GLADSTONE NICKEL PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT

Alternative Residue Pipeline Route Environmental Assessment

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Gladstone Pacific Nickel LTD

Gladstone Pacific Nickel Ltd

GLADSTONE NICKEL PROJECT

ALTERNATE RESIDUE PIPELINE ROUTE

Environmental Assessment for Supplementary EIS

November 2007

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1 INTRODUCTION

1.1 BACKGROUND

Gladstone Pacific Nickel Ltd (GPNL) is proposing to build and operate a nickel/cobalt refinery. The project, known as the Gladstone Nickel Project (GNP), will consist of a high pressure acid leach plant (HPAL) and metals plant with supporting facilities (collectively called the refinery) to be located at Gladstone, Queensland. The refinery site will be approximately 8 km west of the Gladstone central business district, and will be located in the Yarwun Precinct of the Queensland Government's Gladstone State Development Area (GSDA) (refer to Figure 1-1).

The refinery will process ores from a nickel laterite mine near Marlborough, approximately 180 km north-west of Gladstone, together with nickel laterite ores imported from the south-west Pacific region. The ores from Marlborough will be beneficiated at a plant adjacent to the mine site and then pumped as slurry through a pipeline to the refinery. Residue from the refinery will be pumped to a residue storage facility (RSF) located in the Aldoga Precinct of the GSDA and approximately 13 km south-west of the refinery site. Excess liquor will be return to the refinery from the RSF via a parallel pipeline.

The refinery will initially be developed in two stages.

- Stage 1 will produce around 60,000 t/y of nickel metal and 6,000 t/y of cobalt metal.
- Stage 2 will produce around 126,000 t/y of nickel metal and 12,000 t/y of cobalt metal.

An Environmental Impact Statement (EIS) for the project, which addressed both stages, was released for public comment in April 2007.

1.2 SCOPE

The scope of this report includes an assessment of a proposed alternate route for the residue and return liquor pipelines, which operate between the refinery and the residue storage facility. This alternate route was identified in the EIS released in early 2007, however, no detailed information regarding the route was included. GPNL have subsequently decided to pursue this alternate option for the residue pipeline and have prepared this report for inclusion in the Supplementary EIS.

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Job No: 00011122 | Drawn: RLMS | Approved: KD | Date: 26/11/2007 | File No: LocalityPlan.mxd

Title: FIGURE 1-1 LOCALITY PLAN

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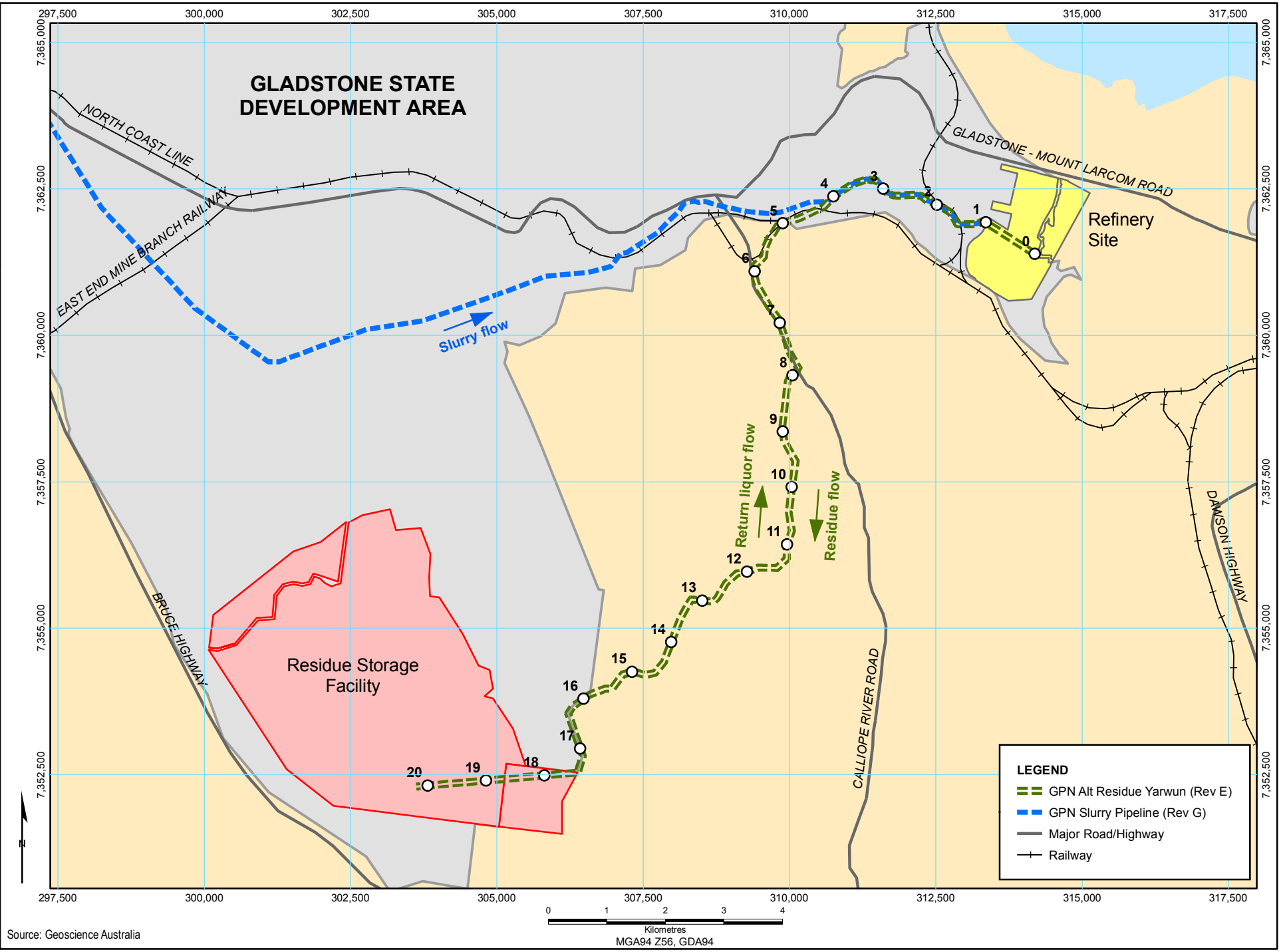

Source: Geoscience Australia

2 PROJECT DESCRIPTION

2.1 PIPE LINE ROUTE

2.1.1 Alternates Considered

As outlined in Section 5.6 of the Gladstone Nickel Project EIS, GPNL has identified an alternate route for the pipelines located between the refinery and the RSF (the residue and return liquor pipelines). The original route for these pipelines documented in the Gladstone Nickel Project EIS is constrained due to the capacity of the existing materials transport corridor between Yarwun and Aldoga precincts of the GSDA. GPNL has identified that capital, efficiency and energy savings could be made through a reduction in the overall length of the pipelines.

A summary of the route options that have been further considered since the release of the EIS is presented in Table 2-1 and illustrated in Figure 2-1.

Table 2-1 : Pipeline Design Specifications

Option	Route	Description
A	This is the original residue pipeline route which was assessed in the Gladstone Nickel Project EIS. This route is 27km long and is totally contained within the Gladstone State Development Area (GSDA). This route runs parallels to the slurry pipeline route for the first 15 km, before heading south in parallel with the Bruce Highway for approximately 5 km, then heading east to the RSF.	While GPNL have not discounted this option, this option is not the preferred due to: • The overall length of this route; • Potential conflict with proposed expansion of rail infrastructure by Queensland Rail (refer to Figure 2-1) within the GSDA; • Constraints associated with the materials transport corridor between Yarwun and Aldoga.
B	This route is approximately 18.2km long and maximises the use of road reserves. This route follows Option A within the GSDA for the first 6km, and then heads in a southerly direction past Yarwun using road reserves (Calliope River Road, Boyles Road) for the majority of the route to the RSF.	This option is now considered the preferred option for the residue and residue return pipelines. This alternate route offers the following advantages: • Reduction in the overall length of the pipelines; • Avoidance of potential conflicts with the expansion of rail infrastructure within the GSDA; • Minimising use of the materials transport corridor between Yarwun and Aldoga. GPNL acknowledges that the Calliope Shire Council does not prefer this option and are continuing to consult with the Council to resolve these issues.
C	This route follows Option A within the GSDA for the first 5.1 km, then heads south via an existing transmission line easement for 1km, before paralleling Option B. This option is however located on private property and does not use the road reserve.	GPNL commenced consultation with landholders impacted by this route, but discontinued further investigation of this option due to feedback provided by the landholders.
D	This route follows a transmission line easement from the refinery for approximately 3 km, through the Mount Stowe State Forest and Calliope Conservation Park and then connection to Option B or C through to the RSF.	This option was discounted due to the topography of the route and potential disturbance to the State Forest and Conservation Reserve. A preliminary engineering investigation of the potential to directionally drill under the State Forest and Conservation Reserve was completed, and concluded that the drilling was not likely to be economically feasible and was technically challenging

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Job No: 00011122 | File No: RouteOptions.mxd

Title: FIGURE 2-1 ROUTE OPTIONS CONSIDERED

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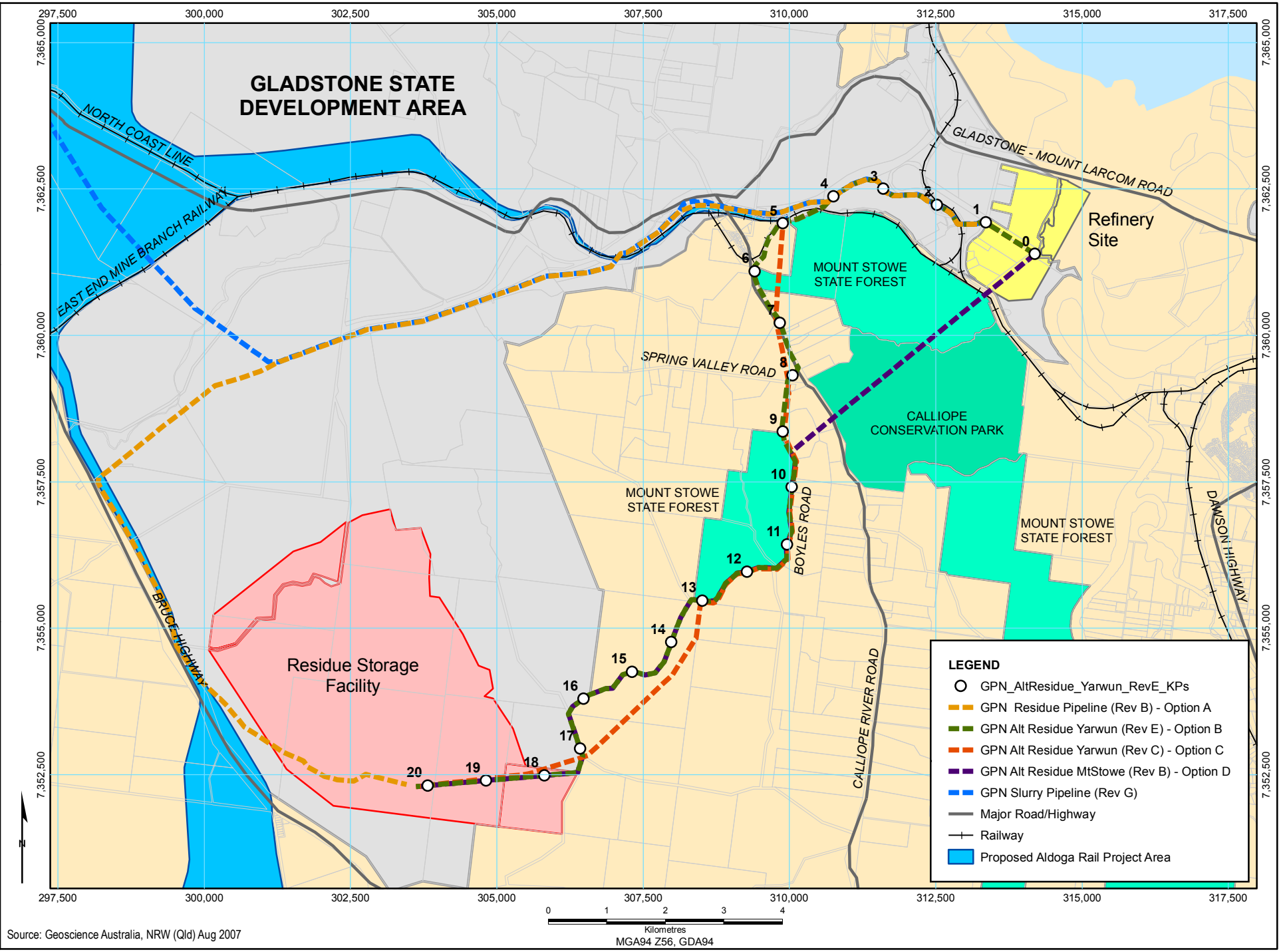

Source: Geoscience Australia, NRW (Qld) Aug 2007

2.1.2 Preferred Route

The proposed route for the residue and return liquor pipelines is illustrated in Figure 2-1 and has a total length of 18.3km. The pipeline commences at the refinery (Kilometre Point (KP) 0) and then heads in a north westerly direction crossing Reid Road (KP 1) and then heads in a westerly direction. The pipeline route then crosses the North Coast Railway KP 1.5 line at approximately KP 1.5 and then heads in general westerly direction to Yarwun (KP 6). From Yarwun, the pipeline route heads south and is contained within the Calliope River Road road reserve to KP 7.8.

The route crosses through private land and then into the Boyles Road road reserve and travels in a south and southwest direction. At approximate KP 17.4, the pipeline route leaves the road reserve and heads in a westerly direction to the RSF thickener location at KP 18.3.

As outlined in Section 1.1, the project is being developed in two Stages. Stage One of the project will require a residue pipeline and residue return pipeline to operate between the refinery and the RSF. Stage Two of the project will require these pipelines to be duplicated.

2.2 PIPELINE DESIGN

GPNL have completed a preliminary design for the pipeline transport systems including sizing/selection of system components and pumping assessment. The residue pipeline design consists of a 26-inch outside diameter steel pipe internally lined with HDPE. The system requires 12 centrifugal pumps (6 operating / 6 standby), designed to operate in packed flow, which will be located within the refinery. The return liquor pipeline design consists of a 24-inch and 16-inch outside diameter steel pipe internally lined with HDPE, with 2 centrifugal pumps (1 operating / 1 standby). The pump station for the residue return pipeline will be located within the RSF.

The pipelines will be designed in accordance with ASME B31.11 Slurry Transportation Piping Systems.

Specifications for the pipelines are outlined in Table 2-2.

Table 2-2 : Pipeline Design Specifications

Pipeline Component	Pipeline Design Specification	
	Residue Pipeline	**Return Liquor Pipeline**
No. of Pipelines	1 (initially for Stage 1) +1 for Stage 2	1 (initially for Stage 1) +1 for Stage 2
Length (approx), km	18.3	18.3
Outside Diameter (OD) (approx) mm	660	610 (16km) 406 (2.3km)
Average Wall thickness, mm	7.1	6.35 – 7.1
Material	API-5LX steel with HDPE lining	API-5LX steel with HDPE lining
External Coating	3LPE	
Depth cover, mm	In accordance with AS 2885, typically: General 750 Cultivated Areas 1200 Rock Areas 450 (minimum) Water courses 1200 – 2000 Road crossings 1200 (minimum)	
Nominal Capacity (approx), m^3/h	1,954	1474
Maximum Operating Pressure (approx), kPa	2,500	530
Construction Right of Way (ROW)	Approx 10m – 30m for Stage 1 (2 pipelines) Same for Stage 2 (2 additional pipelines)	
External	External Corrosion Coating and Cathodic Protection	

Pipeline Component	Pipeline Design Specification	
	Residue Pipeline	**Return Liquor Pipeline**
Corrosion Protection		
Internal Corrosion Protection	Internal HDPE liner	
Non Destructive Testing (NDT)	In accordance with AS2885	
Supervisory Control and Data Acquisition (SCADA)	At pump station at start of pipeline and at terminal at end of pipeline	
Operation	Continuous	
Monitoring system[1]	Inlet and outlet pressure, inlet and outlet flow rate Remote monitoring as part of plant control system	
Location of 'pipeline operations centre'	Yarwun Refinery	

2.2.1 Above Ground Facilities

Above ground facilities that will be required for the pipelines include:

- Marker Signs;
- Cathodic Protection Systems.

The pipelines will be buried for their entire length with no additional above ground infrastructure or intermediate valves or intermediate pump stations. The pump stations will be located at the refinery (for the residue pipeline) and residue storage area (for the return liquor pipelines).

Refer to Section 2.5.6 of the Gladstone Nickel Project EIS for additional information regarding facilities.

2.3 PIPELINE CONSTRUCTION

2.3.1 Construction Process

A description of the pipeline construction process was included in Section 2.3.6 of the Gladstone Nickel Project EIS. The construction process for the residue and return liquor pipelines will follow the same general process with the following differences:

- The maximum width of the construction Right of Way (ROW) will be 25m for the dual pipelines,
- Where significant constraints are located along the pipeline route (e.g. along Calliope River Road), the construction width can be reduced to 10m by:
  - Placing excavated material from the trench direct into a truck, instead of stockpiling beside the trench. The excavated soil is then transported to the previously completed section of trench for filling. This removes the need to have spoil stockpiles.
  - Placing the steel pipe (unwelded) directly in the trench and welding the pipe together within the trench. To achieve this, a "bellhole" of approximately 3m x 4m is required at every pipe length (e.g. 18m) to enable access and a safe working area for the welders. Where possible, two pipes will be welded together before lowering into the trench, this reducing the number of "bell holes" to every 36m.
- Pipeline construction rates will vary from 50m per day (where construction is constrained) to approximately 200m per day.
- The length of open trench will be up to 1000m, but this will be reduced to 100m where construction is constrained.

The key characteristics of the construction program are defined in Table 2-3.

[1] *Each pipeline will have a flow meter and pressure transmitter located at each end. The control system will monitor the flow into and out of each pipeline on a continuous basis. An alarm will occur if a mismatch in flow is detected which would indicate that a leak is occurring in the pipeline. Pressure transmitters are installed primarily to indicate an over-pressure condition.*

Table 2-3 : Characteristics of the Construction Program

Construction Element	Stage 1 (2 pipelines)	Stage 2 (2 additional pipelines)
Width of vegetation clearing, m (approx)	10m in constrained areas and besides roads- Up to 25 in open country	10m in constrained areas and besides roads- Up to 25 in open country
Number of trenches	One	One (separate to Stage 1 trench)
Maximum length of open trench,	100m in constrained areas Up to 1km in open country	Up to 1km
Combined rate of movement of construction crews, m/day	50m in constrained areas Up to 200m in open country	50m in constrained areas Up to 200m in open country
Number of crews	2	2
Potential Construction duration (entire pipeline length)	7-9 months	7-9 months
Standard construction working hours	10 h/day, 28 days on, 7 days off	

2.3.2 Crossings

Several methods can be used to construct road, infrastructure and watercourse crossings and these include:

- Open cut (including flow diversion if applicable);
- Boring; and
- Horizontal Directional Drill (HDD).

Refer to Section 7.3.4.2 of the Gladstone Nickel Project EIS, which provides a description of these construction techniques and methodology for selection of the appropriate crossing method.

Major roads, the railway and existing pipelines crossings will be bored. GPNL will consult with infrastructure holders regarding the design of the crossing and any necessary permits or consents (refer to Section 0).

2.4 PIPELINE OPERATIONS

A description of the operation of the pipelines, including the residue and residue return pipelines was addressed in Section 2.8.4 of the Gladstone Nickel Project EIS. Additional information regarding the operation of the pipelines, including monitoring program, is provided in Section 5 of the draft Pipeline EMP, which is included in the Supplementary EIS.

2.5 INFRASTRUCTURE REQUIREMENTS

A description of infrastructure requirements for the construction of the project pipelines, including the residue pipelines and residue return pipelines was included in Section 2.3.6 of the Gladstone Nickel Project EIS. The infrastructure requirements will not significantly change as a result of the alternate pipeline route.

Refer also to Section 3.2.4 for information regarding third party infrastructure associated with the proposed pipeline route and assessment of potential impacts.

2.6 WASTE MANAGEMENT

Waste management will be an integral component of the Gladstone Nickel Project operations. GPNL commits to reducing wastes production through recovery, re-use and recycling and through encouraging efficient utilisation of resources.

A detailed description GPNL's waste management plan was included in Section 4.0 of the Gladstone Nickel Project EIS, which included pipeline related issues. This waste management plan will not change as a result of the alternate pipeline route.

3 ENVIRONMENTAL EFFECTS

3.1 LAND TENURE

3.1.1 Tenure

The majority of the proposed pipeline route is contained within road reserves, however parcels of state land, leasehold and freehold also occur on the proposed route. A summary of the land tenure of the proposed pipeline routes is provided in Table 3-1 and illustrated on Figure 3-1. Details of infrastructure intersected by the pipeline route are provided in Section 3.2.4.

Table 3-1 : Land Tenure

Type of Tenure	Location	No. Lots
Road Reserve	Entire route except for locations detailed below	
Leasehold	KPs (approx) 1.5	3
State Land	Between KP 1.7 and 3.2, KP 4.2	4
Freehold	7.9 - 8.1, 17.5 to end	2

3.1.2 Native Title

The proposed pipeline route is located within the Port Curtis Coral Coast (PCCC) Native Title Claim. The extent of land subject to Native Title intersected by the alignment of the proposed pipelines is being investigated by GPNL. Should any of the route be subject to native title, then an Indigenous Land Use Agreement will be negotiated with the PCCC Claimants.

3.2 LAND USE

3.2.1 General

The land use of the project area, including alternate reside pipeline route was addressed in Section 10.11 of the Gladstone Nickel Project EIS. The majority of the proposed route is contained within the Gladstone State Development Area and road reserves. Adjoining land use along the proposed route is largely agricultural including orchards and grazing.

3.2.2 Conservation Areas

The proposed pipeline route does not enter any Conservation Park or State Forest, but is located within a road reserve which is adjacent to the Mt Stowe State Forest at KP 3.5-5 & KP 6-6.3 and KP 9-13.1.

3.2.3 Mining and Petroleum

Mining and petroleum tenures include permits to prospect and/or explore as well as licenses, claims and leases for the development of resources. Mining and petroleum tenures intersected by the proposed route are outlined in Table 3-2. GPNL will contact all mining and petroleum tenure holders to advise them of the location of the proposed route, request information regarding existing or proposed infrastructure and identify any potential issues.

Table 3-2 : Mining and Petroleum Tenures

Approximate KP	Permit	Owner
1-3	MDL 225	Southern Pacific Petroleum
1-3	EPM 3 215	Qld Energy Resources
3-4.8	EPM 15771	Genesis Resources Limited

MDL = Mineral Development Lease; EPM = Exploration Permit – Minerals under the *Mineral Resources Act*

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Title: FIGURE 3-1 LAND TENURE AND INFRASTRUCTURE

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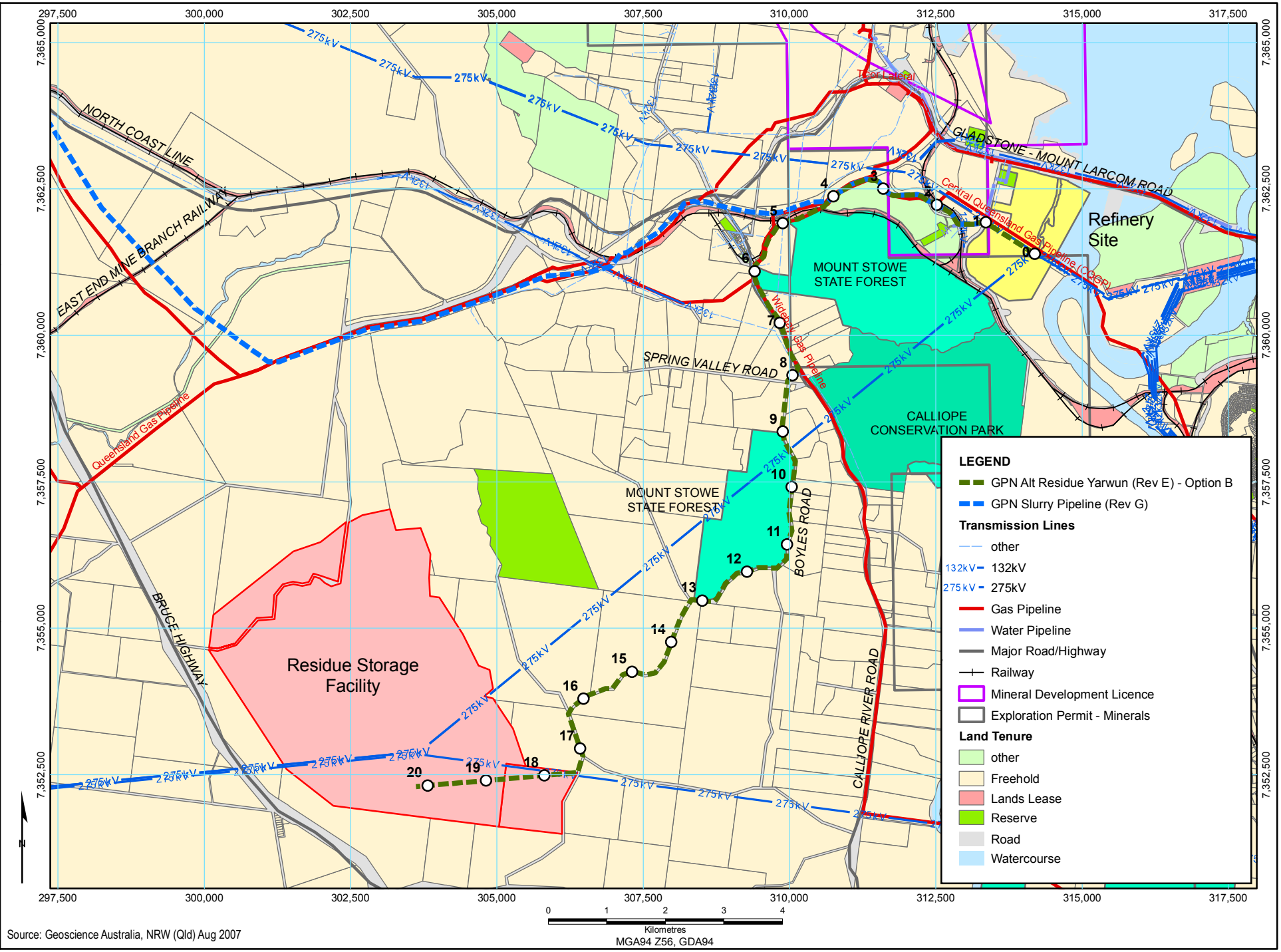

Source: Geoscience Australia, NRW (Qld) Aug 2007

3.2.4 Existing Infrastructure

The location of the various types of infrastructure (e.g. roads, powerlines, railways, other pipelines) intersected by the pipeline routes are summarised in Table 3-3 and illustrated in Figure 3-1. All key highways are bitumen sealed. A series of secondary, minor and local roads, and farm access tracks will also be crossed by the pipeline route or used by vehicles associated with pipeline construction activities.

Table 3-3 : Existing Infrastructure

Approximate KP	Name / Number	Owner/Custodian
Major Sealed Roads		
1	Reid Road	Department of Main Roads
6-7.9	Calliope River Road (within road reserve)	Calliope Shire Council
Minor unsealed Roads and Tracks		
8.1	Spring Valley Road	Calliope Shire Council
8.1-13.2	Boyles Road (within road reserve)	Calliope Shire Council
13.2-17.5	Unnamed Road (within road reserve)	Calliope Shire Council
Railways		
1.5	Fisherman's Landing branch railway	Qld Rail
4.3	North Coast Rail Line	Qld Rail
Power lines		
5, 6.9, 7.9	66kV Powerline	Ergon
Pipelines		
1.5	900mm Water Pipeline	GAWB
7.9	Widebay Gas Pipeline	Envestra

3.2.5 Potential Impacts and Mitigation Measures

3.2.5.1 Mining and other Industrial Land Uses

The proposed pipelines have generally been located within close proximity to existing major infrastructure and it is not considered that the construction of the pipelines will adversely impact on any mining tenure held within the area.

Industrial activities will not be directly impacted by the construction and operation of the proposed pipelines; however, indirect disturbances may include short term disruptions to local traffic conditions.

3.2.5.2 Existing Infrastructure

The potential impacts of pipeline construction and operation on existing infrastructure was discussed in Section 10.11.3.2 of the Gladstone Nickel Project EIS. The most significant potential impact is associated with potential disruption to the operation of the existing infrastructure during the construction of the pipelines. As out lined in the EIS, major services will be crossed via drilling/boring. The design of the crossings will be finalised during the detailed design phase of the project. During this phase, GPNL will liaise with the relevant regulators regarding the design of the crossing, obtain the necessary consents/approvals and agree on access protocols for operational activities.

3.2.5.3 Mitigation Measures

The pipeline route has been selected to avoid or minimise adverse impacts to land use and infrastructure. Mitigation measures are outlined in the Pipeline EMP (refer to Section xx) and summarised below.

To mitigate potential impacts, GPNL will:

General

- Maintain on-going landholder negotiations with the aim of achieving a mutually agreed pipeline route and a fair and reasonable compensation for any disruptions.

- Where required along the route, install temporary fences to protect humans and livestock.
- Clearly locate existing fences and install temporary gates at locations where the pipelines cross fence lines.
- Reinstate fence lines post construction.

Infrastructure

- Work with infrastructure holders in regard to:
  - accurately determine the location of existing underground infrastructure,
  - design of the crossings, taking into account the specific requirements of the infrastructure holders,
  - developing agreed safety protocols for the purpose of constructing crossings,
  - obtaining the relevant consent/licence agreements for crossings,
  - agreeing a schedule for construction of crossings,
  - developing agreed protocols for any operational activities associated with the pipelines where an infrastructure crossing exists.
- Design crossings in accordance with AS2285 to maintain the integrity of the existing infrastructure and public safety.

3.3 LAND AND TERRAIN CHARACTERISTICS

3.3.1 Description of Environmental Values

An assessment of the land and terrain characteristics of the route was completed by HLA Envirosciences Pty Ltd. The assessment was completed through a review of the field assessment of the refinery, RSF and slurry pipeline route (documented in the Gladstone Nickel Project EIS) and desktop study of additional digital and hardcopy special data. A summary of the outcome of this assessment is provided in the following section. Refer to Appendix 1 for full copy of the assessment.

3.3.1.1 Topography

The topography of the pipeline alignment is illustrated in Figure 3-2. The proposed pipeline was sited to avoid major hills and slopes. The area is dominated by the following landforms:

- Undulating to rolling hills, rises and fans on sedimentary rocks and unconsolidated sediments – constituting approximately 35% of the alignment;
- Areas of steep to rolling hills on steeply dipping sedimentary rocks – constituting approximately 35% of the alignment;
- Broad, level to gently undulating alluvial plains – constituting approximately 15% of the alignment. Alluvial plains are associated with Oaky Creek and Gravel Creek (refer to Figure 3-2)
- Undulating footslopes and rises, and gently undulating fans below hills on intermediate and acid volcanic rocks – constituting approximately 10% of the alignment; and
- Undulating footslopes and rises on sedimentary rocks – constituting approximately 5% of the alignment.

The maximum elevation is approximately 60 mAHD on the southern edge of the RSF. The lowest elevation is at KP 0 on the residual soils of the GPN Refinery site at approximately 12 mAHD.

3.3.1.2 Geology

The alignment encounters Early Carboniferous geology of the Rockhampton Group and Late-Devonian - Early Carboniferous geology of the Doonside Formation, part of the Curtis Island Group. The geology of the Late Paleozoic comprises sediments including sandstones, mudstones, limestone and calcareous sandstones and conglomerate of marine shelf origin with felsic to basaltic volcanics. This Late Paleozoic geological succession is overlain by Quaternary alluvium and residual sediments both within and adjoining the drainage depressions intersected by the alignment.

The geology traversed by the proposed alignment is summarised in Table 3-4.

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Job No: 00011122 | File No: Geology.mxd

Title: FIGURE 3-2 GEOLOGY AND TOPOGRAPHY

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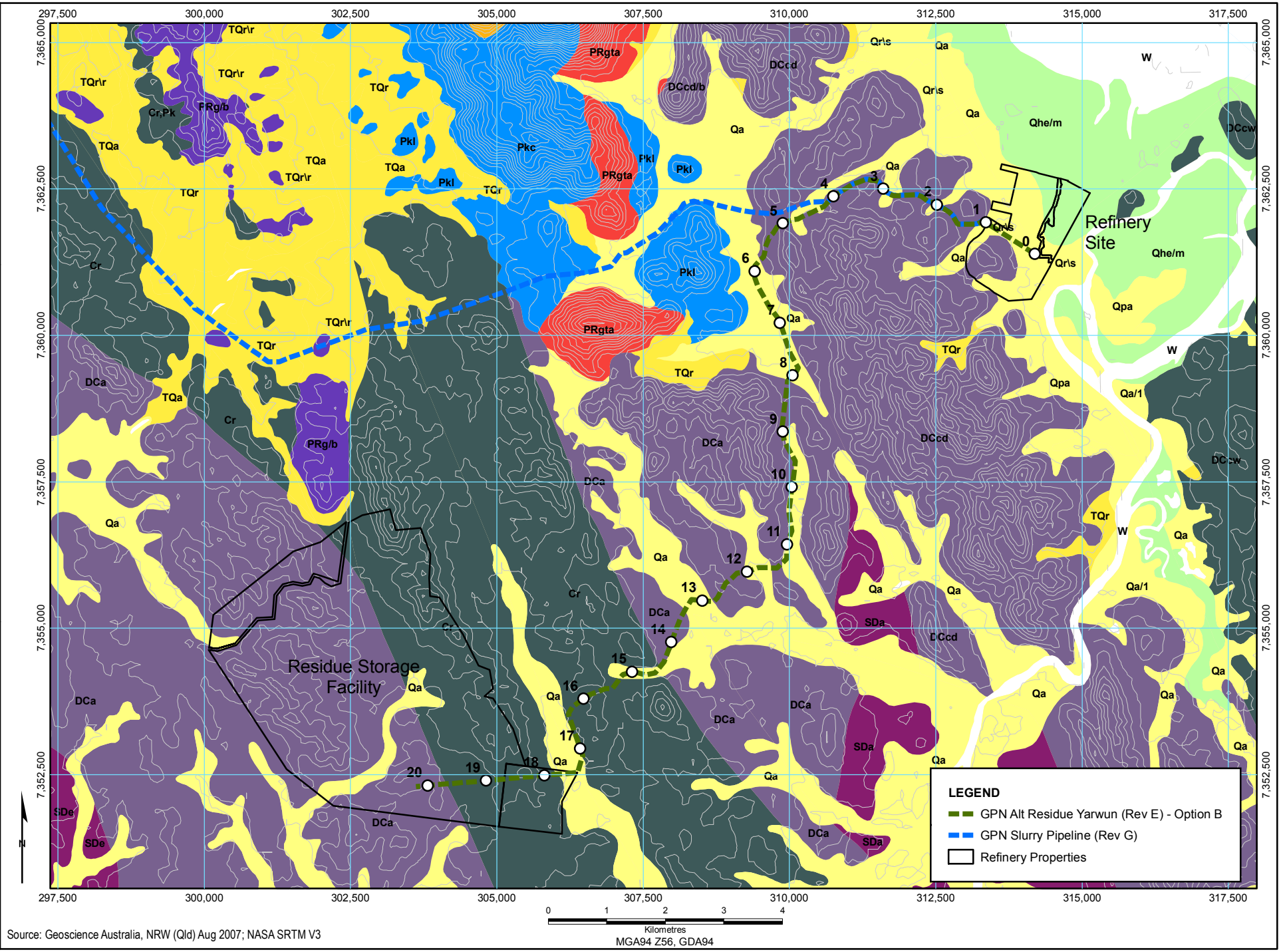

Source: Geoscience Australia, NRW (Qld) Aug 2007; NASA SRTM V3

Table 3-4 : Geology Descriptions of the Pipeline Alignment

Approx KP	Geological Unit[1]	Description[1]	Age
0-1	Qrs	Sand, silt, mud, gravel; residual soil	Quaternary
1-6	DCcd	Chert, jasper, mudstone, siltstone, lithic sandstone, tuff, limestone and altered basalt.	Devonian - Carboniferous
6-8	Qa	Clay, silt, sand, gravel; floodplain alluvium	Quaternary
8-15	DCy (with occurrence of Qa)	DCy – Interbedded sandstone and siltstone, dacitic to rhyolitic volcaniclastic conglomerate with rip-up clasts; moderate to high magnetic domain. Qa – As above.	Devonian – Carboniferous
15-17	Cr	Dark grey mudstone and siltstone; felsic volcaniclastic sandstone; ooid-bearing sandstone; ooid-bearing conglomerate with dark grey mudstone rip-up clasts; rounded polymictic conglomerate; oolitic limestone	Carboniferous
17-18	Qa	As above	Quaternary
18-19	Cr	As above	Carboniferous
19-20	Cr with abrupt change to DCa	Cr – Above DCa – Thinly interbedded fine-grained sandstone and siltstone and thick beds of conglomerate with andesitic to dacitic volcanic clasts and siltstone rip-up clasts.	Carboniferous to Devonian - Carboniferous

Gladstone 1:100 000 Geological Special 9150 & Part 9151 (NRM, 2001) – from HLA, 2007.

While no surface rock outcrops were encountered during the field work for the ecological surveys, the potential for shallow rock to occur between KP1-6 in association with the Doonside Formation.

3.3.1.3 Soils

A summary of the land systems that are traversed by the proposed alignment is provided in Table 3-5.

Table 3-5 : Land System Mapping Descriptions

Approx KP	Land System[1]	Description
0-1	Fanside[1]	Undulating footslopes and rises on sedimentary rocks. Red, structure gradational clay loams, and uniform clays. Red duplex soils.
1-6	Rundle[1]	Steep to rolling hills on steeply dipping sedimentary rocks. Shallow stony brown and black massive loams and clay loams.
6-8	Sleipner[1]	Undulating footslopes and rises, and gently undulating fans below hills on intermediate and acid volcanic rocks, and small areas of granitic rocks. Bleached loamy and clay loamy surface, brown and grey, alkaline sodic duplex soils.
8-10	Rundle[1]	As above
10-13	Nagoorin[1]	Undulating to rolling hills and fans on fine-grained sedimentary rocks and unconsolidated sediments. Bleached clay loamy and silty surface, brown and grey alkaline sodic duplex soils.
13-14	Nulgi[1]	Broad, level to gently undulating alluvial plains on silty and fine textured alluvium. Bleached silty surface, brown and grey, alkaline sodic duplex soils.
14-16	Carrara[1]	Undulating to low rolling hills and rises on sedimentary rocks, Shallow brown and black, massive loams and clay loams, bleached sandy and loamy surface, brown and grey, alkaline sodic duplex soils.
16-18	Nulgi[1]	Broad, level to gently undulating alluvial plains on silty and fine textured alluvium. Bleached silty surface, brown and grey, alkaline sodic duplex soils.
18-19	Carrara[1]	As above
19-20	Wycheproof[1]	Undulating to rolling hills and rises on sedimentary rocks and greenstone, saline outbreaks on lower slopes and drainage flats. Shallow, stony, brown and black, massive loams and clay loams. Shallow, red and brown, structured gradational clay loams.

1. Land Systems of the Capricornia Coast. 1:250,000 Map 3 – Calliope Area (NRM, 1995) from HLA, 2007.

Shallow rocky soils may occur in association with the Rundle land system (KP 1-6 and 8-10).

Based on a review of the soil analysis previously completed and documented within the Gladstone Nickel Project EIS and review of desktop information of the alternate pipeline route, the following key issues have been identified (refer to Appendix 1 for additional details):

- Soil sodicity will be variable over the pipeline route, ranging from non-sodic at the refinery site and first 5km of the route, to sodic and strongly sodic soils at the RSF site.
- Approximately 13km of the pipeline route has been identified as having moderate-high susceptibility to erosion, with erosion most likely to occur at KP 5-9, KP 18 & KP19.
- Soil salinity will be variable (low to moderate) over the pipeline route.

3.3.1.4 Good Quality Agricultural Land

A review of agricultural land class mapping for the Calliope Shire Council has identified that approximately 20% of the alignment traverses agricultural land classed as Good Quality Agricultural Land (GQAL) (refer to Appendix 1 for additional details). As the majority of the pipeline alignment is located within the Gladstone State Development Area (GSDA) and within road reserves, it is not considered that the buried pipeline will inhibit farming practices of the development area in the long term.

3.3.1.5 Contamination

The pipeline alignment crosses road and rail ways at various points (refer to section 3.2.4) where hydrocarbon contamination, and herbicide residues associated with weed control, may be present. Where asbestos brake linings have been used on trains, dust and fibres from these can accumulate in the soil adjacent to tracks. The likelihood of other forms of contamination being present (such as coal fines and poly-aromatic hydrocarbons) is low. No other sources of contamination were observed during fieldwork undertaken by HLA ENSR in August 2007.

3.3.2 Potential Impacts and Mitigation

Potential terrain and soil impacts are associated with the construction phase only. Construction activities which have the potential to impact on the soils and terrain of the project area include:

- Pipeline route clearing and excavation activities;
- Development of additional access tracks;
- Establishment and operation of any construction work areas; and
- Refuelling of construction equipment.

Potential impacts may include:

- Soil erosion and sedimentation;
- Loss of / disturbance to topsoil; and
- Soil contamination.

The pipeline route has been selected to avoid or minimise impacts associated with land and terrain constrains. The implementation of appropriate control measures during construction will ensure that any impacts are of a temporary nature and limited to the immediate construction area.

A comprehensive program to manage impacts to soil was documented in Section 7.2 of the Gladstone Nickel Project EIS and will apply to this alternate residue pipeline route. Refer also to the control measures documented in the draft Pipeline EMP, which is contained as an Appendix of the EIS Supplement.

3.4 FLORA

An assessment of the ecological characteristics of the route was completed by HLA Envirosciences Pty Ltd. The assessment was completed through a desktop study of additional digital and hardcopy special data and field assessment of the proposed pipeline. A summary of the outcome of this assessment is provided in the following section. Refer to Appendix 2 for full copy of the assessment

3.4.1 Description of Environmental Values

3.4.1.1 Vegetation Communities / Regional Ecosystems

The field survey identified 9 Regional Ecosystems (RE's) either transacted or immediately adjacent to the proposed pipeline route. These generally corresponded to the Environmental Protection Agency's (EPA's) RE mapping, however there were some differences (refer to Appendix 2 for additional information). The location of RE's recorded during the field study, including description and legislative status, is summarised in Table 3-6.

Table 3-6 : Vegetation Communities and Regional Ecosystems

Vegetation Communities/REs		Status		Approx KP	Approx length intersected (km)
		EPBC	VMA		
11.3.4	*Eucalyptus tereticornis* and/or E. *camaldulensis* tall woodland on alluvial plains.	-	OC	13.2-13.4 14.5-14.6 14.9-15.0	0.3
11.3.11	Semi-evergreen vine thicket on alluvial plains	E	E	12.8-12.9	0.1
11.3.26	*Eucalyptus moluccana* or *E. microcarpa* woodland to open forest on margins of alluvial plains.	-	N	12.5-12.8 12.9-13.2 13.4-14.5 15.0-15.2 17.4-17.5	1
11.11.3	*Corymbia citriodora, Eucalyptus crebra, E. acmenoides* open forest on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges	-	N	8.7-9.3 9.4-12.5 (with 11.11.4) 15.6-17.4 (with 11.11.15)	5.3 (2.9 with 11.1.4 & 1.8 with 11.11.5)
11.11.4	*Eucalyptus crebra woodland* on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges	-	N	9.4-12.5 (with 11.11.3) 18.0-18.9	4 (2.9 with 11.11.3)
11.11.15	*Eucalyptus crebra* woodland on deformed and metamorphosed sediments and interbedded volcanics. Undulating plains	-	N	14.6-14.9 15.6-17.4 (with 11.11.3)	2.1 (1.8 with 11.11.3)
11.11.18	Semi-evergreen vine thicket on old sedimentary rocks with varying degrees of metamorphism and folding. Lowlands.	E	E	8.15-8.3	0.15
12.11.6	*Corymbia citriodora, Eucalyptus crebra* open forest on metamorphics ± interbedded volcanics	-	N	2.8-4.2	1.4
12.11.14	*Eucalyptus crebra, E. tereticornis* woodland on metamorphic+/- interbedded volcanics.	-	OC	4.4-4.8	0.4

E = Endangered; OC = Of Concern; N = Not of Concern under the *Vegetation Management Act (VMA)*

Commonwealth Endangered Ecological Communities

The proposed route may potentially impact on two communities regarded as Endangered under the EPBC Act (refer to Figure 3-3). EPA mapping indicates that the proposed residue pipeline transects and / or lies adjacent to one mapped area of Endangered RE from KP 8.7-12.5. This mixed polygon is reported to contain 5% of the Endangered vine thicket community, RE 11.11.18, which is also endangered at a Commonwealth level.

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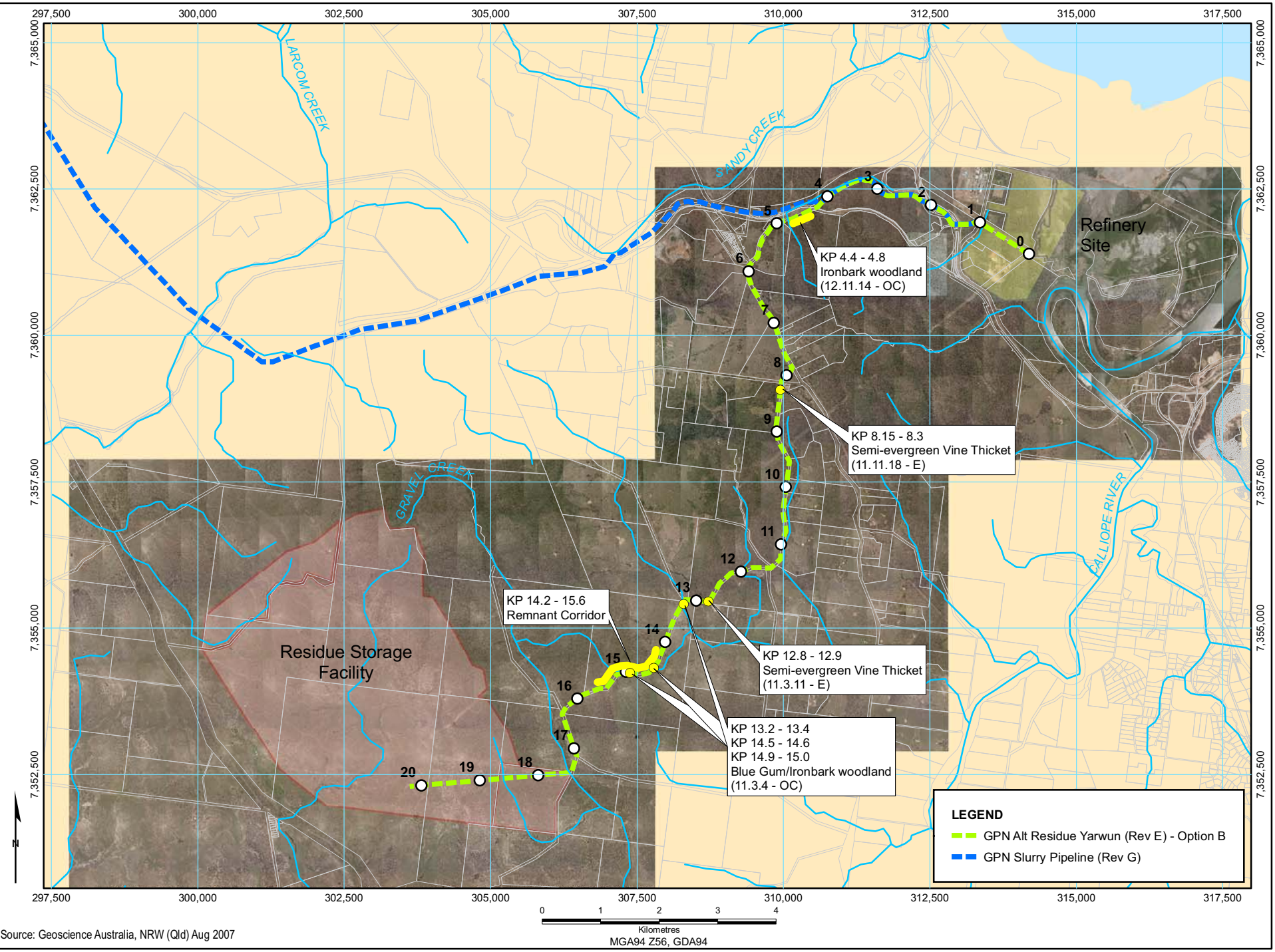
Drawn: RLMS | Approved: KD | Date: 28/11/2007
Job No: 00011122 | File No: Ecology.mxd

Title: FIGURE 3-3 ECOLOGICAL CONSTRAINTS

Rev: A4



Source: Geoscience Australia, NRW (Qld) Aug 2007

This RE was not recorded in proximity to the corridor along this section of the alignment, although a small patch was detected at KP 8.15-8.3. This community is located within the road reserve, to the west of the existing cleared area and extends into the adjoining property.

A small patch of endangered semi-evergreen vine thicket on alluvial plains (RE11.3.11), which is also endangered at a Commonwealth level, was also identified within the north eastern side of Boyles Road reserve at KP 12.8-12.9, in association with a small creek. The patch is approximately 0.8ha and extends into the adjoining property.

Regional Ecosystems

The proposed pipe route does may potentially impact on two regional ecosystems listed as 'Endangered' under the *Vegetation Management Act 1999*. In addition, two REs transacted by the proposed route are listed as “Of Concern” (refer to Figure 3-3); and five are listed as “Not of Concern” (refer to Table 3-6).

3.4.1.2 Protected Vegetation

Database searches identified a total of 25 EVR flora species that may occur in the broader study area (refer to Appendix 2). The field survey recorded preferred habitat for 10 of these EVR species, but targeted surveys failed to detect any EVR species. The ecological assessment concluded that it was unlikely that significant populations of any EVR species occur along the alignment, although the existence of populations could not be ruled out as not all remnant vegetation was examined.

3.4.1.3 Regionally Significant Flora

The only regionally significant species identified in literature searches for the broader study area is *Graptophyllum spinigerum,* although targeted surveys during the field assessment did not detect any *Graptophyllum* species.

3.4.1.4 Declared Weeds

Four weed species declared under the *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act) were recorded during the field survey. These include:

- Lantana (*Lantana camara*) - Class 3;
- Creeping Lantana (*Lantana montevidensis*) - Class 3
- Rubber Vine (*Cryptostegia grandiflora*) - Class 2; and
- Prickly Pear (*Opuntia stricta*) - Class 2.

Under the *LP(P&SR) Act*, pest species for both plants and animals are classified into 3 categories:

- **Class 1 species:** not generally established in Queensland and has potential to cause adverse economic, environmental or social impact. The landowner is obliged to take reasonable steps to keep their land free of Class 1 pest species, unless the owner holds a declared pest permit allowing the pests to be kept on the land.
- **Class 2 species:** established in Queensland and can cause significant adverse economical, environmental or social impact. The landowner is obliged to take reasonable steps to keep their land free of Class 2 pest species, unless the owner holds a declared pest permit allowing the pests to be kept on the land.
- **Class 3 species:** established in Queensland and has or could have adverse economical, environmental or social impact. Legislative obligations relating to control of these species are generally limited to specific conservation areas.

Several environmental weeds that may prove troublesome during rehabilitation works were also noted during the field survey and included :

- Thatch Grass (*Hyparrhenia rufa*);
- Guinea Grass (Megathyrsus maximus);
- Sabi Grass (Urochloa mosambicensis)
- Corky Passionfruit (*Passiflora suberosa*); and
- Coral Berry (*Rivina humilis*).

3.4.2 Potential Impacts and Mitigation

The primary impacts on vegetation communities as a result of construction and operation of the project pipelines are considered to be:

Vegetation Loss – as a result of clearing for the pipeline easement

Fragmentation of habitat – as a result of clearing for the pipeline easement through patches of remnant woodland and grassland.

Edge effects –clearing for the pipeline within areas of remnant vegetation increasing the boundary to area ratio of remnant vegetation communities traversed by the pipeline and therefore increasing the potential for edge effects.

Spread of pathogens – due to the movement of vehicles and construction machinery along the pipeline route and the disturbance of topsoil during the construction phase.

These potential impacts were discussed further in Section 7.4.11 of the Gladstone Nickel Project EIS.

3.4.2.1 Remnant Vegetation

The proposed pipeline route crosses a number of patches of remnant vegetation, which are provided some level of protection under the VMA. The proposed pipeline corridor transects or lies immediately adjacent to 11.15 km of remnant vegetation, including 0.25 km of Endangered RE, 0.8 km of Of Concern RE and 10.1 km of Not of Concern RE.

A very conservative approach has been taken to calculate the area of clearing of remnant vegetation required, as the pipeline alignment within the road reserve has not been finalised. It is estimated that the maximum width of clearing to enable the construction of the pipeline and relevant traffic control measures will be 30m. Assuming all of this length was fully vegetated and required clearing to the full 30 m width, a total of 33.45 ha of remnant vegetation would be cleared. This is considered to be the worst case. On this basis, the required clearing for each RE, compared to the total extent of the RE within a 10km buffer is presented in Table 3-7. Based on these calculations, this represents approximately 0.46% of the total area of these RE's within the 10km buffer.

The actual extent of clearing of remnant vegetation will be substantially less than 33.45 ha as approximately 7km of the pipeline route will be contained within wholly or partially cleared road (from approximately KP 8.2-13.2 and KP 14.4-16.4). This comprises 5.75 km of the total 11.15 km of remnant vegetation along the corridor. For example, if it is assumed that approximately 50% of the area required for construction in this area is already cleared, the total clearing required for a 30 m corridor along the alignment would drop to approximately 23.6 ha. In addition, in constrained areas and sensitive areas, the width of the clearing will be reduced, which would further reduce the extent of clearing of remnant vegetation.

Table 3-7 : Estimated Clearing of Remnant Vegetation

Vegetation Communities/REs		Est. Area to be cleared (ha)	Est. Area within 10km wide buffer (ha)	% Of Area Cleared
Endangered				
11.3.11	Semi-evergreen vine thicket on alluvial plains	0.4	36.9	1.08
11.11.18	Semi-evergreen vine thicket on old sedimentary rocks with varying degrees of metamorphism and folding. Lowlands.	0.45	390.8	0.12
Of Concern				
11.3.4	Eucalyptus tereticornis and/or E. camaldulensis tall woodland on alluvial plains.	1.2	247.5	0.48
12.11.14	Eucalyptus crebra, E. tereticornis woodland on metamorphic+/- interbedded volcanics.	1.2	244.7	0.49
Not of Concern				
11.3.26	Eucalyptus moluccana or E. microcarpa woodland to open forest on margins of alluvial plains.	6.0	1 120	0.54

Vegetation Communities/REs		Est. Area to be cleared (ha)	Est. Area within 10km wide buffer (ha)	% Of Area Cleared
11.11.3	Corymbia citriodora, Eucalyptus crebra, E. acmenoides open forest on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges	9.3	270.4	3.4
11.11.4	Eucalyptus crebra woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges	7.2	1 167	0.62
11.11.15	Eucalyptus crebra woodland on deformed and metamorphosed sediments and interbedded volcanics. Undulating plains	3.6	908.2	0.40
12.11.6	Corymbia citriodora, Eucalyptus crebra open forest on metamorphics ± interbedded volcanics	4.2	2 921	0.14

As outlined in Section 3.4.1.1, the two occurrences of semi-evergreen vine thicket occurs on the western/northern side of the road reserve and could be avoided by locating the pipeline on the opposite side of the road. While the alignment of the pipeline has not been finalised, the location of the SVI are considered to be a constraint and the pipeline and construction area will be designed minimise disturbance to these two communities.

The proposed clearing through Eucalypt Woodland (RE 11.3.4) is associated with minor watercourses and while the potential disturbance will be minimised, it is not possible to avoid disturbance to these communities.

The proposed alignment through Eucalypt Woodland (RE 12.11.14) at KP 4.4-4.8 follows the edge of the GSDA services corridor however, the concentration of infrastructure within the corridor limits any opportunities to avoid this vegetation.

Once the pipeline has been constructed, vegetation will be able to re-establish over all but the area immediately over the pipelines (due to the need to protect the pipeline integrity from damage from tree roots). As such, subject the landholder's property management practises (including Calliope Shire Council in regards to the road reserve), it is expected that over the medium term (10-50 years) significant portions of the pipeline construction footprint will naturally regenerate. For example, if 15 of the construction clearing width is allowed to regenerate, it is possible that the cleared areas identified in this report, as being required for pipeline construction, will be reduced by up to 70% within 10-50 years.

The pipeline is likely to be decommissioned within several decades. Subject to the exception that landholders may, at that future time, choose to manage their properties in a manner that inhibits natural regrowth, the impacts associated with clearing for construction and maintenance of the pipeline are considered to be reversible within all RE's.

The clearing of remnant vegetation associated with the proposed pipeline will require a Clearing Permit from the Department of Natural Resources and Water. GPNL will be making application for the clearing subsequent to the EIS process, once the pipeline alignment has been confirmed. The application will address the requirements of the relevant Vegetation Clearing Code, including proposals for offsets where required.

3.4.2.2 Spread of Weeds

Without appropriate mitigation measures, there is the potential for the Project to spread declared and environmental weeds along the alignment. This potential relates particularly to the movement of vehicles and construction machinery along the pipeline route and the disturbance of topsoil during the construction phase.

The Calliope Shire Councils has developed Weed/Pest Management Plans for the Shire, which contains details regarding priority activities to control weeds within the Shire and procedures for weed control. GPNL will consult with representatives from Local Authorities with respect the development of specific weeds controls for the construction of the pipeline and post construction activities and ensure that plans are consistent with Local Plans.

3.4.2.3 Proposed Mitigation Measures

Measures to minimise impacts to vegetation during pipeline construction were discussed in Section 7.4.12 of the Gladstone Nickel Project EIS and are presented in Section 4.1.5 of the draft Pipeline EMP (refer to an Appendix of the EIS Supplement). In addition, measures specific to the residue pipeline route are detailed below.

General

- Restrict disturbance to the 30m (max) Right of Way (ROW) and designated work areas;

Remnant Vegetation

- Finalise the pipeline alignment to avoid clearing of semi-evergreen remnant vegetation (KP 8.15-8.3 and 12.8-12.9) as far as possible.
- The location and final clearing boundaries at these locations will be clearly marked on construction maps and in the field.

3.5 FAUNA

3.5.1 Description of Environmental Values

3.5.1.1 Terrestrial Fauna and Fauna Habitat

A review of fauna databases identified a large number of fauna species that have been recorded from, or that may potentially utilise habitat, within the wider area. A total of 581 fauna species were identified, comprising 17 butterflies, 61 fish, 25 amphibians, 104 reptiles, 287 birds and 83 mammals.

Listed EVR species are defined as those taxa listed in the Commonwealth *Environmental Protection and Biodiversity Conservation Act* (EPBC Act) or the *Nature Conservation Act* (NC Act) as critically endangered, endangered, vulnerable or rare.

Regionally significant fauna were also identified from species identified by the Brigalow Belt South Fauna Expert Panel (EPA 2003b) as non-EVR priority taxa for the Brigalow Belt Bioregion and/or had been listed in a relevant Action Plan for the specific taxonomic groups including butterflies, freshwater fishes, frogs, reptiles, birds, monotremes and marsupials, bats and rodents.

Based on field habitat assessments and RE mapping, seven broad habitat types were identified as present within the proposed corridors and these are summarised in Table 3-8.

Table 3-8 : Broad Fauna Habitat

Fauna Habitat	Description	Approx. KPs
Riparian Woodland	Queensland Blue Gum (*Eucalyptus tereticornis*) woodland on broad alluvial plains, generally with a sparse grassy understorey. Other eucalypts may be present. Corresponds to RE 11.3.4.	13.2-13.4 14.5-14.6 14.9-15.0
Fringing Riparian Open Forest	Fringing open forest along creeks dominated by Queensland Blue Gum, Narrow-leaved Red Ironbark (*E. crebra*) and Moreton Bay Ash (*Corymbia tessellaris*). The lower layers may be dense and floristically diverse. Corresponds to RE 11.3.25 and gullies within Eucalypt Woodland on hills.	4.3, 10.9, 12.0, 12.9, 14.9
Lemon-scented Gum and Ironbark Woodland on hills	Lemon-scented Gum (*Corymbia citriodora*) and Narrow-leaved Red Ironbark woodland on hills and lowlands. Other Eucalypts may be locally prominent and the understorey quite dense in patches. Corresponds to REs 11.11.3, 11.11.4, 11.11.15, 12.11.6 and 12.11.14.	2.8-4.2, 4.4-4.8 8.7-9.3, 9.4-12.5 14.6-14.9, 15.6-17.4 18.0-18.9
Eucalypt Woodland with Semi-evergreen Vine Thicket understorey.	Eucalypt woodland on hills and lowlands with an understorey approaching a semi-evergreen vine thicket structure and composition. Corresponds to RE 11.11.18 and 11.3.11.	8.15-8.3
Farm Dam	Constructed dam within drainage line. Little to no aquatic plants or fringing vegetation. Does not correspond to any RE.	
Cleared land and non-remnant vegetation	Land cleared or mostly cleared of trees and other woody vegetation, for agriculture such as grazing or crops. Often includes occasional scattered 'paddock' trees, remaining as individuals or small stands.	Remainder

Fauna Habitat	Description	Approx. KPs
Gum-topped Box woodland	Gum-topped Box (*Eucalyptus moluccana*) woodland on alluvial plains, generally with a grassy understorey. Corresponds to RE 11.3.26.	12.5-12.8 12.9-13.2 13.4-14.5 15.0-15.2 17.4-17.5

EVR Fauna Species

A review of fauna databases for the wider area of the pipeline identified the potential presence of 48 EVR fauna species listed under the EPBC Act and / or NC Act as having previously been recorded from the wider study area or have geographic ranges that overlap the wider study area. These include 1 invertebrate, 1 fish, 15 reptiles, 21 birds and 10 mammals. Of these species, 21 are listed under both the EPBC Act and NC ACT, 4 are listed under the EPBC Act only and 23 are listed under the NC Act only (refer to Appendix 2 for additional details).

Based solely on the desktop review of habitat preference, 13 of these 48 listed EVR species may potentially utilise habitats within the pipeline corridor. A full listing of EVR fauna species, together with their preferred habitat and an indication as to whether the habitat is present within the proposed alignment is contained within Appendix 2. No EVR fauna species were recorded along the pipeline alignment during the field assessment.

Other Fauna Species of Conservation Significance

A further 71 fauna species of Regional Significance were identified as potentially occurring along the proposed alignment, including 2 fish, 10 frogs, 13 reptiles, 19 birds and 26 mammals. Based solely on the desktop review of habitat preference, 57 of these 71 Regionally Significant species could potentially utilise habitats within the proposed alignments.

Four Regionally Significant fauna species were recorded along the proposed alignments, including the Copper-backed Broodfrog (*Pseudophyrne raveni*), Fine-spotted Mulch Skink (*Glaphyromorphus punctulatus*), Australian Bustard (*Ardeotis australis*) and Barking Owl (*Ninox connivens*).

An additional 113 bird species listed under the EPBC Act as Migratory and / or Marine protected species were identified as previously recorded from the wider study area, or with geographic ranges that overlap the wider study area. Fifty-one of these were listed as both Migratory and Marine Protected species and 36 as Marine only.

Based solely on the desktop review of habitat preference, 53 of these 113 listed Migratory and / or Marine protected species could potentially utilise habitats within the proposed alignments (refer to Appendix 2 for additional information).

3.5.2 Potential Impacts and Mitigation Measures

General Fauna Impacts

The key potential impacts to fauna as a result of the construction and operation of the pipelines was discussed in Section 7.5.8 of the Gladstone Nickel Project EIS. Issues specifically related to this pipeline route include:

- **Removal of habitat** such as mature vegetation, hollow-bearing trees and fallen logs, and therefore loss of nesting, perching and foraging resources.

  Clearing for the proposed pipeline is not considered to be a significant impact on local fauna populations, including EVR fauna species. Although up to 33.5 ha of remnant vegetation may be cleared, the route generally traverses the edge of remnant vegetation patches or within disturbed infrastructure corridors (e.g. railway easements, road reserves, power line easements). Therefore, clearing for the pipeline within many areas may be limited to previously disturbed areas and is unlikely to significantly impact on fauna or contribute to habitat fragmentation.

  In general, there is a low density of hollow-bearing trees within surveyed sites along the proposed alignment corridor with most observed within riparian vegetation and within the State Forest. The density of small fallen logs and dead timber within the proposed pipeline varies

considerably depending upon age of vegetation, land management practices and fire regime. However, large fallen logs and dead timber are scarce at most sites sampled during the field survey and absent altogether in others. .

- **Disturbance to seasonal and permanent wetland habitats**.

  The proposed alignments occur within the catchment of the Port Curtis Wetlands, which are listed in the Directory of Important Wetlands in Australia. A number of EVR bird species that are potentially present within the proposed alignment are reliant on these wetlands as habitat (e.g. Australian Painted Snipe and Cotton Pygmy-Goose), as are a wide range of protected Migratory and Marine birds. These EVR birds utilise rank vegetation (rushes, sedges and grasses) around the edge of wetlands as habitat.

  Apart from riparian areas, the only wetlands observed during the surveys were associated with small farm dams. These dams may provide seasonal habitat for a range of amphibians and waterbirds and provide an important water source during the dry season.

  Provided sediment control measures are appropriately impacted, it is considered unlikely that the pipeline will significantly impact on the wetland species.

- **Disturbance to fauna movement corridors and dry season fauna refuges**.

  The various watercourses transacted by the alignment and their associated riparian vegetation are important movement corridors and refugia for a range of fauna, assisting dispersal of populations and persistence in a dry and fragmented landscape. Another potential movement corridor follows the proposed alignment along the road reserve from 13.2-15.6, which contains the only remaining remnant vegetation within a large expanse of cleared pasture and may allow highly mobile species to move between the large blocks of remnant vegetation to the north and south. The adjoining landholder is not agreeable to the location of the pipeline within the private property, hence this section of vegetation cannot be avoided.

- **Unearthing of burrowing fauna species during construction**.

  A broad range of burrowing fauna including frogs, lizards, snakes and small mammals are potentially present along the entire length of the alignment. EVR species vulnerable to being unearthed include small reptiles such as Ornamental Snake and Brigalow Scaly-foot.

- **Trench fall** - the potential for fauna to fall into and become trapped in the open pipeline trench during construction.

Impact to Significant Fauna

Thirteen EVR species have been identified as potentially occurring within the proposed alignments. Of these, seven species are considered to be highly mobile species (EPA, 2004) and are unlikely to be significantly impacted by the construction of the residue pipeline. The remaining six species may be impacted by the proposed construction works in the form of habitat loss (i.e. mature vegetation, shelter), loss of foraging resources and / or trench fall (refer to Table 3-9 and refer to Appendix 2 for more details).

Table 3-9 : Significant Fauna Potentially Impacted

Common Name	Scientific Name	Ecology and Preferred Habitats	Potential Impacts
Reptiles			
Short-necked Worm Skink	Anomalopus brevicollis	Burrowing skink, dependent on rocks, logs and ground debris for shelter. Recorded in Gladstone area and potentially present in riparian woodland and vine thickets.	Habitat loss (vegetation, logs), trench fall.
Brigalow Scaly-foot	Paradelma orientalis	Eucalypt woodland, usually found under logs and debris. Also found climbing on rough Acacia trees. Potentially present within remnant vegetation along the alignment.	Habitat loss (vegetation, logs),

Common Name	Scientific Name	Ecology and Preferred Habitats	Potential Impacts
Yakka Skink	Egernia rugosa	Ground-dwelling, reliant on logs and ground debris for shelter. Widespread but rare, potentially present in eucalypt woodland, particularly in rocky areas.	Habitat loss (vegetation, ground debris), trench fall
Birds			
Black-breasted Button-quail	Turnix melanogaster	Semi-evergreen vine thickets with deep litter and lantana thickets adjacent to vine thickets. Potentially present in vine thickets along Boyle's Road.	Habitat loss (shelter, foraging resources)
Mammals			
Large-eared Pied Bat	Chalinolobus dwyeri	Dry forests and woodlands, moist eucalypt forests, caves and mine. No roosting sites for this species occur within the proposed residue pipeline.	Habitat loss (foraging resources)
Northern Quoll	Dasyurus hallacatus	Most abundant in rocky Eucalypt Woodland but occurs in a range of vegetation types. Potentially present along the alignment.	Habitat loss (vegetation), trench fall

Mitigation Measures

Measures to minimise impacts to fauna during pipeline construction were discussed in Section 7.5.9 of the Gladstone Nickel Project EIS and are presented in Section 4.1.5 of the draft Pipeline EMP (refer to an Appendix of the EIS Supplement). In addition, measures specific to the residue pipeline route are detailed in Table 3-10.

Table 3-10 : Mitigation Measures

Relevant KP	Issue	Mitigation and Rehabilitation
Full route	Removal of mature vegetation	Within all remnant vegetation and fauna habitats, minimise the area of clearance to the minimum width required to safely construct the pipeline.
Full route	Fauna trapped in the open pipeline trench	Trenching will occur progressively to minimise the period of time the trench is open and the length of open trench. Construction will be planned where practicable to take place in the coolest and driest months (i.e. May to September), when reptiles and amphibians are least active and when conditions are most favourable for minimising mortality in the trench. The open trench will be surveyed on a daily basis by qualified fauna spotters and handlers. Ramps and trench plugs with slopes of no greater than 50% (APIA, 2005) will be located at least every 500m to assist escape for some species. Cool insulated covers will be installed in the trench at regular intervals, as well as higher platforms where there is the potential for accumulation of water within the trench.
Full route	Clearing of hollow-bearing trees	Clearing of trees that contain hollows will be avoided wherever practicable. Where such trees cannot be retained the hollow will be left on the ground adjacent to the cleared corridor, subject to landholder consent, to provide habitat for ground-dwelling fauna.
Full Route	Construction near wetland and within catchment	Installation of sediment and erosion control measures (refer to Section X of the Pipeline EMP).
Full route, in particular KP 10.3-11.5, 13.4 & 17.5	Fringing riparian vegetation along watercourses	Pipeline will be aligned to cross watercourses with fringing riparian at right angles to minimise the distance transected. Clearing widths will be limited to the minimum practicable within this habitat and the route aligned to avoid mature trees with hollows as far as possible.
KP 8.2 & KP 12.8	Semi-evergreen vine thicket vegetation, which provides habitat for EVR species such as Black-breasted Button-quail and Short-necked Worm Skink	Align the pipeline route to avoid clearing of patches of vine thicket as far as possible.

Relevant KP	Issue	Mitigation and Rehabilitation
Full route	Revegetating corridor (post construction)	Logs, hollows and dead timber will be spread across disturbed areas within woodland habitats (subject to landholder consent) to facilitate small ground fauna movement.

3.6 AIR

The environmental values of the general project area were described in Sections 7.6, 8.7 and 9.12 of the Gladstone Nickel Project EIS. There are a number of residences located within 50m of the proposed pipeline route along Calliope River Road (KP 5-8), which may be sensitive to potential air impacts (refer to Figure 3-4).

Based on proposed construction activities and the types of plant likely to be required for construction of the pipelines, the key activities with the potential to impact on the air quality of the project area are:

- Construction earthworks, including stripping, trench excavation, backfilling and rehabilitation – fugitive dust emissions;
- Movement of construction vehicles on unsealed tracks and roads – fugitive dust emissions; and
- Exhaust emissions from vehicles – gaseous emissions.

The construction earthworks and associated vehicle movements are likely to generate dust that may become a temporary nuisance in dry, windy weather conditions. The potential impacts from dust generation during the construction period are not considered to have a significant long term nuisance or ecological impact due to the temporary nature of the activities and the availability of a range of effective dust control measures.

Exhaust emissions from vehicles associated with pipelines construction are considered to be of negligible significance in terms of environmental impacts due to the relative low number of movements when compared to total road traffic in the area.

GPNL will liaise closely with landholders potentially impacted during construction with regards to site specific mitigation measures. Refer also to Section 4.1.1 of the draft Pipeline EMP (Attachment of the EIS Supplement) for mitigation measure to minimise adverse impacts associated with air emissions.

3.7 NOISE

The environmental values of the general project area were described in Sections 7.7, 8.8 and 9.13 of the Gladstone Nickel Project EIS.

Potential adverse noise impacts are associated with the construction phase only. The primary construction activities with the potential to cause adverse noise impacts include:

- Traffic movements associated with construction equipment and delivery of pipe and associated construction materials;
- Blasting in rocky areas (if required);
- Boring of major road crossings.

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Title: FIGURE 3-4 STRUCTURES

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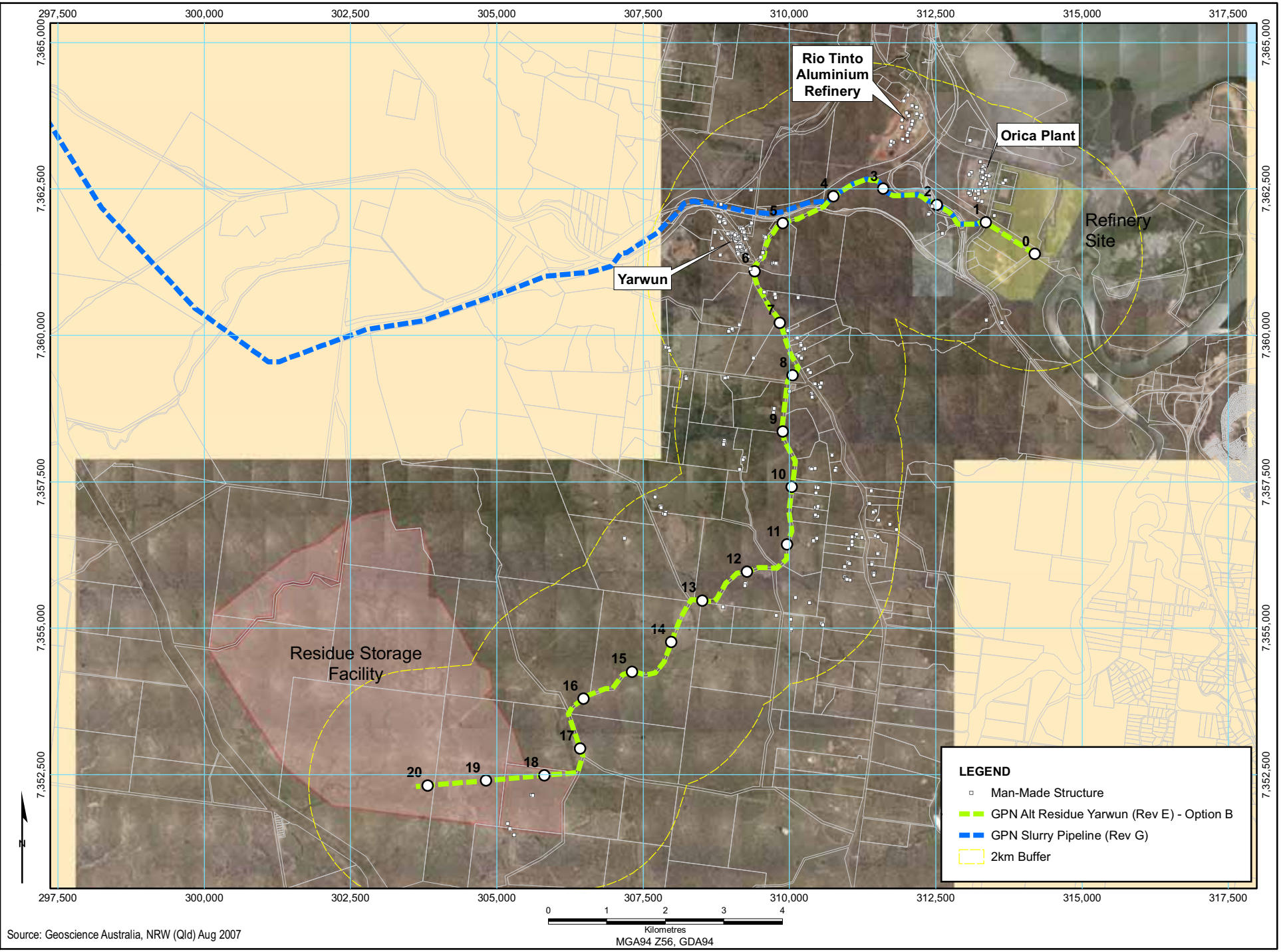

Source: Geoscience Australia, NRW (Qld) Aug 2007

Blasting activities also have the potential to cause adverse vibration impacts associated with blast pressure.

Pipeline construction activities will result in a temporary increase in noise levels within the immediate vicinity of the construction activity (refer to Section 7.7 of the GPN EIS for additional information). Noise sensitive receptors located within 500m of the proposed pipeline route are illustrated in Figure 3-4. The most significantly impacted residences will be those located along Calliope River Road (KP 5-8), where some houses are located within 50m of the proposed route.

As construction activities are continually moving forward along the pipeline route, the duration of these noise levels will be short term at a given location. However, GPNL undertakes to liaise GPNL will liaise closely with landholders within close proximity to the proposed route regards to site specific mitigation measures. Noise associated with traffic accessing the construction location will be short term as access routes will change as pipeline construction proceeds into new areas.

Initial assessment of the route indicates that potential blasting or drilling locations are not associated with populated areas, however this will be confirmed during the detailed design phase of the project upon completion of a detailed geotechnical assessment of the route.

Refer also to Section 4.1.3 of the draft Pipeline EMP (refer to an Attachment of the EIS Supplement) for mitigation measure to minimise adverse impacts associated with noise emissions.

3.8 HAZARD AND RISK

A preliminary risk assessment for the pipeline aspects of the project, including the residue pipeline, has been completed and was addressed in Section 7.8 of the Gladstone Nickel Project EIS. Although the pipeline alignment of the residue pipelines has changed, the outcome of the risk assessment is considered to still apply to the alternate route.

Further information related to the risks associated with the operation of the pipelines associated with the Gladstone Nickel Project, including residue pipelines, is also contained in the EIS Supplement.

3.9 CULTURAL HERITAGE

The proposed pipeline route is located within an area included in the PCCC native title claim (QC01/29). A Cultural Heritage Management Plan (CHMP) for the Gladstone Nickel Project has been agreed with the PCCC and was signed on March 15, 2007 and approved by the Department of Natural Resources and Water in May 2007 under the Aboriginal Cultural Heritage Act 2003. Arrangements are in place for a Cultural Heritage Survey to be carried out on the alternate residue pipeline route.

4 COMMUNITY CONSULTATION

GPNL has implemented a community consultation program for the Gladstone Nickel Project and this was documented in Section 12 of the Gladstone Nickel Project EIS. The following section provides a summary of the consultation that has been completed in relation to the alternate residue pipeline route, which has been consistent with the program documented within the EIS.

4.1 STAKEHOLDER IDENTIFICATION

Stakeholder groups identified during the EIS process were broadly categorised into the following groups:

- Communities and businesses from Gladstone and the surrounding area
- Local Councils
- State and Commonwealth government departments
- Environmental and community groups
- Property Owners
- Indigenous groups and traditional owners
- Federal and State elected representatives
- Regional business, development, industry organisations and individual businesses
- Media

While no additional stakeholder groups have been identified in association with the alternate residue pipeline, GPN have identified additional property owners and neighbouring landholders as having an interest in the project.

4.2 CONSULTATION

A summary of the consultation completed in regards to the alternate residue pipeline route, the consultation methodology and outcomes is provided in Table 4-1.

Table 4-1: Consultation Completed

Stakeholder	Consultation	Outcome
Yarwun Community	Presentation on the outcome of the Gladstone Nickel Project EIS including alternate route under consideration for the residue pipelines	Undertook to provide additional information and maps on the proposed route
	Presentation of modifications to project (Nov 07) and key issues for Yarwun residents including alternate pipeline route.	
Landholders Impacted by proposed route	Personal contact (where possible) to explain the proposal and proposed route. Mail out of individual property maps to landholders.	Landholders were generally not agreeable to the proposal to locate the pipelines on private property and the route was realigned to maximise use of road reserves.
Environmental Protection Agency	Meeting to discuss potential for route to traverse the Mt Stowe State Forest and Calliope Conservation Reserve.	EPA indicated that they preferred, to the fullest extent practicable, for infrastructure to be located outside of these areas. The overland route was then discounted and a feasibility study of drilling under this area was commissioned.
Department of Infrastructure	Ongoing consultation regarding the project and alternates being considered for the residue pipelines.	
Calliope Shire Council	Personal contact and provision of a proposal document in regards to use of Council road reserves.	Initial concern expressed from Council with preference for pipeline to follow state infrastructure corridor
Department of Natural Resources and Water	Meeting to discuss vegetation clearing, including clearing associated with the alternate residue pipeline route.	No major issues. DNRW highlighted that Vegetation Clearing Permits will be required and that GPNL will need to provide a proposal for offsets where the clearing is inconsistent with the relevant Vegetation Clearing Codes.

4.3 ONGOING CONSULTATION

As more detailed design of the residue slurry pipeline is developed the following consultation steps will be engaged:

- Discussion of engineering details and reasoning with Calliope Shire Council (or amalgamated shire council).
- Contact with mining and petroleum tenure holders to advise them of the location of the proposed route, request information regarding existing or proposed infrastructure and identify any potential issues.
- Formal request for Calliope Shire approval.
- Approvals to be sought from Department of Natural Resources and Water for remnant vegetation clearance and agreements on offsets.
- Newsletter and information updates to Yarwun community.
- Pre-construction activities – community advice as to planning for construction and measures to be taken to reduce likely disruption to community.
- Construction activities – community updates and consultation on issues raised during construction.
- Post-construction – ongoing overall GNP consultation and issues management.

5 LAND USE, PLANNING AND ENVIRONMENTAL APPROVALS

5.1 ENVIRONMENTAL IMPACT ASSESSMENT

The residue and return liquor pipelines from part of the Gladstone Nickel Project, which has been declared a "significant project" under the Qld *State Development and Public Works Organisation Act (SDPWO Act),* for which an Environmental Impact Statement is required.

The Gladstone Nickel Project has also been declared a "controlled action" pursuant to Section 75 of the Commonwealth *Environment Protection and Biodiversity Conservation Act (EPBC Act),* and is being assessed under the EPBC Act via the bilateral agreement between the Commonwealth and Queensland Governments, which recognises the process under the SDPWO Act as an appropriate process pursuant to Section 87 of the EPBC Act.

The EIS for the Gladstone Nickel Project was released for public comment in April 2007, which included a description of the proposed alternate route for the residue pipelines, and a commitment to undertake further studies should this option be pursued.

This report has now been prepared for inclusion in the Supplementary EIS, which will be provided to both State government agencies and the Commonwealth Department of Environment and Water to enable the alternate pipeline route to be incorporated into the overall project approval. Refer to Section 1.8 of the Gladstone Nickel Project EIS for additional information regarding this process.

5.2 LAND USE PLANNING

5.2.1 Gladstone State Development Area

The first 5km of the residue pipelines are contained within the Gladstone State Development Area (GSDA). Land use approvals within the GSDA are managed by the Coordinator General (CoG) under the provisions of the GSDA Development Scheme, through a "material change of use" process.

The GSDA Development Scheme has been prepared in accordance with the provisions of the SDPWO Act. The CoG is the assessment manager for development applications under the Development Scheme.

The portion of the pipeline contained within the GSDA is located within the Yarwun and Materials Transportation and Services Corridor Precincts of the GSDA. Under the GSDA Development Scheme, the proposed pipelines fit the description of "materials transport infrastructure'.

Under Schedule 1 of the Scheme, "materials transport infrastructure" are considered uses *"highly likely to meet the purpose of the land use designation"* within the Yarwun and Materials Transportation and Services Corridor Precincts.

Refer to Section 10.12.1 for of the Gladstone Nickel Project EIS for additional information in regards to this process.

5.2.2 Calliope Shire Council

The remainder of the residue pipelines are contained an area zoned as "rural" under the Calliope Shire Council Planning Scheme. As such, an application for a material change to the Calliope Shire Council will be required for the section of the pipelines not contained within the GSDA, in accordance with the Integrated Development Assessment Scheme (IDAS).

The IDAS process normally requires referrals to be made to individual referral agencies. However, since the EIS process is under the SDPWO Act, this referral process has been undertaken as part of the SDPWO Act assessment process. After the Coordinator General's assessment report has been received by the proponent, the required development application will be lodged for development approval.

5.3 OTHER PRE-CONSTRUCTION LAND AND ENVIRONMENTAL APPROVALS

A summary of the relevant legislation, policies and approvals relevant to the project was presented in Section 1.9 and Section 10 of the Gladstone Nickel Project EIS. Additional approvals that will be applicable to the alternate residue pipeline route will include:

- Permit to clear vegetation under the *Vegetation Management Act 1999;*
- Approval for ancillary works and encroachments under the *Transport Infrastructure Act 1994;*
- Riverine Protection Permit under the *Water Act 2000* ;
- Approval to undertake operational work within electricity easements in favour of a transmission entity under the *Electricity Act 1994;*
- Permit for the alteration or improvement of a road, under local law 21 Local Government Act 1993.
- Negotiated easement under the Land Act for the pipeline route located on freehold land.

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HLA-Envirosciences Pty Limited (HLA ENSR), 2007. Supplementary Soil, Geology and Topography Report – Gladstone Nickel Project Alternate Residue Pipelines.

URS, 2007. Gladstone Nickel Project Environmental Impact Statement. Prepared for Gladstone Pacific Nickel.

Appendix 1

Supplementary Soil, Geology and Topography Report – Gladstone Nickel Project Alternate Residue Pipelines
HLA Envirosciences Pty Ltd

Supplementary Soil, Geology and Topography Report Gladstone Pacific Nickel Project Alternate Residue Pipelines

4 December 2007

Prepared for:
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DISTRIBUTION

Supplementary Soil, Geology, and Topography Report
Gladstone Pacific Nickel Project Alternate Residue Pipelines
4 December 2007

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EXECUTIVE SUMMARY

The soil, geological resources and topography of the proposed alignment for the alternate route residue and residue return pipelines were assessed by HLA ENSR. This desktop assessment was based on available digital and hardcopy spatial data including topographic maps, geological maps and land systems maps. These were used as surrogate soil maps as there is limited existing soil mapping data for the project area. Where available, data was derived from more detailed field surveys in the general vicinity. The proposed alignment extends approximately 20 km in length. The features along the alignment are described in relation to Kilometre Points or (KPs).

The proposed easement is dominated by the following landforms:

- Undulating to rolling hills, rises and fans on sedimentary rocks and unconsolidated sediments – constituting approximately 35% of the alignment;
- Areas of steep to rolling hills on steeply dipping sedimentary rocks – constituting approximately 35% of the alignment;
- Broad, level to gently undulating alluvial plains – constituting approximately 15% of the alignment. Alluvial plains are associated with Oaky Creek and Gravel Creek;
- Undulating footslopes and rises, and gently undulating fans below hills on intermediate and acid volcanic rocks – constituting approximately 10% of the alignment; and
- Undulating footslopes and rises on sedimentary rocks – constituting approximately 5% of the alignment.

Elevation ranges from around 12 mAHD, in the vicinity of KP 0, to 60 mAHD in the vicinity of KP 20. Approximately 2.5 km of the alignment traverses slopes greater than 5% (< 10%).

The alignment encounters Early Carboniferous geology of the Rockhampton Group and Late-Devonian – Early Carboniferous geology of the Doonside Formation, part of the Curtis Island Group. These groups are overlain by Quaternary alluvium and residual sediments both within and adjoining the drainage depressions intersected by the alignment.

Quaternary alluvium is encountered for approximately 31% of the pipeline alignment. The alluvium, consisting of unconsolidated clays, silts, sands and gravels, is associated with tributaries of the Calliope River, including Gravel Creek and Oaky Creek; as well as Boat Creek and an unnamed stream near KP 4.

Gladstone lies on the northern edge of what appears to be a high seismicity belt stretching from Brisbane to Gladstone.

The proposed alignment crosses a number of significant faults in the following approximate locations: KP0, KP6, KP7, KP13, KP20. These faults may be susceptible to movement due to increased seismicity in parts of the study area.

No surface rock outcrops were encountered along the proposed alignment during site visits (for flora and fauna) undertaken by HLA ENSR in August 2007.

Land system mapping provides the generalised soil data used in this study. The proposed pipeline alignment traverses seven types of mapped land systems. Soils include red duplex soils, massive soils, alkaline sodic duplex soils, massive soils and structured gradational soils. Soils are likely to vary in depth, texture and erodibility over the length of the alignment.
In general, acid sulphate soils (ASS) are commonly found in coastal areas below 5 mAHD. In this case, the proposed easement does not transect land that is below 5 mAHD, the elevation below which further ASS investigation would be required.

Based on previous studies in the vicinity of the alignment, topsoil thickness are likely to vary along the length of the pipeline, with an average depth of approximately 30 cm. Prescriptions for the removal, stockpiling and replacement of topsoil are provided.

Available erodible soils mapping has enabled the identification of areas most susceptible to soil erosion along the proposed alignment. This information, in conjunction with slope analysis, enabled the delineation of the areas that, with disturbance, are most susceptible to erosion. These areas include approximate KP 5 to KP9 and in the vicinity of both KP 18 and KP 19. These areas will require particular attention in terms of soil erosion and sediment control measures in order to prevent soil degradation.

Soil sampling undertaken as part of various projects across the broader study area indicate soil sodicity to be highly variable. A number of land systems that the alignment will traverse have soils described as alkaline sodic duplex soils. Sodic soils are unlikely to be encountered where the alignment enters the Refinery site. Sodic soils are likely to be encountered where the alignment enters the Residue Storage Facility (RSF) site.

The review of Good Quality Agricultural Land (GQAL) mapping indicates that approximately 20% of land traversed by the proposed alignment is classified as GQAL. The rest of the land is deemed to be non-agricultural land and not suitable for agricultural uses due to steep slopes, shallow soils, rock outcrops or poor drainage.

No sites of chemical contamination were observed during the limited field investigations undertaken; however, the following potential sources were identified:

- Domestic and agricultural waste dumps on rural land; and
- Hydrocarbon and pesticide contamination from road and railway crossings.

The major potential impact of the proposed works on soils is initiation or exacerbation of soil erosion, in particular gully and tunnel erosion and disturbance of stream banks. A detailed set of mitigation recommendations are proposed to ameliorate such potential impacts.

In summary, construction and post-construction mitigation recommendations include:

- Stripping the topsoil and stockpiling separately from the subsoil and vegetation. Following pipe emplacement and backfilling with subsoil, topsoil should be respread over the subsoil and left slightly rough to provide a suitable seed bed. Revegetation should be undertaken as soon as possible after topsoil spreading;
- Construction of contour banks on moderate to steep slopes should be undertaken;
- Any disturbance to GQAL should be rehabilitated as quickly as possible and productivity of the land affected returned, as near as is practicable, to its pre-disturbance levels;

- Construction practices that reduce soil erosion and sedimentation should be adopted (e.g. erosion banks, sediment trapping devices etc.);
- In woodland areas, timber should be respread on slopes, on the contour, to assist with soil stabilisation / restoration and to prevent trail bikes and 4WD vehicles accessing the easement in these vulnerable areas;
- A range of drainage management techniques should be implemented for waterway crossings;
- The construction methods should reduce the exposure periods for non-vegetated areas and undertake revegetation as soon as practical after construction; and
- Should contaminated soils be identified during construction, a range of measures is prescribed to deal with this issue.

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1 INTRODUCTION

Gladstone Pacific Nickel Limited (GPN) released the Environmental Impact Statement (EIS) for the Gladstone Nickel Project in April 2007. Included in the EIS was an assessment of the proposed parallel slurry and seawater pipelines operating between the mine at Marlborough and the Yarwun Refinery near Gladstone, and the residue and residue return pipelines operating between the Refinery and Residue Storage Facility (RSF).

Subsequent to the EIS, GPN have identified an alternate route for the residue and residue return pipelines (approximately 20km). As a result, an environmental assessment of the alternate residue pipeline route is required to enable this option to be included in the Supplementary EIS.

HLA-Envirosciences Pty Limited (HLA ENSR) was commissioned by RLMS to undertake desktop geology, soils and landform assessments for the proposed alternate route residue and residue return pipeline alignment extending from the Refinery to the RSF (**Figure F1**). The soil, geological resources and topography of this additional proposed alignment were assessed by HLA ENSR. The results of the assessment were used as a basis for predicting possible impacts, identifying potential issues and subsequently, strategies for management and rehabilitation were devised.

The soils occurring along the proposed alignment have been broadly mapped and classified as part of various soil surveys and Land Resource studies undertaken in the past. These maps and the digital data derived from them, in combination with data derived from more detailed field surveys in the general vicinity, form the basis of the soils mapping and interpretation presented in this report.

The features along the alignment are described in relation to Kilometre Points (KPs). All KP references in this report are based on the Revision E Alignment. (**Figure F1**)

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2 SCOPE OF WORKS

The scope of works of this desktop assessment is as follows:

- Describe the topography of the additional alignment corridor;
- Describe the geology of the additional alignment corridor and identify geological hazards and features which may impact construction, or be impacted by construction;
- Describe the soils of the additional alignment corridor;
- Determine the soils' susceptibility to erosion, based on previous studies and observed surface erosion features of the soil;
- Identify sites which may contain contaminated materials or acid sulfate soils;
- Determine areas where near-surface rock will require specific management during restoration so that it will not degrade the land use;
- Identify local soil management practices in cropping / grazing areas, areas of Good Quality Agricultural Land (GQAL) and areas susceptible to erosion;
- Identify key constraints for construction; and
- Provide a report on the findings.

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3 METHOD

The desktop assessment was based on available digital and hardcopy spatial data including the following resources:

- Topographic maps;
- Geological maps;
- Land system (soils) mapping; and
- A digital elevation model.

The major topographic and geological features of the proposed additional pipeline alignment were identified. Topography was assessed using a combination of topographic mapping and the available land system mapping. Landforms and slopes were assessed in the context of potential instability and engineering constraints.

The assessment of the geology of the project area, including structural geology, was based on the published 1:100,000 scale Gladstone Geological Special sheet 9150 and Part 9151 (NRM, 2001) and the 1:100,000 scale Gladstone Geological sheet 9151 (QDM, 1988). Seismic activity data for the region was gained from earthquake mapping of the Gladstone region available from the Queensland University Advanced Centre for Earthquake Studies.

Soils mapping was derived from the Land Systems of the Capricornia Coast. 1:250,000 Map 3 – Calliope Area (NRM, 1995).

The same land system mapping also formed the basis of the GQAL classification. Acid sulphate soil (ASS) information was obtained from elevation contour mapping and ASS indicative mapping (Ross, 2004) and recent investigations undertaken by URS (2006).

The Queensland Universal Soil Loss Equation (USLE) K-factor data were used to identify soils that are susceptible to erosion. The K-factor data, at 1:250,000, is based on the function of particle size, soil structure and permeability. The K-factor data are based on the existing land system mapping. These data, used in conjunction with slope, identify areas where erosion is most likely to occur.

The results of soil testing in the broader area were derived from the following sources;

- HLA Envirosciences, 2006. *Soil, Geology and Topography Report: Gladstone Pacific Nickel Project Slurry Pipeline (ref: B60099001_Soil_RPTFinalRev01_17Aug06), August*;
- URS, 2007. *Gladstone Nickel Project Environmental Impact Statement*. Prepared on behalf of Gladstone Pacific Nickel Limited.

Figure F2 and **Attachment A** indicate the location of soil survey sites associated with previous investigations.

The general erosion potential for each site was determined by a combination of field observation of erosional features and the results of soil sodicity analyses and Emerson Aggregate Tests conducted as part of previous studies.

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4 TOPOGRAPHY

The topography of the pipeline alignment is shown in **Figure F3**. The proposed pipeline was sited to avoid major hills and slopes. The area is dominated by the following landforms:

- Undulating to rolling hills, rises and fans on sedimentary rocks and unconsolidated sediments – constituting approximately 35% of the alignment;
- Areas of steep to rolling hills on steeply dipping sedimentary rocks – constituting approximately 35% of the alignment;
- Broad, level to gently undulating alluvial plains – constituting approximately 15% of the alignment. Alluvial plains are associated with Oaky Creek and Gravel Creek (**Figure F3**);
- Undulating footslopes and rises, and gently undulating fans below hills on intermediate and acid volcanic rocks – constituting approximately 10% of the alignment; and
- Undulating footslopes and rises on sedimentary rocks – constituting approximately 5% of the alignment.

The maximum elevation is approximately 60 mAHD in the vicinity of KP 20 on the southern edge of the RSF. The lowest elevation is at KP 0 on the residual soils of the GPN Refinery site at approximately 12 mAHD.

A longitudinal cross-section of the surface elevation for the proposed pipeline alignment is presented in **Figure F3**. (Note that the topographic profile is necessarily exaggerated relative to the x-axis and gives the impression of steeper slopes than those that actually occur).

A slope analysis was undertaken to classify slopes along the pipeline based on the 25 m digital elevation model. The resulting slope classes are shown in **Figure F4**. The sections of the pipeline that traverse terrain of slopes greater than or equal to 5% are provided in **Table 1**. Landforms are classified according to McDonald *et al*. (1990).

Table 1: Alignment Slope Analysis

Approximate KP	Landform	Slope
KP 5-6	Simple slope	5-10%
Around KP 7	Simple slope	5-10%
Around KP 9	Simple slope	5-10%
Around KP10	Lower slope	5-10%
Around KP 18	Lower slope	5-10%
Around KP 19	Simple slope	5-10%

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5 GEOLOGY

Reference to the geology of this area is based on information from published maps (NRM, 2001; DM, 1988).

The alignment encounters Early Carboniferous geology of the Rockhampton Group and Late-Devonian - Early Carboniferous geology of the Doonside Formation, part of the Curtis Island Group. The geology of the Late Paleozoic comprises sediments including sandstones, mudstones, limestone and calcareous sandstones and conglomerate of marine shelf origin with felsic to basaltic volcanics. This Late Paleozoic geological succession is overlain by Quaternary alluvium and residual sediments both within and adjoining the drainage depressions intersected by the alignment.

The geology of the proposed pipeline alignment is presented in plan view in **Figure F5**. Table 2 describes the geology traversed by the proposed alignment.

Table 2: Geology Descriptions of the Pipeline Alignment

Approx KP	Geological Unit[1]	Description[1]	Age
0-1	Qrs	Sand, silt, mud, gravel; residual soil	Quaternary
1-6	DCcd	Chert, jasper, mudstone, siltstone, lithic sandstone, tuff, limestone and altered basalt.	Devonian - Carboniferous
6-8	Qa	Clay, silt, sand, gravel; floodplain alluvium	Quaternary
8-15	DCy (with occurrence of Qa)	DCy – Interbedded sandstone and siltstone, dacitic to rhyolitic volcaniclastic conglomerate with rip-up clasts; moderate to high magnetic domain. Qa – As above.	Devonian – Carboniferous
15-17	Cr	Dark grey mudstone and siltstone; felsic volcaniclastic sandstone; ooid-bearing sandstone; ooid-bearing conglomerate with dark grey mudstone rip-up clasts; rounded polymictic conglomerate; oolitic limestone	Carboniferous
17-18	Qa	As above	Quaternary
18-19	Cr	As above	Carboniferous
19-20	Cr with abrupt change to DCa	Cr – Above DCa – Thinly interbedded fine-grained sandstone and siltstone and thick beds of conglomerate with andesitic to dacitic volcanic clasts and siltstone rip-up clasts.	Carboniferous to Devonian - Carboniferous

1. Gladstone 1:100 000 Geological Special 9150 & Part 9151 (NRM, 2001).

Quaternary alluvium is encountered for approximately 31% of the pipeline alignment. The alluvium, consisting of unconsolidated clays, silts, sands and gravels, is associated with tributaries of the Calliope River including Gravel Creek and Oaky Creek; as well as Boat Creek and another unnamed stream that directs surface flows directly into The Narrows (associated with Port Curtis).

The pipeline alignment crosses a number of geological unit boundaries as well as following river drainage lines where possible. Two major fault lines are intersected by the pipeline alignment: the Ambrose Fault at the western end of the alignment (approx. KP 20) and the Yarrol Fault at the eastern half of the alignment (approx. KP7). The Abrose Fault is a major basin thrust fault

separating the Older (Late Devonian) Mount Alma Formation sediments and volcanics from the from the younger (early Carboniferous) Rockhampton Group marine sediments.

Another unnamed thrust fault system intersected by the alignment (approx KP 13) marks the boundary between the Calliope Beds (Silurian age) and Yarwun beds. This fault lies between the Ambrose and Yarwun fault systems.

5.1 Surface Rock

No surface rock outcrops were encountered along the alternate residue pipelines route during fieldwork (for flora and fauna) undertaken by HLA ENSR in August 2007.

6 LAND SYSTEM SOILS

Land System mapping is presented in **Figure F6**. Table 3 describes the mapped land systems that are traversed by the proposed alignment.

Table 3: Land System Mapping Descriptions

Approx KP	Land System[1]	Description
0-1	Fanside[1]	Undulating footslopes and rises on sedimentary rocks. Red, structure gradational clay loams, and uniform clays. Red duplex soils.
1-6	Rundle[1]	Steep to rolling hills on steeply dipping sedimentary rocks. Shallow stony brown and black massive loams and clay loams.
6-8	Sleipner[1]	Undulating footslopes and rises, and gently undulating fans below hills on intermediate and acid volcanic rocks, and small areas of granitic rocks. Bleached loamy and clay loamy surface, brown and grey, alkaline sodic duplex soils.
8-10	Rundle[1]	As above
10-13	Nagoorin[1]	Undulating to rolling hills and fans on fine-grained sedimentary rocks and unconsolidated sediments. Bleached clay loamy and silty surface, brown and grey alkaline sodic duplex soils.
13-14	Nulgi[1]	Broad, level to gently undulating alluvial plains on silty and fine textured alluvium. Bleached silty surface, brown and grey, alkaline sodic duplex soils.
14-16	Carrara[1]	Undulating to low rolling hills and rises on sedimentary rocks, Shallow brown and black, massive loams and clay loams, bleached sandy and loamy surface, brown and grey, alkaline sodic duplex soils.
16-18	Nulgi[1]	Broad, level to gently undulating alluvial plains on silty and fine textured alluvium. Bleached silty surface, brown and grey, alkaline sodic duplex soils.
18-19	Carrara[1]	As above
19-20	Wycheproof[1]	Undulating to rolling hills and rises on sedimentary rocks and greenstone, saline outbreaks on lower slopes and drainage flats. Shallow, stony, brown and black, massive loams and clay loams. Shallow, red and brown, structured gradational clay loams.

1. Land Systems of the Capricornia Coast. 1:250,000 Map 3 – Calliope Area (NRM, 1995).

6.1 Acid Sulfate Soils (ASS)

Acid sulfate soils (ASS) are the common name given to soils containing iron sulfides. Normally, the iron sulfides are contained in a layer of waterlogged soil developed in intertidal areas of the coastal plain. This layer can range in texture from clay to sand and is usually dark grey and soft. While remaining waterlogged the water limits oxygen in the air reacting with the iron sulfides. This layer is commonly known as potential acid sulfate soil (PASS) because it has the potential to oxidise to sulfuric acid when exposed to air. Oxidation of PASS can cause damage to the environment and ecosystems. Actual acid sulfate soils (AASS) are soils in which some oxidation of sulfides has already occurred and are characterised by a low soil pH.

In general, ASS are commonly found in coastal tidal areas below 5 mAHD.

In this case, the proposed alignment does not transect land that is below 5 mAHD, the elevation below which further ASS investigation would be required. The pipeline avoids areas mapped as indicative for ASS according to the 1:50 000 ASS mapping (**Figure F7**) for the Tannum Sands - Gladstone area (Ross, 2004).

6.2 Sodic Soils and Dispersion

Sodicity is a measure of the proportion of sodium ions present in a soil. Sodic soils can be a problem during excavation and rehabilitation. The clay is easily dispersed, the soil structure collapses when wet, soils pores are blocked, and dense surface crusting and impermeable horizons develop.

Sodicity is measured as the exchangeable sodium percentage:

$$ESP = \text{Exchangeable Na} / CEC$$

General ratings for sodicity established by Northcote and Skene (1972) are as follows:

- Non-sodic ESP < 6%;
- Sodic ESP 6-14%;
- Strongly Sodic ESP >14-25%; and
- Very Strongly Sodic ESP >25%.

Soil sampling undertaken by HLA ENSR for the GPN slurry pipeline alignment in February 2006 found soil sodicity to be highly variable along the alignment and that non-sodic soils were dominant. Sampling undertaken in June 2006 along a former alignment option for the residual pipeline showed non-sodic conditions at each of the two sampling sites (SS45 and SS41) from which ESP was measured. One of these sites (SS41) is intersected by the current alignment option (Revision E alignment) at its eastern end (**Figure F2**).

Soil sampling undertaken by URS across the Refinery site (and reported in the GPN EIS, 2007) indicated sodic Kurosols in the lower lying areas of the north-east quadrant of the site and non-sodic Kandosols (soil types 4.1 and 4.2) across the majority of the site and extending to the west, from where the Additional Residue Pipelines will enter the Refinery site (**Attachment A**).

Soil sampling undertaken across the RSF site and reported in the GPN EIS indicates that the subsoil B1 and deeper subsoil B2 and B-C horizons in soil types 6.2 (Mottled Yellow-Brown

Sodosols) and 7.2 (Vertic Sodic Brown-Black Dermosols) are sodic or strongly sodic (URS, 2007) (**Attachment A**).

A number of land systems that the alignment will traverse have soils described as alkaline sodic duplex soils. These landsystems include:

- Sleipner;
- Nagoorin
- Nulgi; and
- Carrara.

6.3 Erosion Potential

USLE mapping (NRM, 2002) has been used for broad-scale mapping of soils susceptible to erosion. The K-factor mapping (that is a classification of erodibility of soils) is shown in **Figure F8** for the project area. The mapping shows that the susceptibility of soils to erosion along the alignment ranges from moderate-low to moderate-high. Approximately 13 km of the alignment is identified as having soils with a moderate-high susceptibility to erosion (i.e. moderate-low erosion resistance).

Areas of sloping relief are more liable to erode where the natural vegetation is disturbed. The K-factor mapping, used in conjunction with a consideration of the areas with slopes greater than 5% indicates that erosion is most likely to occur at the following locations:

- KP 5-9;
- Around KP 18; and
- Around KP 19.

6.4 Bulldust

Bulldust formation is common in arid areas and is more likely to occur in soils with high calcium carbonate content. Bulldust will generate wind blown dust and cause dry bogging of vehicles and equipment. Once a soil turns to bulldust it is very difficult to manage. Grading the bulldust and returning it to the track, a little at a time, wetting it constantly has had some success. Following generation of bulldust final rehabilitation and revegetation is difficult because the soil structure has been destroyed.

No sites of bulldust occurrence were observed along the pipeline during field investigations undertaken by HLA ENSR in August 2007.

6.5 Salinity

Soil sampling undertaken by HLA ENSR for the GPN Slurry Pipeline alignment in February 2006 showed that laboratory electrical conductivity (EC) results on field samples ranged from 0.02 to 0.86 dS/m. Conversion of these results to EC of saturated extract (ECe) indicates a range from very low to moderately saline soils for the respective soil texture categories. Sampling undertaken in June 2006 along a former alignment option for the Residual Pipeline showed non-saline conditions at each of the three sampling sites (SS41, SS45, SS47) from which salinity was measured. One of these sites (SS41 is intersected by the current alignment option (Revision E alignment) at its eastern end (**Figure F2**).

Soil sampling undertaken across the Refinery site and reported in the GPN EIS indicates non-saline conditions throughout the profile of those Kandosols (soil types 4.1 and 4.2) found across the majority of the site and extending to the west, from where the Additional Residue Pipelines will enter the Refinery site.

Soil sampling undertaken across the RSF site and reported in the GNP EIS indicate low to moderate salinity levels in the subsoil (B2 and B-C horizons) of soil types 6.2 and 7.2 (URS, 2007) (**Attachment A**).

Moderate salinity may restrict the growth of moderately tolerant crops. If these soils were to be respread on the surface they may affect the growth of some pasture species. Native species tend to be more tolerant of moderate salinity levels. It is expected that salinity results increase with depth. Careful separation of topsoil and subsoil will prevent this from occurring.

6.6 Fertility

The capacity of a soil to hold the major cations calcium (Ca), magnesium (Mg), sodium (Na) and potassium (K) is a measure of the general fertility of the soil. This factor is known as the cation exchange capacity (CEC) and is a major controlling agent of stability of soil structure, nutrient availability for plant growth, soil pH, and the soil's reaction to fertilisers and other ameliorants. Low CEC is associated with low levels of phosphorus (P) and K, the primary indicators of fertility of a site.

Soil sampling undertaken by HLA ENSR for the GPN Slurry Pipeline alignment and Residual Pipeline alignments in February 2006 and June 2006 showed that CEC values ranged from 4.5 cmol(+)/kg (very low) to 23.1 cmol(+)/kg (moderate). The lowest CEC value was recorded for site SS41, which is intersected by the current alignment option (Revision E alignment) (**Figure F2**). Most Australian soils are nitrogen (N) and P deficient. Australian native vegetation is adapted to low N and P soils. Soils seeded with pasture species used in revegetation works can be ameliorated with NPK fertiliser.

7 GOOD QUALITY AGRICULTURAL LAND (GQAL) AND LAND SUITABILITY

For the purposes of implementing State Planning Policy 1/92 *Development and the Conservation of Agricultural Land* there is a need to identify areas of GQAL. GQAL is land that is capable of sustainable use for agriculture, with a reasonable level of inputs, and without causing degradation of land or other natural resources. Agricultural land is defined as land used for crop or animal production, but excluding intensive uses such as feedlots and piggeries. Four classes of agricultural land have been defined for Queensland as summarised in Table 4 (from *Planning Guidelines, The Identification of Good Quality Agricultural Land*, DHLGP, 1993).

Table 4: Description of Land Classes (Source: DHLGP, 1993)

Class	Description
A	**Crop Land** Land suitable for current and potential crops. Limitations to production range from minor up to moderate levels. There are 3 sub-classes of crop land: **A** – Land Suitable for plantation, tree and vine crops; **A1** – Crop land suitable for rainfed cropping; and **A2** – Crop land suitable for horticulture. All crop land is considered to be GQAL.
B	**Limited Crop Land** Land marginal for current and potential crops and suitable for pastures. Land that is marginal or unsuitable for most current and potential crops due to severe limitations. Further engineering and / or agronomic improvements may be required before land would be considered suitable for cropping. Land marginal for particular crops of local significance is considered to be GQAL.
C	**Pasture Land** Land suitable only for improved or native pastures. Limitations preclude continuous cultivation for crop production but some areas may tolerate a short period of ground disturbance for pasture establishment. In areas where pastoral industries are the major primary industry, land suitable for improved or high quality native pastures may be considered to be GQAL. There are 3 subclasses of pasture land: **C1** – Land suitable for sown pastures with moderate limitations; **C2** – Land suitable for sown pastures with severe limitations; and **C3** – Land suitable for light grazing of native pastures in inaccessible areas. Of these, only C1 is considered to be GQAL.
D	**Non-Agricultural Land** Land not suitable for agricultural uses. This may be undisturbed land with significant habitat, conservation and / or catchment values. Severe limitations preclude any interference with the land or biological resources for the production of agricultural goods.

Agricultural land class mapping for the Calliope Shire was used to identify areas of GQAL. The mapping sources were as follows:

- Agricultural Land Classes for the Calliope Shire - (http://tpscheme.dz1.calliope.qld.gov.au/Shared_Maps/Guide%20Line%20Map%201.pdf);
- Agricultural Land Classes for Central Queensland Coast Horticultural Lands Project - (http://tpscheme.dz1.calliope.qld.gov.au/Shared_Maps/Guide%20Line%20Map%202.pdf);

Accordingly, the identified GQAL for the length of the proposed alignment is outlined in Table 5.

Table 5:- GQAL Classifications for the Proposed Alignment

Approx KP	Land Class	GQAL (Y/N)?
0-1	A2	Y
1-2	Urban	N
2-5	C2	N
5-6	A	Y
6-7	C3	N
7-9	A	Y
9-13	C3	N
13-20	C2	N

Proportionally, only approximately 20% of the alignment traverses agricultural land classified as GQAL. The rest of the land is deemed to be non-agricultural land and not suitable for agricultural uses due to steep slopes, shallow soils, rock outcrops or poor drainage.

8 CONTAMINATED LAND

Observations and experience have been used to determine the likely presence of sources of contamination along the proposed alignment and these include:

- Many rural properties do not have access to waste collection services and waste is usually disposed on site. Wastes may include not only domestic waste, but also animal carcasses (and possibly pathogens), chemical containers and scrap (including asbestos sheeting). Burning of wastes, particularly treated or painted timber can also release heavy metals into the soil. There is potential for such tips to be encountered along the alignment;
- Rural pastoral properties may also have operational or abandoned animal dips, which contain pesticide residues and heavy metals; and
- The alignment crosses road and rail ways at various points (e.g. Mount Miller Road at approx. KP 2, Calliope River - Targinie Road from approx. KP 6 to KP 8, Boyles Road from approx. KP 8 to KP 13, and the railway line at approx. KP 1 to KP 2 and KP 4 to KP 6). Hydrocarbon contamination, and herbicide residues associated with weed control, may be a potential problem at such points. Where asbestos brake linings have been used on trains, dust and fibres from these can accumulate in the soil adjacent to tracks. The likelihood of other forms of contamination being present (such as coal fines and poly-aromatic hydrocarbons) is low;

No other sources of contamination were observed during fieldwork undertaken by HLA ENSR in August 2007.

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9 SEISMIC ACTIVITY

Gladstone lies on the northern edge of what appears to be a high seismicity belt stretching from Brisbane to Gladstone (QUAKES, http://quakes.earth.uq.edu.au).

A large earthquake of Richter magnitude 6.0 (instrumental estimate) struck about 135 km offshore Gladstone in 1918. Although the epicentre of the quake was offshore, it was felt from Mackay in the north to Grafton, NSW in the south, to Charleville in the west. Reported damage to infrastructure in the Rockhampton region included fallen chimneys, cracks in walls and broken windows. Minor damage was reported for Gladstone (Modified Mercalli Intensity of VI). Modified Mercalli Intensities of VII and VIII, which are capable of causing serious damage, were noted on Quaternary floodplain alluvium in the Rockhampton area (QUAKES, http://quakes.earth.uq.edu.au).

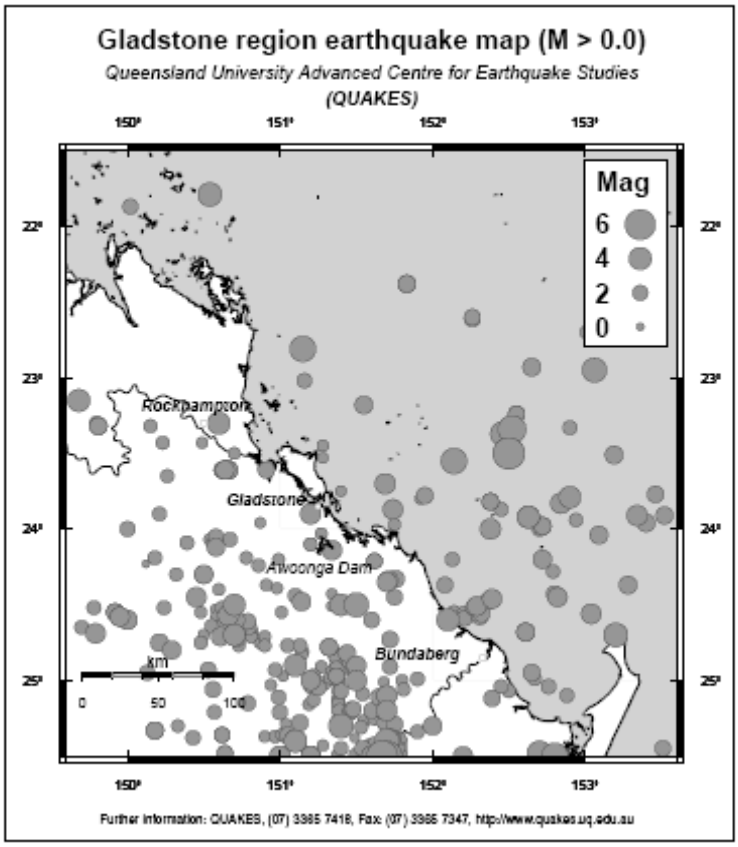

Figure F9: Gladstone Region Earthquake Map

The proposed alignment crosses the Yarrol Fault in the vicinity of KP 7 and a thrust fault known as the Ambrose Fault in the vicinity of KP 20. Thrust faults are formed by compressive stresses in which the angle of dip is very low and the upthrown block moves horizontally over the downthrown block. The thrust fault is confirmed by a sudden change in geology. The RSF is centred on the Ambrose Fault.

These faults may be susceptible to movement due to increased seismicity in this part of the study area.

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10 IMPACTS AND MITIGATION MANAGEMENT

10.1 Topsoil and Subsoil Management

In the majority of areas along the proposed alternate alignment, topsoil protects the potentially dispersible subsoils from erosion. Once stripped of topsoil, the subsoil is susceptible to sheet wash and gully erosion. The topsoil is therefore critical to erosion control and is also important for revegetation purposes and weed management.

Vegetation that is to be stripped should be stockpiled separately to soil stockpiles. There should also be a distinct break of at least 1 m between the vegetation and soil stockpiles.

The topsoil over the trench should be stripped to a depth of 20 - 25 cm depending on the soil type. On volcanic soils 20 cm of soil is suitable, on alluvial, colluvium and sedimentary derived soils, a thickness of 25 cm is suitable. In duplex soils (where there is a distinct texture and colour boundary between the topsoil and subsoil) the complete topsoil should be stripped and stockpiled (to a depth of up to 40 cm).

The topsoil and subsoil shall not be contaminated with welding stubs, general rubbish or any foreign material which might damage the pipe or coating or effect rehabilitation if allowed to become mixed with the soil materials.

The subsoil should be stockpiled separately from the topsoil. There should be a distance of at least 1 m between the topsoil and subsoil stockpiles such that there will be no blending of this material. This blending has the potential to occur in particular at a tie in or other bell hole sites where additional volumes of subsoil are removed. It also has the potential to occur following rain or in dispersible soils where trench collapse requires trench excavation of greater quantities of subsoil, leading to mixing with topsoil stockpiles. While reducing the easement width may be required for other environmental purposes it often is not best environmental practice. Provision of good widths (e.g. 25 m) provides ample room for stockpile separation which leads to better rehabilitation outcomes.

On hill slopes, soil should only be placed on the high side of the easement. Where cut and fill is required, topsoil should be placed in a temporary workspace. Stockpiles should not exceed 2 m in height and will have gaps left to coincide with fence lines, natural and constructed surface drainage lines, access tracks and every 50 m to allow for drainage and in some cases where trench plugs occur, to allow for stock and wildlife movement across the easement.

Clearing, grading and trenching work is to be undertaken promptly in channels, slopes and erosion prone areas. Clearing of slopes leading to watercourses shall be delayed until the construction of the crossing is imminent.

Soil should not to be placed within the immediate vicinity of a drainage line (at least 10 m from the bank) or against live trees. Soil stockpiles near drainage lines should be bounded with silt fencing on their down-slope side to contain the material in the case of rainfall.

If rocks are encountered during trenching they should be returned during backfill (with care not to damage the pipe or coating) or removed for erosion control rip rap or dumped in an approved location. Rocks respread on or just below the surface can greatly reduce the effect of final rehabilitation and they may need to be hand picked from the surface.

Topsoil should not be used for backfill or padding around the pipe or trench breakers. Suitable backfill material (certified weed and disease free) should be imported for this purpose if the subsoil cannot be made suitable. Displaced subsoil should be disposed of appropriately e.g.

stockpiled for use in repair of future subsidence. It is expected that in rocky areas where backfill material will be required, it may be necessary to remove some subsoil from site, rather than mounding up the easement with this excess material.

Topsoil application should only take place following respreading of all the subsoil, compaction and crown development over the trench for subsidence, deep ripping to relieve compaction over other parts of the easement and construction of contour banks on steep slopes and above the bank at water course crossings. Topsoil should then be evenly spread across the easement. Topsoil should not be compacted, but rather left slightly rough (in micro-relief) to provide a suitable seed bed and water retention. Revegetation should be undertaken as soon as possible after topsoil spreading. No vehicles should drive on the freshly topsoiled easement until vegetation is re-established.

10.2 Acid Sulfate Soils

ASS are unlikely to be disturbed by the proposed works.

10.3 Good Quality Agricultural Land

Approximately 20% of the land along the easement is suitable for arable or pastoral use. The installation of the pipeline and ancillary infrastructure has the potential to permanently degrade or alienate GQAL. GQAL is regarded as a finite resource and as such is protected through State Planning Policy 1/92. The Authority responsible for development approval is likely to consider whether an overriding need, in terms of benefit to the community, can be demonstrated for the development.

The construction of the pipeline should not inhibit farming practices over the easement on neighbouring land in the long term.

The final footprint will be narrow and provided that construction does not lead to accelerated erosion and degradation outside of the footprint, the actual area of land that will be temporarily affected is anticipated to be relatively small. Provided topsoils are properly managed, not mixed with subsoil and returned following construction (particularly within the areas specified in Table 5) land use over the pipeline can sustain both arable and pastoral uses.

Any disturbance should be rehabilitated as quickly as possible and productivity of the land affected returned, as near as is practicable, to its pre-disturbance levels. To this end the mitigation and management recommended in this report for soil management and erosion and sediment control should be adopted. Provided these recommendations are successfully implemented, GQAL along the easement should not be affected in the long term.

10.4 Erosion and Sediment Control

The environmental induction process must adequately cover the principles of least possible disturbance and appropriate methods of erosion and sediment control. Operators are to be trained and experienced in soil management, sediment and erosion control, contour bank construction and rehabilitation techniques.

Construction practices that reduce soil erosion and sedimentation should be adopted. Temporary and more permanent erosion control banks and sediment collection devices should be installed across slopes and in the vicinity of drainage lines along the easement as necessary.

Temporary sediment collection devices such as sediment fences should be constructed so that they are both wide enough and are correctly installed into the soil (no gaps between base of

fence and ground surface). They should be inspected on a regular basis and replaced where damaged (e.g. cattle have eaten them or rubbed up against the stakes). They should be checked following rainfall events and reinstated where required.

Care is to be taken where water is pumped and directed onto the ground as this area will be susceptible to erosion. This is relevant to creek crossings and hydrotest sites. Water shall be directed into stable heavily vegetated areas. If this does not occur at the site, a nest of straw bales covered with geofabric is to be developed at the site.

10.4.1 Slope management

Trench breakers (e.g. cement filled sandbags) should be installed at regular intervals on steep slopes and the approaches to watercourses to encourage groundwater seepage along the pipe trench to the surface.

The location of trench breakers should be marked prior to backfilling. Final diversion berms should be installed immediately down slope of the trench breaks so that seepage water will be diverted away from the easement.

On slopes, a series of earth banks should be installed every 20 – 70 m (depending on gradient and soil types) immediately following Clear and Grade. They should be re-instated when damaged (e.g. following flattening by traffic movement) until restoration when they are to be permanently established. These berms should be high enough to collect water but not so high that they are dangerous to drive over on steep slopes. In such instances, two layers high of sandbags may be used as an alternative as long as they are removed and replaced regularly. Banks should be constructed across the entire disturbed width of the working area. Water should be discharged onto undisturbed land on the down slope side of the easement to a stable, vegetated site. If no vegetation occurs, the discharge should be directed into a silt fence.

In woodland areas, timber should be respread on slopes, on the contour, to assist with soil stabilisation and restoration, and to prevent trail bikes and 4WD vehicles accessing the easement in these vulnerable areas.

10.4.2 Drainage line management

Clear and Grade crews should leave a 20 m buffer of vegetation adjacent to water course crossings until such time as a vehicle crossing is required. Then, vegetation should be cleared only for the temporary vehicle crossing, leaving the vegetation buffer on the trench side of the easement. Trees may be chain sawed and felled away from the watercourse and removed from the buffer but disturbance to the ground cover and root grubbing should not take place until the crossing is imminent.

Soil should be graded away from the watercourses. Where soil and vegetation stockpiles are required they should be placed away from the banks of watercourses (a minimum of 10 m outside the high bank). Silt fences should be erected on the down slope side of soil stockpiles, which occur on slopes leading to watercourses.

Mainline trenching activities should stop short of a watercourse to prevent silty trench water from entering the watercourse. Hard trench plugs (of width 3 m) should be left in place until the watercourse crossing has been initiated.

Where it is necessary to pump water around the watercourse crossing, the outlet water should not be directed onto the bed or bank of the drainage line, rather into dense vegetation or a nest of geofabric wrapped straw bales.

Temporary earth banks should be installed along the slope on approaches to watercourses immediately following Clear and Grade. These should be maintained until restoration, when permanent banks should be installed. The bank should extend beyond the easement edge, in a manner that results in runoff water being discharged to the down slope side of the pipeline to stable, preferably vegetated discharge sites. Silt fences should be installed at the outlet of diversion banks (of vegetation cover is poor) and near the base of the slope to prevent heavy rain and runoff resulting in siltation of the watercourse.

The majority of smaller drainage lines are ephemeral and are expected to be dry at the time of construction. If there is the possibility of flow returning during the construction period, adequately sized culverts should be installed in the crossing so as not to impede water flow and cause erosion and sedimentation of the watercourse. Structures developed for vehicles to cross water courses (pipes and rock) should be removed with care to remove all imported material and reduce sedimentation of the water system.

Where the original creek or riverbed had a surface layer of cobbles and coarse gravels, care should be taken to ensure that the material is replaced, or suitable imported comparable rock is spread over the disturbed area. If restoration does not replace the armour layer, failure can occur during a flood, a head cut can be initiated, bed lowering can occur and extensive bank collapse and gullying of tributaries can result. Watercourses elected for rock armour works should generally have banks prepared to a maximum slope of 2H:1V. Suitable rock used for this purpose is usually clean basalt gabion rock (100 - 250 mm). The rock should generally extend 2 m up the bank from the toe and across the creek bed. Rock armour should be placed to an average thickness of 300 mm and pressed into the soil base with an excavator.

During restoration, the river, creek or gully walls should be re-established to a stable slope consistent with the ‘natural’ slope on either side of the disturbed area. This shaping is to eliminate irregularities that would interfere with flows. Sheer banks will; however, need to be battered back. Following topsoil application, the banks should be immediately revegetated. The easement will attract cattle as a cleared area for watering. Stabilisation of these sites could be assisted by pushing riparian vegetation over the area to provide seedstock, to stabilise the area, and to render it inaccessible for cattle movement where practicable. In some instances it may be necessary to provide temporary fencing and at some sites to pin jute erosion matting over seed to assist with rehabilitation of the bank.

10.4.3 Ancillary facilities and access tracks

Erosion control measures should be implemented in the planning, installation and restoration of ancillary facilities. Topsoil management, management of runoff and careful restoration will be required for directional drill sites, compressor stations, mainline valves, scraper traps, cathodic protection ground beds and communication systems.

Upon completion of construction, temporary access tracks should be closed and rehabilitated to a condition compatible with the surrounding land use unless they are to be maintained by the landowner or Authority. Windrows are to be removed and contour ripping undertaken to relieve compaction and develop a suitable seedbed. Tracks should be reseeded with a suitable native grass or pasture mix.

10.4.4 Revegetation

Revegetation management is addressed in the Flora and Fauna Report.

10.4.5 Dust mitigation

The construction methods should aim to reduce the exposure periods for non-vegetated areas and undertake revegetation as soon as practical after construction. Contractors should avoid the use of access tracks to the easement that directly pass farm residences. Contractors should also keep a register of dust complaints and undertake corrective action-generally through spraying water from water trucks. A maximum speed limit should be imposed within the construction site to control dust.

It is generally recognised that heavy vehicles, which cut into the soil and pulverise it, cause the greatest amount of bulldust. Provision of access to the easement at regular intervals rather than forcing these trucks along the easement will assist in reducing the generation of bulldust.

Pipelines have managed bulldust in the past by designating the side of the easement as the access track for rubber tyred vehicles only (no track machinery). Tracks can be maintained nightly using water trucks and graders to maintain a crust on the top, which helps reduce dust from vehicles where necessary. In this situation, the track closest to the trench where track vehicles traverse is only watered just prior to welding.

A hydroscopic dust suppressant such as *Dustmag* (magnesium chloride based) may be added to the water trucks to help bind the soil together were necessary. While this is very expensive it reduces the need for constant watering. A biodegradable, salt-based preparation, it draws water from the air at night then the first vehicles on the easement in the morning act to compact the surface. The additive may only be required once (generally lasts 3 months) although repeat applications may be required in high use areas. Some watering may be required in extremely dry (less humid) periods.

Temporary vegetation (e.g. sterile cover crops such as Rye Corn or Japanese Millet) can be utilised to assist with the stabilisation of soil stockpiles and other exposed areas.

10.5 Contamination

If contaminated land is encountered during the construction phase there may be a risk to construction personnel and the wider public. There is also a risk that the release of contaminated material into the environment beyond the work area will cause environmental harm and / or affect public health.

The following mitigation measures should be carried out:

- Continue consultation with all landowners prior to construction to determine whether tips or dips are likely to occur within the easement;
- Areas of known or potential contamination should be avoided where possible or directional drilling or boring carried out where appropriate (such as for rail tracks). If areas cannot be avoided or drilling is inappropriate, site and contaminant specific management practices should be developed and adopted. This may involve a site investigation. The Queensland EPA will have to approve any management plan that is developed. If contaminated material must be removed from the work area, this will require the approval of the EPA; and

- All Operators should be made aware of potential contamination issues through the induction training process. Should suspect contamination be found during earthworks, work in that area should stop until a suitably qualified person has inspected the site and the hazard has been assessed and appropriate action taken.

Potential contamination from construction vehicles would be minimised through:

- Cleaning of plant and equipment prior to leaving the site;
- Not undertaking vehicle maintenance on site;
- Removing accidental spills of oil or other material;
- Undertaking refuelling only in designated bunded areas;
- Providing spill kits to contain spills; and
- Development of an emergency response plan to be implemented in the event of an accidental spill.

11 LIMITATIONS

This assessment of soil conditions along the pipeline is based on coarse resolution land system mapping and limited site observations undertaken as part of previous studies in the broader study area. There are subsequently limitations to the applicability of this assessment. Some features may be missed along the alignment, and soil conditions within a land system may vary considerably.

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