GLADSTONE NICKEL PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT

Acid Pipeline Route Environmental Assessment

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URS

Gladstone Pacific Nickel LTD

Gladstone Pacific Nickel Ltd

Gladstone Nickel Project
PAM Haul Route
Acid Pipeline

Environmental Assessment for Supplementary EIS

November 2007

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Table of Contents

Appendices:

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).

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 a 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 15 km south-west of the refinery site.

The refinery will initially be developed in two stages.

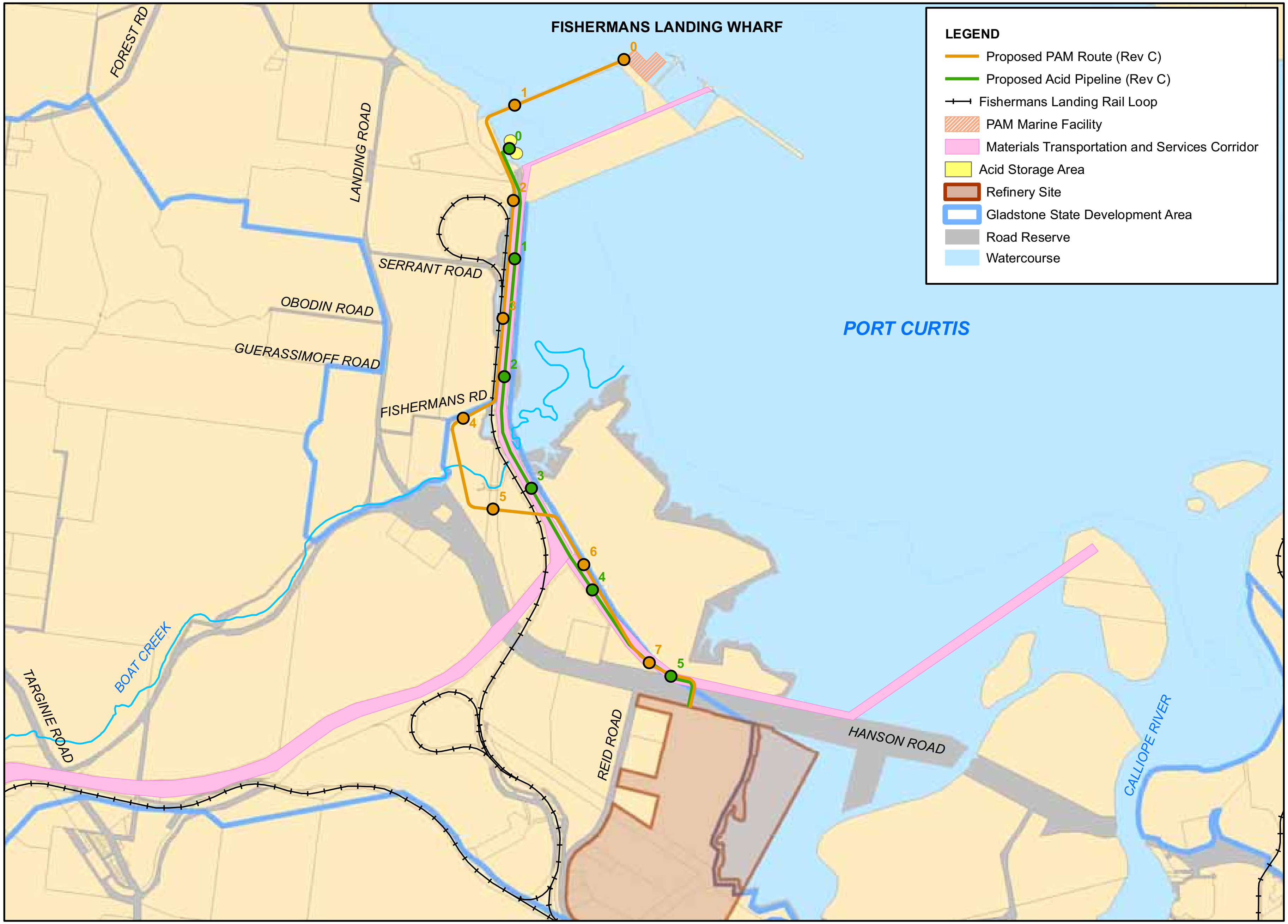
- Stage 1 will produce up to 60,000 t/y of nickel metal and 4,800 t/y of cobalt metal.
- Stage 2 will produce up to 126,000 t/y of nickel metal and 10,400 t/y of cobalt metal.

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

1.2 SCOPE

This report describes two infrastructure components required for the GNP but not included in the original EIS. That is, it is proposed to import pre-assembled modules (PAMs) for the construction of the refinery via the Fisherman's Landing Wharf. Therefore a haul road, designed and constructed to transport the PAMs, is required from the Wharf to the refinery site. In addition, during plant design, it was determined that additional sulphuric acid tanks and a pipeline were needed for efficient operation of the refinery. The acid tanks are proposed to be located at Fisherman's Landing Wharf to allow the import and export of sulphuric acid. The proposed PAM haul route and acid pipeline alignment are considered together because they follow a similar route from the Fisherman's Landing Wharf to the refinery site in Yarwun (see **Figure 1-1**). Separate kilometre points (KPs) are marked on each alignment in order to reference locations of features and activities.

The purpose of this report is to describe the additional infrastructure components required for the GNP and present the environmental effects of the components. This information will be used by regulatory authorities in deciding conditions of relevant approvals.



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Source: Department of Natural Resources and Water 2007, Geoscience Australia.

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Job No: 00011122 | File No: EISsup_PAMhaulRouteAndAcidPipeline_Fig1_RevB.mxd

Title: **FIGURE 1-1 PAM HAUL ROUTE AND ACID PIPELINE ALIGNMENT**

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2 PROJECT DESCRIPTION - PAM HAUL ROUTE

The Department of Infrastructure has commissioned a number of studies to investigate the feasibility of a PAMs route to GPNL's refinery site, and is also considering the provision of a permanent PAM route to satisfy future users within the GSDA.

A PAMs importation facility for the GNP will require a marine facility for ship to shore transfers and a haul route from the marine facility to the refinery site. The marine facility is proposed to be located in the north-east corner of the existing Fisherman's Landing Wharf area between the existing berth 5 and proposed berth 6.

2.1 PAM HAUL ROUTE LOCATION

Figure 2-1 shows the proposed PAM haul route. The proposed PAM haul route starts at the marine facility (KP 0) and runs west along an existing access road on the northern boundary of the current reclamation area of Fisherman's Landing Wharf. It continues along the existing access road on the southeast boundary of the reclamation area, over the Cement Australia conveyor (grade separated) and enters the Materials Transportation and Services Corridor (MTSC) at KP 2. The PAM haul route would be located within the westernmost portion of the MTSC, between the existing Rio Tinto Australia licensed area (containing a conveyor and two pipelines) and the Queensland Rail corridor for the Fisherman's Landing rail loop.

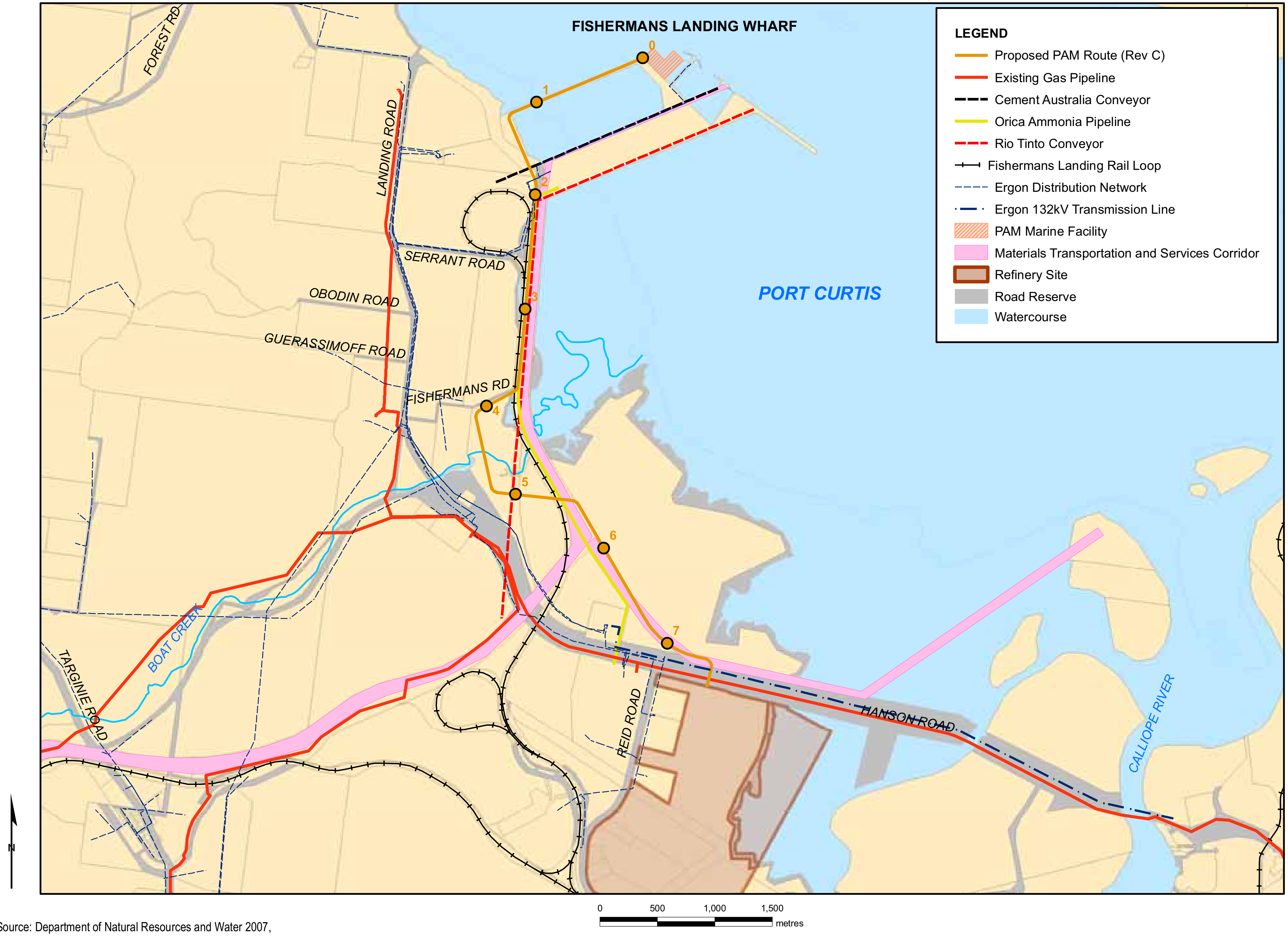
Due to the requirement for the PAM haul route to gain enough height to cross over the top of Rio Tinto's conveyor, the PAM route deviates from the MTSC to the west at KP 3.7 (immediately south of Fisherman's Road), crossing the rail line, at grade, at the same location. The PAM haul route crosses Boat Creek at KP 4.5 and turns east to cross over the conveyor (grade separated crossing) at KP 5. The PAM haul route crosses the rail line a second time (at grade) before rejoining the southern section of the MTSC at KP 5.5. The PAM route will be co-located with the acid pipeline (described in section 3) in the easternmost portion of the MTSC, which is located on the northern side of Hanson Road. The PAM haul route turns south and crosses Hanson Road at grade approximately 500m east of Reid Road (KP 7.5). The PAM haul route enters the refinery site at this location.

2.2 PAM HAUL ROUTE DESIGN

The assumed dimensions of the PAMs required for the construction of Stage 1 of the refinery are shown in **Table 2-1** below.

Table 2-1 - Dimensions of Pre-Assembled Modules (PAMs) for Stage 1

Max weight	7,500 tonnes
Max width	34m
Max height	45m (from formation to top of module)
Max length	57.9m module / 60.2 transport vehicle
Max applied ground pressure	10 tonnes/m^2
Formation width required	30m
Number of units	185 units (assumed at maximum size)



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Job No: 00011122 | File No: EISsup_PAMhaulRouteLocations_Fig2_RevB.mxd

Title: FIGURE 2-1
PAM HAUL ROUTE

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The PAM haul route will be designed as permanent infrastructure and to accommodate PAMs of this size and weight. The formation width will be 30m, with a clearway of 36m. The surface of the entire PAM haul route will be gravel, except at crossings.

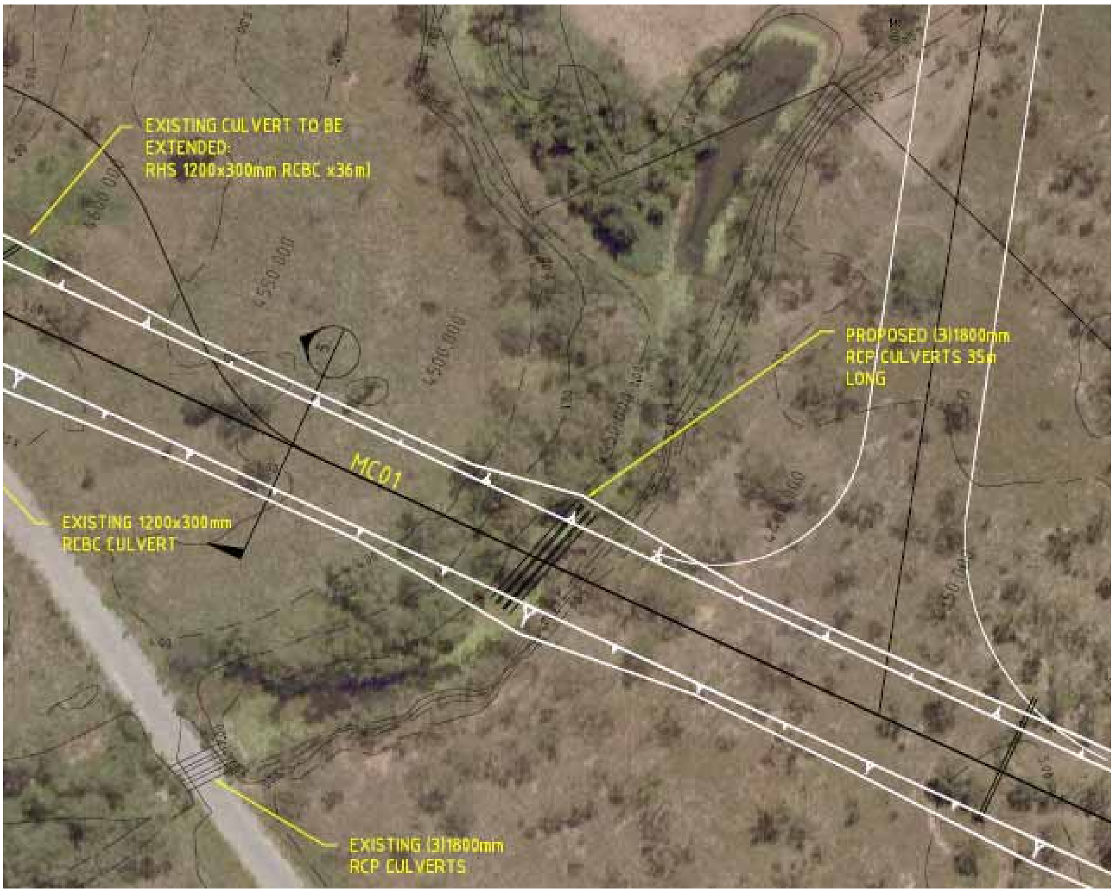
The grade separated crossing of the Cement Australia conveyor at KP 1.8 will be an extension of the two existing 4.5m x 3.4m precast concrete box culverts. A structural check of the existing overpass will be undertaken to confirm it will carry the proposed PAM loadings. Consultation will be undertaken with Cement Australia to determine any future expansion plans.

Existing constructed cross-drains on the northern portion of the MTSC will be extended to accommodate the PAM haul route.

The new grade separated crossing of the Rio Tinto conveyor and pipelines will involve a single span bridge with a clear span of 20m and underdeck clearance of 4m to ground level.

Road preparation will require selected fill in some areas with a gravel surface 300 mm thick.

A narrow section of Boat Creek will be crossed using 3 x 1800mm culverts as installed downstream at the Rio Tinto infrastructure crossing. The culvert length is 35m.



A detailed geotechnical investigation will be undertaken during the detailed design phase of the PAM haul route.

2.3 PAM HAUL ROUTE CONSTRUCTION

Construction of the PAM haul route will involve the following:

- levelling of existing reclamation at Fisherman's Landing Wharf;
- construction of embankment to widen existing access road around boundary of existing Fisherman's Landing Wharf area;
- extension by 25m of overpass structure over the Cement Australia conveyor (KP 1.8);
- widening of the existing MTSC earthen platform including extending cross drains (KP 2 to KP 3.7);
- clearing of the route off the existing formed MTSC (KP 3.7 to KP 7.7);
- earthworks/embankment for the section of the route off the existing formed MTSC;
- drainage (culverts) under the formed PAM haul route where applicable;
- crossing of Boat Creek to consist of three 1800mm culverts 35m long (KP 4.5);
- additional earthworks for ramping up/down to overpass/bridge;
- single span bridge over Rio Tinto conveyor and pipelines (KP 5); and
- gravel surfacing of the entire PAM haul route.

2.4 PAM HAUL ROAD OPERATIONS

PAMs will be delivered to the marine facility at Fisherman's Landing Wharf using barges, lift on - lift off vessels or roll on - roll off vessels. AQIS inspection will take place at a holding area adjacent to the PAM wharf. Where necessary, the PAM will be stored in a secure temporary holding yard at Fisherman's Landing Wharf until the transport vehicle transfers the PAM to the refinery site.

PAMs are often of significant size and weight and require specific handling and transport requirements. Due to the dimensions of PAMs and the haul route, transport to the refinery site will require temporary shutdown of the Fisherman's Landing rail line and Hanson Road to enable the PAMs to cross.

Specific PAM traffic management plans will be prepared for this activity in consultation with the Department of Main Roads.

2.5 WASTE MANAGEMENT

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

A detailed description of GPNL's waste management plan was included in Section 4 of the Gladstone Nickel Project EIS. This waste management plan will apply to the construction and operation of the PAM haul route.

3 PROJECT DESCRIPTION - ACID PIPELINE

3.1 ACID STORAGE AND PIPELINE LOCATION

The offsite sulphuric acid storage area will be located at the southern end of the Fisherman's Landing Wharf Area, approximately five kilometres from the refinery site. The storage area is approximately 1km from the existing Fisherman's Landing bulk liquids Berth 5. The storage area will hold two 10,000 tonne storage tanks connected to the refinery by a pipeline capable of supplying the refinery at 4000 tonnes per day to maintain supply if one acid plant is offline. The location of the storage area and the pipeline route is shown on **Figure 1-1**.

The acid pipeline alignment generally follows Orica's ammonia pipeline alignment. From the acid storage area, it will be constructed on the easternmost edge of the existing formed MTSC and then continue within the eastern branch of the MTSC, on the northern side of Hanson Road until the end of the MTSC at KP 5. The pipeline enters the refinery site approximately 250m east of the Hanson Road - Reid Road intersection.

3.2 ACID STORAGE AREA DESIGN

The acid storage facility and pipeline will be designed to operate two ways, in order to be capable of receiving imported acid and for exporting acid. Criteria for the design of the acid storage facility include:

- Storage required for 20,000 tonnes of sulfuric acid (density = 1.85 grams/cm^3, Vol = 10,811 m^3);
- Bulk ship unloading rate into the storage tanks - 600-800 m^3/hour for up to 20,000 tonnes;
- Minimum delivery to site to supplement an acid plant if one is off line - 4,000 tonnes/day;
- Ship loading for export of acid in the case of maintaining acid production;
- Delivery to the facility from site of excess capacity during plant maintenance;
- Pumps required for delivery to site and ship loading/unloading;
- Bunded area to contain 120% of tankage volume;
- Bunded area sump to be diverted to a weak acid neutralisation unit or a containment tank for neutralisation prior to release;
- Bunded area surfaces to be sulfuric acid resistant concrete or coating.
- All pumps, wiring, and instruments to be above site 'full bund level';
- Low pressure compressed air required for blow out of hoses after loading complete;
- Wash down required for cleanup after disconnection of delivery hoses;
- Safety showers required near delivery and maintenance points;

3.3 ACID PIPELINE DESIGN

GPNL have completed a preliminary design of the acid pipeline. The pipeline will be approximately 5km in length and 250mm diameter and made from carbon steel. Detailed design of the pipeline will be carried out in accordance with the applicable Australian Standards.

Specifications for the design of the acid pipeline are outlined in **Table 3-1** below.

Table 3-1 Acid Pipeline Design Specifications

Pipeline Component	Pipeline Design Specification
No. of pipelines	1 (for both stages of the refinery)
Length (approx.), km	5
Outside diameter, mm	250
Material of construction	Carbon steel
Nominal capacity, t/d	4000
Inlet operating pressure, kPa	700
Maximum flow velocity, m/s	0.8
External coating	painted – purple (AS AS1345:1995)
Mode of construction	Above ground; sections in high traffic areas to go underground.
Construction Right of Way (ROW), m	Approximately 10 - 15
Depth cover, mm	Underground sections, typically 1200 in accordance with AS 2885. Depth of burial may increase at crossings and where higher risk of exposure is identified (based on risk assessment during detailed design phase).
External corrosion protection	Coating on pipe, external wrapping and cathodic protection on underground sections.
Internal corrosion protection	Natural oxidation layer builds up on pipe due to acid, which protects the pipe from corrosion.
Operation	Two way flow; Intermittent, as needed; pipeline to remain full when not in use.
Monitoring system	pressure and flow
Location of pipeline operations centre	Yarwun refinery

The internal corrosion protection relies on the chemical deposition of a reaction product layer on the inside surface of the pipe. The velocity of the acid flowing in the pipe must be kept low to minimise turbulence which can remove the protection layer. Similarly, the pipe must be fully welded with no inline flanges, gaskets or valves which can also create turbulence. The acid pipeline will not be designed with vents or drains and must be kept full of acid when not in use in order to exclude air and water which can react and interfere with the internal deposition layer.

As required by the Australian Standard AS1345:1995 (Identification of the contents of pipeline, conduits and ducts) the entire above ground section of the acid pipeline will be painted purple to identify the contents as an alkali/acid.

3.4 PIPELINE CONSTRUCTION

The majority of the length of the acid pipeline will be constructed above ground. The pipeline will be underground from the acid storage tank site until it is clear of other infrastructure on the formed MTSC (KP 0.0 - 0.5). The pipeline will then run above ground, on concrete supports, to the Boat Creek crossing where screw piles will be used to ensure the pipe is above the 1:100 year flood level. The pipe continues above ground until crossing Hanson Road underground at KP 5. It is expected that the two underground sections (totalling 600 - 700m) will be constructed using boring techniques to minimise impact on the other infrastructure (conveyors, access roads and pipelines) at the Fisherman's Landing Wharf and Hanson Road traffic at the refinery site. It is anticipated that the drilling entry hole to cross Hanson Road will utilise land on the refinery site. Refer to Section 7.3.4.2 in the GNP Project EIS for additional information on boring for pipeline construction. A description of a pipeline construction process was included in Section 2.3.6 of the original project EIS. General pipeline construction methods described in that section will apply to the construction of the acid pipeline including:

- survey of the pipeline route;
- provision of access tracks and temporary facilities;
- clear and grade of the right of way;
- pipe stringing and bending;
- pipe welding;
- hydrotesting; and
- rehabilitation of right of way.

For the majority of its length, it is proposed to support the pipeline at intervals above ground on reinforced concrete caps and on driven piles where additional clearance is required to ensure the pipeline is located above the 1:100 year flood level.

One major difference between construction of the above ground acid pipeline and the construction of other underground project pipelines is that the width of the right of way/clearing required can be reduced with above ground construction. It is not necessary to allow width for trenching and spoil stockpiling.

Permanent access for inspection and maintenance activities will be constructed along the acid pipeline alignment. This will involve lining natural drainage lines with concrete along the pipeline alignment south of the formed MTSC (south of KP 2.5). Access to the pipeline along Boat Creek will be limited to personnel only – no vehicle access will be available following post installation remediation works. Construction of the acid pipeline will take approximately two months to complete and will involve 10 to 20 people.

3.5 ACID STORAGE AND PIPELINE OPERATIONS

The sulphuric acid storage and pipeline has been designed to transfer acid both to and from the refinery. The acid system will be operated from the refinery as will be the case for the other project pipelines. Acid will be transferred to the refinery when additional acid is required for the refining process, such as when one of the acid process trains is off-line. Acid will be transferred from the refinery to the storage tanks when there is an excess quantity of acid produced, such as during abnormal operating conditions in the refinery. It is proposed to operate the system intermittently, as needed, to provide flexibility and efficiency to the refinery operations.

Pumps located at the acid storage area will be capable of loading or unloading ships with acid. Pumps will also be located at the refinery site and at the acid storage area to transfer the acid to and from the tanks.

Monitoring of the cathodic protection system for external corrosion of the underground sections will be undertaken regularly. Periodic visual inspection of the pipeline and easement will be carried out on a routine basis and during acid transfer. The timing of monitoring, inspections and planned maintenance will be determined during the development of the operating procedures.

Emergency response equipment including availability of a neutralising agent, such as magnesia, will be available at the refinery site and the port area. Appropriate training of GPN staff will be provided as described in the Project EIS.

Additional information regarding the operation of the acid pipeline is provided in the updated pipeline Environmental Management Plan presented in the Project's Supplementary EIS.

3.6 WASTE MANAGEMENT

As described in section 2.5 of this report, a detailed description of GPNL's waste management plan was included in Section 4 of the Gladstone Nickel Project EIS and addressed pipeline related waste issues. This waste management plan will apply to the construction and operation of the acid pipeline.

3.7 RISK AND SAFETY

A preliminary risk assessment has been undertaken for the acid pipeline. GPNL's risk matrix, previously used in the risk assessment of the refinery and other associated infrastructure components for the Project EIS, was adopted to maintain consistency. The hazard identification and risk assessment was undertaken in a workshop and performed in accordance with the principles of AS/NZS4360:2004.

Major hazards to the acid pipeline include interference, internal and external corrosion, intentional damage, natural events, operations and maintenance. All of the identified risks were rated as low or medium as many controls are designed into the pipeline itself. Results of the risk assessment are presented in **Table 3-2** below. In summary, control measures to be implemented to reduce risk include:

- markers, lighting, barricades, fences and pipeline labelling/colour coding;
- coating, wrapping, cathodic protection, and wall thickness testing;
- pressure testing and construction quality control;
- isolation at either end of pipeline to minimise volume of acid released in a spill (pipeline holds 245m^3 acid);
- routine inspections and maintenance, job hazard analysis;
- acid-specific emergency response procedures; and
- consultation, education and training.

Table 3-2 Acid Pipeline - Risk Assessment Worksheet

Item No.	Guideword	Causes	Consequences	Controls	Risk				Comments
					Sev.	Type	Freq.	Risk	
5.01	Interference	Excavation – Main Roads work, other pipeline services in area Collision – vehicle Construction / maintenance of other pipelines in Material Transport Services Corridor (MTSC) Excessive loads from heavy vehicles (PAM route, roads)	Major pipeline damage and loss of acid to land / water Failure of other pipelines / services located in area of acid release	Above ground markers for underground sections Minimum separation of pipeline from other pipelines / services Minimum depth of cover Consultation and education program with community, in particular other users of MTSC Access controls around pipeline route e.g. gates, fencing Lighting in high traffic areas Pipeline labelling and colour coding in accordance with standards for aboveground pipeline sections Pipeline located at outer edge of MTSC Barricades for aboveground pipeline sections at high risk areas adjacent to roads etc Routine inspections of pipeline route Isolation at refinery and port when not transferring acid to minimise volume released Emergency response procedures specific to acid release, including containment and neutralisation of release Earth / neutralising agent available at refinery / port for neutralising spills Management system procedures e.g. permit to work, dial before dig process Road and track maintenance Road use controls e.g. speed limits, traffic access control on pipeline service road	4	E/P/S	D	M	
5.02	External Corrosion	Air salinity Ground moisture, salinity and acidity Abrasive action	Failure of buried section of pipeline and loss of acid to land / water Failure of other pipelines /	Painting specification and paint maintenance Aboveground pipeline supported on concrete plinths Coating on aboveground pipeline sections Cathodic protection of underground sections	3	E	D	L	

Item No.	Guideword	Causes	Consequences	Controls	Risk				Comments
					Sev.	Type	Freq.	Risk	
		Failure of cathodic protection	services located in area of acid release	Wrapping on underground pipeline sections Isolation at refinery and port when not transferring acid to minimise volume released Preventative maintenance program includes thickness testing of pipeline and checks on cathodic protection – above and below ground sections Routine maintenance to remove vegetation and soil build-up around pipeline Routine inspections of pipeline route – including signs of bubbling at surface Emergency response procedures specific to acid release, including containment and neutralisation of release					
5.03	Internal Corrosion	High acid velocity Air / water in pipeline	Failure of pipeline and loss of acid to land / water Failure of other pipelines / services located in area of acid release	Pipeline and pump selection based on maximum velocity of 0.8 m/s – protective internal layer not removed by erosion Pump controls to include a constraint on velocity Design to ensure minimal likelihood of removal of protective layer Pipeline designed to remain full between acid transfers to minimise internal corrosion - eliminates intrusion of air and water Pipeline designed without vents, drains, intermediate valves etc Preventative maintenance program includes thickness testing of pipeline Routine inspections of pipeline route Isolation at refinery and port when not transferring acid to minimise volume released Emergency response procedures specific to acid release, including containment and neutralisation of release PPE during inspections and maintenance	3	E	C	M	

Item No.	Guideword	Causes	Consequences	Controls	Risk				Comments
					Sev.	Type	Freq.	Risk	
5.04	Natural Events	Cyclone Inundation Fast flowing water - tidal movement	Potential for pipeline damage especially at Boat Creek	Aboveground pipeline sections located above 1:100 flood event level Inspections after adverse weather Isolation at refinery and port when not transferring acid to minimise volume released Emergency response procedures specific to acid release, including containment and neutralisation of release	3	P	D	L	
5.05	Natural Events	Seismic activity	Damage to pipeline and release of acid to land / water Failure of other pipelines / services located in area of acid release	Included in design of pipeline Inspections after seismic events Isolation at refinery and port when not transferring acid to minimise volume released Emergency response procedures specific to acid release, including containment and neutralisation of release	4	E	D	M	
5.06	Intentional Damage	Malicious damage	Damage resulting in release of acid to land / water Failure of other pipelines / services located in area of acid release	Consultation and education program with community Pipeline labelling and colour coding for aboveground sections Signage No valves etc on pipeline route Acid terminal at port fenced Access controls on pipeline route Routine inspections of pipeline route Isolation at refinery and port when not transferring acid to minimise volume released Emergency response procedures specific to acid release, including containment and neutralisation of release	4	E/S	E	L	
5.07	Operations	Inadequate monitoring during acid transfer Vibration from cavitating pump	Failure of pipeline when under pressure Release of acid to land / water Failure of other pipelines / services located in area of acid	Welded pipelines Overpressure pump trip before pipeline reaches certain percentage of pipeline overpressure Pressure design allowance Leak detection from flow/pressure difference measurements and					No credible consequences identified

Item No.	Guideword	Causes	Consequences	Controls	Risk				Comments
					Sev.	Type	Freq.	Risk	
			release	automatic shutdown of acid transfer Remote monitoring and control possible from refinery central control room Routine inspections of pipeline route, frequent inspections during acid transfer Emergency response procedures specific to acid release, including containment and neutralisation of release Design includes for thermal expansion					
5.08	Maintenance	Inadequate or incomplete maintenance and inspection procedures Incorrect implementation of procedures – training Flammable atmosphere (hydrogen generation) during maintenance when pipe empty	Release of acid Injury to maintenance workers Explosion / fire	Maintenance procedures and permit system Emergency response procedures specific to acid release, including containment and neutralisation of release PPE during maintenance Containment areas set-up during maintenance Permit to work system Lock-out and tagging procedures Pipeline labeling and colour coding Job Hazard Analysis	4	S	D	M	
5.09	Material Defects	Inadequate inspection and test procedures to confirm acceptability Weld failure	Failure of pipeline and loss of acid to land / water Failure of other pipelines / services located in area of acid release	Pressure testing to standard requirements before use X-ray of welds 100% Quality control on pipeline manufacture Routine inspections of pipeline route Isolation at refinery and port when not transferring acid to minimise volume released Emergency response procedures specific to acid release, including containment and neutralisation of release	3	E	D	L	

Item No.	Guideword	Causes	Consequences	Controls	Risk				Comments
					Sev.	Type	Freq.	Risk	
5.10	Construction	Undetected damage to pipeline e.g. coating	Failure of pipeline during operations Release of acid to land / water Failure of other pipelines / services located in area of acid release	Construction and QA procedures Construction management plan Construction hazard identification process Pressure testing to standard requirements before use Construction inspection procedures Emergency response procedures specific to acid release, including containment and neutralisation of release	3	E	D	L	Included in corrosion risks assessed above

4 ALTERNATIVES

4.1 ALTERNATIVE PAM HAUL ROAD ROUTES CONSIDERED

The Queensland Department of Infrastructure commissioned Connell Hatch to undertake a series of investigations regarding the provision of a feasible PAM haul route within the GSDA. The Stage 1 report (Stage 1 - Feasibility of PAMs access to GPN Site, March 2007) considered a number of alternative alignments to the GNP site, and also allowed for the future use by other industries that may be located within the GSDA. Consultation with State Government and GPNL determined the preferred route which is presented in **Figure 2-1**.

This assessment of environmental effects of the preferred PAM haul route considered a number of route deviations on the basis of potential ecological impacts of crossing Boat Creek and from the clearing of an area of Blue Gum woodland (an endangered regional ecosystem). These route deviations are described in more detail in **Appendix 2**. Due to technical requirements for the PAM haul route, and the presence of culturally sensitive places along Boat Creek, these deviations have not been further assessed at this stage.

The original PAM haul route identified in the Connell Hatch Stage 1 report and described in more detail in the report "GPN PAMs access Definitive Study Stage 2 - PAMs access to Gladstone Study" (October 2007) is the preferred route.

4.2 ALTERNATIVE ACID PIPELINE ROUTE CONSIDERED

The acid pipeline follows the multi-user MTSC from Fisherman's Landing Wharf to its end on Hanson Road. Option 1 for the pipeline alignment is to cross Hanson Road at the end of the MTSC and enter the GPNL site at approximately KP 5.2. Option 2 for the pipeline alignment is the same as Option 1 in the northern section but continues on the northern side of Hanson Road to the location where the GNP's ore conveyors are proposed to cross under Hanson Road. The pipeline turns south and crosses under Hanson Road at this same location and remains in the conveyor corridor to enter the GPNL site at KP 8.2. Option 2 is longer and potentially passes through an additional 2.4 km of marine plant dominated vegetation communities and 0.8 km of endangered Blue Gum woodland. Therefore Option 1 has been adopted as the preferred acid pipeline route.

5 ENVIRONMENTAL EFFECTS

The environmental effects of the PAM route and the acid pipeline are addressed together in this section as they follow a similar alignment. This part of the document should be read in conjunction with Section 7 of the original Project EIS which describes the environmental effects of the project pipelines. This document provides additional relevant information for the new infrastructure components and describes the existing environmental values and the potential environmental impacts. Mitigation measures to be implemented to minimise environmental impacts are summarised. **Figure 5-1** presents an overview of environmental constraints for the PAM haul route and acid pipeline.

5.1 LAND TENURE

5.1.1 Tenure

The tenures listed in **Table 5-1** are directly affected by the PAM haul route and acid pipeline alignment.

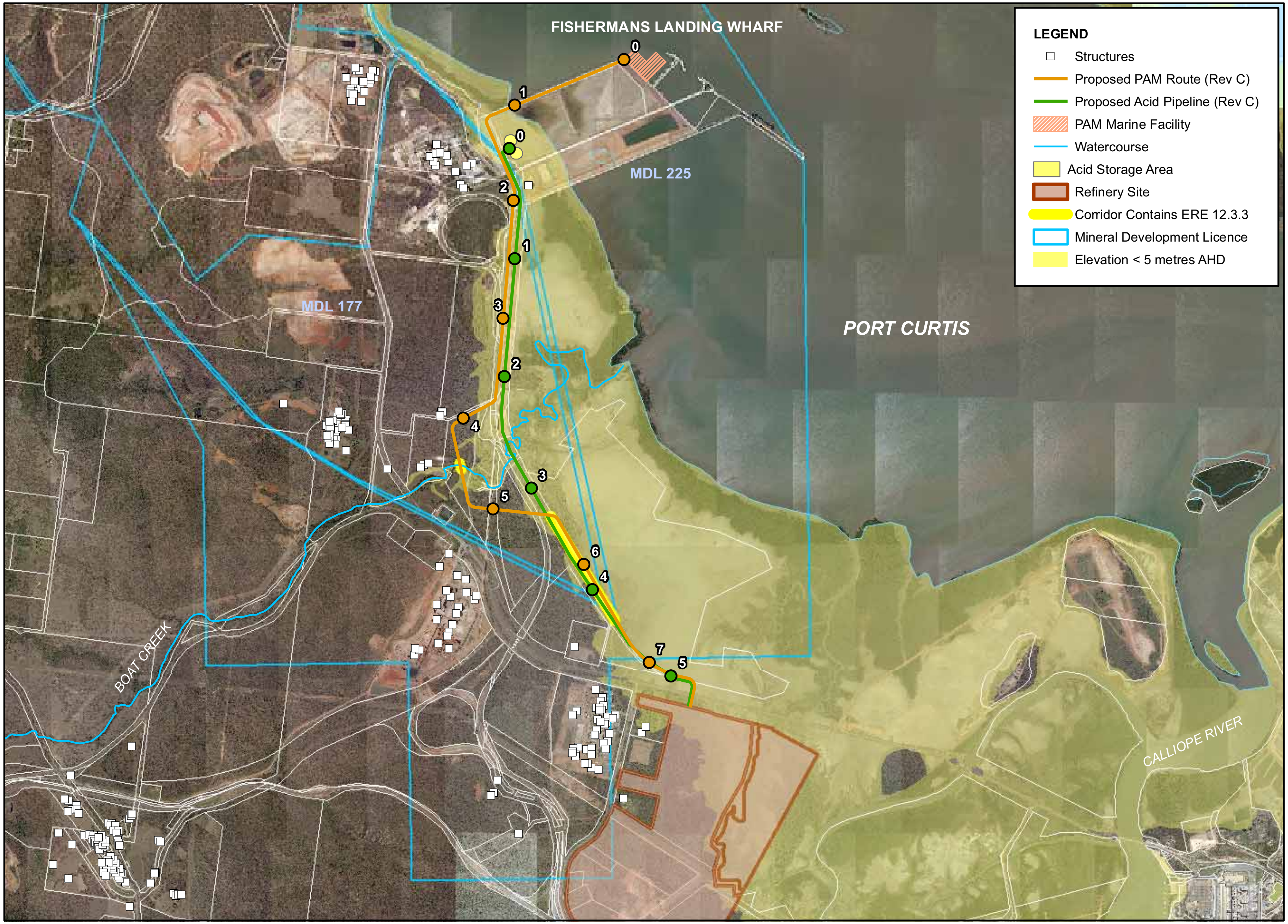
Table 5-1 - Affected tenures

Lot and Plan	Description	Owner
Strategic Port Land	Fisherman's Landing Wharf	Central Queensland Port Authority (CQPA)
Lot 502 SP144781	Fisherman's Landing Wharf	CQPA
Road Reserve	Serrant Road	Department of Infrastructure
Lot 1 SP144433	Materials Transportation and Services Corridor (MTSC)	CQPA
Lot 30 SP103899 Lot 29 SP103897 Lot 27 SP103897 Lot 26 SP103896 Lot 25 SP103896 Lot 21 SP103896	Fisherman's Landing Rail Corridor	Queensland Rail
Lot 1 SP147871	Vacant land	Department of Infrastructure
Lot 9 SP147866	Rio Tinto services corridor	CQPA
Lot 10 SP147866	Vacant land	Department of Infrastructure
Lot 3 SP157699	MTSC	CQPA
Lot 1 SP157699	Vacant Land	Department of Infrastructure
Road reserve	Hanson Road	Department of Main Roads

It is unlikely that the PAM haul route or acid pipeline will have a significant impact on properties listed above as the land is included within the Gladstone State Development Area and is designated for use as transport corridor or industrial development.

5.1.2 Native Title

The PAM haul route and acid pipeline are located within the Port Curtis Coral Coast (PCCC) Native Title Claim. The extent of land subject to Native Title intersected by the haul route and pipeline alignments is currently being investigated. In the event that any of the land is subject to Native Title, an Indigenous Land Use Agreement will be negotiated with the PCCC Claimants.



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Job No: 00011122 | File No: EISsup_PAMhaulRoute_EnviroValues_RevA.mxd

Title: FIGURE 5-1 ENVIRONMENTAL VALUES

Rev: A | A4

5.1.3 Mining and Petroleum

Mining and petroleum tenures intersected by the PAM haul route and acid pipeline include:

- EPM 3215 - Queensland Energy Resources
- EPM 3436 - Queensland Energy Resources
- MDL 177 - Queensland Energy Resources
- MDL 225 - Southern Pacific Petroleum
- PPL 30 - Alinta

5.2 LAND USE AND INFRASTRUCTURE

The PAM route and acid pipeline are located within the Yarwun Precinct and MTSC of the GSDA. Therefore the Development Scheme for the GSDA applies. A small portion of the PAM haul route is located within the Stuart Oil Shale Reserve Preservation Area designated in the Development Scheme.

The PAM haul route has been considered by the Department of Infrastructure as part of a wider study into providing a permanent PAM haul route for future industrial developments within the GSDA. The GPNL PAM route deviates from the MTSC in order to cross the Rio Tinto conveyor at height. The route has been selected to minimise impact on other land uses.

There will be impacts on existing infrastructure from the construction and operation of the PAM haul route (see **Figure 2-1** for affected infrastructure). As a result, the following will be required:

- relocation of overhead power lines on the Fisherman's Landing Wharf access road near Serrant Road;
- modification of Serrant Road entry to Fisherman's Landing Wharf area from where it crosses the rail loop to the MTSC;
- protection of the Orica ammonia pipeline;
- extension of the existing grade separated crossing of the Cement Australia conveyor;
- construction of two at grade crossings of QR's Fisherman's Landing rail line;
- protection of the Alinta gas pipeline and Gladstone Area Water Board's raw water pipeline;
- construction of an at grade crossing of Hanson Road; and
- raising of 2 x 132 kV transmission lines along Hanson Road.

The construction of the acid pipeline will involve crossing the following existing infrastructure:

- Cement Australia conveyor (KP 0.2);
- Rio Tinto conveyor and pipelines at Fisherman's Landing Wharf (KP 2);
- cross-drains within the formed northern section of the MTSC;
- Boat Creek (KP 2.6);
- natural drainage channel at KP 4.3 (gas meter station); and
- Hanson Road.

5.3 TERRAIN AND GEOLOGY

HLA - Envirosciences Pty Ltd completed a desktop assessment of soils, topography and geology for the acid pipeline route (see **Appendix 1** for further information and references). The assessment was based on available digital and hardcopy spatial data. The scope of the desktop assessment did not include the specific PAM haul route, however, the majority of the routes are the same and the information applies.

5.3.1 Topography

The existing topography of the land along the PAM route and acid pipeline route varies between 3m AHD (at the Fisherman's Landing Wharf tank site) and 10m AHD (at the refinery site) with no areas within the route alignments exceeding 4% slope.

The landforms in the location of the PAM haul road and acid pipeline include:

- Areas of low-lying poorly drained lower slopes, drainage flats with intermittent stream channels and depressional drainageways; marine extratidal and supratidal flats; periodically floodprone or inundated; slopes mostly <0.5%. Approximately 61% of the alignment traverses these types of landforms;
- Reclaimed land – imported fill material. Approximately 39% of the alignment traverses this landform type which has been/will be reclaimed by the Central Queensland Port Authority; and
- Seasonal or permanent swamps, tidal lands and drainage-ways; areas subject to regular inundation. Less than 1% of the alignment traverses these types of landforms.

5.3.2 Geology

The haul route and pipeline encounter Quaternary alluvium and residual sediments underlain by Late-Devonian – Early Carboniferous geology of both the Wandilla and Doonside Formations, part of the Curtis Island Group. The geology of the Late Palaeozoic comprises sediments including limestone and calcareous sandstones and conglomerate of marine shelf origin with felsic to basaltic volcanics.

5.4 SOILS AND CONTAMINATED LAND

As described above, HLA - Envirosciences Pty Ltd completed a desktop assessment of soils for the acid pipeline route only (see **Appendix 1** for further information and references). The assessment was based on available digital and hardcopy spatial data. Mapped land systems that are traversed by the proposed alignments are described in **Table 5-2** below.

Table 5-2 Land System Mapping Descriptions

Approx acid pipeline KP	Land System[1]	Description
0-3	Carpentaria[1]	Marine plains with extensive bare tidal flats inundated by tidal waters and dissected by tidal channels. Crusting surface, grey mottled, saline cracking clays; saline muds and sands.
3-4	Fanside[1]	Undulating footslopes and rises on sedimentary rocks. Red, structure gradational clay loams, and uniform clays. Red duplex soils.
4-5	Carpentaria[1]	As above

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

5.4.1 Soils

The mapped soils that are traversed by the PAM haul road and acid pipeline routes are listed below. The soils are described in relation to the geological units in which they occur:

- **Soils Associated with the Quaternary Marine Deposits (Qm)** – In general these soils comprise uniform fine or medium-textured crusting surface dark grey brown to dark brown and pale grey mottled saline clays and silty clay, saline muds and sands. They occur on mangrove flats and within tidal inlets, tidal salt flats with samphire or with saltwater couch grassland plains along the landward margins of the marine deposits.
- **Soils Associated with the Quaternary Alluvial Deposits (Qa)** – A complex association of soils occurs on alluvial flats, floodplains, intermediate terraces and higher alluvial plains. In general, they comprise silty to loamy surface duplex soils often with a pale or bleached A2 subsurface horizon underlain by slightly acidic to slightly alkaline, grey and yellowish brown sodic clay subsoils which occur on the intermediate and higher alluvial plains and terraces.

  On the lower-lying alluvial flats, a complex association of silty to clay loamy surface duplex soils occurs which have neutral to slightly alkaline brown sodic clayey subsoils. These occur locally in association with deep dark coloured cracking clay soils that have sodic mostly alkaline heavy clay subsoils. These are highly reactive soils that are subject to substantial swelling when wet and shrinkage and cracking when dry.

- **Soils Associated with the Quaternary Residual Soil / Alluvial Fan Deposits (Qr)** – These soils may vary depending on the topographic position in the soil landscape and tend to become somewhat finer-textured (more clayey) downslope. The surface soils comprise dark brown slightly acidic gravely sandy loam to clay loam, and grade to gravely sandy clay loam or light clayey subsoils which tend to become somewhat dispersive with depth. On the lower less well-drained sectors of the terrain unit, the soils may comprise siliceous or ferruginous gravely silty to loamy surface duplex soils with bleached sub-surface (A2) soil horizons and diffusely mottled clayey subsoils.
- **Reclaimed Land (Dr)** – Imported fill material.

Quaternary marine deposits constitute the majority of the geology encountered along the haul route and pipeline alignment. Quaternary marine deposits of the locality are mostly deep non-gravelly and strongly saline soils and exhibit slight to moderate dispersion characteristics (Emerson Stability Classes 2, 3 and 5).

5.4.2 Potential impact on soils

Construction of the PAM haul road and acid pipeline will clear vegetation and expose topsoil and potentially subsoils to erosion. Appropriate erosion control procedures must be implemented during construction of these infrastructure components. In addition, topsoil management is important to minimise erosion, promote revegetation and reduce weed establishment. As outlined in the project description, the PAM haul road will be permanent infrastructure involving the clearing of any vegetation, stripping of topsoil and significant earthworks. In contrast, the acid pipeline involves clearing of vegetation, construction of the pipeline above ground, and natural regeneration of vegetation to within 1.5m either side of the pipeline.

HLA - Envirosciences Pty Ltd identified that approximately 75% of the alignments length have soils with a moderate to high susceptibility to erosion (i.e. moderate-low erosion resistance).

Most of the alignment for the PAM haul route and pipeline is and/or will remain devoid of vegetation as it is within a multi-user materials transport corridor. Therefore erosion and sediment control will be the major control strategies for minimising impact on other infrastructure, soils and downstream water resources. The relevant control strategies to be implemented to prevent or minimise impacts to soils include:

- The area disturbed by the construction of the haul route and acid pipeline will be minimised.
- Construction practices that reduce soil erosion and sedimentation (such as those outlined in the Project Environmental Management Plan) will be adopted.
- Temporary and more permanent erosion control banks and sediment collection devices will be installed across slopes and in the vicinity of drainage lines along the haul road and pipeline alignments, as necessary.
- Temporary construction sediment collection devices such as sediment fences will 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 will be inspected on a regular basis and replaced where damaged. They will be checked following rainfall events and reinstated where required.
- Clearing, grading and earthworks will be undertaken promptly in channels, on slopes and in erosion prone areas. Clearing of slopes leading to watercourses will be delayed until the construction of the crossing is imminent.
- Soil stockpiles will 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 will be bounded with silt fencing on their down-slope side to contain the material in the case of rainfall.
- Cleared vegetation will be stockpiled separately to soil stockpiles.
- The topsoil over the pipeline construction footprint and where the PAM haul road will be constructed will be stripped.

- The topsoil and any subsoil excavated will not be contaminated with any foreign material and will be stockpiled separately from each other.
- On any slopes, soil will only be placed on the high side of the alignment easement.
- Topsoil removed prior to construction of the acid pipeline will be stockpiled along the alignment. The stockpiles will 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 to allow for wildlife movement across the alignment.
- Topsoil removed prior to the construction of the PAM haul road will not be stockpiled but rather respread immediately in the vicinity of the construction alignment.
- Construction contractors will be required to prepare and submit a site-specific erosion and sediment control plan for each of the haul route and acid pipeline.

5.4.3 Acid Sulphate Soils

In general, acid sulphate soils (ASS) are commonly found in coastal lowlands such as mangrove tidal flats, salt marshes or in tea-tree swamps. The haul route and pipeline alignments fall within areas mapped as indicative for ASS. The likelihood of occurrence of ASS along the alignments is generally high, especially within those sections which pass through marine extra-tidal flats, supratidal coastal flats and tidal lands.

Where haul route and pipeline construction activities are likely to intersect potential ASS environments, a site investigation, soil sampling and testing programme will be undertaken prior to surface disturbance. This will determine the vertical and lateral extent of any ASS materials and the resultant level of environmental impact which may arise should any such materials be disturbed and become fully oxidised. If ASS are encountered, a comprehensive ASS management program will be implemented to prevent any adverse environmental impacts.

It is unlikely that the construction of the PAM haul route will result in disturbance of ASS as the majority of the route will be constructed from imported fill rather than excavated. To minimise disturbance of ASS during pipeline construction, it is proposed to use driven piles to support the acid pipeline at the Boat Creek crossing. Section 8.1.9.4 of the original Project EIS outlines the preliminary design and control measures for support of the conveyors and pipelines coming from the Wiggins Island Wharf to the GNP refinery site which will be adopted for the construction of supports for the acid pipeline.

5.4.4 Good Quality Agricultural Land

The proposed acid pipeline alignment lies entirely within Land Class D – Non-agricultural land. This land is deemed not suitable for agricultural uses therefore the haul route and acid pipeline will not impact on good quality agricultural land.

5.4.5 Potential Contaminated Land

Observations and experience have been used to determine the likely presence of sources of contamination along the proposed alignments. The PAM haul route twice crosses the Fisherman's Landing rail line and once crosses Hanson Road. The acid pipeline alignment crosses Hanson Road at approximately KP 5. Hydrocarbon contamination, and herbicide residues associated with weed control, may be a potential problem at these locations. The likelihood of other forms of contamination being present (such as poly-aromatic hydrocarbons) is low.

Potential contamination from construction machinery and vehicles and PAM transport vehicles using the PAM haul route 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.

5.5 WATER RESOURCES

5.5.1 Existing values

The PAM haul route and the acid pipeline are contained within the catchment of the Calliope River. In addition, they run adjacent to and transect the Port Curtis Wetlands Area which is listed in the Directory of Important Wetlands in Australia. The environmental values of the Port Curtis Wetlands Area include:

- extensive mangrove forests (3,300 ha), seagrass beds (2,430 ha) and salt flats (2,800 ha);
- one species of seagrass (*Halophila tricostata*) and several species of mangrove (*Acanthus ilicifolia*, *Avicennia eucalyptifolia*, *Xylocarpus australasicus* and *Bruguiera exaristata*) at the limits of their distribution;
- habitat for significant species including Beach Stone-curlew (*Esacus neglectus*), Radjah Shelduck (*Tadoma radjah*), Eastern Curlew (*Numenius madagascariensis*), Chestnut Teal (*Anas castanea*), Little tern (*Sterna albifrons*), Sooty Oystercatcher (*Haematopus fuliginosus*) and Black-necked Stork (*Ephippiorhynchus asiaticus*);
- significant feeding areas for Dugongs (*Dugong dugon*);
- habitat for significant marine turtle species, including Green Turtle (*Chelonia mydas*), Flatback Turtle (*Natator depressus*), Loggerhead Turtle (*Caretta caretta*) and Hawksbill Turtle (*Eretmochelys imbricata*); and
- Colonies of Flying Foxes (*Pteropus scapulatus*, *Pteropus alecto* and *Pteropus poliocephalus*)

The PAM haul route and the acid pipeline will cross Boat Creek, at different locations, and a number of minor drainage channels and local wetlands.

Table 5-3 provides a summary of median water quality values for the freshwater reaches of Boat Creek.

Table 5-3 - Boat Creek Median Water Quality Data[1]

Parameter	Units	No. of samples	Median Value	Queensland Water Quality Criteria (2006) Lowland Streams
Conductivity	µS/cm	18	805	20 - 250[2]
pH		18	7.5	6.5 - 8.0
Total Dissolved Solids	mg/L	18	350	not available
Turbidity	NTU	18	64	50
Total Suspended Solids	mg/L	9	40	10
Total Nitrogen as N	mg/L	10	0.66	0.5
Total Phosphorus	mg/L	10	0.10	0.05

1 - reference: Chlor Alkali/Ethylene Dichloride Plant Gladstone EIS (2003) prepared for LG Chem by URS

2 - criteria from Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000) for a lowland river in Northern Australia.

An artificial wetland/lagoon area has formed on Boat Creek approximately 100m upstream of the PAM haul route crossing. It is surmised that the wetland resulted from the construction of the existing access road crossing on Boat Creek. The wetland and fringing vegetation provides habitat for fauna as described in **Section 5.7.2** of this report.

5.5.2 Potential impacts and mitigation measures

Potential impacts on the wetlands, Boat Creek and other drainage channels will occur during both construction and operation and include:

- change of hydrology;
- sediment loading;
- erosion;
- removal of vegetation; and
- change in water quality (e.g. pH).

There will be no impact from the proposal on the artificial wetland located on Boat Creek upstream from the crossings. The crossing of Boat Creek by the PAM haul route is defined by engineering and technical feasibility, however consideration will be given to minimising disturbance during the detailed design phase.

Management of environmental impacts from the construction of the haul route and pipeline at water course crossings is important. Additional detail is provided in the Project EIS and EIS Supplementary, however a summary of control measures to be implemented at water course and drainage channel crossings is given below:

- Clear and grade crews will leave a 20 m buffer of vegetation adjacent to water course crossings until such time as a vehicle crossing is required.
- Soil will be graded away from the watercourses. Where soil and vegetation stockpiles are required they will be placed away from the banks of watercourses (a minimum of 10 m outside the high bank). Silt fences will be erected on the down-slope side of soil stockpiles, which occur on slopes leading to watercourses.
- Where it is necessary to pump water around the watercourse crossing, the outlet water will 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 will be installed along the slope on approaches to watercourses immediately following clear and grade. These will be maintained until restoration, when permanent banks will be installed.
- 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 will be installed at the pipeline crossing so as not to impede water flow and cause erosion and sedimentation of the watercourse. Where necessary to maintain access to the acid pipeline, permanent structures will be constructed for vehicles to cross smaller drainage lines.
- To minimise long term damage to drainage lines and water courses, bed and bank materials will be replaced if disturbed and restored to its original profile and characteristics. The creek or drainage line will be re-established to a stable slope consistent with the 'natural' slope on either side of the disturbed area.
- All barriers to flow will be removed after construction finishes. Permanent structures necessary to maintain flow will be provided where necessary.
- Permanent drainage and sediment control structures will be constructed along the PAM haul route.
- Regular inspection and maintenance of the acid pipeline and easement will be undertaken.

Relevant measures will be incorporated into the detailed design of the haul route and acid pipeline. In particular, the crossing of Boat Creek will be investigated further and designed in accordance with the water crossing objectives. It has been noted that past crossings of Boat Creek have contributed to a change in hydrology and the creation of a wetland approximately 100m upstream.

5.6 FLORA

5.6.1 Methodology

The flora assessment was undertaken by HLA - Envirosciences Pty Ltd as a desktop study and a field assessment - restricted due to land tenure. The field survey looked at a 100m corridor along the PAM haul route and a 30m corridor along the acid pipeline route. The HLA - Envirosciences Pty Ltd report in **Appendix 2** provides further information on methodology and also on the assessment of the alternative routes considered. At the time of finalising the HLA - Envirosciences Pty Ltd report, Option 2 for the acid pipeline was the preferred alignment option.

The impact of the current preferred alignments for the PAM haul route and the acid pipeline are discussed below.

5.6.2 Existing Values

No vegetation communities regarded as threatened under the *Environment Protection and Biodiversity Conservation Act* (EPBC Act) were detected within the alignment corridors during the field survey. The PAM route and acid pipeline alignments both transect one Regional Ecosystem (RE) considered endangered under the *Vegetation Management Act* (VM Act), i.e. 12.3.3 *Eucalyptus tereticornis* woodland. The area of RE 12.3.3 within the PAM route corridor from KP 5.0 to KP 5.3 and KP 5.5 - KP 6.1 has been degraded by selective logging. The acid pipeline alignment transects RE 12.3.3 from KP 3.0 - KP 4.3.

Not of concern REs under the VM act that are transected by the PAM haul route include:

- Narrow fringe of riparian woodland community (RE 12.3.7) occurring along Boat Creek from KP 4.45 - KP 4.54;
- Ironbark woodland (RE 11.3.29) from KP 3.5 - KP 3.9;
- Coastal paperbark dominated woodlands (RE 12.3.5) from KP 5.9 - KP 6.3 and KP 7.6 - KP 7.7;
- Small area of mangrove forest (RE 12.1.3) from KP 1.0 - KP 1.2; and
- Saltpans containing bare saline mud, saltwater couch grasslands, and samphire herbland (RE 12.1.2) occurring in several locations including KP 1.2 - KP 1.3, KP 2.6 - KP 3.2, KP 6.3 - KP 7.6.

Similarly, not of concern REs under the VM Act that are transected by the acid pipeline alignment include:

- Several mangrove forest communities (RE 12.1.3) from KP 2.5 - KP 2.7; and
- Saltpans containing bare saline mud, saltwater couch grasslands, and samphire herbland (RE 12.1.2) occurring in several locations including KP 2.5 -KP 2.7, KP 2.7 - KP 3.0, KP 4.3 - KP 5.0.

Dedicated field searches failed to detect any flora species considered endangered, vulnerable or rare (EVR) under the *Nature Conservation Act 1992* (NC Act) and EPBC Act or regionally significant flora species. The field survey recorded potential habitat for two EVR species - *Graptophyllum excelsum* (Scarlet Fuchsia) and *Quassia bidwillii* (Quassia) as occurring in the alignment corridors.

A number of declared weeds (*Land Protection (Pest and Stock Route Management) Act 2002)* and environmental weeds were recorded as present in the two alignments during the field survey.

5.6.3 Potential impacts and mitigation measures

Constraints with respect to flora for the PAM route and pipeline alignment include:

- Clearing of up to 32.4 ha of remnant vegetation for the haul road and clearing of up to 8.1 ha of remnant vegetation for the acid pipeline;
- Crossing of patches of endangered RE (12.3.3 - Blue Gum woodland);
- Crossing of Boat Creek and associated riparian vegetation, freshwater wetlands and marine vegetation;
- Intersection of marine plants (salt marsh, saltwater couch grasslands, salt pan and mudflats, and mangrove shrublands) within the Port Curtis Wetland;
- Not of concern REs transected or adjacent to approximately 4.1km (53%) of the PAM haul route and approximately 1.4 km (27%) of the acid pipeline alignment.

Direct impacts from the PAM haul route, such as clearing of vegetation will not be reversible through rehabilitation as the haul route is a permanent structure. Construction of the pipeline will have direct impacts on vegetation, however the majority of the cleared area along the alignment will be allowed to regenerate.

Construction of the PAM haul route will require 800m of the endangered RE 12.3.3 to be cleared. Assuming a 100m wide corridor of clearance for the construction, this equates to 8 ha. Construction of the acid pipeline will require 1.3 km of this endangered RE to be cleared (assuming 30 m corridor this equates to 3.9 ha). It is estimated that within a 10km zone of the alignments there is 320 ha of the

12.3.3 RE. Therefore, construction of the haul route and pipeline will clear 3.7% of this total. These are conservative estimates and it is expected that clearing for construction will be reduced to less than the corridor width particularly within areas of the endangered RE.

Table 5-4 and **Table 5-5** provide summaries of the estimated areas of remnant vegetation impacted on by the PAM haul route and pipeline. The estimates are conservative as it was assumed that the entire corridor is fully vegetated and the maximum width would be cleared.

Table 5-4 Approximate Areas of Remnant Vegetation Impacted by PAM Haul Route

Vegetation Communities/REs		Area within PAM route corridor (ha)	Area within 10km buffer (ha)	% of Buffer Area Cleared
Endangered				
12.3.3	*Eucalyptus tereticornis* woodland to open forest on alluvial plains	8	320.8	2.5
Not of Concern				
11.3.29	*Eucalyptus crebra, E. exserta, Melaleuca* spp. Woodland on alluvial plains	2	528.8	0.4
12.1.2	Saltpan vegetation including grassland and herbland on marine clay plains	16.5	910.7	1.8
12.1.3	Mangrove shrubland to low closed forest on marine clay plains and estuaries	1	995.7	0.1
12.3.5	*Melaleuca quinquenervia* open forest on coastal alluvium	4	0	100*
12.3.7	*Eucalyptus tereticornis, Callistemon viminalis, Casuarina cunninghamiana* fringing forest along watercourses	0.9	79.9	1.1

*The EPA mapping does not identify this community within the corridor or 10km buffer. However it does record over 700ha within the Gladstone and Calliope Shire areas. The field survey also detected this community in numerous low-lying areas within and adjacent to the study area. Clearing of up to 4ha is therefore considered unlikely to have a significant impact on this community on a regional basis.

Table 5-5 Approximate Areas of Remnant Vegetation Impacted by Acid Pipeline

Vegetation Communities/REs		Area within pipeline corridor (ha)	Area within 10km buffer (ha)	% of Buffer Area Cleared
Endangered				
12.3.3	*Eucalyptus tereticornis* woodland to open forest on alluvial plains	3.9	320.8	1.2
Not of Concern				
12.1.2	Saltpan vegetation including grassland and herbland on marine clay plains	3.6	910.7	0.4
12.1.3	Mangrove shrubland to low closed forest on marine clay plains and estuaries	0.6	995.7	0.06

As discussed in **Section 4** of this report, alternative alignments for the PAM route and acid pipeline that avoided areas of endangered REs were considered. Due to engineering requirements, these were discounted, however, during detailed design and survey of the PAM haul route, there may be opportunities for slight realignments to reduce the area of endangered RE to be cleared. This is not the case for the pipeline as it follows the MTSC and then joins another infrastructure corridor and therefore the alignment is not as flexible.

The PAM haul route will require clearing of up to 0.9 ha of riparian vegetation including marine plants at the proposed crossing of Boat Creek. Clearing and other impacts on riparian areas will be minimised by reducing the width of the construction corridor at this location. The impacts could be further reduced by utilising the existing crossing approximately 100 m downstream.

It is proposed to construct the acid pipeline above the 1:100 year flood level at Boat Creek. Construction will involve the driving piles in to the ground for support and stringing the pipe across the creek. Clearing for this purpose will be kept at a minimum with only those areas required for access to be cleared.

The haul route corridor contains approximately 17.5 ha of REs dominated by marine plants, although at the time of the field survey approximately 7 ha were devoid of vegetation. The remaining 10.5 ha that will be cleared for construction of the haul route represents approximately 0.17% of the total of these communities contained within the Port Curtis Wetland Area. Similarly, the construction of the pipeline has the potential to clear approximately 4.2 ha of existing vegetation within the marine plants communities which equates to approximately 0.07% of the total within the Port Curtis Wetland Area. Pipeline construction methods may further reduce this area of clearing.

Specific mitigation measures to minimise the impact on flora include:

- The width of the construction corridor for the PAM haul route and acid pipeline, within all areas of remnant vegetation will be minimised (no greater than 100m for the haul route and 30 m for the pipeline). The width of construction will be further reduced at the Boat Creek crossings and in areas of the endangered Blue Gum woodland community;
- At the detailed pipeline alignment survey stage, use of other construction methods within areas of high ecological value (e.g. mangrove channels, vegetated areas of salt pans) will be considered;
- Construction vehicle access tracks and laydown areas will be located within areas already devoid of vegetation;
- Clearing boundaries within areas of remnant vegetation will be clearly marked prior to clear and grade activities;
- Vegetation will be allowed to naturally regenerate, subject to access and easement requirements;
- Cleared vegetation will be spread over the pipeline corridor where practicable after construction has finished. Where practicable, mulching will not be undertaken, rather the vegetation will be left to provide animal habitat, assist in regeneration and provide some erosion control;
- All vehicles will contain spark arresters on diesel engines. Fire fighting equipment and trained personnel will be available during activities that may cause fires, such as welding;
- Topsoil will be removed prior to construction. Where the topsoil is to be reused, it will be stockpiled (height limited to 2m) and have appropriate erosion and sediment control measures applied. Topsoil will be re-spread across regeneration areas as soon as practicable following disturbance;
- Vegetation re-establishment will be monitored during and post-construction. Key flora indicators will include percentage groundcover of desirable species compared to adjacent undisturbed areas;
- A weed management plan that addresses the construction and operation phases will be prepared and implemented prior to construction to minimise the likelihood of introduction and spread of declared and environmental weeds. Monitoring of weed infestations will be undertaken monthly during construction and regularly during operations; and
- Hydrological characteristic of riparian, wetland and tidal areas will be retained and soil and erosion management will be implemented.

The clearing of remnant vegetation associated with the PAM haul route and acid 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. The application will address the requirements of the relevant Vegetation Clearing Code, including proposals for offsets where required.

5.7 FAUNA

5.7.1 Methodology

The fauna assessment by HLA - Envirosciences Pty Ltd consisted of a desk top study followed by a field survey. A precautionary approach was adopted. That is, any species that could potentially occur within the corridors, as identified through the ecological databases and habitat assessment, was assumed to occur. As detailed targeted field surveys were not undertaken, the presence or otherwise of a particular fauna species could not be confirmed. No fauna trapping was undertaken, rather, the field survey targeted habitat assessments of representative habitats within the vicinity of the PAM haul route and acid pipeline corridors. These sites were selected based on the following:

- occurrence of forested patches and other fauna habitats such as riparian corridors and wetlands as identified from aerial photography;
- preferred habitat for EVR and Regionally Significant fauna identified from databases, mapping and aerial photography; and
- occurrence of endangered and of concern REs from Queensland Herbarium mapping.

Listed EVR fauna 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 (BBS) Fauna Expert Panel and/or the South East Queensland (SEQ) Fauna Expert Panel as non-EVR priority taxa 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. The study area is located at the interface of the BBS and SEQ Bioregions, hence the use of two expert panel reports.

Further details are contained in **Appendix 2**.

5.7.2 Existing Values

The PAM haul route and acid pipeline are located within a landscape that contains relatively large areas of remnant vegetation interspersed with industrial areas and associated infrastructure. The habitat value within this landscape for those fauna species sensitive to disturbance would be limited. In addition, the habitat for hollow dependent fauna has been reduced due to historical clearing of remnant vegetation and removal of large, old trees. However, potential habitat for a number of EVR, Regionally Significant and Migratory/Marine species exists within the PAM haul route and acid pipeline corridors.

Mangroves and adjoining mudflats within the Port Curtis Wetland provide foraging and roosting habitat for EVR species such as the False Water Rat (*Xeromys myoides*) and Black-necked Stork (*Ephippiorhynchus asiaticus*), and listed Migratory and marine shorebirds such as Ruddy Turnstone (*Arenaria interpres*), Sharp-tailed Sandpiper (*Calidris acuminata*), Great Knot (*Calidris tenuiostris*) and Lesser Sand Plover (*Charadris mongolus*). The saltmarsh and mudflat communities adjacent to the existing MTSC also provide temporary foraging habitat for a wide variety of wader and shorebirds but is dependent on the frequency of inundation. EVR species likely to utilise these areas are Beach Stone-curlew (*Esacus neglectus*) and Eastern Curlew (*Numenius madagascariensis*).

The artificial wetland/lagoon created by water backing up Boat Creek has created habitat for a wider range of predominantly bird species than the downstream habitats. The EVR listed Cotton Pygmy-goose (*Nettpus coromandelianus*) and Regionally Significant species such as Musk Lorikeet (*Glossopsitta concinna*), Yellow-bellied Sunbird (*Nectarinia jugularis*), Brown Treecreeper (*Climacteris picumnus*), Barking Owl (*Ninox connivens*) and a variety of microbats may utilise this wetland habitat. A variety of woodland and open country bird species are expected to use the riparian vegetation on Boat Creek as a migratory pathway from coastal environments to the inland forested areas.

The Blue Gum woodland is the largest patch of intact remnant vegetation traversed by the alignments. It provides suitable habitat for a wide variety of significant and common fauna species and provides a linkage to other woodland patches and riparian vegetation along Boat Creek. The Fisherman's Landing rail line has a built height of approximately 10m through this woodland and may restrict the movement of some fauna. The Blue Gum woodland contains some hollow-bearing trees which provide nesting habitat for Regionally Significant species such as Common Brushtail Possum (*Trichosurus vulpecula*) and Common Ringtail Possum (*Pseudocheirus peregrinus*) and other common mammal and bird species. The Blue Gum woodland also provides habitat for EVR species such as Brigalow Scaly-foot (*Paradelma orientalis*), Square-tailed Kite (*Lophoictinia isura*), Large-eared Pied Bat (*Chalinolobus dwyeri*) and Little Pied Bat (*Chalinolobus picatus*). A variety of Regionally Significant fauna and Migratory birds may also be found within this community, in particular the Koala (*Phascolarctos cinereus*) which is Regionally Significant in the BBS Bioregion.

A total of 37 fauna species were recorded during the field survey (1 amphibian, 3 reptiles, 31 birds and 2 mammals). No EVR fauna species were detected during the field survey however habitat for 18 EVR fauna species was recorded. Potential habitat for 44 fauna species of Regional Significance is contained within the PAM haul route and acid pipeline alignments, and one of these species was recorded during the survey (*Pseudophryne major* - Great Brown Broodfrog). A full listing of EVR and Regionally Significant fauna species, together with their preferred habitat and an indication as to whether the habitat is present within the two alignments is contained in **Appendix 2.**

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. These include species listed under International Conventions. These bird species are not EVR fauna, they are protected species that may utilise local habitats on a seasonal basis, or marine species that may overfly or utilise the wider area. Nine of these species were observed during the field survey including:

- Australian White Ibis (*Threskiornis molucca*)
- Black Kite (*Milvus migrans*)
- Gull-billed Tern (*Sterna nilotica*)
- Magpie-lark (*Grallina cyanoleuca*)
- Masked Lapwing (*Vanellus miles*)
- Rainbow Bee-eater (*Merops ornatus*)
- Welcome Swallow (*Hirundo neoxena*)
- Whistling Kite (*Haliastur sphenurus*)
- White-bellied Sea-eagle (*Haliaetus leucogaster*)

While 25 introduced species have been recorded in the wider study area (2 fish, 1 amphibian, 5 birds and 10 mammals), three introduced species were observed or detected within the haul road corridor. These were the Indian Peafowl (*Pavo cristatus*), European Rabbit (*Oryctolagus cuniculus*), and Dog (*Canis familiaris*).

5.7.3 Potential impacts and mitigation measures

HLA - Envirosciences Pty Ltd concluded that there is potential for seven of the 18 EVR fauna species to be impacted on by the construction and use of the PAM haul route and acid pipeline. These are:

- Reptiles - Brigalow Scaly-foot (*Paradelma orientalis*) and Rusty Monitor (*Varanus semiremex*);
- Birds - Lewin's Rail (*Rallus pectoralis*);
- Mammals - Large-eared Pied Bat (*Chalinolobus dwyeri*), Little Pied Bat (*Chalinolobus pictatus*), False Water Rat (*Xeromys myoides*), Koala (*Phascolarctus cinereus*).

The potential impacts will be in the form of habitat loss, such as loss of mature vegetation and nesting sites, loss of foraging resources and increased likelihood of vehicle strikes. The remaining EVR species are highly mobile, have large home ranges and/or have abundant preferred habitat in areas adjacent to those that will be impacted.

General potential impacts on fauna are listed below:

- Removal of mature vegetation and tree hollows - a large number of Australian vertebrate fauna species are dependent on tree hollows for shelter. These trees are particularly important in fringing riparian vegetation. Similarly, fallen timber is used as shelter and also as a source of food. The loss of this timber reduces the abundance and diversity of small ground-dwelling fauna.

- Disturbance to seasonal and permanent wetlands - the major impact to wetlands would be changes in hydrology (changes in freshwater inflow and tidal connections). Construction activities may also cause disturbance to fringing vegetation and changes in water quality from sedimentation.
- Disturbance to movement corridors and dry season refugia - Boat Creek and riparian vegetation form a significant movement corridor and refugia for local fauna. The crossings required for this project will result in the removal of the riparian vegetation and thus impact on the movement of fauna.
- Fauna injury or death by vehicle strike - This impact will be relevant during construction activities and during the temporary use of the PAM haul route at various times. The impact on fauna by vehicle strike will be particularly relevant in the Blue Gum woodland area where a large area of remnant vegetation will be traversed by the PAM haul route.
- Unearthing of burrowing fauna during construction - there is potential for direct impact on burrowing fauna during construction activities. Rather than move away during disturbance, these fauna species (including frogs, lizards, snakes and small mammals) remain under the surface and risk being injured or killed.

Measures to minimise impacts to fauna from the Project were discussed within the original Project EIS. Measures specific to the PAM haul route and acid pipeline are presented in **Table 5-6**.

Table 5-6 Fauna Mitigation Measures

Relevant KP	Issue	Mitigation Measures
Full route and 5.5-6.5	Removal of mature vegetation and transect Blue Gum Woodland	If possible, use will be made of existing cleared areas rather than clearing new areas. The clearance footprint will be the minimum width required to safely construct the PAM haul route and acid pipeline. The majority of the pipeline corridor will be left to naturally regenerate in order to provide habitat for fauna and to facilitate fauna movement.
Full route	Clearing of hollow bearing trees	Hollow-bearing trees are potential nesting and roosting habitat for the Little Pied Bat and regionally Significant and common arboreal fauna species. All trees that contain hollows will be retained wherever practicable. Where such trees cannot be retained, the hollow will be plugged with a cloth or hessian bag and carefully removed from the tree with a chainsaw. The hollow will be affixed to a retained tree or left on the ground adjacent to the cleared corridor to provide habitat for ground-dwelling fauna.
Full route	Construction within wetland and catchment	Where construction is proposed within the mudflat and saltpan communities, the haul route design will incorporate culverts or similar to maintain tidal influence within these communities. Erosion and sediment control devices will be installed where there is potential for erosion.
4.2-4.3	Bisect Boat Creek and riparian vegetation	Detailed design and survey will investigate options for crossing Boat Creek at a location that is already disturbed. Consideration will be given to a crossing design that preserves as much existing vegetation as possible and promotes adequate flow through the crossing point.
3.5-5.0; 2.1-7.0; 7.7-7.8	Increased vehicular traffic and road kill	Higher likelihood of vehicle strike during construction phase. Warning signs and speed-limiting on the construction access tracks will be implemented from dusk to dawn when most ground-dwelling fauna are active. The use of exclusionary fencing will be considered at the Boat Creek crossings.
Full acid pipeline route	Regeneration of pipeline corridor post construction	Where possible, natural regeneration of vegetation will be encouraged to reduce the barrier to fauna movement. Spreading of dead timber across disturbed areas within the woodland habitats will be carried out.
Full route	Pest fauna species (mosquito) breeding grounds	Equipment and materials used during construction will be stored in a manner that prevents retention of water. Natural drainage systems will be protected during construction and reinstated immediately following construction.

5.8 AIR AND NOISE

The environmental values of the project area were described in the original EIS and are applicable to the PAM route and acid pipeline.

There are no residences within 500m of the acid pipeline. Residences are located on lot 11 SP108408 (approximately 100m from the PAM haul route) and on lot 1 MPH32292 (approximately 200m from the PAM haul route) (see **Figure 5-1**).

The potential impacts on air quality in the area and the key activities likely to generate the impacts are:

- fugitive dust emissions - movement of construction vehicles on unsealed tracks and roads and construction earthworks, including clearing, grading, excavation, importing fill and rehabilitation work;
- fugitive dust emissions - movement of PAM transport vehicles along the haul route during operations; and
- gaseous emissions - exhaust from vehicles and machinery during both construction and operations.

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 and temporary operational use of the PAM haul route 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.

Potential adverse noise impacts are associated with:

- vehicle and machinery movements during construction of both the PAM haul route and acid pipeline; and
- movements of PAM transport vehicles during temporary use of the PAM haul route.

As the construction activities continually move forward, the result will be a temporary increase in noise levels within the immediate vicinity of the activities at the time. Similarly, use of the PAM haul route will be temporary in nature and will not be a long term nuisance.

GPNL will liaise closely with the residents potentially impacted during construction and operation of the PAM haul route with regards to site specific mitigation measures. Refer also to the draft Pipeline EMP and Refinery EMP for mitigation measures to minimise adverse impacts associated with air and noise emissions.

5.9 CULTURAL HERITAGE

There are a number of culturally sensitive places located along Boat Creek. A cultural resting place and midden have previously been identified and marked. These locations will be avoided during the construction of the PAM haul route.

The PAM haul route and acid pipeline are within an area included in the PCCC native title claim (QC01/29). A Cultural Heritage Management Plan 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 under the *Aboriginal Cultural Heritage Act 2003*. A Cultural Heritage Survey will be undertaken on the PAM haul route and acid pipeline alignment prior to construction commencing.

5.10 COMMUNITY CONSULTATION

Community consultation with relevant stakeholders has taken place. The facilities are located on government-owned land designed for infrastructure corridors. Connell Hatch was contracted by CQPA and the State Government (Department of Infrastructure) to identify a preferred PAM route based on Connell Hatch's understanding of proposed regional development initiatives.

A stage 2 report, funded by GPNL and the State government, sought more specific planning information. Connell Hatch contacted, amongst others, the following parties:

- QR – rail operations and utilisation of rail corridor for potential PAM route earthworks;

- Ergon – powerline realignment (underground);
- Cement Australia - extension of conveyor underpass;
- Rio Tinto – conveyor overpass;
- CQPA – wharf locations and availability of laydown areas
- Orica – ammonia pipeline burial and PAM road overpass

6 LAND USE, PLANNING AND ENVIRONMENTAL APPROVALS

6.1 ENVIRONMENTAL IMPACT ASSESSMENT

The PAM haul route and acid pipeline form part of the GNP, which has been declared a "significant project" under the Queensland *State Development and Public Works Organisation Act (SDPWO Act),* for which an Environmental Impact Statement is required.

The GNP 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 GNP was released for public comment in April 2007. The PAM haul route and acid pipeline were not included in the original EIS. This report has 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 PAM haul route and acid pipeline to be incorporated into the overall project. Refer to Section 1.8 of the Project EIS for additional information regarding this process.

6.2 LAND USE PLANNING

6.2.1 Gladstone State Development Area

The acid pipeline and PAM route are contained within the GSDA. Land use approvals within the GSDA are managed by the Coordinator General 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 Coordinator-General is the decision maker for development applications under the Development Scheme.

The acid pipeline is located within the Yarwun and Materials Transportation and Services Corridor Precincts of the GSDA. Under Schedule 1 of the GSDA Development 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. Therefore, the proposed pipeline fits the description of "materials transport infrastructure'.

The PAM haul route transects land identified as the "Stuart Oil Shale Reserve Preservation Area" within the GSDA. Under the Development Scheme, the purpose of this area is to:

- Recognise the prime areas of the Stuart Oil Shale Resource within the GSDA.
- Identify mining as the primary land use within this area.

Advice from the Coordinator General is that this proposal is not considered to conflict with this purpose.

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

6.2.2 Strategic Port Land

0.5km of the acid pipeline and 2km of the PAM Haul Route are located on Strategic Port Land, as defined under the *Transport Infrastructure Act 1994*. Strategic Port Land is not subject lo local government planning schemes. The Central Queensland Port Authority regulates development on Strategic Port Land and is the assessment manager for applications. Where proposals are considered to be inconsistent with the Port's Land Use Plan, approval of the Minister for Transport is required.

6.3 OTHER PRE-CONSTRUCTION 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 original Project EIS. Additional approvals that will be applicable to the PAM haul route and acid pipeline include:

- Permit to clear vegetation under *the Vegetation Management Act 1999;*
- Permit to remove marine plants or construct a waterways barrier under *the Fisheries Act 1994;*
- Approval for ancillary works and encroachments under the *Transport Infrastructure Act 1994;*
- Approval for operational works in a tidal area under the *Coastal Protection and Management Act 1995*;
- Approval for works Development below high water mark, within the limits of a Port under the *Transport Infrastructure Act 1994*;
- Approval for development where the land, soil and sediment is at or below 5m AHD under State Planning Policy 2/02 (Acid Sulfate Soils)
- 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*; and
- Permit to disturb/interfere with items of cultural heritage significance under the *Aboriginal Cultural Heritage Act 2003*.

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.

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URS, 2003. Chlor Alkali/Ethylene Dichloride Plant Gladstone Environmental Impact Statement. Prepared for LG Chem.

Appendix 1

Supplementary Soil, Geology and Topography Report, Gladstone Pacific Nickel Project Acid Pipeline

HLA - Envirosciences Pty Ltd

Supplementary Soil, Geology and Topography Report Gladstone Pacific Nickel Project Acid Pipeline

4 December 2007

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DISTRIBUTION

Supplementary Soil, Geology, and Topography Report
Gladstone Pacific Nickel Project Acid Pipeline
4 December 2007

Copies	Recipient	Copies	Recipient
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This document was prepared for the sole use of RLMS, Gladstone Pacific Nickel and the regulatory agencies that are directly involved in this project, the only intended beneficiaries of our work. No other party should rely on the information contained herein without the prior written consent of HLA-Envirosciences Pty Limited (HLA ENSR) and Gladstone Pacific Nickel Limited.

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CONTENTS

TABLES

FIGURES

ATTACHMENTS

EXECUTIVE SUMMARY

The soil, geological resources and topography of the proposed alignment for the GPN acid pipeline was 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 that 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 8 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:

- Areas of low-lying poorly drained lower slopes, drainage flats with intermittent stream channels and depressional drainageways; marine extratidal and supratidal flats; periodically floodprone or inundated; slopes mostly <0.5%. Approximately 61% of the alignment traverses these types of landforms;
- Reclaimed land – imported fill material. Approximately 39% of the alignment traverses this landform type (from approximately KP 0.5 to KP 1.8; and from approximately KP6.5 to KP 8); and
- Seasonal or permanent swamps, tidal lands and drainage-ways; areas subject to regular inundation. Less than 1% (in the vicinity of KP 6.3) of the alignment traverses these types of landforms.

The above calculations are based on the assumption that the proposed Central Queensland Ports Authority (CQPA) reclamation area (in which the alignment is situated from KP 6.5 to >KP 8) is completed prior to construction of the GPN acid pipeline.

Elevation ranges from approximately 3 mAHD at KP 0 to approximately 10 mAHD at KP8. The alignment is relatively flat. No section of the alignment traverses slopes greater than 4%.

The alignment encounters Quaternary alluvium and residual sediments underlain by Late-Devonian – Early Carboniferous geology of both the Wandilla and Doonside Formations, part of the Curtis Island Group.

Holocene estuarine sediments, consisting of mud, sandy mud, muddy sand and minor gravel, underly soils and imported fill for approximately 65% of the pipeline alignment. The alignment also encounters Quaternary residual soils (24%) and alluvium (11%).

Gladstone lies on the northern edge of what appears to be a high seismicity belt stretching from Brisbane to Gladstone. The proposed alignment crosses an inferred fault in the approximate location between KP 7 and KP 8. This fault may be susceptible to movement due to increased seismicity in this part 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 generalised soil data. The proposed pipeline alignment traverses two types of mapped land systems. Soils include red duplex soils, saline cracking clays, saline muds and sands. 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. The pipeline alignment falls within areas mapped as indicative for ASS. The likelihood of occurrence of ASS along the alignment is generally high, especially within those sections which pass through marine extra-tidal flats (including KP 0 to KP 0.5; KP 2 to KP 3; KP 4.5), supratidal coastal flats (including KP 4.5 to KP 6.5) and tidal lands (in the vicinity of KP 6.3).

Where pipeline construction activities are likely to intersect potential acid sulphate soil (PASS) environments, a site investigation, soil sampling and testing programme will be undertaken prior to surface disturbance. This will determine the vertical and lateral extent of any ASS materials and the resultant level of environmental impact which may arise should any such materials be disturbed and become fully oxidised. If ASS are encountered, a comprehensive ASS management program would be implemented to prevent any adverse environmental impacts. Possible management strategies may include:

- Avoidance of particular locations;
- Minimisation of acid leachate in stockpiled soils by minimising the amount of time the excavated soils are stockpiled;
- Lime treatment of excavated material;
- Disposal of trench water to appropriate disposal receptor;
- Surface liming of (short-term) excavated temporary soil stockpiles, together with monitoring and neutralising of any acidic leachates prior to discharge;
- Strategic burial of PASS material below permanent water / groundwater table;
- The use of a low permeability zone within and beyond the width of the trench backfill to reduce the potential for percolation of surface water; and
- Compaction of trench backfill to ensure that the trench does not provide a permeable pathway for acid leachate migration and that permanent lowering of the water table does not occur.

Available erodible soils mapping has enabled the identification of areas most susceptible to soil erosion along the proposed alignment. Approximately 6 km of the alignment is identified as having soils with a moderate-high susceptibility to erosion (i.e. moderate-low erosion resistance). These areas will require particular attention in terms of soil erosion control measures in order to prevent soil degradation.

Soil sampling undertaken as part of various projects across the broader study area indicates soil sodicity to be highly variable. Quaternary marine deposits constitute approximately 46% of the geology encountered along the acid pipeline alignment. Quaternary marine deposits of the study area sampled by URS (2003) exhibited slight to moderate dispersion characteristics (Emerson Stability Classes 2, 3 and 5).

The review of Good Quality Agricultural Land (GQAL) mapping indicates that the proposed acid pipeline alignment falls entirely within Land Class D – Non-agricultural land. This land is deemed not suitable for agricultural uses and may comprise 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.

No sites of chemical contamination were observed during the limited field investigations undertaken; however, the potential sources are likely limited to hydrocarbon and pesticide contamination from road and railway crossings.

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 practices that reduce soil erosion and sedimentation should be adopted (e.g. erosion banks, sediment trapping devices etc.);
- 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 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 the need for an acid system involving two acid storage tanks at Fishermans Landing and a pipeline connecting the tanks to the Refinery. An environmental assessment of this acid pipeline route is required for inclusion 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 acid pipeline alignment extending from Fishermans Landing to the Refinery (**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 previous 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).

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2 SCOPE OF WORKS

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

- Describe the topography of the alignment corridor;
- Describe the geology of the alignment corridor and identify geological hazards and features which may impact construction, or be impacted by construction;
- Describe the soils of the 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 acid pipeline alignment were identified. Topography was assessed using a combination of topographic mapping and aerial photography. Landforms and slopes were assessed in the context of potential instability and engineering constraints.

The geology of the project area was assessed primarily according to the 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). Geological structure was determined from these sheets. Seismic activity in 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 Chlor Alkali / Ethylene Dichloride Plant Gladstone Environmental Impact Statement (URS, 2003) and the Gladstone Pacific Nickel Environmental Impact Statement (URS, 2007). Soils mapping was also 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 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; and
- URS, 2003. *Chlor Alkali / Ethylene Dichloride Plant Gladstone Environmental Impact Statement*. Prepared on behalf of LG Chem.

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

The Queensland Universal Soil Loss Equation (USLE) K-factor data was 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 general erosion potential for each site was determined by a combination of field observation (during the flora and fauna site assessments) 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 TOPOPGRAPHY

The topography of the pipeline alignment is shown in **Figure F3**. The alignment is dominated by the following landforms:

- Areas of low-lying poorly drained lower slopes, drainage flats with intermittent stream channels and depressional drainageways; marine extratidal and supratidal flats; periodically floodprone or inundated; slopes mostly <0.5%. Approximately 61% of the alignment traverses these types of landforms;
- Reclaimed land – imported fill material. Approximately 39% of the alignment traverses this landform type (from approximately KP 0.5 to KP 1.8; and from approximately KP 6.5 to KP 8); and
- Seasonal or permanent swamps, tidal lands and drainage-ways; areas subject to regular inundation. Less than 1% (in the vicinity of KP 6.3) of the alignment traverses these types of landforms.

The above calculations are based on the assumption that the proposed Central Queensland Ports Authority (CQPA) reclamation area (in which the alignment is situated from KP 6.5 to >KP 8) is completed prior to construction of the GPN acid pipeline.

The entire alignment falls below 20 mAHD and ranges from approximately 3 mAHD at KP 0 to approximately 10 mAHD at KP 8.

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**. No section of the alignment exceeds slopes of 4%.

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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 Quaternary alluvium and residual sediments underlain by Late-Devonian – Early Carboniferous geology of both the Wandilla and Doonside Formations, part of the Curtis Island Group. The geology of the Late Palaeozoic comprises sediments including limestone and calcareous sandstones and conglomerate of marine shelf origin with felsic to basaltic volcanics.

The geology of the proposed pipeline alignment is presented in plan view as **Figure F5**. **Table 1** describes the geology traversed by the proposed alignment.

Table 1: Geology Descriptions of the Pipeline Alignment

Approx KP	Geological Unit[1]	Description[1]
0-2	Qhe	Mud, sandy mud, muddy sand and minor gravel; estuarine channels and banks, supratidal flats and coastal grasslands.
2-3	Qa / Qhe / Qrs	Qa – Clay, silt, sand, gravel; floodplain alluvium. Qhe – As above Qrs - Sand, silt, mud, gravel; residual soil
3-4	Qrs	As above
4-5	Qa / Qhe / Qrs	As above
5-8	Qhe	As above

1. Gladstone 1:100 000 Geological Special (NRM, 2001).

The proposed alignment crosses an inferred fault in the approximate location between KP 7 and KP 8. This fault may be susceptible to movement due to increased seismicity in this part of the study area.

5.1 Surface Rock

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

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6 LAND SYTEMS

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

Table 2: Land System Mapping Descriptions

Approx KP	Land System[1]	Description
0-3	Carpentaria[1]	Marine plains with extensive bare tidal flats inundated by tidal waters and dissected by tidal channels. Crusting surface, grey mottled, saline cracking clays; saline muds and sands.
3-4	Fanside[1]	Undulating footslopes and rises on sedimentary rocks. Red, structure gradational clay loams, and uniform clays. Red duplex soils.
4-8	Carpentaria[1]	As above

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

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7 SOILS

The soils of an area that includes the alignment were mapped by URS in 2003 as part of the EIS prepared for the proposed LG Chem Gladstone Chlor Alkali / Ethylene Dichloride Plant. The soils are described in relation to the geological units in which they occur (**Attachment B**).

The mapped soils that are traversed by the acid pipeline alignment are as follows:

- **Soils Associated with the Quaternary Marine Deposits (Qm)** – In general these soil comprise uniform fine or medium-textured crusting surface dark grey brown to dark brown and pale grey mottled saline clays and silty clay, saline muds and sands. They occur on mangrove flats and within tidal inlets, tidal salt flats with samphire or with saltwater couch grassland plains along the landward margins of the marine deposits.
- **Soils Associated with the Quaternary Alluvial Deposits (Qa)** – A complex association of soils occurs on alluvial flats, floodplains, intermediate terraces and higher alluvial plains. In general, they comprise silty to loamy surface duplex soils often with a pale or bleached A2 subsurface horizon underlain by slightly acidic to slightly alkaline, grey and yellowish brown sodic clay subsoils which occur on the intermediate and higher alluvial plains and terraces.

  On the lower-lying alluvial flats, a complex association of silty to clay loamy surface duplex soils occurs which have neutral to slightly alkaline brown sodic clayey subsoils. These occur locally in association with deep dark coloured cracking clay soils that have sodic mostly alkaline heavy clay subsoils. These are highly reactive soils that are subject to substantial swelling when wet and shrinkage and cracking when dry.
- **Soils Associated with the Quaternary Residual Soil / Alluvial Fan Deposits (Qr)** – These soils may vary depending on the topographic position in the soil landscape and tend to become somewhat finer-textured (more clayey) downslope. The surface soils comprise dark brown slightly acidic gravely sandy loam to clay loam, and grade to gravely sandy clay loam or light clayey subsoils which tend to become somewhat dispersive with depth. On the lower less well-drained sectors of the terrain unit, the soils may comprise siliceous or ferruginous gravely silty to loamy surface duplex soils with bleached sub-surface (A2) soil horizons and diffusely mottled clayey subsoils.
- **Reclaimed Land (Dr)** – Imported fill material.

7.1 Acid Sulphate 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. This layer can range in texture from clay to sand and is usually dark grey and soft. The water prevents 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 lowlands such as mangrove tidal flats, salt marshes or in tea-tree swamps.

The pipeline alignment falls within areas mapped as indicative for ASS according to the 1:50 000 ASS mapping (**Figure F7**) for the Tannum Sands – Gladstone area (Ross, 2004).

The likelihood of occurrence of ASS along the alignment is generally high, especially within those sections which pass through marine extra-tidal flats (including KP 0 to KP 0.5; KP 2 to KP 3; KP 4.5), supratidal coastal flats (including KP 4.5 to KP 6.5) and tidal lands (in the vicinity of KP 6.3).

7.2 Sodic Soils and Dispersion

Sodicity is a measure of the proportion of sodium ions present in a soil. It 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%.

At high sodicity, soils have a tendency to lose aggregation and to develop clay dispersion, impermeability, surface crusting, and poor aeration, i.e. lead to soil erosion, (Baker and Eldershaw, 1993).

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 (**Figure F2**).

Soil sampling undertaken by URS across the Refinery site (**Attachment A**) 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.

Soil sampling undertaken across the RSF site (**Attachment A**) and reported in the GNP EIS indicate 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.

Quaternary marine deposits constitute approximately 46% of the geology encountered along the acid pipeline alignment. URS (2003) reported on soils of the locality, including the section of alignment extending from KP 0 to approximately KP 6.5 (**Attachment B**). URS found the Quaternary marine deposits of the locality to be mostly deep non-gravelly and strongly saline soils. The Quaternary marine deposits sampled by URS exhibited slight to moderate dispersion characteristics (Emerson Stability Classes 2, 3 and 5).

7.3 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 along the alignment to erosion ranges from moderate-low to moderate-high. Approximately 6 km of the alignment is identified as having soils with a moderate-high susceptibility to erosion (i.e. moderate-low erosion resistance).

7.4 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 (for flora and fauna) undertaken by HLA ENSR in August 2007.

7.5 Salinity

Quaternary residual sediments sampled by URS (and reported in the GPN EIS, 2007) indicated low levels of salinity (<0.44 mS/cm) in the deeper clayey subsoil horizons. URS (2003) reported that the Quaternary marine deposits of the locality are strongly saline. The Quaternary marine deposits, which constitute approximately 46% of the soils / geology encountered along the acid pipeline alignment, are subject to marine influence and are likely to be saline at least in the surficial soil horizons.

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8 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 3** (from *Planning Guidelines, The Identification of Good Quality Agricultural Land*, DHLGP, 1993).

Table 3: 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); and
- Agricultural Land Classes for Central Queensland Coast Horticultural Lands Project - (http://tpscheme.dz1.calliope.qld.gov.au/Shared_Maps/Guide%20Line%20Map%202.pdf).

The proposed acid pipeline alignment lies entirely within Land Class D – Non-agricultural land. This land is deemed not suitable for agricultural uses and may comprise 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.

9 CONTAMINATED LAND

Observations and experience have been used to determine the likely presence of sources of contamination along the proposed alignment. The alignment crosses the Gladstone - Mount Larcom Road at approx. KP 6.5. Hydrocarbon contamination, and herbicide residues associated with weed control, may be a potential problem at this point. The likelihood of other forms of contamination being present (such as 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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10 SEISMIC ACTIVITY

Gladstone lies on the northern edge of what appears to be a high siesmicity 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).

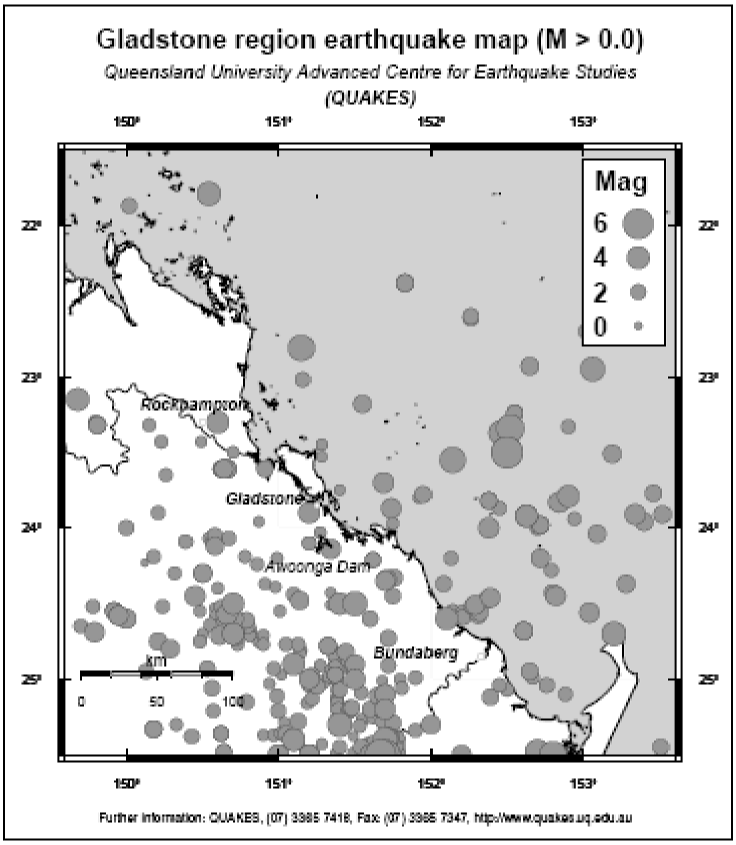

Figure 9: Gladstone Region Earthquake Map

The proposed alignment crosses an inferred fault in the vicinity of KP 7.5. This fault may be susceptible to movement due to increased seismicity in this part of the study area.

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11 IMPACTS AND MITIGATION MEASURES

11.1 Topsoil and Subsoil Management

In the majority of areas along the proposed 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 alluvial, colluvium and sedimentary derived soils of the alignment, a thickness of 25 cm is considered 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 any 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 track 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.

Topsoil should not be used for backfill, 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.

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 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. 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.

11.2 Acid Sulfate Soils

The likelihood of occurrence of ASS along the alignment is generally high.

Where pipeline construction activities are likely to intersect PASS environments, a site investigation, soil sampling and testing programme will be undertaken prior to surface disturbance. This will determine the vertical and lateral extent of any ASS materials and the resultant level of environmental impact which may arise should any such materials be disturbed and become fully oxidised (AASS). If ASS are encountered, a comprehensive ASS management program would be implemented to prevent any adverse environmental impacts. Possible management strategies may include:

- Avoidance of particular locations;
- Minimisation of acid leachate in stockpiled soils by minimising the amount of time the excavated soils are stockpiled;
- Lime treatment of excavated material;
- Disposal of trench water to appropriate disposal receptor;
- Surface liming of (short-term) excavated temporary soil stockpiles, together with monitoring and neutralising of any acidic leachates prior to discharge;
- Strategic burial of PASS material below permanent water / groundwater table;
- The use of a low permeability zone within and beyond the width of the trench backfill to reduce the potential for percolation of surface waters; and
- Compaction of trench backfill to ensure that the trench does not provide a permeable pathway for acid leachate migration and that permanent lowering of the water table does not occur.

11.3 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. 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.

11.3.1 Slope management

Trench breakers (e.g. cement filled sandbags) should be installed at regular intervals on 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.

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.

11.3.2 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 (if 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.

11.3.3 Ancillary facilities and access tracks

Erosion control measures should be implemented in the planning, installation and restoration of ancillary pipeline facilities. Topsoil management, management of runoff and careful restoration will be required for any 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.

11.3.4 Revegetation

Revegetation issues are addressed in the Flora and Fauna Report.

11.3.5 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 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.

An additive such as *Dustmag* 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.

11.4 Contaminated Land

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:

- 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.

12 LIMITATIONS

This assessment of soil conditions along the pipeline is based on coarse resolution 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 the mapped areas may vary considerably.

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Figures

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PROJECT NUMBER	B6018400302
DATE	August 2007
DRAWN	CS
VERSION	A

Legend

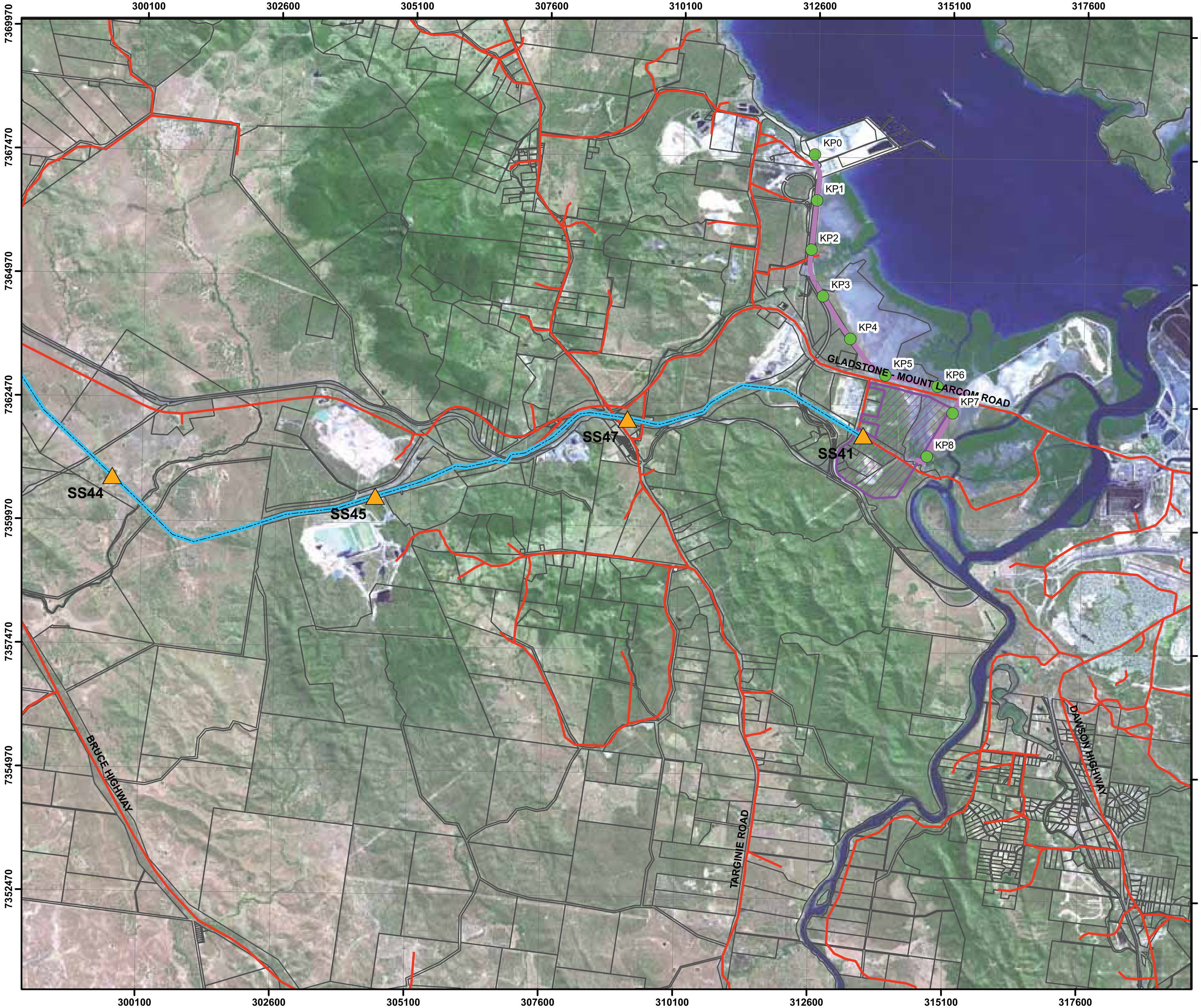
- GPN Acid Pipeline
- KPs (1km)
- Yarwun Refinery
- Roads
- DCDB

Source:
Alternate Acid Pipeline, Yarwun Refinery, & imagery supplied by RLMS. 2007. (c) RLMS, 2007.
DCDB & roads sourced from the Department of Natural Resources & Water, 2005. (c) NRW, 2007.

GPN Acid Pipeline Locality
RLMS
Alternative Acid Pipeline Route
Gladstone

HLA

Figure
F1



PROJECT NUMBER B6018400302
DATE August 2007
DRAWN CS
VERSION A

Legend

- Soil Sampling Sites
- Acid Pipeline
- KPs (1km)
- Former Alignment Option
- Yarwun Refinery
- Roads
- DCDB

N

Datum GDA94 56s

0 0.45 0.9 1.8 2.7

Kilometres

1:30,000 at A3

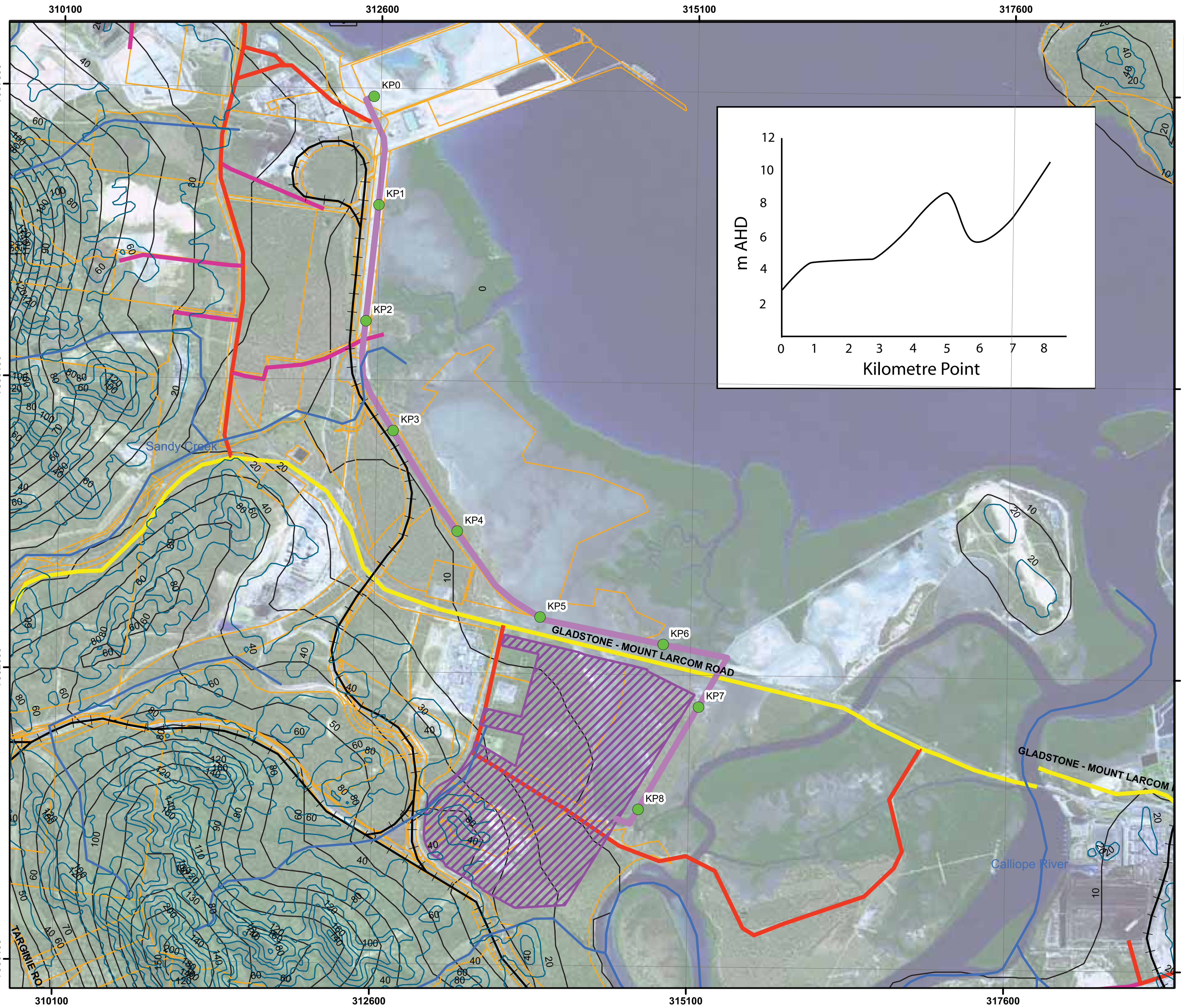
Source:
Alternate Acid Pipeline, Yarwun Refinery, & imagery supplied by RLMS. 2007. (c) RLMS, 2007.DCDB & roads sourced from the Department of Natural Resources & Water, 2005. (c) NRW, 2007.

Acid Pipeline Soil Survey Sites
RLMS
Alternative Acid Pipeline Route
Gladstone

HLA

Figure

F2



PROJECT NUMBER B6018400302
DATE August 2007
DRAWN CS
VERSION A

Legend

- GPN Acid Pipeline
- KPs (1km)
- Yarwun Refinery

Roads

- Minor Road
- Principal Road
- Track
- DCDB
- Railway Line
- Contours
- Waterways

N

Datum GDA94 56s

0 0.2 0.4 0.8 1.2
Kilometres
1:30,000 at A3

Source:
Alternate Acid Pipeline, Yarwun Refinery & imagery supplied by RLMS. 2007. (c) RLMS, 2007.
Contours, DCDB, roads & railway sourced from the Department of Natural Resoures & Water, 2005. (c) NRW, 2007.

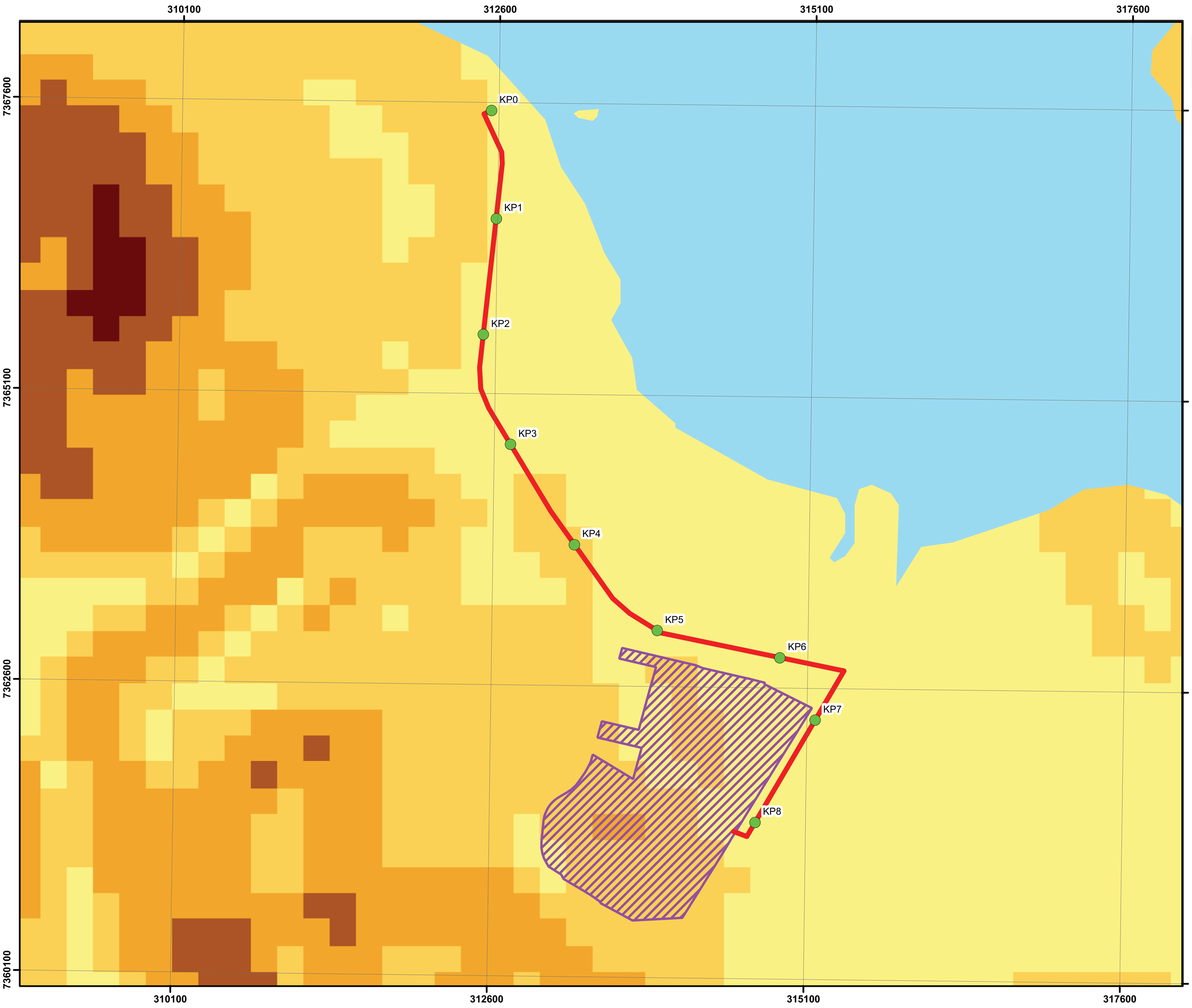
GPN Acid Pipeline Topography RLMS

Alternative Acid Pipeline Route
Gladstone

HLA

Figure

F3



PROJECT NUMBER B6018400302
DATE August 2007
DRAWN CS
VERSION A

Legend

GPN Acid Pipeline

KPs (1km)

Yarwun Refinery

Slope

0 - 2%

3 - 4%

5 - 10%

11 - 80%

> 80%

N

Datum GDA94 56s

0 0.2 0.4 0.8 1.2

Kilometres

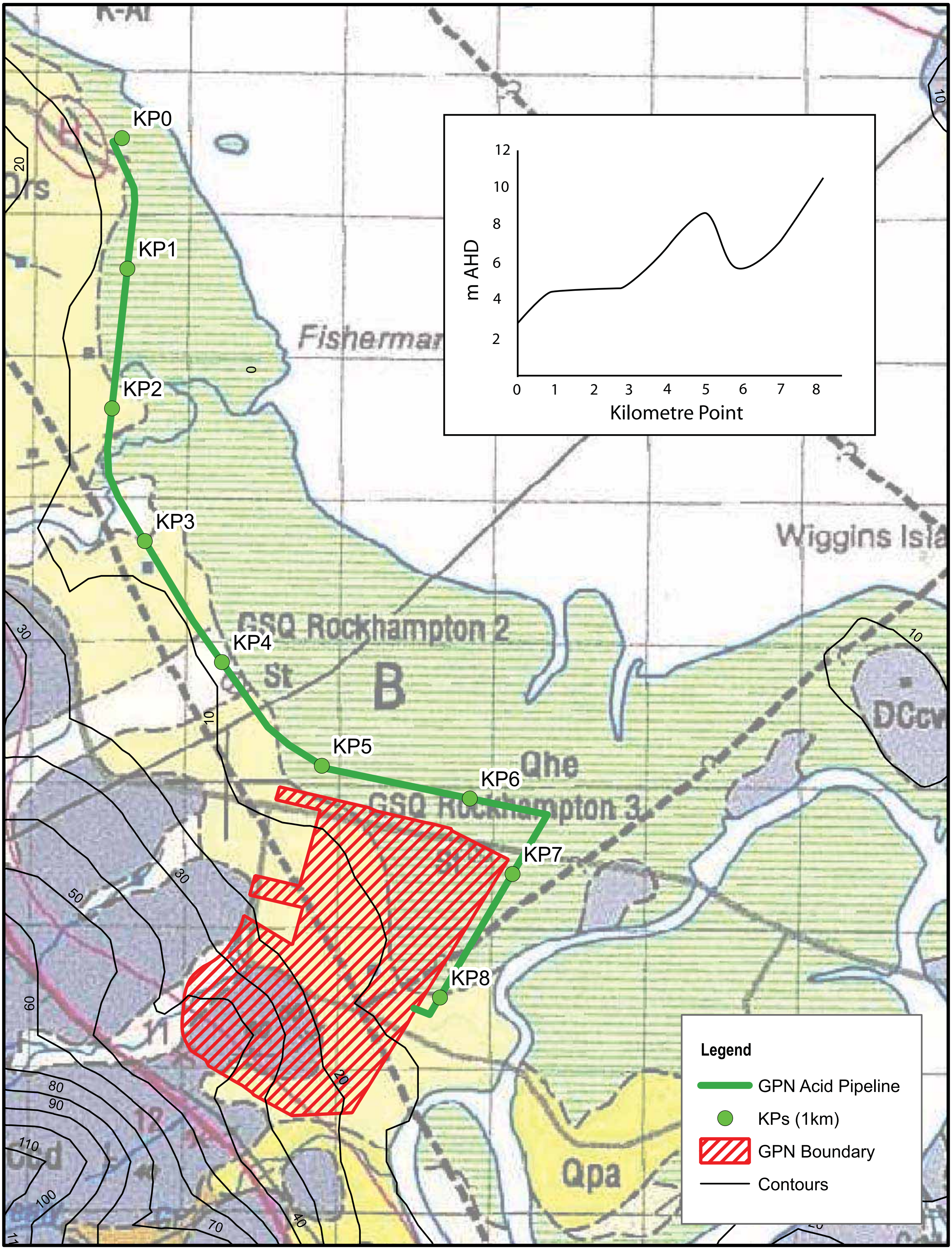
1:30,000 at A3

Source:
Alternate Acid Pipeline & Yarwun Refinery supplied by RLMS. 2007.
(c) RLMS, 2007.
Based on or contains DEM data sourced from the Department of Natural Resources & Water, 2005. (c) NRW, 2007.

GPN Acid Pipeline Slope Analysis
RLMS
Alternative Acid Pipeline Route
Gladstone

HLA

Figure
F4



HLA

GPN Acid Pipeline Geology and Cross-section
RLMS
Alternative Acid Pipeline Route
Gladstone

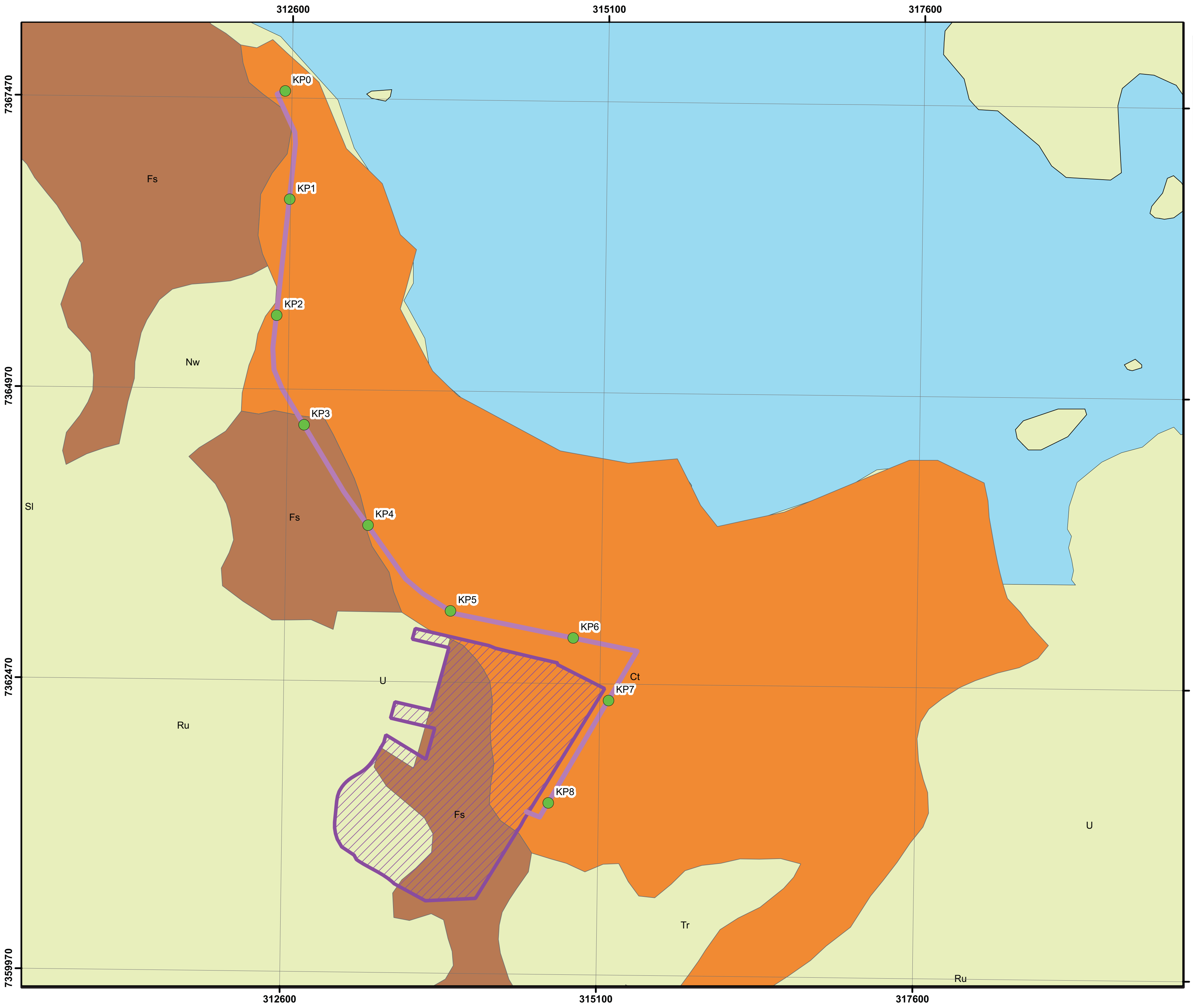
0 0.2 0.4 0.8 1.2
Kilometres
1:35,000 at A4

Source:
Alternate Acid Pipeline & GPN Boundary supplied by RLMS, 2007. (c) RLMS, 2007. Geology data sourced from the Department of Natural Resources & Water, 2001. (c) NRW, 2007. Based on or contains DEM data provided by the Natural Resources & Water, 2005. (c) NRW, 2007.

N
Datum
GDA94 56s

Figure
F5

PROJECT NUMBER B6018400302 | DATE August 2007 | DRAWN CS | VERSION A



PROJECT NUMBER B6018400302
DATE August 2007
DRAWN CS
VERSION A

Legend

GPN Acid Pipeline
KPs (1km)
Yarwun Refinery

Landsystems

Carpentaria
Fanside

N

Datum GDA94 56s

0 0.2 0.4 0.8 1.2
Kilometres
1:30,000 at A3

Source:
Alternate Residue Yarwun & Yarwun Refinery supplied by RLMS. 2007. (c) RLMS, 2007.Land systems data sourced from the Department of Natural Resources & Water, 2005. (c) NRW, 2007.

GPN Acid Pipeline Land Systems RLMS
Alternative Acid Pipeline Route
Gladstone

HLA

Figure
F6

PROJECT NUMBER	B6018400302
DATE	August 2007
DRAWN	CS
VERSION	A

Legend

- Indicative locations of Acid Sulfate
- Alternate Acid Pipeline
- KPs (1km)
- Yarwun Refinery
- Roads
- DCDB

N

Datum GDA94 56s

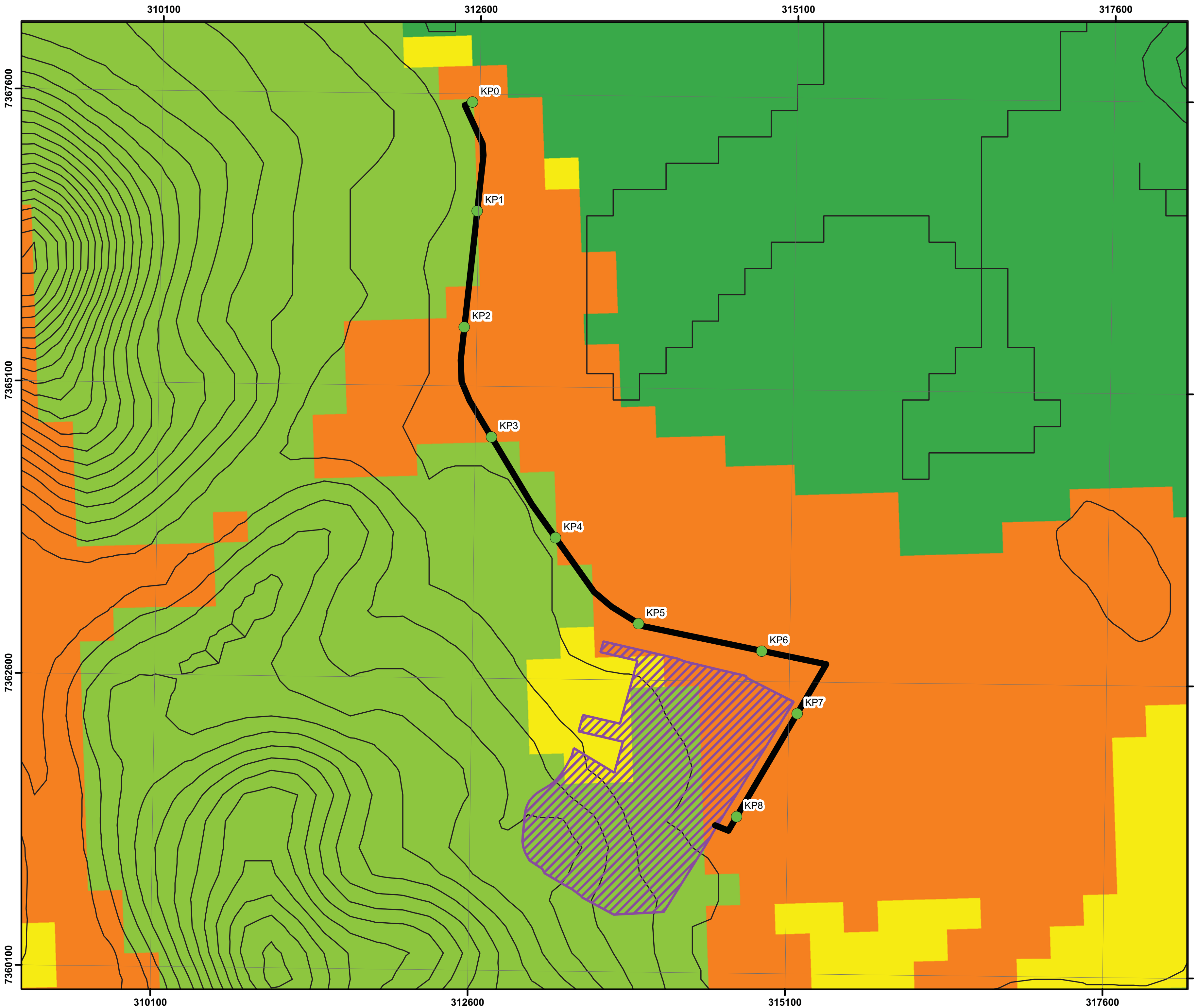
0 0.2 0.4 0.8 1.2
Kilometres
1:65,000 at A3

Source:
Alternate Acid Pipeline, Yarwun Refinery, & imagery supplied by RLMS. 2007. (c) RLMS, 2007. Acid Sulfate, DCDB & roads data sourced from the Department of Natural Resources & Water, 2005. (c) NRW, 2007.

GPN Acid Pipeline Acid Sulfate RLMS
Alternative Acid Pipeline Route
Gladstone

HLA

Figure
F7



PROJECT NUMBER B6018400302
DATE August 2007
DRAWN CS
VERSION A

Legend

GPN Acid Pipeline
KPs (1km)
RSF Boundary
Yarwun Refinery
Contours

Erosion Resistance

High
Medium High
Medium
Medium Low
Low

N

Datum GDA94 56s

0 0.2 0.4 0.8 1.2
Kilometres
1:30,000 at A3

Source:
Alternate Residue Yarwun & Yarwun Refinery supplied by RLMS. 2007. (c) RLMS, 2007. Based on or contains data provided by the Natural Resources & Water, 2005. (c) NRW, 2007.

GPN Acid Pipeline Erodibility
RLMS
Alternative Acid Pipeline Route
Gladstone

HLA

Figure
F8

Attachment A: Terrain Units and Soil Types Identified in URS, 2007

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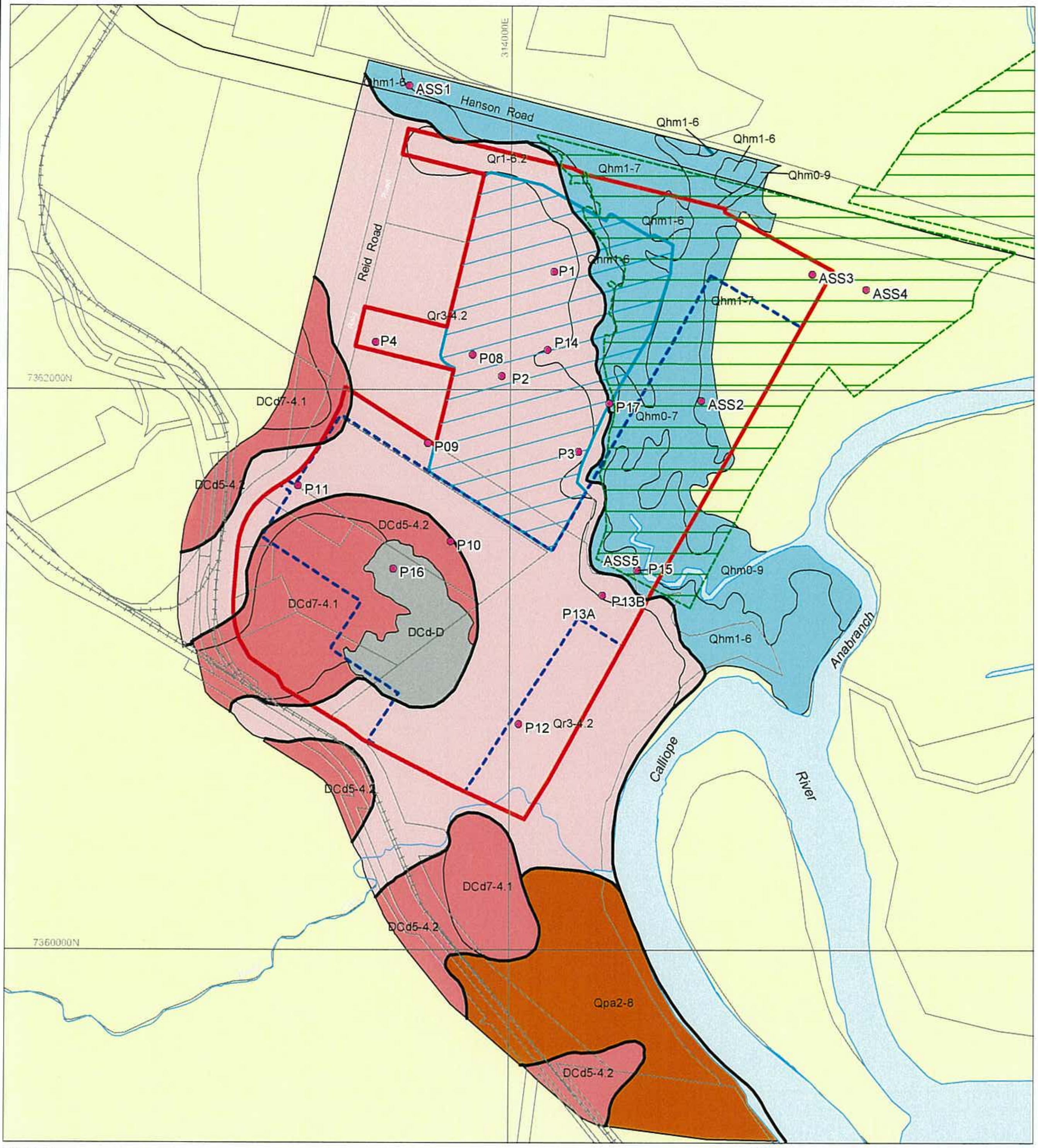


NOTE:
This Figure 8.1.2a must be viewed with Figure 8.1.2b (Terrain Units Identification Key)

0 250m 500m
Scale 1:20 000 (A4)
MGA Z56, GDA94

P08 Soil sampling location
Geological Regime Boundary
Cr4-6.2 Terrain Unit and Terrain Unit Boundary

Refinery Site Boundary
Proposed Development Footprint
Potential construction pad area (Stage 3)
Proposed CQPA reclamation area

Client	Project	Title
Gladstone Pacific Nickel Ltd	GLADSTONE NICKEL PROJECT ENVIRONMENTAL IMPACT STATEMENT	TERRAIN UNITS AND GEOLOGICAL REGIMES - REFINERY SITE
URS	Drawn: VH · Approved: CMP · Date: 23-10-06 · Job No: 4262 5791 · File No: 42625791-g-054b.wor	Figure: 8.1.2a · Rev: B · A4

Key to the Identification of Terrain Units

Geological Regime

Symbol	Formation/Lithology
Qa	Quaternary:- creek and floodplain alluvial deposits; clay silt, sand and gravel.
Qpa	Quaternary Pleistocene:- older alluvium on higher terraces; clay sand mud and gravel commonly with melon hole gilgai
Qr	Quaternary:-residual soils and colluvial deposits: clay, silt, sand and gravel.
Qhm	Quaternary Holocene:- estuarine coastal flats, supratidal flats and coastal grass-lands; saline mud, muddy sand, silt and clays
TQr	Tertiary-Quaternary:-alluvio-colluvial deposits and residual soils; clay, silt, sand, gravel
PRg	Late Permian-Early Triassic Intrusives:- grey fine to coarse-grained porphyritic gabbro, hornblende quartz biotite`diorite
CPk	Permian-Carboniferous Berserker Group: - mudstone, siltstone, felsic volcaniclastic sandstone and conglomerate, minor limestone and rhyolitic ignimbrite
Cr	Early Carboniferous Rockhampton Group :- dark grey sandstone, siltstone, poly-mictic conglomerate, oolitic limestone
DCd	Devonian-Carboniferous Doonside Form-ation:- chert, jasper, siltstone, sandstone, tuff, limestone and altered basalt
DCa	Devonian-Carboniferous Mt. Alma Form-ation:- thinly interbedded fine-grained sandstone, siltstone and conglomerate

Landform

Class	Description – Surface Form and (Slope Range)
0	Seasonal or permanent swamps, tidal lands and drainage–ways; areas subject to regular inundation.
1	Low-lying poorly drained lower slopes, drainage flats with intermittent stream channels and depressional drainageways; estuarine/marine extratidal and supratidal flats; periodically floodprone or inundated; slopes mostly <1%.
2	Alluvial plains, terraces, outwash and residual plains; slopes <2%- frequently <1%; areas infrequently floodprone or inundated; some locally poorly drained areas.
3	Gently undulating higher plains and colluvial footslopes; slopes of up to 3%.
4	Near level to undulating erosional surfaces; broadly rounded crestal surfaces separated by depressional erosion gullies and ill-defined drainageways slopes mostly in the range of 3 to 5%.
5	Undulating rises and planar-concave footslopes (typically flanking steeper hills); broadly rounded dissection slope interfluves and irregular low rounded rises; slopes up to12% mostly in the range of 3 to 7%
6	Rolling to moderately steep hilly lands and rises mostly with planar to broadly rounded hill slopes and dissection slope interfluves; slopes typically 12 to 25% locally steeper.
7	Moderately steep to steep dissected low hilly lands; with ridge and spur slopes up to 35% , locally steeper in dissection gullies
8	Mostly steep to very steep higher hilly lands, with locally sharply incised erosion gullies; hill and ridge slopes are typically convex to planar mostly in a range 25 to 50%.
D	Disturbed lands modified by cut and/or fill operations or existing industrial development activities.

Example :- Terrain Unit (Cr 6-6.1)

Cr	*6*	*- 6.1*
Geological Regime	*Landform*	*Soil Type*

Soil Class

Class	Soil/Material Type
1	Predominantly rocky or coarse gravelly residual, colluvial or alluvial soils (K-Uc to K-Um) - *Rudosols*
2	Coarse textured sandy soils (Uc) – siliceous or calcareous sands - *Rudosols*
3	Sandy to silty medium to coarse-textured soils, earthy sands-sandy earths (Uc-Um2-4) - *Tenosols*.
4	Silty to loamy mostly medium-textured soils, uniform or gradational profiles (Um1-7 or Gn1-2) -*Kandosols*.
5	Sandy to silt loamy surface duplex soils mostly with acidic to alkaline non to low sodic, non-saline clay or sandy clay subsoils (Dr-Db-Dy): - *Chromosols*
6	Silty or clay loamy surface duplex soils with strongly acidic or strongly alkaline, sodic often saline clay subsoils (Dr-Db-Dy) - *Kurosols, Sodosols*
7	Uniform or weakly gradational (non-cracking) clay or silty clay soils (incipient cracking clays) (Uf6, Gn3-4): *Dermosols, Ferrosols*
8	Uniform (cracking) grey, brown or red clay soils (Ug1 – Ug5); - *Vertosols*
9	Organic soils with organic rich or peaty surface horizons (O), saline clays or muds, seasonally or permanently saturated – *Organosols, Hydrosols.*

Note:

1. Dual symbols for soil type, eg.(4-5) indicate that both material types or integrades between the two types occur within the mapping unit.

2. Soil types designated 4.1, 5.1, 6.1, 7.1 etc. indicate shallow soil variants (<0.6m) mostly underlain by HW Rock
Soil types designated 4.2, 5.2, 6.2, 7.2 etc., indicate the occurrence of medium deep (0.6-1.2m) or deep (1.2-1.5m+) soil variants over HW Rock or other substrate materials.

Client: Gladstone Pacific Nickel Ltd

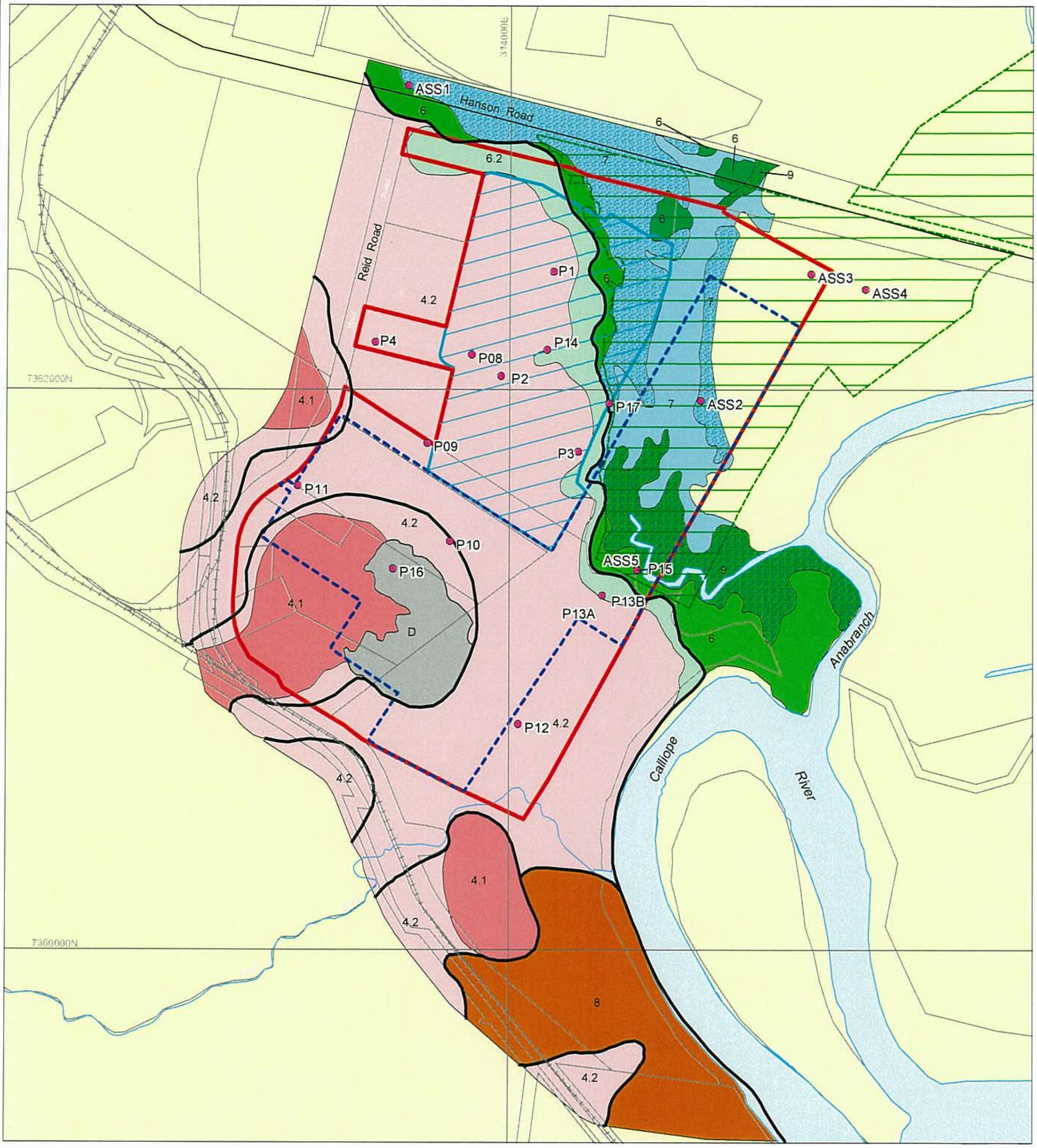
URS

Project: GLADSTONE NICKEL PROJECT ENVIRONMENTAL IMPACT STATEMENT

Title: **IDENTIFICATION KEY - TERRAIN UNITS**

Drawn: VH	Approved: CMP	Date: 23-10-06
Job No: **4262 5791**	File No: 42625791-g-054b.wor	

Figure: **8.1.2b** Rev:B A4



NOTE:
This Figure 8.1.3a must be viewed with Figure 8.1.3b (Legend - Soil Mapping Units - Refinery Site)

0 250m 500m
Scale 1:20,000 (A4)
MGA Z56, GDA94

P12 ● Soil sampling location

Geological Regime Boundary

8 Terrain Unit Boundary and Soil Mapping Unit

Refinery Site Boundary

Proposed Development Footprint

Potential construction pad area (Stage 3)

Proposed CQPA reclamation area

Client	Project	Title
Gladstone Pacific Nickel Ltd	GLADSTONE NICKEL PROJECT ENVIRONMENTAL IMPACT STATEMENT	**SOIL TYPES - REFINERY SITE**
URS	Drawn: VH · Approved: CMP · Date: 23-10-06	Figure: **8.1.3a** · Rev: B
	Job No: **4262 5791** · File No: 42625791-g-055b.wor	A4

LEGEND: SOIL MAPPING UNITS – REFINERY SITE

Map Unit	Description
4.1	Shallow gravelly gradational red earth soils – Gravelly Red-Brown Kandosols
4.2	Medium to deep gravelly gradational red earth soils – Ferric Red Kandosols
6.2	Medium to deep silt loamy surface duplex soils – Mottled Sodic Grey-Brown Kurosols
6	Medium to deep silt loamy surface mottled duplex soils with saline clayey subsoils – Mottled Extratidal Hydrosols
7 7	Medium to deep saline silty clays and muds – Supratidal Hydrosols Medium to deep saline silty clays and muds –Intertidal Hydrosols
8	Deep uniform (cracking and non-cracking) clay soils – Sodic Brown Vertosols
9	Medium to deep organic estuarine sands, muds and saline silty clays – Intertidal Hydrosols
D	Disturbed land, reconstituted soil and weathered rock material resulting from existing quarry/borrow pit operations.

Client: Gladstone Pacific Nickel Ltd	Project: GLADSTONE NICKEL PROJECT ENVIRONMENTAL IMPACT STATEMENT	Title: SOIL MAPPING UNITS - REFINERY SITE
URS	Drawn: VH; Approved: CMP; Date: 23-10-06; Job No: 4262 5791; File No: 42625791-g-055b.wor	Figure: 8.1.3b; Rev: B; A4

Attachment B: Terrain Units Identified in URS, 2003.

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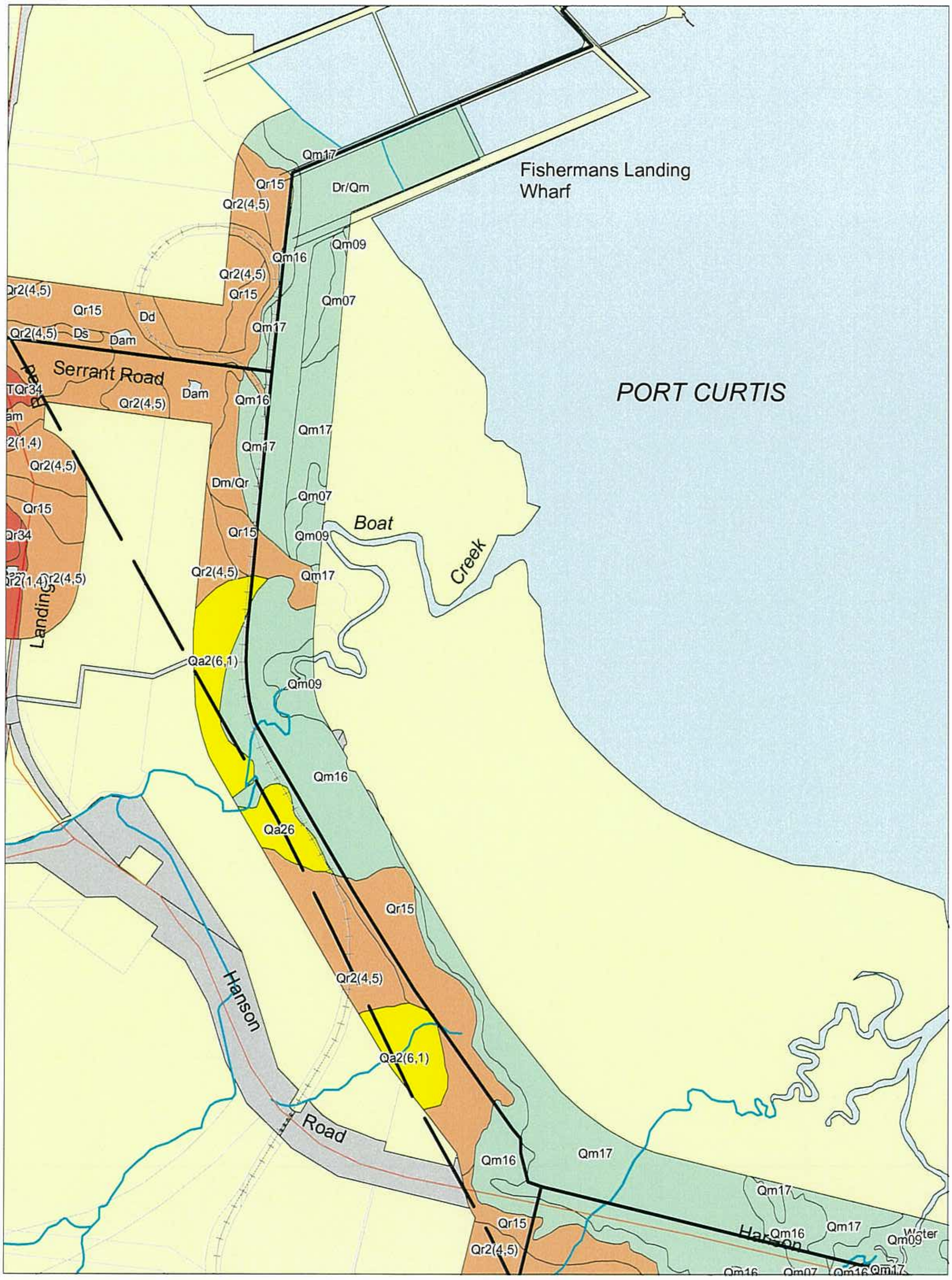

Note: Refer to Table 10.1.1 for a Key to the Identification of Terrain Units.

0 500m 1000m

Scale 1:25000 (A4)

LG Chem Boundary
Proposed Pipeline Routes
Inferred Fault Line
(Department of Mines 1983)
Dw84 Terrain Unit Boundary and Symbol
Sample Location

Client: LG CHEM	Project: ENVIRONMENTAL IMPACT STATEMENT GLADSTONE CA/EDC PLANT		Title: TERRAIN UNITS PLANT SITE TO WHARF CORRIDOR
URS	File: 51520-003-g-116.wor Date : 04/02/03 Checked: AJD Revision: A Approved: CMP	51520-003-559	Figure: 10.1.2

A4