293 , 623-626 624-637 , 692-695, 703-737 , 740-749 784-836 , 838-851, 853-912 , 920-943	323
	Eucalyptus tetrodonta and *E. miniata* woodland with or without *Corymbia bleeseri* with *Sarga spp.* tall grasses (H6)	78-84 , 127-220, 597-607, 626-634 647-681 , 769-777, 912-920	167
	Eucalyptus tetrodonta and *E. miniata* woodland with or without *Corymbia spp.* and/or *Livistona spp* with a ground layer of tussock grasses and *Triodia bitextura* (D14)	256-263 , 293-309, 355-366 , 367-374 383-389 , 391-394	50
	Eucalyptus tetrodonta and/or *Melaleuca viridiflora* woodland with or without *Callitris intratropica,* with *Triodia bitextura* hummock grasses (D13)	737-740 , 749-769, 777-784, 851-853	32
Open forests and woodlands dominated by *Eucalyptus spp.* and *Corymbia spp*. on drainage lines and alluvial plains (3)	*Eucalyptus camaldulensis* and/or *Eucalyptus spp.* woodland on channels and levees (C7)	462-471	9
	Eucalyptus spp. grassy low woodland on alluvial plains with or without *Excoecaria parvifolia* (C10)	574-586	12
Woodlands dominated by *Eucalyptus tectifica* and *Corymbia spp.* (4)	*Eucalyptus tectifica* and\or *Corymbia spp.* woodland with *Sarga spp.* Tussock grasses (D10)	65-74 , 220-256, 314-355 , 405-416 423-433 , 509-530, 536-574 , 586-597 607-623 , 681-692, 695-703	212
Low woodlands to open woodlands dominated by *Corymbia dichromophloia* (10)	*Corymbia dichromophloia*, *Eucalyptus miniata* open woodland with or without *E. tetrodonta,* with *Triodia bitextura* and *Sarga spp.* grasses (H9 and D5)	74-78 , 389-391, 394-405 , 366-367 374-383 , 433-440, 457-462	39
Low woodlands dominated by *Melaleuca spp.* on depositional plains or alluvium (20)	*Melaleuca viridiflora or M. nervosa* grassy low open woodland with or without a shrub layer and\or emergent trees (C13)	41-65	24
Low open woodlands dominated by *Corymbia terminalis* (8)	*Corymbia terminalis* low open woodland with *Triodia pungens* hummock grasses with or without tussock grasses (D25)	309-314	5

Broad Vegetation Groups*	Vegetation Units*	KP Ranges	Total Distance Traversed (km)
Woodlands dominated by *Eucalyptus pruinosa* and *Bauhinia cunninghamii* (9)	*Eucalyptus pruinosa* low open woodland with or without *Bauhinia cunninghamii*, with a sparse understorey of tussock grasses or *Triodia spp.* hummock grasses (D29)	416-423 , 471-507	43
Acacia shirleyi and *Acacia spp.* associations on dissected residual surfaces and sandstone hills (17)	*Acacia shirleyi* and\or other *Acacia spp.* and\or *Eucalyptus spp.* low woodland with short tussock grasses and\or *Triodia spp.* hummock grasses (E1)	440-457	17
Tussock grasslands (23)	Tussock grassland sparsely wooded with low trees (C18)	507-509 , 530-536	8
Open forests and woodlands of *Melaleuca spp*. associated with rivers, lagoons and swamps (19)	*Melaleuca spp*. Open forest (C3)	836-838	2

** Vegetation Groups and Units descriptions and codes taken from Fox et al. 2001.*

Table 6-6 'Threatened' Flora Species

Species	Status#	Preferred habitat and distribution	Likelihood of occurring in project area*
Acacia praetermissa	NT(V)	Hillsides in lateritic soil or in sand silt in Eucalypt woodland An NT endemic known from three locations near Emerald Springs, Hayes Creek and near the western boundary of Litchfield	Unlikely Reasons: Known populations over 100 km away from corridor\not recorded during field surveys.
Alyogyne cravenii	NT(V)	Sandy soils at the base of sandstone escarpment Endemic to the NT known only from Keep River National Park near WA\NT border	Unlikely Reasons: Known populations over 200 km away from corridor\not recorded during field surveys
Gleichenia microphylla	NT(V)	Seepage areas at the base of sandstone scarps and rock overhangs Known in the NT from Twin Falls in Kakadu and Victoria River Gorge in Gregory National Park	Unlikely Reason: No habitat in corridor\not recorded in field surveys
Hernandia nymphaeifolia	NT (V)	Seashore in littoral forests and coastal swamps Known in NT from Groote Eylandt and Port Bradshaw	Unlikely Reason: No habitat in corridor\not recorded in field surveys
Mapania macrocephala	NT (V)	Wet spring-fed rainforests Known in the NT from Melville Island, Bathurst Island and one locality in north-east Arnhem Land	Highly unlikely Reasons: No habitat in corridor\not identified in surveys
Nervilia plicata	NT(E)	Open forest along rainforest margins and in thickets of monsoonal rainforest Known in NT from one locality on Stuart Highway north of Pine Creek	Highly unlikely Reason: No habitat in corridor\no further plants located despite considerable survey effort
Platysace saxatilis	NT(V)	Sandstone cliff faces Known in the NT from Keep River National Park	Unlikely Reason: No habitat in corridor\not identified in field surveys
Pternandra coerulescens	NT(V)	Spring-fed rainforests and riparian forests Known from four localities in north-east Arnhem Land	Possible Reason: Previous record 750 m south-east of KP922 in similar habitat on Latram River
Schoutenia ovata	NT(V)	Monsoon vine thickets on granite and limestone outcrops Known in the NT from Mt Goyder area and near Tipperary Station	Highly unlikely Reason: No habitat in corridor\not identified in field surveys
Solanum carduiforme	Comm (E) NT (DD)	Sandstone, at the base of columns and half way up a sandstone escarpment, and has been collected with Triodia and *Grevillea dryandri* Known in the NT from two places at Nathan River Station.	Highly unlikely Reasons: No habitat in corridor\known populations over 250 km south of corridor
Sticherus flabellatus var. compactus	NT(V)	On damp banks along creeks and rivers, river flats or among rocks and boulders in wet places Known in the NT from one location in north-east Arnhem Land	Unlikely Reason: Known from only one location over 10 km away from corridor\not identified in field surveys
Triodia D62418 Matt Wilson	NT(V)	Rocky cliff tops A potential NT endemic known from one area on the edge of a plateau 2-3km north of Mt Wilson Lookout in	Unlikely Reason: Known populations over 200 km away from corridor\not identified in field surveys

Species	Status#	Preferred habitat and distribution	Likelihood of occurring in project area*
		Gregory National Park	
Zeuxine oblonga	NT(V)	Dark moist situations on the floor of rainforests and usually occurs in colonies. Also, in small swampy areas adjacent to streams. Known in the NT from five widely spaced localities from Keep River to near Adelaide River	Unlikely Reason: No habitat in corridor\not recorded in field surveys

 # Status codes: E = Endangered, V = Vulnerable, DD = Data Deficient
NT = Territory Parks and Wildlife Conservation Act
Comm = Commonwealth EPBC Act.
**Likelihood definitions:*
Highly unlikely – No preferred habitat in corridor and known populations a large distance away from corridor.
Unlikely – Preferred habitat or similar available in corridor but known populations a large distance away from the corridor.
Possible – Preferred habitat or similar available in corridor and known populations in close proximity to the corridor.
Likely – Preferred habitat or similar available in corridor and known populations in close proximity to the corridor.

- **Table 6-7 Declared Weed Species Recorded in Project Area**

Weed species	Common name	Class	Location * Recorded in field surveys
Acacia nilotica	Prickly Acacia	A WONS	KP499, KP523, KP525, KP563
Acanthospermum hispidum	Goat's Head	B	Near KP421*
Calotropis procera	Rubber Bush	B	KP266–267, KP322, KP523 Old route near Velkerri Creek
Cenchrus echinatus	Mossman River Grass	B	Near KP935*
Hyptis suaveolens	Hyptis	B	Numerous locations across entire corridor
Parkinsonia aculeata	Parkinsonia	B WONS	Near KP553
Pennisetum polystachion *Pennisetum pedicellatum*	Mission Grass. Annual Mission Grass.	B	KP514, KP550
Senna alata *Senna obtusifolia* *Senna occidentalis*	Candle Bush. Sicklepod. Coffee Senna	B	KP494, KP499, KP609, Near KP935*
Sida acuta *Sida cordifolia* *Sida rhombifolia*	Spiny Head Sida. Flannel Weed. Paddy's Lucerne	B	KP499, KP600
Stachytarpheta spp	Snake Weed	B	KP929, KP934
Tribulus terrestris	Caltrop	B	2km north KP324*, KP421*
Xanthium strumarium	Noogoora Burr	C	KP266–267, KP309–310, KP317

* Denotes locations recorded from NT Herbarium database.

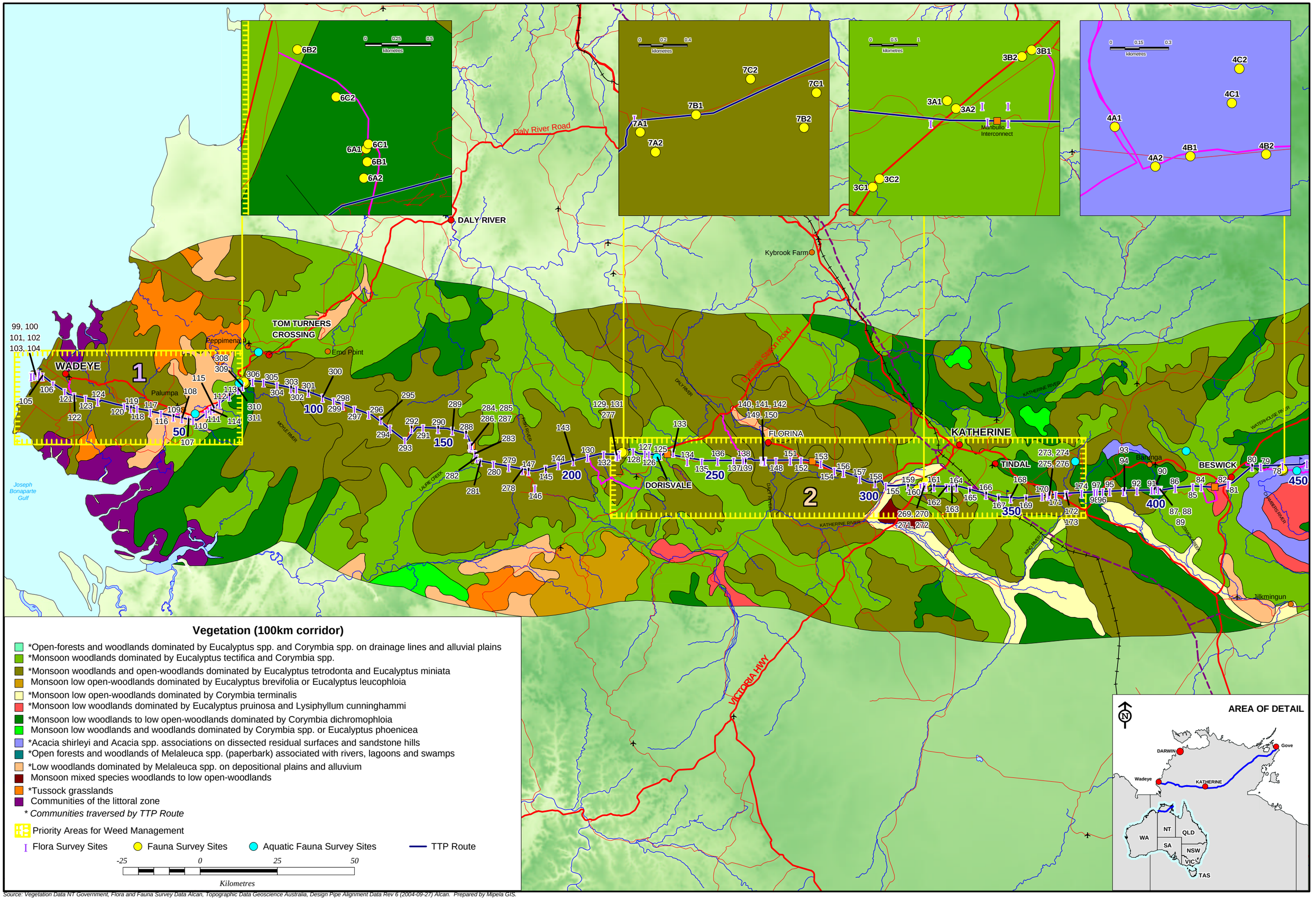
Class Key:

Class A – to be eradicated. Class B – growth and spread to be controlled. Class C – not to be introduced. Class D – not to be spread by human means. Class E – species under an approved strategy. X – not declared but considered an environmental weed by Smith & others.

Note: No strategies are currently in place for the project lease area.

WONS – Weed of National Significance.

Figure 6-8: Vegetation Communities, Survey Sites and Priority Areas for Weed Management in the Project Region (Map 1 of 2)



Vegetation (100km corridor)

- *Open-forests and woodlands dominated by Eucalyptus spp. and Corymbia spp. on drainage lines and alluvial plains
- *Monsoon woodlands dominated by Eucalyptus tectifica and Corymbia spp.
- *Monsoon woodlands and open-woodlands dominated by Eucalyptus tetrodonta and Eucalyptus miniata
- Monsoon low open-woodlands dominated by Eucalyptus brevifolia or Eucalyptus leucophloia
- *Monsoon low open-woodlands dominated by Corymbia terminalis
- *Monsoon low woodlands dominated by Eucalyptus pruinosa and Lysiphyllum cunninghammi
- *Monsoon low woodlands to low open-woodlands dominated by Corymbia dichromophloia
- Monsoon low woodlands and woodlands dominated by Corymbia spp. or Eucalyptus phoenicea
- *Acacia shirleyi and Acacia spp. associations on dissected residual surfaces and sandstone hills
- *Open forests and woodlands of Melaleuca spp. (paperbark) associated with rivers, lagoons and swamps
- *Low woodlands dominated by Melaleuca spp. on depositional plains and alluvium
- Monsoon mixed species woodlands to low open-woodlands
- *Tussock grasslands
- Communities of the littoral zone

** Communities traversed by TTP Route*

Priority Areas for Weed Management

I Flora Survey Sites ● Fauna Survey Sites ● Aquatic Fauna Survey Sites — TTP Route

-25 0 25 50

Kilometres

AREA OF DETAIL

Source: Vegetation Data NT Government, Flora and Fauna Survey Data Alcan, Topographic Data Geoscience Australia, Design Pipe Alignment Data Rev 6 (2004-09-27) Alcan. Prepared by Mipela GIS.

Figure 6-8: Vegetation Communities, Survey Sites and Priority Areas for Weed Management in the Project Region (Map 2 of 2)

Vegetation (100km corridor)

- *Open-forests and woodlands dominated by Eucalyptus spp. and Corymbia spp. on drainage lines and alluvial plains
- *Monsoon woodlands dominated by Eucalyptus tectifica and Corymbia spp.
- *Monsoon woodlands and open-woodlands dominated by Eucalyptus tetrodonta and Eucalyptus miniata
- Monsoon low open-woodlands dominated by Eucalyptus brevifolia or Eucalyptus leucophloia
- *Monsoon low open-woodlands dominated by Corymbia terminalis
- *Monsoon low woodlands dominated by Eucalyptus pruinosa and Lysiphyllum cunninghammi
- *Monsoon low woodlands to low open-woodlands dominated by Corymbia dichromophloia
- Monsoon low woodlands and woodlands dominated by Corymbia spp. or Eucalyptus phoenicea
- *Acacia shirleyi and Acacia spp. associations on dissected residual surfaces and sandstone hills
- *Open forests and woodlands of Melaleuca spp. (paperbark) associated with rivers, lagoons and swamps
- *Low woodlands dominated by Melaleuca spp. on depositional plains and alluvium
- Monsoon mixed species woodlands to low open-woodlands
- *Tussock grasslands
- Communities of the littoral zone

** Communities traversed by TTP Route*

Priority Areas for Weed Management

Flora Survey Sites | Fauna Survey Sites | Aquatic Fauna Survey Sites | TTP Route

-25 0 25 50

Kilometres

Continued in Inset A

ARAFURA SWAMP

Gapuwiyak

Gurrumuru

Donydji

Barraputna

ARNHEM LAND

Weemol

BULMAN

MAINORU

Ngukurr

Jilkminggan

Joseph Bonaparte Gulf

Gulf of Carpentaria

INSET A

0 20 40

kilometres

GOVE

NHULUNBUY

Galupa

Yirrkala

Yanunghi

Dhalinybuy

Gurrumuru

0 0.3 0.6

kilometres

2C2 2B2 2A2 2A1 2C1 2B1

0 0.5 1

kilometres

1B1 1A2 1A1 1C1 1B2 1C2

AREA OF DETAIL

DARWIN Gove Wadeye KATHERINE

WA NT QLD SA NSW VIC TAS

Source: Vegetation Data NT Government, Flora and Fauna Survey Data Alcan, Topographic Data Geoscience Australia, Design Pipe Alignment Data Rev 6 (2004-09-27) Alcan. Prepared by Mipela GIS.

6.3.2 Terrestrial Fauna and Habitats

The terrestrial fauna that occur or are likely to occur in the project area were identified through:

- a desktop review of literature and datasets;
- consultations with experts from the Northern Territory Parks and Wildlife Service and Northern Territory Department of Infrastructure, Planning and Environment;
- field surveys at 36 sites located in habitat types that typically support a diverse or unique fauna (or both), and in habitat types potentially utilised by species classified as 'threatened' under Northern Territory and\or Commonwealth legislation.

The results of the terrestrial fauna study are summarised in this section from the full report in **Appendix I**, **Volume 2** of this Draft EIS.

Fauna Habitats: The following fauna habitats were identified in or near the project area during field surveys:

- eucalyptus forests and woodlands;
- floodplains;
- riparian corridors;
- sandstone communities;
- permanent and seasonal swamps;
- monsoon rainforest patches.

Most of the habitats that occur in the project area, especially on Aboriginal owned land (approximately two thirds of the corridor) are largely undisturbed by humans and as a result are in good ecological condition and have high value as fauna habitat. The majority of the pipeline corridor through pastoral and agricultural lands (the remaining one third of the route) also traverses habitats that are in good condition, although in some areas, weeds, cattle and feral animals have degraded the habitat values to fauna.

Significant fauna habitats, including riparian corridors, monsoon rainforest patches, sandstone communities and habitats of 'threatened' species were identified in the project area from the desktop review and field surveys. These habitats types have a restricted geographic distribution and provide a niche for fauna species with specific habitat requirements. Accordingly they are assigned a high conservation value, and are sensitive to disturbance. The locations and conservation significance of these habitats is discussed in **Section 6.3.4**.

Survey Results: Fauna surveys were undertaken from June to August 2004 using standard field methods, including 'Elliot' and cage trapping, pitfall traps, diurnal active searching and opportunistic observations. Six survey sites were established at each of the six survey locations identified in **Table 6-9**. Significant fauna habitats were targeted when selecting the survey sites. Locations of the survey sites in relation to the project area are shown in **Figure 6-8**.

- **Table 6-9 Habitats and Species Targeted in Fauna Surveys**

Survey Location	Habitats/Species of Interest	Closest Pipeline KP
Moyle River	Riparian Corridor, Monsoon Rainforest, Sandstone Community	75–77
Bradshaw/Dorisvale Station	Riparian Corridor, Monsoon Rainforest, Sandstone Community	216–219
Chainman Creek and Chinaman Creek	Sandstone Community, Riparian Corridor, Gouldian Finch	319, 322
Chambers River	Riparian Corridor, Sandstone Community	444
Goromuru and Richard Rivers	Riparian Corridor, Monsoon Rainforest, Tall coastal Eucalyptus Forest, Brush-tailed Phascogale, Brush-tailed Tree Rat, Wood Frog, Brush-tailed Tree Rat	840
Latram, and Giddy Rivers	Riparian Corridor, Rainforest, Tall coastal Eucalyptus Forest, Brush-tailed Phascogale, Brush-tailed Tree Rat, Wood Frog	922

A total of 186 fauna species were recorded during the field surveys, including 16 frogs, 45 reptiles, 107 birds and 18 mammals. The open woodlands, woodlands and open forest habitats of the Dorisvale Station, Chambers River and Goromuru survey sites were the most species rich locations with richness ranging from 102 to 116 species.

An additional 173 species of native vertebrate fauna were listed in the Northern Territory Fauna Atlas records within 10 km of the pipeline corridor. The Northern Territory Fauna Atlas covers a wider geographic area and greater range of habitat types than was covered by the field surveys, and therefore the large number of species recorded in the Atlas but not in the field surveys is expected. A further ten species of vertebrate fauna that may occur in the pipeline corridor were identified through a search of the EPBC Act Protected Matters Search Tool (DEH 2004e). The additional species identified in the desktop review may or may not occur in the project area, depending on suitable habitat being available. A full list of species recorded in field surveys and from the desktop review is included at **Appendix F**, **Volume 2**, **Table 2** of this Draft EIS.

Mammals: Eighteen species of mammal, including three introduced species**,** were recorded during the field surveys. The Moyle River and Goromuru River locations recorded the highest species diversity with seven mammal species recorded at each location. The lowest species richness was recorded at the Chainman and Chinaman Creek sites where only three species of mammal were recorded. At three of the sites in this area no mammal species were recorded. All of the species recorded during the field surveys are common to the areas where they were observed. A further 34 mammal species were recorded in the Northern Territory Fauna Atlas.

Birds: One-hundred and seven bird species were identified during the field surveys. Bird species richness was highest at the Chambers River location where 52 species were recorded between the six survey sites. Sites 4B1 and 4C1 had the highest individual species richness of all of the sites surveyed with 29 species recorded at each. Diversity was lowest at the Latram and Giddy River locations where only 36 bird species were recorded. Site 1B1 recorded the lowest individual site

diversity with six species recorded. An additional 94 bird species were recorded or predicted in the Northern Territory Fauna Atlas.

Reptiles: Forty-five species of reptile were recorded during the surveys, including six snakes, eight geckoes, 21 skinks, five dragons and five goannas. The Moyle River and Chambers River survey sites produced the highest number of reptile species with 23 species recorded at each. Species richness was lowest at the Dorisvale Station location where 11 species were recorded and no site recorded over five reptile species. Provided suitable habitat is available, the majority of the additional 39 species listed in the Northern Territory Fauna Atlas are likely to occur within their ranges in the vicinity of the pipeline route.

Amphibians: Sixteen native amphibian species were recorded during the field surveys. An additional six species were recorded in the Northern Territory Fauna Atlas. Species richness was greatest at the open forest and woodland sites 4A1 and 4A2 at Chamber's River, where 12 and 11 species were recorded respectively. Only one native frog species was recorded at the Bradshaw Creek sites. Generally, trapping numbers for frogs were low at all sites and some species that could be expected to occur were absent. This could be largely attributed to the cool weather and dry conditions that prevailed at the time the field surveys were conducted, especially in regards to some burrowing and aestivating frog species which are not active at lower temperatures (for example *Cyclorana* species).

Introduced Species: Six introduced vertebrate feral species were recorded during field surveys. These were the Cane Toad *Bufo marinus*, Donkey *Equus asinus*, Horse *Equus caballus*, Pig *Sus scrofa*, Water Buffalo *Bubalus bubalis* and House Mouse *Mus musculus*. Signs of pigs and buffalo were observed throughout the project area, especially in seasonally inundated areas and along watercourses. Large numbers of donkeys and horses were observed in the eastern parts of the project area.

Cane Toads *Bufo marinus* are present across all but the western one-third of the project area. The Cane Toad is an introduced species that now occupies much of Queensland, northern New South Wales and the Top End of the Northern Territory. Concern regarding the ecological impacts of Cane Toads is widespread. Predation, competition and lethal toxic ingestion caused by Cane Toads are currently nominated for listing as 'key threatening processes' under the Federal EPBC Act. Their current range extends from Nhulunbuy in the east to west of Katherine, and sightings have been reported in the Lower Daly River region (Frogwatch NT [online] Accessed 2004 May 14). It is expected that they will move across the entire Top End in the next few years.

The Yellow Crazy Ant *Anoplolepis gracilipes* is an invasive species that was first reported in the Gove Peninsula in 1982 and was believed to have been introduced during the Second World War. The species has since been recorded at numerous sites across north-east Arnhem Land, including at 25 sites in proximity to the project area (*Hoffmann pers. comm. 2004*). The Global Invasive Species Program recognises *A. gracilipes* as one of the world's 100 worst invaders and the species poses a major environmental and a secondary agricultural pest in Australia (O'Dowd 2004). It is known to affect ecosystem processes such as litter decomposition and can impact community

structure and composition. Transport by people across the country is the main method of spread of *A. gracilipes* and the TTP project has the potential to aid in the spread of this species. The sites in the pipeline corridor where Crazy Ant colonies already exist are earmarked for treatment by the Crazy Ant Management Group in 2004 and 2005 (Ben Hoffmann *pers comm.* 2004).

Threatened Fauna: A review of the distribution and habitat requirements of fauna species afforded protection under Northern Territory and\or Commonwealth legislation identified 13 'threatened' fauna species in the bioregions traversed by the pipeline corridor. Each of the 'threatened' species identified are listed in **Table 6-10** along with and indication of the likelihood of the animal occurring in the project area.

Two 'threatened' fauna species, namely the Gouldian Finch *Erythrura gouldiae* and the Wood Frog *Rana daemeli* have been recorded in the project area. The Red Goshawk *Erythrotriorchis radiatus* and Pignose Turtle *Carellochelys insculpta* are threatened species that are considered likely to occur in the project area. Other threatened species that possibly occur are the Brush-tailed Tree-rat *Conilurus penicillatus*, Northern Brush-tailed Phascogale *Phascogale tapoatafa pirata* and Northern Shrike-tit *falcunculus frontatus whitei*, although there are no previous records of these species.

Migratory Species: Three migratory species protected under the Commonwealth EPBC Act were recorded during the field surveys. These are the Gouldian Finch *Erythrura gouldiae*, White-bellied Sea-eagle *Haliaeetus leucogaster* and the Rufous Fantail *Rhipidura rufifrons.* A further 11 migratory species are likely to occur in the project area (DEH 2004e). These species include the Freshwater Crocodile *Crocodylus johnstoni*, the Saltwater Crocodile *C. porosus*, five wetland bird species and five terrestrial bird species. Freshwater Crocodiles and Saltwater Crocodiles occur in most of the wetlands, creeks and rivers traversed by the proposed pipeline corridor. A full list of migratory species that may occur in the project area is included in **Appendix I**, **Volume 2** of this Draft EIS.

No significant shorebird or waterbird colonies are known to occur in proximity to any aspects of the proposed project (Chatto 2003, 2001, 2000) and no colonies were observed during field surveys of the project area, although detailed shorebird surveys were not conducted for this project.

Near-threatened Fauna: Fifty-five terrestrial fauna species are classified as Near-Threatened (excluding fish and invertebrates) in the Northern Territory. The known range of 26 of these species extends into the project area. These species are listed in **Table 6-12** along with an indication as to whether or not preferred habitats exist along the pipeline corridor.

Endemic Fauna: The known ranges of 25 terrestrial fauna species that are endemic to the Top End region of the Northern Territory extend to the pipeline corridor. These species are detailed in **Table 6-13** along with an indication of whether or not preferred habitats exist in the pipeline corridor.

Table 6-10 Threatened Terrestrial Fauna Species

Species name	Status	Preferred Habitat and Known Distribution	Likelihood of occurrence
Brush-tailed Tree-rat *Conilurus penicillatus*	VUL	Tall eucalypt forests with a shrubby understorey, however, in some locations within its range it also occurs on coastal grasslands (Woinarski 2002a).	Possible *Reason:* Well south of known distribution. Not recorded in field surveys, but preferred habitat present.
False Water Rat *Xeromys myoides*	Comm–VUL	Inhabits a variety of well-watered habitats from mangrove forests to sedged lakes (Strahan 1995). Has been recorded in the NT from the South Alligator River, Daly River and Glyde River in north-east Arnhem Land (Woinarski *et al*. 2000a).	Highly Unlikely *Reason:* Preferred habitat not present. Known sightings away from project area.
Northern Quoll *Dasyurus hallucatus*	NT–NT Comm–nominated VUL	Known to occupy a range of habitats from Eucalyptus open forests, monsoon vine thicket, rocky environments and savanna woodlands (Maxwell *et al*. 1996).	Present – recorded during the fauna surveys at Moyle River (KP75) *Reason:* Habitats occur across the full east to west length of the pipeline corridor.
Northern Brush-tailed Phascogale *Phascogale tapoatafa pirata*	VUL	Tall, open forests dominated by *Eucalyptus miniata* and *E. tetrodonta*. Few records on Cape York Peninsula, the Top End of the NT (Woinarski 2002b). The most recent mainland records are from Kakadu and Litchfield National Parks.	Possible *Reason:* Well south of recent records although old records exist from around Katherine and Gove. Preferred habitats present in project area.
Northern Hopping Mouse *Notomys aquilo*	NT–VUL Comm–VUL	Largely restricted to sandy substrates, particularly those supporting floristically diverse heathlands and/or grasslands (Woinarski et al. 1999). Majority of specimens known from Groote Eylandt and coastal north-eastern Arnhem Land.	Unlikely *Reason:* Preferred habitat not present. Not recorded in project area.
Bare-rumped Sheathtail Bat *Saccolaimus saccolaimus nudicluniatus*	Comm–EN	Open Pandanus woodland fringing the sedgelands of the South Alligator River and eucalypt dominated, tall-open forests. It has a large distribution from south-east Asia to the Solomon Islands including north-east Queensland and the Northern Territory (Duncan, Baker and Montgomery 1999).	Highly Unlikely *Reason*: Well south of the only known record of this species in the Northern Territory.
Red Goshawk *Erythrotriorchis radiatus*	NT–VUL Comm–VUL	Coastal and sub-coastal tall open forests and woodlands, tropical savannas traversed by wooded or forested rivers, and along the edges of rainforest (Marchant and Higgins 1993). Large distribution across much of northern Australia (Woinarski, 2001).	Likely *Reason:* Record of species in NT Fauna Atlas 3.5 km east if KP928. Suitable habitats across the full pipeline corridor.
Gouldian Finch *Erythrura gouldiae*	NT–EN Comm-EN	In the dry season and part of the late wet season, Gouldian Finches live and nest within wooded hills that contain Eucalyptus species (typically *E. tintinnans* and *E. brevifolia*). In the wet season the birds move from the hills into the lowland drainage lines to feed on perennial grasses (Lewis 2001).	Present - recorded in field surveys at the Chambers River KP443–445. *Reason:* Suitable habitats occur between KP320 and KP460

Species name	Status	Preferred Habitat and Known Distribution	Likelihood of occurrence
Northern Shrike-tit *Falcunculus (frontatus) whitei*	Comm–VUL	Sightings have been mainly recorded from woodlands dominated by *Eucalyptus miniata, E. tetrodonta* or *Corymbia bleeseri* (Garnett and Crowley 2000). There are few records which are scattered from near Borroloola to the south-west Kimberley with various records from the Sturt Plateau and Arnhem Land (Woinarski 2002c).	Possible *Reason:* Suitable habitats occur across the full pipeline corridor, however, the paucity of knowledge of this species makes it difficult to determine where it may occur.
PignoseTurtle *Carettochelys insculpta*	NT–NT Comm-nominated–VUL	Freshwater and estaurine reaches of rivers, and in large waterholes and lagoons isolated during the dry season known in the Northern Territory from the Daly River, Victoria River and Alligator River.	Likely *Reason:* Suitable permanent habitats present at the Daly River crossing point. Previously recorded in the freshwater reaches of the Daly River.
Yellow-snouted Ground Gekko *Diplodactylus occultus*	NT–VUL	Known from only a few localities, almost entirely from the northwest areas of KNP and appear to occur in well-developed leaf litters and grasses in open Eucalyptus dominated forests (Beggs and Armstrong 2001).	Highly Unlikely *Reason:* The known range of this species does not extend to the pipeline corridor.
Wood Frog *Rana daemeli*	NT–VUL	Appears to be restricted to dense riparian vegetation, mainly rainforest or Pandanus thickets (Woinarski 2002d). Known from four sites in north-east Arnhem Land.	Present – recorded at the Giddy River (KP913), Latram River (KP922) and Cato River (KP880) *Reason:* Suitable habitats occur where the pipeline corridor crosses the Latram River, Cato River and Giddy River.
Gove Crow Butterfly *Euploea alcathoe enastri*	NT–EN Comm–nominated EN	Patches of tall forest associated with groundwater seepages. Known from only four locations including the upper Goromuru River (Wilson 2002).	Highly Unlikely *Reason:* Suitable habitats not present\not identified in surveys

 # Status codes: E = Endangered, V = Vulnerable, DD = Data Deficient

**Likelihood definitions:*

Highly unlikely – No preferred habitat in corridor and known populations a large distance away from corridor.

Unlikely – Preferred habitat or similar available in corridor but known populations a large distance away from the corridor.

Possible – Preferred habitat or similar available in corridor and known populations in close proximity to the corridor.

Likely – Preferred habitat or similar available in corridor and known populations in close proximity to the corridor.

- **Table 6-12 Near-Threatened Fauna**

Species	Suitable Habitats present in Project Area	Recorded in Project Area **recorded in field surveys*
Mammals		
Northern Quoll *Dasyurus hallucatus*	Yes	KP75–77* (Moyle River)
Golden Bandicoot *Isoodon auratus arnhemensis*	Yes	No
Lesser Wart-nosed Horseshoe Bat *Hipposideros stenotis*	Yes	No
Ghost Bat *Macroderma gigas*	Yes	KP354 (Fauna atlas)
Black-footed Tree-rat *Mesembriomys gouldii*	Yes	KP926 (Fauna atlas)
Northern Nailtail Wallaby *Onychogalea unguifera*	Yes	KP474 and KP548 (Fauna atlas)
Western Chestnut Mouse *Pseudomys nanus nanus*	Yes	KP209 (Fauna atlas)
Pale Field-rat *Rattus tunneyi*	Yes	KP75–77 and KP216–219* (Moyle River and Dorisvale)
Orange Horseshoe Bat *Rhinonycteris aurantius*	Yes	KP392 (Fauna atlas)
False Water Rat *Xeromys myoides*	Yes	No
Arnhem Sheathtail Bat *Taphozous kapalgensis*	Yes	No
Birds		
Australian Bustard *Ardeotis australis*	Yes	KP78 and KP505 (Fauna atlas)
Bush Stone-curlew *Burhinus grallarius*	Yes	KP216–219* (Dorisvale)
Emu *Dromaius novaehollandiae*	Yes	KP366 and 897 (Fauna atlas)
Yellow-rumped Mannikin *Lonchura flaviprymna*	Yes	KP840* (Goromuru River)
Square-tailed Kite *Lophoictinia isura*	Yes	KP421 (Fauna atlas)
Grass Owl *Tyto capensis*	No	No
Clamorous Reed Warbler *Acrocephalus stentoreus*	No	No
Grey Falcon *Falco hypoleucos*	Yes	No
White-lined Honeyeater *Meliphaga albilineata*	Yes	No
Hooded Parrot *Psephotus dissimilis*	Yes	KP319, KP322 and KP444* (Chainman Creek, Chinaman Creek and Chambers River)
Banded Fruit-Dove *Ptilinopus cinctus*	Yes	No
Reptiles		

Species	Suitable Habitats present in Project Area	Recorded in Project Area *recorded in field surveys
Chameleon Dragon *Chelosania brunnea*	Yes	No
Pig-nosed Turtle *Carettochelys insculpta*	Yes	No
Northern Blunt-spined Monitor *Varanus primordius*	Yes	KP444* (Chambers River)

- **Table 6-13 Endemic Fauna**

Species	Suitable Habitats present in Project Area	Recorded in Project Area * Recorded in field surveys
Mammals		
False Water Rat *Xeromys myoides*	Yes	No
Fawn Antechinus *Antechinus bellus*	Yes	KP926 (Fauna atlas)
Kakadu Dunnart *Sminthopsis bindi*	Yes	KP216–219, KP444* (Chambers River and Dorisvale)
Red-cheeked Dunnart *Sminthopsis virginiae nitela*	Yes	KP75–77, KP216–219 and KP840* (Moyle, Dorisvale and Goromuru)
Black Wallaroo *Macropus bernardus*	Yes	No
Northern Hopping-mouse *Notomys aquilo*	Yes	No
Dusky Rat *Rattus colletti*	Yes	KP741 (Fauna atlas)
Birds		
Hooded Parrot *Psephotus dissimilis*	Yes	KP319, KP322 and KP444* (Chambers River, Chainman Creek and Chinaman Creek)
Reptiles		
Dark-tailed Skink *Glaphyromorphus nigricaudis*	Yes	KP922* (Latram River)
Stout-tailed Skink *Glaphyromorphus crassicaudis arnhemicus*	Yes	No
G. douglasi	Yes	KP738 (fauna atlas)
Griffin's Lerista *Lerista griffini*	No	KP293 (fauna atlas)
Karl Schmidt's Lerista *Lerista karlschmidtii*	Yes	No
Single-toed Lerista *Lerista stylis*	Yes	No
MacFarlane's Lerista *Carlia macfarlani*	Yes	KP922* (Latram River)

6.3.3 Aquatic Environments

The nature of the aquatic environments that occur in the project area was assessed through:

- a desktop review of literature and datasets;
- consultations with experts from the Museum and Art Galleries of the Northern Territory (MAGNT);
- field surveys at 21 sites on 17 waterways that are traversed by the pipeline corridor.

The freshwater environments that occur in the project area are identified and classified in **Section 6.2.9**. The results of the aquatic fauna study are summarised in this section from the full report in **Appendix J**, **Volume 2** of this Draft EIS.

Aquatic Survey Results: Aquatic surveys were conducted at 21 sites on 17 waterways which the TTP will intersect (sites were as close as possible and all within 30 km of the TTP corridor) using standard field methods, including multi-panel gill-nets, fine-mesh seine, scoop-nets or push-nets, hook and line, dip-net and torch at night, and sight observations from the bank or by snorkelling. Twelve sites were surveyed in October and November 2003 whilst the remaining nine sites were surveyed, once accessible after the wet season, in June 2004. The Katherine and Daly, the largest rivers crossed by the proposed TTP route were not surveyed because the aquatic fauna in these rivers is well known (*Helen Larson pers. comm. 2003*). The locations of the aquatic fauna survey sites are documented in **Appendix F, Volume 2 Table 3** and are shown in relation to the pipeline corridor in **Figure 6-8**.

The Daly River, one of the largest and best-studied rivers in the Northern Territory, possesses the highest fish species diversity (49 species) of the proposed waterways to be crossed by the pipeline corridor. The waterway with the lowest number of species was the seasonal Krabakuk Creek, a tributary of the Mainoru River, where only two species of fish were identified.

Fish Species: A total of 50 fish species representing 23 families were recorded during the field surveys. A further 13 species from four families not recorded during the survey were identified from the records of the Northern Territory Museum and Art Gallery and in Midgley (1983, 1980). Eight of the species identified in the desktop review were recorded only from the Daly system which was not sampled as part of the field survey. The family Eleotridae (gudgeons) was represented by more species (seven) than any other recorded, followed closely by the grunters (family Terapontidae), the fork tailed catfish (family Ariidae) and Rainbowfish (Melanotaeniidae) which were each represented by six species. The highest number of species recorded during the field surveys was on the Cato River with 24 species. Twenty-one fish species were recorded on the Goyder River and 20 species were recorded on the Habgood River.

Overall a total of 63 species comprising 27 families are known from the aquatic systems that will be traversed by the pipeline corridor. These species and the waterbodies from which they are recorded are listed in **Appendix F**, **Volume 2 Table 4** of this Draft EIS.

Crustaceans: Five species of crustacean were recorded during the field surveys including a Glass Shrimp *Caradina sp*, Redclaw *Cherax quadricarinatus*, Cherabin *Macrobrachium rosenbergii* and two unidentified species of freshwater prawn (*Macrobrachium sp 1* and *2*). Voucher specimens for the unidentified species were lodged with the MAGNT for identification but have not yet been identified.

Amphibians: The aquatic survey encountered eight species of amphibian. These were the Northern Dwarf Tree Frog *Litoria bicolor*, Rockhole frog *L. meiriana*, Rocket Frog *L. nasuta*, Red Tree-frog *L. rubella*, Wotjulum Frog *L. wotjulumensis*, an unidentified *Crinia sp.*, Wood Frog *Rana daemeli* and the introduced Cane Toad *Bufo marinus.* The Wood Frog is classified as Vulnerable under Northern Territory legislation and is further discussed later in this section.

Reptiles: Seven species of aquatic reptiles were identified during the field surveys. These were the Arafura File Snake *Acrochordus arafurae*, Freshwater Crocodile *Crocodylus johnstoni*, Saltwater Crocodile *Crocodylus porosus*, Northern Snapping Turtle *Elseya dentata*, Yellow-faced Turtle *Emydura sp*, Northern Red-faced Turtle *Emydura victoriae* and Merten's Water Monitor *Varanus mertensi*. The Saltwater Crocodile and Freshwater Crocodile are listed migratory species under the Commonwealth EPBC Act and are further discussed later in this section.

Introduced Species: No introduced fish species were found during the field surveys, however the Cane Toad *Bufo marinus* was common at all the study sites from east of the King River to the Giddy River.

Aquatic Flora: Plant communities in submerged environments that occur in the project area can be divided into two basic categories, those that live in waters with a high amount of dissolved solids, such as the Daly and Mainoru Rivers, and those that live in waters with very small amounts of dissolved solids. The majority of the waters to be crossed by the proposed pipeline route fall into this latter category. Aquatic flora recorded during the field surveys is listed in **Appendix F, Volume 2, Table 5** of this Draft EIS.

Extensive coverage of the aquatic plant *Hanguana malayana* was observed along the banks and across the surface of the water into the Habgood River. This macrophyte was not observed on any of the other waterways and created a complex habitat over some quite deep water and was exclusive to this river. The Gulf Saratoga *Scleropages jardinii* which has a preference for habitat with overhanging vegetation, was extremely common at this site during the field surveys, most likely as a result of this habitat. No introduced aquatic species were recorded during surveys.

Water Quality: Physical water quality parameters were recorded at each aquatic survey site including pH, temperature, dissolved oxygen, hardness, conductivity, alkalinity and turbidity. These water quality data are summarised in **Appendix F**, **Volume 2**, **Table 6** of this Draft EIS.

Threatened Aquatic Fauna: A review of the distribution and habitat requirements of fish species afforded protection under the *Territory Parks and Wildlife Conservation Act 2000* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* identified one

'threatened' fish species that occurs in watercourses traversed by the pipeline corridor. The Freshwater Sawfish *Pristis microdon* is classified as Vulnerable under the EPBC Act. This species has been recorded from three major rivers traversed by the pipeline corridor. These are the Daly River, Wilton River and Mainoru River. This species is generally restricted to the larger upstream waterholes in the lower reaches of large river systems (Allen *et al*. 2002; Herbert *et al*. 1995). Historically, the Freshwater Sawfish has been reported in the lower reaches of several rivers in Eastern Arnhem Land including the Goyder River and Cato River, however, these records are from areas far downstream of the proposed pipeline corridor.

The Pig-nosed Turtle *Carettochelys insculpta* is classified as Near Threatened under the NT legislation and Vulnerable under the IUCN Red List, and is currently proposed for listing as a threatened species under the EPBC Act. Although this species was not found during the surveys it is recorded from the upstream Daly River system which is traversed by the pipeline corridor (Wilson and Swan 2003).

The Wood Frog *Rana daemeli*, a species classified as Vulnerable under Northern Territory legislation was recorded at the Giddy River and Cato River during the aquatic fauna surveys. Both species are further discussed in **Table 6-10**.

Potential impacts of the project on these 'threatened' species and measures that will be adopted to minimise impacts are discussed in **Section 9-4**.

Migratory Aquatic Species: The Saltwater Crocodile *Crocodylus porosus* a listed migratory species under the Commonwealth EPBC Act, was spotted in the Habgood River and is likely to occur in all of the major waterways crossed by the pipeline corridor. The Freshwater Crocodile, also a listed migratory species under Commonwealth legislation, was identified at a number of the field survey sites and is also likely to be present in all watercourses traversed by the pipeline corridor.

Species Outside Known Range: A number of fish species recorded during the aquatic fauna surveys were far outside of the known habitat range. The Aru gudgeon *Oxyeleotris aruensis* located in the Cato River was previously known only from Aru Island near Southern New Guinea and the eastern side of the tip of Cape York, Queensland. Two species of gobies, *Glossogobius concavifrons* and Munro's Goby *Glossogobius sp.* were collected in the Cato River, which represents a significant range extension for these species. The observation of the Freshwater Whipray *Himantura chaophraya* in the Cato River represents the first record of this species in Arnhem Land as it was previously only recorded from South Alligator and Daly Rivers (Midgley 1980; Allen *et al*. 2002). Further range extensions were recorded for the Exquisite Rainbowfish *Melanotaenia exquisita* in Dook Creek, Butler's Grunter *Syncomistes butleri* in the Goyder River and Rocky Bottom Creek, the Primitive Archerfish *Toxotes lorentzi* in the Moyle River and Tom Turner Creek and the Penny Fish *Denariusa bandata* in Tom Turner Creek. This finding could be expected as there have been few studies undertaken in most of the Northern Territory river systems besides the Daly River and Katherine River. Many of the Northern Territory fish species are classified as Data Deficient because of the paucity of aquatic fauna surveys. Thirty-two Data

Deficient fish species were identified during the aquatic fauna surveys, and at least one Data Deficient species was present at all watercourses traversed by the pipeline corridor that were surveyed (except the seasonal Krabakuk Creek). These findings highlight the importance of taking a precautionary approach to the protection of aquatic environments from disturbance.

6.3.4 Ecologically Sensitive Habitats

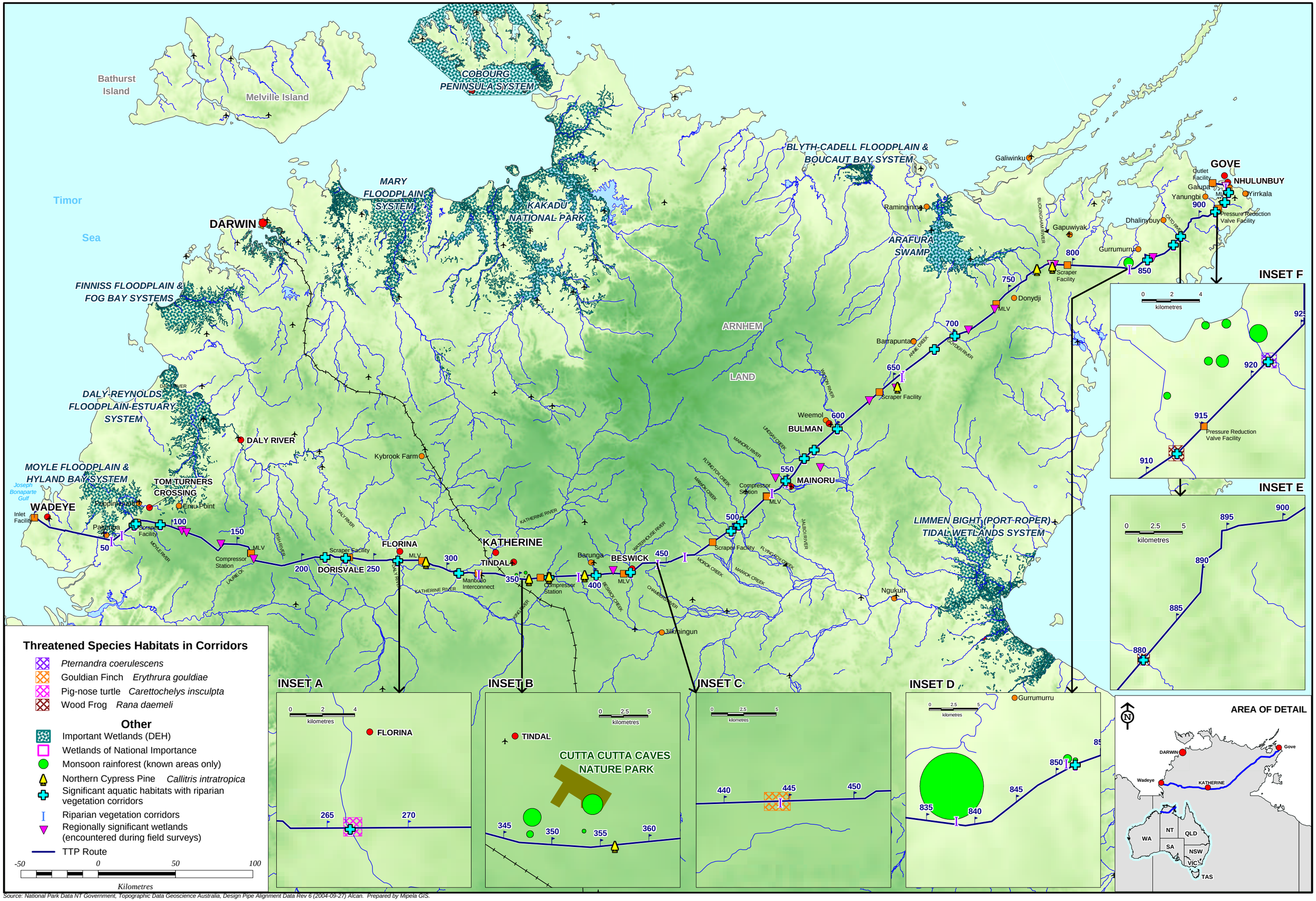
Terrestrial and aquatic habitats with high conservation values were identified based on the following criteria:

1) Areas that provide habitat for 'threatened' flora and fauna species as listed under the Commonwealth EPBC Act or the *Territory Parks and Wildlife Conservation Act.*
2) 'Endangered ecological communities' as listed under the Commonwealth EPBC Act and 'areas of essential habitat' listed under the *Territory Parks and Wildlife Conservation Act.*
3) Areas that contain regionally restricted species, vegetation types or habitats with outstanding diversity.
4) Vegetation types which are outside their normal distribution or have other biogeographical significance.
5) Areas which have ecological importance beyond the immediate site, for example wetlands, rainforests, riparian forests, etc.

Habitats that fulfil these criteria typically have a restricted geographic distribution and provide a niche for species with special habitat requirements. The factors that contribute to the conservation significance of these habitats also make them particularly sensitive to disturbance. The ecologically sensitive habitats identified in the project area from the desktop study and field surveys are discussed below. The locations of ecologically sensitive areas in relation to the project area are shown in **Figure 6-10**.

Riparian Corridors: The pipeline corridor crosses 16 major permanent watercourses, nine smaller perennial watercourses, and numerous seasonal watercourses, many of which support distinct riparian vegetation communities. Detailed descriptions and locations of riparian corridors that are traversed by the pipeline corridor are included in **Appendix H, Volume 2, Table 9-5** of this Draft EIS.

Figure 6-9: Sites of Ecological and Conservation Significance in the Project Region



Threatened Species Habitats in Corridors

- *Pternandra coerulescens*
- Gouldian Finch *Erythrura gouldiae*
- Pig-nose turtle *Carettochelys insculpta*
- Wood Frog *Rana daemeli*

Other

- Important Wetlands (DEH)
- Wetlands of National Importance
- Monsoon rainforest (known areas only)
- Northern Cypress Pine *Callitris intratropica*
- Significant aquatic habitats with riparian vegetation corridors
- Riparian vegetation corridors
- Regionally significant wetlands (encountered during field surveys)
- TTP Route

-50 0 50 100

Kilometres

Source: National Park Data NT Government, Topographic Data Geoscience Australia, Design Pipe Alignment Data Rev 6 (2004-09-27) Alcan. Prepared by Mipela GIS.

The riparian corridors associated with permanent and semi-permanent watercourses that were assessed during the field surveys were typically characterised by a canopy dominated by *Melaleuca spp*. with other riparian tree species including *Lophostemon lactifluus, Barringtonia acutangula, Terminalia platyphylla, Casuarina cunninghamiana, Eucalyptus camaldulensis* and *Nauclea orientalis*. A dense mid storey comprised of tree and shrub species including *Pandanus spiralis, Pandanus aquaticus, Grevillea pteridifolia, Banksia dentata, Livistona humilis and Acacia spp*. was often present with or without a grass\sedge understorey. These riparian vegetation communities play an important ecological and hydrological role in maintaining the ecological functions of waterways and associated wetland environments.

Riparian vegetation also provides essential habitat for terrestrial and aquatic fauna species, many of which are confined to riparian habitats for all or parts of their life cycle, or at times of adverse environmental conditions (i.e. late in the dry season). Riparian corridors typically exhibit a higher bird species richness and greater abundance of many species (Woinarski *et al*. 2000b). Fauna species commonly associated with specialised monsoon rainforest habitats (Bach *et al*. 1999; Price *et al*. 1998; Woinarski 1993) were found in some of the riparian corridor habitats along the pipeline corridor during the field surveys. It is likely that fauna move seasonally between riparian and non-riparian vegetation and for this reason there is a need to maintain connections between riparian and non-riparian vegetation (Woinarski *et al*. 2000b).

Monsoon Rainforest Patches: Monsoon rainforests in northern Australia occur as scattered patches in a landscape dominated by Eucalypt savannas (Bach *et al*. 1999). Rainforests are not uncommon; however, they are generally small in area and contain distinct flora and fauna species assemblages that warrant conservation measures (Woinarski 2004). The project area does not directly impact on any monsoon rainforests, as rainforest patches that were identified during the field surveys were avoided when selecting the pipeline corridor. Four sections of the proposed pipeline corridor (KP348–356, KP834–840, KP850 and KP912–925) traverse within 800 m to 5 km of monsoon rainforest communities (**Figure 6-10**). In the country traversed by the proposed pipeline corridor monsoon rainforest is the primary habitat of the 'threatened' flora species *Pternandra coerulescens* and the 'threatened' fauna species Gove Crow Butterfly *Euploea alcathoe enastri* and Wood Frog *Rana daemeli*. Potential impacts on these species are discussed in **Section 9.3**.

Sandstone Communities: Rugged sandstone terrain often supports vegetation communities and species that typically do not occur elsewhere. Heath vegetation is a community that is restricted in distribution to the rugged sandstone terrain of north and north-west Australia (Keith *et al*. 2002) and is becoming more restricted due to high susceptibility to the frequent and intense fire regimes that dominate the Top-End (Yates *et al.* 2000). The rugged terrain provides topographical protection from fire and therefore can support communities and plants species that typically do not occur in habitats that experience more frequent exposure to fire. Four sections of the pipeline corridor traverse rugged sandstone terrain (KP75-85, KP210-220, KP430-530 and KP760-785). The landforms traversed are characterised by rocky sandstone slopes, hills and ridges. No heath vegetation communities or flora species of notable conservation significance were identified in the

pipeline corridor. This does not preclude significant flora from being present, however, it does indicate that it is unlikely that significant populations of species of high conservation significance occur in the pipeline corridor.

Wetlands: The pipeline corridor traverses well south of the extensive and highly productive coastal floodplain wetlands that are characteristic of the near coastal environments of the Top End. However, scattered isolated billabongs and seasonally inundated swamps that are floristically similar to the coastal floodplains occur as far inland as Lake Woods (Cowie *et al.* 2000) which is about 300 km south of the pipeline corridor. Sensitive wetland ecosystems were avoided during the design phase. Six of the eleven wetlands identified during the field surveys occur in the pipeline construction corridor. These include permanent and semi-permanent swamps, permanent springs, and permanent and semi-permanent waterholes (refer to **Appendix H**, **Volume 2**, **Table 6** of this Draft EIS for locations). The conservation value of these communities lies in the strong interactions that exist between fauna and flora, especially where aquatic communities add dimension to the habitat value (Cowie *et al.* 2000). The wetlands are of regional conservation significance as they provide a niche for aquatic and semi-aquatic vegetation communities that are uncommon in the drier inland regions of the Northern Territory, and they are recognised as significant habitats for fauna (Whitehead and Chatto 1996).

The Directory of Important Wetlands in Australia identifies and describes wetlands which are considered to be of national importance based on six natural and cultural heritage criteria (Environment Australia 2001). The proposed pipeline corridor traverses the upstream section of the nationally important Moyle Floodplain and Hyland Bay System between KP17 and KP82. Between KP699 and KP781 the pipeline corridor traverses the Goyder River catchment, which is approximately 25 km south of the nationally important Arafura Swamp wetland. The Moyle River floodplain is most notable for its waterbird fauna and is considered to be one of the most important areas for colonial breeding waterfowl in the Northern Territory (Chatto 2000; National Land and Water Resources Audit 2002). The Arafura Swamp is a significant breeding area for the Magpie Goose *Anseranus semipalmata*, Saltwater Crocodiles *Crocodylus porosus* and Freshwater Crocodiles *Crocodylus johnstonii*. The swamp also supports abundant waterbird populations and at least three significant waterbird breeding rookeries (Whitehead and Chatto 1996). The proposed pipeline corridor does not directly or indirectly affect any known important waterbird habitats (*Chatto pers. comm. 2004*) as they are avoided by the TTP. The boundaries of these nationally important wetland areas are shown on **Figure 6-10**.

Aquatic Habitats: Perennial lagoons are crucial habitats for some species of fish, as they typically support aquatic vegetation as well as providing important refuges in dry seasons and breeding grounds prior to floods (Herbert *et al.* 1995). Lagoons are crucial as refuges in the middle and upper reaches of waterways, which is mainly where the pipeline corridor will traverse. These habitats are also known to harbour the complete diversity of aquatic plants in a catchment. The pipeline corridor traverses 25 watercourses where perennial waterbodies are present at the proposed crossing location (**Table 6-14**).

The Cato River can be attributed high conservation significance as it recorded the highest species diversity of the surveyed rivers, and it yielded two fish species not previously recorded from the Northern Territory, as well as the threatened Wood Frog *Rana daemeli*. These species were all recorded from swamps within associated monsoon rainforest patches that occur downstream of the pipeline corridor. It is likely that other rivers within north-eastern Arnhem Land such as the Giddy River, Goromuru River and Habgood River, would also support a similar diversity of fish species. The habitat of both the Daly and Katherine River systems are also attributed high conservation significance not only because of the high level of species diversity recorded from these rivers, but also the sheer size and volume of water that flows down this system. Impacts and management measures for these watercourses are addressed in **Section 9**.

- **Table 6-14 Perennial Watercourses Traversed by Pipeline Corridor**

KP	Name
74	Branch of Moyle River
75	Moyle River
92	Moyle River upstream
217	Whiskey Spring Creek
231	Bradshaw Creek
266	Daly River
309	Katherine River
370	King River
401	Beswick Creek
424	Waterhouse River
499	Maiwok Creek
506	Flying Fox Creek
509	Derim Derim Creek
550	Mainoru River
570	Horse Creek
579	Branch of Horse Creek
600	Wilton River
685	Annie Creek
701	Goyder River
852	Boggy Creek
873	Branch of Cato River
880	Cato River
912	Giddy River
922	Latram River
929	Unnamed creek

Habitats of Threatened Species: Threatened flora and fauna species that have been identified in or near the project area have been discussed in the sections above. **Table 6-15** summarises the locations of known threatened species habitats that occur in or near the project area. Other threatened fauna species identified in **Table 6-10** are more widely distributed and therefore specific habitat areas are difficult to predict.

- **Table 6-15 Habitats of Threatened Flora and Fauna in the Project Area**

Species	Class*	Habitat	Location in Project Area
Plant *Pternandra coerulescens*	NT–VUL	Rainforest patches riparian corridors.	KP922 Latram River
Gouldian Finch *Erythrura gouldiae*	NT–EN Comm–EN	*Eucalyptus tintinnans* woodlands on rocky hills	KP320 to KP460 but mainly KP443 to KP445
Wood Frog *Rana dameli*	NT–VUL	Riparian rainforest	KP880 Cato River KP912 Giddy River KP922 Latram River
Pig-nosed Turtle *Carettochelys insculpta*	NT–NT Comm–nominated as VUL	Major rivers	KP266 Daly River

Note *
- NT = Northern Territory classification;
- Comm = Commonwealth classification; NT = Near-Threatened; VUL = Vulnerable; EN = Endangered

6.3.5 Biting Insects

The potential biting insect problems that are likely to be encountered or exacerbated during construction and operation of the pipeline were identified through:

- a desktop review of topographical maps;
- review of biting insect survey data relevant to the east and west coastal sections of the pipeline corridor;
- predictions based on mosquito and biting midge biology and population information.
- discussions with NT Department of Health and Community Services (DHCS) entomology branch regarding risk of diseases such as dengue.

The results of the biting insects study are summarised in this section from the full report at **Appendix K**, **Volume 2** of this Draft EIS.

Biting Midge Species and Sources: The main species likely to be present within the pipeline corridor is the mangrove biting midge species *Culicoides ornatus.* Other main species that may be present in the project area include *Culicoides marksi, Culicoides flumineus, Culicoides* undescribed Sp. (near *C. immaculatus*), *Lasiohelia spp.* and a species of *Styloconops.* These species have been recorded from previous studies across the region.

Culicoides ornatus will breed in the upper tidal creek mangrove areas within 3.5 km of the pipeline corridor where it nears the east and west coasts of the Northern Territory. *Culicoides marksi* will breed along the margins of freshwater lakes and streams. *Lasiohelia spp.* will breed in damp, surface terrestrial environments, such as patches of tropical rainforest, and general vegetation ranging from wet-sclerophyll forest to open grassland. *Culicoides flumineus* will breed in the lower levels of creekbanks in small tidal tributaries. *Culicoides undescribed sp.* (near *C. immaculatus*) may breed in the lower reaches of mangrove creeks. *Styloconops* species may be breeding in open sandy beaches.

Table 6-17 summarises the presence and potential abundance of biting midges in the project area.

- **Table 6-17 Biting Midge Presence and Potential Abundance in the Project Area**

Species	Seasonal Prevalence	Proportional Abundance – Gove Area	Potential Abundance
Culicoides ornatus	The major human pest species within 3.5 km of mangroves. High localised populations all year round, with maximum numbers occurring in August to November and minimum in the wet season.	~75%	Dominant
C. undescribed species No. 6	Rarely bites humans; A major species near extensive areas of mangroves at coast Nhulunbuy and Wadeye, tidal areas. High numbers in the late dry season and early wet season, and low populations in the post wet season.	3% to 14%	Possible
C. papuensis	Nhulunbuy and Wadeye, breeds in similar areas to *C. ornatus*. may also be present near the tidal areas approaching Gove Peninsula. Not a human pest species.	4% to 10%	Possible
C. actoni	Wadeye, west coast, likely at other areas. Not a major pest.	NA	NA
C. austropalpalis	Nhulunbuy and Wadeye trapping, likely to be present in some areas. Not a human pest species.	0.2%	Possible
Culicoides clavipalpis		<0.1%	Possible
C. marksi	A major species in sub-coastal and inland areas, with only low populations at coast. Low populations in the late dry season and moderate populations in the early wet and post wet to mid dry seasons. Near Nhulunbuy, and near freshwater lakes and streams. Can be a minor human pest species	<1% to 7%	Possible near freshwater lakes
Lasiohelia sp.	Minor pest. Damp, surface-terrestrial environments - rainforest to open grassland.	1%	Possible
C. undescribed species (Vic) No. 42	A minor species. Peak numbers in mid wet season.	4%	Possible
C. pallidothorax	Nhulunbuy and near freshwater areas. A minor pest species. Peak populations during the early to mid wet season.	<0.1% to 4%	Possible
C. flumineus	An important pest species with high numbers inside mangroves only. Peaks in late dry season, early wet season. Not recorded on TTP, but important pest species	Likely	Possible near Gove Peninsula
C. undescribed sp. (near *C. immaculatus*)	A serious pest in lower reaches of mangrove creeks. Not recorded on TTP.	Likely	Possible near Gove Peninsula
C. immaculatus	A minor to rare species near rock-sand or sandy beaches only. Peak numbers in mid to late dry and early wet season.	0.5%	Possible
Styloconops	Open sandy beaches in small numbers biting and swarming around the head on open sandy beaches during the day	Possible	Possible

Source: Adapted from: Whelan et al 2004; Dyce N.D.; Shivas 1999

Mosquito Species and Sources: The main mosquito species likely to be present along the pipeline corridor will be *Ochlerotatus vigilax* (salt marsh mosquito), *Culex annulirostris* (common banded mosquito), *Ochlerotatus normanensis* (floodwater mosquito), *Anopheles farauti s.l.* (north Australian malaria mosquito), *Anopheles bancroftii* (black malaria mosquito), *Coquillettidia xanthogaster* (golden mosquito), *Mansonia uniformis* (waterlily mosquito) and *Anopheles annulipes s.l.* (Australian *Anopheles* mosquito). These species have been identified from previous studies across the region.

The large brackish water and freshwater reed swamp located 2 km north of the western most limit of the pipeline corridor will likely be a source of large numbers of mosquitoes. Very high numbers of *Ochlerotatus vigilax,* and moderate to high numbers of *Culex annulirostris, Coquillettidia xanthogaster* and *Anopheles bancroftii* are likely to affect the section of the pipeline corridor within 5 km of this swamp. Moderate to high numbers of *An. farauti s.l.* are likely to affect the section of pipeline corridor within 3 km of this swamp.

The old red mud ponds area near the Alcan Gove mine, upper tidal creek areas in the Gove Peninsula (Crocodile Creek, Buffalo Creek and East Woody Creek), and potentially Nhulunbuy Lagoon, will provide minor to very high numbers of *Ochlerotatus vigilax* and moderate to high numbers of *Culex annulirostris* to the section of pipeline corridor that runs parallel with the mine conveyer system. However, these areas are subject to a Mosquito Management Plan that has been upgraded as a part of the Alcan Gove Refinery Expansion Project EMP.

For the remaining areas of the project area, poorly draining floodways associated with creeks and rivers may be sources of large numbers of *Ochlerotatus normanensis.* Vegetated seasonal swamps, floodways, billabongs, creeks and rivers may be sources of minor to large numbers of *Culex annulirostris, Anopheles bancroftii, Coquillettidia xanthogaster* and *Mansonia uniformis.* Temporary flooded vegetated ground pools and vegetated floodways will also be sources of minor to high numbers of *Cx. annulirostris.* Vegetated seasonal swamps and creeks may be sources of minor to moderate numbers of *Anopheles annulipes* and *An. farauti s.l.*

Pest Species: There are over 100 species of mosquitoes recorded in the Northern Territory of which 16 are regarded as either potential pest species and\or disease vector species. There are likely to be at least eight mosquito species capable of causing minor to major pest and\or potential mosquito borne disease problems in the project area. These species are listed in **Table 6-18** with a brief description of preferred breeding sites, pest and disease status.

Table 6-18 Mosquito Pest Species

Species/Common name	Habitat Description	Flight Range & Pest Solutions	Peak Period	Pest Status	Vector (Disease) status
Ochlerotatus vigilax (Salt marsh mosquito)	Brackish reed swamps Upper mangrove margin and tidal creek extremities	0–5 km major pest 5–50 km pest numbers 50–over 200 km dispersal	September–January 9–10 days after peak tides; pests up to two weeks	Major pest, bites day or night within 5 km of breeding sites. Plagues associated with high tides in late dry season, early wet season.	Major vector of Ross River (RRV) and Barmah Forest virus (BFV) diseases and dog heartworm. Potential vector of many other arboviruses.
Ochlerotatus normanensis (Floodwater mosquito)	Flooded freshwater sub-coastal or inland floodways and creeks	0–2 km major pest 2–5 km pest numbers	January–April; 9–10 days are extensive rainfall, pests up to two weeks	Major pest, bites in evening and night within 3 km of breeding sites. Plagues in inland areas a week after widespread flooding rains in wet season.	Major vector of RRV and BFV. Potential vector of Murray Valley encephalitis (MVEV). Potential vector of many other arboviruses.
Culex annulirostris (Common banded mosquito)	Freshwater and coastal reed swamps. Streams, storm drains, and sewage effluents	0–3 km major pest 2–10 km pest numbers 10–15 km dispersal	January to August	Major pest, very common and widespread in both urban and rural areas. Bites mainly in evening and at night.	The most important arbovirus vector of MVEV, Kunjin virus, RRV and BFV, and dog heart worm. Vector of numerous other arboviruses.
Anopheles bancroftii (Black malaria mosquito)	Freshwater, Melaleuca and coastal reed swamps. Shaded streams and swamps	0–3 km major pest 3–5 km pest numbers	February–July, highest numbers April–July	Major pest, widespread, bites anytime near breeding site, nightly or shaded areas elsewhere.	Potential malaria vector.
Coquillettidia xanthogaster (The golden mosquito)	Freshwater swamps with reeds Vegetated streams	0–3 km major pest 3–5 km pest numbers	March–August	Major localised pest near extensive reed swamps, disperses widely, bites at dusk and night, or in dense shade in day, attracted to lights	No diseases. Filariasis in frill neck lizard

Species/Common name	Habitat Description	Flight Range & Pest Solutions	Peak Period	Pest Status	Vector (Disease) status
Anopheles farauti s.l. (Australian malaria mosquito)	Coastal and brackish reed swamps Freshwater swamps and vegetated streams	0–1.5 km minor pest 1.5–3 km dispersal	March–June	Local minor to moderate pest, bites at night. Uncommon, except near mostly sub-coastal and extensive freshwater or brackish swamps.	Major potential vector of malaria.
Anopheles annulipes s.l. (Australian *Anopheles* mosquito)	Freshwater streams and vegetated swamps.	up to 2 km from breeding site	Wet season and post wet	Widespread pest, bites at night and will enter houses.	Potential malaria vector.
Mansonia uniformis (Waterlily mosquito)	Extensive freshwater reed swamp	0–2 km major pest 2–3 km dispersal	March–June	Localised pest, bites at night near the breeding site, attracted to lights, does not disperse far from breeding sites.	No diseases.

Source: Adapted from Whelan 1997, and Warchott, Whelan & Carter 2004.

Seasonality of Mosquito Pest Problems: For freshwater breeding mosquitoes in the Top End of the Northern Territory, highest abundance generally occurs in the post wet season months of April, May and June. Swamps with freshwater stream inflows can be continual sources of mosquitoes until August, particularly if the swamps are heavily vegetated with reeds. The construction workforce will be at greatest risk of exposure to mosquito pests and disease during these months.

Seasonally flooded creek lines can be sources of pest numbers of mosquitoes when stream flows cease and the waters begin to dry, leaving behind isolated vegetated pools. Mosquito problems can occur until August nearby to larger creeks that hold water permanently, or for extended periods after the wet season. Rivers can be sources of pest numbers of mosquitoes from April to June, when receding water levels leave behind isolated, vegetated pools on levee river banks. Seasonally flooded grasslands and poorly draining floodways can be large sources of mosquitoes in the wet season months of January to April, after initial flooding. Large floodplains associated with rivers can be sources of pest numbers of mosquitoes from January to June. Billabongs and lakes can be perennial sources of mosquitoes, particularly if there is perennial or long lasting surface water, and an abundance of semi-aquatic and aquatic vegetation.

Tidal areas can be sources of pest numbers of mosquitoes, with the main breeding areas being upper tidal creeks and brackish water swamps. Elevated mosquito breeding in upper tidal creeks generally occurs from September to December. Elevated mosquito breeding in brackish water swamps generally occurs from September to June, with brackish water swamps that receive freshwater stream flows capable of breeding pest numbers of mosquitoes until August in extended wet season years. Also, excavations and changes to drainage patterns by road construction, pipeline construction activities and the establishment of borrow pits will add to this risk.

6.3.6 Bushfires

Bushfires are frequent and widespread throughout the grassy savannas of Northern Australia. Within the extensive region traversed by the TTP, they occur throughout the dry season from March or April each year to the end of the dry season in about November or December. The region experiences fires on an annual basis, and approximately a quarter to half of the natural vegetation may burn each year. Fire history studies across the region indicate that the frequency and scale of fires vary considerably from a few hectares to hundreds of square kilometres in extent. Early dry season fires are usually of less intensity than the later fires when the conditions are hotter and drier, and winds are stronger. The scale and intensity of fires can be reduced if many small patches are lit throughout the dry season. Most fires are lit by people. Lightning has been suggested as a source of ignition in the late dry season ('build-up') when lightning storms are common, but there are no data on the frequency and occurrence of lightning fires.

Fires in the savannas are normally much less severe and intense than in temperate zones, but they create a lot of smoke, burn very hot in some grass types (especially the exotic weeds Gamba Grass, Mission Grass, and Grader Grass), and can move quite quickly. To people inexperienced with fires in this environment, they can be very frightening. They present a risk to life and property, both

directly from being burnt, and indirectly from reduced visibility from smoke and a threat to health from smoke inhalation.

The *Bushfires Act 2004* regulates the lighting of fires throughout the Northern Territory. For much of the dry season, permits to light fires must be obtained from the Bushfires Council, through the regional offices. The TTP traverses four Bushfires Regions – Arnhem Land, Katherine, Arafura and the north-west corner of the Gulf Bushfire Region. The Bushfires Regional Committees plan annual prescribed burning programmes for their regions. These prescribed burns include aerial control burning and ground-based burning.

6.4 Gaps in Information

Short sections of the pipeline route have not been subject to a detailed survey. The sections of the pipeline corridor between Annie Creek and the Goyder River (KP685 to KP701), and through the Mitchell Ranges (KP744 to KP775), that have not been surveyed on the ground were subject to a helicopter reconnaissance survey and desktop review to identify the key potential environmental issues. The corridor has been chosen to avoid environmentally sensitive areas identified in the survey and desktop review. However, a ground survey is required to verify that sensitive areas are avoided by the final chosen corridor. A broad description of the environment that is likely to characterise these sections of the pipeline corridor is provided below.

Annie Creek to Goyder River (KP685-701): The pipeline corridor between Annie Creek and the Goyder River traverses a number of minor drainage lines all of which are likely to be ephemeral. Away from the drainage lines the vegetation is expected to be similar to that described in the areas to the east and west which is dominated by *Eucalyptus miniata* and *E. tetrodonta* woodland with a mixture of *Sarga spp*. and *Plectrachne spp*. grasses in the understorey. There are a number of swamps in the area that are avoided by the pipeline corridor.

Mitchell Ranges (KP744-775): Through the Mitchell Ranges the pipeline corridor traverses a seasonal creek line and numerous ephemeral drainage lines. The vegetation is likely to be dominated by *Eucalyptus tetrodonta* and *E. miniata* woodland with tussock grasses in the understorey. *E. phoenicea*, a species common to rocky sandstone hills, is likely to be a co-dominant species in the canopy. A few small rainforest patches were identified in the sandstone hills. These patches should be avoided when the pipeline corridor is verified on the ground.

Archaeological Material: The two sections have not been investigated for archaeological material. There is a high potential for the presence of archaeological sites in both these areas, based on the findings from the archaeological surveys of the rest of the pipeline route surveyed. The Mitchell Ranges lie in an area where there may be rock outcrops used as a source of raw material for the manufacture of stone artefacts, and between the Goyder River and Annie Creek there may be artefact scatters near the several permanent sources of fresh water in the area.